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STUDY OF AGRONOMIC AND IMMUNOLOGICAL TRAITS OF NEW FACULTATIVE AND WINTER WHEAT CULTIVAR SAMPLES

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Abstract. This study presents the research on economically valuable traits of 70 varieties of Facultative and Winter Wheat Observation Nursery for Semiarid Environments (FAWWON-SA) received from the International Wheat and Maize Improvement Center (CIMMYT). The study of agronomic and immunological characteristics of plants under field conditions is of great importance in breeding since it allows a selection of the best genotypes more effectively, identifies and uses the sources of valuable traits and increases the accuracy of breeding. The results showed that 57 cultivar samples were winter-hardy, and the days to maturation ranged from 242 to 247. The mass of 1000 kernel ranged from 45.00 to 97.33 grams being coarse and fulfilled. Under artificial infection background of rusts, 15 cultivar samples were resistant to stem, leaf and yellow rusts. Based on the results, wheat cultivar samples were grouped by agronomic and immunological traits, resulting in the identification of 41 cultivar samples with valuable characteristics which recommended as donors in breeding.

Key words: resistance; wheat; cultivar samples; rust; yield

Introduction

Kazakhstan is known in the world market as a producer of grains crops, mainly bread wheat, which contains much protein but has a low yield. Despite this, wheat cultivation in Kazakhstan continues due to the need to ensure the country's food security. The low harvest is compensated for by the high quality of the grain, making it a good ingredient for the production of lower-grade flour, providing excellent baking properties [1,2].

One of the limitations to achieving higher yields in winter and spring wheat is fungal diseases that spread through airborne droplets, which can contribute to a decrease in grain yield and product quality in some years. Fields of wheat infected with disease agents continue to exist in many regions of the country due to violations of agro-technics, the cultivation of susceptible varieties, insufficient protective measures, and favourable weather conditions. In Kazakhstan, among the most common and dangerous wheat diseases are rusts: *Puccinia triticina* Erikss (leaf rust), *Puccinia graminis* f. *tritici* Erikss & Henning (stem rust) and *Puccinia striiformis* Westend (yellow rust) [3-5].

A complex of diseases that cause significant yield losses develops annually on wheat crops in the republic. Leaf rust and septoria occur almost everywhere but are particularly severe in areas with sufficient moisture. Leaf rust and septoria epidemics were observed in 2000-2016, yield losses of spring wheat reached 20-30%, or 3-5 c/ha and more, and grain quality was reduced [3,6,7].

The emergence of a new aggressive race of the stem rust pathogen, Ug99, and its expansion threatens the food security of world wheat production. In Kazakhstan, the repeated development of stem rust is observed in some areas of the country. For example, in the Kostanay and North Kazakhstan regions in 2006-2007, the yield losses ranged from 20% to 40%, and some regions, were 80-100% [8]. In 2015-2017, epiphytotic development of stem rust was noted in the North Kazakhstan and in the Omsk region of Russia, resulting in grain losses of up to 30-40% [9].

Yellow rust is another dangerous rust species affecting wheat. Highly aggressive races of this disease are rapidly spreading across continents, causing severe outbreaks in many countries. The new races threaten wheat production because they have adapted to higher temperatures, and their spread is not limited to areas with cooler climates than before. In Kazakhstan and other Central Asian

countries, the pathogen occurs almost yearly except for dry years. During 2009-2014, epiphytotic development of yellow rust occurred four times in the southern and southeastern regions of Kazakhstan and Uzbekistan [10-12]. Moreover, many winter wheat cultivars approved for use in Kazakhstan are susceptible to yellow rust [3, 4, 13]. All of the above, in turn, affects the stability of food safety. Therefore, there is a need to search for new sources of resistance to wheat rusts using modern approaches.

Disease-resistant crop cultivars creation and introducing them into production is a leading challenge in modern plant breeding. Economically valuable traits are studied in field conditions, allowing for the identification and utilization of valuable trait sources and donors for targeted breeding. For example, the maturation period affects yielding and impacts resistance to drought, diseases, and other stress factors. This task is closely related to the theoretical foundations of plant immunity, and breeders work with various specialists to develop resistant varieties. Thus, comprehensive studying of economically valuable traits such as maturation duration, disease resistance, and yield predictability is necessary to select wheat lines with high yields and good grain quality. Another essential part of targeted breeding is conducting trials of individual varieties under different agro ecological conditions to identify the geographic locations where a wheat sample is best suited and what resistance traits it must possess to produce high and stable yields.

Materials and methods

Total of 70 cultivar samples of Facultative and Winter Wheat Observation Nursery for Semiarid Environments (27 FAWWON-SA 2019-2020) from International Wheat and Maize Improvement Center (CIMMYT) were studied under artificial infection with rust species in Zhambyl region Kazakhstan at the Research Institute for Biosafety Problems (RIBSP). The disease was recorded starting from the tasseling stage.

Field plot was cultivated using a SOLO 503 cultivator after plowing and harrowing. Seeds were sown manually from 0.4 to 3.0 square meters, with 20 cm spacing between rows and 100-300 cm row length, resulting in 65-80 seeds per row. The control variety, which served as an accumulator of infection and propagator, was a susceptible spreader cultivar – Steklovidnaya 24. The experimental plots were regularly sprayed with water to create favorable conditions for plant development and disease control [14].

