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Adaptation and Performance Evaluation of Bread Wheat (*Triticumaestivum* L.) Varieties in Guagusa-shikudad District of North western Ethiopia

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ABSTRACT

Bread wheat is cultivated in a wide range of high and mid-altitude areas of Ethiopia ranking 4th in area coverage and 2nd in productivity. Although many improved bread wheat varieties have been released nationally and regionally, these varieties are not well disseminated and popularized. In Western Ethiopia "Guagusashikudad" district, there is only one older bread wheat variety called Dendaa'(Danphe#1) under production which is risky if there would be an occurrence of new diseases and other stresses. To alleviate such a crop's potential challenge, recently released bread wheat varieties were tested for their phenotypic performance to confirm their environmental adaptation using Randomized Complete Block Design in three replications for two consecutive years (2018/2019 to 2019/2020) on two separate locations. Quantitative traits such as plant height, spike length, 1000 seed weight, and grain yield were collected and analyzed using SAS 9.3 statistical package. Qualitative trait such as lodging and disease data (leaf rust, stem rust and strip rust) were also collected. The combined analysis of variance indicated that the five tested varieties differed significantly for all traits except for their grain yield. The highest combined mean grain yield was recorded by the variety "Lemu" (2720.60 kgha-1) followed by "Ogolcho" (2665.00 kgha^{-1}).

Key words: *Bread Wheat, Evaluation, Guagusa-shikudad, RCBD, Variety*

Introduction

In Ethiopia, wheat is one of the major cereal crops and largely grown in the southeast, central and northwest parts with moderate rainfall, humidity and temperatures. The most common species grown are *Triticumaestivum L.* (Bread wheat) and *Triticumturgidum* var. durum L. (Durum wheat) [1]. Bread wheat is one of the major crops predominantly grown by small-scale farmers under rain fed condition in the highlands of Ethiopia [2].

Crop adaptation to climate change requires accelerated crop variety introduction accompanied by improvement and recommendations to help farmers match the best variety with their field contexts [3] contributing to the increase in agricultural production in several regions worldwide [4].The ideal cultivar for high grain yield or for any other desirable traits needs to express genetic potential with low value of variance in different environmental factors of growing [5].

The main objectives of wheat breeding in Ethiopia are to develop varieties with high and stable grain yield and quality, and resistant to biotic and abiotic stresses. With these objectives, the Ethiopian institute of agricultural research has developed different improved bread wheat varieties with key characteristics such as high grain yield and quality, resistance to rusts, tolerance to drought and consumer preferences such as taste, baking and nutritional quality. Farmers however have subjective preferences for different varietal attributes and their varietal demand is significantly affected by their perceptions [2].

Although there are recently released and better performing bread wheat varieties in Ethiopia, farmers of the western Amhara regional state grow relatively older varieties [6]. In the study area called "Guagusa-shikudad" district there is only one improved bread wheat variety called "Dendaa" (Danphe#1) under cultivation by most local farmers that makes it risky if there will be an occurrence of new disease that can destroy the whole wheat production in the area. Thus, an adaptation trial was conducted in two locations for two years on four disease resistant bread wheat varieties

including one standard check so as to increase the diversity and productivity of bread wheat varieties in the tested area with the objective of evaluating and recommending the best performing varieties.

Materials and methods

Materials and Experimental Design

Four improved and promising bread wheat varieties (Table 1) were selected and their seeds were received from Kulumsa agricultural research center of Ethiopian institute of agricultural research. The Researcher-managed trial involving four improved bread wheat varieties and one standard check (Dendaa') was conducted in Guagusa-shikudad district of Awi zone in western Ethiopia for two consecutive cropping years (2018/19 and 2019/20) on two separate and strategically selected small hold farms characterized with a sandy loam soil using a randomized complete block design with three replications per a location on a plot area of (5mx5m= 25m^2) with 20 rows per plot and 25cm spacing between rows. Seeds of each variety were manually drilled approximately 2-3cm deep into the prepared plots at all locations with the seed rate of 60 kgha^{-1}. Mineral fertilizer was applied at the rate of 100 kgh^{-1} DAP and 150kg h^{-1} of Urea. Crop management practices for each location in each year were done manually. The research area is located at an altitude range between 2220 masl and 2600 masl and has an annual rainfall range of 1700mm to 2560mm and an annual mean minimum and maximum temperature range from 7oc to 12 ℃ and 18 ℃ to 25 ℃ respectively.

