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RESEARCH ARTICLE

Screening of winter wheat varieties for leaf diseases resistance

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The results of long-term field research on the search for resistant varieties of bread winter wheat, created at the V. M. Remeslo Myronivka institute of wheat, to major leaf diseases are presented. Researches were performed under conditions of artificial inoculation by pathogens in field infectious nurseries. Varieties with resistance to brown rust have been identified: Kolumbiia, Remeslivna, Pereiaslavka, Bohdana, Monotyp, Khazarka, Pam'iati Remesla, Yasnohirka, Dostatok, Svitanok Myronivskyi, Berehynia Myronivska, Horlytsia myronivska, Trudivnytsia Myronivska, MIP Kniazhna, MIP Vyshyvanka. Powdery mildew: Kolumbiia, Remeslivna, Snizhana, Pereiaslavka, Favorytka, Bohdana, Khazarka, Monotyp, Pam'iati Remesla, Voloshkova, Yasnohirka, Lehenda Myronivska, Svitanok Myronivskyi, Oberih Myronivskyi, Berehynia Myronivska, Horlytsia Myronivska, Hospodynia Myronivska, MIP Valensiia, Trudivnytsia Myronivska, MIP Kniazhna, MIP Vyshyvanka. Common bunt: Kolumbiia, Snizhana, Pereiaslavka, Favorytka, Volodarka, Bohdana, Pyvna, Madiarka, Yuviliar Myronivskyi, Myronivska storichna, Yasnohirka, Dostatok, Lehenda Myronivska, Oberih Myronivskyi, Berehynia Myronivska, Horlytsia Myronivska, MIP Kniazhna and MIP Vyshyvanka. As well varieties with group resistance to leaf diseases: Kolumbiia, Smuhlianka, Snizhana, Pereiaslavka, Volodarka, Favorytka, Bohdana, Zolotokolosa, Khazarka, Monotyp, Madiarka, Pam'iati Remesla, Lehenda Myronivska, Svitanok Myronivskyi, Berehynia Myronivska, MIP Vyshyvanka and varieties MIP Dniprianka, Estafeta Myronivska, Vezha Myronivska.
Keywords: Breeding; winter wheat; varieties; diseases; brown rust; powdery mildew; lesion; resistance

Introduction

Intensive use of chemical plant protection products creates several negative consequences - environmental pollution, destruction of beneficial entomofauna, accelerates the formation of resistant populations, complicates plant-growing technologies, and increases energy consumption (Trybelet al., 2010). There are enough fac ts, which confirm the reality of the genetic danger of pesticides' accumulation in soil, water, and atmosphere (Grant, 1982; Christoffers et al., 2002; Saratovskikh et al., 2007; Akyil et al., 2017; Tonkha et al., 2014). However, one of the leading aspects of the "long-term consequences" of the adverse effects of pesticides is the induced mutation process in humans, which may result in the frequency of pathology increase with a genetic component (Boltina et al., 2009; Butenko, 2019). A study of 230 pesticides found that 50% of them have genotoxic activity (Durnev & Seredenyn, 1998; Kolisnyk et al., 2019; Tsyhanskyi et al., 2019).

The mutagenic properties of the fungicides Fundazole (benomyl), Maxim (fludioxonil) and Thiophene (thiophanate methyl) were confirmed by studies in a standard semi-quantitative Ames test. It was found that the compounds have a mutagenic effect on the test strain of S. *typhimurium* TA 98. The lowest mutagenic activity was characterized by compound Fundazole. Compounds Maxim and Thiophene showed a weak mutagenic effect even at concentrations 10 times lower than recommended (Tereshchuk & Butsenko, 2014; Didur, 2019; Karpenko, 2019).

Growing resistant varieties in crop rotations - is one of the key elements of nature resources rational use and preservation of the environment in an ecologically clean state. In the fight against wheat diseases, the breeding of disease-resistant varieties is the most effective method. Analysis of the modern range indicates the presence of a small number of disease-resistant varieties. Therefore, the creation of varieties that combine high yield potential with disease resistance is one of the central issues in plant breeding and is the most economical, environmentally friendly, and justified method of pest control (Trybel et al.,2006; Dmytrenko et al., 2019; Kovalyshyna et al., 2020; Osmachko et al., 2020).

The relevance of the research of bread winter wheat varieties resistance against leaf diseases on artificial infectious backgrounds of their pathogens is due to the need to reduce the use of pesticides during the growing of crops, where fungicides occupy a special place.

