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AGRONOMIC PERFORMANCE AND YIELD STABILITY OF WHEAT ACCESSIONS UNDER RAINFED CONDITIONS IN UZBEKISTAN

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Abstract

A two-year field trial (2024–2025) was conducted to evaluate the agronomic performance of 11 wheat accessions, under rainfed conditions of Uzbekistan. Significant variation was observed in plant height, thousand kernel weight (TKW), days to heading and maturity and grain yield across years and accessions and varieties, reflecting differential responses to stress. Lalmikor-1 demonstrated superior stability in plant height (97 cm and 94 cm), kernel weight (40.2 g and 38.4 g), and yield (2.89 t/ha and 1.36 t/ha), outperforming the standard variety by 32–42%. These findings highlight the potential of this variety for wheat production programs targeting yield stability in drought affected years.

Keywords: *Wheat, Yield, TKW, Plant height, days to heading and maturity*

Introduction

Wheat (Triticum aestivum L.) is a staple crop in Uzbekistan, where climatic variability poses significant challenges to yield stability under rainfed conditions. Drought frequency has increased markedly compared to long-term climatological data, necessitating adaptive breeding strategies. Contemporary breeding programs increasingly prioritize traits that confer resilience under abiotic stress conditions, particularly drought and nutrient limitations. Semi-dwarf plant architecture and stable grain filling capacity are critical determinants of yield component formation in winter wheat production (Jobson et al., 2019; Ingvordsen et al., 2022). This study aims to identify wheat accessions showing higher yield productivity under rainfed conditions in Uzbekistan.

Materials and Methods

Experimental Site and Design

A competitive trial was conducted over two consecutive growing seasons (2024 and 2025) at the experimental farm of the Scientific Research Institute of Rainfed Agriculture, Gallayaral district, Jizzakh province, Uzbekistan. Eleven wheat accessions, including the standard variety Tezpishar, were evaluated using a randomized complete block design (RCBD) with three replications.

Soil Characteristics

The experimental site was characterized by typical sierozem (gray desert soil) with inherently low organic matter content, containing approximately 0.8% humus. The low humus content (0.8%) observed at this site is characteristic of these soil types and significantly below the 2–3% threshold generally considered adequate for optimal crop productivity.

Climatic conditions during the Growing Season

Meteorological data for the 2023–2024 growing season are presented in Figures 1 and 2, illustrating temporal patterns of key environmental variables including precipitation rate and temperature and precipitation.

