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Research Article

Adaptability Evaluation of Bread Wheat (*Tritium aestivum* L.) Varieties Under Irrigated Conditions in the Upper and Middle Awash Area

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Abstract

Wheat (Triticum spp) is one the most important and strategic cereal crops in Ethiopia, because of its role in food security, import substitution and used as raw material for the agro-processing. Bread wheat is recently cultivated in the lowland irrigated areas of Ethiopia. Despite many improved bread wheat varieties have been released nationally for rainfed areas, the adaptability of these varieties were not identified. To overcome this challenge, adapatabilty evaluation of recently released bread wheat varieties were conducted to confirm their environmental adaptation across four locations. Systematic growth, yield and yield components, and environmental data were collected and analyzed using standard agronomic and statistical methodologies. The combined analysis of variance indicated that the sixteen tested varieties differed significantly for all traits except for their numbers of kernesl per spike. Variety Boru (4823.5 and 4566.7 kg ha^{-1}), Dursa (4352.9 and 3950 kg ha^{-1}) and Abay (4078.4 and 4433 kg ha^{-1}) stand out as the highest yielders at Werer and Arage respectively, indicating these varaieteis are best adapted and high yielding next to Ga'ambo-2 (chek) (4352.9 and 4388.3 kg ha^{-1}) in Afar region. Varaiety Biftu (3339.2 and 2965.2 kg ha^{-1}), Dursa (2880.4 and 3122.6 kg ha^{-1}) and Deka (2779.4 and 3087.5 kg ha^{-1}) recorded higher gran yield at Jeju and Merti respectively, indicating these varieties were best performing in Oromia region. High combined mean grain yield was recorded from Boru and Dursa variety (3626.22 kgha^{-1} and 3563.97 kgha^{-1}) following the standard check variety "Gambo-2" (3781.89 kgha^{-1}) suggesting Boru and Dursa could be used as a widely adapted durum wheat variety with high grain yield to enhance wheat cultivation in irrigated lowland of Ethipia. The lowest grain yield was recorded in variety Wane (3006.37 kg ha^{-1}) and Ardi (2368.87 kg ha^{-1}) suggesting, Wane and Ardi may be less adaptable and low yielder.

Keywords

Bread Wheat, Yield, Adaptability, RCBD, Variety

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1. Introduction

Ethiopia, with total area of 2.1 million hectares and total annual production of 6.7 million tons [17], is the largest wheat producer in SSA followed by South Africa Wheat *(Triticum spp)* is one the most important and strategic cereal crops in Ethiopia, because of its role in food security, import substitution, used as raw material for agro-processing industry and its leftover used as livestock feed [17] (Wheat shares 14% of the total calorie intake which makes it the second most important food crop behind maize and ahead of teff [15] and ranks third after teff and maize in area coverage [6]. The two wheat species dominantly grown in Ethiopia are durum wheat (*Triticum turgidum* L. var. *durum*.) and bread wheat (*Tritium aestivum* L.). Ethiopia has set a plan to expand irrigated wheat production and expansion as one of the pillar for wheat self-sefficiency by producing 6 Mts of wheat from 1.5 Mha by irrigation alone, which is equivalent to wheat produced in 2021 [1]. Small scale (<200ha) to large-scale (>3000ha) irrigation schemes along the Awash River, Omo, Genale, Wabi-Shebele and other river basins in the lowland araes are suitable for the crop production [17]. The expansion of lowland irrigated wheat areas has been driven by the availability of extensive untapped irrigation land in different parts of the country [5]. Wheat variety development activities for lowland irrigated areas were started with adaptation trials which were conducted from 1969/70 up to 1986/87 at Werer Agricultural Research Center [12]. There are two main approaches in developing, testing, and releasing new wheat varieties. The first is the conventional breeding process, which involves long-term variety development and a formal release procedure. The second is a fast- track approach that accelerates variety development and release [16]. Testing nationally released wheat variety for their adaptability and recommendation of high yielding and heat stress tolerant varieties is also imporatant to enhance wheat production in the lowland areas. In countries such as Egypt illet temperature tolerant varieties could yield more than 10 t ha^{-1} under optimum irrigation and modern cultivation techniques [13]. In spite of, untapped potential in the lowlands of Ethiopia, alternative wheat varieties having wide adaptabilty, high yielding, disease resistant, heat stresss tolerant with good processing quality is one of the bottlenecks. Despite there are recently released wheat varieties, shortage of improved varieties and a limited study in nationaly released bread wheat variety for their adaptability under lowland irrigated condtion was a problem. Thus, with this objective adaptability evaluation of bread wheat variety trial were conducted in four locations.

