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PRODUCTIVITY INDICES OF BREAD WHEAT (*TRITICUM AESTIVUM* L.) GENOTYPES UNDER DIVERSE ENVIRONMENTAL CONDITIONS OF UZBEKISTAN

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SUMMARY

The identification of stable and high-yielding wheat genotypes under variable environmental conditions is essential for sustainable grain production. In this study, evaluating 201 bread wheat (*Triticum aestivum* L.) cultivars succeeded during 2021–2023 under contrasting environmental conditions in the Tashkent and Khorezm regions of Uzbekistan. Based on morphophysiological characteristics, yield components, and stress tolerance indices, 20 promising genotypes attained selection for detailed evaluation. Several productivity and stability indices used included the stress tolerance index (STI), mean productivity (MP), geometric mean productivity (GMP), plant productivity index (PPI), and Mexican index (Mx), assessing the adaptability and yield performance of studied genotypes. The results revealed considerable variability among wheat genotypes in yield components and productivity indices across environments. The highest recorded 1000-kernel weight resulted in the cultivar Krasnovodopadskaya 210 under Tashkent conditions, whereas in the Khorezm Region, high values were evident in cultivars Krasnovodopadskaya 210, Ramin, and Frunzenskaya 60. Combined analysis of yield performance and stress tolerance indices identified cultivars Asr, Alex, and Genotype-2 as the most stable and high-yielding genotypes across contrasting environments. The identified promising genotypes represent valuable genetic resources aimed at improving yield stability and stress tolerance under diverse agroecological conditions in Uzbekistan.

Keywords: Bread wheat (*T. aestivum* L.), stress tolerance index, yield indicators, different conditions

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Key findings: Promising bread wheat (*T. aestivum* L.) genotypes, Asr, Alex, Genotype 2, Karavan, and Krasnovodopadskaya 210, emerged with higher yield potential and stability through multi-environment evaluation across the contrasting environments of Uzbekistan.

INTRODUCTION

The emerging global population has an urgent need to vertically improve the yield and quality of primary grain crops to ensure food security and prevent hunger worldwide. However, the current climate change has made it increasingly difficult to predict crop yields due to the diverse climatic stresses occurring in agricultural fields (Chadalavada *et al.,* 2021). For selecting high-yielding crop cultivars, particular attention centers on their ecological plasticity, including yield stability and adaptation to diverse environmental conditions (Brooker *et al.,* 2022; Milla, 2023). Therefore, for developing productive crop cultivars and maintaining their performance, it is crucial to employ modern technologies in genetic selection and ensure their resistance to multiple stress factors and adaptability for sustaining productivity under diverse environmental conditions (Zolkin *et al.,* 2023).

In the selection of wheat (*Triticum aestivum* L.) genotypes, numerous agronomic and physiological parameters require evaluation; however, yield-related traits remain the primary criteria for selection. At the early stages of breeding programs, accurate yield assessment is particularly critical when identifying elite lines and determining their productive potential.

In Uzbekistan, wheat cultivars experience frequent exposure to multiple abiotic and biotic stress factors, including limited irrigation water, shortened spring growth periods, elevated temperatures during key ontogenetic stages, and the prevalence of rust diseases. These constraints significantly influence yield formation and stability across environments.

According to the classification proposed by Zhuchenko (2008), varietal adaptability and yield stability across diverse environments have progressively improved, reaching 30%–50% in officially zoned cultivars (Matvienko *et al*., 2022). This highlights the increasing importance of breeding strategies aimed at enhancing both productivity and environmental resilience.

Nevertheless, cultivars that produce the highest yields under certain conditions may perform poorly under different soil and climatic conditions. The proposal of several productivity indices has sought to evaluate whether the productivity of such cultivars remains within acceptable limits across diverse environments (Singh *et al.,* 2015; Dai *et al.,* 2016; Asmamaw *et al.,* 2023; Ghanem and Al-Farouk, 2024). The widely used indices include Tolerance (TOL) and Mean Productivity (MP) under optimal and stress conditions (Rosielle and Hamblin, 1981), the Stress Susceptibility Index (SSI) (Fischer and Maurer, 1978), the Stress Tolerance Index (STI), and the Geometric Mean Productivity (GMP) (Fernandez, 1992).

