Asian Journal of Research in Crop Science

Volume 9, Issue 4, Page 295-309, 2024; Article no.AJRCS.127031
ISSN: 2581-7167

Development of Bread Wheat (*Triticum aestivum* L.) Varieties for Lowland Areas of Ethiopia and Registration of the "Asgori" Variety

Rut Duga [a*], Demeke Zewdu [a], Alemu Dabi [a], Gadisa Alemu [a], Berhanu Sime [a], Negash Geleta [a], Habtemariam Zegaye [a], Tafesse Solomon [a], Abebe Delesa [a], Bayisa Asefa [a], Abebe Getamesey [a], Tamirat Negash [a], Bekele Abeyo [b] and Ayele Badebo [b]

[a] EIAR, Kulumsa Agricultural Research Center, Asella, Ethiopia.
[b] CIMMYT, P.O. Box 5689, Addis Ababa, Ethiopia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ajrcs/2024/v9i4319

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/127031

Original Research Article

Received: 20/09/2024
Accepted: 22/11/2024
Published: 10/12/2024

ABSTRACT

Identifying improved crop varieties is crucial for Ethiopia's diverse agroecologies, as different crops respond differently. To meet food grain demand, stable, high-yielding genotypes and resistance to diverse factors are needed. Conducting trials in multiple locations is essential. Multi-location trials in

---

**Corresponding author: E-mail: rutduga22@gmail.com;*

Cite as: *Duga, Rut, Demeke Zewdu, Alemu Dabi, Gadisa Alemu, Berhanu Sime, Negash Geleta, Habtemariam Zegaye, Tafesse Solomon, Abebe Delesa, Bayisa Asefa, Abebe Getamesey, Tamirat Negash, Bekele Abeyo, and Ayele Badebo. 2024. "Development of Bread Wheat (Triticum Aestivum L.) Varieties for Lowland Areas of Ethiopia and Registration of the 'Asgori' Variety". Asian Journal of Research in Crop Science 9 (4):295-309. https://doi.org/10.9734/ajrcs/2024/v9i4319.*

Ethiopia from 2020-2021 involved 75 advanced bread wheat genotypes across 13 environments. The finest genotype, exhibiting high grain yield and stability, was selected based on its performance across different locations. In comparison to the Control Ogolcho, Hawi, Kakaba, Kingbird, Deka, Abay, Dursa, Balcha, and EBW192369, Asgori demonstrated significantly improved agronomic characteristics and enhanced yield by 121.6%, 53.9%, 29.6 %, 29.2%, 14.8%, 13.6%, 9.6%, 5.3%, and 4.1%, respectively. The newly chosen and released genotype, named Asgori, with the pedigree of MUTUS*2/HARIL#1/3/SWSR22T.B./2*BLOUK#1//WBLL1*2/KURUKU/4/MUTUS*2/HARIL#1, was officially developed by the Kulumsa Agricultural Research Center, Ethiopia Institute of Agricultural Research in 2023. Asgori is a widely adaptable, high-yielding, medium, erect cultivar with excellent end-use qualities. It is resistant to leaf rust, yellow rust, and stem rust, and has been approved for cultivation under rain-fed conditions.

Keywords: Adaptable; asgori; genotype; high yielding; improved; rust.

1. INTRODUCTION

Bread wheat (*Triticum aestivum* L. Genome BBAADD, 2n = 6x = 42), is an annual, autogamous species in the Triticeae tribe of the grass's (Poaceae) family. Bread wheat, the most important cereal grain, is widely grown globally. Wheat plays a significant role in food security and global market share, with Ethiopia being a major wheat-producing country. This cereal is polyploidy in nature and domestically grown worldwide and plays an important role in agriculture [1-3]. Wheat is a basic food for both the rich and the poor. It accounts for over half of the food calories consumed globally and a primary source of nutrition for 36% of the world's population and is grown in 70% of the world's farmed areas [3]. It provides nearly 20% of the world's calories Randhawa et al., [4] and daily proteins to 4.5 billion people [5,6].

Hexaploidy wheat (*Triticum aestivum* L.) and tetraploid wheat (*Triticum durum* Desf.) now account for around 95% and 5% of the world production, respectively [7]. Wheat is a high-yielding crop that is easy to store and is very adaptable to different climates [7]. From the most primitive form of wheat to the species currently grown, these and other desirable characteristics have been selected and developed by human societies since ancient times [8,9].

Wheat is a crucial crop for Ethiopia's growing population, providing protein and energy as a vital food security resource [10]. Biotic and abiotic factors limit wheat productivity. The development of stable and high-yielding genotypes combined with resistance to diverse abiotic and biotic factors will be necessary to meet the demand for food grain in the nation. The availability of genetically diverse wheat genotypes is crucial for developing new wheat varieties that are both high-yielding and resilient to stress [10]. Therefore, the multi-location trial is a key solution for selecting stable and best-performing genotypes in different environments [11,12]. The grain yield and its related trait were determined by the genotypic potential (G), environmental effect (E), and the genotype x environment (G × E) interaction. Evaluation of wheat genotypes under various environments is crucial for testing performance stability and adaptations [13]. Bread wheat yield enhancement has been achieved through adaptable, high-yielding, and rust-resistant genotypes [13].

Wheat breeding has a long history, of utilizing new technologies and interdisciplinary approaches for efficiency. Proof of concept is crucial before changing breeding pipelines. The varieties under production, which significantly contribute to higher production and eventually to the livelihood improvement of the farming community and raw materials for industries, have been released/registered with this practice. Wheat productivity, production, and the area it covers all increase over time as a result of the favorable opportunities that exist. However, several obstacles contribute to the country's slower development of wheat output and productivity [14]. To improve the wheat sector, it is crucial to take action to increase possibilities and reduce obstacles. This study examines the overall performances of the recently developed and released bread wheat variety Asgori intending to play a significant role in filling the variety out of the production in the country and to exploit its wheat production capacity for end-users.

2. MATERIALS AND METHODS

2.1 Study Materials and Experimental Sites

The wheat variety "Asgori" was carefully chosen from the 2019 Elite for Ethiopia trials obtained from CIMMYT in Mexico for the 2019 cropping season. It was selected based on its exceptional characteristics, including high yield potential, drought tolerance, and resistance to various plant diseases such as leaf rust, yellow rust, and stem rust. Due to its impressive yield potential and rust resistance, the "Asgori" variety was directly included in national variety trials using a fast-track method.

