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On Farm Demonstration of Improved Malt Barley (Hordeum vulgare L.) Varieties in Alicho Wuriro and Gumer Districts of SNNPRS, Ethiopia

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Abstract
Farmers were provided with three improved malt barley varieties for demonstration at Alicho wuriro and Gumer districts of southern Ethiopia during the 2017 cropping season with the objective to demonstrate improved malt barley variety under farmer's condition through their participation. A total of twelve farmers; six from each district were used for demonstration. Single plot with 10 m x 10 m size was used on each farmer's field. The analysis of paired samples revealed there is highly significant difference ($p<0.05$) for location and among the varieties in grain yield. Grain yield ha^{-1} had significant and positive correlation with spike length and highly significant and positive correlations with thousand grain weights (0.95). Control variety (IBON-174/03) showed percentage increase by 11.77 and 19 % in grain yield over Sabini and HB-1533 under similar management; the rank analysis indicated that IBON-174/03 was highly preferred by farmers in terms of seed color, early maturity and resistance to lodging under farmer's condition. Therefore, IBON-174/03 was recommended for production at Alicho wuriro and Gumer districts and similar agro ecological conditions to improve malt barley production and productivity under smallholder farmers.
Keywords: Demonstration, malt barley, grain yield

1. Introduction

Barley (*Hordeum vulgare* L.) is one of the most important cereal crops in the world, ranking fourth in production area next to wheat, rice and maize (FAO, 2016). In Ethiopia, it is ranked fifth next to teff, wheat, maize and sorghum (CSA, 2015). The most important use of barley is in beer, but also in hard liquors malted milk and flavoring. Barley malt is added to biscuits, bread, cakes and desserts. Brewers, distiller grains and sprouts from malting barley have desirable protein content for animal diets. Modern malting in Ethiopia was started in 1974 at St. George Brewery. At present there are six breweries in Ethiopia and the existing total capacity of these breweries is 2.7 million hectoliters which needs 45,679 tons of malt every year. However, the capacity of Asela Malt Factory is supplying only 15,000 tons of malt (Getachew *et al*., 2006). The national barley research program has focused primarily on breeding using exotic malting barley lines (Fekadu and Hailu, 1987).

Demonstration provides an opportunity of getting large number of varietal choices to farmers, enhances farmer's access to crop varieties and increase in diversity, increases production and ensures food security, helps to disseminate the adoption of pre and released varieties in larger areas, allows doing varietal demonstration in targeted areas at cost-effective way and also in a lesser time and helps seed production at community level. One of the main consequences is that a large amount of breeding material is discarded without knowing whether it could have been useful in the real conditions of farmers' fields and the one that demonstrated is likely to perform well in environments similar to the research stations and may not perform as well in the fields of the poorest farmers. In terms of the area coverage and production, Southern region contributes 7.22 and 6.5%, respectively, to the nation with average productivity of 1.72 t ha^{-1} (CSA, 2014), which is lower than the potential yield of the crop, which is 6 t ha^{-1} (Hasan, 2014) and it is significantly lower than high performing countries such as France, Germany and the Netherlands average barley yield (Shahidur *et al.,* 2015), due to different factors such as lack of high yielding cultivars, inadequate management practices, weed and low fertility conditions.

Even though some varieties of malt barley have been released in Ethiopia, most of them were not demonstrated and evaluated. Hence, farmers of the study areas used their own variety which is low yielder and susceptible to diseases and weeds. Therefore, this activity was specifically initiated to demonstrate improved malt barley variety under farmer's condition through their participation.

2. Materials and Methods

2.1. Description of the study area

The study was conducted at Alicho wuriro and Gumer districts in the 2017 main cropping season. List of the testing locations with their characteristics is indicated in Table 1.

Table 1. Agro-ecological characteristics of test sites

Location	Altitude (masl)	Mean annual rainfall (mm)*	Average temp (°C)*	Soil texture	Global position	
					Latitude	Longitude
Gumer	2825	895.83	14.45	Loam	7^0 54′ 47″	38^0 03′58″
Alicho	2984	825	13.26	Clay loam	7^0 58′ 23″	37^0 29′ 49″

*Source: National Meteorology Agency, Hawassa branch

2.2. Treatments and Experimental Design

The experiment was carried out at Bune-sakemo and Shilimat in Siltie and Denber and Abeke kebeles in Gurage zones, respectively using single plot size of 10 m x 10 m for each variety at three farmer's field in each kebele with three released malt barley varieties, IBON-174/03, Sabini and HB1533 planted on mid-July, 2017. Varieties were planted at the seed rate of 125 kg ha^{-1} hand drilling in plots of 100 m^2 with 0.2 m within row spacing. Fertilizer rates of 121 kg NPS ha^{-1} was applied once during planting time whereas 50kg urea ha^{-1} were applied in split (at planting and tillering) in equal amount. Weeding, plowing and other management practices were done as required.

2.3. Data collection and analysis

Grain yield and biomass yields were measured from the three places diagonal of the 1 m^2 plot at maturity. Similarly, number of kernels per spike and spike length were determined on five randomly sampled plants from the central rows. The experiment was conducted on twelve farmers' field. A group of farmers having fourty members (fifteen female and twenty five male) and randomly selected were organized to participate in the variety evaluating process. Farmers have evaluated and ranked the varieties at different growth stages of the crop. They used parameters like, seed color, resistance to lodging, spike length and kernel number, to evaluate the varieties. These evaluation criteria were identified through brainstorming.