These indices have become widely used to evaluate the relative performance and efficiency of genotypes across diverse environments while accounting for inter-annual climatic variability. Among them, the Stress Tolerance Index (STI) has particularly reached many recommendations for identifying genotypes that combine high-yield potential with stress resilience under both favorable and unfavorable conditions.

According to STI principles, genotypes exhibiting high stability are those capable of maintaining comparatively superior yield in stress conditions while also sustaining competitive performance under non-stress environments (Abd-El-Mohsen *et al*., 2015; Nargeseh *et al*., 2020; Poudel *et al*., 2021; Ayed *et al*., 2021). Thus, effective breeding strategies should prioritize genotypes that demonstrate consistent performance across contrasting environments rather than those that perform well exclusively under either stress or optimal conditions (Fernandez, 1992; Mardeh *et al*., 2006; Khatibi *et al*., 2022).

In 2021–2022, the wheat experiments proceeded in the Tashkent Region under two contrasting conditions: irrigated and non-irrigated (water-deficient). During these trials, the evaluation of wheat cultivars' resistance to both biotic and abiotic stresses progressed. In 2023, all 201 cultivars underwent cultivation in the Tashkent and Khorezm regions to assess their adaptability to diverse agroclimatic conditions. Based on morphophysiological traits, yield indicators, stress resistance, and adaptability characteristics, 20 wheat cultivars succeeded in their identification as promising genotypes (Baboeva *et al.,* 2023). Therefore, based on the above circumstances, the following study aimed to evaluate the efficiency of cultivating resistant and adaptable winter wheat genotypes selected under two contrasting agroecological conditions.

MATERIALS AND METHODS

Site selection

The conduct of wheat (*T. aestivum* L.) field trials commenced during 2021–2023 at the experimental fields of the Institute of Genetics and Plant Experimental Biology, Academy of Sciences, Tashkent, Uzbekistan (latitude 41.36, longitude 69.39). This region received a designation as environment E1. In 2023, the same set of plant materials also incurred evaluation at the Khorezm experimental station of the Research Institute of Seed Breeding and Agrotechnology, Khorezm, Uzbekistan (latitude 41.53, longitude 60.68), with a designation as environment E2**.**

Genetic material and experimental design

Out of the 201bread wheat (*Triticum aestivum* L.) cultivars initially tested, 20 promising genotypes finally attained their selection based on morphophysiological traits, yield-related traits, and stress resistance. The experiment, as conducted, used a randomized complete block design (RCBD) with three replications. These genotypes comprised six different groups of selections from different countries—a) Kazakhstan selections**:** Konditerskaya*,* Krasnvodopadskaya 210*,* Ramin*,* Tyngysh*,* Farabi*,* and Sama*r*, b) Uzbekistan selections: Asr*,* Ezoz*,* and Kayroktosh, c) Russia selections: Antonina*,* Afina*,* and Karavan, d) Kyrgyzstan selections: Dordoi-16*,* Frunzenskaya 60*,* and Forblanc, e) Tajikistan selection: Alex*,* and f) Turkey selections: Sonmez and TCI (Turkey–CIMMYT–ICARDA) gene pool*:* KUV/LJILN//ORACLE/Pehlivan (Genotype-1), Nikifor//Kroshka (Genotype-2), and DORADE-5/3/Progress//PYN/BAU/-4/TX71A983 (Genotype-3).

Yield traits and selection indices

The data recorded included the following wheat yield-related traits, viz., kernel weight per spike (KWS, g), kernel number per spike (KNS), spike weight (WS, g), spike length (LS, cm), the number of spikelets per spike (NSS), plant height (PH, cm), 1000-kernel weight (TKW, g), and grain yield per m² (Y, g). Additionally, the study determined the wheat grain yield under optimal field conditions (Yp), yield under water-deficit conditions (Ys), mean yield across all the cultivars under optimal conditions ($\bar{Y}p$), and mean yield across all cultivars under water-deficit conditions ($\bar{Y}s$). The stress tolerance index (STI) calculation ensued, along with other widely used yield indices, to assess the wheat genotypes' performance under contrasting environmental conditions.

Statistical analysis

From each nursery representing the two contrasting environments, 10 spikes incurred random sampling per accession for detailed morphological assessment (totaling 201 accessions). In the laboratory, key spike-related traits entailed measurements following standard evaluation procedures. Grain yield calculation was the total grain mass harvested per square meter (g m^{-2}) from each experimental plot.

