

# EFFECT OF PREPARATIONS

## on the sowing quality of spring barley (*Hordeum vulgare* L.) seeds and grain yield

**Goal.** To study the sowing qualities of spring barley seeds depending on pre-sowing treatment with a biopreparation, as well as fungicidal and insecticidal preparations from different chemical groups and their mixtures. **Methods.** The research was conducted in a nine-field fallow-grain-row crop rotation at the Department of Plant Production and Variety Study of the V.Ya. Yuriev Institute of Plant Production of the NAAS of Ukraine (eastern part of the Forest-Steppe of Ukraine) during 2019–2020. **Results.** The sowing qualities of spring barley seeds were studied depending on pre-sowing treatment with the biopreparation Trichodermin BT, wp (spores of the fungus *Trichoderma viride*, strain T-4, spore titer 5.0 billion CFU/cm<sup>3</sup>) and systemic chemical preparations. Under field conditions, the fungicides Insure Perform FS, SC (triticonazole, 80 g/L + pyraclostrobin, 40 g/L), Lamardor 400 FS, SC (prothioconazole, 250 g/L + tebuconazole, 150 g/L), and the biopreparation Trichodermin BT, wp increased germination by 5–7%. The fungicide Vitavax 200 FF, EC (carboxin, 200 g/L + thiram, 200 g/L) and the insecto-fungicide Vibrance Integral 235 FS, SC (sedaxane, 25 g/L + fludioxonil, 25 g/L + tebuconazole, 10 g/L + thiamethoxam, 175 g/L) reduced field germination by 9% and 5%, respectively. In the control (without seed protection), field germination was 91%. In the variant with the application of organo-mineral fertilizers and pre-sowing seed treatment with the insecto-fungicide Yunta Quattro 373.4 FS, SC (prothioconazole, 33.3 g/L + tebuconazole, 6.7 g/L + imidacloprid, 166.7 g/L + clothianidin, 166.7 g/L), the preserved grain yield was 0.75 t/ha. **Conclusions.** The influence of the biological preparation and seed treatments with different chemical compositions on germination energy, laboratory and field germination, lodging resistance under field conditions, and the yield of spring barley grain was established.

**spring barley; preparation; germination energy; laboratory and field germination; yield**

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Seed treatment with chemical pesticides is carried out for integrated plant protection. It allows you to protect seeds and seedlings from harmful organisms that attack seeds, roots and aboveground parts of plants in the early stages of development. Seed treatment is a guarantee of obtaining healthy, friendly seedlings, uniform distribution of plants over the area and high yields, and is an economically and environmentally very effective measure [1].

Seed treatments help reduce the pathogen load and, thus, improve the condition of plants at the earliest stages of development, but they may have consequences beyond main protective function of fungicides [2].

Practical experience of the effect of preparations of different origins for the seed pretreatment of agricultural crops on the growth and development of plants at the initial stages of ontogenesis is covered in

literary sources. The influence of biologically active substances on seed quality of spring durum wheat has been established [3]. The use of growth regulators, nanofertilizers made it possible to increase the germination energy, laboratory germination capacity, and field germination of winter wheat seeds [4–6]. It has been proven that microfertilizers of carboxylates of natural acids and immunomodulators (stimulators of growth processes) have a positive effect on the seed germination of winter cereal crops. However, a higher concentration of the aqueous solution leads to inhibition of seed germination [7]. Based on the results of research Savchuk & Starodub, a conclusion was made about the stimulating effect of nanocomposites based on saponites, which were used as microfertilizers, on the sowing qualities and growth indicators of corn seeds [8].

Presowing bacterization of winter wheat seeds with preparations containing nitrogen-fixing bacteria and phosphate-mobilizing bacteria thanks to the activity of microorganisms, contributed to an increase in the field germination of seeds [9]. According to the results [10] biological seed treatments can improve maize yields. A positive effect of biological preparations and compositions was established on the laboratory germination of chickpea seeds [11]. Studies on the effect of bioproducts on vegetable seeds have established that, depending on the type of cultivated plants and the doses used, bioproducts can cause enhanced plant growth or phytotoxic effects [12].

Preparations of different origin are used for presowing seed treatment. Dressing of soft winter wheat seeds with biological prepara-



tions and the chemical preparation showed that the biological preparation Trichodermin (spores of the fungus *Trichoderma lignorum*), provides higher germination energy, laboratory and field germination capacity, compared to the chemical preparation Raxyl ultra (active agent tebuconazole, 120 g/l), and the control, without seed treatment [13]. Fungicide and insecticide biological preparations which used to protect sweet corn from pathogens and pests, the germination energy of seed and the germination capacity increased. At the same time, the depressing effect of chemical treaters was clearly observed [14]. According to studies on the control of the phytosanitary state of soybean seeds, variants with the use of biological preparations have more leveled seedling, while the chemical dresser delayed the germination and growth of plants even compared to the control [15].

Studies on the complex use of preparations of different origin showed that presowing treatment of winter wheat seeds with a mixture of preparations (chemical fungicide for seed treatment and plant growth regulator) which was applied against *Fusarium* root rot, contributes to an increase in germination energy and laboratory germination [16].

According to multi-year studies, in the technology of growing spring ear crops (triticale, wheat and barley), presowing seed incrustation with aqueous solutions of growth-stimulating and microelement preparations on a chelate basis in a complex with a dresser provides plants with reliable starting growth at the initial stage of their development, contributes to the improvement of biometric indices and elements of the yield structure [17]. When determining the sowing qualities of spring wheat seeds, depending on the treatment with chemical protectants in combination with the biological microfertilizer, it was found that all preparations had a positive effect. Higher increases in grain yield were noted in variants using insecticidal and fungicidal dressers together with the biological microfertilizer [18]. Application of preparation mixtures of the plant

growth regulator with the microbial preparation and the fungicide for the treatment of soybean seeds provided a positive result: germination rates were higher compared to the control [5]. It was established that the incrustation of sunflower seeds semi-synthetic film-forming plant growth regulator with anti-stress effect with the use of the chemical preparations stimulates germination, which confirms an increase in germination energy and laboratory germination [19].