A total of 75 advanced bread wheat genotypes and standard checks were rigorously tested under national variety trials for two consecutive years, from 2020 to 2021, at various locations including Asasa, Alem Tena, Ambo, Dhera, Kulumsa, Melkasa, Goro, and Sirinka. The genotypes were arranged in a row-column experimental design, with specific plot sizes and uniform agronomic management practices. Data were collected for various traits such as days to heading, days to maturity, plant height, thousand seed weight, hectoliter weight, grain yield, and disease resistance. To evaluate these genotypes for yellow and stem rust diseases, they have been planted at two hot spot areas Meraro and Debreziet for yellow and stem rust respectively. The data for yellow rust from the Meraro site and stem rust from Debreziet were collected from hot spot areas by observing the spore severity on the leaf surfaces of each genotype. A 0-9 scale was used to take notes on the rust diseases.

Following comprehensive analysis, the "Asgori" genotype stood out in terms of agronomic performance, disease resistance, and quality parameters. As a result, it was selected and verified on farmers' fields alongside two standard checks, Abay and Kakaba, in 2022. After evaluation and proposal by the National Variety Release Committee and farmers, the "Asgori" variety is set to be officially registered as a commercial variety in 2023. This marks a significant milestone in the agricultural landscape, as "Asgori" is poised to contribute to the country's agricultural productivity and resilience.

2.2 Data Collection and Analysis

Data were collected for days to 50% heading (DTH), days to 90% maturity (DTM), plant height (PHT), thousand kernel weight (TKW), hectoliter weight (HLW), grain yield (GY), and stem rust (Sr). The analysis of variance was done to determine the significance of the differences among the bread wheat genotypes for the numerous agronomic traits.

3. RESULTS AND DISCUSSION

3.1 Varietal Evaluations and Yield Performance

A recently released variety with the pedigree names MUTUS*2/HARIL #1/3/SWSR22T.B./ 2*BLOUK#1//WBLL1*2/KURUKU/4/MUTUS*2/H ARIL #1 has been awarded the commercial name Asgori. CIMMYT was the source of that. The performance of ‘Asgori’ was assessed in a national variety trial of the national bread wheat research program during 2020-2021 wherein this line was tested as ‘Asgori’. Based upon its superiority over checks the genotype along with other test entries and check varieties were evaluated for two years i.e. 2020 and 2021. The outcome showed that there were significant differences in grain yield amongst bread wheat genotypes across test environments, suggesting that it may be possible to choose a genotype or genotype that performs effectively. The genotypes' average grain yield in the 13 environments was 4.34 t/ha, with values ranging from 1.96 t/ha (Ogolcho) to 4.34 t/ha Asgori (Table 1). ‘Asgori’ showed a superior and stable yielding ability under timely sown conditions at various locations in Ethiopia over the two years (Table 1). The recently released variety " Asgori " surpassed standard checks in terms of grain yield, proving the broad adaptability of the genotypes. The newly released variety Asgori has a 121.6%, 53.9%, 29.6 %, 29.2%, 14.8%, 13.6%, 9.6%, 5.3%, and 4.1%, yield advantage over the Control Ogolcho, Hawi, Kakaba, Kingbird, Deka, Abay, Dursa, Balcha, and Candidate genotypes EBW192369 respectively (Fig. 1). Crop yields have to increase to provide food security for the world’s growing population. To achieve these yield increases there will have to be a significant contribution from genetic gains made by conventional plant breeding. It is a stable and adaptable wheat variety for different bread wheat-growing lowland to midland agroecologies of Ethiopia (Table 1). The recently released variety 'Asgori’ surpassed standard checks in terms of grain yield, proving the broad adaptability of the genotypes.

Table 1. Mean grain yield of tested genotypes

Genotype	20AA	20AT	20DR	20KU	20MK	21AA	21AB	21AT	21DR	21GR	21KU	21MK	Mean
Atlas	3.98	3.06	6.32	1.79	3.63	3.24	4.16	2.88	2.99	2.15	3.09	2.36	3.30
Balcha	8.00	2.87	5.84	3.11	2.35	6.00	3.87	3.04	4.02	1.37	6.89	2.25	4.13
BW120086	4.68	2.91	5.59	2.33	2.64	4.31	3.61	2.66	3.09	1.96	4.15	2.13	3.34
BW120104	2.59	3.07	5.45	2.01	2.46	3.65	3.69	2.74	3.15	2.07	2.61	2.17	2.97
BW120105	2.15	3.00	5.20	1.79	2.03	3.26	3.76	2.68	2.95	1.79	2.28	1.94	2.74
Deka	7.09	2.83	5.81	2.52	2.58	5.05	3.59	2.71	3.25	1.92	5.47	2.22	3.75
BW120101	4.21	2.43	5.04	2.04	1.77	2.84	3.48	2.12	1.82	1.64	3.15	1.45	2.67
BW120106	3.31	2.70	4.95	2.00	1.83	3.78	3.66	2.71	3.29	1.61	2.78	1.89	2.88
BW120109	2.34	2.80	5.67	1.71	2.82	2.52	4.00	2.66	2.71	1.97	1.84	2.01	2.75
BW120110	5.75	3.15	5.82	2.75	2.39	5.00	3.82	2.95	3.69	1.79	5.04	2.31	3.71
BW120111	6.23	3.21	6.05	2.72	3.23	4.71	3.82	2.81	3.27	1.90	5.22	2.27	3.79
BW120115	3.48	2.53	5.43	1.70	2.37	2.48	3.85	2.38	2.12	1.69	2.58	1.66	2.69
BW120116	1.45	2.52	4.67	1.59	1.41	2.54	3.74	2.53	2.85	1.51	1.23	1.60	2.30
BW120118	2.26	3.28	5.79	1.82	2.59	2.72	4.28	2.93	3.21	1.75	2.01	2.10	2.90
BW120125	1.89	2.62	5.11	1.56	2.15	2.89	3.88	2.67	3.00	1.62	1.93	1.82	2.60
BW120126	2.58	2.88	5.43	2.14	2.34	3.11	4.16	2.87	3.24	1.45	2.59	1.91	2.89
BW120135	4.89	3.18	6.41	2.49	3.57	3.68	4.03	2.72	2.74	2.09	4.39	2.26	3.54
BW120137	2.43	2.80	5.30	1.87	2.19	2.96	3.91	2.65	2.92	1.64	2.37	1.84	2.74
BW120149	2.07	2.68	5.27	1.67	2.45	2.59	3.86	2.52	2.55	1.71	2.04	1.76	2.60
BW120152	3.59	2.56	4.77	1.98	1.17	2.89	3.90	2.51	2.79	1.04	2.73	1.40	2.61
BW172060	5.64	3.25	6.16	2.15	2.83	4.15	4.07	2.94	3.40	1.88	4.35	2.32	3.60
BW172600	6.46	3.37	6.64	2.32	3.80	3.95	4.11	2.79	2.78	2.08	5.00	2.34	3.80
BW172604	5.48	3.06	6.05	2.07	3.60	4.02	3.79	2.65	2.95	2.06	4.43	2.19	3.53
BW172608	6.70	4.06	7.23	2.25	4.60	4.67	4.25	3.11	3.49	2.39	5.67	2.81	4.27
BW172619	5.71	3.40	6.35	2.39	3.41	4.25	3.97	2.83	3.08	2.06	4.81	2.36	3.72
BW172620	5.92	3.29	6.32	2.57	3.00	4.35	4.17	2.96	3.29	1.74	5.10	2.29	3.75
BW172627	5.52	3.13	5.97	2.18	2.69	4.36	3.83	2.83	3.36	2.00	4.37	2.30	3.55
BW172709	5.37	2.98	6.08	2.30	3.09	4.09	3.75	2.62	2.67	2.08	4.62	2.19	3.49
BW172713	4.97	2.68	5.48	1.93	2.39	3.97	3.60	2.57	2.82	1.90	3.83	2.00	3.18
BW172714	5.09	3.09	5.79	2.02	2.78	4.46	3.70	2.75	3.21	2.00	4.41	2.24	3.46
BW172771	5.85	3.61	6.31	2.13	3.47	4.09	3.88	2.73	2.88	2.15	4.62	2.32	3.67
BW172779	5.87	3.84	6.98	2.31	3.90	4.62	4.43	3.27	3.67	2.05	5.32	2.73	4.08

