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EFFICIENCY OF THE APPLICATION OF FUNGICIDES IN THE PROTECTION OF WINTER WHEAT FROM DOMINANT SPOTS

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Leaf and stem infections of winter wheat plants result in a decrease in the surface area of the leaves and intensity of photosynthesis during spike development and grain filling, which negatively affects productivity of the crop. It requires high-quality monitoring of phytosanitary conditions of agrocenoses and implementation of appropriate protection measures. In case of intensive development of diseases, the use of fungicides is warranted. Their assortment is continuously updated. Thus, the aim of the research was to establish the optimal terms of application of fungicides to protect winter wheat from dominant spots. Research was carried out during 2020–2021 in the Poltava region according to generally accepted methods of field and laboratory research on the effectiveness of fungicides. It was established that the dominant leaf and stem infections in winter wheat agrocenoses were septoriosis and pyrenophorosis. During the research, the effectiveness of one and two applications of the following fungicides against a complex of diseases of leaves and spikes was studied: Esculap 250, k.e. (propiconazole, 250 g/l) – triazole derivatives; Impact K, k.s. (flutriafol, 117.5 g/l + carbendazim, 250 g/l) – triazole derivatives + benzimidazoles; Elatus Ria 358 ES, k.e. (solatenol, 83.33 g/l + propiconazole, 208.33 g/l + cyproconazole, 66.67 g/l). The use of modern fungicides provided effective protection of the photosynthetic surface of winter wheat plants from damage by septoria and pyrenophorous spots. In addition, the studied compounds showed a pronounced physiological effect due to photosynthesis prolongation (greening effect), which positively affected the grain productivity of plants and the technological quality of grain. The highest technical and economic efficiency was registered in groups with one and two applications of fungicide Elatus Ria 358 EC, k.e. Upon analysis of obtained data, one can assume that efficiency of one application of fungicides during the period of emergence into the tube exhibits protective antifungal activity of the compound while two applications exhibit a therapeutic effect.

Keywords: *winter wheat, septoriosis, pyrenophorosis, efficiency of fungicides, intensity of disease development, active substances of fungicides.*

ЕФЕКТИВНІСТЬ ЗАСТОСУВАННЯ ФУНГІЦИДІВ У ЗАХИСТІ ПШЕНИЦІ ОЗИМОЇ ВІД ДОМІНУЮЧИХ ПЛЯМИСТОСТЕЙ

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Наслідком ураження рослин пшениці озимої збудниками листостеблових інфекцій є зменшення площі поверхні листків і зниження інтенсивності фотосинтезу в період колосіння-наливу зерна, що негативно позначається на продуктивності культури. Це вимагає якісного моніторингу фітосанітарного стану агроценозів і реалізації відповідних заходів захисту. За інтенсивного розвитку хвороб виникає потреба у використанні фунгіцидів, асортимент яких постійно оновлюється. Саме тому метою досліджень стало встановлення оптимальних строків застосування фунгіцидів для захисту пшениці озимої від домінуючих плямистостей. Дослідження виконувались протягом 2020-2021 рр. у Полтавському регіоні за загальноприйнятими методиками польових і лабораторних досліджень по вивченню ефективності фунгіцидів. Встановлено, що домінуючими листостебловими інфекціями в агроценозах пшениці озимої в роки досліджень були септоріоз і піренофороз. Під час проведення досліджень вивчали ефективність фунгіцидів: Ескулап 250, к.е. (пропіконазол, 250 г/л) – похідні триазолів; Імпакт К, к.с. (флутріафол, 117,5 г/л + карбендазим, 250 г/л) – похідні триазолів + бензимідазоли; Елатус Ріа 358 ЕС, к.е. (солатенол, 83,33 г/л + пропіконазол, 208,33 г/л + ципроконазол, 66,67 г/л) – похідні карбоксамідів і триазолів проти комплексу хвороб листя та колосу за одно- та дворазового застосування. Використання сучасних фунгіцидів забезпечило ефективний захист фотосинтезуючої поверхні рослин пшениці озимої від ураження септоріозною та піренофорозною плямистостями. Крім того досліджуванні препарати виявили виражений фізіологічний ефект за рахунок пролонгації фотосинтезу (ефект озеленення), що позитивно вплинуло на зернову продуктивність рослин і технологічні якості зерна. Найвищу технічну та господарську ефективність зареєстровано у варіантах із застосуванням фунгіциду Елатус Ріа 358 ЕС, к.е. за однократного і двократного використання. Аналізуючи увесь спектр отриманих даних, можна припустити, що ефективність однократного використання фунгіцидів у період виходу в трубку в більшій мірі виявляє захисну антифунгальну активність препаратів, а за двократного їх внесення підключається також лікувальна дія.

