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СКРИНИНГ СОРТООБРАЗЦОВ ПШЕНИЦЫ РОССИЙСКОЙ СЕЛЕКЦИИ НА УСТОЙЧИВОСТЬ К БУРОЙ РЖАВЧИНЕ

Агапова В.Д., Ваганова О.Ф., Кудинова О.А., Волкова Г.В.
Федеральный научный центр биологической защиты растений
Краснодар, Россия

Представлены результаты иммунологической оценки сортообразцов озимой твердой и озимой мягкой пшеницы селекции Аграрного научного центра «Донской» на устойчивость к бурой ржавчине. Опыт проведен на территории Краснодарского края в 2016–2019 гг. Скрининг 86 селекционных образцов (63 сортообразца озимой твердой пшеницы и 23 образца озимой мягкой пшеницы) осуществляли в условиях искусственного инфекционного фона. Для заражения растений использовали популяцию, собранную во время маршрутных обследований производственных и селекционных посевов озимой пшеницы. Оценку сортообразцов проводили по двум критериям: типу реакции (в баллах) и степени поражения (в процентах) в период максимального развития болезни. Скрининг образцов осуществляли в течение трех вегетационных сезонов, для второго и третьего года изучения отбирали устойчивые сортообразцы с типом реакции 1,2 балла и степенью поражения не больше 10%. Степень поражения на контроле по восприимчивости достигала от 50 до 80%. В результате исследования образцы озимой твердой пшеницы ранжированы следующим образом: устойчивые – 16 образцов, среднеустойчивые – 26, средневосприимчивые – 20, восприимчивые – 1. Среди образцов озимой мягкой пшеницы выделили 6 устойчивых образцов; 11 среднеустойчивых; 5 средневосприимчивых, 1 восприимчивый. За 3 года исследований выявлены 16 устойчивых образцов озимой твердой пшеницы (465/15, 502/15, 515/15, 537/15, 597/15, 663/15, 681/15, 694/15, 730/15, 742/15, 753/15, 979/15, 996/15, 993/12, 1035/15, 417/13) и 6 устойчивых образцов озимой мягкой пшеницы (134/11, 1415/11, 1765/14, 1074/14, 1813/14, Танаис). В результате проведенного скрининга обнаружен высокий процент устойчивых сортообразцов к бурой ржавчине. Выделенные источники устойчивости рекомендованы для включения в программы селекции пшеницы на устойчивость к патогену в Российской Федерации.

Ключевые слова: пшеница озимая, бурая ржавчина, *Puccinia triticina*, источники устойчивости, селекция

SCREENING OF WHEAT VARIETIES OF THE RUSSIAN BREEDING FOR RESISTANCE TO BROWN RUST

Agapova V.D., Vaganova O.F., Kudinova O.A., Volkova G.V.
Federal Scientific Center for Biological Plant Protection
Krasnodar, Russia

The results of immunological assessment of varieties of durum and soft winter wheat bred by the Agrarian Scientific Center Donskoy for resistance to leaf rust are presented. The experiment was carried out in Krasnodar Territory in 2016–2019. Screening of 86 selection samples (63 varieties of durum winter wheat and 23 samples of soft winter wheat) was carried out in an artificial infectious environment. To infect plants, a population collected during route surveys of production and selection crops of winter wheat was used. The varieties were assessed according to two criteria: the type of

reaction (in points) and the degree of damage (in percent) during the period of maximum disease development. Screening of the samples was carried out during three growing seasons; for the second and third years of the study, resistant varieties were selected with the reaction type of 1.2 points and the degree of damage of no more than 10%. The degree of damage on the susceptibility control reached from 50 to 80%. As a result of the study, the samples of durum winter wheat were ranked as follows: 16 resistant samples, 26 medium-resistant, 20 medium-susceptible, 1 susceptible. Among the samples of soft winter wheat, 6 resistant samples were identified, 11 medium-resistant, 5 medium-susceptible, 1 susceptible. Over 3 years of research, 16 resistant samples of durum winter wheat were identified (465/15, 502/15, 515/15, 537/15, 597/15, 663/15, 681/15, 694/15, 730/15, 742 / 15, 753/15, 979/15, 996/15, 993/12, 1035/15, 417/13) as well as 6 resistant samples of soft winter wheat (134/11, 1415/11, 1765/14, 1074/14, 1813/14, Tanais). As a result of the screening, a high percentage of varieties resistant to leaf rust was found. The sources of resistance that were identified have been recommended to be included in wheat breeding programs for pathogen resistance in the Russian Federation.

