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Participatory varietal selection of bread wheat (*Triticum aestivum* L.) genotypes at Marwold Kebele, Womberma Woreda, West Gojam, Ethiopia

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Participatory variety selection was conducted at Marwoled Kebele, Womberma Woreda, to select superior bread wheat varieties on farmers' fields with their participations. Bread wheat variety called Kubsa (HAR1685) is the sole variety grown by farmers. Twelve alternative bread wheat varieties were evaluated under rainfed conditions using a randomized complete block design with three replications as grandmother trial and three farmers' fields with one replication each as mother trial. In both trials, highly significant differences among the genotypes were observed in terms of plant height, spikelets per spike, hectoliter weight, thousand grain weights, leaf rust, yellow rust and days to maturity. HAR3730 (5.4 t ha^{-1}), ETBW5518 (5.3 t ha^{-1}), Plcafeor (4.8 t ha^{-1}), ETBW5521 (4.7 t ha^{-1}), ETBW5520 (4.4 t ha^{-1}) and HAR1685 (4 t ha^{-1}) were highest yielding over the check variety Kubsa (HAR1685) and selected by farmers and researcher. Developed participatory bread wheat varietal selections have solved many constraints related to farmers' participations, set parameters, select superior varieties, evaluating the performance of better varieties, and identify better varieties and accelerating the dissemination of farmers' selected varieties at Marwoled Kebele. Therefore, promotion of higher yielding selected cultivars is necessary at Marwoled Kebele to diversify wheat varieties to cope up with evolving disease pathogens and epidemic occurring in wheat system in the region.

Key words: Participatory selection, bread wheat, varietal selection.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the second most important cereal crop after rice (Ekboir, 2000) followed by maize *(Zea mays)* and barley (FAO, 1999). To meet the food needs of the ever growing world population, the forecast demand for the year 2020 varies between 840 (Rosegrant et al., 1995) and 1050 million tons (Kronstad, 1998).

Ethiopia is the first largest wheat producer in sub-Saharan Africa, except South Africa (Aquino et al., 1996). The major wheat producing areas in Ethiopia are located in Arsi, Bale, Shewa, Ilubabor, Western Hareghe, Sidamo, Tigray, Northern Gonder and Gojam Zones (Beke1e et al., 2000).

Ethiopia is one of the centers of diversity and origin for various agricultural crops. The importance of adaptation to variable and risky low-input rain-fed conditions,

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secondary crop uses, and cultural preferences has received little or no attention (Sperling et al., 1993).

Participatory Variety Selections (PVS) can thus effectively be used to identify farmer's acceptable varieties that are better than old and obsolete varieties with which farmers stick for long period (Joshi and Witcombe, 1996). Participatory varietal selections are farmer-centered varietal selections limited to testing of the finished varieties. Farmers evaluate multiple traits that are important to them and help to increase on-farm varietal diversity, faster varietal replacement and rapid scaling up. Moreover, quality traits like milling percentage, cooking and keeping quality, taste, and market price can be assessed in PVS that are difficult or expensive to evaluate in conventional trials. All PVS use some form of mother and baby trials where the former are fewer in number than the latter has to compare all of the test entries (Witcombe et al., 2005). Similarly, participation of farmers during varietal selection in the Marwoled Kebele is uncommon. This on-farm management and informal plant breeding increasingly becomes crucial in many areas of the developing world, while it ensures the conservation of genetic diversity and continuous evolution of crop species to meet local needs and environmental constraints (Smith et al., 2001). Marwoled Kebele has high potential for the production of bread wheat. Almost all farmers of the Kebele grow only one bread wheat variety called Kubsa (HAR 1685) which is a risky practice while an outbreak of disease can devastate the whole bread wheat grown in the area. Although the area has high potential for increasing wheat productivity and quality, little is known about the existing bread wheat production, productivity and grain quality as well as, the adequacy of current participatory variety selection to improve yield and quality and to develop alternative cultivars adaptable to the area through participatory varietal selection approach. Therefore, it is of paramount importance to identify high yielding and good quality bread wheat genotypes for the area.

Thus, this study was carried out with the objective of selecting bread wheat varieties with the participation of farmers at Marwoled Kebele in Womberma Woreda.

