

Section 1. Agriculture

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COMPARATIVE ASSESSMENT OF EIGHT BARLEY GENOTYPES FOR PRODUCTIVITY IN RAINFED CONDITIONS OF UZBEKISTAN

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Abstract

Barley production in rainfed areas faces challenges from climate variability, with severe hot winds and high temperatures during grain filling which are causing yield declines in Uzbekistan. This study evaluated the agronomic performance and yield stability of eight barley varieties and accessions under rainfed conditions during 2022–2023 growing seasons. Field germination increased from 29.2–36.5% in 2022 to 57.8–75.5% in 2023 due to better moisture availability. Plant height ranged from 57–75 cm, while tillering capacity varied from 1.6–2.8 tillers per plant. Grain yield improved dramatically from 0.3–0.5 t/ha in 2022 to 1.8–2.8 t/ha in 2023. Variety Ang'iz demonstrated superior performance with the highest yield (2.8 t/ha), followed by HM-12–20 and KP-24 (DNS-4) with 2.4–2.5 t/ha. The results revealed significant genotype × environment interactions affecting all agronomic traits, highlighting Ang'iz as a promising candidate for rainfed production systems and breeding programs.

Keywords: *barley, rainfed conditions, agronomic traits, yield components, genotype × environment interaction, drought tolerance*

Introduction

Barley is the most important forage crop in Uzbekistan, mainly cultivated under rainfed conditions. Although existing varieties are adapted to local soil and climatic conditions, recent global climate changes have exposed their insufficient resistance to environ-

mental stresses. In rainfed areas and regions with limited water supply, severe hot winds (*garmsel*) and high temperatures during grain filling cause sharp yield declines and deterioration of nutritional quality (Mamatkulov et al., 2025). Winter barley generally shows higher yield potential than spring

barley (Bisharev et al., 2017), as they develop strong root systems which gives drought tolerant during the plant growth and development. Therefore, targeted breeding research for varieties combining drought tolerance and stable productivity remains essential for sustainable crop production in these challenging environments.

Materials and Methods

A competitive trial nursery was conducted at the experimental farm of the Scientific Research Institute of Rainfed Agriculture, Gallaorol district, Jizzakh province, Uzbekistan during the 2022–2023 growing seasons. Eight genotypes including the local check variety ‘Lalmikor’ were evaluated using a randomized complete block design (RCBD) with three replications.

Measurements included field germination, plant survival, morphological traits

(plant height, tillering capacity, spike length), yield components (spike weight, thousand kernel weight, test weight), and grain yield productivity. Analysis of variance (ANOVA) was performed using GenStat 18th Edition software, with mean separations conducted using LSD test at the 5% significance level ($P \leq 0.05$).

Climatic Conditions

The two growing seasons exhibited contrasting weather patterns. Precipitation in 2023 was substantially higher than in 2022, particularly during critical growth stages (Figures 1–3). Air temperatures fluctuated between 5–25 °C, with 2023 providing more favorable growing conditions as this positively affected barley grain yield. The marked differences in air humidity patterns between years significantly affected plant development and grain filling processes.

Figure 1. Precipitation rate in Gallaorol, mm (2022–2023)

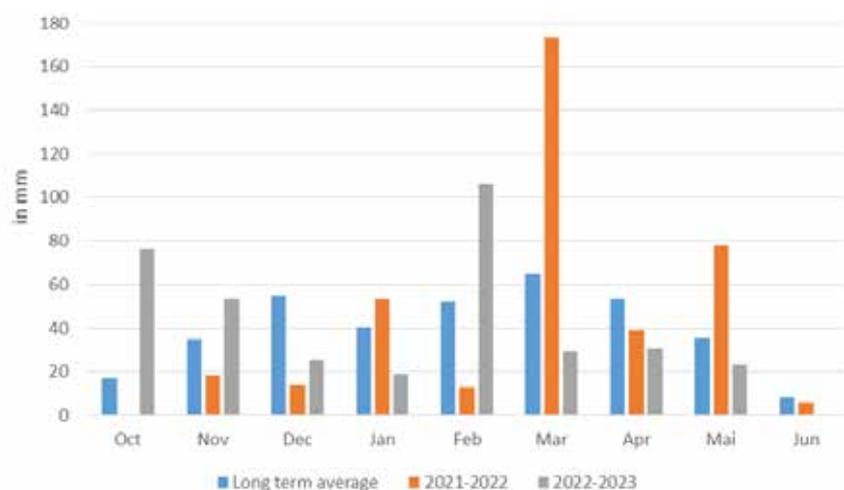
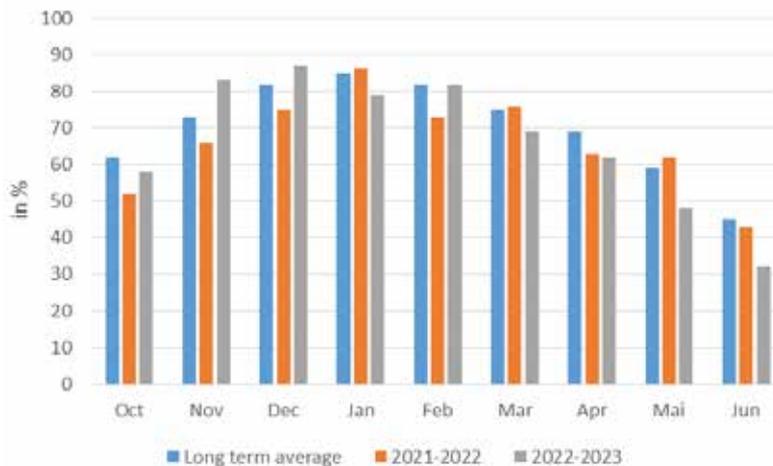


