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YIELD STRUCTURE AND GRAIN QUALITY OF SPRING WHEAT VARIETIES OF ALTAI AND FOREIGN SELECTION (TYUMENTSEVSKY DISTRICT, ALTAI KRAI)

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Wheat is one of the three major agricultural crops worldwide. The yield of any agricultural crop, including spring soft wheat, largely depends on compliance with regional requirements during its cultivation, while variety is one of the decisive factors. The current research aims to identify the difference in the yield structure and grain quality of spring wheat varieties of Altai and foreign selection for the Tyumentsevsky district (Altai Krai) for the first time.

The tasks are as follows: (1) to analyze the growing season weather conditions, (2) to compare the yield, yield structure elements, and indicators of grain quality, and (3) to find the best variety of spring soft wheat. Sampling during the experiment and processing of the results was carried out in accordance with standard methods. There was a difference in the yield structure and grain quality of spring wheat varieties of Altai and foreign selection in the Tyumentsevsky district of Altai Krai. The 2020 growing season was extreme, with droughts, higher temperatures, and precipitation lower than in multiannual terms.

A comparison of varieties has shown the highest yield variability. The highest amount of grains (21.1 c/ha) was received by Variant 2 – Altayskaya 75 (elite seeds). The research results have shown that it is best to use the varieties of local selection to obtain the maximum yield of spring soft wheat in the conditions of the Tyumentsevsky district of Altai Krai.

Keywords: *spring soft wheat; crop production; risky farming*

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СТРУКТУРА УРОЖАЯ И КАЧЕСТВО ЗЕРНА СОРТОВ ЯРОВОЙ ПШЕНИЦЫ АЛТАЙСКОЙ И ИНОСТРАННОЙ СЕЛЕКЦИИ (ТЮМЕНЦЕВСКИЙ РАЙОН, АЛТАЙСКИЙ КРАЙ)

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Пшеница является одной из трех основных сельскохозяйственных культур в мире. Урожайность любой сельскохозяйственной культуры, в том числе мягкой яровой пшеницы, во многом зависит от соблюдения региональных требований при ее возделывании, при этом сорт является одним из решающих факторов. Впервые исследование направлено на выявление различий в структуре урожая и качестве зерна сортов яровой пшеницы алтайской и зарубежной селекции для Тюменцевского района (Алтайский край).

В рамках исследования были поставлены следующие задачи: (1) проанализировать погодные условия вегетационного периода, (2) сравнить урожайность, элементы структуры урожая и показатели качества зерна, (3) подобрать лучший сорт мягкой яровой пшеницы. Отбор проб в ходе эксперимента и обработка результатов проводились в соответствии со стандартными методами. Была выявлена разница в структуре урожая и качестве зерна сортов яровой пшеницы алтайской и зарубежной селекции в Тюменцевском районе Алтайского края. Вегетационный период 2020 года был экстремальным, с засухами, более высокими температурами и меньшим количеством осадков, чем во многие предыдущие годы. Сравнение сортов показало наибольшую вариабельность урожайности. Наибольшее количество зерна (21,1 ц/га) получил Вариант 2 – Алтайская 75 (элитные семена). Результаты исследований показали, что для получения максимального урожая мягкой яровой пшеницы в условиях Тюменцевского района Алтайского края лучше всего использовать сорта местной селекции.

Ключевые слова: *мягкая яровая пшеница; растениеводство; рискованное земледелие*

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Introduction

Increasing spring soft wheat grain production is very urgent, as it occupies up to 70% of the area of grain crops in some territories. The stability of the grain economy must be considered as one of its basic characteristics since it reflects the degree of efficiency of economic activity and considers the entire set of factors affecting the results of the functioning of the grain market [9].

Spring soft wheat cultivation in Altai Krai is in the zone of risky farming and requires constant scientific support and correction of recommendations on the agricultural technology, which is especially relevant in a changing climate and increasing economic risks [14; 16; 17; 19].

The yield of any agricultural crop, including spring soft wheat, largely depends on compliance with regional requirements during its cultivation, while variety is one of the decisive factors. Wheat is one of the three major agricultural crops worldwide. Plant breeders have created many varieties of soft spring wheat [12]. An important task of modern plant growing is to increase the efficiency of spring soft wheat variety cultivation under various conditions. The research relevance lies in the fact that the productivity of Altai and foreign spring wheat varieties is compared for a given territory for the first time.

The average wheat yield in Altai Krai for the last years is in the range of 13–15 c/ha. These relatively low rates indicate that the varieties are far from fully unlocking their potential. This value significantly depends on the variability of the natural and climatic factors.

The following sections provide information on the goal and tasks, the location of the experiment, the studied varieties of spring soft wheat, and the results obtained.