According to the data Choromoret, preparations for winter wheat seed treatment that have several active agents in their composition have a much better effect on the plant both in the initial and subsequent phases of development and, as a result, on increasing the yield and quality of grain: Kinto Plus, SC (active agents: triticonazole, 33.3 g/l + fludioxonil, 33.3 g/l + xemium, (fluxapiraxad, 33.3 g/l)) — 1.5 l/t; Vibrance Integral 235 FS, TH (active agents: sedaxan, 25 g/l + fludioxonil, 25 g/l + tebuconazole, 10 g/l + thiamethoxam, 175 g/l) — 2.0 l/t; Maxim Forte 050 FS (active agents: azoxystrobin, 10 g/l + tebuconazole, 15 g/l + fludioxonil, 25 g/l) — 2.0 l/t; Junta Quadro 373.4 FS (active agents: prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l) — 2.5 l/t [20].

The results of studies on the influence of multi-component dresser Cantaris FS (active agents: insecticide thiamethoxam, 250 g/l + fungicides prochloraz, 150 g/l + flutriafol, 50 g/l) showed that presowing treatment reduces the laboratory germination of winter wheat seeds [21].

According to laboratory tests incubation of barnyard millet seeds under continuous exposure to fungicides and nystatin inhibited seedling growth. When applied at the 0.5 % concentration continuously or for one hour natamycin suspension inhibited seedling growth and decreased the vigour index. Incubation of seeds with 0.25 % natamycin suspension for one hour was less detrimental to seed physiology [22].

Research on improving the sowing qualities of spring barley seeds showed that soaking spring barley

seeds in an aqueous solution of natural bischophyte revealed stimulation of the growth processes of spring barley already at the early stages of ontogenesis, as well as on its further growth and development, increasing the yield of fodder and nutritional qualities of the grain [23].

According to research results, microfertilizers of carboxylates of natural acids and immunomodulators (stimulators of growth processes) Iodis-concentrate and Iodis-concentrate + Se have a positive effect on the germination of spring barley seeds even at an increased concentration of the aqueous solution [7].

For the cultivation of spring barley in the Western Forest-Steppe of Ukraine the treatment of spring barley seeds of growth regulator VympeL-K (500 g/t) and microfertilizer Oracle seeds (1.0 l/t) contributed to an increase in grain as well as the 1,000-kernel weight [24].

It has been proven that the timely treatment of spring barley seed with biological preparations contributes to the preservation of seed quality [25].

Improving the nutrient regime of the soil with the use of the preparation Polymyxobacterin based on the growth-stimulating bacterium *Paenibacillus polymyxa* contributed to the improvement of plant nutrition and increased the crop yield of spring barley depending on the forecrop [26].

Presowing treatment of spring barley seeds with bacterial preparations, fungal preparations and growth regulators had a positive effect on the field germination of seeds. The use of fungal and bacterial preparations and plant growth regulators contributed to an increase in spring barley grain yield [27].

Under the influence of the presowing incrustation of spring barley seeds with a tank mixture of three components (the fungicide protectant Granivit (carboxyl, 200 g/l + thiram, 200 g/l ingredients), the film-forming agent Mars EL and the complex microfertilizer on a helate base Reacom-C-grain, the components of which are the trace elements necessary for plants in the balanced relationship (Zn, Mn, Cu, Co, Mo), the indices of the struc-

ture of spring barley productivity elements improved significantly [28].

Recent trends in crop production tend to eliminate the use of pesticides. Instead, environmental friendly methods based on biological and physical measures are becoming increasingly popular in plant protection and are an alternative to the standard chemical treatment of winter wheat [29] and spring barley seeds [30–35].

It was established that seed treatments with fungicides had a significant effect on spring barley germination and seed vigor. Seed treatment with fungicidal compositions had various retarding effects on barley germination. The results showed a retarding effect on seedlings from seeds that were treated with triticonazole and prochlorase mixtures. Seedlings from seeds treated with tebuconazole, mixtures with prothioconazole and fludioxonil emerged faster on soils after different forecrops (spring barley, wheat and oilseed rape). After the forecrop of oilseed rape, a slight difference in germination rate between treated and untreated seeds was observed [36].

Treatments of spring barley seeds with different fungicides (thiram, Apron star, Dynamic and propiconazole) and coatings with different formulations (Genius Coat and Disco AG Blue L-237) caused significant differences in germination and flowering days, number of shoots, and yield [37]. The effect of treating spring barley seeds with substances from the succinate-dehydrogenase-inhibitors group was studied [2].

The purpose of our investigations was to study the sowing quality of spring barley seeds depending on the presowing seed treatment with a biological preparation, as well as chemical fungicides, insecticides of different groups, and their mixtures.

**Materials and methods.** The investigations were conducted in a stationary field, fixed nine-course-fallow-grain-row crop rotation of the Department for Plant Production and Cultivar Investigations of the Yuriev Plant Production Institute (eastern part of the Forest-Steppe of Ukraine) during 2019–20.

The soil was a typical, medium-humus, black earth soil on loess with up to 5.4 % humus in the plowing layer.

To protect spring barley from pests and diseases, the seeds before sowing (1–8 days before) were treated with systemic preparations of different chemical groups and biological preparation. Trade names are presented in the ‘List of pesticides and agrochemicals approved for use in Ukraine, 2018’ [38, 39].

**The experiment included the following treatments:**

1. Control, water — 10.0 l/t (without protection).

**Fungicide active agents:**

2. Vitavaks 200 FF (active agents: carboxin, 200 g/l + thiram, 200 g/l), standard — 3.0 l/t;
3. Vintsyt Forte SC (active agents: flutriafol, 37.5 g/l + imazalil, 15 g/l + thiabendazole, 25 g/l) — 1.25 l/t;
4. Inshur Perform SC (active agents: triticonazole, 80 g/l + pyraclostrobin, 40 g/l) — 0.5 l/t;
5. Lamardor 400 FS (active agents: prothioconazole, 250 g/l + tebuconazole, 150 g/l) — 0.25 l/t;
6. Lamardor Pro 180 FS (active agents: prothioconazole, 100 g/l + tebuconazole, 60 g/l + fluopyram, 20 g/l) — 0.6 l/t;
7. Stsenik 80 FS (active agents: fluoxastrobin, 37.5 g/l + prothioconazole, 37.5 g/l + tebuconazole, 5.0 g/l) — 1.6 l/t;
8. Supervin SC (active agents: flutriafol, 30 g/l + thiabendazole, 45 g/l) — 1.8 l/t;
9. Ultrasyll Duo FS (active agents: tebuconazole, 60 g/l + imazalil, 100 g/l) — 0.5 l/t;
10. Maksym Star 025 FS (active agents: fludioxonil, 18.7 g/l + cyproconazole, 6.25 g/l) — 1.5 l/t;
11. Trykholdermin BT, powder (biological preparation). Spores of the fungus *Trichoderma viride*, strain T-4, spore titer 5.0 billion colony-forming unit (CFU)/cm<sup>3</sup> — 5.0 g/t.

