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Harmfulness of fungal diseases of winter wheat in the conditions of Western Forest Steppe

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Goal. To study the development of fungal diseases of winter wheat and to determine their harmfulness. **Methods.** The study was conducted using field (assessment of disease development on winter wheat varieties), laboratory (identification of pathogens of winter wheat), analytical and mathematical methods. **Results.** It was found that the most common diseases of winter wheat during 2017 – 2019 were leaf septoria and dark brown spots. The harmfulness of dark brown spots and leaf septoria on the varieties Vodohray Bilotserkivskyi, Mudrist Odeska on artificial infectious backgrounds was studied. It should be noted that the fungal attack of winter wheat affected the economic indicators. The coefficient of harmfulness (on an artificial infectious background) on susceptible to dark brown spot varieties, depending on the level of disease development was 0.26 – 0.49%, leaf septoria — 0.14 – 0.66%. **Conclusions.** Over the years of research, the development of dark brown spots (on the natural background), depending on the variety was 1.5 – 28.5%, leaf septoria — 1.5 – 32.5%. Dark brown spot affected the least variety of Mudrist Odeska, leaf septoria — variety Oberig Myronivskyi. It should be noted that the fungal attack of winter wheat by leaf septoria and dark brown spot affects the length of the ear, the number of grains in it, the weight of grain in the ear, the weight of 1000 grains. Thus, with increasing lesions of leaf septoria of the variety Vodogray Bilotserkivskyi grain weight from the ear decreased, in particular at the intensity of the disease 50%, it decreased by 0.27 g, at 75% — 0.57 g, 100% — by 0.81 g The disease affected significantly the weight of 1000 grains, which decreased with increasing degree of damage and with the development of the disease 25% was 2.7 g less, while in unaffected plants it was 45.7 g. With a lesion intensity of 75%, this figure decreased by 14.6 g. With the fungal attack by the dark brown spot of the variety Mudrist Odeska the mass of 1000 grains decreased and at the intensity of the disease 50% was 6 g less, while in unaffected plants it was 47 g, at the intensity of the defeat 75% this figure decreased by 10 g. The coefficient was determined of the harmfulness of leaf septoria on the artificial infectious background (0.14 – 0.66%) and dark brown spot (1.5 – 28.5%) on susceptible to diseases varieties.

Key words: *dark brown spot, leaf septoria, variety, economic indicators of winter wheat.*
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The problem of development of grain production, in particular wheat, and intensification of the industry was studied by S. S. Bakay, V. I. Boyko, M. G. Lobas, P. M. Rybalkin, V. S. Rubka, V. F. Sayko, A. I. Stepanov, M. I. Shchur and others [1].

It is established that wheat yield has increased by 50-70% over the last 50 years due to the use of high-yielding varieties in production. However, genetic and selection improvement and creation of a variety with further increase of productivity potential, resistance to adverse effects of abiotic and biotic environmental factors is too difficult a task [2–4]. Reducing the level of logistics of domestic grain production, violation of wheat cultivation technologies and abrupt changes in weather conditions require the creation of intensive varieties with the most defined adaptive properties, high quality, frost, winter and drought resistance, resistance to pathogens, grain shedding, endurance to various deviations in cultivation technology, etc. [3–5].

Researchers [5–9] believe that special experiments with new varieties should be conducted in each region to determine the biological, morphological and economically valuable features. This applies to varieties of domestic and foreign selections,which are actively involved in cultivation. On of particular note are the varieties of foreign selection, mainly German and Canadian, which in recent years have been widely promoted and introduced in our fields, in particular in the area of the Western Forest-Steppe.

According to studies by domestic scientists [10–12] and others. in the last decade, powdery mildew, leaf spot and septoria occupy one of the first places in terms of harmfulness to the grain economy of Ukraine. The causative agents of these diseases can affect all organs of the plant during the growing season and lead to a decrease in the assimilation surface, premature drying of leaves, lagging behind in growth and massive crop failure.