Genotype	20AA	20AT	20DR	20KU	20MK	21AA	21AB	21AT	21DR	21GR	21KU	21MK	Mean
BW172797	5.23	3.32	6.57	1.95	3.62	4.57	4.00	2.99	3.43	2.28	4.84	2.61	3.78
BW172803	5.52	3.55	6.95	2.74	4.06	3.83	4.41	3.00	3.03	2.02	4.94	2.47	3.88
BW172827	6.10	3.65	6.61	2.27	3.76	4.45	4.22	3.07	3.52	1.98	5.07	2.51	3.93
BW172828	5.58	3.18	6.47	2.58	3.62	4.59	4.17	3.06	3.50	1.90	5.17	2.46	3.86
BW172831	6.68	3.52	6.47	2.67	3.28	4.31	4.09	2.81	3.00	1.85	5.51	2.26	3.87
BW174102	5.07	3.65	6.53	2.26	3.21	3.88	4.30	3.03	3.27	1.96	4.30	2.43	3.66
BW174116	7.04	3.85	7.12	2.33	4.39	4.29	4.13	2.89	2.92	2.42	5.47	2.65	4.13
BW174302	3.63	3.30	6.27	1.99	3.13	3.10	4.40	2.97	3.15	1.77	3.23	2.22	3.26
BW174334	4.49	3.42	6.43	1.72	3.10	4.68	4.13	3.10	3.50	1.98	4.96	2.54	3.67
BW174371	3.51	3.05	5.97	2.04	2.99	3.28	4.00	2.74	2.81	2.00	3.15	2.16	3.14
BW174374	2.56	2.75	6.04	1.55	3.31	2.79	4.05	2.76	2.79	2.20	2.23	2.24	2.94
BW174388	3.19	2.60	5.90	1.76	2.76	3.15	3.96	2.73	2.84	2.06	2.78	2.16	2.99
BW174389	4.62	3.06	5.63	2.12	2.48	3.84	3.81	2.72	3.03	1.82	3.68	2.07	3.24
BW174413	3.84	3.00	5.61	1.93	2.71	3.54	3.95	2.81	3.16	1.79	3.08	2.08	3.13
BW174425	2.20	3.06	6.39	1.61	3.84	3.01	3.90	2.75	2.59	2.71	2.27	2.53	3.07
EBW192349	5.55	3.44	6.68	2.37	3.88	5.10	4.04	3.17	3.64	2.30	5.26	2.79	4.02
EBW192350	**7.54**	**3.37**	**6.52**	**2.86**	**3.55**	**6.08**	**3.91**	**3.17**	**4.00**	**2.02**	**6.78**	**2.71**	**4.38**
EBW192351	6.06	3.04	6.10	2.94	3.01	5.29	3.84	2.98	3.65	1.88	5.69	2.42	3.91
EBW192352	5.44	3.24	6.14	2.52	2.99	4.86	4.02	3.07	3.73	1.86	4.99	2.44	3.78
EBW192353	7.26	3.09	6.04	2.73	2.71	4.81	3.87	2.78	3.27	1.70	5.78	2.16	3.85
EBW192357	5.01	2.38	5.00	2.67	1.86	4.86	3.56	2.75	3.64	1.45	4.50	1.92	3.30
EBW192360	6.65	2.91	5.46	3.04	2.28	5.15	3.75	2.84	3.61	1.40	5.56	2.02	3.72
EBW192361	5.55	2.94	5.54	2.13	2.25	4.61	3.63	2.71	3.23	1.79	4.65	2.09	3.43
EBW192363	3.91	3.56	6.37	2.42	3.31	3.70	4.30	3.08	3.40	1.97	3.60	2.44	3.51
EBW192364	5.53	3.03	6.09	2.62	2.76	4.70	4.14	3.13	3.84	1.71	4.80	2.39	3.73
EBW192369	6.08	3.72	6.47	3.12	3.32	5.75	3.98	3.21	4.00	2.02	6.11	2.72	4.21
EBW192370	6.26	2.73	5.51	2.72	2.20	5.02	3.64	2.85	3.64	1.77	4.81	2.21	3.61
EBW192371	5.77	2.46	5.34	2.70	1.68	4.70	3.82	2.82	3.50	1.33	4.89	1.94	3.41
EBW192375	5.81	2.85	5.36	2.48	2.10	4.95	3.61	2.80	3.55	1.66	4.77	2.10	3.50
EBW192377	5.81	2.50	4.88	2.54	1.47	4.90	3.50	2.69	3.52	1.37	4.64	1.83	3.30
EBW192380	5.65	2.90	5.62	2.31	2.45	4.94	3.71	2.89	3.69	1.81	4.71	2.26	3.58
EBW192382	6.07	2.69	5.28	2.65	1.79	5.05	3.57	2.74	3.39	1.56	5.09	2.01	3.49
ETBW9080	6.33	3.52	6.47	3.02	3.33	5.26	4.26	3.30	4.04	1.77	5.69	2.61	4.13
ETBW9172	5.74	3.15	6.39	2.83	3.27	4.72	4.07	3.02	3.58	1.96	5.18	2.47	3.87