2. Materials and Methods

2.1. Study Area

This study was conducted during 2021/22 cropping seasons in Afar Region (Werer Agricultural Research Center and Amibara districts) and Oromia Region Merti and Jeju districts (Figure 1).

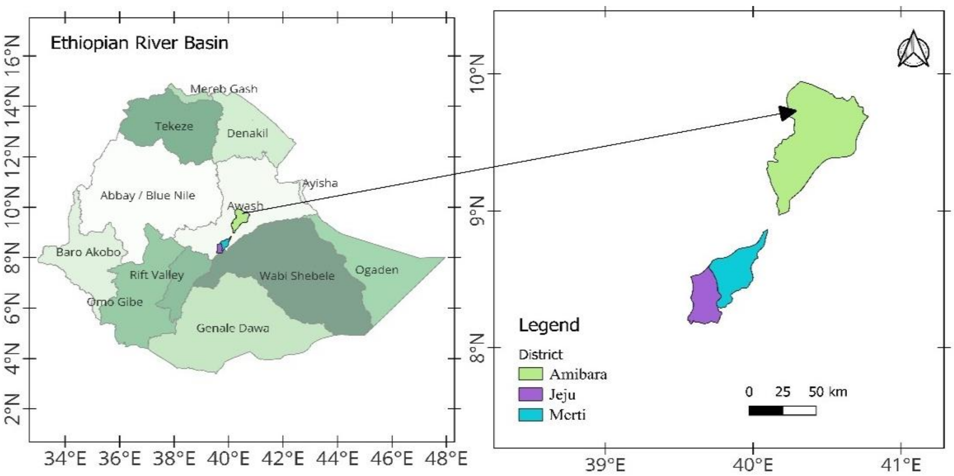

Figure 1. *Map of study area.*

2.2. Experimental Design and Crop Management

The minimum and maximum temperatures and Average monthly rainfall of the experimental sites are presented on Figure 2. Sixteen Bread wheat Varieties released for highland, Mid-land and lowland areas were selected and used to conduct the experiment (Table 1). The field experiment was laid out in RCBD design with four replications. The total plot area was 15m^2 (3m width x 5m length) and two rows per ridge with 30 cm spacing between rows were used. Each plot was planted using a seed rate of 150 kg/ha. NPS fertilizer was applied at the rate of 100 kg ha^{-1} once at sowing time and 150 kg ha^{-1} Urea (69N) was applied in split application; half at seedling or tillering stage and the remaining half at booting stages. The trial was raised under irrigation across all the test locations and irrigation water was applied at every 10 days interval using furrow method. All other agronomic activities were applied uniformly for each plot.