Figure 1. *Precipitation rate in 2024–2025 growing season, mm*

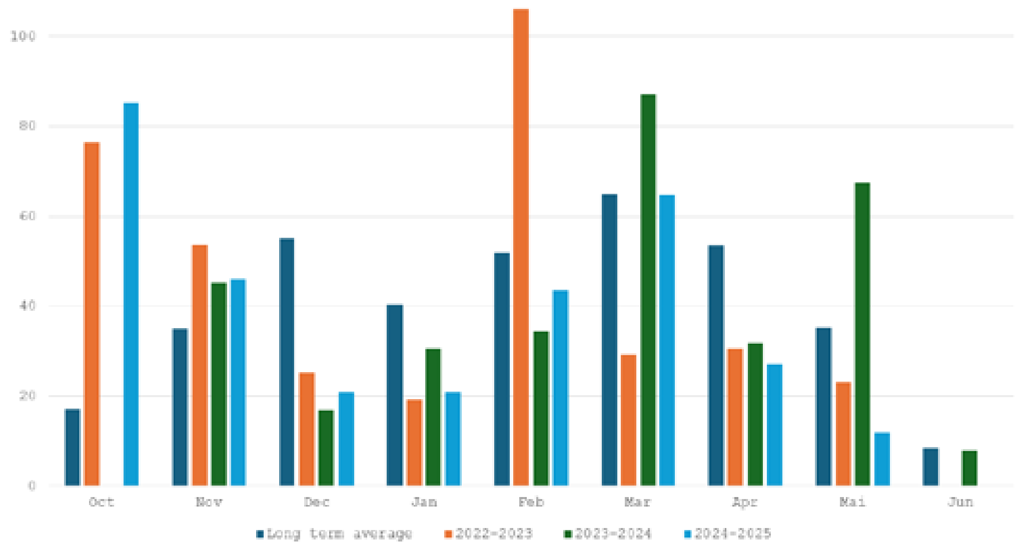
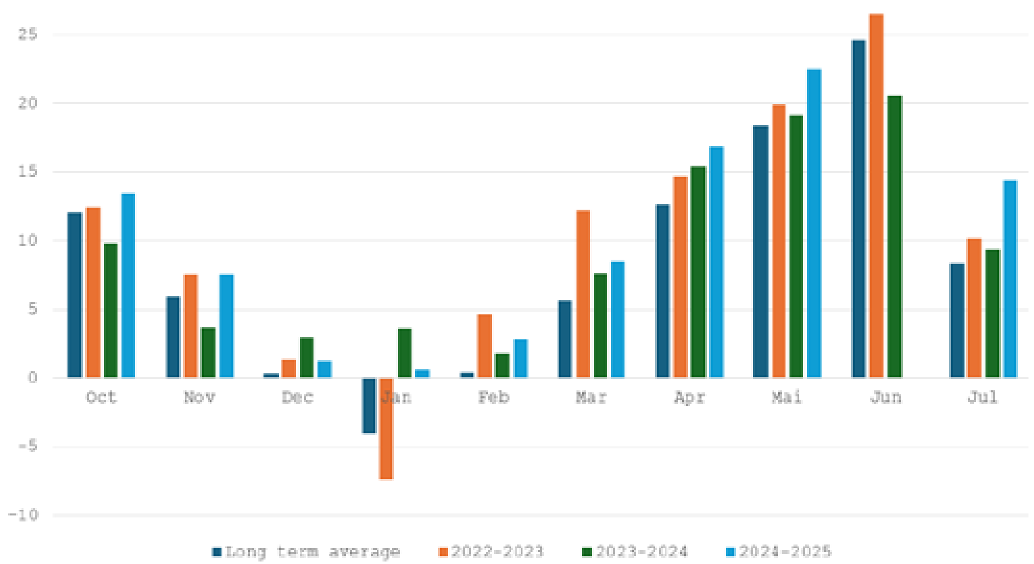


Figure 2. *Air temperature in 2024–2025 growing season, mm*



The climatic conditions during the experimental period showed great variability in temperature and precipitation in 2023–2024 growing season was favorable for wheat growth and development while 2024–2025 was relatively unsuitable weather conditions. These environmental conditions significantly influence critical physiological processes in wheat, including germination, plant height, grain filling, and overall grain yield formation.

Statistical Analysis

Analysis of variance (ANOVA) was performed using GenStat 18th Edition software. Mean separations were conducted using Fisher's Least Significant Difference (LSD) test at the 5% significance level ($P \leq 0.05$).