Before infecting the wheat plants, the inoculum was activated at 40°C for 10 minutes, followed by watering in a humid chamber at 20°C for 2 hours. During the spring, samples were inoculated with an aqueous suspension of leaf, stem and yellow rust spores supplemented with Novec™ 7100 Engineered Fluid (Sigma-Aldrich, St. Louis, MI, USA), resulting solution was sprayed with an airbrush spray gun onto wheat plants at the seedling stage. Novec 7100 is the most efficient chemical for facilitating penetration of the spores into the leaf surface [15]. After inoculation, experimental plants were covered with polyethylene film for 16-18 hours. The plants were inoculated in the evening during windless weather conditions after preliminary watering of the experimental crops [16].

Winter hardiness was evaluated according to the methodology of the state variety testing [17]. Mass of 1000 seeds was evaluated following GOST 10842-89 [18].

During the growing season, the adult plant resistance was assessed three times, with a two-week interval starting from the appearance of the first signs of disease. Scales for reaction type and severity were used as an evaluation criterion. The type of infection for stem rust was determined according to Stakman et al. [19], leaf rust was determined using the Mains and Jackson scale [20], and yellow rust was evaluated by Gassner and Straib scale [21]. The evaluation scores ranged from 0 (indicating immunity) to R (resistance), MR (moderate resistance), MS (moderate susceptibility), and S (susceptibility) [22]. The degree of lesion caused by rust diseases was estimated using the modified Cobb scale developed by Peterson et al. [23]. The rate of disease onset expressed by the area under the disease progress curve (AUDPC) was used as an indicator of nonspecific genotype resistance [24].

The data were plotted and analyzed using GraphPadPrism 9.2.0 (GraphPad Software, Inc., LaJolla, CA, USA).

Results

In 2022, we studied 70 cultivar samples of Facultative and Winter Wheat Observation Nursery for Semiarid Environments (FAWWON-SA) from CIMMYT. In the experiments, the total duration of the maturation trait of the new wheat lines ranged from 242 to 247 days. In many cultivar samples, this trait was at the level or higher than the control variety Steklovidnaya 24. The duration of the interphase periods from emergence to tasseling for all samples varied significantly, ranging from 28 to 43 days. The average maturation period for facultative and winter wheat samples was 245 days, designated as medium-ripening group.

Based on the results of agronomic trait research, the FAWWON-SA cultivar samples were grouped by winter hardiness and mass of one thousand grains (Figure 1).

Winter hardiness in bread wheat is a complex physiological process that depends on a cultivar's genotype and environmental factors. Therefore, the relevance of creating and cultivating varieties resistant to abiotic factors is beyond doubt. Most cultivar samples (57) were winter-hardy, while 11 were medium hardiness and two lines, PP346/NOVAZVEZDA/5/CUPRA-1/3/... and AISBERG/AE.SQUARROSA(369)//DEMIR, showed a low level of winter hardiness. The final agronomic feature of wheat cultivars assessment is their productivity trait.

