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Growth, Development and Yield Indicators of Triticale Varieties in the Conditions of Karakalpakstan

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Annotation: Triticale (/trɪtɪˈkeɪliː/; ×Triticosecale) is a hybrid of wheat (Triticum) and rye (Secale) first bred in laboratories during the late 19th century in Scotland and Germany.[8] Commercially available triticale is almost always a second-generation hybrid, i.e., a cross between two kinds of primary (first-cross) triticale. As a rule, triticale combines the yield potential and grain quality of wheat with the disease and environmental tolerance (including soil conditions) of rye. In this article describes the biological and morphological characteristics of triticale (Triticosecale) samples grown on grassland and saline soils in the Republic of Karakalpakstan, their growing season, yield, and laboratory test results. According to the results of the study, the varieties "Sergey" and "Tikhon" were distinguished by high yield, good grain quality, and adaptability to climatic conditions.

Keywords: triticale, variety, yield, morphological characteristics, salinity, Karakalpakstan, environmental testing.

INTRODUCTION

Importance. Triticale is a valuable cereal, contains a lot of protein and essential amino acids (lysine, tryptophan). On average, there is 1,0-1.5% more protein than wheat, and 3-4% more than rye. Gluten is the same as wheat, but the quality is lower. Grain is used in bread baking, the confectionery industry, and for animal feed. Straw is used for animal feed and for bedding for livestock. Feed triticale varieties are sown for green fodder, silage, and grass meal. Feed from triticale is well eaten by animals.

Triticale is cultivated where wheat and rye are sown. It is widespread in Russia, in the Caucasus. There is interest in such hybrids in several European countries. The grain yield is 5-7 t / ha, and the biomass is 40-55 t / ha. In Uzbekistan, this crop is studied in a number of research institutes. It is cultivated in intermediate crops of forage crops. (Atabayeva, Khudaykulov)[1]

Triticale is useful as an animal feed grain. However, it is necessary to improve its milling and bread-making quality aspects to increase its potential for human consumption. The relationship between the constituent wheat and rye genomes were noted to produce meiotic irregularities, and genome instability and incompatibility presented numerous problems when attempts were made to improve triticale. This led to two alternative methods to study and improve its reproductive performance, namely, the improvement of the number of grains per floral spikelet and its meiotic behaviour. The number of grains per spikelet has an associated low heritability value (de Zumelzú et al. 1998). In improving yield, indirect selection (the selection of correlated/related traits other than that to be improved) is not necessarily as effective as direct selection. (Gallais 1984)[13]

Lodging (the toppling over of the plant stem, especially under windy conditions) resistance is a polygenically inherited (expression is controlled by many genes) trait, and has thus been an important breeding aim in the past.[14] The use of dwarfing genes, known as *Rht* genes, which have been incorporated from both *Triticum* and *Secale*, has resulted in a decrease of up to 20 centimeters (7,9 in) in plant height without causing any adverse effects.

The aim of a triticale breeding programme is mainly focused on the improvement of quantitative traits, such as grain yield, nutritional quality and plant height, as well as traits which are more difficult to improve, such as earlier maturity and improved test weight (a measure of bulk density). These traits are controlled by more than one gene.[12] Problems arise, however, because such polygenic traits involve the integration of several physiological processes in their expression. Thus the lack of single-gene control (or simple inheritance) results in low trait heritability (Zumelzú *et al.* 1998).

In the 19th century, crossing cultivars or species became better understood, allowing the controlled hybridization of more plants and animals. In 1873, Alexander Wilson first managed to manually fertilize the female organs of wheat flowers[10] with rye pollen (male gametes), but found that the resulting plants were sterile, much the way the offspring of a horse and donkey is an infertile mule. Fifteen years later in 1888, a partially-fertile hybrid was produced by Wilhelm Rimpau[de], "Tritosecale Rimpaui Wittmack". Such hybrids germinate only when the chromosomes spontaneously double. Unfortunately, "partially fertile" was all that was produced until 1937. In that year, it was discovered that the chemical colchicine, which is used both for general plant germination and as a treatment for gout, would force chromosome doubling by keeping them from pulling apart during cell division.[11] Triticale had become viable, though at that point the cost of producing the seeds was disproportionate to the yield.