Materials and methods

Many Russian and foreign scientists focus their attention on studying the influence of various factors on certain crops yield, including different varieties of wheat. In this regard, the works of the following authors are of great interest: S.A. Babkenova et al. [11], I. Ivanova, S. Ilina and D. Dementiev [15], N.I. Korobeinikov and V.S. Valekzhanin [7], V.I. Lazarev, J.N. Minchenko and A.Ya. Bashkatov [8], V.A. Pukhalskij et al. [18], E.V. Seminchenko [10], A.V. Sidorenko et al. [20], L.V. Volkova and I.N. Shchennikova [3].

The research aims to identify the differences in the yield structure and grain quality of spring wheat varieties of Altai and foreign selection in the Tyumentsevsky district of Altai Krai. The tasks are as follows: (1) to analyze the growing season weather conditions, (2) to compare the yield, yield structure elements,

and indicators of grain quality, and (3) to find the best variety of spring soft wheat.

The experiment was conducted in the *Zaitsev* LLC agricultural enterprise in the Tyumentsevsky district of Altai Krai in 2020. The farm is located in the steppe zone of the region (Fig. 1) [21].

Fig. 1. Tyumentsevsky district (in red) of Altai Krai

In the field, nine spring wheat varieties of Altai and foreign selection have been compared in the following variants:

1. *Altayskaya 75* (second reproduction seeds [RS2]);
2. *Altayskaya 75* (elite seeds [ES]);
3. *Stepnaya Niva* (ES);
4. *Altayskaya Zhnitsa* (ES);
5. *Altayskaya 70* (ES);
6. *Altayskaya 325* (ES);
7. *Buran* (ES);
8. *Astrid* (first reproduction seeds [RS1]) – foreign;
9. *Kitri* (RS1) – foreign.

Sowing was performed on May 28, 2020, with a JD9430 + JD-730 complex with the introduction of ammonium nitrate at a dose of 140 kg/ha and a sowing rate of 4.5 million germinating grains per hectare. During the growing season, the following chemical treatment of crops was conducted (June 26):

- Asterix (0.5 l / ha);
- Argamak (10 g/ha);

- Puma super (0.8 l/ha);
- Operkot Acra (50 ml/ha).

Sampling during the experiment and processing of the results was carried out in accordance with standard methods [5]. Sampling was performed in triplicates for each variant. The following indicators confirmed the reliability of the results: mean, confidence interval, standard deviation, coefficient of variation, and standard error of the mean.

Results

The Tyumentsevsky district of Altai Krai is located in the northwest of the region and is characterized by a flat relief (Priobskoe plateau). The climate is continental. An average temperature is -18.4°C in January and +19°C in July. The annual precipitation is 380 mm [16].

Table 1 shows the distribution of precipitation and temperature (according to the data of the meteorological station in the Baevo village) in 2020.

The precipitation distribution by months of the 2020 growing season was low and extremely uneven. In July, it rained 82.7% above the norm. In the rest of the months, there was a drought. The temperature regime in May was 42.3% higher than the norm, and in all summer months, it was close to the average long-term values. On average, during the 2020growing season, the amount of precipitation was 12.0% lower than the long-term average, and the average temperature was 7.6% higher.

Table 1.

Precipitation and temperatures of the 2020 growing season

Month	Precipitation, mm		Temperature, °C	
	total	% of long-term annual average	mean	% of long-term annual average
May	11	34.3	17.5	142.3
June	30	68.2	17.3	95.1
July	95	182.7	20.0	99.0
August	11	28.2	18.3	107.0

The summary data on the results of harvest sampling for the compared variants are shown in Tables 2 and 3.

Based on the analysis of the data obtained, it has been found that the number of seedlings according to the variants of the experiments varied from 289.0 pcs/m^2 (Variant 6, *Altayskaya 325* (ES)) to 383.0 pcs/m^2 (Variant 2, *Altayskaya 75* (ES)), with an average value of 343.1 pcs/m^2, a deviation of 32.0 pcs/m^2, and variation of 9.3%. As a result, the field germination of wheat seeds in the plots varied from 64.2% to 85.1%. On average, it was 76.2% for the compared varieties, with a deviation of 7.1% and a variation of 9.3%.

At the same time, the number of yielding plants for harvesting was in a wide range from 237.3 pcs/m^2 (Variant 1, *Altayskaya 75* (RS2)) to 350.3 pcs/m^2 (Variant 9, *Kitri* (RS1)). The average value was 320.0 pcs/m^2, with a deviation of 51.9 pcs/m^2 and a variation of 16.2%. These varieties differed significantly in terms of the number of plants to be harvested. According to the variants of the experiments, the safety of wheat plants for harvesting was high and amounted to 93.4%, with a variation of 14.6%.

