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Laboratory of Winter Bread Wheat Breeding: New winter wheat cultivar Zhemchuzhina Povolzhjya.

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Winter wheat is a priority for grain production in the Saratov Region of the Russian Federation. Since the mid-1990s, a number of the Saratov winter wheat cultivars were established, including Saratovskaya 90, Victoria 95, and Gubernia. These cultivars are high-yielding with adaptability to the steppe conditions of the region. In addition, the cultivars have a wide range of individual characteristics that allow them to compete in the climatic conditions of Volga region.

To further enhance the yield of winter wheat, we have released the cultivar **Zhemchuzhina Povolzhjya**, which has a higher yield potential compared with the existing popular cultivars. The description of this new cultivar is presented in Table 1. According to winter hardiness, this cultivar belongs to the Saratovskaya 90 group, which is the most resistant to stable cold temperatures. Zhemchuzhina Povolzhjya also is resistant to leaf rust and has high grain quality.

Table 1. Grain yield, 1,000-kernel weight, test weight, protein content, and SDS-sedimentation test of winter wheat in the ecological test. All data is the mean from plants grown at Saratov in 2000–07.

Cultivar	Yield (t/ha)	1,000-kernel weight (g)	Test weight (g/l)	Protein content (%)	SDS sedimentation (mm)
Mironovskaya 808 (check)	3.47	43.0	753	13.88	53
Donskaya bezostaya (check)	2.72	39.6	746	15.58	67
Saratovskaya 90	3.35	43.7	747	14.42	59
Victoria 95	3.42	41.9	738	14.68	50

Laboratory of Spring Bread Wheat Breeding: A new spring bread wheat cultivar for the Volga River region.

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A new cultivar of spring bread wheat Saratovskaya 73 for Volga river region was introduced in 2008. The new cultivar was breed at the Agricultural Research Institute for South-East Regions of Russia (Saratov). In the last five years (2003–07), the grain yield of Saratovskaya 73 was higher than those of the standards from mean 0.4 t/ha (≥ 27%; Table 2), although environmental conditions varied greatly between the years. Saratovskaya 73 is characterized by higher 1,000-kernel weight and resistance to leaf rust than those of the check cultivars. Saratovskaya 73 had higher baking properties than those of the other best cultivar Povolgye.

Table 2. Grain yield, quality of grain and phytopatogenes test of spring bread wheat cultivars (means from 2003–07). Items with an * are significant at the 5% level.

Traits	Saratovskaya 55 (new cultivar)	Saratovskaya 70 (standard)	Saratovskaya 73 (standard)
Grain yield (t/ha)	15.8	15.2	20.1*
1,000-kernel weight (g)	34.9	35.6	37.5
Test weight (g/l)	769	772	767
Protein content (%)	13.4	14.5	14.3
Bread volume (sm^3)	638	732	748
Strength of flour, W e.a.	488	279	381
Loose smut severity (%)	0.28	0.03	0.04
Leaf rust severity (%)	75	85	17*

Laboratory of Spring Durum Wheat Breeding: New spring durum wheat cultivars for the Volga River region of Russia.

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The durum wheat-breeding program was begun in 1910 in Saratov with the main goal to develop new cultivars for resistance to heat and drought, the main diseases and pests that are wide-spread in this region, and high grain quality. The description of two newly developed cultivars are presented here.

Yelizavetinskaya. The early, strong gluten cultivar Yelizavetinskaya is recommended for the dry conditions of the Volga River region of Russia (vast steppe area). This cultivar was derived from the cross 'Saratovskaya zolotistaya (Saratov zolotistaya)/Svetlana'. Saratovskaya zolotistaya is the well-known local cultivar that has a very high yellow pigment content, and Svetlana is resistant to loose smut.

