academicresearchJournals

Vol. 7(1), pp. 37-41, January 2019
DOI: 10.14662/ARJASR2018.110

ISSN: 2360-7874
http://www.academicresearchjournals.org/ARJASR/Index.htm

Academic Research Journal of Agricultural Science and Research

Full Length Research

Evaluation and Development of Bread wheat Varieties adapted to irrigated lowland areas of Ethiopia.

Mihratu Amanuel[1], Desta Gebre[1], Hailu Mengistu[1] and Tadiyos Bayisa[1]

[1]Ethiopian Institute of Agricultural Research, Werer Research Center, Irrigated Wheat Research Sub-Program, P. O. Box 2003 A.A., Ethiopia

Accepted 30 January 2019

The two breeding activitie;National Variety Trial (NVT) and Variety Verification Trial (VVT) according to the variety development processes were considered in this paper. The trials were conducted during the cool season at Werer Agricultural Research Center (WARC) onstation and On-farms from 2010 to 2015 using the appropriate experimental designs for each type of activities with the objectives of selecting best performing lines and candidate varieties for further evaluation and release, respectively. The number of genotypes evaluated under NVT and VVT were 31 and 9, respectively. The recommended agronomic practices were applied similarly. Required agronomic data for the trials were collected and analyzed using the appropriate software (SAS). Based on statistical analysis results, 6 candidate varieties from NVT were selected. Among the three candidate varieties selected in 2014/15 Moontiji-3, Saamid-3 and Doukkala-4; Moontiji-3 and Doukkala-4 were accepted and released by the standing committee of the national variety release in 2015. From the other candidate varieties selected in 2016/17; SERI82/SHUHA'S'//PASTOR-2, QAFZAH-2/FERRIUG-2 and REYNA-28 evaluated by national variety releasing committee; QAFZAH-2/FERRIUG-2 is officially released. Quality characteristics of the released and candidates varieties were better than the standard. The studuy result implies more comprehensive technology developmemt potential of the country's lowland irrigated areas.

Keywords: Environment; Genotypes; Quality; Yield.

Cite this article as: Mihratu, A., Desta, G., Hailu M.,Tadiyos, B. (2019). Evaluation and Development of Bread wheatVarieties adapted to irrigated lowland areas of Ethiopia. Acad. Res. J. Agri. Sci. Res. 7(1): 37-41

INTRODUCTION

Wheat is one of the most important crops and it is common diet for more than one third of the world population and contributes more calories and proteins to the world diet than any other cereal crops. The wheat consumption in Sub-Saharan African countries has also become increased. Africa produced 23 million tons of wheat and imported nearly 36 million tons of wheat grain during the periods of 2009 to 2011, creating a huge food gap between supply and demand (Negassa, et al., 2013). Wheat in Ethiopia is one of the most important cereal crops both in terms of production and use. It has been widely cultivated in mid and high altitude rainfed areas of Ethiopia by five million households on 1.6 million ha with current annual total grain production of nearly 4 million metric tons (ATA, unpublished data). Wheat used as food and its straw as sources of feed for animals and thatching the house. In Ethiopia, there is a big gap between wheat grain production and its consumption. Which lead importing Millions MT of wheat grain annually at a cost of Millions of USD (Personal communication, 2018), resulted in losing of huge foreign currency. Nutrient self sufficiency for semi-arid dwelling community of Ethiopia is

the great issue asin addition to the yield, the grain quality is becoming a widely concerned in crop sciences (Lingan Kong et al., 2013).The variety development activities have been implemented using the introduced wheat germplasms from ICARDA and CIMMYT at different locations (Werer, Amibera, Gewane and later on Fentale and Mehoni). As a result, seven bread wheat varieties have been officially released by the national variety releasing committee for irrigated lowland areas of Ethiopia based on the results of multi-locations data. Both the recommended and released bread and durum wheat varieties were demonstrated on agro-pastorals fields both in Middle- and Lower-Awash areas (Afar Region) and in Fentale District (Oromiya Region) followed by demonstration and pre-scaling up activities. Therefore, the objective of this paper is to present the findings of the variety development works undertaken so far in irrigated lowland areas of Ethiopia.