**Insecticide active agents:**

12. Kruizer 350 FS (active agent thiamethoxam, 350 g/l) — 0.5 l/t.

**Insecticide-fungicide mixture preparations:**

13. Vaibrans Intehral 235 FS (fungicide active agents: sedaxan, 25 g/l + fludioxonil, 25 g/l + tebuconazole, 10 g/l + insecticide active agent thiamethoxam, 175 g/l) — 2.0 l/t;
14. Yunta Kvadro 373.4 FS (fungicide active agents: prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + insecticide active agents: imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l) — 1.6 l/t.

Analysis of seed material was carried out in accordance with the requirements of State Standard of Ukraine 4138 [40]. Spring barley (‘Inclusive’, brewing variety of use in 2019, and ‘Agrarian’, type of grain direction of use in 2020) was sown in the first ten days of April at the rate of sowing  $4.5 \times 10^6$  viable seeds/ha after soybeans as forecrop. Nutrition was humus, 6.6 t/ha of the crop rotation area (after effect), and N<sub>30</sub>P<sub>30</sub>K<sub>30</sub>. The accounting area was 30 m<sup>2</sup>. Experiments were replicated three times. Agrotechniques were general use.

The research method was laboratory-field. The grain harvest was harvested with a ‘Sampo-130’ combine harvester. Statistical analysis of the results of experimental studies was carried out by dispersion method using Microsoft Office Excel and Statistica 6 licensed computer programs [41].

In general, the spring-summer period (April–July) of 2019 was hot and dry, that is the meteorological conditions were unfavorable for growing spring barley. The average daily air temperature for April, May and June exceeded the norm by 3.2; 2.9 and 5.4 °C, respectively. In July, it was at the level of the climatic norm, 21.4 °C. The amount of precipitation in April exceeded the norm by 26 %; in May it was almost at the level of the climatic norm; in June and July it was significantly lower than the norm by 77 % and 42 %, respectively.

The spring of 2020 was exces-

sively wet and cool. The average daily temperature in April and May was 0.8 °C and 2.6 °C lower than normal, respectively. The amount of precipitation in April was less than the norm by 61.2 %, and in May it exceeded the norm by 126.6 %. In June, the average daily temperature was higher than the norm by 1.7 °C, and the amount of precipitation was lower than the norm by 16.6 %. In July, the average daily temperature and the amount of precipitation exceeded the norm by 1.4 °C and by 59.6 %, respectively. In general, the spring-summer period in 2020 can be characterized as sufficiently moistened and favorable for growing spring barley.

**Results and their discussion.** In 2019, under laboratory conditions, the germination energy of spring barley seeds in the control treatment (without protection) was 97 % (Table 1). A significant decrease in the germination energy was in Vaibrans Intehral 235 FS, Stsenik 80 FS, and Inshur Perform SC treatments, by 12.0; 5.0 and 3.0 %, respectively, compared to the control, according to  $LSD_{05} = 2.5$  %. In other variants, the index ranged between 95–98 %, which was practically at the level of control or equal to control. Laboratory germination in the control was 98 %. In the Stsenik 80 FS, Inshur Perform SC, and Vaibrans Intehral 235 FS treatments the index was 95; 96 and 96 %, respectively, which was significantly lower, compared to the control (at  $LSD_{05} = 2.0$  %). In other variants, the laboratory germination was almost at the level of control or equal to control, ranging between 98–99 %.

In 2020, the preparations in following treatments significantly reduced the germination energy: Vitavaks 200 FF, standard, by 38 %; Vaibrans Intehral 235 FS, by 27 %; Maksym Star 025 FS, by 11 %; Stsenik 80 FS, by 7.0 %; Lamardor Pro 180 FS, by 4.0 %; Yunta Kvadro 373,4 FS, by 4.0 %; bacterial Trykhodermin, by 3.0 %, whereas the control had 98 % ( $LSD_{05} = 3.0$  %). In other treatments with pretreatment the index ranged 96–97 %, which was almost at the control level. The laboratory germination in control was 98 %. A significantly

lower index, compared to the control, was in the variants for seed treatment with Vaibrans Intehral 235 FS, by 11 %; Vitavaks 200 FF, by 5.0 %, and Maksym Star 025 FS, by 5.0 % (at  $LSD_{05} = 3.0$  %). In other variants, the index ranged between 96–98 %, which was practically at the level of control or equal to control.

Averaged over the years (2019–20), the germination energy in control was 97 %. A significant decrease in this index was in Vitavaks 200 FF and Vaibrans Intehral 235 FS treatments, by 19 %, respectively; in Stsenik 80 FS and Maksym Star 025 FS treatments, by 6.0 %, respectively. In other variants, the index was between 95–96 %, which is almost

at the control level. The laboratory germination in the control was 98 %. In the Vaibrans Intehral 235 FS treatment, a significant decrease in the index, by 7.0 %, was noted, compared to the control. In Vitavaks 200 FF, Stsenik 80 FS, and Maksym Star 025 FS treatments the laboratory germination was 95 %, respectively, that was 3 % less, than in the control. In other variants this index ranged between 97–98 %, which was practically at the level of control or equal to control.