Dark brown spot – the causative agent of *Drechslera tritici – repentis* Ito causes the most damage in years with warm and rainy summers in the Western Forest-Steppe. Pathogens are spread by conidia during the growing season. The leaves first appear yellow-brown spots, slightly elongated along the leaf. In the

center they are lighter with a dark brown border. Spots are found on the internodes, which leads to lodging of plants. In wet weather, the affected leaves form a brown or dark gray plaque, the stem is covered with a black plaque, consisting of conidial sporulation of the fungus. Infection is promoted by high humidity of 95–97% and temperature of 22–26 °C [11–13].

Long-term wet and warm windy weather during the growing season causes crop damage; precipitation; late sowing dates, application of only nitrogen fertilizers. The disease leads to a decrease in the assimilation surface area, premature drying of leaves and plants, reduced grain yield and deterioration of its sowing and technological qualities. With the intensive development of the disease, crop losses can be 30–40%.

Septoria. Wheat is parasitized by more than 10 species of pathogens, among which the most common and harmful are *Septoria tritici Rob. Desm* and *Septoria graminum* (mainly leaves) and *Stagonospora nodorum Berk* (affects all aboveground organs, including the ear). Appears on leaves, leaf sheaths, stems and ears. On the stairs, the first symptoms appear in the form of small chlorotic or yellowish spots. Later the spots increase, become light brown with or without a dark border. In the center of the spots are formed dark brown, shiny pycnidia in the form of black dots. On the stems there are vague spots without a border. On spikelets scales septoria has the appearance of vague dark brown or dark purple spots. In the affected areas, the tissue lightens, and picnics are formed on it.

Leaf septoria in Ukraine periodically attracts the attention of grain producers due to high harmfulness in areas with high humidity and in years with high rainfall. The causative agents of this disease develop in the temperature range (4–35 °C). Favorable for the development of the disease are air temperature of 15–25 °C, frequent precipitation and high relative humidity (over 80%) [10, 12, 13].

Leaf septoria is manifested in winter wheat crops almost every year. Losses are especially significant on unstable varieties.

Decreased yields may be primarily due to reduced frost resistance under the influence of plant depletion by septoria. Yield losses from septoria fungi, which spread intensively in years with humid, favorable weather conditions for their development, are 10–15%, and sometimes reach 40%. In the leaves of affected wheat plants, the content of chlorophyll is reduced by 19–71%, ascorbic acid – 33–59 mg/%, intensive respiration – 4–17%, the intensity of photosynthesis – 4–9 times [10].

Materials and methods of research. The research was conducted in 2017–2019 in the field and laboratory conditions (plant protection laboratory) of the Institute of Agriculture of the Carpathian region of NAAS.

The subject of research were varieties of winter wheat Vodohray bilotserkivs′kyy, Oberih Myronivs′kyy, Mudrist′ odes′ka.

The development of dark brown spot and leaf septoria on 3 varieties was studied on a natural background, on the artificial background – on susceptible varieties to diseases to dark brown spot (Vodohray bilotserkivs′kyy) and leaf septoria (Mudrist′ odes′ka).

Records of disease on a natural background were performed in the phases of tube exit, earing, milk ripeness according to generally accepted methods [18].

We created 2 artificial infectious backgrounds, by spraying plants in the tube exit phase with a knapsack sprayer with a suspension of spores of dark brown spot pathogens (*Drechslera tritici – repentis* Ito) (Vodohray bilotserkivs′kyy) and leaf septoria (Mudrist′ odes′ka) isolated from the local population of pathogens.

In the phase of milk ripeness was labeled 30 plants with different intensity of damage – 0; 25; 50; 75; 100% and calculated ear length, number of grains in the ear, weight of grain from an ear, weight of 1000 grains.

The intensity of winter wheat plant disease was determined on a 9-point scale according to conventional methods [18, 19].

Disease development rate and harmfulness were calculated according to generally accepted formulas, which are in the methods [20, 21].

Harmfulness was determined by the formula:

$$\mathbf{K_v} = \frac{100 - Y_x}{B},$$

Where, Y_x – yield of diseased plants as a percentage of control;

B – detection of the disease.