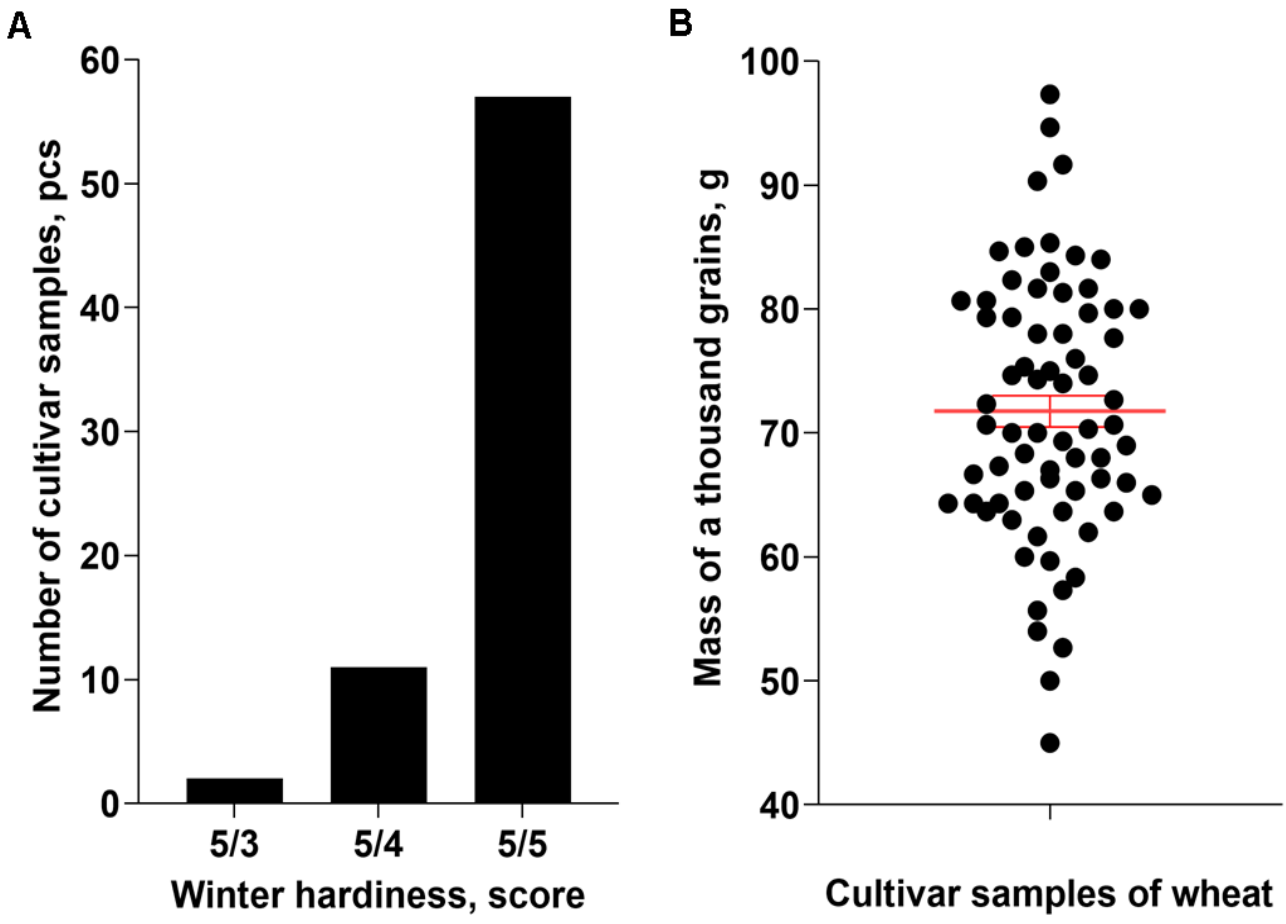
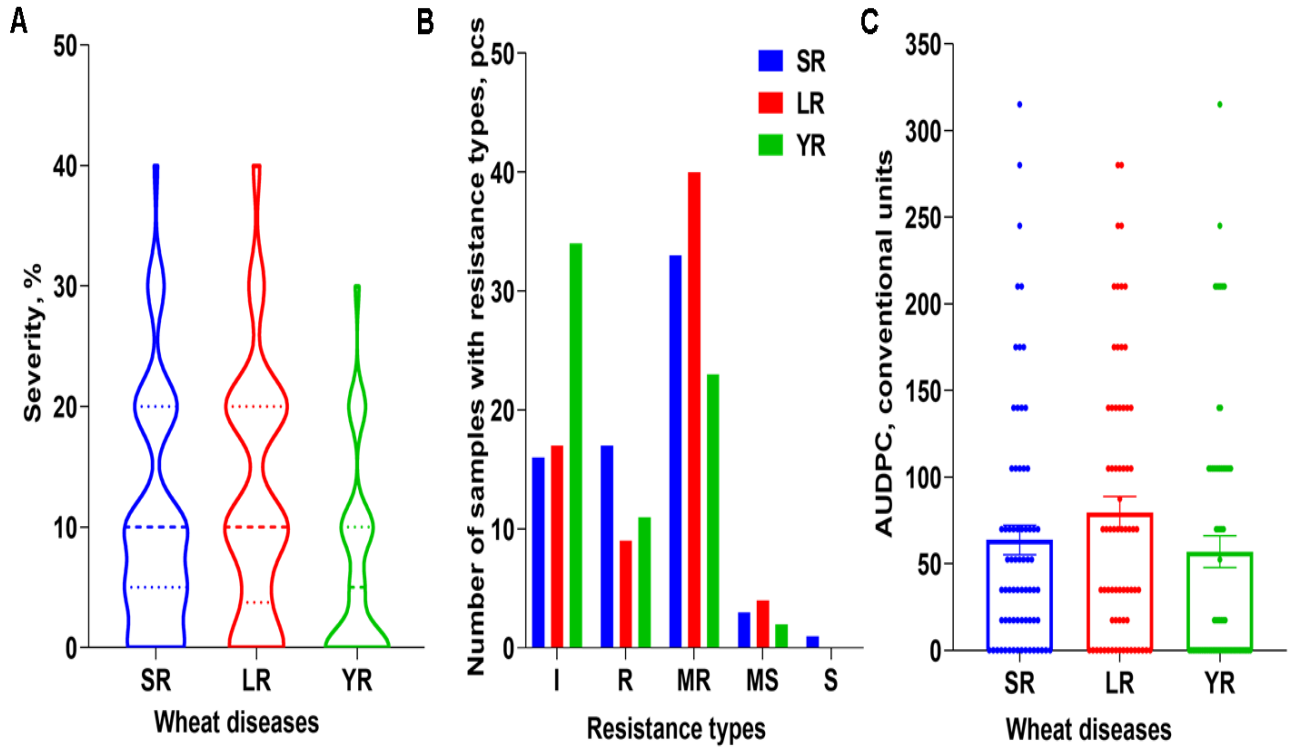


Figure 1 – Distribution of FAWWON-SA cultivars samples by winter hardiness (A) and mass of a thousand grains (B)

Mass per 1000 grains is a genetically determined feature, which serves as a certain guarantee of yield when creating a new cultivar. The mass of 1000 kernel ranged from 45.00 to 97.33 grams being coarse and fulfilled. The highest values of this feature were noted in the samples HK96/3/CHAM6//1D13.1/MLT/4/KONYA 2002 (90.33 g), CHAM6/TK13//LND/6/MV8/5/BEZ//BEZ/TVR/3/KREMENA/LOV29/4/KATE-A1 (91.67 g), and TOSUNBEY/2*MUFITBEY (94.67).

During the growing season, field assessments of adult plant resistance (APR) were carried out three times. Based on the results of APR to diseases, the FAWWON-SA cultivar samples were grouped by severity, resistance types, and area under the disease progress curve (AUDPC) (Figure 2).