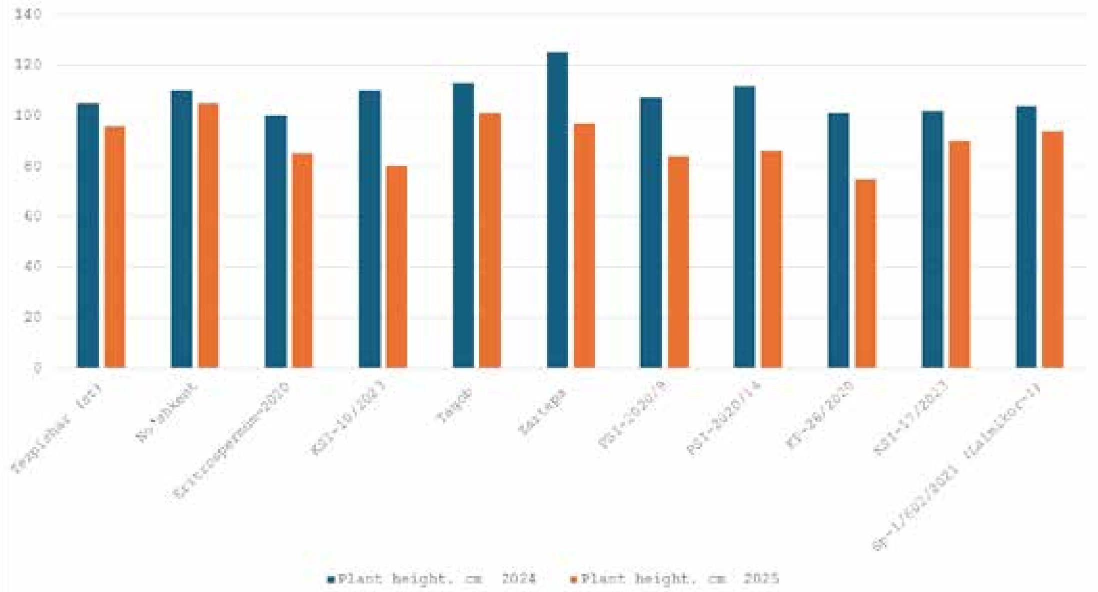
Results

Plant Height

The studied accessions of bread wheat showed significant variation in plant height across studied years: 100–125 cm in 2024 and 75–105 cm in 2025. A mean reduction of 10–20 cm was observed in the second year, likely attributable to drought stress, which aligns with observations by Nyaupane et al. (2024). The lowest plant height was recorded in KP-26/2020 (75 cm) during 2025, while the highest was observed in Zartepa variety (125 cm) in 2024 (Figure 3).

Notably, Lalmikor-1 maintained semi-dwarf plant height (104 cm in 2024 and 94 cm in 2025), demonstrating only a 10 cm reduction which is the smallest change among all accessions (Figure 1). This morphological stability is particularly valuable under rainfed conditions in Uzbekistan, where semi-dwarf plant height correlates with improved lodging resistance during high-rainfall years, a critical trait for sustainable wheat crop management in variable.

Figure 3. *Plant height of bread wheat accessions (2024–2025)*



TKW

In the 2025 growing season, TKW declined significantly for the majority of accessions, with reductions ranging from –1.8 to –9.4 g relative to 2024 values (Figure 4). This widespread decrease in kernel weight likely reflects suboptimal environmental conditions during the critical grain-filling period (Calderini et al., 1995), such as heat stress, drought, or reduced assimilate availability. The accession KSI-10/2023, which recorded the highest TKW of 43.7 g in 2024, experienced a substantial decline to 36.7 g in 2025 (–16.0% reduction), demonstrating high sensitivity to inter-annual environmental variation.

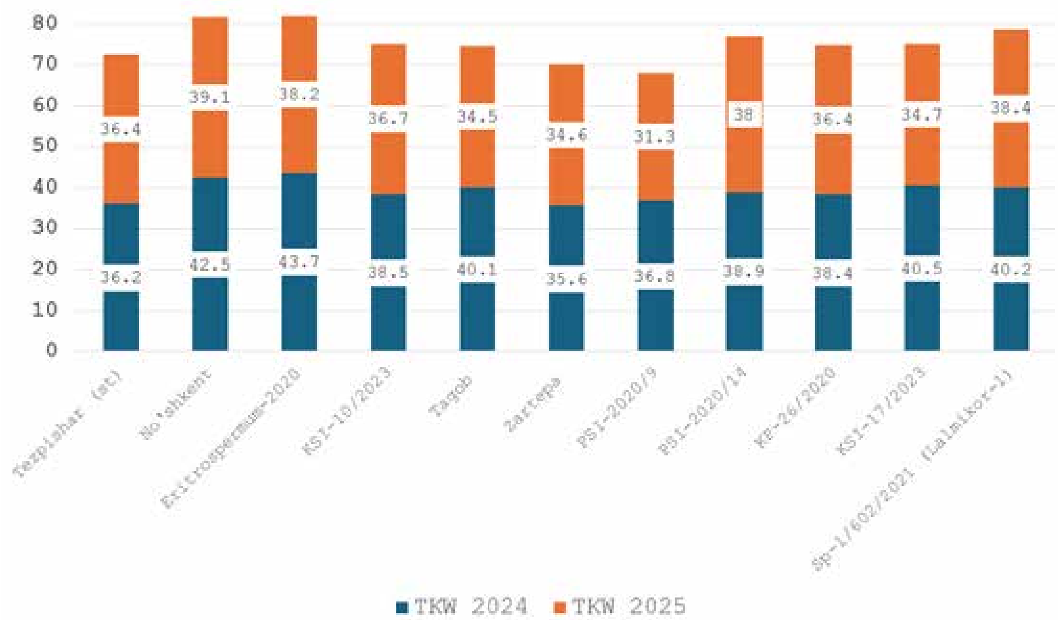
In contrast, the variety Lalmikor-1 demonstrated superior phenotypic stability across both years, maintaining relatively high TKW values of 40.2 g (2024) and 38.4 g (2025), with only a modest 4.5% decline (Figure 4). We hypnotize that this stability suggests enhanced adaptive capacity and maintenance of grain-filling processes under variable environmental conditions, making Lalmikor-1 a valuable genetic resource for breeding programs targeting climate resilience and stable grain quality.