MATERIAL AND METHOD

Thenational Variety Trials (NVTs) were conducted in a randomized complete block design with three replications on a plot size of $9m^2$ (ten rows of 3m length and 0.3m between rows. The trials were conducted across several locations for two to three years and promising varieties were identified and promoted to VVT. Three candidate wheat varieties each in 2014 and 2016 cropping seasons were selected based on their multi-location performance. Then after, the breeders applied to the National Variety Release Committee, the Variety Verification Trial (VVT) were conducted over location in 2014/15 cropping seasons for the first VVT and in 2016/17 for the second in each location using the standard plot size of $100m^2$ (10m x10m) without replications for one season. The candidate varieties were evaluated by the technical committee at maturity stage. For all types of trials, sowing was done every year from Mid-October to Mid-November by hand drilling at a seed rate of 80 kg/ha. Irrigation interval was every 10 days using furrow method. UREA and DAP fertilizers were applied at the rate of 100 and 50 kg/ha, respectively. UREA fertilizer was applied in split, half at seedling stage and at booting stage while DAP whole at sowing time. Data were collected on days to heading, days to maturity, plant height, spike length, number of spikelet per spike, number of kernel per spike, 1000 kernel weight and grain yield. The collected data were compiled and subjected to statistical analysis using the appropriate software (SAS version 9.0).

RESULTS AND DISCUSSION

National variety trials

Prior to new variety release evaluation of advanced lines across location and over year is important to access its adaptability and stability performance for important traits of yield and yield components (Friedrich *et al*., 2017).Varity development under lowland stressful irrigated areas of the Ethiopia is the key to utilize the potential of the Agro-ecology untouched resources. As per other scientific findings a cost effective and environmentally sound means of meeting global demand for grain is through the genetic improvement of wheat (B. Skovmand*et al*.,2001). Combined analysis of variance for the first national variety trial showed that the effect of location was highly significant ($P<0.01$) for all parameters studied. Highly significant differences ($P<0.01$) were observed among the genotypes for almost all parameters studied. The combined analysis of variance showed that Genotype x Location were highly significant ($P<0.01$) for most traits studied (table 1). Combined analysis of variances for the second national variety trial showed that the effects of environments, Genotypes and Environment x Genotype were highly significant ($P<0.01$) for parameters studied (table 2). The most important is the genotypic variance, environmental variation. Year by location interaction, Environmental variation, due to years, locations are important to check stability of lines. For the most traits and quality, genotypic variation accounts for more total variability to explain variation (Friedrich *et al*., 2017).

In the first national variety trial, four genotypes were reached to 50% heading earlier than the mean value (56 days of sowing) and the check variety (table3) and six genotypes including the check variety attained the physiological maturity stage earlier than the mean value (86 days of sowing). Four genotypes were taller than the mean height (70.5 cm) of the range is 64 cm to 74 cm. The range of spike length was 6.5 to 8.1 cm with mean values of 7.2 cm. The number of spikelet per spike and number of kernels per spike varied from 13 to 15 with mean value of 14 and from 29 to 38 with mean value of 33.1, respectively. The yield value of the lines evaluated were varied from 2322 to 3487 kg/ha with the mean yield value of 2975 kg/ha. Based on the mean performances of the genotypes evaluated for the past four years across three locations, three promising lines (Moontiji-3, Doukkala-4 and Saamid-3) were selected as candidate varieties for verification. The 1000 seed weight ranged from 29 to 36 g with the average weight of 32.4 g. Among the three candidate varieties, Doukkala-4 possessed higher 1000 KW (35 g) as compared to the other two candidate varieties and the standard check (table 3).