SR – stem rust, LR – leaf rust, YR – yellow rust; AUDPC – area under the disease progress curve; I – immune, R– resistant, MR – moderate resistant, MS – moderate susceptible, S – susceptible

Figure 2 –Distribution of FAWWON-SE cultivar samples by severity (A), resistance types (B) and AUDPC (C) to the stem, leaf and yellow rust

Depending on their resistance to pathogens, the wheat materials differed according to the APR to diseases. Under artificial infection, the maximum severity of stem rust was 40%, leaf rust was 40%, and yellow rust was 30% (Figure 2A). Although, the number of wheat cultivar samples resistant to yellow rust was significantly higher than stem and leaf rust. Consequently, only 45 cultivar samples were resistant and moderately resistant to yellow rust, 33 were resistant to stem rust, and 26 were resistant to leaf rust (Figure 2B). The maximum AUDPC value under artificial infection of stem and leaf rust was 315 conventional units, and for yellow rust was 280 units, indicating medium and low susceptibility, respectively (Figure 2C). 29 cultivar samples in the study showed valuable agronomic traits, however, were excluded during the experiment because they were susceptible to wheat rust species. 26 samples were resistant or moderately resistant to two types of rust. Overall 15 cultivar samples had complex resistance to all three types of rust. The selection is established on the best combinations of economically valuable traits through data grouping of agronomic and immunological parameters. Based on the results, 41 wheat cultivar samples were selected, which

showed at least moderate resistance to two types of rust and had economically valuable traits (Table 1).

Table 1 – Selected cultivar samples of FAWWON-SA with valuable immunologic and agronomic traits

No.	Name of the cultivar samples of FAWWON-SA	Agronomic traits					Immunologic traits		
		hardiness, score	Duration, days			Mass of 1000 seeds, g	Resistance[2]		
			emergence-tasseling	tasseling-maturation	emergence - maturation		Stem rust	Yellow rust	Leaf rust
1	**GEREK79**[1]	**5/5**	**208**	**39**	**247**	**60,00**	**5R**	**0**	**0**
2	LOCAL CHECK	5/5	205	37	242	80,67	40MR-S	20R	10MR
3	**AGRI/NAC//KAUZ/3/NU DAKOTA**	**5/5**	**208**	**39**	**247**	**75,00**	**5R**	**20R**	**0**
4	**VORONA/KAUZ//1D13.1 /MLT/3/POSTROCK**	**5/4**	**208**	**39**	**247**	**84,33**	**10R**	**10R**	**10MR**
5	**PYN/BAU/3/AGRI/BJY// VEE/4/HBK0935-29-15/K S90W077-2-2/VBF0589-1**	**5/5**	**207**	**40**	**247**	**81,67**	**10MR**	**0**	**0**
6	**QUAIU/3/MILANCM751 18/KACM75118//TAJAN/ 4/MAHON DEMIAS/3/ HIM/CNDR//CA8055**	**5/5**	**202**	**41**	**243**	**74,67**	**0**	**0**	**0**
7	**BILLING(N566/OK94P5 97)/3/ATTILA*2/PBW65/ /TNMU**	**5/5**	**201**	**41**	**242**	**70,67**	**0**	**0**	**0**
8	**MOSKVICH/3/ZANDER -10//BOW/NKT**	**5/4**	**204**	**38**	**242**	**79,33**	**5MR**	**10R**	**10MR**
9	**MILLENNIUM/NE93613 //T07/07**	**5/4**	**208**	**39**	**247**	**84,67**	**0**	**0**	**0**
10	BLUEGIL-2/BUCUR// SIRENA/4/2180*K/2163// ?/3/W1062A*HVA114/W3 416	5/4	212	35	247	75,33	30MS	0	10MR
11	**ZUBKOV/4/C80.1/3*BA TAVIA//2*WBLL1/3/2*K RONSTAD F2004/5/ ZUBKOV**	**5/5**	**205**	**37**	**242**	**84,00**	**20MR**	**0**	**0**
12	ZUBKOV/4/C80.1/3*BAT AVIA//2*WBLL1/3/2*KR ONSTAD F2004/5/ ZUBKOV	5/5	207	40	247	81,33	10R-MR	20MR	10MR
13	**MINO/5/REH/HARE//2* BCN/3/CROC_1/AE.SQU ARROSA(213)//PGO/4/ HUITES/6/DH01-29-33* R/7/TAM200/KAUZ//DA**	**5/5**	**211**	**36**	**247**	**70,00**	**5R**	**10MR**	**0**
14	VOEVODO/TX96V2427	5/4	211	36	247	79,33	5R	20MS	0
15	VOEVODO/TX96V2427	5/4	211	36	247	77,67	5MR	30MS	10MR
16	KAPKA-I.P./MV10-2000// DORADE-5	5/4	205	37	242	65,00	5R	10MR	10MR
17	**DORADE-5/3/SHI# 4414/CROWS"//GK SAGVARI/CA8055**	**5/4**	**208**	**39**	**247**	**63,67**	**5R**	**10MR**	**5R**
18	**HUW234+LR34/PRINIA/ /INQALAB91*2/KUKUN A/5/FRET2*2/4/SNI/TRA P#1/3/KAUZ*2/TRAP//K AUZ/6/ORKINOS-3**	**5/5**	**204**	**38**	**242**	**63,00**	**0**	**0**	**0**

Table 1 (continued)

