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Bread Wheat Variety Adaptation for Irrigated Farming Systems of Amhara Region

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Abstract

Twenty bread wheat varieties were evaluated with the objective of selecting adaptable and best performing bread wheat varieties for vertisol areas of North Gondar with the participation of farmers under irrigation condition. The trial was conducted at Dembia District of north western Ethiopia during 2011 and 2012 off seasons. Randomized complete block design was used in the two seasons. At Dembia, the combined analysis of variance over years indicated that varieties bobicho and shina gave relatively higher yield with (6223kg/ha) and (5422kg/ha) respectively. Dinknesh and KBG-01 were found to be the early to mature (124 days) whereas Digalu and Kubsa were the later type of all the varieties in both years. The spearman rank correlation analysis at both Districts showed statistically significant correlation (P<0.01) among farmers and breeders with objectively measured quantitative trait (grain yield). This result also indicated that farmers were as competent as breeders in varietal selection. Therefore, based on objectively measured traits (grain yield, days of maturity and yellow rust resistance) and farmers' preference Bobicho and shina are recommended with their production packages for Dembia and similar areas which were under irrigation condition.

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INTRODUCTION

In Ethiopia, wheat is the 3rd important crop after tef and maize. It comprises about 14.64% (1.68 million hectares) of the total land devoted to cereal. It is produced on 1.68 million hectares of land, from which 3.076 million tons are obtained at national level. It is widely grown in the Amhara Region, it covers 548, 315 ha of land and giving 896,

093 ton in the region, which is 29% of the total national production (CSA, 2010). It is grown in the highlands at altitudes ranging from 1500 to 3000 meters above sea level situated between 6-16^{0}N and 35-42^{0}E. However, the most suitable agro-ecological zones for wheat production fall between 1900 and 2700 meters above sea level (Hailu *et al*., 1991).

This low productivity is mainly due to disease and pests, low-yielding varieties, frost, poor soil fertility, and lack of full or supplemental irrigation, in fact. Ethiopia has a large potential of water resources that could be developed for irrigation.

Despite this, Ethiopia continues to receive food aid for about 10% of the population, who are at risk annually, out of 70 million. The government is committed to solve this paradox through an agriculture led development program that includes irrigation schemes development as one of the strategies.

In order to increase total production, new wheat cultivars should be tested for different ecologies & locations. The success of a new variety depends upon its yield and adaptation potential in those locations.

The expectation from this particular project is to meet the regional demand of wheat varieties suited to the irrigated agriculture, which is a viable development strategy for the region & the nation at large. In line with the implementation of irrigated agriculture, the government has made invaluable efforts which called forth varieties adapted to the system.

Objective

To evaluate and identify adaptive, high-yielding and disease resistant bread wheat varieties for irrigated agriculture**.**

MATERIALS AND METHODS

The experiment was conducted in 2011 and 2012 at irrigable command areas of Megech; which was located between 1369558N latitude and 0322891E longitude UTM at an elevation of 1797 masl. Twenty released bread wheat varieties were tested for their suitability to irrigated farming in Megech irrigation District of Amhara Region. The trial was laid down in randomized complete block design (RCBD) with three replications. Each plot consisted of six rows each 2.5 m long and 0.2 m apart. The distance between blocks and the spacing between plots were 1.5 and 0.2 m, respectively. Planting was done by hand drilling at seed rate of 150 kg ha^{-1}. Fertilizer was applied at the rate of 41/46 kg/ha N and

P_2O_5 respectively. Half of the total nitrogen and total phosphorus were applied at the time of planting while the remaining nitrogen was applied at the time of tilling. To reduce border effects, data were recorded from the four central rows. Weeding and other management practices were done as r as per recommendation. Farmers Research and Extension Group (FREG) was established having a member of 30 farmers. The FREG consists of men and women, poor and rich, young, adult, and old aged persons. Analysis of variance was computed using the SAS statistical software (SAS, 2004).