According to Stankevych et al. [34], treatment of spring barley seeds of the 'Aspect' and 'Vykyk' varieties with Vitavaks 200 FF at the recommended rate of 2.5 l/t to a decrease in the seed sprouting ener-

### 1. The germination energy and laboratory germination of spring barley seeds depending on presowing seed treatment, %

Active agent	Treatment	The germination energy			Laboratory germination		
		Years					
		2019	2020	average for 2019–20	2019	2020	average for 2019–20
–	Control	97	98	97	98	98	98
Carboxin, 200 g/l + thiram, 200 g/l	Vitavaks 200 FF (standard)	96	60	78	98	93	95
Flutriafol, 37.5 g/l + imazalil, 15 g/l + thiabendazole, 25 g/l	Vintsyt Forte SC	96	96	96	98	98	98
Triticonazole, 80 g/l + pyraclostrobin, 40 g/l	Inshur Perform SC	94	96	95	96	98	97
Prothioconazole, 250 g/l + tebuconazole, 150 g/l	Lamardor 400 FS	96	96	96	99	98	98
Prothioconazole, 100 g/l + tebuconazole, 60 g/l + fluopyram, 20 g/l	Lamardor Pro 180 FS	97	94	95	99	97	98
Fluoxastrobin, 37.5 g/l + prothioconazole, 37.5 g/l + tebuconazole, 5.0 g/l	Stsenik 80 FS	92	91	91	95	96	95
Flutriafol, 30 g/l + thiabendazole, 45 g/l	Supervin SC	96	97	96	98	98	98
Tebuconazole, 60 g/l + imazalil, 100 g/l	Ultrasyl Duo FS	95	96	95	98	98	98
Fludioxonil, 18.7 g/l + cyproconazole, 6.25 g/l	Maksym Star 025 FS	96	87	91	98	93	95
Thiamethoxam, 350 g/l	Kruizer 350 FS	97	96	96	98	98	98
Spores of the fungus <i>Trichoderma viride</i> , strain T-4, spore titer 5.0 billion CFU/cm <sup>2</sup>	Trykhodermin BT, powder	98	95	96	99	96	97
Sedaxan, 25 g/l + fludioxonil, 25 g/l + tebuconazole, 10 g/l + thiamethoxam, 175 g/l	Vaibrans Intehral 235 FS	85	71	78	96	87	91
Prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l	Yunta Kvadro 373.4 FS	98	94	96	99	96	97
LSD <sub>05</sub>		2.5	3.0	–	2.0	3.0	–

gy. According to our study, taking into account the varietal characteristics of barley, the preparations in the Vitavaks 200 FF treatment had a negative effect on laboratory vigor and germination.

In the study of Kosylovych & Holiachuk, the presowing treatment of spring barley seeds with Vaibrans Intehral 235 FS pesticide in the rate 2.0 l/t did not have a negative effect on seed quality, on the contrary, the drug provided 1.7–1.9 % better indicators of germination energy and laboratory germination than the control [42]. According to our data, the preparations in the Vaibrans Intehral 235 FS treatment reduced these indices. Author Olisa found that, seed germination is influenced by several factors among which are the genetic factors and environmental cues of the prevailing growing conditions where the plant grows [43].

According to studies on the vigor parameters of the barley grain, seed treatments based on substances from the succinate-dehydrogenase-inhibitors group (sedaxane and fluxapyroxad) did not cause inhibition of seedling growth, and had the highest vigor index values. Seeds treated with prothioconazole plus tebuconazole showed the lowest germination energy and germination capacity as compared to other analyzed seed treatments [2]. So, our data do not fully agree with the authors' data. The fungicide mixture of prothioconazole, 250 g/l + tebuconazole, 150 g/l in the Lamardor 400 product did not have a significant effect on the vigor and germination of spring barley seeds. At the same time, the fungicide mixture of prothioconazole, 100 g/l + tebuconazole, 60 g/l + fluopyram, 20 g/l in the Lamardor Pro 180 product as well as fungicide-insecticide mixture of prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l in the Yunta Kvadro 373,4 FS product reduced germination energy. Fungicide mixture of fluoxastrobin, 37.5 g/l + prothioconazole, 37.5 g/l + tebuconazole, 5.0 g/l in the Stsenik 80 FS product reduced germination energy and laboratory germination. Fungicide-insecticide mixture

of sedaxan, 25 g/l + fludioxonil, 25 g/l + tebuconazole, 10 g/l + thiamethoxam, 175 g/l in the Vaibrans Intehral 235 FS product also reduced these indices. Fungicide mixture of tebuconazole, 60 g/l + imazalil, 100 g/l in the Ultrasyll Duo FS product insignificantly reduced the germination energy.

In 2019, the germination of plants under field conditions in the control was 87 % (Table 2). In Vitavaks 200 FF, Vaibrans Intehral 235 FS and Kruizer 350 FS treatments, the index was 68; 74 and 78 % respectively, which is significantly less compared to that in the control (at  $LSD_{05} = 5.0$  %). In variants for seed treatment with Inshur Perform SC, Lamardor 400 FS and Trykhodermin, the field germination was 95; 96 and 99 %, respectively, that it significantly exceeded this index in the control. Practically at the level of control or equal to control, the field germination was in Vintsyt Forte FS (92 %); Yunta Kvadro 373.4 FS (91 %); Lamardor Pro 180 FS (83 %); Stsenik 80 FS (84 %), Supervin, SC (85 %); Ultrasyll Duo

FS (87 %), and Maksym Star 025 FS (87 %) treatments.

In 2020, field germination according to the experimental variants was higher than in 2019, which can be explained the more favorable meteorological conditions for the development of spring barley. This index ranged 96–98 % in variants with the use of pesticides, whereas the control was 96 %.

Averaged over two years, the fungicides in Vitavaks 200 FF, insecticide in Kruizer 350 FS, and insecticide-fungicides in Vaibrans Intehral 235 FS treatments significantly reduced field germination, up to 82; 87 and 86 %, respectively, compared to the control, 91 %. In Inshur Perform SC, Lamardor 400 FS and bacterial Trykhodermin treatments, field germination was 96; 96 and 98 %, respectively, which significantly exceeded this index in the control. Practically at the level of control or equal to control, the field germination was in pretreatment with: Lamardor Pro 180 FS (89 %); Stsenik 80 FS (90 %); Supervin SC (91 %); Ultrasyll Duo