Ключові слова: *пшениця озима, септоріоз, піренофороз, ефективність фунгіцидів, інтенсивність розвитку хвороб, діючі речовини фунгіцидів.*

Introduction

The current situation on the world grain market has shown that Ukraine is an important component of the world's food security. Therefore, problems related to ensuring the full realization of the productivity potential of grain crops need more attention. Infectious diseases are one of the reasons that negatively affect grain productivity. Pathogenic organisms affect wheat plants throughout the growing season and remain a factor of negative impact even after harvest [1, 11, 12, 15, 21, 23]. One of the consequences of the modern transformation of climatic conditions is the mobility of pathogenic complexes [7, 8, 10, 19]. This especially applies to pathogens, the functioning of which leads to a decrease in the surface area of leaves and intensity of photosynthesis during spike development and grain filling [2, 15, 21]. This problem requires constant monitoring of the variety of fungicides and the study of new possibilities of chemical protection of plants against diseases, taking into account the general phytosanitary condition of crops and the structure of the pathogenic complex [8]. The variety of fungicides recommended for use on grain crops in Ukraine is quite wide and includes active substances from various chemical groups with contact and systemic effects on pathogenic structures [18]. At the same time, fungicides from the same chemical group differ in a number of important parameters, such as the rate of use, species specialization in relation to pathogens, mobility in the plant body, the principle of biochemical action on pathogenic organisms, and the risk of resistance, etc. [14].

Currently, the world market of fungicides offers a wide range of preparations for use on grain crops, the vast majority of which are characterized by systemic and contact-systemic activity. However, a small number of modern fungicides exhibit contact mechanism of action [16, 18]. Based on peculiarities of mobility of active substances, the nature of interaction of fungicides with pathogens is manifested as protective or therapeutic. Active substances with systemic or local-systemic mode of mobility and a one-site type of biochemical effect on pathogenic organisms exhibit therapeutic effects and pose a risk of development resistant populations of pathogens [14].

The specified features of modern active substances of fungicides provide farmers with a wide selection of compounds for use in each specific phytosanitary situation. On the other hand, it requires a deep understaning of active substances and determination of optimal terms and frequency of treating crops with them. Currently, the application of fungicides during flowering and grain filling is considered the most effective against leaf diseases [3, 4, 20]. Control of pyrenophorosis and septoriosis in cereal crops includes one to three fungicidal treatments, depending on the spread and intensity of the infection in the agrocenosis; the optimal period for the first treatment lasts from the phase of tillering to spike development [5, 9].

Purpose and goals. The purpose of the research was to establish the optimal terms of fungicide application to protect winter wheat against dominant spots.

Materials and Methods of research

The research was conducted from 2020 to 2021 on a farm in the Poltava region. Winter wheat of the Blagodarka Odeska variety was chosen as the research object. Traditional methods of field and laboratory research were used to study the effeciency of fungicides together with generally accepted methods and determination of the main indicators of the phytosanitary state of the agrocenosis (intensity/degree of disease development) [13]. Experimental plots with a registered area of 20 m^2 were allocated in production sowing; the experiment was repeated three times. Dividend Star 036 FS t.k.s., 1.0 l/t was used for pre-sowing treatment of winter wheat seeds; the herbicide Granstar Gold v.g., 25 g/ha was used to control weeds in the tillering phase . The study groups had either one fungicide application (emergence into the tube) or two applications (emergence into the tube and flowering).

The research examined technical efficiency of fungicides against a complex of diseases of leaves and spikes with one or two applications: Esculap 250, k.e. (propiconazole, 250 g/l) – triazole derivatives; Impact K, k.s. (flutriafol, 117.5 g/l + carbendazim, 250 g/l) – triazole derivatives + benzimidazoles; Elatus Ria 358 ES, k.e. (solatenol, 83.33 g/l + propiconazole, 208.33 g/l + cyproconazole, 66.67 g/l) – derivatives of carboxamides and triazoles [17].