The obtained data were processed by the method of analysis of variance according to the method [22].

Research results. In April 2017, with the beginning of the growing season, precipitation was 16.1 mm less than normal, or 68% of normal. The temperature in April exceeded the norm by 1.1 °C and was equal to 8.5 °C, in May it increased by 0.9 °C.

The amount of precipitation in May in the third decade was 22 mm higher than normal. In June-July, they were observed to be lacking: in June, only 22.2 mm fell – 24% of the norm, in July 57.2 mm, or 56%. In June, the air temperature was 1.9 °C higher than normal (Fig. 1). The average monthly temperature in July was 18.5 ° C, which is 1 °C higher than normal.

The third decade of May was favorable for the development of dark brown spots, leaf septoria.

April 2018 was characterized by very warm and moderately dry weather (air temperature was 6.3 ° C higher than normal, and precipitation was 29.4 mm lower than normal). In May, the air temperature was 4 °C higher than normal, and the amount of precipitation was 16 mm lower than normal (Figs. 1, 2).

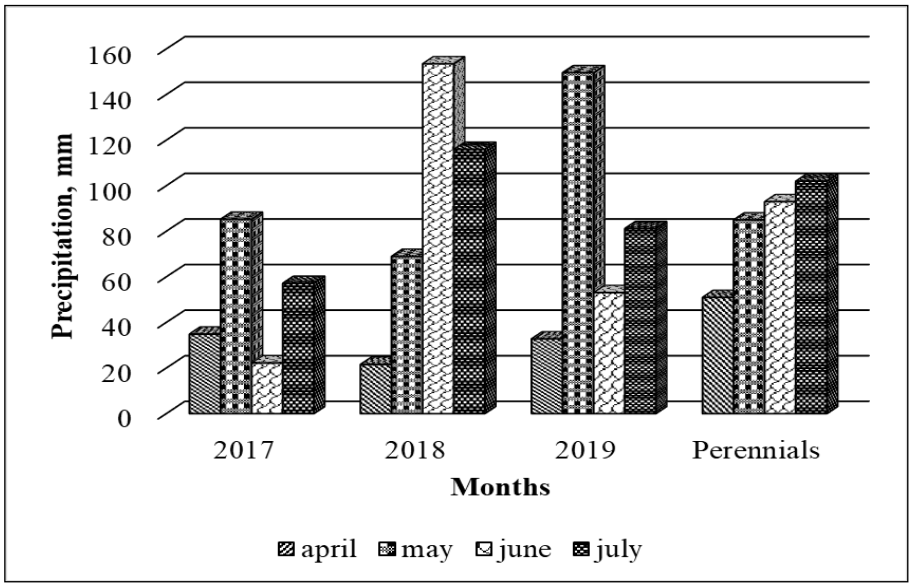

Fig. 1. The amount of precipitation for april-july relative to the long-term amount (2017–2019)

Summer weather conditions differed. June was characterized by humid and warm weather (precipitation was 60.5 mm higher than normal, air temperature was 2 °C higher than normal. Air temperature in July was 1.7 °C higher than perennial, and precipitation – 14 mm more than normal.

It should be noted that the weather conditions of the growing season in 2018 contributed to the development of dark brown spot, septoria leaves, so no varieties with high resistance.

In 2019, April was characterized by warm and dry weather (air temperature was 2.6 °C higher than normal, and precipitation – 18.2 mm less than normal).

In 2019, April was characterized by warm and dry weather (air temperature was 2.6 °C higher than normal, and precipitation – 18.2 mm less than normal). Temperature the air in May was 0.3 °C higher than normal, and the amount of precipitation was 64.6 mm higher than normal (see Figs. 1, 2).