Days to heading and maturity

Figure 5 illustrates the temporal variation in days to heading and days to full maturity for 11 wheat accessions across two consecutive growing seasons (2024 and 2025).

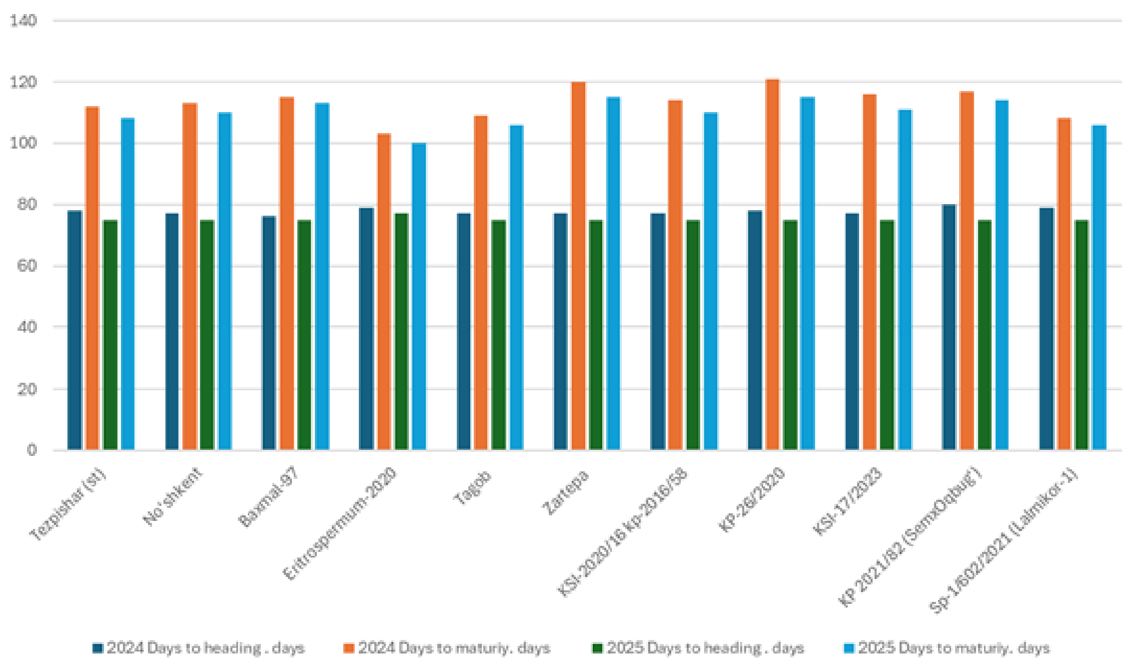
Heading occurred within a narrow range of 75–82 days in both years, indicating relatively consistent phenological timing for reproductive initiation. Maturity duration, however, exhibited greater variability: 100–120 days in 2024, contracting to 95–115 days in 2025. All accessions reached full maturity earlier in 2025, with accelerated heading and maturity likely attributable to abiotic stress factors, particularly drought and elevated temperatures, which are known to hasten developmental progression – a pattern consistent with findings reported by Nyaupane et al. (2024).

Figure 4. *Thousand Kernel Weight of bread wheat accessions (2024–2025)*



Accessions such as Lalmikor-1 and Eritrospermum-2020 demonstrate promising adaptive capacity, making them valuable germplasm resources for breeding programs targeting climate-variable rainfed systems (Rajotia et al., 2025).