Performing analysis of variance (ANOVA) sought to determine the significance of differences among genotypes for all evaluated traits. Based on grain yield performance and stability across environments, 20 cultivars exhibiting relatively stable and superior productivity obtained their selection for further analysis. Subsequently, yield-related indices' calculation continued for these selected genotypes. Descriptive statistics and correlation analyses, when performed, used Microsoft Excel data analysis tools. The distribution and variability of the studied traits reached visualization through boxplot analysis using OriginPro 2021 software.

RESULTS

Yield components

Bread wheat (*Triticum aestivum* L.) is an important dryland crop extensively cultivated in semi-arid regions across the world. Ongoing climate change, characterized by increasing temperature variability, irregular precipitation patterns, and more frequent abiotic stress events, has intensified the need to develop high-yielding, stress-resilient, and environmentally adaptable wheat cultivars (Kirigwi *et al.,* 2004; Kruglova *et al.,* 2022; Esaulko *et al.,* 2022). Genotypes capable of sustaining stable productivity under both stress and favorable conditions exhibit high phenotypic plasticity, a key attribute for successful cultivation in regions with contrasting agroclimatic environments.

For some wheat genotypes, including Krasnovodopadskaya 210, Ezoz, Antonina, Afina, and Genotype-1, the spike length remained the same across both environments. Spike weight was higher in most cultivars grown in Khorezm, except for the genotype Forblanc, exhibiting heavier spikes in the Tashkent Region. Spikelet number was also higher in the Khorezm Region, except for genotypes Krasnovodopadskaya 210, Asr, Forblanc, Genotype-1, and Genotype-3, which remained at par for spikelet number in both regions. Spike density classification followed these standard categories: sparse (< 1.6), medium (1.7–2.2), dense (2.3–2.8), and very dense (> 2.8). In the Tashkent Region, genotypes Ezoz and Kayroktosh revealed sparse spikes, while the cultivar Samar exhibited dense spikes. In the Khorezm Region, sparse spikes were evident in the wheat cultivars Frunzenskaya 60, Afina, and Genotype-3, whereas other cultivars displayed moderate density (Figure 1).

The kernel weight per spike considerably varied among the wheat genotypes at both locations. In the Tashkent Region, the Genotype-3 exhibited the highest value for kernel weight per spike (2.57 g), while the lowest value resulted in the cultivar Samar (1.34 g). In the Khorezm Region, the cultivar Forblanc had the lowest (1.3 g), while the genotype Farabi had the highest (3.5 g). Several other cultivars (Ezoz, Sonmez, Afina, Karavan, Genotype-1, and Genotype-3) displayed stable grain weights across both regions. The plant productivity index (PPI), which integrates spike length, grain number, and grain weight (Manukyan *et al*., 2019), identified the high-yielding cultivars, such as Karavan, Forblanc, Genotype-1, and Genotype-3 in the Tashkent Region. In the Khorezm Region, the cultivar Forblanc showed average productivity, while the majority of other wheat cultivars achieved the highest PPI values (Table 1).

For 1000-grain weight, wheat genotypes showed considerable variability in both regions. In Tashkent, the cultivar Krasnovodopadskaya-210 had the highest 1000-grain weight (55.6 g), while the lowest appeared in cultivars Afina and Kayroktosh (38 g). In Khorezm, cultivars Krasnovodopadskaya 210, Ramin, and Frunzenskaya 60 exceeded 51 g for 1000-kernel weight, with the lowest values recorded in genotypes Forblanc (34.7 g) and Afina (36.2 g). Comparative analysis revealed that wheat genotypes Konditerskaya, Krasnovodopadskaya 210, Ezoz, Sonmez, Dordoi 16, Afina, and Genotype 3 had higher 1000-kernel weight in Tashkent than in Khorezm, while genotypes Alex and Genotype-1 showed nearly identical values across both regions. The remaining 11 cultivars demonstrated higher 1000-kernel weight in the Khorezm Region. These results confirmed that 1000-kernel weight is a variable indicator of grain yield, largely dependent on environmental conditions.