## 2. Field germination capacity of spring barley depending on presowing seed treatment, %

Active agent	Treatment	Field germination		
		2019	2020	average
–	Control	87	96	91
Carboxin, 200 g/l + thiram, 200 g/l	Vitavaks 200 FF (standard)	68	96	82
Flutriafol, 37.5 g/l + imazalil, 15 g/l + thiabendazole, 25 g/l	Vintsyt Forte SC	92	96	94
Triticonazole, 80 g/l + pyraclostrobin, 40 g/l	Inshur Perform SC	95	97	96
Prothioconazole, 250 g/l + tebuconazole, 150 g/l	Lamardor 400 FS	96	97	96
Prothioconazole, 100 g/l + tebuconazole, 60 g/l + fluopyram, 20 g/l	Lamardor Pro 180 FS	83	96	89
Fluoxastrobin, 37.5 g/l + prothioconazole, 37.5 g/l + tebuconazole, 5.0 g/l	Stsenik 80 FS	84	97	90
Flutriafol, 30 g/l + thiabendazole, 45 g/l	Supervin SC	85	98	91
Tebuconazole, 60 g/l + imazalil, 100 g/l	Ultrasyll Duo FS	87	97	92
Fludioxonil, 18.7 g/l + cyproconazole, 6.25 g/l	Maksym Star 025 FS	87	97	92
Thiamethoxam, 350 g/l	Kruizer 350 FS	78	96	87
Spores of the fungus <i>Trichoderma viride</i> , strain T-4, spore titer 5.0 billion CFU/cm <sup>3</sup>	Trykhodermin BT, powder	99	97	98
Sedaxan, 25 g/l + fludioxonil, 25 g/l + tebuconazole, 10 g/l + thiamethoxam, 175 g/l	Vaibrans Intehral 235 FS	74	98	86
Prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l	Yunta Kvadro 373.4 FS	91	98	94
LSD <sub>05</sub>		5.0	2.0	–

FS (92 %); Maksym Star (92 %); Vintsyt Forte SC (94 %); Yunta Kvadro 373.4 FS (94 %).

According to literature data, the use of the biological preparation Trykholdermin increased the sowing qualities of soft winter wheat seeds [13], soybeans [15], chickpeas [11]. Our study has confirmed the positive effect of the Trykholdermin treatment on the field germination of spring barley seed.

It was established that treatment of winter wheat seeds with imidacloprid and clothianidin did not affect the germination of winter wheat [44]. According to our study on spring barley, fungicide-insecticide mixture of prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l in Yunta Kvadro 373.4 FS product also did not have a negative effect on the field germination of plants.

In studies of Stankevych et al., after treating the spring barley seeds with Vitavaks 200 FF, field germination for the 'Aspect' and 'Vykyk' varieties was significantly higher, compared to the control [34]. On the contrary, in our study fungicide mixture of carboxin, 200 g/l + thiram, 200 g/l in the Vitavaks 200 FF product had a negative effect on the field germination of spring barley plants. According to Al-Ragam O. et al., the growth and yield of barley is highly influenced by the production environment and genotype [45].

The data Sooväli et al. showed a retarding effect on germination from seeds that were treated with triticonazole and prochlorase mixtures. Seedlings grown from seeds treated with tebuconazole, mixtures with prothioconazole and fludioxonil emerged faster on soils after different forecrops (spring barley, wheat and oilseed rape) [46]. Our data are partially consistent with the authors' data. The fungicide mixture of triticonazole, 80 g/l + pyraclostrobin, 40 g/l in the Inshur Perform SC product, and prothioconazole, 250 g/l + tebuconazole, 150 g/l in the Lamardor 400 FS product significantly exceeded the germination of plants under field conditions. The fungicide mixture of fludioxonil,

18.7 g/l + cyproconazole, 6.25 g/l in the Maksym Star 025 FS product, and fungicide-insecticide mixture of prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l in the Yunta Kvadro 373.4 FS product slightly exceeded this index. The fungicide mixture of prothioconazole, 100 g/l + tebuconazole, 60 g/l + fluopyram, 20 g/l in the Lamardor Pro 180 product did not reduce field germination. Fungicide mixture of fluoxastrobin, 37.5 g/l + prothioconazole, 37.5 g/l + tebuconazole, 5.0 g/l in the Stsenik 80 FS product slightly reduced this index.

During tillering stage in 2019, the largest number of shoots was formed by plants in the Yunta Kvadro 373.4 FS, Kruizer 350 FS, and Stsenik 80 FS treatments, there were 960; 990 and 1,080 shoots per 1 m<sup>2</sup>, res-

pectively; at the level of tendency, according to LSD<sub>05</sub> = 246 shoots (Table 3). The number of shoots per 1 m<sup>2</sup> in other treatments ranged from 780 shoots (Vitavaks 200 FF, standard) to 940 shoots (Inshur Perform SC, Vaibrans Intehral 235 FS), that was practically at the level of control or equal to control (870 shoots).

In 2020, in the control was 890 shoots per 1 m<sup>2</sup>. The largest number of shoots noted in Lamardor 400 FS and Vintsyt Forte SC treatments, there were 1,030 shoots per 1 m<sup>2</sup> and 1,070 shoots/m<sup>2</sup>, respectively (at the level of tendency), and in Lamardor Pro 180 FS treatment (1,100 shoots/m<sup>2</sup>), that was a significant level (at LSD<sub>05</sub> = 203 shoots). In other treatments the number of shoots per 1 m<sup>2</sup> ranged from 780 shoots (Maksym Star 025 FS)

### 3. Total tillering and stem density of spring barley at tillering stage depending on presowing seed treatment

Active agent	Treatment	Total tillering, shoots per 1 plant			The number of shoots per 1 m <sup>2</sup>		
		2019	2020	average	2019	2020	average
-	Control	2.0	1.9	1.9	870	890	880
Carboxin, 200 g/l + thiram, 200 g/l	Vitavaks 200 FF (standard)	2.6	3.1	2.8	780	970	870
Flutriafol, 37.5 g/l + imazalil, 15 g/l + thiabendazole, 25 g/l	Vintsyt Forte SC	1.7	2.0	1.8	810	1.070	940
Triticonazole, 80 g/l + pyraclostrobin, 40 g/l	Inshur Perform SC	2.0	2.1	2.0	940	870	905
Prothioconazole, 250 g/l + tebuconazole, 150 g/l	Lamardor 400 FS	2.0	2.2	2.1	860	1.030	940
Prothioconazole, 100 g/l + tebuconazole, 60 g/l + fluopyram, 20 g/l	Lamardor Pro 180 FS	2.2	2.2	2.2	870	1.100	985
Fluoxastrobin, 37.5 g/l + prothioconazole, 37.5 g/l + tebuconazole, 5.0 g/l	Stsenik 80 FS	2.8	2.1	2.4	1.080	930	1.005
Flutriafol, 30 g/l + thiabendazole, 45 g/l	Supervin SC	1.6	1.8	1.7	790	850	820
Tebuconazole, 60 g/l + imazalil, 100 g/l	Ultrasyl Duo FS	2.1	2.0	2.0	910	980	945
Fludioxonil, 18.7 g/l + cyproconazole, 6.25 g/l	Maksym Star 025 FS	1.7	1.7	1.7	830	780	805
Thiamethoxam, 350 g/l	Kruizer 350 FS	2.4	1.9	2.1	990	960	975
Spores of the fungus <i>Trichoderma viride</i> , strain T-4, spore titer 5.0 billion CFU/cm <sup>3</sup>	Trykholdermin BT, powder	1.9	1.8	1.8	860	950	905
Sedaxan, 25 g/l + fludioxonil, 25 g/l + tebuconazole, 10 g/l + thiamethoxam, 175 g/l	Vaibrans Intehral 235 FS	3.3	2.9	3.1	940	960	950
Prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l	Yunta Kvadro 373.4 FS	2.1	2.2	2.1	960	980	970
LSD <sub>05</sub>		1.0	0.5	-	246	203	-

to 980 shoots (Ultrasyl Duo FS, Yunta Kvadro 373.4 FS), that was practically at the level of control.

