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RESISTANCE OF WINTER BARLEY TO FUNGAL DISEASES DEPENDING ON THE VARIETY

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Abstract

The results of research of winter barley varieties for resistance to foliar fungal diseases in the conditions of the Western Forest Steppe of Ukraine are highlighted. According to the assessment of resistance to diseases, and in particular to dark brown spotting, the following varieties were less affected: Dev'yatyy val, Status, Dariy, Val'kiriya; dwarf rust: Dev'yatyy val, Hladiator, Paladin Myronivs'kyy, Status, Dariy, Snihova koroleva, Val'kiriya; to striped mottling: Dev'yatyy val, Status. Zbruch, Status, Dariy and Val'kiriya were note to have the highest indices of complex resistance to pathogens of two diseases. It was detect that the most valuable are varieties that are characterized by a combination of a high index of complex resistance with individual resistance to some foliar fungal diseases.

Key words*: complex resistance index, dark brown spotting, dwarf rust, productivity, striped spotting.*

INTRODUCTION

Concerns of the world community regarding the provision of food products for the ever-growing population of the planet is an urgent issue today. The increase in food production is largely achieved at the expense of the grain group, which is the most attractive for the agricultural market in all countries (Nargan, 2015; Petrychenko & Lykhochvor, 2020). Barley is a valuable food, fodder and technical crop, which is used for the production of high-quality cereals, concentrated and coarse fodder for animals, for brewing, etc. (Bliznyuk et al.; 2019; Mostovyak, 2019). In recent years, the deterioration of the phytosanitary condition of grain crops has been recorded more and more often. This is mainly due to the violation of agrotechnologies of crop cultivation and soil cultivation, the increase in the share of permanent crops in the structure. The use of low-quality pesticides and non-compliance with the regulations for their use, etc. (Mostovyak, 2020; Borzykh & Fedorenko, 2016). Large shortages of the winter barley harvest cause diseases of various etiologies. Thus, the shortfall of the barley harvest due to damage to plants by flying soot can reach 10-15%, root rot – 20-40%, spotting – 30-60%, bacteriosis – up to 50% (Kyryk & Pikovsky, 2017; Bilovus, 2022; Shakhova & Shapovalov, 2014). The selection and introduction into production of resistant varieties of agricultural crops is one of the radical methods of combating diseases. Cultivation of such varieties contributes to the reduction of plant diseases, the increase of the harvest and its quality. Even relativelyresistant varieties are more valuable as their cultivation greatly increases the effectiveness of chemical measures (Mukha & Murashko, 2017; Gudzenco & Vasylkivskyi, 2017). In view of global climate changes, special attention is paid to the selection of varieties for specific soil and climatic conditions, with high genetic potential for productivity increased drought resistance, heat resistance, resistance to diseases and pests. (Demyanyuk, 2016). A massive increase in the specific weight of grain crops in crop rotations, violations of agricultural technology and high weediness of crops, certain types of phytopathogens from rare to particularly dangerous, and the diseases caused by them acquired epiphytotic development. Genotypes with complex resistance to the causative agents of leaf diseases and other diseases, which are

especially valuable for breeding, rarely occur. (Demidov et al., 2017; Muzafarova et al., 2016). The experience of scientists (Korniychuk, Vinnichuk & Parminska, 2014) has proven that the selection of varieties and hybrids carried out taking into account their ecological plasticity, tolerance and resistance to the main phytopathogens contributes to the preservation of up to 40% of the biological yield of the crop without additional costs. Thanks to the use of resistant varieties, the world's agriculture annually receives a profit equivalent to about 30% of the total value of the products produced. In addition, the cultivation of such varieties helps to reduce the use of pesticides. What is important for identifying varieties of winter barley with a high level of environmental protection from pollution (Bliznyuk et al., 2019). It should be noted that in connection with the significant expansion of winter barley sowing areas in Ukraine, in particular in the Central, Western and Northern regions, the issue of creating modern domestic varieties adapted to these conditions is urgent, especially taking into account global climate changes. . Based on the analysis of the literature, an insufficient number of works devoted to the study of winter barley in Ukraine, especially in the Forest Steppe, was established. The purpose of the work is to identify varieties of winter barley with a high level of productivity and resistance to dark brown spotting, dwarf rust and striped spottin.

MATERIALS AND METHODS

The research was conducted in 2019-2021 in the conditions of selection and seed rotation of the laboratory of grain and fodder breeding and in the laboratory conditions (plant protection laboratory) of the Institute of Agriculture of the Carpathian Region of the National Academy of Sciences. The object of the research was 10 varieties of winter barley in the ecological variety testing nursery. The agricultural technique of growing varieties of winter barley is generally accepted for winter barley in the conditions of the Western Forest Steppe of Ukraine.

Records of diseases on winter barley were carried out in the phase of emergence into the tube, earing and milk ripeness according to 9-point scale (Kyrychenko et al., 2012):

9-8 – very high and high resistance;
7-6 – stable;
5 – weak receptivity;
4-3 – receptivity;
2 – high susceptibility;
1 – very high susceptibility.