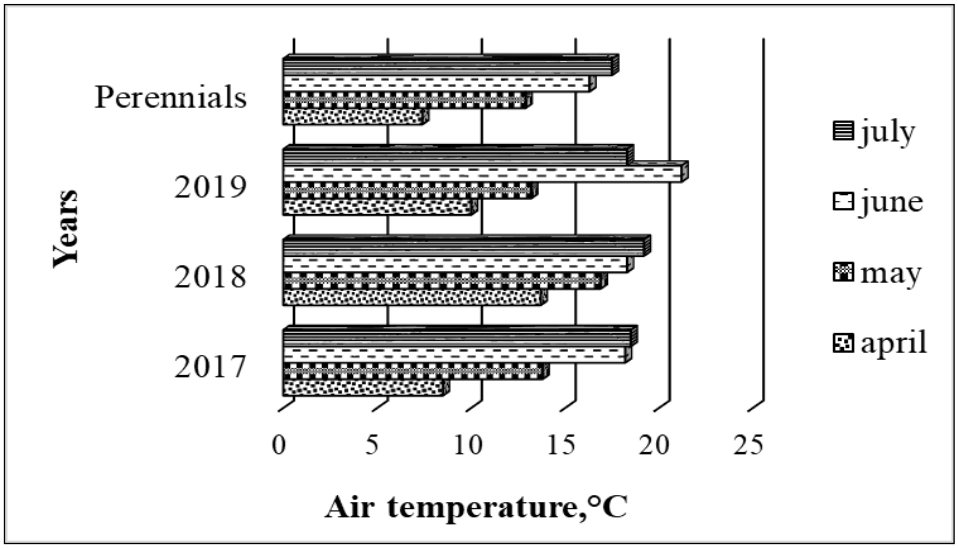

Fig. 2. Air temperature for april – july relative to the long-term indicator (2017–2019)

In summer, weather conditions varied. June was characterized by warm and relatively dry weather (air temperature was 4.9 °C above normal, precipitation was 39.9 mm less than normal). The air temperature in July was 0.8 °C higher than for many years, and the amount of precipitation was 20.8 mm less than normal.

Weather conditions in the third decade of May and the first decade of June contributed to the development of dark brown spots, septoria leaves.

Thus, the weather conditions of 2017–2019 contributed to the maximum development of pathogens due to optimal and excessive humidity and the optimal air temperature.

Under such conditions, you can reliably assess the varieties of winter wheat for resistance to dark brown spot, leaf septoria.

The intensity of development of dark brown spot (on a natural background) depending on the studied variety in 2017 was: 2.5–20.0%, 2018 – 1.5–20.5%, 2019 – 1.5–28.5%; leaf septoria – 4.5–27.5%, respectively; 1.5–24.5%; 1.5–32.5%.

According to the results of our research, in 2019, resistant varieties to dark brown spots were not detected. It is established that the intensity of the disease on varieties of winter wheat in the yield phases in the tube was 1.5–5.5%, earing – 4.0–12.5, milk ripeness – 14.5–28.5% (table).

The least intensive development of dark brown leaf spot was in the phase of milk ripeness on the variety Mudrist′ odes′ka (14.5%), the most intensive – in the variety of Vodohray bilotserkivs′kyy (28.5%) (see table).

According to the results of our research, dark brown leaf spot in 2017 on the studied varieties developed the least compared to other years of research.

It should be noted that during the years of research dark brown, leaf spot developed the least on the variety Mudrist′ odes′ka.

The development and rate of spread of leaf septoria on the studied varieties were largely determined by their biological and genetic characteristics. Intensive development of the disease was facilitated by frequent rains, relative humidity of 80% and above and air temperature of 14–25 °C.

Development of dark brown spot and septoria on winter wheat varieties (natural background, 2017–2019)