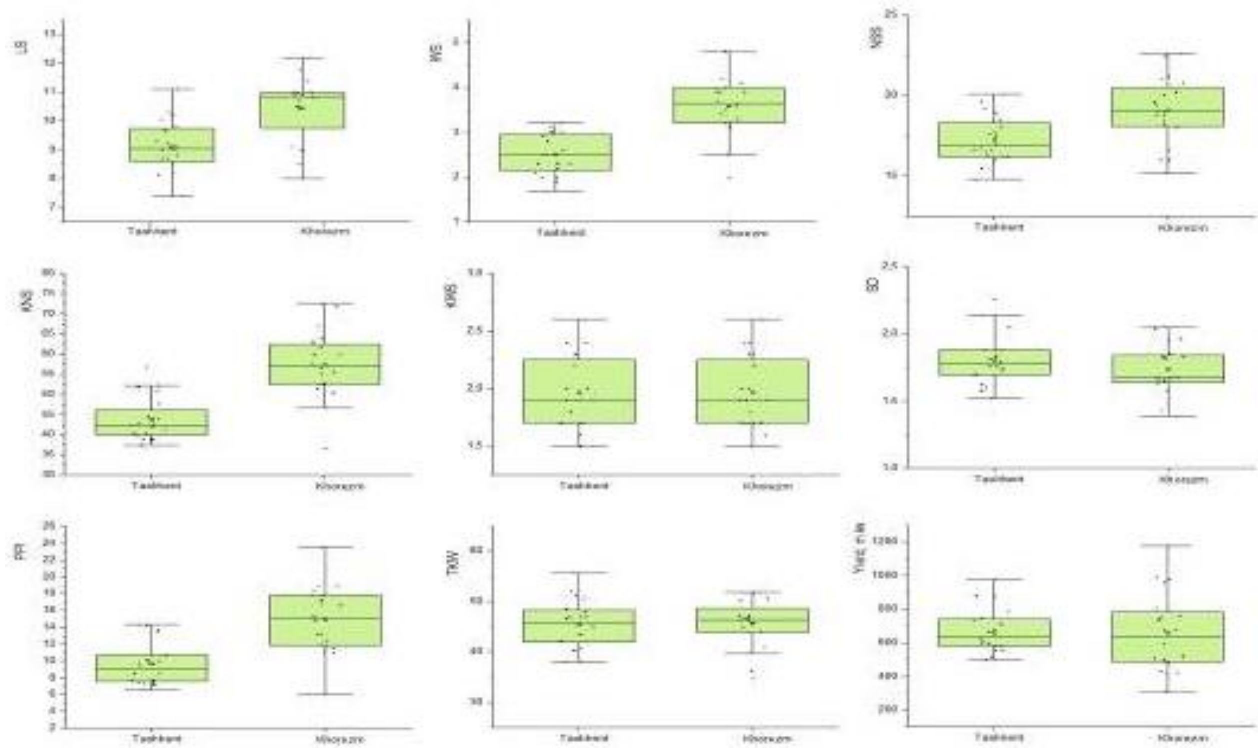

Figure 1. Yield indicators of bread wheat cultivars: A - Tashkent Region. B - Khorezm Region. (I) LS - length of spike, cm; (II) WS - weight of a spike, g; (III) NSS - number of spikelet per spike, pcs; (IV) KNS - kernel number per spike, g; (V) SD – spike density; (VI) KWS - kernel weight per spike, g; (VII) PPI - plant production index; (VIII) TKW - thousand kernel weight; and (IX) Yield - crop yield per m^2.

Table 1. Yield indices of wheat cultivars.

Indices	Name	Formula
Mx	Mexican index	KWS / PH
SD	Spike density	(NSS -1) /LS
PPI	Plant production index	(NSS × KYS) /LS
STI	Stress tolerance index	$[1-(Ys/Yp)]/(\bar{Y}s/\bar{Y}p)$
MP	Mean productivity	(Yp + Ys) / 2
GMP	Geometric mean productivity	$\sqrt{[(Yp) \times (Ys)]}$

Stress tolerance indices

Bread wheat genotypes evaluated totaled 201 under irrigated and non-irrigated conditions to determine their response to water-deficit stress. Based on grain yield performance in stress conditions, calculating the stress tolerance index (STI) helped classify genotypes according to their drought resilience. Approximately 25% of the evaluated genotypes exhibited moderate tolerance, whereas the majority received a resistant classification. Notably, nearly half of the collection demonstrated high-stress tolerance. Among the 20 selected cultivars, six genotypes emerged as moderately resistant based on STI values, while the remaining genotypes showed high levels of tolerance (Table 2). These findings indicate substantial genetic variability for drought tolerance within the studied wheat germplasm.