MATERIALS AND METHODS

Participatory varietal selection of bread wheat trial was conducted in Marwoled Kebele at Womberma Woreda in Western Gojjam Zone, in Ethiopia, in 2010/11 main cropping season. The trial site is located at 10° 05.7'N latitude and 37° 02.6'E longitude with an altitude of 1,970 meters above sea level. Marwoled Kebele is one of the 19 peasant associations (rural Kebeles) of the Womberma Woreda. The altitude of Marwoled Kebele varies from 1038 to 2,067 masl and the average annual rainfall is about 1,260 mm. The soil coverage of the Kebele is Vertisol (20.63%) and leptosol (79.37%). The pH is 6.05. The average N content is 0.11%, and organic matter content is 2.41% at the depth of ≥ 0.2 m.

The general agro ecological condition of the experimental site is suitable for growing different crops. According to Marwoled Kebele Agriculture and Rural Development Office, the total population of the Kebele is estimated at about 4,214 which is 3.52% of the total population of the district. The Kebele shares 3.13% (4,139 ha) of the total area of the district. This area is dominated by bread wheat production in addition to other major crops under rain fed condition.

Experimental design

Five released bread wheat varieties namely Paven-76, kubsa (HAR1685), Millenium, Plcafeor, and Gasay (HAR3730) and seven promising varieties namely ETBW5518, ETBW5519, ETBW5520, ETBW5521, ETBW5522, ETBW5525 and ETBW5526 were assessed on-farm at Marwoled Kebele peasant association in Womberma Woreda. Randomized complete block design with three replications on one host farmer's field was used for this research. This was named grandmother trial. Three other host farmers planted one replication each as mother trial. The grandmother trial was used to generate breeder's data while the three mother trials were used for participatory varietal selection and to value farmers' preferences during evaluation.

Farmers' data collection

Four different groups of farmers having eight members each were selected to rate different traits from emergence to maturity and post-harvest evaluation. Farmers and the breeder jointly evaluated the genotypes, but the farmers alone made the final decision. Traits considered and criteria used for participatory varietal selection by farmers were: Plant stands (PS), Number of tillers (NT), Spike length (SL), Number of Kernels (NK), Disease Resistance (DR), Seed Coat color (SCC) and Seed Size (SS).

Breeders' data collection

Plant height (PH), Tiller number per plant (NT), Stand Percent at Emergence (SPG, %) and at harvest (SPH, %), Days to maturity (MA), Days to heading (HD), Spike length (SL), Number of spikelets per spike (NSKPS), Kernel number per spike (KSP), Grain filling period (GFP), Biological yield (BM),Thousand grain weight (TGW), Grain yield (YD), Hectoliter weight (HLW) (Kg/hl), Harvest index (HI) and Disease score.

Data analysis

To reveal the total variability present within the genotypes in randomized complete block design, analysis of variance (Table 1) was computed for all the characters as per Gomez and Gomez (1984) using "SAS" software window version 8 (1999). Statistical Package for Social Science (SPSS) Version 16 was used to analyze the participatory varietal selection data collected through farmer participation.

RESULTS AND DISCUSSION

Farmers employed seven different parameters to select their preferred varieties including plant stand, number of tillers, seed coat color, seed size, spike length, number of kernels and disease resistance.

The use of PVS proved to be a useful selection method. Farmer participation creates a feeling of ownership (Weltzien et al., 2003). Variety selection by farmers at the same low input farming conditions

Table 1. Analysis of variance.

Source of variation	Df	Mean squares	Expected mean squares	F-ratio
Replication	(r-1)	MS_r	$\sigma^2_e + g\sigma^2_r$	
Genotype	(g-1)	MS_g	$\sigma^2_e + r\sigma^2_g$	MS_g/MS_e
Error	(r-1) (g-1)	MS_e	σ^2_e	
Total	rg-1			

r = number of replications, g = number of genotypes, DF = degree of freedom, MS_r = mean Square due to replications, MS_g = mean square due to genotypes, and MS_e = mean square due to environment, σ^2_e = Environmental variance and σ^2_g = Genotypic variance.

Table 2. Farmers' preference scores and ranking on grandmother trial.