Figure 2. Air temperature in Gallaorol, C (2022–2023)



Figure 3. Air humidity in Gallaorol, mm (2022–2023)



Results and Discussion

Germination and Plant Establishment

Field germination varied considerably between varieties and years (Table 1). In 2022, germination ranged from 29.2% (Adir) to 36.5% (KP-24), while 2023 showed substantially improved performance from

57.8% to 75.5%. This improvement reflects more favorable moisture conditions during early growth. Variety Dunyo M achieved the highest germination rate (75.5%) in 2023 while maintaining acceptable performance (33.2%) during the drier 2022 season.

Table 1. Important agronomic traits of barley varieties and accessions in competitive trial nursery (2022–2023)

Variety and accessions	Field germination, %		Germinated plants, unit		Number of plants remained till harvest, unit		Plant height, cm		Tillering capacity, unit	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Lalmikor, check	33.8	65.5	102	197	88	165	59	75	2.2	2.4
Adir	29.2	61.5	88	185	77	159	58	70	2.4	2.5
Bahorikor	34.7	68.8	104	207	92	172	64	62	2.8	2.5
Sharof 100	35.9	71.1	108	213	97	175	57	59	1.8	2.2
Dunyo M	33.2	75.5	100	227	85	184	59	71	2.4	2.6
Ang'iz	35.4	70.5	106	212	99	176	60	65	1.6	2.7
HM-12–20	36.4	69.0	109	207	92	170	59	75	2.6	2.6
KP-24 (DNS-4)	36.5	57.8	107	174	95	160	61	75	2.7	2.8
LSD 05	1.2	1.7	3.5	5.4	2.3	4.1	1.3	2.2	0.11	0.10

Plant survival from germination to harvest remained significantly higher across varieties and accessions, averaging 85–92% in 2022 and 81–86% in 2023. This stability demonstrates good adaptation to local environmental conditions.

Morphological Characteristics

Plant height showed moderate variation, ranging from 57–64 cm in 2022 and 59–75 cm in 2023. Previous research by Paramonov (2010) established that plants with stem lengths between 64–74 cm combined with short, dense spikes of 7–8 cm produce

the highest yields, with plant height and spike length showing a moderately positive correlation ($r = 0.44$). In our trial, Lalmikor and HM-12–20 reached 75 cm in 2023, approaching the upper optimal range, while Sharof 100 (59 cm) and Ang'iz (65 cm) maintained moderate plant height suitable for rainfed conditions where lodging resistance is crucial.

Tillering capacity ranged from 1.6–2.8 tillers per plant in 2022 and 2.2–2.8 in 2023. Bahorikor showed the highest tillering (2.8) in 2022, though this trait decreased to 2.5 in 2023. As noted by Kostylev (2017), produc-

tive tillering is a quantitative trait with polygenic inheritance, and its expression depends significantly on environmental conditions and genotype-environment interactions.

Spike Characteristics and Yield Components

Main spike length varied from 6.6–8.8 cm in 2022 and 7.6–10.2 cm in 2023 (Table 2), with the longer spikes in 2023 reflecting improved growing conditions. KP-24 (DNS-4) produced the longest spikes (10.2 cm) in 2023, while Ang'iz maintained relatively shorter, denser spikes consistent with optimal productivity parameters.

Table 2. Yield components of barley varieties and accessions in Competitive trial nursery (Gallaorol 2022–2023)

Variety and accessions	Main spike length, cm		Spike weight, g		TKW, g		Test weight, g/l	
	2022	2023	2022	2023	2022	2023	2022	2023
Lalmikor, check	8.2	9.8	1.1	1.2	58.0	52.0	655	672
Adir	7.6	7.8	1.2	1.2	54.8	52.0	666	677
Bahorikor	8.8	8.8	1.2	1.3	59.0	52.5	659	669
Sharof 100	7.4	7.6	1.1	1.1	60.0	46.5	657	676
Dunyo M	8.2	8.0	1.2	1.2	47.8	42.5	650	660
Ang'iz	6.8	9.0	1.1	1.3	51.4	44.0	661	694
HM-12–20	6.6	9.0	1.1	1.4	60.0	50.4	659	669
KP-24 (DNS-4)	6.8	10.2	1.1	1.3	55.7	53.2	665	679
LSD 05	0.28	0.47	–	–	2.2	2.0	–	–

Spike weight ranged from 1.1–1.2 g in 2022 and 1.1–1.4 g in 2023. HM-12–20 and KP-24 showed notable increases in spike weight in 2023 (1.4 and 1.3 g respectively), indicating good responsiveness to favorable conditions.

