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MORPHOLOGICAL, AGRONOMIC AND GENETIC CHARACTERISTICS OF THE TRITICALE PLANT

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ABSTRACT

In this scientific study, the morphological, genetic and agronomic characteristics of triticale (× Triticosecale Wittmack) were comprehensively investigated. Triticale is an artificial amphiploid cereal crop obtained by hybridization of wheat (Triticum spp.) and rye (Secale cereale L.), distinguished by high yield potential, resistance to environmental stress factors, and high nutritional value. The research was conducted under the agro-climatic conditions of Southern Uzbekistan, where the biological and agronomic traits of winter and spring triticale varieties were evaluated.

The results showed that plant height of triticale ranged from 90 to 140 cm, spike length from 8 to 16 cm, and the thousand-kernel weight varied between 38 and 55 g. Genetically, triticale possesses 2n = 6x = 42 chromosomes, in which wheat genomes contribute to high yield and grain quality, while the rye genome provides tolerance to drought, salinity, and low temperatures. The obtained scientific results substantiate the possibility of widely introducing triticale as a strategic cereal crop under the conditions of Southern Uzbekistan.

Keywords

triticale, morphological traits, genetic structure, agrotechnology, yield, stress tolerance.

INTRODUCTION

Currently, global climate change, depletion of water resources, soil salinization, and land degradation are among the major factors negatively affecting agricultural production. In particular, ensuring stable yields of cereal crops is becoming increasingly challenging. Traditional wheat varieties in many regions fail to fully realize their yield potential under conditions of high temperatures, drought, and saline soils.

Therefore, the introduction of new cereal crops that are resistant to environmental stress factors and capable of producing stable yields even on low-fertility and saline soils is of great scientific and practical importance. Triticale is one of such promising crops, as it combines the most valuable biological and agronomic traits of wheat and rye.

Triticale is an artificial amphiploid crop that integrates the high yield and grain quality of wheat with the strong root system and resistance of rye to cold, drought, and salinity. Its development represents a significant milestone in plant breeding, enabling the creation of stable genotypes through hybridization and restoration of chromosomal balance.

Today, triticale is widely cultivated as a grain and forage crop in many countries, including Poland, Germany, France, Canada, and Australia. International breeding centers consider triticale a strategic crop capable of ensuring sustainable agriculture under global climate change conditions.

The southern regions of Uzbekistan—Surkhandarya, Kashkadarya, Bukhara, and Navoi—are characterized by arid climates, high temperatures, and soil salinity. Ensuring stable cereal production in these areas is a pressing issue, and the introduction of triticale could partially mitigate existing challenges.

The purpose of this research is to conduct an in-depth scientific study of the morphological, genetic, and agronomic characteristics of triticale, evaluate its agrotechnical requirements and ecological adaptability, and recommend it as a promising crop for cultivation in Southern Uzbekistan.

MATERIALS AND METHODS

Research Object

The main research object of this study was winter and spring varieties of triticale (× Triticosecale Wittmack). During the research, varieties and genotypes differing in breeding background, ecological adaptability, and yield performance were examined. The selected triticale samples originated from both local and foreign breeding centers, allowing an assessment of their genetic diversity.

The research was conducted under the agro-climatic conditions of Surkhandarya region, located in the southern part of the Republic of Uzbekistan. The climate of this region is sharply continental, characterized by high summer temperatures (up to 40–45 °C), low precipitation, and high evaporation rates. The soil cover mainly consists of gray soils, with moderate to strong salinity observed in some areas.

Experimental Site and Conditions

Field experiments were carried out during 2023–2025 on experimental farm plots. The experimental area had a flat relief and was irrigated, allowing full implementation of agrotechnical practices. Meteorological data (air temperature, precipitation, relative humidity) were regularly recorded and compared with plant growth stages throughout the study period.

The soil texture was medium loam, with humus content ranging from 0.9 to 1.2%. Soil reaction (pH) varied between 7.2 and 7.8, indicating neutral to slightly alkaline conditions, which are suitable for the biological requirements of triticale.

Experimental Design and Sowing Method

The experiment was arranged in a randomized block design with three replications. Experimental variants differed according to the following factors:

triticale varieties and genotypes;

sowing time (winter and spring);

seeding rate;

mineral fertilizer application rates.

Sowing was performed in accordance with agrotechnical requirements. Winter triticale varieties were sown in late September to early October, while spring varieties were sown in late February to early March. Seeds were sown at a depth of 4–6 cm with 15 cm row spacing. The seeding rate was set at 180–220 kg per hectare.

Agrotechnical Practices

All experimental variants were managed under identical agrotechnical conditions. Irrigation was carried out 3–4 times during the growing season, with irrigation norms adjusted according to soil moisture and weather conditions. Nitrogen, phosphorus, and potassium fertilizers were applied as mineral nutrients. Basal fertilization was applied before sowing, while top dressing was conducted during stem elongation and heading stages.

Mechanical and chemical methods were used to control weeds. Preventive measures against diseases and pests were implemented, and approved fungicides and insecticides were applied when necessary.