Research Results and Discussion

According to the results of phytosanitary monitoring of agrocenoses of winter wheat of the Blagodarka Odeska variety in 2020–2021, the dominant types of leaf and stem infections were septoriosis and pyrenophorosis, the intensity of which in the phase of milky grain maturity was 26.5–33.5 % and 8.4–10.6 %, respectively. This level of disease manifestation, in our opinion, made it possible to conduct an objective evaluation of the efficiecy of fungicides (Tables 1 and 2).

Table 1 shows experimental data for 2020.

1. Development of Diseases of Winter Wheat with the Use of Fungicides (Blagodarka Odeska Variety, 2020)

Groups	Rate of use, l/h	The intensity of disease development in the phase of milk maturity, %		Technical efficiency, %	
		septoriosis	pyrenophorosis	septoriosis	pyrenophorosis
Control		26.5	8.4	–	–
Esculap 250, k.e.*	0.5	9.9	3.2	62.6	61.9
Esculap 250, k.e.**	0.5	5.9	2,2	77.7	73.2
Impact K 367.5, k.s.*	1.0	9.4	2.8	64.2	65.5
Impact K 367.5, k.s.**	1.0	5.5	1.9	79.4	77.9
Elatus Ria 358 ES, k.e.*	0.5	5.4	2.5	79.5	70.2
Elatus Ria 358 ES, k.e.**	0.5	3.7	1.7	85.9	80.1
NIR_{095}		8.3	2.4	–	–

Note: *one application during the period of emergence into the tube; **two applications during the period of emergence into the tube and flowering.

The data presented in Table 1, shows that all studied groups that used fungicides had a significant decrease in the development of infection, both septoriosis and pyrenophorosis in 2020.

In control group, the level of winter wheat plants damage with septoriosis was 26.5 %. One application of Esculap 250, k.e. reduced it to 9.9 %, providing a technical efficiency of 62.6 %. Two applications of this

fungicide increased the level of technical efficiency to 77.7 % while septoriosis intensity was reduced to 5.9 %. These results were the worst among the studied drugs.

The highest antifungal activity under these conditions was demonstrated by the fungicide Elatus Ria 358 EC, k.e., which provided a reduction in the development of septoriosis to 5.4 % with one application and 3.7% with two applications. The level of technical efficiency was 79.5 and 85.9 % respectively.

The drug Impact K 367.5, k.s. showed intermediate results with fairly high efficiency. The development of septoriosis was limited to 9.4 % with one application while technical efficiency was 64.2 %. Whereas, two applications of this fungicide resulted in 79.4 % technical efficiency and 5.5 % damage of the plant leaf surface.

In 2020, the manifestation of pyrenophorosis in the control group of winter wheat plants of the Blagodarka Odeska variety was noted at the level of 8.4 % during the period of milk ripeness. One application of fungicides in the phase of emergence into the tube reduced the level of disease development by 2.6–3.5 times, and the affected area of the leaves was reduced by 3.8-4.9 times with two applications. The best results were also shown with Elatus Ria 358 ES, k.e., the technical efficiency of which reached 70.2 % with one application. The second application provided a level of technical efficiency of 80.1 %.

Spraying plants with the drug Impact K 367.5, k.s. showed somewhat worse results with technical efficiency of 65.5 % with one application and 77.9 % with two applications, respectively.

Suppression of the development of pyrenophorosis on winter wheat plants with Esculap 250, k.e. was the least effective. Thus, one application of this fungicide showed 61.5 % efficiency while two applications resulted in 73.2 %.

The hydrothermal conditions of 2021 provoked more intense development of pyrenophorosis in the period of milky grain ripeness – 10.6 %; the intensity of damage to plants by septoriosis under these conditions was 33.5 % (Table 2). The data presented in Table 2 shows that the change in the intensity of disease manifestation to some extent affected the level of effectiveness of fungicides, but the general trend of their antifungal activity remained unchanged.