By the 1960s, triticale was being produced that was far more nutritious than normal wheat. However, it was a poorly-producing crop, sometimes yielding shriveled kernels, germinating poorly or prematurely, and did not bake well.

Modern triticale has overcome most of these problems, after decades of additional breeding and gene transfer with wheat and rye. Millions of acres/hectares of the crop are grown around the world, slowly increasing toward becoming a significant source of food-calories. [9]

The optimum temperature for seed germination is 20°C, the minimum is 5°C and the maximum is 35°C. The critical temperature in the tillering node zone is 18 - 20°C. Tillering occurs in the fall, may continue in the spring. Total tillers – 4-6, productive tillers – 2.5 - 3.3 shoots. Triticale is a self-pollinating plant, cross-pollination is possible. Maturation of triticale occurs 3–5 days later than winter wheat. The vegetation period in the conditions of Russia is 250 - 325 days, and in Uzbekistan – 165 - 196 days. Triticale is a moisture-loving plant. A lot of water is required in the period of stem elongation, the formation and loading of grain. Less demanding on soil conditions than winter wheat and grows on various types of soil. The marsh and saline soils are unfavorable. The soil reaction can be pH 5.5 - 7.0. (Atabayeva, Khudaykulov)[1]

In recent years, triticale has been recognized as a strategic crop worldwide. According to FAO (2023), it is more drought and salinity tolerant than wheat and barley. As B.Turgunov (2020) noted, the physiological adaptability and quick-ripening properties of triticale make it a promising crop for Central Asian countries.[4]

In the studies of S. Amanov and J. Ernazarov (2021), a comparison of wheat and triticale varieties in the conditions of Karakalpakstan also revealed that triticale yields 15–20% higher in saline soils. [5]

Also, N.Zamonboboeva (2022) analyzed the nutritional value of triticale and noted that its protein content was 13–14%, which makes it a valuable raw material in the bread and feed industry. [6]

Creation of high-yielding and climate-friendly varieties of agricultural crops is one of the priorities of today's scientific research. The climate of the Republic of Karakalpakstan is continental, with little precipitation, hot and dry summers, and cold and windy winters. Since most of the soils are saline and of the grassland-barren type, many crops do not grow normally in these conditions. Therefore, it is very important to select high-yielding grain varieties that are adaptable to the local climate, tolerant to drought and salinity.

Triticale is a hybrid of wheat and rye, a crop with high grain yield and green mass, suitable for saline soils. Studying its growth characteristics in local conditions is of great practical importance for the agriculture of Karakalpakstan.

RESEARCH METHODS

The researches were conducted in Chimboy district of the Republic of Karakalpakstan, in a meadow-barren type, medium salinity soil. The depth of shallow waters is 1.8-2.0 m.

Four varieties of triticale were tested in the experiment - "Prague Serebristy", "Sergey", "Tikhon", "Khlebarob". The experiments were conducted in triplicate, with three replicates, with a plant density of 5.0 million seeds per hectare. The seeding depth was 3-5 cm.

Triticale seeds were sown in the experimental field in the first and second decade of October each year, and irrigation was carried out to ensure full germination of the seeds.

SCIENTIFIC ANALYSIS OF RESEARCH RESULTS

Before planting, the seedlings were fertilized with 80 kg/ha of pure phosphorus fertilizer, 60 kg/ha of potash fertilizer, and twice in the spring with nitrogen fertilizer (the first time 40 kg/ha, the second time 70 kg/ha).

During the growth period, phenological (growth stages), morphological (plant height, spike length, number of leaves and joints), laboratory analyzes (grain yield, weight of 1000 pieces) were carried out.

The results of the study were analyzed using MS Excel based on arithmetic averages and dynamic changes.

The seed germination of triticale samples planted in the experimental area was between 5-6 days, and the period of flowering was 12-15 days.