Varieties	Parameters and scores								
	Plant stand	Number of tillering	Seed coat color	Seed size	Spike length	Number of kernel	Disease resistance	Total scores	Rank
Paven-76	3.6	2.3	2	2.3	2.6	2	1.3	16	8
HAR1685	4.3	5	3.3	4	4.3	4.3	3.3	28	2
Millennium	4	2.6	2	2	2	2	2	17	7
Plcafeor	3.3	3	2	2	2	2	2	16	8
HAR3730	5	3.6	4.6	4.6	5	4.4	4.6	31	1
ETBW5518	4.3	3	2.3	2.3	4.3	3.6	4.3	24	4
ETBW5519	2.6	3	2	2	2	2	4.3	18	6
ETBW5520	3.6	3.6	2	2	3	2.6	3	20	5
ETBW5521	5	3.3	3	3	4.6	3.3	5	27	3
ETBW5522	3.6	3.6	2	2.3	2.6	3.3	3	20	5
ETBW5525	5	4	2.6	3.3	4.3	4	4	27	3
ETBW5526	4.6	3.6	3	3	5	4	4.6	27	3

N.B: Farmers preference ranking, key for scaling (1-5); 1=least 5=best.

addresses also the needs of more marginalized farmers (Dawson et al., 2007). It is a rapid and cost effective way to assess and select potential varieties (Abidin, 2004). Joshi and Witcombe (1996) reported that adoption rates of cultivars would be improved through increased farmers' participation. Poor farmers can adopt new varieties as rapidly as wealthier ones through participatory varietal selection.

In the grandmother trial, HAR3730 and ETBW5526 were selected by farmers and the latter was selected due to its good plant stand, white seed coat color, large seed size, better spike length, many kernels and better resistance to disease (rust) over kubsa (HAR1685) though it had less tillers than kubsa (HAR1685). Other varieties were not selected by farmers and not rated over the check variety kubsa (HAR1685) (Table 2). Farmers ranked HAR3730 variety first from grandmother trial.

In the mother trials, HAR3730, ETBW5526 and ETBW5521 were selected in descending order with overall ranking of seven parameters. HAR3730 was ranked highest in terms of tillers, white seed coat color, larger seed size, larger spike length, number of kernels and better disease resistance.

ETBW5526 ranking 2nd was selected by farmers due to its good plant stand, large spike length, more kernels and better disease resistance. ETBW5521 ranking 3rd was selected owing to its high tillering, large spike length, more kernels and better disease resistance (Table 3).

Comparison of varieties for yield and yield related traits

Yield and grain quality of produced grain play an important part in the successful production and marketing of wheat. Traditionally, high yielding ability alone was the most important factor to the producer. Grain quality becomes also more important as it is produced for commercial purposes (Berhanu, 2010).

Grain yield is the final result of its components. In the Grandmother trial, HAR3730 (5.4 t ha^{-1}), ETBW5518 (5.3 t ha^{-1}), Plcafeor (4.8 t ha^{-1}), ETBW5521 (4.7 t ha^{-1}), ETBW5520 (4.4 t ha^{-1}) and HAR1685 (4 t ha^{-1}) gave more yield than the check variety Kubsa (HAR1685).

Table 3. Farmers' preference scores and ranking on mother trial.

Varieties	Parameters and scores							Total score	Rank
	Plant stand	Number of tillering	Seed coat color	Seed size	Spike length	Number of kernel	Disease resistance		
Paven-76	2.6	2.3	2.3	2.6	2	1.6	1.6	15	9
HAR1685	4.3	3.6	3	3.6	3	2.6	3	23	4
Millennium	4.6	2	2	2	2	2.3	3.3	18	8
Plcafeor	2	2	2.3	2	2	2	1.6	14	10
HAR3730	4.3	4.6	4.6	4.6	5	4.3	4.3	32	1
ETBW5518	4	3.3	2.3	2.6	3	3	3	21	6
ETBW5519	3.6	2.6	2.3	2	2	2.6	2.6	18	8
ETBW5520	3.3	3	2.6	3	3.3	2	2.6	20	7
ETBW5521	3.6	4.3	3	3.6	4	3	4	25	3
ETBW5522	4.3	4	3	2.6	3.6	3.3	2.3	23	4
ETBW5525	3.3	3.3	3	3	4	3	3.6	22	5
ETBW5526	4.6	3.3	2.6	3.6	4	4.6	3.6	26	2

Farmers preference ranking,key for scaling (1-5): 1=least 5=best.