Keywords: winter wheat, brown rust, *Puccinia triticina*, sources of resistance, breeding

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INTRODUCTION

Wheat is one of the most demanded agricultural crops in Russia. According to the Federal State Statistics Service of the Russian Federation it dominates in terms of the crop production area in the country (27.7 million hectares)[1]. The increased interest in this culture can be explained by the high nutritional value of products obtained as a result of grain processing [1]. According to forecasts, by 2050 the demand for wheat will have grown by 60%, and its yield is expected to have declined by 29% due to climatic factors, diseases and pests [2]. The most acceptable and economically profitable way to increase crop yields is the selection of an optimal varietal assortment for the characteristics of the cultivation site [3].

When improved varieties of new selection are used in the production, the yield increases, the adaptability of plants to critical weather conditions goes up, resistance to insect pests and phytopathogens increases, the output increases and the quality of products improves. However, a violation of crop rotation, a change

[1]Federal State Statistics Service. URL: http://rosstat.gov.ru/storage/mediabank/posev_pl1(1).xls (date of the application 29.12.2020).

in the genetic resistance of industrial varieties and the introduction of seed material provoke a change in the species composition of pathogens of agricultural crops [4].

One of the most geographically widespread and common wheat infections is brown rust caused by the obligate biotrophic fungus Puccinia triticina Erikss. Wheat brown rust is a serious problem for many grain-producing regions of the world and can lead to a loss of yield in the range of 10–50% with a high infection [5]. A distinctive feature of P. triticina is a high plasticity of the fungus population, which leads to the selection and accumulation of virulent pathotypes capable of overcoming the race-specific resistance of the sown varieties [6]. To prevent an epiphytotic situation, it is necessary to take into account constantly updated data on the resistance of varieties when they are placed.

A study of the varieties' resistance under conditions of an artificial infectious background in the zones of their regional assignment is important information for breeders. Currently, research on this issue is being carried out in various agroclimatic zones of Russia and abroad [7–10]. A comprehensive program of the Kazakh-Siberian Network (KASIB) made it possible to give an objective ecological assessment of the breeding material and highlight the most promising genotypes. During the variety testing of the KASIB network in 2000–2016 more than 500 varieties of spring soft wheat were considered. It was found that 64.8% of the samples belonged to the susceptible group, 18.5 were partially resistant and 16.7% were highly resistant to brown rust of wheat [11]. Extensive work on this issue is also being carried out by the Agricultural Research Institute of the South-East. 597 collection samples of soft spring breeding CIMMYT (Mexico), the world collection of VIR (St. Petersburg), varieties of domestic breeding and wild wheat species were studied, of which 335 varieties resistant to brown rust were identified [12].

For the screening of samples from the International Center for the Improvement of Corn and Wheat (CIMMYT) for resistance to wheat brown rust in Egypt 716 samples were studied. During three growing seasons (2017–2020) it was determined that 94 wheat genotypes were resistant to brown rust [13]. In Pakistan, as a result of an assessment of 152 lines of common wheat 68 varieties resistant to this infection were identified. The study was carried out on the experimental territory of the Ayub Research Institute of Agriculture (Faisalabad) [14].

This work presents the results of studying the variety samples of the selection of the Agrarian Scientific Center "Donskoy" (Zernograd, Rostov region) for their resistance to brown rust. In the ASC "Donskoy" promising research aimed at obtaining highly productive varieties and hybrids of grain crops, the search for methods for obtaining new starting material, and the analysis of genetic processes have been carried out. The resulting varieties in their physiological and economic qualities correspond to the best foreign and domestic samples, have high ecological plasticity and have complex resistance to the dominant diseases common in the cultivation zones [15].

The purpose of the study is to screen 86 cultivars of the ASC "Donskoy" selection for resistance to the North Caucasian population of the wheat brown rust pathogen under conditions of an artificial infectious background.

MATERIAL AND METHODS

The studies were carried out in 2016–2019 at the experimental field of the Federal Scientific Center for Biological Plant Protection (FSCBPP).