Compared to the check Saratovskaya zolotistaya, Yelizavetinskaya has a more compact plant habit. The color of that plant before heading is bright-green. After heading, the waxiness of the plant is expressed, but less than that of the check. Yelizavetinskaya is characterized by high gluten strength, higher than that of Krasnokoutka 10 and Saratovskaya zolotistaya. Yellow pigment content is similar to that of Saratovskaya zolotistaya and falling number is equal to that of Krasnokoutka 10 (Table 3, p. 112). This cultivar has s higher grain yield when compared with the check cultivars, but 1,000-kernel weight and test weight are lower than those of the check (Table 3, p. 112).

Annoushka. In 2007, the very strong gluten cultivar Annoushka was included in the state list of the cultivars permitted for use in vast steppe area of the dry south-east regions of Russia. This cultivar was derived from the cross 'Saratovskaya 53/Medora//D-1995/3/Leucurum 5594'. Annoushka is high yielding, drought resistant, and a well-adapted cultivar for the Volga River region of Russia, which can provide to farmers a wide area of for durum wheat cultivation. Potential productivity of the cultivar under dry conditions is about 3 t/ha. Annoushka is resistant to loose smut and moderately tolerant to tan spot.

The yield and micro-SDS-sedimentation test parameters of Annoushka are higher than those of the check cultivars. The micro-SDS-sedimentation test parameter was approximately 59 mm compared to 49 mm in Saratovskaya zolotistaya and 30 mm in Krasnokoutka 10 (Table 3, p. 112). Falling number is close to that of Saratovskaya zolotistaya, the check cultivar. The carotenoid content in the grain of Annoushka is higher than that of Krasnokoutka 10 and less

Table 3. Yield, 1,000-kernel weight, test weight, falling number, protein content, micro-SDS-sedimentation test, and carotinoid pigment content of Yelizavetinskaya and Annushka, new cultivars for the South-East Region of Russia in comparison with check cultivars. All data are means from the ARISER main yield trial grown at Saratov in 2003–07.

Cultivar	Yield (t/ha)	1,000-kernel weight (g)	Test weight (g/l)	Falling number (sec)	Protein content (%)	Micro-SDS-sedimentation (mm)	Carotinoid pigment content (mg/kg)
Krasnokoutka 10 (check)	1.88	44.8	808	458	13.9	30	4.4
Saratovskaya zolotistaya (check)	1.82	44.4	785	438	14.5	49	7.5
Yelizavetinskaya	1.97	42.5	773	456	14.4	54	7.1
Annoushka	2.09	43.2	777	432	14.2	59	6.0
LSD (5%)	0.13	1.3	8	36	0.6	5	0.6

only when compared with Saratovskaya zolotistaya. Annoushka is recommended for cultivation on agrotechnologies accepted in the given zone for durum wheat.

Laboratory of Plant Cell Breeding: Characterization of primary triticales for storage protein spectra and peculiarities of the meiosis in the mother pollen cells.

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The primary hexaploid and octoploid triticale (AABBRR and AABBDDRR, respectively) were developed with the participation of Saratov-bred cultivars of winter bread wheat and rye using of embryo rescue followed by colchicine treatment of plants.

Cytology of meiosis in the pollen mother cells showed that all amphidiploids studied have a significantly higher percentage of irregular metaphase I that of the standard cultivar Student. The frequency of PMCs with univalent chromosomes ranged from 73.4 to 86.1%. The frequency of univalent chromosomes in the PMCs of standard cultivar is rather high, above 40%. Interploid hybrids between hexaploid and octoploid triticales did not have an advantage compared to the primary triticales.

Protein markers are used in the genetic analysis of triticale, because they permit the study of the peculiarities of chromosomal fragments in amphiploids and control substitutions in recombinant breeding. The amphidiploids studied have 2–4 biotypes of gliadin spectra. These biotypes differ from one another in gliadin components that are controlled by genes on chromosomes 1A, 6A, and 1B. AD 460/08 (Novinka/Saratovskaya 6) has three biotypes with differences in 1A, 6A, and 1B chromosomes. AD 459/08 (Leucurum 921h21/Saratovskaya 6) has four biotypes with differences on chromosomes 1A and 6A. The electrophoretic spectra of the emergency proteins of AD 458/08 (Leucurum 170h389/Saratovskaya 6) contain two types with differences in chromosome 6A. Octoploid triticale was homogenous for the emergency protein spectra.