The drug Elatus Ria 358 EC, k.e. showed the highest fungicidal activity against the infectious structures of pathogens of both types of leaf and stem infections. One application decreased the development of septoriosis to 6.2 % and pyrenophorosis to 3.2 %, providing technical efficiency of 81.4 % and 69.8 %. Two applications increased efficiency level to 87.8 % and 82 %, respectively.

2. Development of the Diseases of Winter Wheat with theUuse of Fungicides (Blagodarka Odeska Variety, 2021)

Groups	Rate of use, l/h	The intensity of disease development in the phaseof milk maturity, %		Technical efficiency, %	
		septoriosis	pyrenophorosis	septoriosis	pyrenophorosis
Control		33.5	10.6	–	–
Esculap 250, k.e.*	0.5	10.3	5.5	69.2	48.1
Esculap 250, k.e.**	0.5	6.7	3.8	80.0	64.1
Impact K 367.5, k.s.*	1.0	8.9	3.7	73.4	65.1
Impact K 367.5, k.s.**	1.0	5.8	2.3	82.7	78.3
Elatus Ria 358 ES, k.e.*	0.5	6.2	3.2	81.4	69.8
Elatus Ria 358 ES, k.e.**	0.5	4.1	1.9	87.8	82.0
NIR_{05}		8.3	2.4	–	–

Note: *one application during the period of emergence into the tube; **two applications during the period of emergence into the tube and flowering.

Fungicide Esculap 250, k.e. appeared to be less effective, especially against yellow spot infection. Thus, one application showed the ability of this drug to protect wheat plants against pyrenophorosis only at the level of 48.1 %, and two applications increased the technical efficiency to 64.1 %. Prevention of the development of septoriosis was more successful with a technical efficiency of 69.2 % with one application and 80.0% with two applications, respectively.

In 2021, two applications of Impact K 367.5, k.s. were more effective (78.3 %) than one application (65.1 %) against infectious structures of pyrenophorosis. With regard to controlling the development of septoriosis, the drug was also quite predictable and provided an efficiency level of 73.4 % and 82.7 %, respectively depending on the number of fungicide applications.

The research showed that the use of modern fungicides provided effective protection of the photosynthetic surface of winter wheat from damage by septoriosis and pyrenophorosis spots. In addition,

the studied drugs showed a pronounced physiological effect of photosynthesis prolongation (greening effect), which positively affected the grain productivity of plants and the technological qualities of grain.

Thus, in 2020, the use of drug Esculap 250, k.e. resulted in an increase in wheat production yield by 0.22–0.44 t/ha with one and two applications, respectively. It is worth noting that the increase in the mass of 1000 grains in these groups reached 0.2 g and 0.3 g, respectively, compared to control group. Fungicide Impact K 367.5 hp. provided an increase in the weight of 1000 grains by 0.8–0.1 g, which contributed to an increase in plant productivity by 0.37–0.53 t/ha. High technical efficiency of Elatus Ria 358 ES, k.e. against septoriosis and pyrenophorosis of winter wheat resulted in maximum indicators of plant productivity for the given conditions. One and two applications of this fungicide resulted in yield increase of 0.48–0.75 t/ha, respectively. The weight of 1000 grains was increased by 1.3–1.4 g (Figure 1).