As a result, the number of productive stalks in the plots varied from 297.3 pcs/m^2 (Variant 6, *Altayskaya 325* (ES)) to 420.0 pcs/m^2 (Variant 9, *Kitri* (RS1)). The average value was 342.7 pcs/m^2, with a variation of 11.4%. The tilling capacity of plants was low, averaging 1.08, with a variation of 10.3%.

The wheat yield on plots varied within wide limits from 6.9 c/ha (Variant 3, *Stepnaya Niva* (ES)) to 21.1 c/ha (Variant 2, *Altayskaya 75* (ES)). The results obtained were much lower than the potential capabilities of the varieties. The differences between the varieties were highly significant. On average, the wheat yield was 13.1 c/ha for the varieties, with a deviation of 4.5 c/ha and a variation of 34.3%. For most varieties, the changes were within the 95% confidence interval and did not differ statistically significantly.

Table 2.

Yield structure of spring soft wheat varieties for 2020

Variant	Number of sprouts, pcs/m^2	Number of yielding plants, pcs/m^2	Number of yielding stalks, pcs/m^2	Yield, c/ha	1,000 grains weight, g
1	319	237.3	298.7	11.7	29.9
2	383	312.0	370.7	21.1	32.8
3	369	333.3	368.0	6.9	24.0
4	373	344.0	345.3	13.9	27.4
5	311	317.3	353.3	10.1	29.0
6	289	272.0	297.3	11.2	28.7
7	332	289.3	337.3	14.7	29.8
8	353	320.0	330.7	9.6	26.6
9	359	350.3	420.0	18.4	25.8
Statistics					
Mean	343.1	320.0	342.7	13.1	28.2
-95%	318.5	280.1	312.6	9.6	26.2
+95%	367.7	359.9	372.7	16.5	30.2
σ	32.0	51.9	39.1	4.5	2.6
C_v, %	9.3	16.2	11.4	34.3	9.2
SEM	10.7	17.3	13.0	1.5	0.9

In general, high-quality grains were obtained according to the sowing variants (Table 3): the gluten content was 40.0% with a variation of 6.7%, that is, the variability of the gluten content was not high by varieties. The grain unit did not differ significantly by varieties: the average value was 778.5 g/l, and the variation was only 0.7%.

Table 3.

Grain quality of spring soft wheat varieties for 2020

Variant	Grain moisture, %	Gluten, %	FDM	Grain unit, g/l
1	11.7	41.8	82.9	771.5
2	11.4	38.2	75.4	771.8
3	12.4	41.1	80.5	774.0
4	11.7	37.8	79.2	782.1
5	11.6	40.8	79.3	784.3
6	11.6	43.8	82.1	785.3
7	12.2	36.2	83.1	781.9
8	12.0	42.9	92.2	774.7
9	11.8	37.4	80.3	781.0
Statistics				
Mean	11.8	40.0	81.7	778.5
-95%	11.6	37.9	78.1	774.3
+95%	12.1	42.1	85.2	782.7
σ	0.3	2.7	4.6	5.5
C_v, %	2.7	6.7	5.6	0.7
SEM	0.1	0.9	1.5	1.8

Discussion

The experiments on studying the productivity of spring soft wheat varieties were conducted by the authors in Altai Krai on a regular basis; the set of varieties and the research location are changing [1; 2; 13].

In addition, experiments aimed at identifying spring soft wheat varieties, which most fully realize their biological potential in difficult natural and climatic conditions of the forest-steppe of the Ob region and show the minimum range of variation of the *yield* trait, were conducted in 2014–2017 on the experimental plot of the Altai State Agrarian University [4]. The most stable varieties with this trait were *Altayskaya 75* and *Altayskaya Zhnitsa*.

The varieties were studied at the Altai Research Institute of Agriculture of the Federal Altai Scientific Center of Agrobiotechnology in 2017–2019 to assess the yield and individual characteristics of grain quality of wheat lines of

the *Strube* company as initial breeding material and, on this basis, create new high-intensity varieties of soft spring wheat for the conditions of the Siberian region [6]. The results indicate the advisability of the widespread use of new varieties of Western European selection in selecting high-intensity varieties for the conditions of Siberia.

In the overwhelming majority of these and other cases, the Altai varieties show the maximum productivity in the conditions of Altai Krai, which was once again confirmed within the research.

Conclusion. The theoretical and practical significance of the current research is that the yields of Altai and foreign spring wheat varieties were for the first time compared in the extra-dry conditions of the Tyumentsevsky district of Altai Krai. The 2020 growing season was extreme, with droughts, higher temperatures, and precipitation lower than in multiannual terms. There is a difference in wheat yield structure and grain quality. A comparison of varieties has shown the highest yield variability. The best variety was Variant 2, *Altayskaya 75* (ES), with a yield of 21.1 c/ha. Thus, the research results have shown that it is best to use the varieties of local selection to obtain the maximum yield of spring soft wheat in the conditions of the Tyumentsevsky district of Altai Krai.

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