Methods of Data collection and analysis

A plant based quantitative data such as plant height (PH): the average height in cm from ground level to the tip of the spike and spike length (SL): the average spike length in cm from its base to the tip , a plot based quantitative data such as grain yield (GY): grain yield obtained from the harvested plot size of 4.6mx5m (23m^2) in gram and converted to kilograms per hectare and thousand seed weight (TGW): the weight of 1000 seeds in gram were collected. Disease reactions of the wheat varieties to rusts and rust severities were collected according to the following scale: O – No disease, R– Resistant (pustules formed distinct chlorosis spots, the leaves' severity up to 5-10%), MR– Moderately Resistant (very small pustules surrounded by a chlorotic area with the leaves' severity up to 10-30%), MS – Moderately susceptible (small/medium pustules, the leaves' severity up to 40-50%) and S – Susceptible (large pustules, the leaves' severity up to 75-100%) (Manandhar et al., 2016). A qualitative data such as lodging in percentage was also collected. SAS 9.3 statistical package [7] was used to analyze the quantitative data. The least significant difference (LSD) test at 5% significance level was used to determine significant differences between the tested bread wheat varieties on the measured parameters. Coefficient of variation (CV) was calculated for each test to indicate the variability in the trial.

Results and Discussion

Analysis of Variance

The combined ANOVA results of five quantitative traits of the bread wheat varieties (Table 2) indicated a very highly significant difference among the tested bread wheat varieties ($P \leq 0.05$) for all the quantitative traits except for their gain yield.

Similarly, Dagnachew et al [8] obtained a significant variation for plant height and spike length and a non-significant grain yield difference among the studied varieties. In contrast with this study [9] reported a significant yield difference among the varieties 'Ogolcho', 'Hidasse' and 'Dendaa' at 5% probability level.

The combined mean value of each quantitative trait over the two locations for each year was computed at which the tested bread wheat varieties showed a significant variation in all measured quantitative traits in the second cropping year (Table 3) but a non-significant variation on their grain yield potential in the first cropping year (Table 4) which resulted in the over-all non-significant year over location combined grain yield variation of the varieties.

While considering the combined mean of grain yield and yield related parameters of two locations over the two consecutive cropping years (Table 5), the variety 'Ogolcho' was measured as the tallest plant (96.65 cm) and 'Hidasse' as the shortest plant (83.68cm). The tested varieties were significantly varied on their spike length which has a positive contribution for yield increment and 'Ogolcho' recorded the tallest spike length with 8.14cm whereas "Wane" recorded the shortest spike length of 5.87cm. The 1000 grain weights of all the tested bread wheat varieties were significantly differed on which the highest 1000 grain weight was recorded in 'Ogolcho' (42.96g) and the lowest 1000 grain weight was recorded for the variety 'Lemu' (36.83g). High 1000 grain weight will increase germination percentage, seedlingemergence, tillerring efficiency, plant density, spike length and grain yield [10].

Thus, the highest spike length and 1000 grain weight for 'Ogolcho' is an indication of its genetic advantage over the other tested varieties. The highest combined grain yield was recorded for the variety 'Lemu' with relatively higher

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

S/N.	Genotypes	Breeder Center	Year of release	Grain yield at time of release (tha-1)		Recommended Agro-ecology zone	
				On-station	On-farm	Alt (mas)	RF (mm)
1	Ogolcho	KARC	2012	2.8-4	2.2-3.5	1600-2100	400-500
2	Wane	Sinana	2016	50-60	40-50	2100-2700	700-1000
3	Lemu	KARC	2016	50-60	40-50	>2200	800-1100
4	Dandaa' (check)	KARC	2010	3.5-5.5	2.5-5	2000-2600	>600
5	Hidase	KARC	2012	4.4-7	3.5-6	2200-2600	>500
Where: KARC=kulumsa Agricultural Research Center, tha^{-1}=tone per hectare, Alt-altitude, masl-meter above sea level, RF-rain fall							

Table 2: Combined analysis of variance for grain yield and yield related traits of bread wheat varieties tested on two locations over two years.

Source of variation	Mean squares				
	DF	PH	SL	TGW	GY
Replication	2	29.09ns	0.61ns	10.78ns	625487.90**
Variety	4	374.82***	10.30***	63.01***	304475.21ns
Location	1	11.44ns	1.84ns	338.44***	2088.25ns
Year	1	1023.41***	3.50**	71.50**	17287483.01***
Variety* Year	4	37.68ns	0.77ns	10.20ns	976454.11**
Variety*Location	4	52.25ns	0.56ns	9.36ns	236084.34ns
Year*Location	1	1080.35***	0.05ns	315.10***	4274259.37***
Variety* Year*Location	4	12.49ns	0.38ns	17.78ns	478359.77*
Error	38	588.55	16.14	260.27	4225920.76
R^2		0.83	0.74	0.80	0.81
CV		5.23	10.11	6.99	16.74
Where: DF-Degrees of freedom, PH-Plant height in cm, SL-Spike length in cm, TGW-1000 seed weight in gram, GY-Grain yield in kilogram per hectare, CV-Coefficient of variation, R^2-Residual effect, *- Significant, **-Highly significant, ***-Very highly significant, ns-non significant					

Table 3: Combined mean of grain yield and yield related parameters of the two locations in 2019/2020.