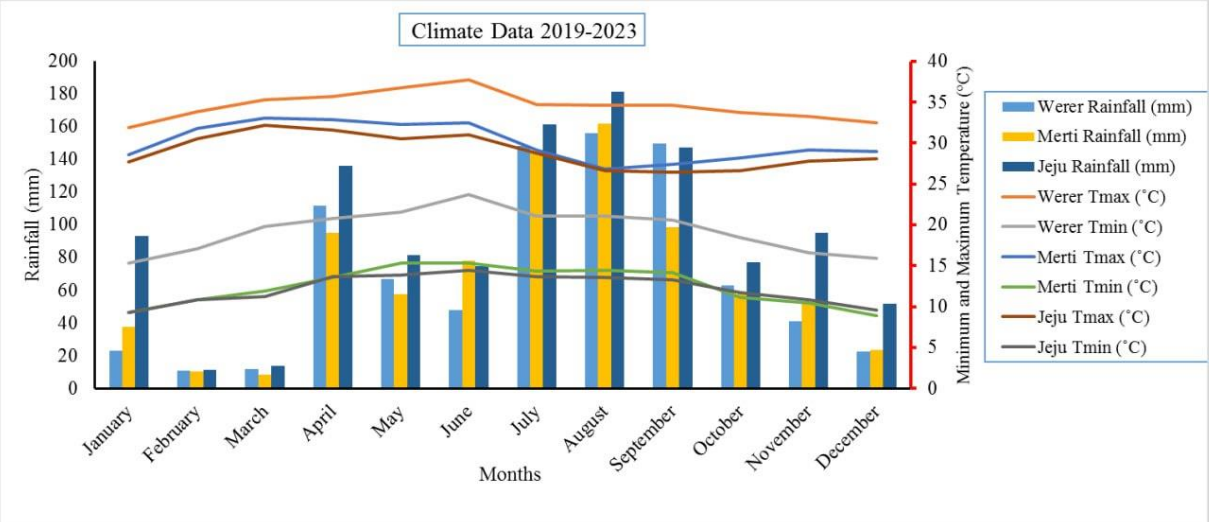

Figure 2. *Monthly maximum and minimum temperature and Rainfall of the three resting sites.*

Table 1. *Nationally released disease resistant bread wheat varieties used in the experiment.*

S/N	Variety Name	Genotype name	Year of release/registration
1	Abay	ETBW9396	2021
2	Amibara–2	ETBW 5963	2017
3	Ardi	GLADIUS?2*BAVIS	2019
4	Balcha	ETBW8260	2019
5	Biftu	ETBW173528	2022
6	Boru	ETBW9554	2020
7	Danda'a	Danphe#1	2010
8	Deka	ETBW7638	2018
9	Dursa	ETBW9578	2020
10	Fentale-2	QAFZAH-2/FERRIUG-2	2017
11	Ga'ambo-2	HEILO//MILAN/MUNIA/3/KIRITATI/2*TRCH	2019
12	Kakaba	Picaflor # 1	2010
13	Kingbird	-	2015
14	Shaki	ETBW9089	2021
15	Shorima	ETBW 5483	2011
16	WANE	(ETBW 6130)	2016

2.3. Data Collection Procedures

Data was collected at plot level as per descriptor from the traits; days to heading, days to maturity, number of kernels per spike, plant height, thousand seed weight and grain yield.

Days to heading was recorded as number of days from planting to the date on which half (50%) of the plants on the plot flower (shade pollen). Days to physiological maturity was recorded number of days from planting to the date on which 90% of the plants in the plot showed physiological maturity (lose their pigmentation and the straw turned yellow). Height of five randomly selected plants was measured from the ground level to the tip of the spike (excluding awns) at physiological maturity and the average expressed as plant height in cm. Spike length was measured in cm from the bottom of the spike to the tip of the spike (excluding the awns) of five randomly selected plants. The following data were collected from five plants randomly selected from the middle four rows of the plot at physiological maturity and the mean of these five plants was used in analysis. Number of spikelet per spike (NSPS) was recorded as number of spikelet found on each sampled plant; the main tiller was used. Number of kernels per spike (NKPS) was recorded as the total number of seed from five randomly sampled spikes from each variety per plot.

The following data were recorded from the whole plot at harvest. Thousand kernel weight (TSW) was recorded as the weight of thousand seeds sampled randomly from the bulk of harvested grain and adjusted to 12.5% moisture content. Grain yield was the weight of grain from a plot in grams adjusted to 12.5% moisture content and converted to kilogram per hectare for analysis.

2.4. Statical Analysis

All the collected agronomic and growth data were subjected to analysis of variance (ANOVA) using R-software. Combined analysis of variance over location was carried out and Least Significant Difference (LSD) test was used to compare the mean separations at (*P< 0.05*) using Fishery's least significant difference for comparison test.

3. Results and Discussion

The combined analysis of variance (ANOVA) reveals significant impacts from replication within location, location, variety, and their interactions on key traits in bread wheat [9]. Replication effects, particularly significant for plant height (PH), spike length (SPL), number of spikelets per spike (NSPS), and grain yield (GYD), highlight how environmental factors within location (Werer, Arage, Jeju, and Merti) shape these traits. The significant variance in PH ($p < 0.05$) and GYD ($p < 0.01$) across replications underscores the influence of localized conditions, such as soil and water availability, on wheat growth and productivity within each study location.