Table 2. Productivity and yield indices of bread wheat in Tashkent and Khorezm Regions.

Wheat cultivars	STI	Grain yield/m²		MP	GMP
		Tashkent	Khorezm		
Konditerskaya	1.49	601.0	595	598.0	598.0
Krasnovodopad 210	0.76	595.5	974	784.8	761.6
Ramin	0.48	602.0	677	639.5	638.4
Tyngysh	1.07	786.5	519	652.8	638.9
Farabi	0.39	879.0	673	776.0	769.1
Asr	0.29	972.5	986	979.3	979.2
Ezoz	0.41	513.0	491	502.0	501.9
Kayroktosh	0.66	624.0	750	687.0	684.1
Alex	0.13	875.5	758	816.8	814.6
Sonmez	0.17	701.5	499	600.3	591.6
Genotype-1	0.75	749.5	958	853.8	847.4
Genotype-2	1.01	736.0	1176	956.0	930.3
Genotype-3	1.15	719.0	423	571.0	551.5
Antonina	0.11	555.5	805	680.3	668.7
Dordoi 16	0.41	498.0	303	400.5	388.5
Samar	1.18	650.5	506	578.3	573.7
Frunzenskaya 60	0.54	583.0	428	505.5	499.5
Afina	0.19	550.5	412	481.3	476.2
Karavan	0.93	575.0	737	656.0	651.0
Forblanc	0.73	664.5	480	572.3	564.8
Means		671.6	657.5	664.5	656.5
Sd		29.1	52.3	34.8	34.5
CV%		4.3	7.9	5.2	5.2
Ranges		498-972.5	303-1176	400.5-979.2	388.5-979.2

Across genotypes, yield components, productivity indices, and 1000-kernel weight appeared to be significantly varied. The highest 1000-grain weight recorded surfaced in the genotypes Asr, Ezoz, Krasnovodopadskaya 210, Ramin, and Frunzenskaya 60, while the cultivar Afina consistently exhibited the lowest value. The grain yield per square meter was the highest in the cultivars Asr and Genotype-2, confirming their superior performance under both environmental conditions.

The quantitative traits determining grain yield and stress resilience acquired considerable influences from environmental conditions, as managed by a complex interaction of multiple genes and genotype–environment interactions. As shown in Table 2, the mean productivity (MP) and geometric mean productivity (GMP) calculations took place for the Tashkent and Khorezm trials. These indices serve as robust indicators of adaptability under contrasting environments. In the Tashkent Region, mean productivity reached 671.6 g/m², on average, with the lowest grain yield recorded in the cultivar Dordoi 16 (498 g/m²) and the highest in cultivar Asr (972.5 g/m²). In the Khorezm Region, cultivar Dordoi 16 again recorded the lowest yield (303 g/m²), while Genotype-2 achieved the maximum productivity (1176 g/m²) (Table 2). High MP and GMP values were evident in the wheat cultivars Konditerskaya, Ramin, Asr, Ezoz, Kayroktosh, Alex, Samar, Frunzenskaya 60, and Karavan. The best-performing cultivars across both regions were Asr, Alex, and Genotype-2, but the cultivar Dordoi-16 consistently displayed the lowest productivity indices.

Past studies enunciated that grain yield occurred negatively correlated with tolerance index (TOL), drought index (DI), and stress susceptibility index (SSI). However, it showed a positive association with MP and GMP under drought stress, suggesting that genotypes with high MP were more likely to be tolerant (Anwaar *et al*., 2020). Similarly, Mardeh *et al*. (2006) reported that under moderate stress conditions, the stress indices MP, GMP, and STI

Table 3. Correlation analysis between yield components and productivity indices.