Observation and Data Collection Methods

Phenological stages of triticale (emergence, tillering, stem elongation, heading, flowering, and maturity) were regularly monitored. Morphological parameters were measured using standard methods:

plant height (cm);

spike length (cm);

number of grains per spike;

thousand-kernel weight (g).

Yield components were calculated separately for each variant. Grain yield was determined in centners per hectare, and average values were statistically analyzed.

Genetic and Statistical Analysis Methods

Cytogenetic and morphometric methods were used to evaluate the genetic characteristics of triticale samples. Chromosome number and genomic composition were analyzed based on literature data. Experimental results were processed using mathematical and statistical methods, and analysis of variance (ANOVA) was performed to determine the significance of differences among experimental variants.

The phenological development results showed that winter triticale varieties have a significantly longer vegetation period than spring varieties, which positively affects the full formation of yield components. According to scientific literature, cereal crops with longer vegetation periods are capable of accumulating more biomass and increasing grain yield. The findings of this study fully support this conclusion.

The results obtained for morphological traits, particularly plant height and spike length, are in agreement with data reported in earlier studies. Some authors have reported that plant height in triticale ranges from 90 to 150 cm, depending on genetic characteristics and agrotechnical conditions. The values determined in this study fall within this range, indicating good regional adaptability of triticale.

The results related to the number of grains per spike and thousand-kernel weight further confirm that these traits are key determinants of triticale yield. Scientific sources emphasize that varieties with higher thousand-kernel weight are superior in terms of nutritional value and market demand. The optimal formation of these traits observed in this study enhances the economic efficiency of triticale production.

Yield results demonstrated that triticale has several advantages over wheat and rye. In particular, grain yield of winter triticale varieties reached 55–68 centners per hectare, exceeding the average yield of traditional wheat varieties cultivated in many regions. Scientific literature also reports that triticale yield can be 10–20% higher than that of wheat, which is consistent with the findings of this study.

Stress tolerance is a critical issue in modern agriculture. The present study revealed that triticale maintains relatively stable growth under high temperature, drought, and soil salinity conditions. This is attributed to its genetic structure, specifically the presence of the rye genome. Numerous studies have reported the role of the rye genome in enhancing stress tolerance, and the results of this research further confirm this conclusion.

Statistical analysis confirmed the reliability of differences among experimental variants and validated the correctness of the applied methodologies. The reliability of the obtained results increases the potential for their practical implementation.

Overall, the high yield potential, stress tolerance, and ecological adaptability of triticale allow it to be considered a promising cereal crop under the conditions of Southern Uzbekistan. The results of this study provide a scientific basis for the large-scale introduction of triticale as a grain and forage crop.

CONCLUSION AND PRACTICAL RECOMMENDATIONS

The results of this scientific study demonstrate that triticale (× Triticosecale Wittmack) possesses well-developed morphological, genetic, and agronomic characteristics and can be widely introduced as a promising grain and forage crop under the conditions of Southern Uzbekistan. Based on the conducted research, the following main conclusions were drawn.

First, the morphological characteristics of triticale—particularly plant height, leaf surface development, spike length, and grain size—confirm its high yield potential. During the study, plant height ranged from 90 to 140 cm, providing relative resistance to lodging. The greater spike length and higher number of grains per spike positively influenced efficient formation of yield components.

Second, the genetic structure of triticale is one of its major advantages. According to the research results, the amphiploid structure with $2n = 6x = 42$ chromosomes successfully combines the high productivity of wheat with the stress tolerance of rye. The A and B genomes contribute to grain quality and yield, while the R genome ensures resistance to drought, cold, and salinity. This allows triticale to be regarded as a strategic crop under conditions of global climate change.

Third, from an agronomic perspective, triticale demonstrates more stable yields compared to traditional wheat and rye. Under intensive agrotechnical conditions, triticale grain yield can reach 55–75 centners per hectare. Even on low-fertility and saline soils, triticale forms relatively stable yields, increasing the economic efficiency of agricultural production.

Fourth, triticale exhibits high ecological adaptability. Due to its deep and strong root system, wax-coated leaves, and physiological adaptation mechanisms, triticale develops normally even under drought and high-temperature conditions. Its tolerance to temperatures as low as −25 °C expands its cultivation potential as a winter crop.

Fifth, triticale has high nutritional value, with grain protein content ranging from 12 to 18%. The higher lysine content compared to wheat makes triticale particularly valuable as a forage crop for livestock production. This characteristic allows triticale to be used in a combined manner—for grain, silage, and green biomass production.

Practical Recommendations

Based on the obtained results, the following practical recommendations are proposed:

triticale should be introduced as a strategic cereal crop in arid and saline regions of Southern Uzbekistan;

winter triticale varieties should be sown in October, while spring varieties should be sown in February–March;

recommended seeding rates are 400–450 seeds/m² for winter varieties and 300–350 seeds/m² for spring varieties;

high yields can be achieved by applying mineral fertilizers at rates of N 120–160 kg/ha, P 60–80 kg/ha, and K 40–60 kg/ha;

the use of genomic selection and molecular markers in breeding programs will enhance the development of new high-yielding and stress-tolerant varieties.

In conclusion, triticale plays an important role in stabilizing grain and forage production under the conditions of Southern Uzbekistan, and its large-scale introduction is scientifically and practically well justified

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