RESULTS AND DISCUSSION

In 2011 off season, the analysis of variance revealed the presence of significant ($P<0.01$) difference among varieties for days to heading and maturity, spike length, plant height and number of tillers per plant (Table 1). The mean values of days to heading and maturity ranged from 61(Pichaflor) to 71 days (Densa and Millennium) and 87(Dinknesh) to 97.50 (Digalu) days respectively. The highest plant height and spike length was recorded by Danphi (93.20) and Tay (8.57) respectively. The tilling capacity of varieties ranged from 4.1(Digalu) to 10.20 (Hawi). The mean value of grain yield ranges from 1908kg/ha (Gassay) to 6223kg/ha (Bobicho). The highest grain yield was achieved as compared to the last year yield. This may be due to the suitability of experimental site. The mean percent protein content was ranged from 11.37(Katar) to 14.17(Densa) (Table 2).

In 2012 off season, the analysis of variance indicated that there were significant differences among all parameters. Variety Dinknesh matured early whereas Digalu, sirbo, kbg-01

matured late. The early type of wheat is suitable to irrigation. In terms of the plant height Senkegna, katar and kubsa were the tallest whereas hawi, abola and shina were the shortest varieties. The grain yields of varieties were very promising, which is very much better than the rain fed system. Grain yield ranged 2840 kg/ha for abola to 5408.3 kg/ha for dinknesh (Table3).

Disease assessment was done at different growth stages of the plant. However, no disease has occurred. This might be due to unfavorable environmental conditions for most fungal diseases. Even the commonly occurred disease, yellow rust has not been prevailed in the trial site. Yellow rust /stripe rust/ contains yellow to orange urediospores, usually form narrow stripe on leaves which needs cool temperature (between 10-15^{0}C) and wet conditions for its sporulation.

The Pearson Correlation Coefficients value indicated that there were significant ($P<0.01$) correlation between days to heading and maturity, and between spike length and days to maturity. There was also significant ($P<0.05$) correlation between days to heading and number of tillers per plant, spike length and days to heading, plant height and spike length, and grain yield and protein content. The rest parameters did not show any significant correlation (Table 3). The presence of significant and positive correlation between plant height and spike length was reported by Khalil et al., (2010). The absence of significant correlation or presence of negative correlation between grain yield and plant height was reported by Tila*et al.*, (2005) and Chowdhry*et al*., (1986). They explained that adequate amount of dry matter was partitioned towards the height of the plant in taller plants, affecting the grain yield adversely. Nevzat*et al*., (2010) explained the presence of negative and significant correlation between grain yield and protein content.

Farmers participated in varietal selection at stage of maturity. Accordingly, farmers set selection criteria of grain yield, maturity period, spike length, tillering capacity and straw biomass. Based on their selection criteria, farmers selected Shina, Tay, Hawi Abola and Dinknesh in descending order

Table 1. Mean value of yield and yield related traits of improved bread wheat varieties during 2011 off season a Megech irrigation