The conditions of the 2017 growing season were characterized by frequent rains and low temperatures, which caused a delay in the maturation of grain crops and contributed to the rapid development of the disease. In the spring of 2018, unstable weather was noted with sharp temperature fluctuations and low precipitation. With abnormally high temperatures in May - June a significant deficit of precipitation was observed (20–30% of the norm). In 2019 weather conditions turned out to be favorable for the development of phytopathogens on grain crops. From the beginning of February to the end of May the air humidity was high (within 65–90%), the temperature for a long time was confined within the optimum for the

development of the pathogen.

The research material consisted of 63 varieties of durum winter wheat and 23 samples of soft winter wheat bred by ASC "Donskoy". Susceptibility control - Michigan Amber cultivar. Infectious material - a combined population of brown rust collected as a result of route surveys of production and selection crops of winter wheat in the Krasnodar, Stavropol Territories and Rostov Region, containing all the virulence genes we have identified [16].

Varieties of winter wheat were sown at the infectious site of the Federal Research Center for Plant Protection and Rehabilitation in rows of 3 linear meters in triplicate, seeding rate - 100-130 seeds per 1 running m. A susceptible cultivar which was the accumulator of infection was placed in every 10 plots.

Inoculation was carried out in spring at a temperature of 10–15 ° C; the plants were infected with a mixture of P. triticina urediniospores and talc in a ratio of 1: 100 (10 mg of pathogen spores / m^2) in the evening under dew or after rain. The duration of the humidified period for the introduction and germination of the pathogen was at least 6 h[2].

To assess the breeding material, the records were carried out during the period of maximum development of the disease. The cultivars were characterized by two parameters: the type of reaction (in points) to brown rust infection and the degree of damage (in percent) on a scale[3] [17]: 0 - completely immune, 0; - practically immune, 1 - highly resistant, 2 - moderately resistant, 3 - moderately susceptible, 4 - highly susceptible.

The collection cultivars were ranked into four groups according to the type of resistance to P. triticina: 1 - resistant (type 1 point; degree of damage 1–5%); 2 - moderately resistant (type 1.2 points; degree of damage 10–20%); 3 - moderately susceptible (type 2.2 (3) points; degree of damage 20-30%); 4 - susceptible (type 2.2 (3) points - more than 30% and type 3.4 points - more than 5%)[4,5].

The research used the material and technical base of the LSRF (large scale research facilities) "Fitotron for the isolation, identification, study and maintenance of races, strains, phenotypes of pathogens" (https://ckp-rf.ru/usu/671925/?sphrase_id = 3644277) and objects of the BRC " State collection of entomoacariphages and microorganisms " of the FSCB-PP.

RESULTS AND DISCUSSION

86 varieties (63 hard winter and 23 winter soft wheat) of the ASC “Donskoy” selection were evaluated with the artificial infection of the North Caucasian population of the brown rust pathogen (see table).

Screening of the samples was carried out during three growing seasons, for the second and third years of the study resistant varieties were selected with a reaction type of 1.2 points and a degree of damage not more than 10. The degree of damage on the control by susceptibility reached from 50 to 80%.

As a result of the study, the samples of durum winter wheat were ranked as follows: resistant - 16 samples (25% of the number studied); medium resistant - 26 (41%); moderately susceptible - 20 (32%); susceptible - 1 (2%).

Samples of soft winter wheat were classified in the same way: resistant - 6 samples (26% of the studied); medium resistant - 11 (48%); moderately susceptible - 5 (22%); susceptible - 1 (4%) (see the figure).

During the three years of the study, 16 resistant samples of durum winter wheat were

