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Research Article

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Adaptation of Bread Wheat (Triticum Aestivum l.) Varieties in Lowland Semi-Arid Agro-Ecology of Ethiopia

Mihratu Amanuel Kitil and Tadiyos Bayisa Sarbesa

Department of Agriculture, Ethiopian Institute of Agricultural Research, Ethiopia

ABSTRACT

Adaption of existing varieties in seed system to variable agro-ecology is the good means in wheat production diversification process. To reduce risks with released varieties seed supply limitation as the irrigated agroecology is new emerging; popular varieties adaptability and yield potential identification is important. The adaptation trial of bread wheat varieties were carried out during 2018/19 and 2019/20 at rift valley from lower Awash to upper Awash on different locations. The analysis of variance (ANOVA) revealed highly significant difference (P≤ 0.01) among varieties and environments except NSPS (P≤ 0.05) and NKSP (ns). According to the mean separation table high yielding and adaptable varieties were identified (Ogolcho) over environments and recommended for irrigated lowland agro-ecologies.The AMMY analysis of ranking revealed that Ogolcho and lowland varieties performance were better and stable across different locations and more adaptable. The result of adaptation trials can make a lesson that aims adaptation of released varieties over variable environment to pick broadly adaptable varieties across diverse agro-ecologies.

Key words: Adaptation; Stability; Yield

Introduction

Wheat is the important staple crop in Ethiopia and ranked 4th in area and grain production of total grain crops mainly by smallholder farmers using rain-fed based production system and used for food [1]. Bread wheat (Triticum aestivum L.) is one of the major cereals grown for use as food and industrial raw materials in Ethiopia providing an estimated 12% of the daily per capita caloric intake for the country's over 90 million population [2] . Although there is a potential for irrigated wheat production in the lowlands of Ethiopia, capacity to produce at commercial scale is at infant stage. Several bread wheat varieties have been released for rain fed production targeted for different agro-ecologies of mid and highland areas production which has lion share but not sufficient. Consequently, Ethiopia is still importing to fulfill domestic wheat demand and loss its foreign currency besides low economic development. Main wheat production constraints are abiotic and biotic stresses across rain-fed and irrigated environments due increasing incidence of climate change heat and drought [3]. The arid and semi-arid agro-ecology of Ethiopia has limiting factors (heat, salinity and drought) that can deter potential yield of released rain fed varieties.In changing climate, introducing crop varieties in semiarid and arid regions could result in more food security and increase in farmers' welfare (James Z. and Julius M., 2013). It is important to develop high yield potential wheat varieties and tolerance to stresses (Wuletaw et.al., 2018, Gennifer et al., 2018) across different Agro-ecologies [4,5].To bridge the wheat demand supply gap, wheat area expansion on irrigable land is one of the approaches that could increase total domestic production. That is why the government launched Irrigated wheat production strategy/initiative to support wheat import substitution.

For production diversification continuous seed supply system is crucial with required quantity and quality of improved varieties. Irrigated Lowland area wheat production has limitations in improved wheat varieties seed system as the agro-ecology's wheat production is new emerging. In addition to the lowland irrigated wheat varieties; recommendation of rain-fed wheat varieties in seed system are very important to speed up the irrigated lowland wheat production diversification. The relative yield performance in variable environment seems to be a common in identifying the better and widely adaptable varieties [6,7]. BMGF irrigated wheat seed support project is strengthening government initiative in lowlands for irrigated wheat production with identifying wheat varieties for yield potential and adaptability in lowland areas is strongly linked to the achievement of the goal. Therefore, the current study was carried out with the objective of identifying adaptable and high yielding bread wheat Varieties for large scale Production under irrigation.

Materials and Methods

The adaptation experiment was conducted for two consecutive years (2018/19-to-2019/20) in the lower, middle and upper Awash River basins at Amibara district Werer Agricultural research centre (WARC) under Ethiopian Institute of Agricultural Research (EIAR). The WARC is located at 740 m a.s.l (9o16'8"N, 40o09'41" É) and Dubti (lower awash) located at 374 m above sea level (41°3'E longitude and 11°50' N latitude, receiving annual rainfall of about 200 mm with mean minimum and maximum temperature of 22.91°C and 37.72°C, respectively in Afar region where crop husbandry is mainly grown using irrigation following cotton production. In Oromia regional state the adaptation trial was done at Fentale district (Gara dima (08o 42'39''N and 39o49'35" E at 1129 m a.s.l) and Gidara), Merti-Jeju district at Tibila (8o 31'23"N and 39o 36' 01" 1241 m a.s.l) and Adami

***Corresponding author:** Mihratu Amanuel Kitil, Department of Agriculture, Ethiopian Institute of Agricultural Research, Ethiopia, E-mail: mihratuamnuel@gmail.com

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Tulu research centre. The seven bread wheat varieties from rain fed wheat research program and three bread wheat varieties released from irrigated wheat program were planted in randomized complete block design with two replications on 5mx5m plot area.