The purpose of the research is to study the stability of bread winter varieties of breeding of the V.M. Remeslo Myronivka institute of wheat (MIW) against leaf diseases on artificial infectious backgrounds of their pathogens and distinguish among them resistant to both individual diseases and their groups.

Materials and methods

As the material was winter wheat varieties, created by MIW breeders. The research was carried out during 1981-2019 in a field infectious nursery of the plant protection department under conditions of artificial inoculation by brown rust and common bunt pathogens on the provocative infectious background of powdery mildew pathogen.

The artificial infectious background of the brown rust pathogen was created by studied varieties inoculation in the shooting phase by a mixture of spores isolated from the local population of brown rust pathogen with talc in a ratio of 1: 100 according to Geshele E.E. (1971). Infection was carried out in the evening hours, on pre-moistened the plants by water sprayer. Variety Myronivs'ka 10 was used as an accumulator of infection. An artificial infectious background of common bunt was created by spraying plants in the shooting phase by a suspension of spores, isolated from the local population of the pathogen by the method of Pyzhikova G.V. et al. (1989). Using the local population of the powdery mildew pathogen, a provocative background of the powdery mildew pathogen was created according to the generally accepted method (Krivchenko et al., 1980; Karbivska, 2019). Variety Keprok was used as infection accumulation. Varieties of infection were sown every 10 samples and along the studied strips in the field nursery. The accounting of the infestation of winter wheat varieties was performed every 10 days in the dynamics, according to the generally accepted methods (Trybelet al., 2010; Karbivska, 2020).

Results and discussion

Variety Ukrainka 0246 is the first winter wheat variety created at the MIW in 1924. In the pre-war period, it was the most popular winter wheat variety of domestic selection, which was sown on the area of over 7 million hectares. The variety was characterized by high winter hardiness but lodged and was affected by brown rust and common bunt.

In the postwar period (1951-1957) the varieties Myronivs'ka 264, Myronivs'ka 808, Illichivka were created. The Myronivs'ka 808 variety is characterized by some endurance against brown rust, but susceptibility to common bunt. During this period, the variety was characterized by resistance to powdery mildew and moderately affected by bacterial diseases. Illichivka variety was less affected by brown and stem rust, common bunt. Varieties Ukrainka 0246, Myronivs'ka 808, and Illichivka are still studied by us on artificial infectious backgrounds of pathogens. The characteristics of the susceptibility of these varieties to pathogens of leaf diseases for the period 1981-2019 are given in Table 1.

Table 1. Lesion of winter wheat varieties by leaf diseases on artificial infectious backgrounds of their pathogens (1981-2019, MIW).

Varieties	Lesion by diseases, %								
	1981-2010			2011-2015			2016-2019		
	brown rust	powdery mildew	common bunt	brown rust	powdery mildew	common bunt	brown rust	powdery mildew	common bunt
Ukrainka 0246	43.0	38.0	25.4	28.6	16.0	7.8	20.0	23.8	11.2
Myronivs'ka 808	43.2	24.9	23.8	22.6	6.8	5.0	25.0	12.0	15.0
Illichivka	44.1	24.4	26.9	17.8	10.6	11.0	15.0	21.2	18.8

Analysis of data on diseases of varieties Ukrainka 0246, Myronivs'ka 808, and Illichivka shows that these varieties have lost resistance against them. Since 2011, the incidence rate has decreased slightly. This can be explained by changes in the composition of pathogens' populations, caused by the introduction into new varieties of new effective resistance genes against these diseases. Varieties, created in subsequent selection work are of medium resistance to brown rust and powdery mildew (Kovalyshyna et al., 2017). State register of plant varieties suitable for dissemination in Ukraine in 2020 includes more than 60 varieties of winter wheat of MIW breeding, which were created in different years. Among the varieties, entered in the State Register in 2000-2019, varieties resistant to one, two and three diseases were isolated on artificial infectious backgrounds. According to the results of our research, mainly resistance to brown rust and powdery mildew (Table 2) characterizes varieties of MIW breeding. Thus, high resistance to brown rust was found in varieties: Kolumbiia, Remeslivna, Pereiaslavka, Bohdana, Monotyp, Khazarka, Pam'iati Remesla, Yasnohirka, Dostatok, and medium resistance - Smuhlianka, Snizhana, Vesnianka, Favorytka, Volodarka, Zolotokolosa, Khurtovyna, Ekonomka, Madiarka, Yavoryna, Svitanok Myronivskyi, Berehynia Myronivska, Horlytsia Myronivska, Trudivnytsia Myronivska, MIP Kniazhna, MIP Vyshyvanka.