Location effects were highly significant ($p < 0.01$) for all examined traits, including phenological (DH, DM), structural (PH, SPL), reproductive components (NSPS, NKPS, TSW), and grain yield (GYD), suggesting that regional environmental factors, like temperature and other invirometal factors, exert a strong influence on wheat growth and yield potential. This finding supports the need to selected specifi adapted variety and management strategies, as they directly affect wheat's structural and reproductive development. In particular, the significant effect of location on GYD indicates that regional environmental variations play a crucial role in determining overall productivity [9].

Variety effects were also found to be highly significant ($p < 0.01$) across all traits, pointing to the importance of genetic factors or varietal response in wheat performance under lowland enviromets. Differences among varieties in DH and DM indicate genetic variation in phenological responses, while the significance of PLH, SPL, NSPS, NKPS, and TSW highlights genetic variabilty in structural and yield-related traits [11]. The significant variation in GYD across varieties suggests that certain varieties are genetically inclined to produce higher yields, supporting the role of targeted variety selection in maximizing wheat productivity. The significant interaction between location and variety across most traits, including GYD, suggests that the relative performance of varieties is location-dependent. This interaction indicates that certain varieties excel in specific environments, reinforcing the value of site-specific recommendations for variety selection to achieve optimal results [14]. Overall, the ANOVA results suggest that yield and yield components in bread wheat are influenced by both genetic and environmental factors, advocating for breeding programs focused on stable, high-yielding varieties adaptable across various environments.

Table 2. *Mean squares analysis of variance for yield and yield related characters of Bread wheat.*

Source of Variations	DF	Traits							
		DH	DM	PLH (cm)	SPL (cm)	NSPS	NKPS	TSW (gm)	GYD (kg/ha)
Rep (Location)	12	7.15ns	5.81ns	50.13**	0.79*	2.29*	18.26ns	6.64*	666540**
Location	3	455.56**	195.33**	363.28**	39.74**	80.80**	544.12**	112.15**	48975746**

Source of Variations	DF	Traits							
		DH	DM	PLH (cm)	SPL (cm)	NSPS	NKPS	TSW (gm)	GYD (kg/ha)
Variety	15	180.55**	352.65**	205.33**	3.93**	15.42**	221.32**	110.92**	1559147**
Location *Variety	45	23.50**	17.21**	29.55*	0.52*	1.37**	26.91	6.77**	563926**
Error	180	7.38	4.10	15.24	0.27	1.04	13,25	3.40	191385.7
Mean		53.18	91.24	76.75	7.15	14.54	39.74	37.50	3291.04
R-Square		0.80	0.99	0.71	0.81	0.76	0.72	0.80	0.86
CV%		5.11	2.22	5.09	7.23	7.00	9.16	4.92	13.29

varieties tests across four locations (Werer, Arage, Jeju and Merti).
*Note: *, **, and ns indicate significance at the 0.05 and 0.01 probability levels and non-significance, respectively. LSD = least Significance Difference, DH = Days to heading, DM = days to maturity, PLH = Plant height, SPL = Spike Length, NSPS = number of spikelet per spike, NKSP = number of kernels per spike, TSW = thousand seed weight, GYD = grain yield per ha.*