Genotype	20AA	20AT	20DR	20KU	20MK	21AA	21AB	21AT	21DR	21GR	21KU	21MK	Mean
ETBW9396	6.76	3.50	6.47	2.16	3.04	4.46	4.01	2.86	3.24	2.02	5.31	2.38	3.85
ETBW9452	5.85	3.80	6.57	2.29	3.48	4.35	4.02	2.92	3.02	2.21	4.85	2.51	3.82
ETBW9578	6.38	3.12	6.53	2.98	3.71	4.68	4.14	2.97	3.33	1.85	5.70	2.40	3.98
ETBW9581	5.91	3.38	6.05	2.66	3.56	4.99	3.74	2.88	3.54	2.08	5.10	2.43	3.86
Hawi	1.48	2.89	5.57	1.50	2.95	2.93	3.86	2.79	3.09	2.20	1.50	2.22	2.75
Kakaba	3.25	3.39	6.18	1.66	3.46	3.17	4.24	2.94	3.13	2.00	2.86	2.30	3.22
Kingbird	4.81	3.05	5.61	2.26	2.51	4.10	3.76	2.75	3.34	1.85	3.85	2.12	3.33
Ogolcho	0.65	1.86	4.13	0.92	1.45	2.15	2.89	1.88	1.72	2.16	0.29	1.40	1.79
Tesfa	3.34	2.90	5.97	1.73	3.26	3.04	4.11	2.78	2.85	1.91	2.90	2.12	3.08
Mean	4.84	3.08	5.93	2.25	2.87	4.09	3.92	2.83	3.20	1.88	4.15	2.22	3.44

20AA = Assasa 2020; 20AT = Alemtena 2020; 20DR= Dhera 2020; 20MK = Melkassa 2020; 21AA = Assasa 2021; 21AB= Ambo 2021; 21AT= Alemtena 2021; 21DR= Dhera 2021; 21GR= Goro 2021; 21MK = Melkassa 2021; 21KU= Kulumsa 2021; 20SK = Sirinka 2020

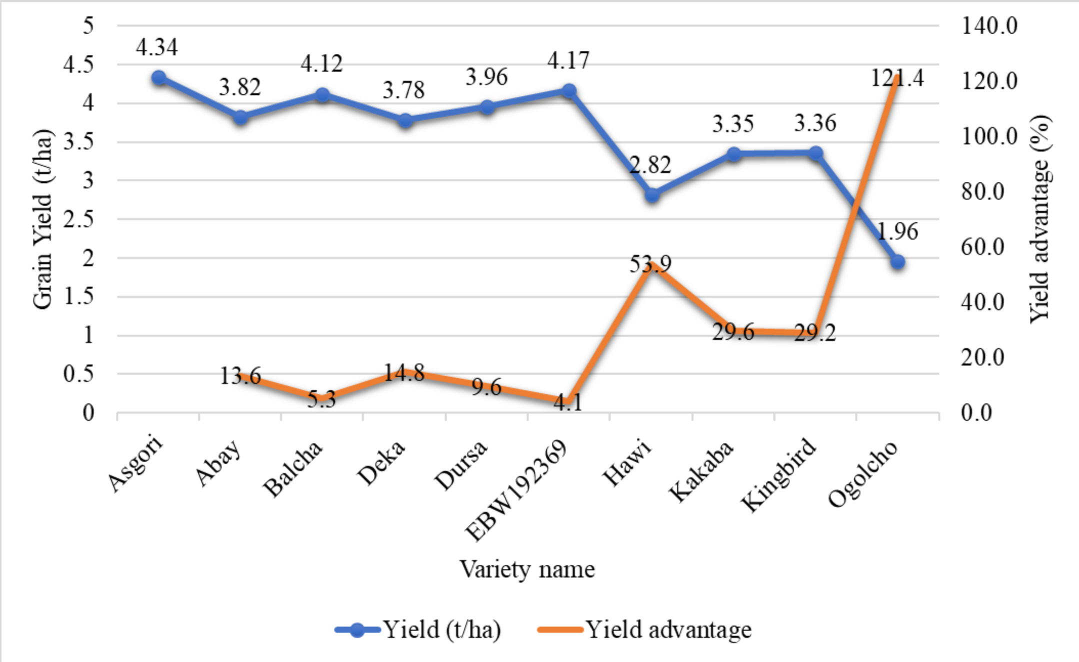

Fig. 1. Yield advantages of Asgori (EBW192350) over the check and candidate 1

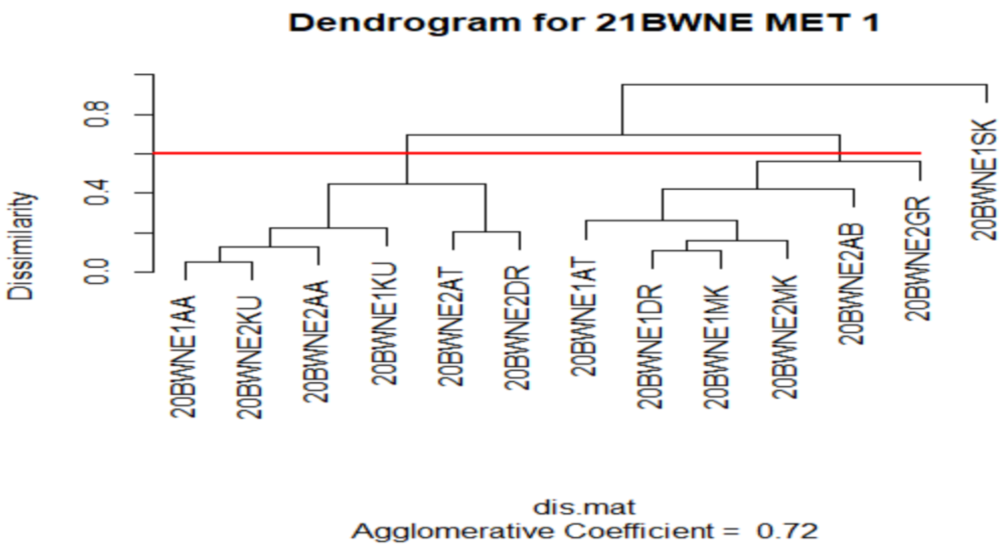

Fig. 2. Dendrogram of the dissimilarity matrix

3.2 Stability Analysis

Table 2 displays the genetic variance and error variance for each environment from the final fitted Spatial +FA models. For genetic variance, the estimates for variance component parameters ranged from 0.069 to 2.896 and error variance ranged from 0.175 to 1.002. Except for one environment (20BWNE2GR), all others had a larger genetic variance for yield. This suggested that the genotype discriminating capacity of 20BWNE2GR was not lower. This environment highly low moisture stress area and all genotypes performed poorly or equally. Thus, we removed the BLUPs from this environment when averaged over others to choose superior genotypes. In general, using spatial and FA models to analyze MET data improved genotype evolution precision and accuracy by capturing non-genetic variation associated with agricultural field experiments and appropriately exploiting the information stored in the MET dataset [15,16].