Averaged over 2019–20, in the control and Vitavaks 200 FF, standard treatments, was formed 870–880 shoots per 1 m<sup>2</sup>; in the Maksym Star 025 FS and Supervin SC treatments was 805–820 shoots; in the Inshur Perform SC and Trykhodermin treatments was 905 shoots, respectively; in the Vintsyt Forte SC, Lamardor 400 FS, Ultrasyl Duo FS, and Vaibrans Intehral 235 FS was 940–950 shoots; in the Yunta Kvadro 373.4 FS, Kruizer 350 FS and Lamardor Pro 180 FS treatments was 970–985 shoots; in the Stsenik 80 FS treatment was 1,005 shoots. The total tillering of spring barley in the control was 1.9 shoots per 1 plant. In Vitavaks 200 FF and Vaibrans Intehral 235 FS treatments the index was significantly higher, by 47.4 % and 63.2 %, respectively, compared to the control. In the variants for seed treatment with Lamardor Pro 180 FS and Stsenik 80 FS products, the total tillering exceeded the index in the control by 15.8 % and 26.3 %, respectively. In the other treatments, the total tillering ranged 1.7 (Supervin SC, Maksym Star 025 FS) – 2.1 shoots/plant (Lamardor 400 FS, Kruizer 350 FS, Yunta Kvadro 373.4 FS), that was almost at the control level.

Presowing treatment as a protective measure had an impact on the number of shoots. According to our results, in 2019, insecticides thiamethoxam, 350 g/l in the Kruizer 350 FS product; imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l in the Yunta Kvadro 373.4 FS product; thiamethoxam, 175 g/l in the Vaibrans Intehral 235 FS product provided protection of spring barley plants at the stage of 3–5 leaves from flea beetles *Phyllotreta vittula* Redt. at the level of 40.0 %, respectively; in control, without protect and fertilizers, leaf damage was 1.5 points [47].

In 2020, during turbing stage on lower layer of plant leaves the technical effectiveness against *Septoria* infection ensured by fungicides in Ultrasyl Duo FS, Vintsyt Forte SC, Vaibrans Intehral 235 FS, Vitavaks

200 FF, standard, Trykhodermin, and Maksym Star 025 FS products at the level 60.1–64.4 %. In the Inshur Perform SC, Lamardor Pro 180 FS, Stsenik 80 FS, Supervin SC, and Yunta Kvadro 373.4 FS treatments this index ranged 50.3–58.8 %; in Lamardor 400 FS treatment (40.1 %). In control (without protection and fertilizer) *Septoria* infection development was 32.6 %. During turbing stage in reducing development of dark brown spotting (*Bipolaris sorokiniana* Shoem.) on lower layer of plant leaves fungicides provided the technical effectiveness from 45.0–46.3 % (Stsenik 80 FS and Vitavaks 200 FF, standard, products); 50.4–57.7 % (Supervin SC, Ultrasyl Duo FS, Vaibrans Intehral 235 FS, Maksym Star 025 FS, Vintsyt Forte SC products) to

61.0–67.6 % (Lamardor Pro 180 FS, Yunta Kvadro 373.4 FS, Inshur Perform SC, Lamardor 400 FS, and Trykhodermin products). In control (without protection and fertilizer), the disease development was 24.4 %.

At wax ripeness stage, in 2019 the treatments did not differ statistically from each other in terms of the number of spike-bearing stems, by exception in the Ultrasyl Duo FS variant, there were 13.2 % less stems than in control (Table 4). In the control treatment was 680 spike-bearing stems per 1 m<sup>2</sup>. In the Lamardor 400 FS variant, there were 16.2 % more spike-bearing stems than in control.

In 2020 the smallest number stems was in Vitavaks 200 FF, standard treatment (650 spike-bearing stems per 1 m<sup>2</sup>) or the difference

#### 4. Productive tillering and stem density of spring barley at wax ripeness stage depending on presowing seed treatment

Active agent	Treatment	Productive tillering, spike-bearing stems/plant			The number of spike-bearing stems per 1 m <sup>2</sup>		
		2019	2020	average	2019	2020	average
–	Control	1.6	1.8	1.7	680	790	735
Carboxin, 200 g/l + thiram, 200 g/l	Vitavaks 200 FF (standard)	1.7	2.3	2.0	640	650	645
Flutriafol, 37.5 g/l + imazalil, 15 g/l + thiabendazole, 25 g/l	Vintsyt Forte SC	1.5	1.6	1.5	710	820	765
Triticonazole, 80 g/l + pyraclostrobin, 40 g/l	Inshur Perform SC	1.6	1.8	1.7	650	910	780
Prothioconazole, 250 g/l + tebuconazole, 150 g/l	Lamardor 400 FS	1.5	1.9	1.7	790	840	815
Prothioconazole, 100 g/l + tebuconazole, 60 g/l + fluopyram, 20 g/l	Lamardor Pro 180 FS	1.5	2.0	1.7	680	870	775
Fluoxastrobin, 37.5 g/l + prothioconazole, 37.5 g/l + tebuconazole, 5.0 g/l	Stsenik 80 FS	1.7	1.8	1.7	710	760	735
Flutriafol, 30 g/l + thiabendazole, 45 g/l	Supervin SC	1.4	1.5	1.4	730	900	815
Tebuconazole, 60 g/l + imazalil, 100 g/l	Ultrasyl Duo FS	1.5	1.6	1.5	590	790	690
Fludioxonil, 18.7 g/l + cyproconazole, 6.25 g/l	Maksym Star 025 FS	1.4	1.7	1.5	720	750	735
Thiamethoxam, 350 g/l	Kruizer 350 FS	1.8	1.9	1.8	700	790	745
Spores of the fungus <i>Trichoderma viride</i> , strain T-4, spore titer 5.0 billion CFU/cm <sup>3</sup>	Trykhodermin BT, powder	1.6	1.4	1.5	750	820	785
Sedaxan, 25 g/l + fludioxonil, 25 g/l + tebuconazole, 10 g/l + thiamethoxam, 175 g/l	Vaibrans Intehral 235 FS	1.9	2.0	1.9	710	730	720
Prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l	Yunta Kvadro 373.4 FS	1.6	1.7	1.6	710	800	755
LSD <sub>05</sub>		0.8	0.7	–	138	119	–