3.1. Mean Grain Yield Performance of Varieties

Grain yield was highly significantly (*P<0.05*) due to varieties as well as interaction between Location and variety (Table 2). The result displayed that there was a significant differences among bread wheat varieteis for grain yield across test locations indicating that there is a possibility to select good performing varieties [7]. (Table 3) highlights the yield performance of various wheat varieties across four locations (Werer, Arage, Jeju, and Merti), presenting both individual variety means and the overall location average. The mean grain yield of the varieties across four locations were 3291.04 kg ha^{-1} which ranged from 3781.89 to 2368.87 kg ha^{-1}). Variety Boru, Dursa and Abay stand out as the highest yielders (4823.5 and 4566.7 kg ha^{-1}), (4352.9 and 3950 kg ha^{-1}) and (4078.4 and 4433. kg ha^{-1}) at Werer and Arage (Amibera) respectively. This shows that *these varaieteis* are best adapted and high yielding varieties next to the chek varaiety Ga'ambo-2 yielding (4352.9 and 4388.3 kg/ha) in Middle Awash, Afar region. Similarlly, Biftu (3339.2 and 2965.2 kg ha^{-1}), Dursa (2880.4 and 3122.6 kg ha^{-1}) and Deka (2779.4 and 3087.5 kg ha^{-1}) outperformed at Jeju and Merti respectively. This indicating these varieties are best adapted and high high yielding varieties followed by the chek varaiety Ga'ambo-2 in upper Awash, Oromia region. [11, 14] reported similar findings. The effects of Variety by location interactions showing that there was cross-over interaction among the wheat varieties studied Figure 3. Thus, the results obtained from the present study showed evaluation of varieties across locations is imporatant to identifying and selecting wide as well as stable wheat varieties possessing the required grain yield. [10, 14] found grain yield to be highly influenced by environment and genotype.

According to the four location combined analysis result as indicated in Table 3; The maximum mean grain yield (3781.89 kg ha^{-1}) was recorded for the chek variety Ga'ambo-2, followed by variety Boru (3626.22 kg ha^{-1}) and Dursa (3563.97 kg ha^{-1}). Hence, these varieties are suitable for wide adaptation with high yield. This higher grain yield might be associated with adaptability and the genetic make-up of the varieties, heat tolerance diseases resistant. The lowest grain yield was recorded in variety Wane (3006.37 kg ha^{-1}) and Ardi (2368.87 kg ha^{-1}) suggesting that Wane and Ardi may be less adaptable or optimally suited to the tested locations [2].

***Table 3**. Performance of varieties over four locations (Werer, Arage, Jeju and Merti).*

Variety	Location				
	Werer	Arage	Jeju	Merti	Mean
Abay	4078.4	4433.3	1715.7	2990.0	3181.86de
Amibara-2	4637.3	4109.99	2048.0	2833.3	3407.16bcd
Ardi	3254.9	2983.3	1539.2	1698	2368.87f
Balcha	4098	4333.3	2505.9	2602	3384.8bcd

Variety	Location				
	Werer	Arage	Jeju	Merti	Mean
Boru	4823.5	4566.7	2674.0	2835.5	3626.22ab
Biftu	3588.2	3666.7	3339.2	2965.2	3293.14cde
Deka	4000	3966.7	2779.4	3087.5	3391.2b-e
Dursa	4352.9	3950.0	2880.4	3122.6	3563.97abc
Fenatle-2	4372.6	4363.3	2187.3	2333.3	3301.62cde
Ga'ambo-2	4352.9	4388.3	2788.2	3598	3781.89a
Kakaba	4058.8	4233.3	1796.1	3476.5	3416.18bcd
Kingbird	4137.3	3716.7	2098.0	2737.3	3197.8def
Pavon 76	3980.4	4000.0	2441.7	3250.5	3418.14bcd
Shaki	4313.7	3766.7	1623.0	2960.8	3347.30bcd
Shorima	3764.7	3733.3	2046.1	3247.1	3197.79de
Wane	3509.8	3500.0	2613.7	2402	3006.37e
Mean					3291.04
CV					13.29
LSD (5%)					305.20

*Note: *, **, and ns indicate significance at the 0.05 and 0.01 probability levels, respectively. LSD = least Significance Difference, and GYD = grain yield per ha*