It was found that the full ripening period was 246 days in samples of Prag seribristy and Khlebarob, 2 days later than in other samples (Table 1).

Table 1. Growth period indicators of triticale varieties, *days*

№	The name of varieties	Germination phase, days	From germination to tillering phase, days	From germination to spiking, days	From germination to flowering, days	From germination to milky maturity, days	From germination to waxy maturity, days	From germination to full maturity, days
1	Prag seribristy	12	25	185	215	226	232	246
2	Sergey	15	26	187	212	225	230	244
3	Tikhon	15	25	180	212	225	232	244
4	Khlebarob	15	27	192	213	227	231	246

All samples were proven to belong to the mid-late maturing group. When studying the morphological characteristics of the triticale samples, it was found that the "Sergey" sample had the highest plant height (81.6 cm) and gave the highest grain yield (8.19 t/ha).

This result indicates its good accumulation, large leaf area, and high photosynthetic activity. It was observed that the “Khlebarob” variety was the leader in terms of green mass yield (18.92 t/ha) compared to other samples by 0.38-7.21 t/ha.

This proved that it can be recommended as a promising variety in the production of green fodder for livestock (see Table 2).

Table 2. Morphological characteristics and yield indicators of triticale varieties

№	The name of varieties	Plant height, cm	Number of leaves, pcs.	Internode, pcsa	Spike length, cm	Weight of one plant, gr	Grain yield, t/ha	Productivity of green mass, t/ha
1	Prag seribristy	62,8	4,4	4,7	7,56	3,0	6,03	11,71
2	Sergey	81,6	4,5	4,5	8,46	4,2	8,19	18,54
3	Tikhon	66,5	4,3	4,7	8,66	3,4	7,12	17,04
4	Khlebarob	63,8	4,2	4,6	8,23	3,5	7,12	18,92

The number of joints in the stems of the tested triticale variety samples is one of the important indicators that prevent them from falling in the wind.

As a result of the study of bundles collected from each site of the experiment in the period of full

ripening in laboratory conditions, the indicators of the length of the spike, the number of grains in one spike, the weight of grain in one spike, the yield of grain, the amount of waste, the weight of 1000 grains were studied.

The sample with the best spike length was the Tikhon sample, which proved to be 1.1 cm longer than the Prague silver variety (see Table 3).

It was found that the Khlebarob sample exceeded all samples by 0.4-3.4 grains in terms of the number of grains per spike, and the Tikhon sample surpassed all samples by 0.1-2.5 grams in terms of grain weight per spike.

Table 3. Indicators of laboratory analysis of triticale varieties

№	The name of varieties	Spike length, cm	The number of grains in one spike, pcs.	Grain weight in one spike, gr	Grain output, %	Amount of waste, %	Weight of 1000 grains, gr
1	Prag seribristy	7,56	41,6	20,4	67,36	32,64	32,16
2	Sergey	8,46	44,6	21,8	76,73	23,27	42,24
3	Tikhon	8,66	43,3	22,6	77,9	22,1	40,71
4	Khlebarob	8,23	45,0	22,5	79,6	20,4	37,66

The triticale sample "Sergey" has a higher 1000-grain weight (42.24 g) than the studied samples, which indicates good grain quality.

The grain yield indicator was "Khlebarob", which was 79.6%. The indicators studied in laboratory conditions are important indicators for increasing grain yield in the selection process of creating new varieties and hybrids of triticale.

SUMMARY

1. All tested samples of triticale showed normal growth and development in the conditions of Karakalpakstan, their full ripening period was 244-246 days.

2. The triticale variety "Sergey" was the most productive in terms of morphological and yield indicators, with a grain yield of 8.19 t/ha and a 1000 grain weight of 42.24 g.

3. The triticale sample “Khlebarob” was distinguished by the highest grain yield (79.6%) and green mass yield (18.92 t/ha).

4. The triticale samples “Sergey” and “Khlebarob” are recommended as environmentally sustainable varieties suitable for the steppe-arid and saline soils of Karakalpakstan.

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