19	DESCONSE../4/C80.1/3*BATAVIA//2*WBLL1/3/2*KRONSTADF2004 /5/TREGO/BTY SIB	5/5	208	39	247	63,67	20MS	20MR	30MS
20	PP346/NOVAZVEZDA/5/CUPRA-1/3/CROC1/AE.SQUARROSA (224)//2*OPATA/4/PANTHEON/6/CUPRA-1/3/CROC1/AE.SQUARROSA (224)//2*OPATA/4/PANTHEON	5/3	204	38	242	70,67	20MS	10MR	20MS
21	AISBERG/AE.SQUARROSA(369)//DEMIR	5/3	211	36	247	74,67	5R	10MR	10R
22	LEUC 84693/AE.SQUARROSA(310)//ADYR	5/5	211	32	243	68,00	5MR	20MR	10MR
23	**LEUC 84693/AE.SQUARROSA(1026)//GEREK79**	**5/5**	**211**	**36**	**247**	**80,00**	**10R**	**0**	**20MR**
24	**VORONA/KAUZ//1D13.1/MLT/3/AGRI/NAC//ATTILA**	**5/5**	**211**	**36**	**247**	**58,33**	**5R**	**10R**	**10R**
25	**VORONA/KAUZ//1D13.1/MLT/3/IVETA NTA-92/89-6**	**5/5**	**205**	**37**	**242**	**63,67**	**0**	**0**	**5R**
26	CRINA/BONITO-37	5/5	205	37	242	61,67	20MR	5R	20MS
27	**ZUBKOV/4/C80.1/3*BATAVIA//2*WBLL1/3/2*KRONSTADF2004 /5/ZUBKOV**	**5/5**	**208**	**39**	**247**	**68,33**	**5R**	**0**	**0**
28	**BEZ/SDV1/5/338-K1-1//TJB368.251/BUC/4/YMH/TOB//MCD/3/LIRA/6/VEE/TSI//GRK/3/NS55.03/5/C126.15/COFN/3/N10B/P14//P101/4/KRC67/7/TAM105/3/NE70654/BBY//BOW"S"/4/Century*3/TA2450/8/CUPRA-1/3/CROC1/AE.SQUARROSA (224)//2*OPATA/4/PANTHEON**	**5/5**	**205**	**37**	**242**	**50,00**	**5MR**	**10R**	**10R**
29	DH01-29-33*R/2*SONME	5/4	208	39	247	80,67	30MR	20MR	20MR
30	**SAAR*2//PBW343*2/KUKUNA/3/EKIZ/4/PANTHEON/BLUEGIL-2**	**5/4**	**211**	**36**	**247**	**65,33**	**10R**	**10R**	**10MR**
31	**ATTILA/3*BCN*2//BAV92/3/CATEDRAL**	**5/5**	**208**	**39**	**247**	**70,33**	**10MR**	**0**	**0**
32	**TAM112/OK02518W//HV9W02-243W**	**5/5**	**205**	**37**	**242**	**74,00**	**0**	**5MR**	**5MR**
33	OK08413/4/MAHON DEMIAS/3/HIM/CNDR//CA8055	5/5	211	31	242	72,67	10MR	20MR	20MR
34	SAULESKU #44/TR810200//QUAIU/3/SAULESKU #44/TR810200	5/4	214	28	242	72,33	20MR	0	30MR

Table 1 (continued)

35	MINO/5/REH/HARE//2*BCN/3/CROC_1/AE.SQUARROSA(213)/ /PGO/4/HUITES/6/DH01-29-33*R/7/TAM200/KAUZ//DAGDAS	5/5	214	33	247	83,00	10MR	5R	20MR
36	**VOEVODO/TX96V2427**	**5/5**	**208**	**39**	**247**	**85,33**	**0**	**10MR**	**0**
37	**SARDARI-HD35/5/DMN/ /SUT/AG(ES86-7)/3/KAUZ/4/TX71A374-4/TX71A1039-V1/6/HK208/7/ATTILA*2/PBW65**	**5/5**	**205**	**37**	**242**	**67,00**	**0**	**0**	**5R**
38	**SARDARI-HD35/5/DMN/ /SUT/AG(ES86-7)/3/KAUZ/4/TX71A374-4/TX71A1039-V1/6/HK208/7/ATTI**	**5/5**	**205**	**37**	**242**	**54,00**	**0**	**0**	**0**
39	**SARDARI-HD35/5/DMN/ /SUT/AG(ES86-7)/3/KAUZ/4/TX71A374-4/TX71A1039-V1/6/HK208/7/ATTILA*2/PBW65**	**5/5**	**208**	**39**	**247**	**55,67**	**0**	**0**	**0**
40	**6720.11//MDA38/WRM/3/69.148/YMH//HYS/4/ASP/BLT/5/GUN91/MNCH/6/6919**	**5/5**	**205**	**37**	**242**	**45,00**	**0**	**0**	**0**
41	**LAGOS-7/RENESANSA/3/VORONA/HD2402//ALBATROSS ODESSKIY**	**5/5**	**211**	**36**	**247**	**66,00**	**5R**	**5MR**	**10MR**
42	BEZ/NAD//KZM(ES85.24)/3/MILAN/4/SPN/NAC// ATTILA/6/LOV26// LFN/SDY(ES84-24)/3/SERI/4/SERI/5/F494J6.11~	5/5	208	39	247	59,67	20MR	5MR	20MR
43	**6920/6/F9.70/MAYA//4105W/3/PLK70/LIRA/4/88ZHONG257//CNO79/PRL/5/SB-360-1**	**5/5**	**204**	**38**	**242**	**64,33**	**10MR**	**0**	**10MR**
44	VORONA//MILAN/SHA7/3/MV17/4/TAM200/KAU	5/5	214	33	247	74,33	20MR	0	10MR
45	**IZYUMINKA**	**5/5**	**204**	**38**	**242**	**66,33**	**5R**	**10R**	**20MR**
46	ASKET	5/5	211	36	247	57,33	0	5R-MR	20MR
47	LOCAL CHECK2	5/5	205	37	242	78,00	20MR	10MR	30MR
48	**KS100114K-14**	**5/5**	**205**	**37**	**242**	**66,67**	**0**	**0**	**0**
49	PASA	5/5	205	37	242	80,00	10MR	5MR	20MR
50	HAMITBEY	5/5	204	43	247	64,33	20MR	0	20MR
51	**HK96/3/CHAM6//1D13.1/MLT/4/KONYA 2002**	**5/5**	**208**	**39**	**247**	**90,33**	**10MR**	**0**	**10R**
52	**DEMIR2000/GELIBOLU**	**5/5**	**208**	**39**	**247**	**82,33**	**5R**	**5R**	**20MR**
53	ANK-8/ZITNICA//SONMEZ01	5/5	207	40	247	64,33	20MR	10MR	20MR
54	**AGRI/NAC//ATTILA/6/TAST/SPRW//ZAR/5/YUANDONG3/4/PPB868/CHRC/3/PYN//TAM101/AMIGO/7/494J6.11//TRAP**	**5/5**	**209**	**38**	**247**	**85,00**	**10MR**	**0**	**10MR**
55	STEKLOVIDNAYA24/SÖNMEZ//KS82142/PASTO	5/5	208	39	247	68,00	30MR	10MR	40MS
56	STEKLOVIDNAYA24/SÖNMEZ//KS82142/PASTO	5/5	204	38	242	69,33	30MR	30MR	20MR