Traits & indices	LS	WS	NSS	KNS	KYS	SD	PPI	TKW	Yield	MP	GMP
LS	1										
WS	0.69	1									
NSS	0.65	0.63	1								
KNS	0.62	0.89	0.71	1							
KYS	0.61	0.95	0.62	0.9	1						
SD	-0.54	-0.18	0.28	-0.01	-0.08	1					
PPI	0.44	0.89	0.6	0.94	0.94	0.11	1				
TKW	0.16	0.39	0.02	0.03	0.4	-0.17	0.22	1			
Yield	-0.14	-0.05	0.06	-0.07	0.02	0.22	0.05	0.13	1		
MP	-0.01	0.02	0.16	0.02	0.08	0.17	0.1	0.06	0.82	1	
GMP	-0.01	0.02	0.16	0.03	0.08	0.17	0.11	0.06	0.82	0.99	1

Note: LS – spike length; WS – spike weight; NSS – number of spikelets per spike; KNS – kernel number per spike; KYS (KWS) – kernel weight per spike; SD – spike density; PPI – plant productivity index; TKW – thousand kernel weight; Yield – grain yield per m²; MP – mean productivity; and GMP – geometric mean productivity.

proved more effective in identifying high-yielding genotypes across stress and non-stress conditions. Comparable results also came from Egypt, where Ali and El-Sadek's (2016) findings showed that grain yield under both irrigated and rainfed conditions had significant correlations with stress indices MP, GMP, and STI. Their principal component analysis revealed the first two components explained more than 98% of the total variation in drought tolerance indices, further confirming the reliability of these measures for genotype evaluation and selection.

Correlation analysis

The study conducted correlation analysis between yield components and yield indices of bread wheat under contrasting environmental conditions (Table 3). Spike length exhibited a moderate positive correlation with most traits and a significant positive correlation with spikelet density per square meter. In contrast, the weak negative correlation was notable with field productivity, while virtually detecting no association with mean productivity and geometric mean productivity.

Spike weight showed considerable positive correlation with the number of grains per spike and grain weight per spike, as well as with the plant productivity index. The thousand-kernel weight has no close association with the number of grains per spike; however, it displayed a moderate positive correlation with grain weight per spike and a weak negative association with spike density index. These results revealed spike weight and grain weight per spike were distinctly reliable predictors of yield potential, whereas spike length and spike density appear to be less consistent under diverse environmental conditions.

The results further detailed that spike density exhibited moderately weak positive correlation with the number of spikelets per spike, grain yield, MP, and GMP, and a moderately weak negative correlation with a thousand-kernel weight. The plant productivity index demonstrated consistently positive associations with all measured traits. Significant positive correlations emerged with spike weight, grain number, and grain weight per spike. Meanwhile, moderate correlations appeared with spike length and spikelet number, and weak correlations with other traits. Both MP and GMP showed considerable correlations with overall crop productivity but negligible associations with individual morphological traits.

The findings emphasized the value of MP and GMP as integrative indices, capable of capturing yield stability under diverse environmental conditions. The presented results were greatly analogous to the findings of Sanogo *et al*. (2023b), who reported the efficiency of combining yield-based stress tolerance indices to improve crop productivity under varied cultivation conditions. The appropriateness of GMP as a robust selection criterion, particularly in environments with considerable inter-annual variability, has also been highlighted by Fernandez (1992).

DISCUSSION

Bread wheat (*Triticum aestivum* L.) is a dryland crop widely cultivated in semi-arid regions worldwide. The evaluation based on the 201 bread wheat genotypes across contrasting environments in Tashkent and Khorezm regions highlighted significant genotype-by-environment interactions for yield-related traits. The spike length remained stable in several genotypes (such as Krasnovodopadskaya 210, Ezoz, and Afina); spikelet number and spike weight increased under the more stressful conditions of the Khorezm Region, suggesting a compensatory adaptation strategy. In contrast, kernel weight per spike and 1000-kernel weight were remarkably the most environmentally sensitive traits, reflecting their dependence on water availability and temperature during grain filling. Similar genotype × environment interaction patterns for yield components have had wide reports in bread wheat grown under contrasting agroecological conditions. Previous studies demonstrated that spike-related traits, such as spike length and spikelet number, are genetically more stable and less affected by environmental fluctuations. Conversely, grain-filling traits, including kernel weight per spike and a thousand-kernel weight, are highly sensitive to water deficit and elevated temperatures during the reproductive stage (Reynolds *et al.,* 2002; Würschum *et al.,* 2018). The observed increase in spike weight and spikelet number in stress conditions supports the concept of compensatory adaptation, where wheat plants adjust sink structure to partially offset reductions in grain size under unfavorable environments (Kirigwi *et al.,* 2004; Sanogo *et al.,* 2023a).