Variety	PH	SL	TGW	GY
Ogolcho	92.07	7.88	42.50	2457.65
Wane	82.30	5.83	36.75	2121.14
Lemu	83.40	7.22	35.83	2413.41
Dendaa'	85.90	6.75	39.42	1602.72
Hidase	80.23	6.43	36.50	1560.18
Grand Mean	84.78	6.82	38.20	2031.02
CV (%)	4.87	6.75	9.65	15.47
Sig.(P<5%)	**	***	*	***

Table 4: Combined mean of grain yield and yield related parameters of the two locations in 2018/2019.

Variety	PH	SL	TGW	GY
Ogolcho	101.23	8.40	43.42	2872.40
Wane	88.10	5.90	41.50	3177.08
Lemu	88.80	8.03	37.83	3027.75
Dendaa'	99.93	7.87	39.50	3321.42
Hidase	87.13	6.33	39.67	3124.17
Grand Mean	93.04	7.31	40.38	3104.56
CV (%)	4.96	12.63	3.45	14.90
Sig.(P<5%)	***	***	***	ns
Where: PH-plant height in cm, SL-spike length in cm, TGW-1000 grain weight, GY-grain yield in kilogram per hectare, *- significant, **-highly significant, ***-very highly significant				

spike length (7.63cm) while comparing with the other varieties. The variety 'Hidasse' produced the lowest grain yield (2342.20 $kgha^{-1}$) but it was not significantly lower than the grain yield of 'Lemu' which scored the highest grain yield (2720.60 $kgha^{-1}$) similar to other genotypes (Table 6). Shibeshi S [11] recorded a yield potential of 5080$kgha^{-1}$ for "Ogolcho" and 5210kgha-1 for "Hidasse" varieties in the mid-altitude areas of southern Ethiopia. Girma et al. [12] also recorded 4438.10 $kgha^{-1}$ yield potential of 'Hidasse'. In the present study, the reduction in grain yield of 'Hidasse' might be due to devastation of rust diseases (yellow leaf rust and stem rust). Misganaw[9] reported a mean

Table 5: Combined mean of grain yield and yield related parameters of the two test locations in 2018/2019 and 2019/2020).

Variety	PH (cm)	SL (cm)	TGW (g)	GY (kgha^{-1})
Ogolcho	96.65	8.14	42.96	2665.00
Wane	85.20	5.87	39.13	2649.10
Lemu	86.10	7.63	36.83	2720.60
Dendaa' (Danphe#1)	92.92	7.31	39.46	2462.10
Hidase	83.68	6.38	38.08	2342.20
Grand Mean	88.91	7.07	39.29	2567.79
CV	5.23	10.71	6.99	16.74
LSD (5%)	2.43***	0.37***	1.44***	224.74ns
Where: PH-Plant height in cm, SL-Spike length in cm, TGW-1000 grain weight, GY-Grain yield in kilogram per hectare, ***-very highly significant, CV-Coefficient of variation, LSD-List significant difference, ns-non significant				

Table 6: Diseases Scoring and Lodging.

S/No.	Variety	Leaf Rust	Stem Rust	Septoria	Lodging
1	Ogolcho	O	O	O	O
2	Wane	R	O	O	O
3	Lamle	R	O	O	O
4	Dendaa'	O	O	O	O
5	Hidase	MR	MS	O	O
Where: O –No disease, R –Resistant (severity up to 5-10%), MR –Moderately Resistant (severity up to 10-30%), MS -Moderately Susceptible (severity up to 40-50%)					

grain yield of 3730kgha^{-1}, 4970kgha^{-1} and 3650kg ha^{-1} for 'Hidasse', 'Ogolcho' and 'Dendaa' respectively. These two literatures confirmed that "Ogolcho" is one of the promising bread wheat variety for the study area. When taking the complete details on the yield performance of each variety in each year over the combined test locations into account, the varieties 'Ogolcho' and 'Lemu' were relatively better overall grain yielder when compared with the other tested varieties including the standard check 'Dendaa' (Danphe#1)'.

Even the varieties were relatively resistant to yellow leaf rust, stem rust and strip rust which are identified as the common disease of the study area and were also resistant to lodging (Table 6). Therefore, based on this reference the variety 'Ogolcho' and 'Lemu' could be disseminated to the local farmers of Guagusa-shikudad district after being demonstrated on the small land farms of the corresponding farmers.

Conclusions and Recommendation

Among the tested bread wheat varieties "Ogolcho" and "Lemu" were identified as the well performing bread wheat varieties across the testing locations over two consecutive years. They were also resistance to yellow leaf rust, stem rust and strip rust wheat diseases when compared to the other tested bread wheat varieties. Hence, cultivation of these bread wheat varieties was recommended in Guagusashikudad district and in other similar wheat growing areas of western Ethiopia.

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