Secondary triticales have been created via intercrossing of the primary hexaploid and octoploid triticale and intra- and intergenomic recombinations with the best cultivars. Combining traditional and tissue culture methods allows the production of hexaploid triticale with higher grain yields and other valuable agronomic characters.

Department of Genetics: Spring bread wheat cultivars from the Department of Genetics, ARISER, during 2004–07.

S.N. Sibikeev, S.A. Voronina, V.A. Krupnov, A.E. Druzhin, T.D. Golubeva, and T.V. Kalintseva.

During 2004–07 in the Department of Genetics, two spring hard red bread wheats and one spring hard white bread wheat cultivars were produced. These cultivars were breed from wide crosses and show the effects and influence of alien chromosomes and genes for resistance to disease, namely leaf rust and powdery mildew. Brief characteristics are described below.

Favorite, a hard red bread wheat derived from the cross 'L2033/Belyanka'; the pedigree of L2033 is 'L504*2/Krasnokutka 10'. L504 has the *Lr19*-translocation and Krasnokutka 10 is a spring durum wheat cultivar. Favorite is a medium maturing, medium-tall cultivar. The grain yield of Favorite is higher than that of the standard cultivar Yugovostochnaya 2 from 0.2 to 0.7 t/ha. This cultivar is resistant to lodging and to preharvest sprouting and has good breadmaking qualities. Favorite is resistant to leaf rust, powdery mildew, and moderately resistant to loose smut.

Voevoda has the same pedigree as that of Favorite. The main difference between Voevoda and Favorite is resistance to stripe rust and moderately resistant to lodging.

Lebedushka is a hard white bread wheat derived from the cross 'Belyanka/Dobrynya'. Lebedushka is a medium maturing, medium-tall cultivar. The grain yield of Lebedushka is higher than that of the standard cultivar Yugovostochnaya 2, from 0.2 to 0.5 t/ha. This cultivar is resistant to lodging, leaf rust, powdery mildew, and has good bread-making qualities. The basic disadvantage for this cultivar is susceptibility to preharvest sprouting. Nevertheless, in the planting area where preharvest sprouting is not a problem, this cultivar may be used successfully.

The evaluation of spring bread wheat cultivars, NILs, and promising lines resistant to stem rust.

S.N. Sibikeev, A.E. Druzhin, T.D. Golubeva, and T.V. Kalintseva.

Stem rust of bread wheat in the Saratov district of the Volga Region of Russia is seldom a problem and epidemics are not severe. Nevertheless, in the southwest part of the Saratov district, epidemics of leaf rust were observed during the last three years. The majority of spring bread wheat plantings in this zone were with cultivars L503, L505, Belyanka, Dobrynya, and Prohorovka. Only Prohorovka has an IT = 0 to stem rust. The cultivars L503, L505, Belyanka, and Dobrynya had ITs = 3 for stem rust. The severity for L503, L505, and Dobrynya was 15–20% and 50–60% for Belyanka. The former cultivars have the T7DS·7DL-7Ae#1- translocation with *Lr19*/*Sr25* genes. Obviously, the decrease in severity in these cultivars are caused by residual effect of *Sr25* gene. The NILs with ITs = 0 were promising lines with the Sr gene combination of *Sr24* + *Sr25* and *Sr25* + *Sr31*.

The identification of wheat–Thinopyrum elongatum chromosomes substitutions in leaf rust-resistant lines.

E.D. Badaeva (Institute of General Genetics Gubkina St. 3, Moscow) and S.N. Sibikeev.