Table 2. Variance component results in MET analysis using spatial and FA models

Environments	Mean GYLD (t/ha)	Genetic Variance	Error Variance
20BWNE1AA	4.726	2.896	0.743
20BWNE1AT	3.101	0.206	0.257
20BWNE1DR	5.92	0.417	0.379
20BWNE1KU	2.212	0.239	0.189
20BWNE1MK	2.929	0.599	0.305
20BWNE1SK	3.786	0.088	0.19
20BWNE2AA	4.089	0.875	0.175
20BWNE2AB	3.925	0.095	0.305
20BWNE2AT	2.891	0.069	1.002
20BWNE2DR	3.178	0.254	0.556
20BWNE2GR	1.82	0.114	0.838
20BWNE2KU	4.175	1.987	0.237
20BWNE2MK	2.282	0.11	0.924

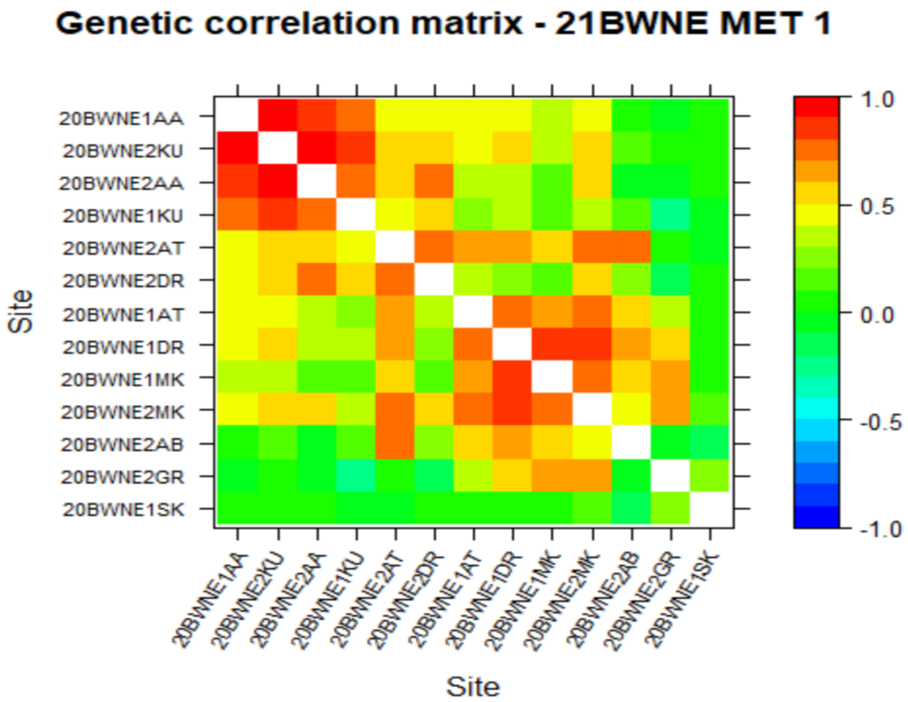

Fig. 3. Heat map representation of the genetic correlation matrix

The component analysis revealed the clustering of studies based on genetic relatedness using a dendrogram, as shown in Fig. 2. Three clusters of related environments were identified, influencing the selection of important wheat genotypes in each cluster. Genotype selection was done independently for each cluster, using mean BLUP values as a selection indicator. Correlations between environments ranged between -1 and 1. A correlation of +1 meant a perfect correlation between the two environments. The heatmap showed that most experiments were well connected (Fig. 3). The heat map shows that there were some trials with positive genetic correlations, such as 20BWNE1AA having a positive correlation with 20BWNE2AA and 20BWNE2KU and also 20BWNE2KU having a positive correlation with 20BWNE1KU and 20BWNE2AA (Fig. 3). This showed that genotype selection may be achieved by averaging genotype means in the first two trials in the first red cluster. There were also some trials with negative genetic correlations, such as 20BWNE2GR, having a negative correlation with 20BWNE1KU and 20BWNE2DH and 20BWNE1SK having a negative correlation with 20BWNE2AB. These suggest that there may have been a reversal effect in genotype ranks among these negatively associated trials. Based on the closeness in terms of discriminating the genotypes, the 13-bread wheat environments were clustered into three mega environments (C1, C2, and C3) for trait yield, where 20BWNE2KU, 20BWNE1AA, 20BWNE2AA, 20BWNE1KU, 20BWNE2AT and 20BWNE2DR were in C1; 20BWNE1AT, 20BWNE1DRH, 20BWNE1MK, 20BWNE2MK, 20BWNE2AB and 20BWNE2GR in C2; 20BWNE1SK in C3.

Table 3. Mean performance of some important agronomic traits of 67 genotypes and 8 checks tested in 2020 and 2021 cropping season

SN	Genotype	DTH (days)	DTM (days)	PHT (cm)	TKW (g)	HLW (hl kg-1))	GYLD (t ha-1)
1	Atlas	56.1	98.3	78.4	29.1	70.6	3.21
2	Balcha	60.7	98.3	79.0	29.3	70.2	3.45
3	BW120086	62.4	101.7	74.6	29.5	68.8	3.09
4	BW120104	62.5	101.8	80.4	29.6	68.5	3.03
5	BW120105	64.1	100.4	78.2	31.1	67.7	2.86
6	Deka	61.6	102.4	81.3	30.2	69.6	3.33
7	BW120101	59.3	105.0	82.9	30.1	71.1	2.54
8	BW120106	65.2	102.5	79.6	30.4	68.8	2.81
9	BW120109	63.2	101.3	84.4	29.0	70.6	2.90
10	BW120110	62.6	101.3	85.7	35.1	70.5	3.36
11	BW120111	59.6	99.1	83.2	33.2	70.2	3.41
12	BW120115	65.4	104.2	84.0	28.0	67.8	2.68
13	BW120116	67.0	105.7	81.3	27.0	69.0	2.60
14	BW120118	56.6	99.6	82.5	28.9	70.1	3.05
15	BW120125	64.6	102.6	76.9	28.8	70.9	2.72
16	BW120126	65.2	103.6	78.5	27.3	70.2	2.89
17	BW120135	56.9	96.3	77.0	28.7	68.9	3.38
18	BW120137	65.2	103.0	77.0	29.9	71.4	2.72
19	BW120149	64.2	103.2	85.7	30.1	70.2	2.71
20	BW120152	69.8	108.0	75.5	26.7	69.5	2.57
21	BW172060	57.7	95.9	79.0	29.4	70.7	3.32
22	BW172600	57.8	97.4	78.5	33.0	69.7	3.47
23	BW172604	57.7	97.0	77.3	31.2	70.9	3.34
24	BW172608	56.2	97.0	77.7	32.3	73.2	3.83
25	BW172619	61.2	100.5	75.4	29.8	70.9	3.44
26	BW172620	61.1	100.4	73.3	29.0	71.2	3.37
27	BW172627	58.7	98.2	80.1	33.6	72.3	3.24
28	BW172709	59.4	98.9	77.1	32.5	71.1	3.24
29	BW172713	62.7	101.5	70.3	33.0	69.5	2.97
30	BW172714	61.5	102.4	75.8	31.8	69.0	3.24
31	BW172771	56.7	96.1	73.9	32.6	70.4	3.37
32	BW172779	57.4	97.3	77.5	32.0	72.6	3.65
33	BW172797	55.6	96.8	77.3	33.9	71.7	3.52
34	BW172803	57.9	97.2	77.2	35.5	71.6	3.61
35	BW172827	58.8	98.1	78.8	33.7	69.2	3.52
36	BW172828	58.7	98.1	78.7	35.2	71.2	3.46
37	BW172831	59.2	98.3	79.4	30.5	72.0	3.48
38	BW174102	60.7	98.9	75.1	27.0	69.2	3.43
39	BW174116	57.4	95.9	76.3	27.4	67.0	3.75
40	BW174302	58.7	97.0	77.2	30.2	70.1	3.13
41	BW174334	58.8	98.2	72.1	31.1	72.3	3.31
42	BW174371	58.4	98.7	77.3	29.3	70.0	3.06