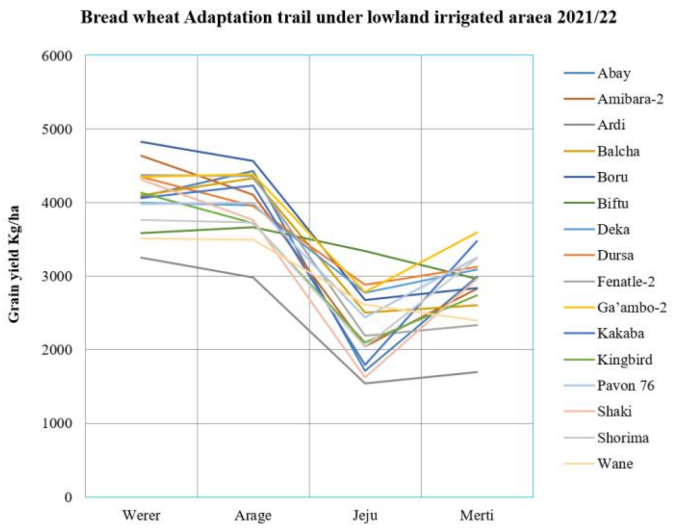

Figure 3*. Variety by location cross over interaction for grain yield.*

3.2. Agronomic Performance

A combined analysis of variance was carried out for seven traits recorded over the locations (Table 4). There was a highly significant difference among the genotypes for all traits including days to heading, days to maturity, plant height, Spike length, number spikelet per spike, number of seed per spike and 1000 seed weight confirming the presence of genotypic variability for phenological traits and yield components [3].

Days to heading (DH) varied from 57 to 43 days with the mean of all varieties 58.18. The earliest heading was recorded in 43 days in variety Ardi, which was significantly different from other varieties. As in the present studies, significant differences among varieteis for DH under low land irrigated conditions. Number of days to physiological maturity (DM) ranging from 78 to 97 days with mean of all varieties 91.24 days. The variety Boru, Deka, Biftu, and Ga'ambo-2 had the longest maturity period (97, 96 and 94 days respectively) which were high yielding varieties suggesting relatively slower development increase grain yield, while Ardi and Dursa were the earliest to mature (78 and 89 days), indicating early maturity times, which can be beneficial in regions with shorter growing seasons [8, 4].

The highest plant height (82.54 cm, 81.85 cm and 79.51 cm) were recorded in variety Boru, Deka and Ga'ambo-2 respectively, suggesting strength in plant structure, which may contribute to favorable light interception. The shorter plant height recorded were 69.74 to 70.04 in varieties Wane and Ardi. Spike lengths varied from 8.1 to 6.2 cm with mean of all varieties 7.15 cm. longest ear length (8.1, 7.79 and 7.58 cm) were recorded in variety Ga'ambo-2, Boru and Shorima respectively, reflecting potential for more spikelet space, which often correlates with higher yield, whereas Ardi (6.2 cm) and Wane (6.35 cm) had the shortest spike lengths, possibly affecting grain production negatively. Number of spikelets per spike varied from 17.85 to 13.8 with mean of all varieties 15.51. Highest spikelets per spike (16.84, 16.12, 15.5 and 15.02)) were formed in variety Boru, Ga'ambo-2 (Check), Deka and Biftu, respectively, which were high yielded varieties. Highest numbers of kernels per spike were formed in variety Boru (44.84), kingbird (44.1), Ga'ambo-2 (43.46), Biftu (43.5), Deka (42.23) and Abay (41.71) and whereas Ardi (31.2) and fentale-2 (35.74) formed the lowest number of kernels per spike. Highest number of spikelet per spike (NSPS) and kernels per spike (NKPS) are crucial indicator for high grain yield. Thousand seed weight (TSW) was highest for Ga'ambo2 (41.72 g), with significant contributions from Fenatle-2 and Shaki, indicating larger seeds that could enhance market value and grain yield. On the lower end, Kingbird had the smallest seed weight (32.74 g), which may suggest a yield drawback in terms of grain volume.

Table 4. *Combined mean of Agronomic parameters over four locations (Werer, Arage, Jeju and Merti).*