Table 1 (continued)

57	**ALTAY2000/ANK S6/10**	**5/5**	**204**	**38**	**242**	**78,00**	**10MR**	**0**	**10MR**
58	(YG 126)/BDME 02.01 S	5/5	205	38	243	76,00	20MR	10MR	40MR
59	58.182/DRC//SPN/3/KATIA/4/BJNC47/5/TSI/VEE//2*TRK13/6/TOSUNBEY	5/5	204	42	246	65,33	30MR	20MR	20MR
60	**KINACI 97/IKIZCE**	**5/5**	**204**	**42**	**246**	**62,00**	**10MR**	**0**	**10MR**
61	F12.71/COC//KAUZ/3/BEZOSTAJA	5/5	204	42	246	52,67	10R-MR	0	30MR
62	**TAHIROVA 2000/ZORNITCHA//ALTAY-2000**	**5/5**	**204**	**42**	**246**	**81,67**	**0**	**0**	**5R**
63	**KATE-A-1/ONEARLY_S-115**	**5/5**	**204**	**42**	**246**	**79,67**	**0**	**0**	**5R**
64	ALTAY2000/4/SWON98-124/3/AGRI/NAC//ATTILA/5/SONMEZ01	5/5	205	41	246	69,00	10MR	10MR	20MR
65	**CHAM6/TK13//LND/6/MV8/5/BEZ//BEZ/TVR/3/KREMENA/LOV29/4/KATE-A1**	**5/5**	**211**	**35**	**246**	**91,67**	**20R**	**0**	**10R**
66	**TOSUNBEY/2*MUFITBEY**	**5/5**	**208**	**38**	**246**	**94,67**	**5R**	**0**	**30MR**
67	TOSUNBEY/2*MUFITBE	5/5	208	38	246	97,33	20MR	0	20MR
68	**ANK S7/10/YAKAR**	**5/5**	**205**	**41**	**246**	**66,33**	**10MR**	**0**	**20R**
69	**MESUT**	**5/5**	**207**	**39**	**246**	**70,00**	**0**	**0**	**20MR**
70	**REIS**	**5/5**	**208**	**38**	**246**	**67,33**	**10R**	**0**	**20MR**

[1] Selected cultivar samples of FAWWON-SA with valuable immunologic and agronomic traits are marked in bold;
[2] Resistance expressed in terms of severity and reaction type.

As a result of the research, the RIBSP grain crops collection has been expanded with 41 cultivar samples of wheat with valuable immunologic and agronomic traits. It should be noted that grain crops collection of the RIBSP, which stores more than 28,000 items, is currently one of the major grain crop repositories in the country.

Discussion

In breeding practice, studies of economically valuable traits of plants in the field conditions allow for increasing the efficiency for selection of best genotypes, identifying and using sources and donors of relevant features and conducting more targeted breeding [9]. Consequently, to select wheat cultivars with high yields and good seed quality, it is necessary to study several economically valuable traits, including the duration of the growing season, resistance to common diseases, yielding, etc.

In the 2022 growing season, 70 cultivar samples FAWWON-SA from CIMMYT were evaluated for rust resistance under artificial infection in Zhambyl regions, Kazakhstan, at the RIBSP. The average maturation period for the facultative and winter wheat samples was 245 days, referring to the medium-ripening group. Most of the lines (57) showed high levels of winter hardiness. The mass of 1000 grains ranged from 45.00 to 97.33 g across the studied cultivar samples. Notably, 15 cultivar samples demonstrated complex resistance to all three types of rust. Based on the results, 41 wheat cultivar samples with valuable immunologic and agronomic characteristics were selected.

It should be noted that the successful breeding of winter wheat lines in the south of Kazakhstan depends not only on their ability to withstand drought and produce high yields but also on their resistance to diseases. Utilization of necessary breeding materials effectively by studying the existing diversity of forms and evaluating different ecotypes under specific conditions is essential. In this case, the initial basis for selection is the CIMMYT collection and breeding lines [25].