ETBW5519 (3.5 t ha^{-1}) and Paven-76 (3.4 t ha^{-1}) were the lowest yielding varieties. In the Mother trial ETBW5518 (4.64 t ha^{-1}), ETBW5521 (4.61 t ha^{-1}), HAR3730 (4.59 t ha^{-1}), HAR1685 (4.03 t ha^{-1}) produced better yield over the check variety. Based on the two trial types HAR3730, ETBW5518 and ETBW5521 were higher yielding bread wheat varieties.

Plant height

In the grandmother trial, HAR3730 (97.4 cm), ETBW5525 (96.6 cm), ETBW5526 (95.3 cm), ETBW5522 (94.8 cm) and ETBW5521 (94.9 cm) were the tallest varieties while HAR1685 (85.0 cm) and ETBW5519 (88.8 cm) were the shortest varieties (Table 4). In the mother trial, ETBW5525 (101.4 cm) and ETBW5522 (100.8 cm) were the tallest varieties while HAR1685 (88.6 cm) was the shortest one (Table 5). Based on the findings of combining the two trials, ETBW5525 (101.4 cm) and ETBW5522 (100.8 cm) observed the tallest varieties and HAR1685 (88.6 cm) showed on the contrary the shortest variety.

Days to maturity

Paven-76, Plcafeor, HAR3730 and ETBW5520 observed early maturing bread wheat varieties whereas ETBW5519 and ETBW5526 showed late maturing in the grandmother trial (Table 4). In the mother trial Paven-76, Plcafeor, HAR3730, ETBW5520 and ETBW5522 appeared early maturing. ETBW5526 and ETBW5519 were recorded as late maturing (Table 5). ETBW5519 was recorded as late maturing as compared to other varieties in both trials. In this finding, delayed maturity was observed due to the difference between maturities from genetic effect.

Days to heading

Paven-76 and plcafeor headed early while ETBW5526 headed late in both trials. In the mother trial, ETBW5519 headed late (Tables 4 and 5).

Biomass yield

ETBW5518 (13.4 t ha^{-1}) and ETBW5521 (12.3 t ha^{-1}) in the grandmother trial and ETBW 5518 (121.63 t ha^{-1}) in the mother trial produced the highest biomass yield (Tables 4 and 5).

Harvest Index

Varieties such as HAR3730 (45%) and Plcafeor (41%) had the highest harvest index in the grandmother trial. Similarly, ETBW5521 and HAR3730 showed the highest harvest index in the mother trial (Tables 4 and 5).

Tillering capacity

In the grandmother trial, HAR1685 and ETBW5525 had more tillers while ETBW5518 and ETBW5521 had few tillers (Table 4). In the mother trial, Paven-76 and ETBW5522 had high number of tillers than the rest varieties (Table 5). Generally, HAR1685, Paven-76 and ETBW5522 had better tillering capacity.

Table 4. Mean separation of different agronomic traits for 11 treatments in grandmother trial.