Variety	Dark brown spot			Septoria		
	tube exit	earing	milk ripeness	tube exit	earing	milk ripeness
2017 year						
Vodohray bilotserkivs′kyy (st)	7,0	15,5	20,0	6,5	15,5	20,5
Oberih Myronivs′kyy	4,5	9,5	17,0	4,5	12,5	15,0
Mudrist′ odes′ka	2,5	5,0	12,5	10,5	22,5	27,5
LSD_{05}	1,6	2,2	1,8	1,4	1,8	2,2
2018 year						
Vodohray bilotserkivs′kyy (st)	3,5	7,5	20,5	2,5	5,0	19,5
Oberih Myronivs′kyy	2,0	5,5	15,0	1,5	3,5	14,0
Mudrist′ odes′ka	1,5	4,0	10,5	4,0	7,0	24,5
LSD_{05}	1,2	1,2	1,4	1,2	1,6	1,6
2019 year						
Vodohray bilotserkivs′kyy (st)	5,5	12,5	28,5	3,5	11,0	22,5
Oberih Myronivs′kyy	3,5	6,5	15,0	1,5	4,5	15,0
Mudrist′ odes′ka	1,5	4,0	14,5	7,0	13,0	32,5
LSD_{05}	1,3	1,2	1,3	1,3	1,4	1,6

The intensity of disease development on varieties during the growing season of winter wheat in 2019 was 1.5–32.5%: in the phases of tube emergence – 1.5–7.0, earing – 4.5–13.0, milk ripeness – 15.0–32.5%.

This disease developed the most in the phase of milk ripeness on the variety Mudrist′ odes′ka (32.5%), the least – on the variety Oberih Myronivs′kyy (15%) (see table).

The least septoria of winter wheat leaves on a natural background in 2017–2019 developed on varieties in 2018. It was found that the intensity of disease development (see table) in the phases of tube emergence was 1.5–4.0%, earing – 3.5 –7.0, milk ripeness – 14.0–24.5%.

The least septoria of winter wheat leaves over the years of research developed on the variety Oberih Myronivs′kyy.

Analyzing the data obtained for 2017–2019 on an artificial background (Fig. 3), we found that the disease of winter wheat septoria leaves significantly affected the disease on yields – the weight of grain from the ear and the weight of 1000 grains.

Yes, with the return of the intensity of the disease on the Vodohray bilotserkivs′kyy variety, the weight of grain from the ear decreased, in particular, with the intensity of its development, the grain weight decreased by 0.27 g at 50%, and at the levels of 75% – 0.57 g, 100% – at 0.81 g.

Significantly affected by the disease per mass of 1000 grains, which decreased with increasing lesion, and at a disease intensity of 25% was 2.7 g less, while the weight of 1000 grains unaffected plants was 45.7 g. With an intensity of lesions of 75%, this figure decreased by 14.6 g.

Taking into account the mass index grain from the ear determined the damage rate of leaf septoria. It is established that the latter changes with increasing intensity of the disease, it is the smallest with a minimum level of damage, the largest – for the maximum.