with the control was 17.7 %. The largest number stems was in Inshur Perform SC treatment (910 spike-bearing stems per 1 m<sup>2</sup>), and in Supervin SC treatment (900 spike-bearing stems per 1 m<sup>2</sup>) or the difference with the control was 15.2 % and 13.9 %, respectively. In the control treatment was 790 spike-bearing stems per 1 m<sup>2</sup>.

Averaged over two years, in the control treatment, the number of spike-bearing stems per 1 m<sup>2</sup> was 735 stems. In Vitavaks 200 FF (standard) treatment the number of spike-bearing stems per 1 m<sup>2</sup> was 645 stems, or 12.2 % less than in the control. In other variants with a chemical pretreatment the number of spike-bearing stems per 1 m<sup>2</sup> ranged between 690 (Ultrasyl Duo FS) — 815 stems (Lamardor 400 FS, and Supervin SC), that was nearly equal to that of the control treatment or equal to the control. In the biological Trykholdermin treatment, the number of spike-bearing stems per 1 m<sup>2</sup> was 785 stems, that was practically at the control level. At the same time the productive tillering capacity in the control treatment was 1.7 spike-bearing stems/plant. In other variants the index ranged 1.4 (Supervin SC) — 2.0 stems/plant (Vitavaks 200 FF, standard), which was practically at the control level or equal to the control.

The authors Liatukas et al. concluded, that the yield increase depended mainly on the improved seed health, thus the main strategy to produce stable yield is seed health [31]. According to our study, under meteorological conditions and phytosanitary state, in 2019 grain yield was 4.51 t/ha in the control with the organic-mineral fertilizer application (Table 5). In Lamardor Pro 180 FS, Kruizer 350 FS, and Yunta Kvadro 373.4 FS treatments grain yield was slightly higher, by 0.11–0.13 t/ha, than in the control. In other variants, the grain yield was from 4.24 t/ha (Vitavaks 200 FF, standard) to 4.54 t/ha (Maksym Star 025 FS), there was within the error of the experiment.

In 2020 the grain yield was 5.89 t/ha (control treatment). In the Yunta Kvadro 373.4 FS treat-

ment this index was 7.27 t/ha, which was 23.4 % higher than the control (significant increase), according to LSD<sub>05</sub> = 0.49 t/ha. In other treatments, the grain yield was from 5.65 t/ha (Lamardor Pro 180 FS) to 6.03 t/ha (Trykholdermin), which was almost at the control level.

Averaged over 2019–20, the grain yield was 5.20 t/ha in the control. In the Yunta Kvadro 373.4 FS treatment the yield was 5.95 t/ha, i.e. a saved yield of 0.75 t/ha was obtained (significant increase). In other treatments, the grain yield ranged 5.02 (Vintsyt Forte SC) — 5.27 t/ha (Kruizer 350 FS), which was within the experimental error.

The authors Smiley et al. established, that fungicide seed treatments are of questionable value for increasing the yields of barley.

Mixtures containing metalaxyl, triadimenol, propiconazole, or several other fungicides reduced the yields of spring barley. But at the same time mixture of carboxin with tolclofos-methyl resulted in spring barley yields 10 % or more above yields from untreated seed [48]. According to our study fungicide mixture of carboxin, 200 g/l + thiram, 200 g/l in the Vitavaks 200 FF product slightly reduced yield capacity.

According to studies of Chornomoretz on pre-sowing treatment for winter wheat seeds, the best results were shown by the preparations containing both fungicide and insecticide substances (Vaibrans Intehral 235 FS, Yunta Kvadro 373.4 FS). The author concluded that preparations that contain several active ingredients have a much bet-

### 5. Grain yield and the 1,000-kernel weight depending on presowing seed treatment

Active agent	Treatment	Grain yield, t/ha			1,000-kernel weight, g		
		2019	2020	average	2019	2020	average
–	Control	4.51	5.89	5.20	47.72	43.08	45.40
Carboxin, 200 g/l + thiram, 200 g/l	Vitavaks 200 FF (standard)	4.24	5.85	5.04	50.58	44.68	47.63
Flutriafol, 37.5 g/l + imazalil, 15 g/l + thiabendazole, 25 g/l	Vintsyt Forte SC	4.34	5.70	5.02	49.23	43.67	46.45
Triticonazole, 80 g/l + pyraclostrobin, 40 g/l	Inshur Perform SC	4.33	5.97	5.15	49.67	43.80	46.73
Prothioconazole, 250 g/l + tebuconazole, 150 g/l	Lamardor 400 FS	4.25	5.83	5.04	49.48	43.82	46.65
Prothioconazole, 100g/l + tebuconazole, 60 g/l + fluopyram, 20 g/l	Lamardor Pro 180 FS	4.62	5.65	5.13	49.58	44.10	46.84
Fluoxastrobin, 37.5 g/l + prothioconazole, 37.5 g/l + tebuconazole, 5.0 g/l	Stsenik 80 FS	4.31	5.89	5.10	49.00	44.30	46.65
Flutriafol, 30 g/l + thiabendazole, 45 g/l	Supervin SC	4.36	6.01	5.18	49.50	43.28	46.39
Tebuconazole, 60 g/l + imazalil, 100 g/l	Ultrasyl Duo FS	4.39	5.74	5.06	49.50	44.22	46.86
Fludioxonil, 18.7 g/l + cyproconazole, 6.25 g/l	Maksym Star 025 FS	4.54	5.96	5.25	50.28	43.93	47.10
Thiamethoxam, 350 g/l	Kruizer 350 FS	4.62	5.92	5.27	49.40	43.28	46.34
Spores of the fungus <i>Trichoderma viride</i> , strain T-4, spore titer 5.0 billion CFU/cm <sup>2</sup>	Trykholdermin BT	4.34	6.03	5.18	48.38	43.63	46.00
Sedaxan, 25 g/l + fludioxonil, 25 g/l + tebuconazole, 10 g/l + thiamethoxam, 175 g/l	Vaibrans Intehral 235 FS	4.46	5.91	5.18	51.90	44.77	48.33
Prothioconazole, 33.3 g/l + tebuconazole, 6.7 g/l + imidacloprid, 166.7 g/l + clothianidin, 166.7 g/l	Yunta Kvadro 373.4 FS	4.64	7.27	5.95	49.62	44.22	46.92
LSD <sub>05</sub>		0.33	0.49	–	0.96	0.52	–