Treatments	PH	SL	SKPSP	YD	HLW	TGW	LR	GFP	MA	HD	HI
Paven-76	92.2^{abc}	8.2^{dc}	16.4^{bcd}	3.4^{d}	75^{cde}	27^{ef}	21.6^{cd}	43.6^{f}	103.3^{e}	59.6^{f}	34.2^{cde}
HAR1685	85^{d}	8.2^{dc}	15.8^{cd}	4^{bcd}	72.2^{e}	25^{f}	23.3^{cd}	47^{bc}	111^{ab}	64^{abc}	32.7^{cd}
Millennium	93^{abc}	7.8^{d}	16.6^{bcd}	3.7^{cd}	77.2^{abc}	30.3^{cde}	33.3^{ab}	46.6^{bcd}	110.3^{b}	63.6^{bcd}	35.5^{bcde}
Plcafeor	90.1^{bcd}	8.4^{dc}	16.6^{bcd}	4.8^{ab}	77.3^{abc}	35^{ab}	18.3^{d}	49^{a}	105^{de}	56g	41.2^{ab}
HAR3730	97.4^{a}	9.2^{ab}	17.2^{b}	5.4^{a}	80.8^{a}	35.3^{a}	33.3^{ab}	45.6^{de}	107.6^{c}	62^{de}	45.6^{a}
ETBW5518	93.6^{abc}	8.4^{dc}	17^{bc}	5.3^{a}	79.8^{ab}	33.6^{abc}	28.3^{bc}	46.6^{bcd}	110.3^{b}	63.6^{bcd}	40.7^{abc}
ETBW5519	88.8^{cd}	8.4^{dc}	17.2^{b}	3.5^{d}	74.5^{cde}	26^{f}	21.6^{cd}	47.6^{b}	113.3^{a}	65.6^{a}	31^{e}
ETBW5520	92.5^{abc}	8.2^{dc}	15.3^{d}	4.4^{abcd}	75.7^{cde}	31^{bcde}	28.3^{bc}	46^{cde}	107^{cd}	61^{ef}	37.1^{bcde}
ETBW5521	94.9^{ab}	8^{d}	16.8^{bc}	4.7^{abc}	77.6^{abc}	33^{abcd}	23.3^{cd}	47.3^{b}	111.6^{ab}	64.3^{ab}	37.6^{bcd}
ETBW5522	94.8^{ab}	9.73^{a}	15.7^{cd}	4.1^{bcd}	74.8^{cde}	31.6^{abcd}	16.6^{d}	45.3^{e}	107.6^{c}	62.3^{cde}	37.3^{bcde}
ETBW5525	96.6^{a}	8.7^{bc}	19.1^{a}	4^{bcd}	73^{de}	29^{def}	21.6^{cd}	47^{bc}	111^{ab}	64^{abc}	34.4^{cde}
ETBW5526	95.3^{ab}	9.8^{a}	16.2^{bcd}	4.6^{abc}	76.2^{bcd}	30.6^{cde}	36.6^{a}	47^{bc}	112.3^{ab}	65.3^{ab}	37.2^{bcde}
Mean	92.88	8.61	16.68	4.36	76.2	30.63	25.55	46.58	109.22	62.63	37.07
CV (%)	3.55	4.32	4.88	14.05	3.05	7.8	19.09	1.44	1.33	1.72	10.48
LSD	5.58	0.63	1.38	1.03	3.94	4.05	8.26	1.14	2.46	1.83	6.58
SE	1.9	0.21	0.46	0.35	1.34	1.37	2.81	0.38	0.83	0.62	2.24

PH=Plant height (cm), SL= spike length (cm), SKPSP= spikeletes per spike, YD= grain yield (t/ha), HLW= hectoliter weight (kg/hl), TGW= thousand grain weight (g), LR= leaf rust (%), YR= yellow rust (%), GFP= grain filling period, MA=days to maturity, HD= days to heading, HI= harvest index, CV(%)= coefficient of variation, LSD= least significant difference, SE= standard error, α = 0.5.

Table 5. Mean separation of different agronomic traits for 7 treatments in mother trial.

Treatments	PH	SKPSP	KPS	HLW	TGW	MA	HD
Paven-76	94.53^{bc}	16^{e}	40.2^{d}	72.13^{c}	27^{d}	105.33^{f}g	60.66^{f}
HAR1685	88.6^{c}	16.86^{cde}	47^{bcd}	72.13^{c}	27.33^{cd}	108.33^{cde}	64^{bcd}
Millennium	98.2^{ab}	17^{cde}	43.13^{cd}	78.46^{a}	29.66^{bcd}	108.333^{cde}	63.33^{cde}
Plcafeor	97.33^{ab}	16.8^{de}	46.66^{bcd}	72.53^{bc}	33.33^{ab}	104^{g}	59^{g}
HAR3730	93.53^{bc}	18.06^{cb}	47.13^{bcd}	75.93^{abc}	31.33^{bcd}	108.33^{cde}	62.66^{de}
ETBW5518	98.73^{ab}	17.13^{cde}	49.13^{bc}	77.2^{a}	31^{bcd}	110^{abc}	64.66^{bc}
ETBW5519	94^{bc}	18.46^{b}	52.93^{ab}	76.93^{ab}	27^{d}	111.66^{a}	66.33^{a}
ETBW5520	98.73^{ab}	17.13^{cde}	48.6^{bc}	79.06^{a}	33.66^{ab}	107^{ef}	62^{ef}
ETBW5521	95.6^{ab}	17.53^{bcd}	49.2^{bc}	79.2^{a}	37.33^{a}	110.33^{abc}	65^{ab}
ETBW5522	100.86^{a}	15.93^{e}	47.2^{bcd}	71.7^{c}	27.66^{cd}	107.33^{def}	62.33^{e}
ETBW5525	101.46^{a}	19.8^{a}	60.06^{a}	76.2^{abc}	32^{bc}	109.33^{bcd}	64.33^{bc}
ETBW5526	98.46^{ab}	18^{bcd}	57.13^{a}	75.26^{abc}	30.66^{bcd}	111.33^{ab}	65.33^{ab}
Mean	96.67	17.39	49.03	75.56	30.66	108.44	63.3
CV (%)	3.67	4.25	9.24	3.59	9.06	1.14	1.52
LSD	6.01	1.25	7.67	4.59	4.7	2.1	1.63
SE	3.6	1.07	5.49	2.8	3.17	2.3	2.09