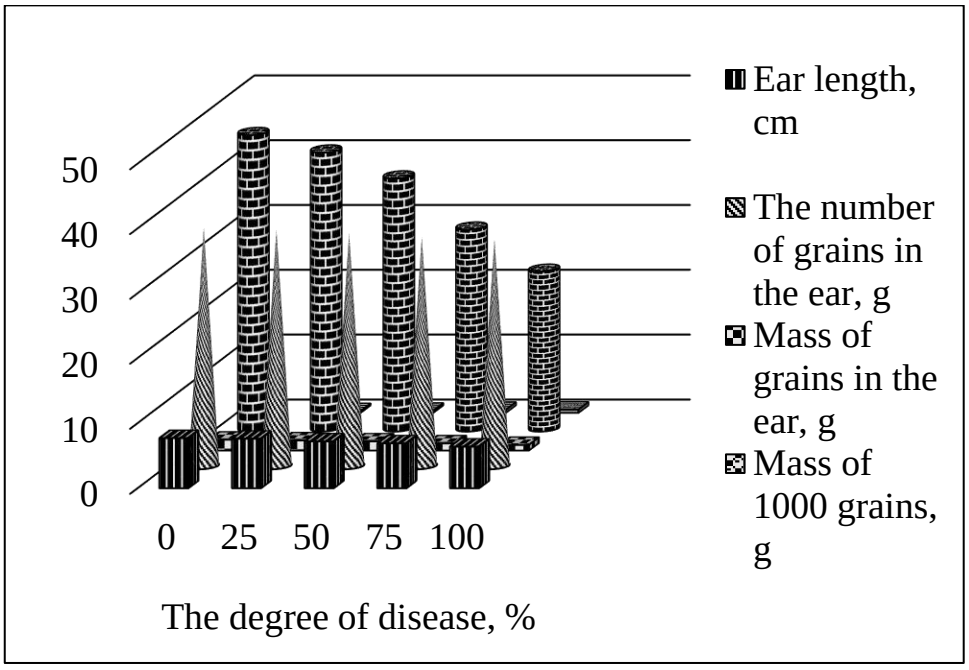

Fig. 3. Harmfulness of leaf septoria at different degrees of winter wheat lesions (Vodohray bilotserkivs′kyy variety, artificial background, 2017–2019)

Thus, for leaf damage of 25% (Vodohray bilotserkivs′kyy) the coefficient of harmfulness was 0.26%; 50% – 0.32; 75% – 0.46; 100% – 0.49%.

It should be noted that the defeat of the dark brown spot significantly affected the mass 1000 grains of the Mudrist′ odes′ka grade, which decreased with increasing degree of lesion and the intensity of the disease 50% was 6 g less in the unaffected plants, it was 47 g (Fig. 4). With a lesion intensity of 75%, this figure decreased by 10 g.

Thus, the defeat of winter wheat dark brown spot affects the length of the ear, the number of grains in it, the weight of grain in the ear and the weight of 1000 grains. The coefficient of harmfulness, depending on the level of disease development, was 0.14–0.66% in the variety Mudrist′ odes′ka.

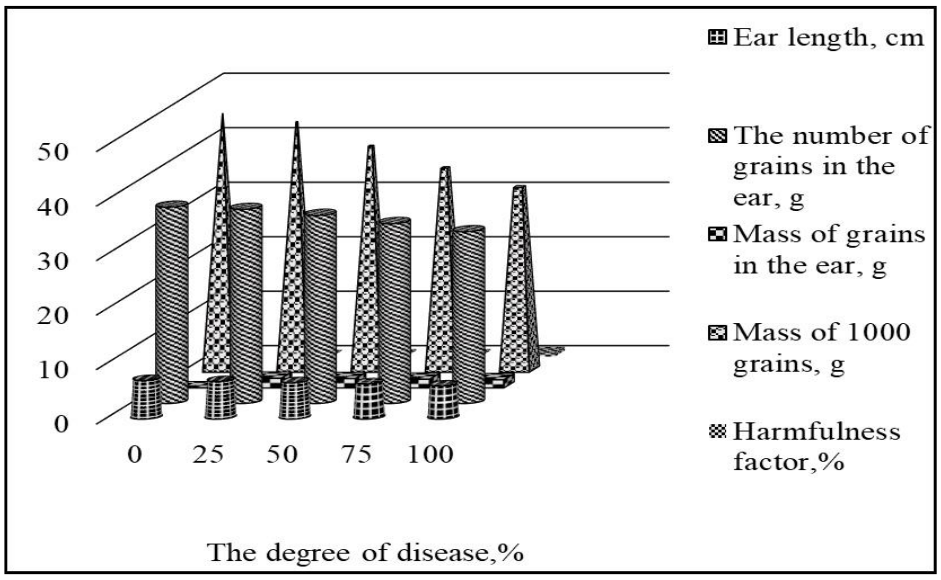

Fig. 4. Harmfulness of dark brown spot at different degrees of damage to winter wheat (variety Mudrist' odes'ka, artificial background, 2017–2019)

Conclusions

During the years of research, the intensity of dark brown spot development, depending on the variety, was 1.5–28.5%, leaf septoria – 1.5–32.5%. The least dark brown spot developed on the variety Mudrist' odes'ka, septoria leaves – variety Oberih Myronivs'kyy.

It should be noted that the defeat of winter wheat septoria leaves and dark brown spot affects the length of the ear, the number of grains in the ear, the weight of grain in the ear, the weight of 1000 grains.

The coefficient of harmfulness on susceptible varieties to dark brown spot, depending on the level of disease development, was 0.26–0.49%, leaf septoria –0.14–0.66%.

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