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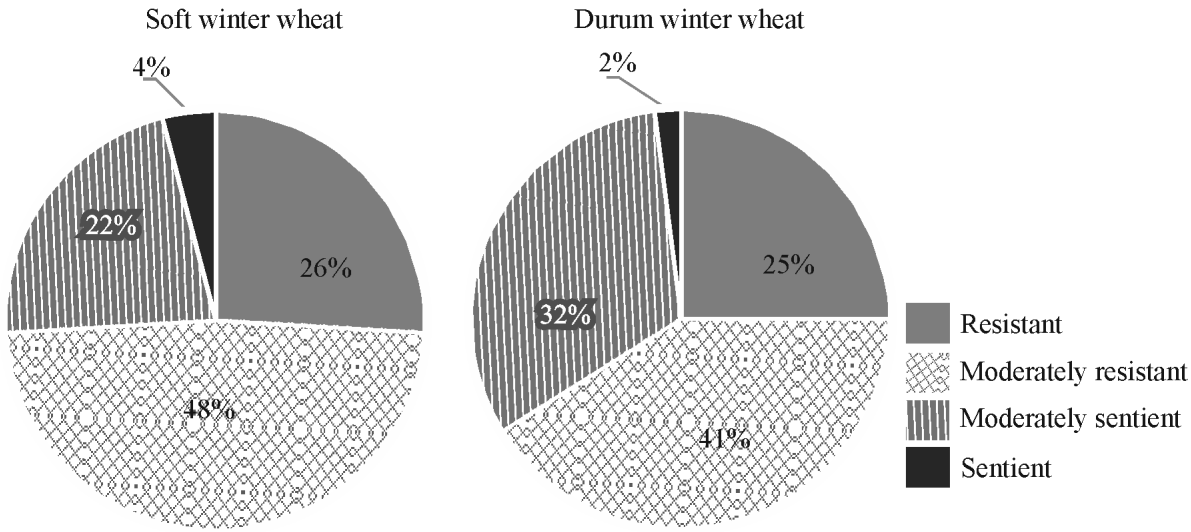
Иммунологическая оценка сортообразцов селекции АНЦ «Донской» (2016–2019 гг.)
Immunological assessment of varieties bred by Agrarian Research Centre Donskoy (2016–2019)

No.	Variety	Year of study			No.	Variety	Year of study		
		first	second	third			first	second	third
Durum winter wheat									
1	484/14	2,3/10	–*	–	33	808/15	2,3/20	–	–
2	533/14	2/5	1,2/10	–	34	820/15	1,2/10	–	–
3	605/14	2,3/10	–	–	35	865/15	2,3/20	–	–
4	627/14	1,2/10	–	–	36	876/15	1,2/20	–	–
5	784/14	2,3/20	–	–	37	907/15	1/5	1/10	–
6	896/14	2,3/20	–	–	38	920/15	1/5	1,2/20	–
7	913/14	2,3/10	–	–	39	961/15	1/5	1,2/10	–
8	465/15	1/5	1,2/5	1/5	40	966/15	1/5	1,2/10	–
9	492/15	1/5	1,2/10	–	41	973/15	1/5	1,2/20	–
10	502/15	1,2/5	1,2/5	1/5	42	979/15	1/5	1/5	1/1
11	515/15	1,2/5	1/1	1,2/5	43	986/15	1/5	1,2/5	1,2/10
12	524/15	1/5	1/1	1,2/10	44	996/15	1/5	1,2/5	1/1
13	528/15	1/5	1/5	1,2/10	45	1014/15	1/5	1,2/5	1,2/20
14	537/15	1,2/5	1,2/5	1/5	46	1035/15	1/5	1,2/5	1,2/5
15	543/15	2,3/20	–	–	47	1040/15	1/5	2,3/20	–
16	546/15	2,3/20	–	–	48	1048/15	2,3/10	–	–
17	550/15	1,2/10	–	–	49	1069/15	1/5	1,2/20	–
18	588/15	2,3/20	–	–	50	1084/15	1/5	2,3/30	–
19	597/15	1,2/5	1,2/5	1,2/5	51	537/11	2,3/15	–	–
20	611/15	1,2/10	–	–	52	737/11	1/5	2,3/20	–
21	631/15	1,2/10	–	–	53	477/12	1/5	1/10	–
22	663/15	1/5	1/5	1/1	54	840/12	1/5	1,2/20	–
23	681/15	1/5	1,2/5	1/5	55	993/12	1/5	1/5	1/5
24	693/15	3/30	–	–	56	114/13	2,3/10	–	–
25	694/15	1/5	1/5	1/5	57	353/13	1/5	1,2/10	–
26	713/15	1,2/5	1,2/10	–	58	417/13	1/5	1/5	1/5
27	721/15	2,3/20	–	–	59	531/13	2,3/20	–	–
28	730/15	1/5	1/5	1/5	60	589/13	2,3/10	–	–
29	742/15	1/5	1/5	1/5	61	655/13	2,3/20	–	–
30	753/15	1/5	1/5	1/5	62	683/13	1,2/5	1,2/10	–
31	773/15	1,2/10	–	–	63	117/14	1/5	1/5	1/10
32	387/15	1/10	–	–					
Soft winter wheat									
1	134/11	1/5	1/5	1/5	13	1545/14	1/1	2,3/30	–
2	1127/10	1/5	1/10	–	14	1580/14	1,2/5	1,2/10	–
3	1415/11	1/5	1/5	1/5	15	1626/14	1,2/5	1/10	–
4	1159/13	1,2/5	1,2/10	–	16	1810/14	2,3/10	–	–
5	1261/13	1/5	1/10	–	17	1813/14	1/5	1/5	1/5
6	1481/13	1/5	2,3/30	–	18	1909/14	1,2/5	1,2/10	–
7	1756/13	1/5	1/10	–	19	1953/14	1/10	–	–
8	1765/13	1/5	1/5	1/5	20	1979/14	1/5	1/5	1/10
9	1074/14	1/5	1/5	1/5	21	1991/14	1/5	2,3/10	–
10	1182/14	2/5	1,2/20	–	22	2028/14	1/5	2/5	1,2/10
11	1309/14	1,2/5	1,2/10	–	23	Tanais	1/5	1/5	1,2/5
12	1441/14	3/30	–	–		Michigan Amber	3/80	3/70	3/50