Chemical fertilizers 100 Kg/ha (46%N) in UREA form and 50kg/ ha P2O5/NPS (19-38-7) (Tagesse et al., 2018) was applied based on previous practice in the irrigable areas [8]. N application was on split basis; 1/2 at 25 days after planting and 1/2 at flower initiation and DAP/ NPS applied all at planting. Aphid was controlled by using chemicals (karate) in 2018/19.We considered the rust disease interaction with varieties and did scoring with irrigated wheat protection team. Other management practices performed as per previous recommendations. All experimental plots irrigated uniformly in 10days interval until the wheat crop reached physiological maturity. Data were recorded forDays to 50 % heading , Days to 75% Maturity, Spike length, spikelet number per spike, Plant height (cm), Number of kernel per spike, Thousand kernel weight (g) and Grain yield (kg ha-1).

Statistical Analysis of Data

The recorded all yield components and average yield across locations and over years data were subjected to analysis of variance (ANOVA) and AMMY analysis of ranking using appropriate software GenStat statistical package18th Edition (VSN International 2015). Comparison of varieties means was done using Fischer's least significant difference (LSD) test at 5% probability levels. The combined analysis of variance was carried out to estimate effects of environment (E), varieties (V) and VxE interaction [9].

Results

Analysis of Variance

Analysis of variances of 10 released bread wheat varieties evaluated for different traits revealed that highly significant (P≤ 0.01) difference among varieties. For environments it was revealed that highly significant (P≤ 0.01) difference for most traits and significant difference (P≤ 0.05) for number of spikelet per spike, and only one non-significant difference observed for number of kernels per spike (Table 1). The variety by environment interaction was highly significant difference for days to heading, days to maturity, plant height, number of spikelet per spike, grain yield and also significant difference for spike length and thousand kernel weight with non-significant for kernels number per spike (Table 1). This indicated that most of yield component traits of varieties were highly influenced by environmental factors.

No	Variety	Pedigree	Year of Release	Target Agro-Ecology	Released Under
1	Kubsa	ATTILA	1995	Midland	Rain fed
2	Alidoro	HK-14-R251	2007	Highland	Rain fed
3	Ogolcho	WORRAKATTA/2*PASTOR	2012	Midland	Rain fed
4	Hidassie	UTQUE96/3/PYN/BAU//MILAN	2012	Mid to Highland	Rain fed
5	Kingbird	TAM200/TUI/6/PVN///CAR422/ ANA/5/ BOW/CROW//BUC/ PVN/3/YR/4/TRAP#1	2014	Low to Midland	Rain fed
6	Fentale-1	MOONTIJ-3	2015	Lowland	Irrigated
7	Wane	SOKOLL/EXCALIBUR	2016	Midland	Rain fed
8	Fentale-2	QAFZAH-2/FERRILUG-2	2017	Lowland	Irrigated
9	Amibara-2	BURI/JARU/METSO	2017	Lowland	Irrigated
10	Deka	ATTILA/3*BCN*3//BAV92/3/ KIRITATTI/WBLL1	2018	Lowland	Rain fed

Table 1: List of bread wheat varieties tested under irrigated areas for their performance

Mean performance of varieties

The overall mean performance of the evaluated varieties for adaptation trial across different location showed promising results described below in table 3. Among the seven rain fed varieties and with the three irrigated varieties (Fentale-1, Fentale-2 and Amibara-2) as a standard checks; the different parameter's data collected showed that Ogolcho variety relatively higher yielded than the checks with non-significant differences to the standard checks but significant different to other rain fed varieties. For the phonological traits day to heading and days maturity the wane Amibara-2 and and Fentale-2 varieties have got similar values earlier with significant different to res of the evaluated varieties even wane yield potential is significantly inferior to the high yielded standard checks (table 3). The values of yield related traits of spike length, spikelet per spike (Alidoro and Ogolcho has better values similar to checks and kernels per spike were higher for Alidoro with significant different to checks followed by kingbird, checks and Ogolcho variety although Others are statistically non-significant difference to the standard checks (Fentale-1 and Amibara-2) (table 3). It is great importance to identify key determinants of choosing crop variety (James Z. and Julius M., 2013) to utilize different agro-ecologies potential.

Under different biotic stresses (stem rust, Aphids) and abiotic stress related to the lowland areas; the overall mean performance of varieties showed promising results in different traits for the last two years adaptation trial. From the lowland to midland rain-fed varieties Ogolcho is the better adaptable variety to lowland irrigated agro-ecology followed by(Kubsa and Deka)showed relatively better performance and adaptable than other highland rain-fed varieties evaluated (Table 2 and 3). Widely adaptable variety has multiple benefits across agro-ecologies with existing stresses and climate change scenarios (Gennifer et al., 2018). Alidoro was better performed variety under rust pressure like Tibila site (Table 2). From the result of adaptation trial in yield quantity and yield related traits data of the last two cropping season Ogolcho was identified as outperformed and more adaptable followed by Kubsa and Deka from rainfed varieties (Table 3).