Extensive partnerships with CIMMYT determine the quality of Genotype X Environment interactions by conducting experiments worldwide at agronomically representative locations. This information helps breeders to overcome yield barriers and improve their understanding of the performance of wheat lines under different conditions. By identifying these geographic "hot spots", changes in disease prevalence associated with climate change and the search for resistance genes are predictable [26]. This approach will help breeders create better-adapted winter wheat lines to changing environmental conditions, ultimately improving the sustainability of wheat production in the region.

Conclusion

The studies have shown that the International Wheat and Maize Improvement Center has a significant reserve of wheat sources with resistance to major diseases. Through 70 cultivar sample studied in the conditions of artificial infection background and weather of the Zhambyl region, 41 wheat cultivar samples with valuable immunologic and agronomic characteristics were selected. The selected cultivar samples of wheat with group resistance to common diseases can be recommended for breeding as donors in Kazakhstan. Utilizing them in breeding programs will result in genetically diverse materials resistant to common rust diseases in Kazakhstan.

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Literature

1 Abugalieva A., Peña-Bautista R.J. Grain quality of spring and winter wheat of Kazakhstan // The Asian and Australasian Journal of Plant Science and Biotechnology. – 2010. – Vol. 4(1). – P. 87-90.

2 Karatayev M. et al. Monitoring climate change, drought conditions and wheat production in Eurasia: the case study of Kazakhstan // Heliyon. – 2022. – Vol. 8 (1). – 08660 p. https://doi.org/10.1016/j.heliyon

3 Koishibaev M. Diseases of grain crops. – Almaty. Bastau. – 2002. – 366 p. (In Russian)

4 Koishybaev M. The risk of spreading brown, stem and yellow rust on grain crops. – Atlas of natural and man-made hazards and emergency risks in the Republic of Kazakhstan. – Almaty. – 2010. – P. 206-208. (In Russian)

5 Koishybaev M. Monitoring and prognosis of the development of especially dangerous diseases in Kazakhstan. Materials of the Third All-Russian Congress on Plant Protection. – St. Petersburg. – 2014. – P. 242-245. (In Russian)

6 Koishibaev M. Wheat diseases. – Ankara. FAO. – 2018. – 365 p. (In Russian)

7 Rsaliyev Sh., Tileubayeva Zh., Agabaeva A., Rsaliyev A. Virulence of wheat leaf, stem and yellow rust pathotypes in Kazakhstan // The Asian and Australasian Journal of Plant Science and Biotechnology. – 2010. – Vol. 4 (1). – P. 71-76.

8 Kokhmetova A., Morgunov A., Rsaliyev Sh., Rsaliyev A., Yssenvekova G., Typina L. Wheat germplasm screening for stem rust resistance using conventional and molecular techniques // Czech journal of genetics and plant breeding. – 2011. – Vol. 47. – P. 146-154.

9 Rsaliyev A., Yskakova G., Maulenbay A., Zakarya K., Rsaliyev S. Virulence and race structure of *Puccinia graminis* f. sp.*tritici* in Kazakhstan // Plant Protection Science. – 2020. – Vol. 56 (4). – P. 275-284. doi: 10.17221/85/2020-PPS

10 Ziyaev Z., Sharma R., Nazari K., Morgounov A., Amanov A.,Ziyadullaev Z., Khalikulov Z., Alikulov S. Improving wheat stripe rust resistance in Central Asia and the Caucasus // Euphytica. – 2011. – Vol.179. – P.197-207. https://doi.org/10.1007/s10681-010-0305-x

11 Sharma R., S. Rajaram, Alikulov S., Ziyaev Z., Hazratkulova S., Khodarahami M., Nazeri S., Belen S., Khalikulov Z., Mosaad M., Kaya Y., Keser M., Eshonova Z., Kokhmetova A., Ahmedov M., Jalal

Kamali M., Morgounov A. Improved winter wheat genotypes for Central and West Asia //Euphytica. – 2013. – Vol. 190 (1). – P. 19-31.

12 Kokhmetova A., Kremneva O., Volkova G., Atishova M., Sapakhova Z. Evaluation of wheat cultivars growing in Kazakhstan and Russia for resistance to tan spot // Journal of Plant Pathology. – 2017. – Vol. 99 (1). – P. 161-167.

13 Rsaliev A., Rsaliev Sh. Wheat resistance to diseases. – Almaty: Asyl kitap. 2020. – 381 p.

14 Rsaliev Sh., Tileubaeva Zh., Rsaliev A., Agabaeva A. Methods for identifying valuable varieties of grain crops among introduced breeding materials // Methodological recommendation. - Guards, 2004. - 15 p. – Inv. № 828. Sørensen C., Thach T., Hovmøller M. Evaluation of Spray and Point Inoculation Methods for the Phenotyping of *Puccinia striiformis* on Wheat // Plant disease. – 2016. – Vol. 100 (6). – P. 1064-1070. https://doi.org/10.1094/PDIS-12-15-1477-RE

15 Sørensen C., Thach T., Hovmøller M. Evaluation of Spray and Point Inoculation Methods for the Phenotyping of *Puccinia striiformis* on Wheat // Plant disease. – 2016. – Vol.100(6). – P.1064-1070. https://doi.org/10.1094/PDIS-12-15-1477-RE

16 Geshele E.E. Methods of infection of plants and accounting for its results in breeding // Fundamentals of phytopathological assessment in plant breeding. – Moscow: Kolos. – 1978. – P. 129-159. (In Russian)

17 Method of state variety testing of agricultural crops release of the second grain, cereals, legumes, corn and fodder crops. – Moscow. – 1989. – 194 p. (In Russian)

18 GOST 10842-89 (Cereals, pulses and oilseeds. Method for determination of 1000 kernels or seeds weight)

19 Stakman E.C. Stewart D.M., Loegering W.Q. Identification of physiologic races of *Puccinia graminis* var. tritici // U.S. Agric. Res. Serv. – 1962. – Vol. 617. – P. 1-53.