SN	Genotype	DTH (days)	DTM (days)	PHT (cm)	TKW (g)	HLW (hl kg-1))	GYLD (t ha-1)
43	BW174374	60.4	99.8	78.4	28.0	71.2	2.98
44	BW174388	59.0	98.1	80.1	28.8	68.7	3.04
45	BW174389	60.4	99.0	77.9	27.5	70.6	3.04
46	BW174413	58.9	98.6	75.6	28.7	70.6	3.06
47	BW174425	56.2	96.4	75.6	30.8	71.4	3.25
48	EBW192349	59.5	99.0	78.5	31.6	71.6	3.71
49	**EBW192350**	**60.3**	**98.5**	**80.8**	**29.5**	**71.7**	**3.83**
50	EBW192351	59.9	98.2	77.1	28.7	72.7	3.52
51	EBW192352	58.5	97.0	77.8	31.2	70.7	3.47
52	EBW192353	60.0	99.6	78.8	31.2	70.2	3.39
53	EBW192357	64.9	104.0	79.2	29.0	69.1	2.97
54	EBW192360	64.6	104.9	75.7	30.9	70.5	3.20
55	EBW192361	64.5	104.3	72.7	30.6	68.9	3.18
56	EBW192363	61.5	99.9	77.4	32.4	69.3	3.31
57	EBW192364	61.2	101.4	81.0	33.4	70.3	3.40
58	EBW192369	61.1	99.1	80.8	31.6	71.9	3.70
59	EBW192370	66.5	103.1	75.3	29.3	69.6	3.25
60	EBW192371	65.7	104.3	77.3	28.7	68.5	3.06
61	EBW192375	64.8	105.4	77.7	30.3	69.5	3.17
62	EBW192377	67.2	105.0	74.7	28.9	69.3	3.00
63	EBW192380	66.2	105.0	77.6	29.2	69.5	3.27
64	EBW192382	66.2	105.0	77.1	30.4	69.8	3.04
65	ETBW9080	58.4	97.3	81.3	34.2	71.5	3.70
66	ETBW9172	60.2	100.0	77.4	31.2	71.6	3.46
67	ETBW9396	58.8	98.2	76.6	27.3	71.6	3.40
68	ETBW9452	58.8	97.6	79.0	34.2	71.6	3.46
69	ETBW9578	56.9	97.2	78.5	31.5	72.4	3.56
70	ETBW9581	58.8	99.2	77.0	34.1	71.8	3.49
71	Hawi	57.4	97.3	76.9	27.3	69.1	2.94
72	Kakaba	52.8	96.5	85.7	30.9	71.0	3.23
73	Kingbird	60.0	99.5	77.4	27.7	69.3	3.15
74	Ogolcho	61.3	98.6	83.2	27.4	65.2	2.34
75	Tesfa	62.7	99.4	75.8	28.0	71.7	3.01
	MEAN	60.8	100.1	78.2	30.4	70.4	3.24
	SE±						0.08

DTH=Days to heading; DTM=Days to maturity; PHT=Plant height; TKW=Thousand kernel weight; HLW=Hectoliter weight; YLD=Grain Yield

Table 4. Morphological characteristics of asgori variety

SN	Description	Type
1	Growth habit	Erect
2	Auricle color	White
3	Leaf waxiness	Weak
4	Ear density	Medium
5	Ear color	White
6	Ear shape	Tapering
7	Glume hairiness	Absent
8	Spike length	Long
9	Seed color	White
10	1000 kernel weight (g)	39.50
11	Hectoliter weight (kg/hl)	71.7

Table 5. Disease reaction of 67 genotypes and 8 checks tested in 2020and 2021 cropping season

SN	Genotypes	DRSr	AASr	KUSr	MKSr	ATSr	GRSr
1	Atlas	5MS	00	5MRMS	20S	15MS	25S
2	Balcha	30MS	30MSS	20S	30S	30MRMS	40S
3	BW120086	00	1MRMS	5MS	10MSS	20MS	10S
4	BW120101	00	30S	10MSS	15MSS	40MS	5MS
5	BW120104	5MS	00	5S	30MSS	5MR	1MS
6	BW120105	5MS	5MS	5MS	20MSS	1MR	1S
7	BW120106	5MS	00	5S	20S	10MRMS	1MS
8	BW120109	1MS	00	5MR	30S	5MR	5S
9	BW120110	00	00	5MRMS	15MSS	10MRMS	10MS
10	BW120111	00	00	10S	20S	5MS	1MS
11	BW120115	40S	00	10MRMS	30S	10MR	5S
12	BW120116	00	1MRMS	00	10S	10MRMS	1S
13	BW120118	5MS	00	5MS	5MSS	5MR	1MS
14	BW120125	5MS	00	15MSS	20S	15MS	15S
15	BW120126	5MS	5MS	5S	30S	5MR	1MS
16	BW120135	10MS	00	5MR	10S	5MR	10S
17	BW120137	5MS	00	15S	10MSS	20MSS	5S
18	BW120149	1MS	00	1MS	20S	5MR	5S
19	BW120152	00	1MRMS	5MS	15S	10MRMS	1MS
20	BW172060	1MS	00	5MS	15MSS	5MRMS	5S
21	BW172600	20MS	00	10S	15MSS	10MSS	10S
22	BW172604	1MS	00	5MSS	20S	20MS	30S
23	BW172608	5MS	5MS	10S	20S	10MRMS	30S
24	BW172619	1MS	5MRMS	5S	15S	20MRMS	30S
25	BW172620	5MS	00	5S	15MSS	10MS	10S
26	BW172627	1MS	5MRMS	00	15S	5MR	10MS
27	BW172709	5MS	1MS	5S	20S	30MSS	15S
28	BW172713	00	00	5S	1MS	1MR	1S
29	BW172714	1MS	00	5S	15S	5MS	1S
30	BW172771	1MS	00	1MS	10MS	5MR	1S
31	BW172779	00	00	15S	20MS	10MRMS	30S
32	BW172797	1MS	5MRMS	00	5MS	5MRMS	5S
33	BW172803	1MS	5MS	10MSS	10MS	5MR	10S
34	BW172827	5MS	00	5MSS	30S	10MS	15S
35	BW172828	5MS	20MSS	15S	20S	15MRMS	20S
36	BW172831	00	00	00	10MS	1MR	1MS
37	BW174102	5MS	1MS	10MRMS	15MRMS	10MR	10MS
38	BW174116	00	00	00	15S	5MR	20S
39	BW174302	5MS	5MRMS	10S	20S	5MRMS	10S
40	BW174334	30S	5MRMS	5MSS	15S	5MRMS	20S
41	BW174371	20MS	00	5MR	15MSS	10MS	1MS
42	BW174374	5MS	00	5S	15MSS	10MRMS	1S
43	BW174388	10S	00	5MRMS	10MSS	10MS	20S
44	BW174389	1MS	00	1MR	5MRMS	5MS	1S
45	BW174413	00	00	5S	10MSS	10MS	1MS
46	BW174425	00	5MS	5MR	20S	5MR	5S
47	Deka	30S	20MSS	20S	30S	30MS	20S
48	EBW192349	40S	20MS	30S	30S	20MS	25S
49	EBW192350	1MS	00	5MSS	15MSS	1MR	00
50	EBW192351	5MS	10MS	5MRMS	20S	1MR	1MS
51	EBW192352	5MS	10MSS	20S	10MSS	10MRMS	30S
52	EBW192353	1MS	00	5S	20S	5MR	1MS
53	EBW192357	1MS	00	5MSS	20S	20MS	10S