Varieties, which show high resistance to powdery mildew: Kolumbiia, Remeslivna, Snizhana, Pereiaslavka, Favorytka, Bohdana, Khazarka, Monotyp, Pam'iati Remesla, Voloshkova, Yasnohirka, while Smuhlianka, Demetra, Volodarka, Pyvna, Zolotokosa, Madiarka, Kolos Myronivschyny, Kalynova, Yuviliar Myronivskyi, Myronivska storichna, Dostatok, Lehenda Myronivska, Svitanok Myronivskyi, Oberih Myronivskyi, Berehynia Myronivska, Horlytsia Myronivska, Hospodynia Myronivska, MIP Valensiia, Trudivnytsia Myronivska, MIP Kniazhna, MIP Vyshyvanka - medium resistance.

Against common bunt varieties with high resistance was not found. Varieties - Kolumbiia, Snizhana, Pereiaslavka, Favorytka, Volodarka, Bohdana, Pyvna, Madiarka, Yuviliar Myronivskyi, Myronivska storichna, Yasnohirka, Dostatok, Lehenda Myronivska, OberihMyronivskyi, Berehynia Myronivska, Horlytsia Myronivska, MIP Kniazhna and MIP Vyshyvanka.

Among the studied varieties, we have identified those that have group resistance to leaf diseases. High resistance to brown rust, powdery mildew and medium resistance to common bunt characterize the Kolumbiia variety. Medium resistance to brown rust and powdery mildew characterizes varieties Smuhlianka and Snizhana. Group resistance to leaf diseases characterizes Pereiaslavka, Volodarka, Favorytka, Bohdana according to our research. Varieties of Zolotokolosa, Khazarka, Monotyp, Madiarka, Pamyati Remesla show high resistance to brown rust and powdery mildew. Variety Lehenda Myronivska has medium resistance to brown rust, powdery mildew and common bunt. The Svitanok Myronivskyi variety is moderately resistant to brown rust and powdery mildew. Varieties Berehynia Myronivska, MIP Vyshyvanka has medium resistance to brown rust, powdery mildew and common bunt.

Table 2. Lesion of winter wheat varieties by leaf diseases on artificial infectious backgrounds of their pathogens entered in the State Register of Plant Varieties for 2020 (2000-2019, MIW).