*Sentient reaction type



Соотношение сортообразцов озимой твердой и мягкой пшеницы по устойчивости к *P. triticina (*2016–2019 гг.)

The ratio of durum and soft winter wheat varieties for resistance to *P. triticina* (2016-2019)

identified (465/15, 502/15, 515/15, 537/15, 597/15, 663/15, 681/15, 694/15, 730/15, 742 / 15, 753/15, 979/15, 996/15, 993/12, 1035/15, 417/13), as well as 6 resistant samples of winter soft wheat (134/11, 1415/11, 1765/14, 1074 / 14, 1813/14, Tanais).

During the screening, a high percentage of varieties resistant to brown rust was found, which indicates the effective breeding work of the ASC "Donskoy" on this trait. They can be used as sources of resistance to P. triticina for wheat breeding in the Russian Federation.

CONCLUSION

Long-term studies carried out at the Federal Research Center for Plant Protection of Natural Resources on artificial infectious backgrounds of P. triticina made it possible to give an objective immunological assessment of winter wheat samples and to isolate varieties with different degrees of resistance. Among 86 varieties of winter wheat bred by ASC "Donskoy" 16 sources of resistance to the causative agent of brown rust among winter durum wheat and 6 - among winter soft wheat were identified.

For perspective breeding of P. triticina-resistant varieties of winter wheat, it is advisable to integrate into crossing both local varieties that retain a long-term high resistance to infection, and varieties from other Russian regions and foreign breeding, showing resistance in certain natural and climatic zones.

The isolated sources of resistance are recommended for inclusion in the programs of wheat breeding for resistance to the pathogen in the Russian Federation.

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Информация об авторах

Агапова В.Д., младший научный сотрудник; e-mail: agapovalera1996@gmail.com

Ваганова О.Ф., научный сотрудник; e-mail: vof54@mail.ru

Кудинова О.А., кандидат биологических наук, старший научный сотрудник; e-mail: alosa@list.ru

✉ **Волкова Г.В.,** доктор биологических наук, главный научный сотрудник, заведующая лабораторией; **адрес для переписки**: Россия, 350039, Краснодарский край, г. Краснодар, п/о 39

Author Information

Valeria D. Agapova, Junior Researcher; e-mail: agapovalera1996@gmail.com

Olga F. Vaganova, Researcher; e-mail: vof54@mail.ru

Olga A. Kudinova, Candidate of Science in Biology, Senior Researcher; e-mail: alosa@list.ru

✉ **Galina V. Volkova**, Doctor of Science in Biology, Head Researcher, Head of Laboratory; **address:** p/o 39, Krasnodar, Krasnodar Territory, 350039, Russia; e-mail: vniibzr@mail.ru

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