In the second national variety trial, five genotypes were reached to 50% heading earlier than the mean value (50.6 days of sowing) and the check variety (table 4). For days to maturity among the genotypes eight genotypes including the check variety attained the physiological maturity stage earlier than the mean value (85.3 days of sowing). Among all the genotypes studied, the highest yielding candidate variety (SERI 82/SHUHA'S'//PASTOR-

Table 1. Combined analysis of variance (ANOVA) for the first NVT in 2012 – 2015

Sources of variation	Parameters MS							
	Days to heading	Days to Maturity	Plant height	Spike length	spikelet number /spike	kernel number /spike	1000 kernel weight	Yield
Location	**	**	**	**	**	**	**	**
Treatment	**	**	**	**	**	**	**	**
L x T	NS	**	**	**	**	*	NS	**
Error	76	6	19	0.4	1.3	13.9	7.9	417691

Table 2. Combined analysis of variance (ANOVA) from 2012 to 2016for the second NVT

Sources of variation	df	Parameters MS							
		Days to heading	Days to Maturity	Plant height	Spike length	Spikelet number	kernel /spike	1000 weight	Yield
E	7	**	**	**	**	**	**	**	**
G	13	**	**	**	**	**	**	**	**
E x G	91	**	**	*	**	**	**	**	**
Error	207	9.51	8.99	36.8	0.45	1.02	145.3	7.35	298599

E= Environment, G = Genotypes

Table 3. Mean performance of the genotypes (2012 – 2015) (1st NVT)

S.N.	Genotypes	DHE	DMA	PLH (cm)	SPL (cm)	NSS	NKS	TKW (g)	YLD (kg/ha)
1	GA'AAMBOO (CK)	56	83	74	7.6	15	35	34	3119
2	SAAMID-3	56	84	72	7.2	14	34	32	3157
3	WERRDAH-1	65	92	64	6.8	15	34	30	2322
4	DOUKKALA-4	57	90	70	7.2	15	29	35	3257
5	SISBAN-3	63	91	67	7.5	15	35	31	2630
6	ZAIN-6	47	82	70	7.2	15	32	32	2996
7	MOONTIJ-3	51	82	74	8.1	15	38	32	3487
8	DOUKKALA-35	61	90	72	7.0	15	30	29	2573
9	SHIBILL-2	53	84	70	7.5	15	32	33	3195
10	NOUHA-4	48	81	71	6.5	13	33	36	3006
	Mean	55.6	86	70.5	7.2	14	33	32.4	2975
	CV%	15.6	3	6	8.6	7.9	11.3	8.7	21.7
	LSD	5.3	1.2	2.6	0.4	0.7	2.3	1.7	394

DH = Days to heading, **DM =** Days to Maturity, **PH =** Plant Height, **SL =** Spike Length, **NKPS =** Number of Seeds per Spike, TKW = Thousand Kernel Weight and **YLD =** Grain Yield

2) was found to be early maturing type (table 4) which is very desirable character for irrigated areas of Ethiopia where double cropping (cotton and wheat) is becoming a common practice. The plant heights ranges of 63 cm to 78 cm six genotypes were taller than the mean height (69.1 cm). The spike length of the lines ranged from 7 to 8 cm with mean values of 7.6 cm. The number of spikelet per spike, number of kernels per spike and total kernel weight varied from 12 to 14 with mean value of 13, 33 to 60 with mean value of 45.2 and 29 to 40 g with mean value of 33.2g respectivelywithexistence high genetic variability among the genotypes for these traitsas per (Reynolds et al., 2001). Among all the genotypes;QAFZAH-2/FERRIUG-2 possessed higher 1000 KW (40 g) (table 4). The yield value of the lines evaluated were varied from 2901 to 4011 kg/ha with the mean yield value of 3404 kg/ha. The highest grain yields obtained from SERI 82/SHUHA'S'//PASTOR-2 (4011 kg/ha) followed by REYNA-28 (3718 kg/ha) and QAFZAH-2/FERRIUG-2(3681 kg/ha). Based on the mean performances of the genotypes evaluated for the past five years across three locations, three promising lines (SERI 82/SHUHA'S'//PASTOR-2, QAFZAH-2/FERRIUG-2 and REYNA-28) were selected as candidate varieties for verification trial implemented in 2016/17. The improved varieties developed though wheat breeding is important catalysts for increasing crop performance at the farm level, where a range of biotic and abiotic stresses impinge on yields (Reynolds et al., 2001).