SN	Genotypes	DRSr	AASr	KUSr	MKSr	ATSr	GRSr
54	EBW192360	5MS	10MS	10MSS	20S	15MS	10S
55	EBW192361	1MS	5MS	5S	20S	10MS	5S
56	EBW192363	5MS	00	10S	20S	20MRMS	10S
57	EBW192364	00	00	10S	15S	20MS	1S
58	EBW192369	1MS	00	5MR	15S	5MS	5MS
59	EBW192370	10MS	5MS	10S	20S	30MSS	15S
60	EBW192371	1MS	5MS	10S	15MSS	30MSS	10S
61	EBW192375	5MS	10MS	10MSS	40S	30MSS	15S
62	EBW192377	5MS	00	5MRMS	30S	30MSS	10S
63	EBW192380	1MS	5MS	5S	20S	30MS	15S
64	EBW192382	5MS	5MS	10MSS	30S	30MSS	20S
65	ETBW9080	00	10MS	5MS	5MSS	10MRMS	5S
66	ETBW9172	10S	20MSS	10MSS	50S	15MS	40S
67	Abay	5MS	1MS	5MS	5MS	15MS	20S
68	ETBW9452	1MS	00	00	5MSS	10MS	1MS
69	Dursa	5MS	1MS	5MRMS	30S	1MS	20S
70	ETBW9581	5MS	00	00	10MSS	10MS	1S
71	Hawi	30S	00	20S	30S	20MS	10S
72	Kakaba	30S	40S	15S	40S	30MSS	60S
73	Kingbird	10MS	00	5MSS	30S	15MS	25MS
74	Ogolcho	70S	40S	10MRMS	90S	50S	90S
75	Tesfa	00	00	5MR	10MSS	10MS	5S

DRSr = Dhera steam rust; AASr = Asasa steam rust; KUSr = Kulumsa steam rust; MKSr = Melkasa steam rust; ATSr = Alemtena steam rust; DRSr = Dhera steam rust

Fig. 4. Heads of Asgori variety

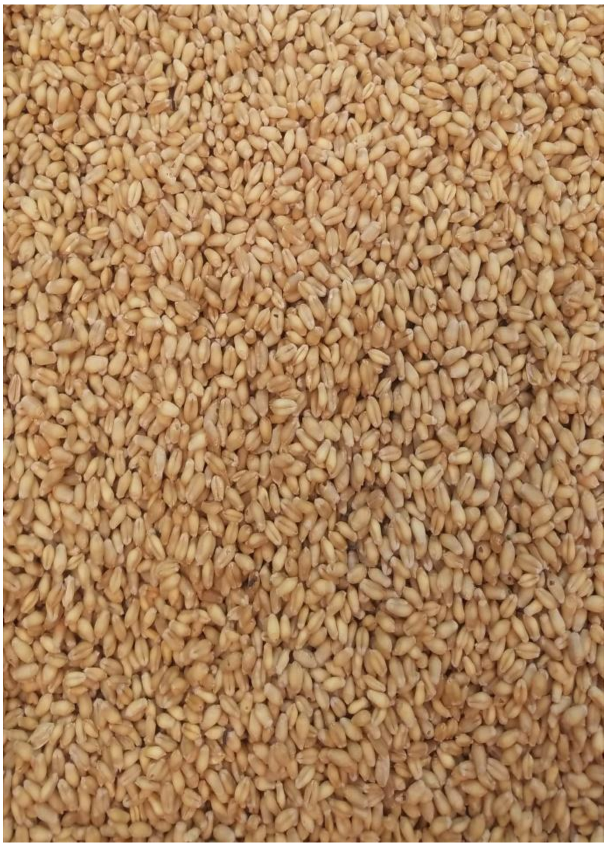

Fig. 5. Seed of Asgori variety

3.3 Agronomic and Morphological Characteristics of Newly Released Variety

Asgori was high-yielding variety adapted to lowland to midland agro-ecologies of Ethiopia, in the range of altitude 1600 m.a.s.l. to 2200 m.a.s.l. It gives a high yield under the range of 500 mm to 800 mm annual rainfall and 125-150 Kg/ha seed rate. It was taken 60 days for heading and 99 days for maturing (Table 3). Asgori is a good resistance variety for major bread wheat diseases (Table 5). It was the best-adapted variety with a stable yield in Ethiopia.

3.4 Disease Resistance

The recently developed bread wheat varieties are comparable to the Danda'a in terms of leaf rust disease and Septoria, and only moderately better resistant to stem rust and yellow rust (Table 5). The highland's current commercial bread wheat cultivars are susceptible to yellow rust. The newly released bread wheat variety with the local name Asgori showed a high level of yellow rust resistance with resistance and a moderately resistant response to stem rust in the face of severe stripe rust disease pressure (Table 5). Therefore, the development of new rust-resistant varieties will provide an excellent chance for producers of wheat in areas with limited resources.