Variety	DH	DM	PLH	SPL	NSPS	NKPS	TSW
Ga'ambo-2	55.5ab	94.13cd	79.51bc	8.1a	16.87ab	43.46ab	41.72a
Boru	56.13ab	97.19a	82.54a	7.79ab	16.37a	44.09a	39.12dc
Dursa	53.06def	89.313g	73.3g	6.94def	13.7fgh	39.25c-f	35.52h
Deka	56.00ab	95.63b	81.85ab	7.39cd	15.5bc	42.23abc	38.11dce
Pavon 76	54.88a-d	92.25ef	75.14gh	6.78f	13.6gh	36.0gh	35.06h
Amibara-2	52.06gf	91.44f	77.89c-f	6.91ef	14.4d-g	39.16c-g	37.15fg
Kakaba	54.69b-e	95.43bc	76.74d-g	7.03def	14.28d-g	40.36b-e	35.1h
Biftu	54.75a-d	93.81d	75.59e-h	7.48bc	15.02bcd	43.40ab	37.8ef
Balcha	52.56f	91.25f	77.8c-f	6.99ef	14.08efg	38.59d-h	35.22h
Fenatle-2	50.00h	86.56h	78.46cd	7.4cd	14.4d-g	35.74h	41.44 a
Abay	53.31c-f	90.87f	78.26cde	7.25cde	14.22d-g	41.71a-d	38.66cde
Shorima	56.63a	95.5bc	78.61cd	7.58bc	14.5def	36.05gfh	35.93gh
Kingbird	55.13abc	92.87de	77.05c-g	6.86f	14.87cde	44.10a	32.74i
Shaki	52.81ef	87.75h	75.43fgh	7.4cd	14.4d-g	37.80e-h	40.93ab
Wane	50.5gh	87.75h	69.74i	6.35g	13.9fgh	40.83b-e	35.73h
Ardi	42.94i	78.12i	70.04i	6.2g	13.05h	31.2h	39.77bc
Mean	53.18	91.24	76.75	7.15	14.54	39.61	37.5
CV	5.11	2.2	5.09	8.53	7.0	9.16	4.92
LSD (5%)	1.89	1.41	2.72	0.36	0.71	2.54	1.29

*Note: *, **, and ns indicate significance at the 0.05 and 0.01 probability levels and non-significance, respectively. LSD = least Significance Difference, DH = Days to heading, DM = days to maturity, PLH = Plant height, SPL = Spike Length, NSPS = number of spikelets per spike, NKSP = number of kernels per spike, TSW = thousand seed weight*

4. Conclusion and Recommendations

The results of the present study showed highly significant differences among durum wheat varieties for phenological, yield and yield related triats indicating differential performance of varieties over the four locations. Both the effect of varaiety and combined analysis showed highly significant differences among the tested varieteis. The effects of L x G interactions that there was high genetic variability among the wheat varieteis studied. This clearly showed that the varieteies were much more influenced by the environmental factors (soil type, soil fertility and temperatures, etc.). This suggests the importance of the assessment of varieties under different locations, in order to identify better performing varieties for a particular location and across location. From the results of this study, it can be concluded that Boru, Dursa and Abay perform better at Werer and Arage (Amibera) indicating these *varaieteis* are adapted and high yielding varieties next to Ga'ambo-2 (chek) for middle Awash. Variety Biftu, Dursa and Dekaa outperformed at Jeju and Merti, indicating these varieties are best adapted and high high yielding varieties followed by the chek varaiety Ga'ambo-2 for upper Awash. High combined mean grain yield was recorded from Boru and Dursa variety following the standard check variety Gambo-2 indicating these varieties can perform for both middle and upper Awash.

Abbreviations

RCBD	Completely Randomized Block Design
BMZ/GIZ	Germen Federal Ministry for Economic Coopration and Development
ADAPT	Adapttation, Demostration and pioliting of Wheat Technologies

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Author Contributions

Hailu Mengistu: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft

Ambesu Tilaye: Data curation, Investigation, Methodology, Supervision, Visualization, Writing – review & editing

Shimelis Alemayehu: Investigation, Project administration, Resources, Supervision, Validation, Writing – review & editing

Desta Gebre: Data curation, Supervision, Writing – review & editing

Daniel Muleta: Investigation, Project administration, Resources, Supervision, Writing – review & editing

Tadiyos Bayisa: Data curation, Visualization, Writing – review & editing

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Ayele Badebo: Conceptualization, Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing – review

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Geremew Awas: Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing – review

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Abate Feyissa Senbeta and Walelign Worku (2023). Ethiopia's wheat production pathways to self-sufficiency through land area expansion, irrigation advance, and yield gap closure.

[2] Abdul Q., Berhanu L., and Amare G. (2020). Evaluation of wheat genotypes (Triticum aestivum L.) for yield and yield characteristics under low land area at Arba Minch, Southern Ethiopia.