ter effect on the plant both in the initial and subsequent stages of development and, as a result, increase the yield and quality of grain [20]. According to our data, significantly higher yields of spring barley were obtained from seeds in the Yunta Kvadro 373.4 FS treatment.

On average over two years, the 1,000-kernel weight in Trykholdermin treatment exceeded the control value by 0.60 g; in variants with pre-sowing seed treatment with chemicals, this index exceeded the control value by 0.94 (Kruizer 350 FS) — 2.93 g (Vaibrans Intehral 235 FS); in the control was 45.40 g.

An average positive correlation have been established between the number of productive stems and yield ( $r = 0.4$ ). Correlation analysis revealed a strong negative relationship between the 1,000-kernel weight and yield ( $r = -0.9$ ).

## CONCLUSIONS

Under laboratory conditions, the fungicides mixture of carboxin, 200 g/l plus thiram, 200 g/l (Vitavaks 200 FF product, standard); fluoxastrobin, 37.5 g/l plus prothioconazole, 37.5 g/l plus tebuconazole, 5.0 g/l (Stsenik 80 FS product), and fludioxonil, 18.7 g/l plus cyproconazole, 6.25 g/l (Maksym Star 025 FS product) significantly reduced the germination energy of spring barley seed compared to that of the control. The fungicide mixtures of sedaxan, 25 g/l plus fludioxonil, 25 g/l plus tebuconazole, 10 g/l plus the insecticide thiamethoxam, 175 g/l (Vaibrans Intehral 235 FS product) significantly reduced both germination energy and laboratory germination of spring barley seed.

Under field conditions (2019–20), fungicides mixture of tritico-nazole, 80 g/l plus pyraclostrobin, 40 g/l (Inshur Perform SC product); prothioconazole, 250 g/l plus tebuconazole, 150 g/l (Lamardor 400 FS product); spores of the fungus *Trichoderma viride* (biological Trykholdermin BT, powder, product) significantly increased field germination. The phytotoxic effect was detected in Vitavaks 200 FF, standard, and Vaibrans Intehral 235 FS treatments.

The grain yield of spring barley in the control (without treatment) in organo-mineral block (humus, 6.6 t/ha of the crop rotation area, after effect, with  $N_{30}P_{30}K_{30}$ ) was 5.20 t/ha. Fungicides prothioconazole, 33.3 g/l plus tebuconazole, 6.7 g/l plus insecticides imidacloprid, 166.7 g/l plus clothianidin, 166.7 g/l (Yunta Kvadro 373.4 FS product) provided the saved yield of 0.75 t/ha or 14.4 % (at a significant level).

The largest of 1,000-kernel weight was in Viabrans Intehral treatment 235 FS compared with that of the control.

The studies deserve for the future. The development of preparation mixtures and their standards requires the study of both protective measures against plant diseases and harmful insects, and phytotoxicity in relation to the plants themselves, which will help increase grain yield.

Fundamental research was carried out in accordance with the theme «Develop theoretical foundations and ensure reliable protection of field crops from harmful organisms in the conditions of the Eastern Forest-Steppe of Ukraine» (St. R. № 0116U001040).

**Conflict of interest:** the authors declare the absence of a conflict of interest.

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**Дія препаратів на посівні  
якості насіння ячменю ярого  
(*Hordeum vulgare* L.)  
та урожайність зерна**

**Мета.** Вивчити посівні якості насіння ячменю ярого залежно від передпосівної обробки насіння біо-

препаратом, а також фунгіцидними, інсектицидними препаратами різних хімічних груп та їхніх сумішей. **Методи.** Дослідження проведено у дев'ятипільній паро-зерно-просапній сівозміні відділу рослинництва та сортовивчення Інституту рослинництва ім. В.Я. Юр'єва НААН (східна частина Лісостепу України) протягом 2019—2020 рр. **Результати.** Вивчено посівні якості ячменю ярого залежно від передпосівної обробки насіння біопрепаратом Триходермін БТ, п. (спори гриба *Trichoderma viride*, штам Т-4, титр спор 5,0 млрд КУО/см<sup>3</sup>) і хімічними препаратами системної дії. У польових умовах фунгіциди Іншур Перформ FS, т.к.с. (третіконазол, 80 г/л + піраклостробін, 40 г/л); Ламардор 400 FS, т.к.с. (протіконазол, 250 г/л + тебуконазол, 150 г/л) та біопрепарат Триходермін БТ, п. підвищували показник схожості на 5—7%. Фунгіцид Вітавакс 200 ФФ, в.с.к. еталон (карбоксин, 200 г/л + тирам, 200 г/л) та інсекто-фунгіцид Вайбранс Інтеграл 235 FS, ТН (седаксан, 25 г/л + флудиксоніл, 25 г/л + тебуконазол, 10 г/л

+ інсектицид тіаметоксам, 175 г/л) знижували польову схожість на 9 та 5%, відповідно. У контролі (без захисту) польова схожість становила 91%. У варіанті застосування органіко-мінеральних добрив та передпосівної обробки насіння інсекто-фунгіцидом Юнта Квадро 373,4 FS, т.к.с. (протіконазол, 33,3 г/л + тебуконазол, 6,7 г/л, + імідаклоприд, 166,7 г/л + клотіанідин, 166,7 г/л) збережений урожай зерна становив 0,75 т/га. **Висновки.** Встановлено дію біологічного препарату та різних за хімічним складом протруйників насіння на енергію проростання, лабораторну схожість, стеблостій у польових умовах та урожайність зерна ячменю ярого.

**ячмінь ярий; препарат; енергія проростання; лабораторна та польова схожість; урожайність**

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