Thousand kernel weight (TKW) is particularly important under drought stress (Kincharov et al., 2020). In our study, TKW ranged from 47.8–60.0 g in 2022 but declined to 42.5–53.2 g in 2023 across most varieties. Sharof 100 and HM-12–20 maintained the highest TKW (60.0 g) in 2022. The reduction in 2023 despite better moisture may reflect trade-offs between grain number and grain size, or heat stress during grain filling.

Test weight, indicating grain density and quality, remained relatively stable at 650–666 g/l in 2022 and 660–694 g/l in

2023, with Ang'iz achieving the highest value (694 g/l) in 2023.

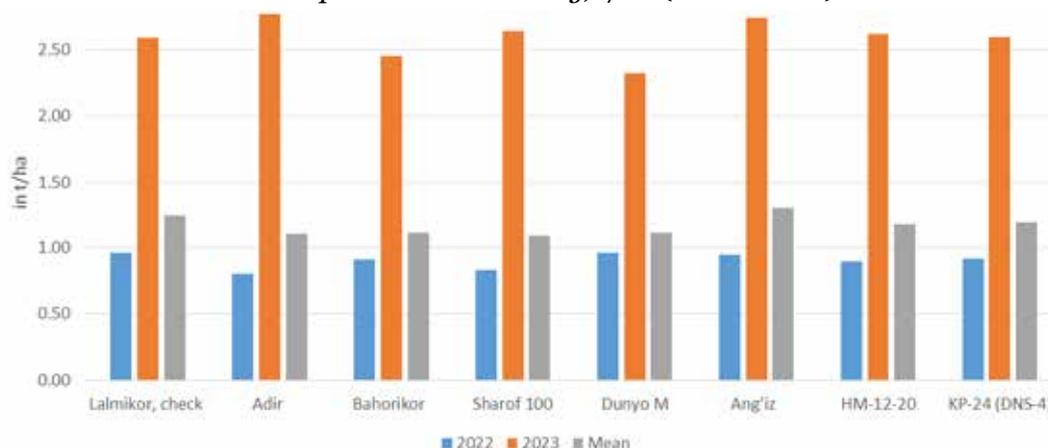
Yield Performance

Grain yield showed a significant difference between the 2022 and 2023 growing seasons (Figure 4). In 2022, yields were extremely low, ranging from 0.80 to 2.77 tons per hectare, primarily attributed to limited precipitation coupled with slightly higher temperatures and air humidity. In contrast, the 2023 season, benefiting from substantially better moisture availability, resulted in significantly higher overall yields, ranging from 2.32 to 2.77 tons per hectare. Furthermore, the mean yield over the two years indicates that the Ang'iz variety provided a higher yield compared to other varieties and accessions in the competitive

trial nursery (Figure 4). This early-ripening variety's success aligns with research emphasizing that early maturity and high yield rates are crucial breeding criteria from both economic and social perspectives (Mamatkulov

et al., 2025). The check variety Lalmikor produced approximately 2.0 t/ha in 2023, while HM-12-20 and KP-24 (DNS-4) showed competitive performance at 2.4–2.5 t/ha.

Figure 4. Yield productivity of barley varieties and accessions in complete trial nursery, t/ha (2022–2023)



Genotype × Environment Interactions

The contrasting performance between years underscores the importance of trait stability under variable conditions. As highlighted by Kholdorov and Do'squlov (2024), in rainfed areas where yield depends heavily on climatic conditions, accessions with low trait variability under environmental influence are particularly valuable for breeding programs. Stolpivskaya (2020) emphasized that when selecting accessions for breeding, using material well-adapted to target cultivation conditions is essential for developing successful varieties.

Conclusions

This two-year study resulted three key findings. First, environmental conditions, particularly precipitation, dramatically affected all agronomic traits and productivity of barley varieties and accessions. Second, Ang'iz

showed superior yield and stability, making it highly promising for rainfed systems. Third, significant genotype × environment interactions affected all measured parameters.

Moving forward, breeding programs should prioritize the selection of varieties that maintain high yields consistently across different environmental conditions, including years with drought or high precipitation. This selection strategy should also focus on incorporating resilient genotypes such as 'Ang'iz'. As Kholdorov (2019) noted, evaluating tolerance and involving resistant genotypes serves as the foundation for creating varieties that produce stable yields under variable climatic conditions. The identification of varieties combining early maturity, stable yield components, and environmental resilience will be crucial for sustainable barley production in Uzbekistan's rainfed areas.

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