20 Mains E.B., Jackson H.S. Physiologic specialization in the leaf rust of wheat *Puccinia triticiana* Erikss // Phytopathology. – 1926. – Vol. 16 (2). – P. 89-120.

21 Gassner G., Straib W. Experimentelle Untersuchungen uber das Verhaltender Weizensorten gegen *Puccinia glumarum* // Phytopathology – 1929. – Vol. 1 (3). – P. 215-275.

22 Roelfs A., Singh R., Saari E.E. Rust diseases of wheat: concepts and methods of disease management // CIMMYT. – Mexico. – 1992. – 45 p.

23 Peterson R.F., Campbell A.B., Hannah A.E. A diagrammatic scale for estimating rust intensity on leaves and stems of cereals // Canad. J. Res. – 1948. – Vol. 26. – P. 496-500.

24 Wilcoxson R.D., Skovmand B., Atif A.H. Evaluation of wheat cultivars for ability to retard development of stem rust // Annual Applied Biology. – 1975. – P. 275-281.

25 Rsaliev A., Savin T., Maulenbai A., Skakovoy G. Stability of the SIMMIT spring soft wheat line to stem and leaf rust // Bulletin of the Korkyt Ata Kyzylorda University, series of Agricultural Sciences. – 2022. – Vol. 2. – P. 69-79. (In Russian)

26 Seeds of innovation: The Strategy of the Summit to Combat Poverty and Hunger by 2020 // SIMMIT (International Center for the Improvement of Corn and Wheat). – Mexico City: SIMMIT. – 2003. – 71 p. (In Russian)

ФАКУЛЬТАТИВТІ ЖӘНЕ КҮЗДІК БИДАЙ ЖАҢА СОРТҰЛГІЛЕРІНІҢ АГРОНОМИЯЛЫҚ ЖӘНЕ ИММУНОЛОГИЯЛЫҚ ҚАСИЕТТЕРІН ЗЕРТТЕУ

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Аннотация. Бұл мақалада Халықаралық бидай мен жүгеріні жақсарту орталығынан (CIMMYT) алынған жартылай құрғақ орталарға ұсынылған факультативті және күздік бидай бақылау тәлімбағының (FAWWON-SA) 70 сортүлгінің құнды белгілерін зерттеу нәтижелері ұсынылған. Өсімдіктердің агрономиялық және иммунологиялық сипаттамаларын далалық жағдайда зерттеу

селекцияда үлкен маңызға ие, өйткені ол ең жақсы генотиптерді тиімдірек таңдауға мүмкіндік береді, құнды белгілердің көздерін анықтайды сонымен қатар селекциялық жұмыстың дәлдігін арттырады. Нәтижелер көрсеткендей, 57 сортүлгінің қысқа төзімділігі жоғары, ал пісу күндері 242-ден 247 күн аралығында. 1000 дәннің салмағы 45,00-ден 97,33 граммға дейін ауытқыды, сонымен қатар ірі және толық болды. Тат ауруларының жасанды инфекциялық фонында 15 сортүлгі сабақ, жапырақ және сары татқа төзімді болды. Нәтижесінде бидай сортүлгілері агрономиялық және иммунологиялық белгілері бойынша топтастырылды. Қорытындылай келе зерттелген тәлімбақтың 41 сортүлгісі іріктеліп, селекцияда донор ретінде ұсынылды.

Түйін сөздер: төзімділік; бидай; сортүлгі; тат; өнімділік

ИЗУЧЕНИЕ АГРОНОМИЧЕСКИХ И ИММУНОЛОГИЧЕСКИХ ХАРАКТЕРИСТИК НОВЫХ СОРТООБРАЗЦОВ ФАКУЛЬТАТИВНОЙ И ОЗИМОЙ ПШЕНИЦЫ

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Аннотация. В данной статье представлены исследования хозяйственно-ценных признаков 70 сортообразцов факультативной и озимой пшеницы питомника наблюдения для полузасушливых сред (Facultative and Winter Wheat Observation Nursery for Semiarid Environments – FAWWON-SA), полученных из Международного центра улучшения пшеницы и кукурузы (International Wheat and Maize Improvement Center – CIMMYT). Изучение агрономических и иммунологических характеристик растений в полевых условиях имеет большое значение в селекционной практике, поскольку позволяет более эффективно отбирать лучшие генотипы, выявлять и использовать источники ценных признаков и повышать точность селекционных работ. Результаты эксперимента показали, что 57 сортообразцов пшеницы обладают высокой зимостойкостью, а продолжительность вегетационного периода новых сортообразцов находится в диапазоне от 242 до 247 сут. Значения массы 1000 семян варьировались от 45,00 до 97,33 г, и характеризовалась крупным и выполненным зерном. В условиях искусственного инфекционного фона видов ржавчины выявлено 15 сортообразцов с комплексной устойчивостью к стеблевой, листовой и желтой ржавчине. На основании результатов исследования была проведена группировка сортообразцов пшеницы по агрономическим и иммунологическим признакам. В результате исследования отобран 41 образец с ценными хозяйственно-ценными признаками, которые рекомендуются использовать в качестве доноров в селекции.

Ключевые слова: устойчивость; пшеница; сортообразцы; ржавчина; урожайность