PH=Plant height (cm), SKPSP= spikeletes per spike, KPS=kernels per spike, HLW= hectoliter weight (kg/hl), TGW= thousand grain weight (g), MA=days to maturity, HD= days to heading, CV (%) =coefficient of variation, LSD=least significant difference, SE=standard error, α = 0.5.

Spike length

ETBW5526 (9.8 cm), ETBW5522 (9.73 cm) and HAR3730 (9.2 cm) had longer spike length while Millennium and ETBW5521 had the shortest spike length in the grandmother trial (Table 4). Similarly, ETBW5521 (9 cm), ETBW5525 (9.26 cm) and ETBW5522 (9.33 cm) had the longest spike length whereas HAR1685 and Millennium had the shortest spike length in the mother trial (Table 5). In both trials, ETBW5522 showed the

Table 6. Analysis of variance for 19 traits of bread wheat varieties in grandmother trial.

Traits	MSr	MSt	Mse	CV (%)
PH	11.42	37.07**	10.87	3.55
SL	0.023	1.22**	0.14	4.32
NT	11.67	1.80^{ns}	1.02	15.55
SKPSP	7.21	2.86**	0.66	4.88
KPS	377.42	36.76^{ns}	21.89	11.61
BM	1.83	2.03^{ns}	1.2	9.34
YD	0.98	1.26**	0.38	14.06
MO	0.58	0.11^{ns}	0.45	8.98
HLW	28.81	19.45**	5.45	3.05
TGW	39.69	34.45**	5.72	7.81
LR	63.19	121.72**	23.8	19.09
YR	158.33	406.25**	117.4	32.92
SR	46.53	42.92^{ns}	45.01	48.3
GFP	0.33	5.28**	0.45	1.45
MA	1.44	28.26**	2.11	1.33
HD	0.44	22.15**	1.17	1.73
SPG	6.25	19.88*	8.52	3.17
SPH	2.08	9.28^{ns}	7.38	2.92
HI	91.05	48.41**	15.1	10.48

MSr=Mean square due to replication, MSt= Mean square due to treatment, MSe= mean square due to error,DF= degree of freedom, PH=plant height, SL= spike length, NT= number of tillering, SKPSP= spikeletes per spike, KSP=kernels per spike, BM= biomass yield, YD= grain yield, MO=moisture contents, HLW= hectoliter weight, TGW= thousand grain weight, LR= leaf rust, YR=yellow rust, SR=stem rust, GFP= grain filling period, MA=days to maturity, HD= days to heading, SPG=stand percentage at growth, SPH= stand percentage at harvesting, HI= harvest index, CV (%) =coefficient of variation, ** indicates significance at 0.01probability level, ns indicates non significance.

Table 7. Analysis of variance for 19 traits of bread wheat varieties in mother trial.