[3] Alemu D., Gadisa A., Berhanu S., Negash G., Abebe D., Tafesse S., Habtemariam Z., Dawit A., Bayisa A., Ruth D., Yewubdar Sh., Abebe G., Demeke Z., Bedada G., Ayele B. and Bekele A. (2023). Biplot for Grain Yield of Bread Wheat (Triticum aestivum) Genotypes under Low Moisture Stress Areas of Ethiopia.

[4] Bayisa T., Habte E., Amanuel M. (2019). Evaluation of bread wheat (Triticum aestivum L.) for potential and related traits under high temperature stress conditions at middle Awash, Ethiopia. Advances in Crop Science and Technology 7: 410.

[5] Effa, K., Fana, D. M., Nigussie, M., Geleti, D., Abebe, N., Dechassa, N., Anchala, C., Gemechu, G., Bogale, T., Girma, D., & Berisso, F. E. (2023). The irrigated wheat initiative of Ethiopia: a new paradigm emulating Asia's green revolution in Africa.

[6] ESS (2021/22). Ethiopian statistics service. Farm management practices (private peasant holdings, meher season).

[7] Gadisa A., Alemu D., Negash G., Tafesse S., Abebe D., Rut D., Habtemariam Z., Dawit A., Abebe G., Bayisa A., Demeke Z., Bekele G., Ayele B., and Bedada G. (2020). Development of Bread Wheat (Triticum aestivum L.) Varieties for High Moisture areas of Ethiopia: A G x E Interaction and Stability Analysis for Grain Yield.

[8] Gebre D., Amanuel M., Debele T., Mengistu H., Bayisa T. (2017). Enhancing sustainable wheat productivity and production through development of wheat varieties best adapted to irrigated lowland areas of Ethiopia. International Journal of Agriculture Innovations and Research 6(2): 2319-1473.

[9] Gedifew G., Mulugeta B., Desta A., Tesfaye G., Desalegn W. (2020). Adaptation and Performance Evaluation of Bread Wheat (Triticumaestivum L.) Varieties in Guagusa-shikudad District of North western Ethiopia.

[10] Geleta N. and Wakgari R. (2019). Adaptation Study of Released Bread Wheat (Triticum aestivum L) Varieties in the Western Oromia, Ethiopia.

[11] Girma D. and Esuyawkal D. (2020). Evaluation of Lowland Released Bread Wheat (*Triticum aestivum* L.) Varieties under Irrigation in Raya Valley Southern Tigray, Ethiopia. Vol. 7, Issue 3, pp: (9-14), Available at: www.noveltyjournals.com

[12] Jamal M. 1994. Performance of wheat genotypes under irrigation in a wash valley, Ethiopia. African Crop Science Journal, 2(2).

[13] Kishk Abdelmageed, CHANG Xu-hong1, WANG De-mei, WANG Yan-jie, YANG Yu-shuang1, ZHAO Guang-cai, and TAO Zhi-qiang (2019). Evolution of varieties and development of production technology in Egypt wheat: A review.

[14] Mihratu A., Desta G. and Tolessa D. (2017). Performance of bread wheat genotypes under different environment in lowland irrigated areas of Afar Region, Ethiopia.

[15] Minot N., Warner J., Lemma S., Kasa L., Gashaw A., Rashid S. (2019). The wheat supply chain in Ethiopia: Patterns, trends, and policy options. Gates Open Res, (2019): 3(174): 174.

[16] Tolessa Debele, Tekeste Kifle, Tesfaye Geleta, Bekele Gemechu, Karta Kaske, Shitaye Homma (2024). A book on National Wheat Seed Roadmap for Ethiopia, Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

[17] Wuletaw T., Habte Z., Tolesa D., Daniel K., Wondwosen Sh., Tafesse S., Tamrat N., Negash G., Zewdie B. and Solomon A. (2022). Wheat Production and Breeding in Ethiopia: Retrospect and Prospects.

Research Field

Hailu Mengistu: Plant Breeding, Genetics and Seed Science and Technology

Ambesu Tilaye: Plant Breeding and Genetics

Shimelis Alemayehu: Plant Breeding and Genetics and Agronomy

Daniel Muleta: soil Science, Microbiology, Land and Water Resources Management

Tadiyos Bayisa: Plant Breeding and Genetics