Varieties	Year of state registration	Lesion by diseases, % 2000-2010			2011-2015			2016-2019		
		brown rust	powdery mildew	common bunt	brown rust	powdery mildew	common bunt	brown rust	powdery mildew	common bunt
Myrkhad	2000	17.1	19.3	18.8	7.8	8.2	7.2	18.7	16.0	12.5
Myronivs'ka 65	2000	22.8	21.1	15.8	14.2	10.2	7.2	16.2	20.7	16.2
Myronivs'ka 66	2000	27.8	16.6	16.4	25.2	7.8	8.4	35.0	10.0	17.5
Myronivska 67	2002	25.0	16.1	15.8	14.1	7.2	7.2	17.5	6.5	15.0
Kryzhynka	2002	11.7	17.6	13.8	7.2	7.0	11.4	16.3	10.3	16.2
Myronivska rannostyhla	2002	27.5	18.2	15.9	12.2	5.4	11.4	26.2	9.0	21.2
Vesta	2003	12.5	17.6	15.0	7.2	6.2	9.2	27.2	14.0	16.2
Kolumbiia	2003	6.3	6.2	9.0	6.2	5.6	12.0	4.5	9.5	12.5
Podolyanka	2003	20.0	7.3	11.0	7.2	11.9	10.2	15.0	20.0	21.2
Smuhlianka	2004	5.0	11.0	16.7	9.8	13.6	11.2	7.5	11.2	17.5
Snizhana	2004	7.5	7.8	11.6	4.8	6.4	10.4	11.2	6.5	15.0
Remeslivna	2004	2.8	7.6	17.8	2.6	4.3	14.0	2.7	6.9	15.8
Pereiaslavka	2004	6.3	6.6	12.4	4.4	6.8	8.4	5.4	7.0	11.7
Demetra	2005	12.5	11.2	12.6	9.7	10.6	8.6	17.5	11.5	20.0
Vesnianka	2005	12.5	15.0	7.7	12.4	10.6	12.2	9.5	14.5	16.2
Favorytka	2005	7.5	7.3	10.3	8.4	9.6	7.4	6.2	6.5	8.7
Volodarka	2005	2.5	7.7	11.0	9.8	8.6	9.2	6.2	13.2	7.5
Bohdana	2006	2.5	5.7	13.3	7.4	7.2	11.0	7.5	5.7	7.7
Pyvna	2006	10.0	8.3	11.0	12.2	11.0	12.2	17.5	12.0	12.5
Zolotokolosa	2006	2.5	5.7	12.7	6.4	8.2	15.4	15.0	17.0	21.5
Khurtovyna	2007	5.0	15.0	9.3	12.2	10.6	10.6	15.0	25.0	20.0
Lasunia	2007	13.8	13.0	20.0	15.9	6.2	13.2	17.5	16.2	17.5
Khazarka	2008	2.5	6.0	11.0	8.8	8.0	13.2	8.2	7.2	13.7
Ekonomka	2008	15.0	23.3	20.0	6.7	5.0	13.3	6.2	10.0	13.7
Monotyp	2008	1.5	6.0	14.3	5.6	2.8	11.8	5.0	6.5	20.0
Madiarka	2008	12.5	8.7	11.0	9.6	6.6	16.4	3.5	11.5	8.7
Kolos	2008	25.0	8.3	13.3	12.8	10.8	8.2	17.5	10.7	17.5
Myronivschyny Kalynova	2008	25.0	5.7	11.0	8.8	8.0	12.2	10.0	9.0	22.5
Voloshkova	2008	15.0	7.0	14.6	9.8	6.2	9.0	16.2	8.2	20.0
Myrliena	2009	19.3	19.0	21.4	13.7	16.0	17.1	8.8	14.5	18.7
Yuviliar Myronivskyi	2009	45.0	12.3	8.7	8.0	7.8	8.8	16.2	17.0	16.2
Pam'iati Remesla	2009	2.5	5.7	12.7	8.7	7.6	11.0	6.2	7.8	18.7
Myronivskastorichna	2009	22.5	9.3	10.0	8.0	8.6	6.2	7.5	8.7	12.5
Yasnohirka	2009	7.5	8.3	11.0	7.2	5.4	8.8	4.5	8.2	12.5
Dostatok	2009	2.5	7.7	13.3	10.4	13.2	10.2	4.0	7.0	9.0
Yavoryna	2010	7.5	31.7	15.0	8.1	21.4	14.6	7.8	19.5	13.7
Lehenda Myronivska	2012							11.2	11.2	11.2
Svitanok Myronivskyi	2014							9.5	9.7	16.2
Oberih Myronivskyi	2014							18.7	12.0	12.5
Berehynia Myronivska	2016							7.5	9.5	10.0
Horlytsia Myronivska	2016							7.0	12.5	10.0
Hospodynia Myronivska	2017							12.5	8.5	13.7
MIP Valensiia	2017							12.7	7.8	13.2
Trudivnytsia Myronivska	2017							9.5	11.2	16.2
MIP Kniazhna	2017							11.5	11.5	10.0
MIP Vyshyvanka	2017							6.7	9.3	10.7

It is necessary to note the high level of resistance against brown rust (the degree of damage for the last two years does not exceed 1 %) for varieties MIP Dniprianka, Estafeta myronivska, Vezhamyronivska, which are included in the State Register in 2018. High resistance to powdery mildew was observed for varieties Estafeta Myronivska and Vezha Myronivska.

Conclusion

As a result of research, conducted during 1981-019, among the studied varieties of winter wheat, created in MIW, selected varieties with high resistance to brown rust: Kolumbiia, Remeslivna, Pereiaslavka, Bohdana, Monotyp, Khazarka, Pam'iati Remesla, Dostatok, Yasnohirka; powdery mildew: Kolumbiia, Remeslivna, Snizhana, Pereiaslavka, Favorytka, Bohdana, Khazarka, Monotyp, Pam'iati Remesla, Voloshkova, Yasnohirka. Varieties with high resistance to common bunt were not

detected. Varieties, which have group resistance to leaf diseases: Kolumbiia, Smuhlianka, Snizhana, Pereiaslavka, Volodarka, Favorytka, Bohdana, Zolotokolosa, Khazarka, Monotyp, Madiarka, Pam'iati Remesla, Lehenda Myronivska, Svitanok Myronivskyi, Berehynia Myronivska, MIP Vyshyvanka, and entered to the State Register in 2018 - MIP Dniprianka, Estafeta Myronivska, Vezha Myronivska.

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