Varieties	Days to heading	Days to maturity	Spike length (cm)	Number of tillers per plant	Plant height (cm)	Grain Yield (kg/ha)	Protein (%)
Pavon-76	66.33^{dc}	94.00^{ab}	8.33^{a}	5.30^{bc}	81.47^{abcd}	2948^{ab}	12.57^{abc}
Digalu(HAR-3116)	70.67^{a}	97.50^{a}	6.87^{a}	4.10^{c}	83.93^{abc}	5150^{ab}	12.77^{abc}
Kubsa(HAR-1685)	70.00^{a}	95.67^{a}	7.80^{abc}	8.50^{ab}	80.53^{bcd}	5795^{a}	11.77^{bc}
Bobicho(HAR-2419)	68.00^{abc}	96.33^{a}	6.73^{abc}	7.07^{abc}	82.93^{abcd}	6223^{a}	12.30^{bc}
Densa(HAR-2562)	71.00^{a}	95.33^{ab}	6.33^{abc}	5.00^{bc}	70.60^{d}	3819^{ab}	14.17^{a}
Shina (HAR-1868)	69.67^{ab}	95.00^{ab}	7.57^{abc}	7.00^{abc}	80.80^{abcd}	5462^{ab}	11.83^{bc}
Gassay((HAR-3730)	66.67^{bcd}	93.67^{ab}	8.13^{abc}	5.80^{bc}	84.20^{abc}	1908^{b}	13.03^{ab}
Senkegna(HAR-3646)	68.00^{abc}	93.67^{ab}	7.20^{ab}	7.30^{abc}	84.73^{abc}	4774^{ab}	12.27^{bc}
Tay(ET12-D4/HAR	69.00^{abc}	93.00^{ab}	8.57^{a}	6.07^{bc}	78.90^{bcd}	5200^{ab}	12.67^{abc}
Guna(HAR-2029)	68.00^{abc}	95.00^{ab}	7.53^{abc}	5.53^{bc}	84.40^{abc}	5613^{ab}	11.80^{bc}
Abola(HAR-1522)	68.33^{abc}	91.67^{ab}	8.00^{abc}	5.80^{bc}	81.20^{abcd}	5072^{ab}	12.73^{abc}
Hawi(HAR-2501)	61.67^{ef}	90.33^{ab}	7.60^{ab}	10.20^{a}	86.70^{ab}	5442^{ab}	12.20^{bc}
Serb(HAR-2192)	70.00^{a}	95.33^{ab}	6.57^{bc}	5.80^{bc}	73.67^{cd}	3817^{ab}	13.10^{ab}
Dinknesh(HAR-3919)	61.67^{ef}	87.00^{b}	7.87^{abc}	5.67^{bc}	83.67^{abc}	5395^{ab}	12.87^{abc}
Millennium(ETBW-4921)	71.00^{a}	95.67^{a}	7.00^{ab}	4.30^{c}	74.70^{bcd}	3122^{ab}	13.07^{ab}
Tuis.(HAR-1407)	64.67^{de}	92.33^{ab}	7.00^{abc}	6.47^{abc}	75.73^{bcd}	4593^{ab}	12.47^{bc}
Katar(HAR-1899)	64.00^{def}	90.33^{ab}	8.20^{ab}	4.20^{c}	82.00^{abcd}	4432^{ab}	11.37^{c}
KBG-01	62.67^{ef}	91.33^{ab}	8.17^{abc}	7.53^{abc}	74.20^{bcd}	4501^{ab}	12.13^{bc}
Pichaflor	61.00^{f}	90.33^{ab}	7.40^{ab}	6.40^{abc}	78.73^{bcd}	4456^{ab}	12.10^{bc}
Danphi	68.67^{abc}	95.00^{ab}	7.73^{abc}	5.13^{bc}	93.20^{a}	4539^{ab}	12.50^{bc}
Mean	67.00	93.46	7.51	6.17	80.81	4613	12.89
CV (%)	1.59	2.84	7.52	18.22	4.63	26.39	4.20
Probability level	**	**	**	**	**	*	**

**,* Significant at 0.01 and 0.05 probability level respectively.

Table 2. Pearson Correlation Coefficients of yield and yield related traits of bread wheat varieties grown during 2011 off season at Megech

	Days to heading	Days to maturity	Number of tillers per plant	Spike length	Plant height	protein
Days to Maturity	0.64**					
Number of tillers per plant	-0.27*	-0.23ns				
Spike length	-0.27*	-0.38**	0.13ns			
Plant height	-0.031ns	-0.07ns	-0.09ns	0.32*		
Protein	-0.11ns	0.01ns	0.26ns	-0.10ns	-0.15ns	
Grain yield	0.15ns	0.19ns	-0.15ns	-0.19ns	0.22ns	-0.26*