3.5 Variety Maintenance

The goal of seed maintenance is to create new breeder seed lots with the same genetic makeup. Once the variety has been released to the public, it is the breeder's responsibility to preserve it. In ear-rows, wheat plants that represent the variety are grown under careful supervision. Row plots, or small plots, are where plants from particular rows are collected and grown. Consequently, it is the responsibility of the wheat breeder at the Kulumsa Agriculture Research Institute to maintain the variety.

4. CONCLUSION

Climate Change is still a present and future threat to the world's basic cereal crops because their healthy development depends on having the best meteorological conditions. Farmers usually need to grow ‘reliable’ and ‘solid’ varieties that can tolerate potential fluctuations in the weather and the potential pressure of diseases; they must, in any case, be able to provide a sufficient yield of grains and straw. The selection of the new varieties is based on the yield level and it is carried out in uniform conditions. Wheat diseases represent a major constraint in almost all wheat-growing environments. The most challenging diseases include stem rust, yellow rust, and leaf rust. A variety may be characterized by specific features due to the interaction between genotype and environment; a favorable factor may be that such varieties can be marketed as a regional product. Multi-location trials of genotype × environmental interaction are an important consideration for crop breeding that combines both yield and stability attributes. High-yielding genotypes should be chosen in the environment. The production of newly released varieties requires a selection from a larger range of candidate genotypes, therefore evaluating genotypic values is crucial to every breeding effort. Depending on the purpose, this allows for the isolation of the genetic influence or a deeper investigation of the GEI effect. From 75 tested genotypes, 43 (57.33%) genotypes average grain yields showed more than the grand mean (3.44 t/ha). The genotypes with the highest potential for future verification and release as a variety may be identified. As a result, the Asgori will be released as a new variety in 2023 and offer new hope to resource-constrained farmers in Ethiopia's rust-prone regions. It is expected to replace the rust-prone cultivar in Ethiopia's low to midland agroecological zones.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

ACKNOWLEDGEMENTS

The authors would like to sincerely acknowledge the Ethiopian Institute of Agricultural Research (EIAR), Kulumsa Agricultural Research Center (KARC), and the AGGW project for their financial support during the current studies. We are also grateful to the Wheat Research Programs of the Collaborating Research Centers for their invaluable assistance in executing field experiments, managing operations, and collecting data. Our appreciation extends to the field assistants, technical assistants, and breeders of the KARC Wheat Research Program for their exceptional technical support with both field and laboratory work.

COMPETING INTERESTS

The authors have declared that no competing interests exist.

REFERENCES

1. Kizilgeci F, Yildirim M, Islam MS, Ratnasekera D, Iqbal MA, Sabagh AE. Normalized difference vegetation index and chlorophyll content for precision nitrogen management in durum wheat cultivars under semi-arid conditions. Sustainability. 2021;13(7):3725. DOI: 10.3390/su13073725
2. Khalid A, Hameed A, Shamim S, Ahmad J. Divergence in single kernel characteristics and grain nutritional profiles of wheat genetic resource and association among traits. Frontiers in Nutrition. 2022;8:805446. DOI: 10.3389/fnut.2021.805446
3. Khalid A, Hameed A, Tahir MF. Wheat quality: A review on chemical composition, nutritional attributes, grain anatomy, types, classification, and function of seed storage proteins in bread making quality. Frontiers in Nutrition. 2023;10:1053196. Available:https://doi.org/10.3389/fnut.2023.1053196
4. Randhawa MS, Bhavani S, Singh PK, Huerta-Espino J, Singh RP. Disease resistance in wheat: Present status and future prospects. Disease Resistance in Crop Plants: Molecular, Genetic and Genomic Perspectives. 2019;61-81. Available:https://doi.org/10.1007/978-3-030-20728-1_4.
5. Ye X, Li J, Cheng Y, Yao F, Long L, Wang Y, Wu Y, Li J, Wang J, Jiang Q, Kang H, Li W, Qi P, Lan X, Ma J, Liu Y, Jiang Y, Wei Y, Chen X, Liu C, Zheng Y, Chen G. Genome-wide association study reveals new loci for yield-related traits in Sichuan wheat germplasm under stripe rust stress. BMC Genomics. 2021;20:640. DOI: 10.21203/rs.2.10187/v1
6. Tabbita F, Ibba MI, Andrade F, Crossa J, Guzmán C. Assessing Payne score accuracy through a bread wheat multi-genotype and multi-environment set from CIMMYT. Journal of Cereal Science. 2023;

103830.
Available:https://doi.org/10.1016/j.jcs.2023.103830

7. De Sousa T, Ribeiro M, Sabença C, Igrejas G. The 10,000-year success story of wheat! Foods. 2021;10(9):2124.
8. Venske E, Dos Santos RS, Busanello C, Gustafson P, Costa de Oliveira,A. Bread wheat: A role model for plant domestication and breeding. Hereditas. 2019;156: 16.
9. FAOSTAT. Food and Agriculture Organizati on.
Available : http://www.fao.org/faostat/en/ #home (accessed on 14 October 2020).
10. Mulugeta T, Abate A, Tadesse W, Woldeyohannes AB, Tefera N, Shiferaw W, Tiruneh A. Multivariate analysis of phenotypic diversity elite bread wheat (*Triticum aestivum* L.) genotypes from ICARDA in Ethiopia. Heliyon. 2024;10(16).
11. Erol O, Enver K, Yusuf D. Selection the best barley genotypes to multi and special environments by AMMI and GGE biplot models. Fresenius Environmental Bulletin. 2018;27:5179-5187.
12. Tekdal S, Kendal E. AMMI model to assess durum wheat genotypes in Mult environment trials. J. Agricultural Sci. and Tech. 2018;20(1):153-166.
13. Alemu G, Dabi A, Geleta N, Duga R, Solomon T, Zegaye H, Getamesay A, Delesa A, Asnake D., Asefa B, Shewaye Y, Abeyo BG, Badebo A. Genotype× environment interaction and selection of high-yielding wheat genotypes for different wheat-growing areas of Ethiopia. Am. J. Biosci. 2021;9:63-71.
14. Adugnaw Anteneh, Dagninet Asrat. Wheat production and marketing in Ethiopia: Review study, Cogent Food & Agriculture. 2020;6:1:1778893,
DOI: 10.1080/23311932.2020.1778893
15. Cullis BR, Smith AB, Beeck CP, Cowling W. A. Analysis of yield and oil from a series of canola breeding trials. Part II. Exploring variety by environment interaction using factor analysis. Genome. 2010;53(11): 1002-1016.
Available:https://doi.org/10.1139/G10-080
PMID: 21076516
16. Smith AB, Cullis BR. Plant breeding selection tools built on factor analytic mixed models for multi-environment trial data. Euphytica. 2018;214:1-19.
Available:https://doi.org/10.1007/s10681-018-2220-5

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/127031