Phenological observations of the development of winter barley plants were carried out, and indicators of the crop structure and technological qualities of grain samples were determined according to the method (Yeschenko et al., 2014). Indices of individual resistance were calculated as the ratio of the average multi-year value of resistance for a separate harmful organism to the average of all samples studied. Complex stability indices were expressed as the average value of individual stability indices (Litun et al., 2009). Under the condition of describing the weather conditions for 2019-2021, we used the data of the Obroshinsk water balance station hydromelioration observation post – v. Obroshyne. Statistical reliability of experimental data was carried out with the help of Microsoft Excel programs by determining the average, minimum (m), maximum values (max) and range of variation. Mathematical processing of yield data was carried out using the dispersion method (Ushkarenko et al., 2013). In the comparative assessment of the studied varieties, the indexing method was used, according to which the damage of plants by diseases in points was translated into an indicator of distance from the average value for all studied samples (resistance indices).

RESULTS AND DISCUSSIONS

The agrometeorological conditions under which the vegetation of winter barley took place during the period of research (2019-2021) and the study of the resistance of sample to foliar diseases differed according to the years of research and were not always favorable for the development of plants and phytopathogens. In 2019, April was celebrate by warm and dry weather (Figures 1, 2). In May, the temperature was slightly higher than normal (0.3ºC), and the amount of precipitation was much higher (+64.6 mm). June and July were characterized by warm and dry weather (precipitation fell by 29.9 and 20.8 mm less than the norm, respectively, and the air temperature exceeded it by 3.9 and 0.8ºC.

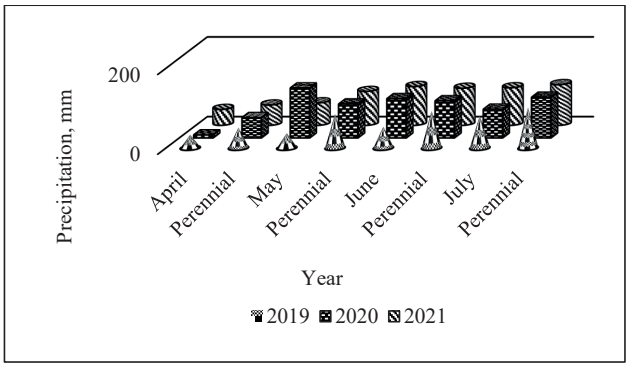

Figure 1. Distribution of average monthly temperatures during the spring-summer growing season of winter rapeseed (2016–2020)

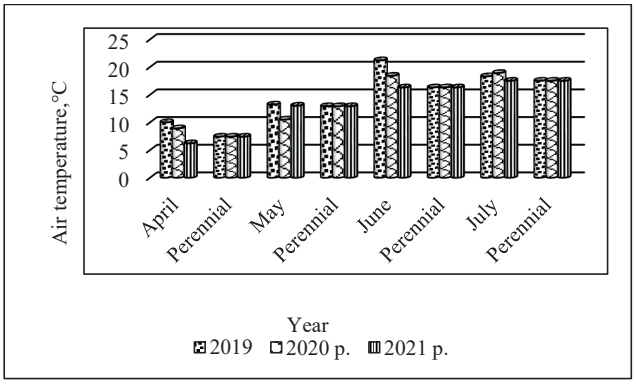

Figure 2. Distribution of average monthly temperatures during the spring-summer growing season of winter rapeseed (2019–2021)

In 2020, meteorological conditions differed due to fluctuations in hydrothermal indicators. The average daily temperature in April was 1.5°C higher than normal and was 8.9°C. They experienced a severe shortage of precipitation: only 7.6 mm fell in a month (according to the norm of 51 mm), and there was no precipitation in the first decade. In May, the hydrothermal conditions changed. The air temperature was lower than normal by 2.1°C and was equal to 10.8°C. In the 1st decade of June, average daily air temperatures corresponded to the norm (15.7°C), in the 2nd and 3rd decade they were equal to 19.4 and 20.0°C and were higher than the norm by 3.4 and 2.8°C, respectively. The monthly amount of precipitation was 98.4 mm against the norm of 93 mm. Average daily temperatures were also higher than normal in July (by 1.4°C) (Figures 1, 2). The amount of precipitation was 70.5 and 28.9% of the monthly norm, respectively. In 2021, April was characterized by cold and moderately wet weather (the air temperature was 1.2°C below normal, and the amount of precipitation was 11.1 mm below normal). The air temperature in May was 0.1°C higher than normal, but in the first decade of the month it was below normal, in the second − by 1°C above the long-term average, and in the third decade of the month − at the level of the long-term average. The amount of precipitation this month was 11.1 mm less than normal. June was characterized by warm and humid weather (air temperature was 2.5°C higher than normal, and precipitation was 4.3 mm more than normal (Figures 1, 2). During the three years of research, the studied winter barley varieties realized their genetic productivity potential in different ways (Table 1). We have established that the variation of winter barley yield by year ranges from 2.35 to 4.8 t/ha, with an average value of 3.57 t/ha. We noted that over the years

of research, the varieties had different yields. This can indicate the conditions of the year, the development of plants and the formation of yields. On average, over the years of research, the highest yield among winter barley varieties was recorded in the village of Valkyrie (4.38 t/ha), Snow Queen (4.18 t/ha).