During 1993–2000 at ARISER, *Th. elongatum* (2n=70) was crossed with the spring bread wheat cultivar Saratovskaya 55 and backcrossed four times with cultivar Saratovskaya 29. Among the wheat–*Th. elongatum* lines that were resistant to leaf rust and powdery mildew, four lines were highly resistant leaf rust, L1858/1, L1858/2, L1857, and L1178. C-banding of these lines showed *Th. elongatum* substitutions with chromosomes 6D (L1858/1 and L1858/2), 3B (L1857), and 7D (L1178). Two bread wheat–*Th. elongatum* translocations with Lr genes are noted in the Gene Catalog, T7DL-7DS-7Ae#1L (*Lr19)* and T3DS-3DL-3Ae#1L (*Lr24*). In the Saratov district of Volga Region of Russia, *Lr19* was overcome in 1994 year and presently ineffective. The test for allele identification in above-mentioned lines will concentrate on *Lr24*.

Genetic control of resistance of wheat to loose smut.

E. Druzhin, V.A. Krupnov, S.N. Sibikeev, T.D. Golubeva, and T.V. Kalintseva.

Four cultivars and lines of spring bread wheat have shown a high level of resistance to a loose smut (race 23 = T18) after artificial inoculation. To determine the genetic control of resistance, these cultivars and lines crosses were made with the susceptible cultivar Saratovskaya 64 and line L528. We inoculated the F_2 and subsequently analyzed individual offspring of each plant. The analysis of hybrid combinations in the F_2 has shown that cultivar Marroqui 588 and line PI 69282 probably contain two independent genes (Table 4). Line L2040 has two resistance genes for loose smut. The segregation for resistance in plants at the F_1BC_1 confirmed two resistant genes in line L2040.

Table 4. Segregation of a population of hybrids F_2 for resistance to 23 race of a loose smut. X^2 degrees of freedom = 1–3.48

		Segregation				
		Experimental		Theoretical		
Cultivar/Line/Hybrid	Generation	R	S	R	S	X^2
L528			98.8			
Saratovskaya 64			98.5			
L2040			7.4			
Preston		100				
Marroqui 588		100				
PI 69282		100				
L528/Marroqui 588	F_2	138	113	9	7	0.16
Marroqui 588/L528	F_2	146	98	9	7	1.28
Saratovskaya 64/Marroqui 588	F_2	77	56	9	7	0.15
Marroqui 588/L528//L528	F_1BC_1	79	20	3	1	1.22
L528/ PI 69282	F_2	156	111	9	7	0.51
PI 69282/L528	F_2	125	89	9	7	0.41
Saratovskaya 64/PI 69282	F_2	83	61	9	7	0.11
PI 69282/L528//L528	F_1BC_1	87	23	3	1	0.98
L528/Preston	F_2	168	138	9	7	0.23
L528/L2040	F_2	122	28	13	3	0.001
L2040/L528	F_2	114	29	13	3	0.22
Saratovskaya 64/L2040	F_2	74	19	13	3	0.17
L2040/L528//L528	F_1BC_1	109	28	3	1	1.52

The relationship between grain yield and grain protein content in spring bread wheat in the Volga region.

V.A. Krupnov, S.N. Sibikeev, O.V. Krupnova, S.A. Voronina, and A.E. Druzhin.

Twenty-eight cultivars and experimental introgressive genotypes from the breeding program of ARISER, Russian Federation, were grown in a bare fallow, leached chernozem soil during four consecutive years, 2003, 2004, 2005, and 2006. The planting rate was $4x10^6$/ha and four replications were made for each trial. Plot size was 7.0 m^2. Fertilizers were not applied. For precipitation and temperature regimes, 2003 was optimal with a grain yield average of 4,433 kg/ha and a grain protein content 15.39%. In the 2004 and 2005, a leaf rust epidemic significantly lowered grain yield of susceptible genotypes. In 2004, the average yield of a susceptible genotype (n = 15) was 2,958 kg/ha with a grain protein of 15.82%. A resistant genotype with an *Lr* translocation yielded 3,289 kg/ha with a grain protein content of 16.05%. In 2005, the average grain yield of the susceptible genotypes (n = 15) was 2,302 kg/ha and the average grain protein content was 16.0%; a resistant genotype had 2,874 kg/ha and 17.0%, respectively. For 1,000-kernel weight, the difference between sibs was not significant. Correlation coefficients between grain yield and 1,000-kernel weight were positive, but weak to average. The correlation coefficients between the grain yield and protein were negative in 2003, r = –0.50**, in 2006 r = –0.39*. During the leaf rust epidemic in 2004, correlation coefficients between grain yield and protein content of the resistant genotypes was –0.85 ** (negative) and 0.34 (positive), for susceptible genotypes, but in 2005, resistant genotypes were r = –0.24 (negative) and susceptible 0.57** (positive). Correlation coefficients between 1,000-kernel weight and grain protein content were negative in all years.