The plant productivity index further distinguished the stable performers, and the genotypes Karavan, Genotype-1, and Genotype-3 showed consistently higher productivity, whereas cultivar Forblanc displayed considerable variability. These results underline the importance of multi-environment trials for identifying the stable and high-yielding wheat genotypes. The identification of stable and high-yielding genotypes, such as Krasnovodopadskaya 210, Karavan, and Genotype-3, provides valuable genetic material for breeding programs aimed at enhancing resilience in semi-arid environments. The study results confirmed earlier observations that spike-related traits display significant genetic variability and heritability in wheat (Würschum *et al.,* 2018). Comparative evidence also revealed that bread wheat genotypes generally showed higher adaptability than durum wheat and triticale under diverse climatic conditions (Reynolds *et al.,* 2002).

The broader evaluation of 201 bread wheat genotypes under irrigated and non-irrigated conditions revealed substantial genetic variability for drought tolerance, with nearly half of the collection classified as highly resistant. Stress tolerance indices (STI), along with mean productivity (MP) and geometric mean productivity (GMP), proved effective in discriminating stable, high-yielding cultivars. Wheat cultivars Asr, Alex, and Genotype-2 consistently performed well across both sites, confirming their adaptability, whereas genotype Dordoi-16 repeatedly ranked lowest, highlighting its limited potential in stress conditions. These results align with earlier studies emphasizing the reliability of MP, GMP, and STI for identifying drought-tolerant wheat genotypes (Mardeh *et al.,* 2006; Ali and El-Sadek, 2016; Anwaar *et al.,* 2020). More recent investigations also supported the use of these indices and demonstrated their predictive value in South Asian bread wheat genotypes (Ahmad *et al*., 2021). It also confirmed their applicability in Egyptian cultivars (Ghanem *et al*., 2024b).

Correlation analysis further reinforced the role of key yield components. Spike weight, grain number per spike, and grain weight per spike exhibited a significant association with overall yield and PPI, indicating their predictive potential for grain productivity. In contrast, morphological traits, such as spike length and spike density, showed weaker and less consistent correlations with MP and GMP, suggesting limited usefulness as selection criteria. These results were consistent with the findings of Sanogo *et al*. (2023a), who highlighted the efficiency of combining yield-based indices for improving wheat productivity under variable environments. Additionally, recent multi-environment studies in Iran and Morocco (Hnizil *et al.,* 2024) reported that MP, GMP, and STI were consistently the most robust predictors of yield stability, confirming their universal applicability across the different regions.

The results highlight the critical importance of integrative stress tolerance indices in modern wheat improvement programs. The identification of high-performing bread wheat genotypes, such as Asr, Alex, Genotype 2, and Karavan, provides valuable genetic resources for future breeding efforts. These genotypes demonstrated superior yield stability and drought tolerance across contrasting environments, making them promising candidates for the development of resilient cultivars. Their incorporation into breeding programs could contribute significantly to sustainable wheat production in semi-arid and drought-prone regions.

CONCLUSIONS

The multi-environment field evaluation of 201 bread wheat (*Triticum aestivum* L.) genotypes conducted during 2021–2023 under contrasting water supply conditions provided important insights into their agronomic performance and adaptive potential. Based on yield components, physiological traits, and stress tolerance indices, 20 wheat genotypes succeeded in their identification as promising candidates for further breeding and cultivation. The results demonstrated significant variability among genotypes and highlighted the importance of stress tolerance indices, such as stress tolerance index (STI), mean productivity (MP), and geometric mean productivity (GMP), as reliable indicators for identifying stable and high-yielding genotypes across contrasting environments. Among the evaluated materials, cultivars Asr, Alex, and Genotype-2 showed superior yield stability and adaptability in both Tashkent and Khorezm conditions. Overall, the identified genotypes exhibited considerable ecological plasticity and maintained stable productivity across environments with different soil and climatic characteristics. These genotypes represent valuable genetic resources for wheat breeding programs aimed at improving drought tolerance, yield stability, and adaptability to diverse agroecological conditions in Uzbekistan and other semi-arid regions.

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