Figure 5. *Days to maturity of bread wheat accessions*

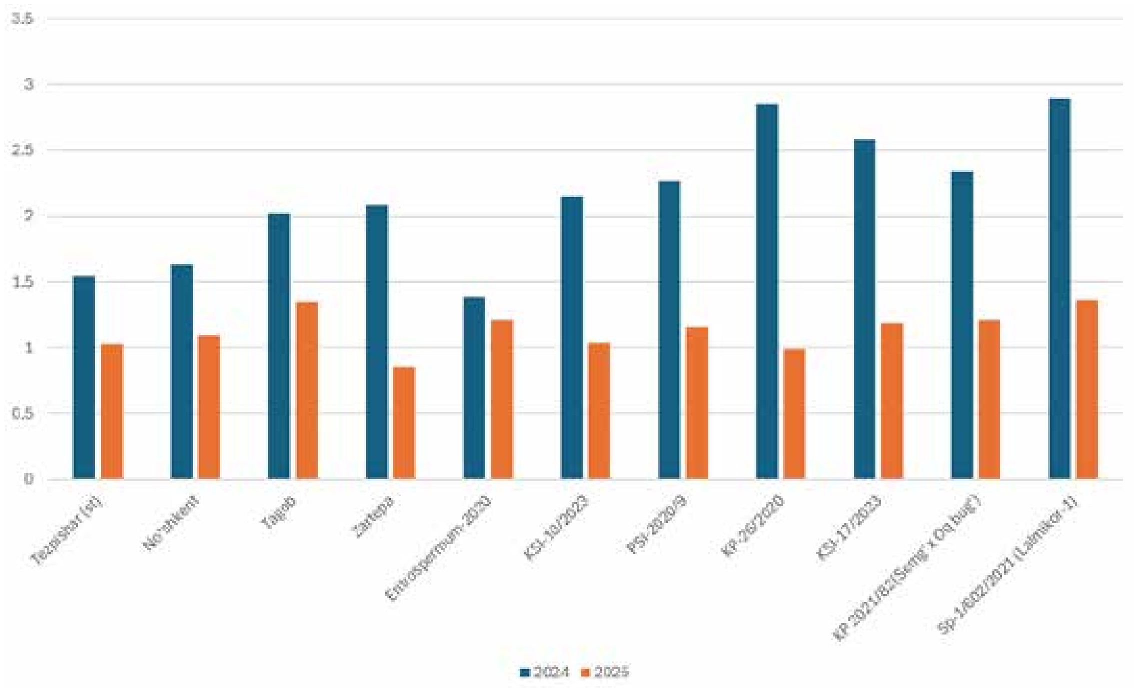


Grain Yield

Grain yields in 2024 consistently outperformed those in 2025 across all accessions and varieties, attributable to more favorable climatic conditions during the 2024 growing season (Figure 6).

Yield reductions in 2025 averaged 45–50% across accessions, reflecting the substantial impact of drought conditions during the wheat growing period.

Figure 6. *Yield variance of different bread wheat varieties and accessions*



Compared to the local check variety Tezpishar, which yielded 1.54 t/ha (2024) and 1.03 t/ha (2025), several accessions demonstrated superior performance. Lalmikor-1 achieved the highest yields of 2.89 t/ha (2024) and 1.36 t/ha (2025), retaining 47% of its baseline productivity under stress conditions. PSI-2020/9 also showed promising performance with 2.27 t/ha and 1.16 t/ha in respective years, maintaining 52% yield retention. The identification of genotypes with superior yield stability across contrasting environments is a key objective in breeding for climate resilience (Geneti et al., 2022).

The highest grain yield across all treatments was recorded with Lalmikor-1 (2.89 t/ha) in 2025, while the lowest was observed with Zartepa (0.85 t/ha) in 2024. This wide range of genotypic variation (1.38–2.89 t/ha under favorable conditions) underscores the importance of varietal selection for optimizing productivity.

Conclusion

Lalmikor-1 as promising candidate for breeding programs targeting yield stability and stress resilience in wheat. These results demonstrate that Lalmikor-1 exhibits dual advantages: high yield potential under optimal conditions and reasonable stress tolerance, maintaining moderate productivity during drought years. Such varieties with combined high-yield potential and stress resilience are particularly valuable for production systems facing increasing climate variability.

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