Table 1. Yield and adaptability parameters of winter barley varieties (2019-2021)

Variety	Productivity, t/ha			Adaptability parameters		
	X_{lim}	X_{opt}	X	R	V, %	σ
Zbruch	2.61	4.60	3.84	1.99	27.86	1.07
Hladiator	3.10	3.40	3.30	0.30	5.15	0.17
Paladin Myronivs'kyy	3.06	3.20	3.19	0.14	3.76	0.12
Status	3.35	3.80	3.52	0.45	7.10	0.25
Dariy	3.11	3.40	3.44	0.29	10.17	0.35
Bureviy	2.35	3.60	3.12	1.25	21.47	0.67
Dev'yatyy val	2.86	4.20	3.39	1.34	20.94	0.71
Dostoynyy	3.04	3.70	3.35	0.66	9.85	0.33
Snihova koroleva	3.43	4.70	4.18	1.27	15.79	0.66
Val'kiriya	4.0	4.80	4.38	0.80	9.13	0.40
X*	3.01	3.94	3.57	0.85	13.12	0.47
min**	2.35	3.2	3.12	0.29	3.76	0.12
max***	4.0	4.8	3.84	1.99	27.86	1.07

Note: X_{lim} – minimum yield; X_{opt} – maximum yield; X – average yield, σ – root mean square deviation; V, % coefficient of variation.

The main problem of breeders and phytopathologists in Ukraine is to ensure the breeding process with sources and donors with group and complex resistance to fungal diseases, taking into account the soil and climatic conditions of the growing zone, since winter barley is under the influence of a powerful complex of harmful phytopathogens. It should was noted that we have been working in this direction for many years and scientists like (Mostovyak, 2019; Demidov et al., 2017; Gudzenco & Vasylkivskyi, 2017). confirm the importance of this problem. To determine the resistance of winter barley varieties to the causative agents of dark brown spotting, striped spotting, and dwarf rust, immunological evaluations were carried out with the translation of the degree of disease damage into indicators of distance from the average value (resistance indices for all studied varieties). It should be noted that the highest index of resistance (I) to the causative agent of dark brown spot (Table 2) among the studied varieties was in Dev'yatyy val, Status, Dariy and Val'kiriya (1.1 each).

Table 2. Resistance index of winter barley variety samples in ecological variety testing against foliar diseases (2019-2021)

Variety	Resistance index, I			Index of complex stability, IKS
	dark brown spotting	dwarf rust	striped spotting	
Zbruch	0.95	0.91	0.97	0.93
Hladiator	0.95	1.06	0.97	0.98
Paladin Myronivs'kyy	0.95	1.06	0.97	0.98
Status	1.1	1.06	1.13	1.09
Dariy	1.1	1.06	0.97	1.03
Bureviy	0.95	0.76	0.97	0.90
Dev'yatyy val	1.1	1.06	1.13	1.09
Dostoynyy	0.79	0.91	0.97	0.98
Snihova koroleva	0.95	1.06	0.97	0.98
Val'kiriya	1.1	1.06	0.97	1.03
X*	0.99	1.0	1.1	1.0
min**	0.79	0.76	0.97	0.90
max***	1.1	1.06	1.13	1.09
R****	0.5	0.3	0.16	0.19

Note: X* – average, min** – minimum value, max*** – maximum value, R****– range of variation (max-min)

The highest resistance index (1.06) to the causative agent of dwarf rust was found in varieties: Dev'yatyy val, Hladiator, Paladin Myronivs'kyy, Status, Dariy, Snihova koroleva. Varieties showed high resistance to striped spotting: Ninth Val, Status (1.13 each). The highest index of complex resistance (ICS) was noted for the causative agents of three diseases in varieties: Dev'yatyy val and Status (1.09 each), Dariy and Val'kiriya (1.03 each).

CONCLUSIONS

Based on the results of three-year research (2019-2021), we selected varieties with individual resistance to a certain disease, as well as with complex resistance to dark brown spotting, dwarf rust and striped spotting.

The highest stability index (I):
− varieties: Dev'yatyy val, Status, Dariy, Val'kiriya showed the causative agent of dark brown spotting (1.1 each); to the causative agent of dwarf rust: Dev'yatyy val, Hladiator, Paladin Myronivs'kyy, Status, Dariy, Snihova koroleva, Val'kiriya (1.06 each);
− to striped spotting: Dev'yatyy val, Status (1.13 each). The highest complex resistance index (ICS) was noted for the causative agents of three diseases in the variety: Dev'yatyy val and Status (1.09 each), Dariy and Val'kiriya (1.03 each).

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