Table 4. Mean performance of the genotypes under irrigated environments (2012 – 2016)

SN	Genotypes	DH	DM	PH (cm	SL (cm)	SPS	NKS	TKW (g)	YLD (kg/ha
1	TEVEE-3/SHUHA-20//SERI 82/SHUHA'S'	53	86	72	8	14	46	32	3499
2	SERI 82/SHUAHA'S'//DOVIN-2	54	86	68	8	13	45	35	3236
3	PAVON 76/HAMAM-4/4/YACO/PWW65/ 3/KUAZ*2	52	87	68	7	13	40	33	3226
4	CHECK (Fentale/Moontij-3)	53	85	77	8	13	53	34	3657
5	FERRROG-3/4/NAI60/HN7//SX/3/JUN'S'	46	82	68	8	12	39	32	3336
6	QAFZAH-2/FERRIUG-2	45	81	72	8	12	39	40	3681
7	SERI 82/SHUHA'S'//PASTOR-2	53	85	66	8	13	44	33	4011
8	QAFZAH-33/FLORKWA-2	55	88	68	8	13	53	37	3413
9	REYNA-28	47	83	70	7	13	60	31	3718
10	SANDALL-3	50	84	78	8	13	54	38	3546
11	NABUR-6	52	86	63	7	13	44	29	3287
12	GONGLASE-4	45	82	63	7	13	40	31	2980
13	CROW'S'/BOW'S'-3-1994/95//	53	85	71	8	14	43	29	2901
14	PBW 343	51	94	63	7	13	33	31	3170
	Mean	51	85	69	7.6	13	45.2	33.2	3404
	CV	6.1	3.5	8.8	8.85	7.7	26.5	8.15	15.99
	LSD	3.1	3.0	6.1	0.7	1.0	12.1	2.7	546.4

Table 5: The performances of the released varieties on research station and farmers' fields

Name of varieties	**Year of release**	**Response to stress;** Moderately	**Yield (ton/ha)**	
			On- station	**On-farm**
Gaa'amboo (Qui#2)	2011	-	4.5-5.0	3.0-4.0
Werer-2 (Adel-6)	2013	tolerant to heat & salinity	3.5-4.0	3.0
Lucy (Nejemah-14)	2013	tolerant to salinity	3.5-4.0	3.0
Fentale (Moontiji-3)	2015	tolerant to heat	5.0-5.7	4.0-4.5
Amibera(Doukkala-4)	2015	tolerant to heat	5.0-5.1	4.0-4.5
Fentale-2 (QAFZAH-2/FERRIUG-2)	2017	Bird attack tolerant	5.0-6.0	4.0-4.5
Amibera-2 (ETBW5963)	2017	Heat tolerant	4.5-5.5	4.0-4.5

Table 6. Quality characteristics of released BW Varieties

Varieties	Seed color	1000 Kernel wt.(g)	HLW (kg/hl)	Protein (%)	Gluten (%)	Zeleny index(ml)
Gaa'amboo	White	35	-	16.56	43.2	84.3
Werer-2	White	33.5	79.2	16.89	44.1	78.5
Lucy	Red	34.8	74.4	14.5	64.3	-
Fentale	White	34.6	71.0	17.46	45.6	85.5
Amibera	White	38.1	71.3	16.63	44.7	86
Fentale-2	White	40	-	16.78	43.3	84.8
Amibera-2	White	36	-	15.35	38.7	74.6