Traits	Mean Square				Means	CV
	Environment (E)	Varieties (V)	V*E	Error	of	of
DH	305.06**	178.726**	11.638**	2.59	52	3.1
DM	355.787**	192.535**	20.786**	5.67	87	2.7
PH	832.34**	309.99**	34.3**	11.2	77	4.3
SPL	6.7058**	5.7905**	0.4316*	0.23	8	6.2
NSPS	11.5706*	13.464**	2.2292**	0.66	15	5.3
NKPS	69.59ns	105.99**	19.59ns	14.9	37	10.4
TKW	226.262**	66.173**	10.647*	5.42	35	6.6
GY	8434323**	1115523**	407889**	106869	2645	12.4

Table 2: ANOVA of the 10 bread wheat varieties over five locations in 2018/19-2019/20.

*, ** and ns, significant at 5%, 1% probability level and non-significant, respectively.Where: CV= coefficient of variation, E- Environment, , V-Varieties, DH-Days to heading, DM-Days to maturity, PLH- Plant height, TT-Total tiller, ET-Effective Tiller, SPL- spike length, NSPS-Number of spikelet per spike, NKSP-Number of kernels per spike, TKW-Thousand kernel weight (gm), GY- Grain yield (Kg/ha).

Trt	Varieties	DAF	DAM	PLH	SL	SLSP	KSP	TKW	YLD
1	Kubsa	58	92	76	8	15	35	33	2698
2	Alidoro	55	91	85	9	18	42	35	2246
3	Ogolcho	52	87	80	8	15	37	35	3091
4	Hidassie	52	85	74	7	15	36	36	2360
5	Kingbird	53	86	74	8	15	39	33	2496
6	Fantale-1	52	86	80	8	16	39	33	2867
7	Wane	48	83	70	7	14	36	36	2314
8	Fantale-2	48	84	77	8	15	33	39	2844
9	Amibara-2	50	83	77	8	15	39	36	2877
10	Deka	55	89	77	8	15	36	37	2656
	Mean	52	87	77	8	15	37	35	2645
	CV	3.1	2.7	4.3	6.2	5.3	10.4	6.6	12.4
	LSD	1.1	1.6	2.2	0.3	0.5	2.6	1.5	247

Table 3: Combined analysis of bread wheat varieties mean performance across different locations and years 2018/19-2019/2020.

*, ** and ns, significant at 5%, 1% probability level and non-significant, respectively. Where: CV= coefficient of variation, DH-Days to heading, DM-Days to maturity, PLH- Plant height, TT-Total tiller, ET-Effective Tiller, SPL- spike length, NSPS- Number of spikelet per spike, NKSP-Number of kernels per spike, TKW-Thousand kernel weight (gm), GY- Grain yield (Kg/ha).

AMMY analysis of ranking

The AMMY analysis of ranking revealed the varieties performance across different locations. Based on the varieties yield potential ammy identified the four better out yielded varieties and ranked them. The AMMI analysis was designed to address "which – won-where" pattern (Yan et.al., 2007) and showed performance of varieties over different locations that helps to identifay wide adaptable [10,11]. Based on AMMY selections per environment analysis and ranking Ogolcho is the better rainfed variety got more rank over location with the standard checks (Table4).For upper Awash (Gara dima, Tibila and Adamitullu) areas the better performed varieties were Ogolcho and Amibra-2. Whereas from the middle awash to lower awash the better performed varieties Ogolcho, Fentale-2, Amibara-2 and Fentale-1 well discriminated. In addition to the irrigated wheat varieties; Ogolcho is more promising and adaptable over different environments and it can be recommended for irrigated lowland semi-arid agro-ecologies of Ethiopia (Table 4).

Conclusion

The executed rain-fed bread wheat variety adaptation trials for two years across different locations of the lowland irrigated areas at central rift valley have performed well and adaptable varieties identified. In general the two years result is promising and Ogolcho variety is identified as best performing among rainfed varieties under lowland irrigated agro-ecology. Therefore we recommend Ogolocho for its yield potential and adaptability under lowland irrigated areas awash basin. Stem rust is becoming influential disease on the irrigated wheat production agro-ecology. Out of the evaluated varieties Alidoro (MR), Ogolcho, Wane and Amibara-2 showed MRMS reaction to stem rust and identified as better varieties.Late planting aggravates the abiotic and biotic stresses effect on yield and seed quality of irrigated wheat. In addition to the further adaptation trial for similar basins the post-harvest and quality analysis of nutritional (protein content, gluten content, Hardness, Diameter) is very important to minimize the expected risks associated with lowland areas abiotic and biotic stresses effect on the varieties.

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