The influence of EXTRASOL on economic valuable characteristics in winter triticale.

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Much recent attention in the agronomical practice has been given to the use of the various biostimulating preparations that influence efficiency, resistance to abiotic and biotic stress, and production quality. One such biostimulator with a complex action is the commercial preparation Extrasol. Extrasol improves feeding elements in a plant, increases seed germination, adjusts enzymatic activity in vegetative cells, accelerates plant development, and reduces infection of phytopathogenic microorganisms, which are reflected in plant productivity.

The action of Extrasol was studied in 2005–06 on the winter triticales Yubileynaya, Sargau, and Student. Experimental sowings were placed in fields of bare fallow in four replicates. We treated vegetative plants at tillering (the beginning of May), a 1% Extrasol solution. The analysis of structure element productivity was carried out using standard techniques. Plant height and spike length were measured. The number of plants, spike productivity, weight of grain from one square meter, and the 1,000-kernel weight were measured. The data were subjected to dispersive analysis.

The extrasol treatment tended to markedly increase the efficiency of productivity parameters, especially 1,000-kernel weight, however, the majority of studied characteristics did not significantly differ from the controls. In 2005–06, the influence of genotype on characteristic prevailed.

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Breeding and genetic analysis for height in spring wheat.

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In the Russian Far East, tall wheat cultivars lodge under the summer monsoon and when grain yield is greater than 2 t/ha. Dwarf cultivars from the U.S., Mexico, Canada, and India were hybridized to create lodging-resistant cultivars. In Khabarovsk, short stalk was inherited very well, but at the same time, negative traits such as wheat drought resistance, suscepibility to *Fusarium* and *Helminthosporium*, and unstable yields, were also inherited.

Materials and Methods. Four F_1–F_2 hybrids, 'ERO-4/Dalnevostochnaya' (ERO-4/DV), 'Opal/Okeanskaya 39' (OPAL/OK39), 'Molodyozhanaya/Primorskaya 1738' (MD/P1738), and 'Molodyozhnaya/Lutescens 47' (MD/L47) were used. The height difference between the cultivars was 12–25 cm. Each cultivar has one or more valuable features. ERO-4 (Brazil) is resistant to disease and drought. Dalnevostochnaya (Russia) is a strong wheat with high quality grain. Opal (Germany) is medium sized, resistant to lodging and disease, and has a large spike. Molodyozhnaya (Russian Federation) has a short stalk and is resistant to lodging. Lutescens 47 (Russian Federation) is productive and has medium resistance to lodging and disease. Okeanskaya 39 and Primorskaya 1783 (Russian Federation) have large spikes and 1,000-kernel weights.

Seed was sown in a field as follows: P_1 (mother) – F_1 – F_2 – P_2 (father). The cultivar Monakinka was used as the check. The height of the parentals and check were determined from 20–30 plants, 15–20 plants of the F_1, and 69–95 in the F_2. Variation within the rows was calculated according to Dospekhov (1973), predomination degree (hp) according to Griffing (1950), heterosis using Omarov (1975), transgression frequency according to Voskresenskaya and Shpot (1967), heritability (H^2) using Warner (1971), and the number of genes according to Rokitsky (1978). The degree of conformity with theoretically expected results was measured by a X^2 test.

Results and Discussion. The efficiency of gene transfer depends on the inheritance and degree of variability of the trait. Three F_1 hybrids inherited height from a dwarf parent; another hybrid (ERO-4/DV) from a tall parent (Table 1, p. 116). The 'MD/P1738' hybrid F_1 had a hp = –1.27, indicating superdominance of the dwarf parent. Plant height increased in