VARIETY VERIFICATION TRIALS

Based on the results of multi-environments test, six wide adaptable candidate varieties (Sammid-3, Doukkala-4 and Moontiji-3 from the first NVT and *SERI 82/SHUHA'S'//PASTOR-2, and REYNA-28* from the second NVT) were identified and promoted to VVT and verified in 2014/15 and 2016/17, respectively. Among the six candidate varieties, Moontiji-3 and Doukkala-4 from the first NVT and *QAFZAH-2/FERRIUG-2*from the second NVT were accepted by the national variety releasing committee and released for commercial production in 2015 and 2017, respectively. The performances of the released varieties under research and agro-pastorals fields with their very promising quality characteristics are indicated in table5 and table 6. A

protein content of 12 percent and above is most desirable. Hard red wheat with a high percentage of yellow berry usually have a lower protein content (D. R. McAllister and R. S. Roberts, 1995). Genetic quality traits and also environmental variables affect wheat grain protein accumulation and processing quality(Lingan Kong *et al*., 2013). The yield gap of the varieties at research center and on-farm is narrow as the varieties scale-out to agro-pastorals with their full production packages.

CONCLUSIONS AND RECOMMENDATION

Introduction of appropriate wheat germplasms using internationally set procedures and following the breeding procedures, from CIMMYT and ICARDA during the period of 2014- 2016/17 three outperforming varieties released. The released varieties were demonstrated on agro-pastoral fields at various locations since 2015 and produced by agro-pastorals in Afar Region and Oromiya Region. In their quality characteristics the varieties are very promising which can be utilized for local factories as raw materials.Released varieties were mainly evaluated at specific places of the Afar and Oromiya Regions despite the presence of wide lowland areas at the different parts of the country with their own specific environmental conditions. Therefore, in future, the wheat variety evaluation trials have to be conducted in all lowland areas of the country to develop and release wide and location specific adaptable varieties having grain quality standard. The quality aspect also requires strengthening in facility and capacity building.

ACKNOWLEDGEMENT

We sincerely acknowledge the National Wheat Research Program/EIAR, SARD-SC-Wheat Project,CIMMYT, and ICARDA for its Genotype source, technical supports as well as capacity building for strengthening the lowland irrigated wheat research.

REFERENCES

B. Skovmand, M.P. Reynolds, and I.H. Delacy, 2001. Searching Genetic Resources for Physiological Traits with Potential for Increasing Yield.

Friedrich Laidig, Hans-Peter Piepho, Dirk Rentel, Thomas Drobek, Uwe Meyer, Alexandra Huesken, 2017. Breeding progress, environmental variation and correlation of winter wheat yield and quality traits in German official variety trials and on-farm during 1983–2014.TheorAppl Genet (2017) 130:223–245.

Lingan Kong, Jisheng Si, Bin Zhang, Bo Feng, Shengdong Li, Fahong Wang, 2013. Environmental modification of wheat grain protein accumulation and associated processing quality: a case study of China, AJCS 7(2):173-181 (2013) ISSN:1835-2707.

Negassa, A., B. Shiferaw, Jawoo Koo, K. Sonder, M. Smale, H.J. Braun, S. Gbegbelegbe, ZheGuo, D. Hodson, S. Wood, T.Payne, and B. Abeyo. 2013. The Potential for Wheat Production in Africa: Analysis of Biophysical Suitability and Economic Profitability. Mexico, D.F.: CIMMYT.

Reynolds, M.P., J.I. Ortiz-Monasterio, and A. McNab (eds.). 2001. Application of Physiology in Wheat Breeding. Mexico, D.F.: CIMMYT.

D. R. McAllister and R. S. Roberts, 1995. Home Storage of Wheat Utah State University Extension Publication EC 371