**, * significant at 0.01 and 0.05 respectively, ns-non significant.

Table 3. Mean values of yield and yield related traits of improved bread wheat varieties during 2012 off season at Megech irrigation

Varieties	Days to heading	Days to maturity	Plant height(cm)	Spike length(cm)	Grain yield(kg/ha)
PAVON76	54^{ef}	89^{a}	57.4^{cd}	6.9^{bc}	3511.7^{fg}
DIGALU	61^{a}	93^{a}	67.1^{abcd}	6.5^{c}	2880.3^{h}
KUBSA	60^{ab}	92^{a}	70.4^{abc}	6.1^{a}	5120.7^{abc}
BOBICHO	56de	91^{a}	61^{abcd}	7.8^{abc}	5329.3^{ab}
DENSA	58^{bc}	91^{a}	63.6^{abcd}	7.7^{abc}	2881.7^{h}
SHINA	57^{cd}	91^{a}	56.4^{d}	7.5^{abc}	5390^{ab}
GASSAY	51^{g}	89^{ab}	67.1^{abcd}	8.2^{ab}	3063^{gh}
SENQEGNA	56de	91^{a}	73.5^{a}	7.7^{abc}	4290^{cde}
TAY	56de	90^{a}	67^{abcd}	7.9^{abc}	4763.3^{bcd}
Guna	56de	92^{a}	65.1^{abcd}	7.5^{abc}	3123.3^{gh}
ABOLLA	55^{e}	87^{ab}	55.9^{d}	6.6^{c}	2840.7^{h}
HAWI	49^{gh}	86^{ab}	55.7^{d}	7.4^{bc}	5293.3^{ab}
SIRBO	61^{a}	93^{a}	65.2^{abcd}	6.9^{bc}	4115^{ef}
DINKNESH	50^{gh}	81^{b}	64.7^{abcd}	6.5^{c}	5408.3^{a}
MILLENIUM	60^{ab}	92^{a}	60.1^{bcd}	7.1b^{c}	2928.3^{gh}
TUISE	50^{gh}	87^{ab}	63.1^{abcd}	6.9^{bc}	3201.3^{gh}
KATAR	53^{f}	87^{ab}	72.8^{ab}	8.0^{abc}	4243.3^{de}
KBG-01	49^{hi}	93^{a}	60^{bcd}	7.4^{bc}	4138.7^{def}
Pichaflor	47^{i}	91^{a}	60^{bcd}	6.9^{bc}	4544^{cde}
Danphi	55^{e}	92^{a}	57.2^{cd}	6.5^{c}	2865.3^{h}
mean	55	100	63.2	7.4	3996.6
CV	1.97	6.24	12.9	12.8	9.5
lsd	2	9.3	13.4	1.55	629.6

Table 4. Combined analysis of mean values of yield and yield related traits of improved bread wheat varieties during at Megech irrigation

Variety	Days to heading	Days to maturity	Plant Height (cm)	Spike Length (cm)	Grain Yield (kg/ha)
PAVON76	60e	91abcde	69cde	7.6abcde	3189.2hij
DIGALU	66a	95a	76abc	6.7e	3911efghi
KUBSA	64ab	94ab	75abcd	8.4a	5343.7ab
BOBICHO	61d	93abcd	72abcde	7.3bcde	5668.8a
DENSA	64ab	94ab	70bcde	7de	3295ghij
SHINA	63bc	93ab	70bcde	7.5abcde	5336.7ab
GASSAY	58f	91abcde	76abc	8.2ab	2448.2j
SENQEGNA	61d	93abcd	79a	7.5abcde	4436.7bcdef