Traits	MSr	MSt	MSe	CV (%)
PH	233.56	38.98**	12.59	3.67
SL	1.77	0.49^{ns}	0.27	6.02
NT	6.94	2.28^{ns}	2.8	19.15
SKPSP	4.55	3.48**	0.54	4.25
KPS	130.92	90.63**	20.56	9.24
BM	578.66	63.23^{ns}	62.57	7.16
YD	1.6	0.58^{ns}	0.48	16.38
MO	1.4	0.73^{ns}	0.43	9.03
HLW	26.31	23.65**	7.36	3.59
TGW	50.58	30.24**	7.73	9.06
LR	63.19	57.32**	17.74	16.66
YR	214.58	285.04**	68.37	29.62
SR	29.86	69.44^{ns}	25.31	36.96
GFP	25.19	0.57^{ns}	0.89	2.09
MA	43.02	15.89**	1.54	1.15
HD	13.36	13.11*	0.93	1.52
SPG	43.75	15.90^{ns}	18.75	4.76
SPH	56.2	8.33^{ns}	12.31	3.79
HI	43.56	39.84^{ns}	38.4	16.21

MSr= Mean square due to replication, MSt= Mean square due to treatment, MSe= mean square due to error, DF= degree of freedom, PH=plant height, SL= spike length, NT= number of tillering, SKPSP= spikeletsper spike, KSP=kernels per spike, BM= biomass yield , YD= grain yield, MO=moisture contents, HLW= hectoliter weight, TGW= thousand grain weight, LR= leaf rust, YR=yellow rust, SR=stem rust, GFP= grain filling period, MA=days to maturity, HD= days to heading, SPG=stand percentage at growth, SPH= stand percentage at harvesting, HI= harvest index, CV (%) =coefficient of variation, ** indicates significance at 0.01 probability level, ns indicates non significance.

longest while Millennium the shortest spike length.

Thousand grain weight

HAR3730 (35.3 g) had the highest thousand seed weight. Similar result was reported by Berhanu (2010). HAR1685 (25 g) had the lowest thousand seed weight (Table 4). In the Mother trial, ETBW5521 had the highest thousand seed weight (Table 5).

Hectoliter weight

Test weight provided a rough estimate of flour yield potential in wheat. It is important to millers just as grain yield is important to wheat producer. HAR3730 (80.8 kg/hl) and ETBW5518 (79.8 kg/hl) scored the highest weight whereas HAR1685 scored the lowest (72.2 kg/hl) hectoliter weight in grandmother trial (Table 4). In the mother trial, ETBW5520 (79.06 kg/hl) and ETBW5521 (79.2 kg/hl) scored the highest weight and Paven-76 and HAR1685 both scored the lowest weight of (72.13 kg/hl) (Table 5).

Analysis of variance

There was significant difference (p<0.01) among the treatments with respect to yield and yield related traits. Genotypes in the grandmother trial exhibited highly significant difference for plant height, spike length, spikelets per spike, grain yield, hectoliter weight, thousand grain weights, leaf rust, yellow rust, grain filling period, days to maturity, days to heading, harvest index and stand percentage (Table 6).

Genotypes in the mother trial significantly varied (p<0.01) in plant height, spikelets per spike, kernels per spike, hectoliter weight, thousand grain weight, leaf rust, yellow rust, days to maturity and days to heading in mother trial (Table 7).

In the grandmother and mother trials highly significant height, spikelets per spike, hectoliter weight, thousand differences among genotypes were observed in plant grain weights, leaf rust, yellow rust and days to maturity in both trial types.

Conclusions

Developed participatory bread wheat varietal selections solves many constraints related to farmers' participations, set parameters, select superior varieties, evaluating the performance of better varieties, and identify better varieties and accelerating the dissemination of farmers' selected varieties in the Kebele. Farmers' participation in the PVS enabled them to increase their knowledge to select superior varieties that fit in their own agro-economic and management condition. Those varieties selected by farmers showed a yield advantage over the local variety kubsa (HAR1685). Bread Wheat varieties diversification in the Kebele may increase remarkably if the PVS approach would be widely used in the Kebele. In general, it can be concluded that the participatory varietal selection of bread wheat could be improved based on the existing potential of the study area. Farmers must have an opportunity to participate with varietal selection to get more yield of bread wheat based their indigenous knowledge. Farmers should diversify their cultivars along with Kubsa which is the only bread wheat variety grown by farmers in Marwoled Kebele. Cultivars such as HAR3730 and ETBW5526 gave high yield compared to other varieties.

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