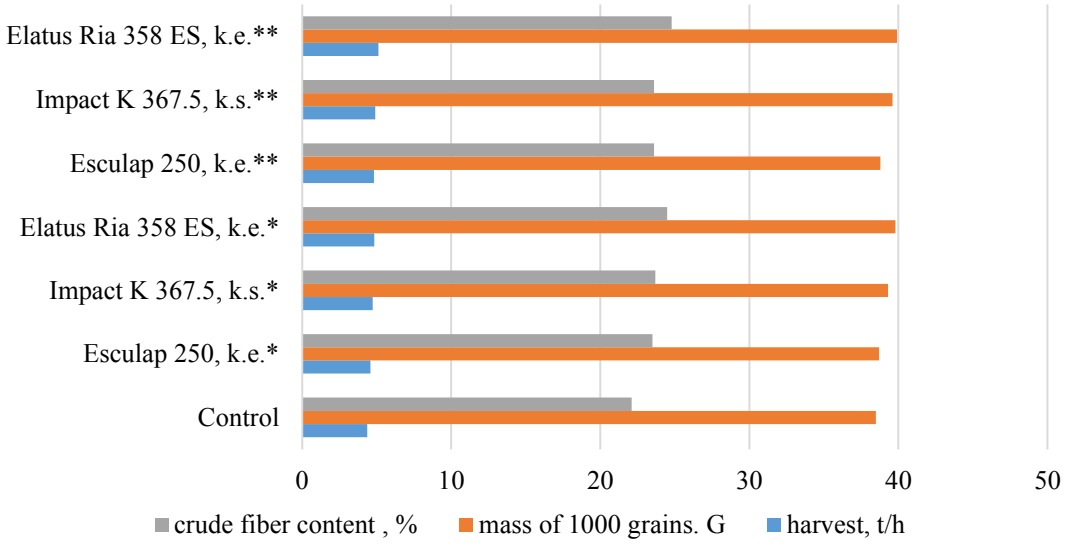

Figure 1. Yield and Grain Quality Indicators of Winter Wheat Blagodarka Odeska variety in 2020

A similar trend was observed in 2021 (Figure 2). The best results were recorded with the use of Elatus Ria 358 EC, k.e. The yield in these groups was 5.89 t/ha and 5.96 t/ha, which is 0.74–0.81 t/ha higher compared to the control group. The mass of 1000 grains increased by 1.0–2.8 g.

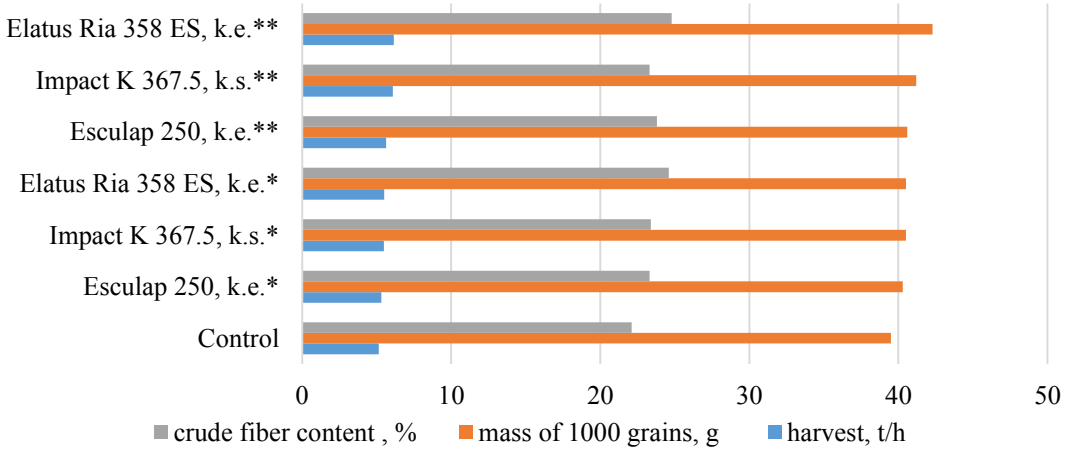

Figure 2. Yield and Grain Quality Indicators of Winter Wheat Blagodarka Odeska Variety in 2021

The use of the discussed fungicides on winter wheat plants of the Blagodarka Odeska variety resulted in the improvement in the quality of grain in terms of gluten content from the third to the second class [6, 22].

However, this tendency was not significant and unstable between one and two administations of the fungicides. In our opinion, this can be explained by ensuring a balanced mineral nutrition during the preparation of the soil for sowing winter wheat.

Conclusions

In 2020–2021, the dominant leaf and steam infections in winter wheat agrocenosis were septoriosis and pyrenophorosis. The tested fungicides showed high technical efficiency regarding the infectious structures of pathogens of these diseases. The highest technical and economic efficiency was found in groups with one and two applications of Elatus Ria 358 EC, k.e.

Upon analysis of obtained data, one may assume that the effectiveness of one application of fungicides during the period of emergence into the tube exhibits protective anti-fungal activity, whereas two applications of fungicides exhibit therapeutic effect.

In further scientific work, we plan to investigate the effectiveness of biological fungicides and growth stimulants in protecting winter wheat against diseases.

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