TAY	62cd	93abcd	75abcd	8.2ab	4885.8abcde
Guna	61d	94abcd	75abcd	7.53abcde	4278.3bcdefg
ABOLLA	61d	90abcde	69cde	7.3bcde	3853.7efghi
HAWI	55gh	88ef	69cde	7.5abcde	5263.3abc
SIRBO	66a	94ab	69cde	6.7e	3899.2efghi
DINKNESH	55g	84ef	74abcd	7.2cde	5312.5abc
MILLENIUM	65a	95a	65e	7.1de	2964.2ij
TUISE	57f	90bcde	69cde	6.9de	3817.3efghi
KATAR	58f	89cde	77ab	8.1abc	4242.5cdefg
KBG-01	55g	91abcde	67de	7.7abcd	4231.8defg
Pichaflor	54fg	89cde	69cde	7.2cde	4409.5bcdef
Danphi	61d	93abcd	73abcde	7.13cde	3620.2fghi
mean	61	92	72	7.4	4220
CV	2.09	4.4	9.9	11.4	12.28
lsd	1.47	4.6	8.2	0.96	1077.9

Table 5. The combined mean values of yield and yield related traits of improved bread wheat varieties at Megech irrigation combined over years 2011 and 2012

Varieties	**Days to maturity**	**Plant height(cm)**	**Spike length(cm)**	**Grain yield(kg/ha)**
PAVON76	91abc	69.3abcd	7.6abcd	3189.2def
DIGALU	94.7a	75.5abc	6.7d	3911dec
KUBSA	94ab	75.3abc	8.4a	5343.7ab
BOBICHO	92.8abc	72.2abcd	7.3bcd	5668.8a
DENSA	94ab	70abcd	7bcd	3295def
SHINA	93.7ab	70.2abcd	7.5abcd	5336.7ab
GASSAY	91abc	75.7abc	8.2ab	2448.2f
SENQEGNA	93.2ab	79a	7.5abcd	4436.7abcd
TAY	92.8abc	74.8abcd	8.2ab	4885.8abc
Guna	93.5ab	74.5abcd	7.5abcd	4278.3bcd
ABOLLA	90.3abc	68.7bcd	7.3abcd	3853.7cde
HAWI	87.5cd	69abcd	7.5abcd	5263.3ab
SIRBO	94.3ab	69.3abcd	6.7d	3899.2cde
DINKNESH	83.7d	74abcd	7.2bcd	5312.5ab
MILLENIUM	94.7a	65.2d	7.1bcd	2964.2ef
TUISE	90abc	69.2abcd	6.9cd	3817.3cde

KATAR	89bc	77.3ab	8.1abc	4242.5bcd
KBG-01	90.5abc	67.2cd	7.7abcd	4231.8bcd
Pichaflor	89.3abc	69.3abcd	7.2bcd	4409.5bcd
Danphi	93ab	72.8abcd	7.1bcd	3620.2cdef
mean	92	71.9	7.4	4220.4
Variety*Year	**	**	ns	**
CV	4.39	9.94	11.4	12.3

Conclusion and Recommendations

From the overall results found on varieties, it was possible to conclude that the performances were promising in both years. The mean value of grain yield ranged from 1908kg/ha (Gassay) to 6223kg/ha (Bobicho) in 2011.The highest grain yield was recorded in irrigation system compared to the rain fed agriculture. This may be due to the fact that much micro nutrients might not be washed out; disease and insect pests might be reduced; amount of water was controlled so that fusarium disease was not occurred and environmental temperature was relatively higher which was not suitable for the occurrence of yellow rust disease.

Dinknesh and Hawi were found to be the earliest to mature (124 days) whereas Digalu and Kubsa were the late type of all the varieties in both years. Farmers' selection criteria were similar in both years and farmers' selection criteria were maturity period, spike length, tillering capacity and straw biomass. Accordingly, farmers selected varietiesShina, Tay, Abola and Dinknesh in descending order. Therefore, based on quantitatively measured agronomic traits (grain yield and maturity date) and farmers' visual observation at field, Varieties Bobicho, Dinknesh, Hawi and Shinaare recommended for production with their full packages for Megech irrigation site.

Currently, the widely grown varieties have been developed for rain fed agriculture. Therefore, further varietal development for irrigated agriculture should be undertaken.

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