Site or kebele selection based on potential production of malt barley and farmer's selection was done with collaboration of agricultural office experts working on cereal production, kebele official and developmental agent by considering different selection criteria. Criteria's like farmers interest to the technology, model farmers and managing the field as required. Accordingly, a total of fourty farmers were selected from both districts (twenty farmers from each district). Farmer's preference were collected and analyzed by using simple ranking method in accordance with the given value of De Boef and Thijssen, (2006). The formula of ranking method used was specified as:

Rank = $\sum \frac{N}{n}$ Where N, is value given by group of farmers for each variety based on the selection criteria and n is number of selection criteria used by farmers.

Farmers set their selection criteria and ranking of varieties. The rank sum method each trait for each variety was used to rank varieties based on farmers' selection criteria. The value of each trait has equal weight. Statistical Package for Social Science (SPSS) Version 20 was used to analyze the varietal demonstration data collected through farmer participation and Pearson coefficients of correlation, respectively.

3. Results and Discussion

3.1. Yield performances

The analysis of paired samples revealed there is highly significant difference ($p< 0.05$) for location and among the varieties in grain yield. The mean yield of Sabini and HB-1533 were found to be 3.4 and 3.2 t ha^{-1}, respectively and that of control variety IBON-174/03 was 3.8 t ha^{-1} at Gumer, whereas the mean yield of Sabini and HB-1533 were found to be 2.80 and 2.75 t ha^{-1}, respectively and that of control variety IBON-174/03 was 3.10 t ha^{-1} at Alicho wuriro. The mean yield of Sabini and HB-1533 was less than that of control which indicated that using IBON-174/03 variety enhance the yield harvest of farmers from their land at both locations.

Table 2. Grain yield performance of the malt barley varieties

Variety	Grain yield (t ha^{-1})		Yield difference (t ha^{-1})		Yield increase over control (%)	
	Gumer	Alicho Wuriro	Gumer	Alicho Wuriro	Gumer	Alicho Wuriro
IBON-174/03	3.8	3.10				
Sabini	3.4	2.80	0.40	0.30	11.78	9.67
HB-1533	3.2	2.75	0.60	0.35	19	11.29

The result of study revealed that demonstrations of controlled variety of IBON-174/03 recorded the higher grain yield (3.8 t ha^{-1}) compared to Sabini and HB-1533 (3.4, 3.2 t ha^{-1}), respectively at Gumer, while 3.10 t ha^{-1} at Alicho. The percentage increase in the yield of IBON-174/03 variety over Sabini and HB-1533 was 11.77 and 19% at Gumer, whereas 9.67 and 11.29% at Alicho, respectively. This result indicated that using IBON-174/03 was more advantageous for farmers (Table 2).

3.2. Farmers Preference

Farmers set out main selection criteria in order to rank the variety. These criteria include seed color, straw biomass, early maturity and resistance to lodging. Based on the selection criteria, farmers indicated that IBON-174/03 was preferred by farmers and other neighbour farmers during field day organized on farmer`s field. The mean scores of farmers' selection criteria ranged from five (HB-1533 variety) to twelve (IBON-174/03 variety) at Gumer, while two (Sabini) to seven (Ibon) at Alicho wuriro. The highest score twelve recorded to early maturity for IBON-174/03 and 5 to seed color for HB-1533 at Gumer.

However, the score in terms of resistance to lodging for both IBON-174/03 and Sabini varieties were the same (10.5) at Gumer. In general control variety (IBON-174/03) got higher score in all parameters than others and selected as 1st by farmers at two locations (Table 3).

Table 3. Farmer's preference criteria on the varieties

Variety	Selection criteria (score out of 4)													
	Gumer							Alicho wuriro						
	SC	BM	EM	RL	TS	Mean	Rank	SC	BM	EM	RL	TS	Mean	Rank
IBON-174/03	8	5.5	12	10.5	36	9	1st	6	3	5	7	21	5.25	1st
Sabini	5.25	8.25	8	10.5	32	8	2nd	2	6	4	5	17	4.25	2nd
HB-1533	5	6	7	6	24	6	3rd	3	4	4	4	15	3.75	3rd

Where, SC = Seed color, BM = Biomass, EM = Early maturity, RL = Resistance to lodging and TS = Total score

Table 4. Paired samples of grain yield for location and varieties in 2017

Trait	Locations		Mean Difference locations	Std. error	Sign	St. deviation
Grain yield	G	A	0.58**	0.09	0.006	0.39
	A	G	-0.58**	0.09	0.006	
	Variety		Varieties	Std. error	Sign	St. deviation
	1	2	0.70ns	0.25	0.06	0.31
		3	0.90*	0.25	0.03	
	2	1	-0.70ns	0.25	0.06	
		3	0.20ns	0.25	0.29	
	3.0	1.0	-0.90*	0.25	0.035	
		2.0	-0.20ns	0.25	0.29	

** The mean difference is significant at the 0.05 probability level, respectively and where, G = Gumer Location, A = Alicho Location, SL = Spike length, NKS = Number of kernels per spike, TKW = Total kernel weight, 1 = IBON-174/03, 2 = Sabini and 3 = HB-1533

Positive and highly significant mean difference at the ($p<0.05$) had observed between Gumer and Alicho wuriro and negative and highly significant mean difference ($p<0.05$) had observed between Alicho wuriro and Gumer locations in grain yield; positive and significant mean difference at the ($p<0.05$) had observed between IBON-174/03 and HB-1533 and negative and significant mean difference ($p<0.05$) had observed between HB-1533 and IBON-174/03 varieties in grain yield.

Table 5. Pearson coefficients of correlation for yield and other traits at Gumer and Alicho wuriro

	Location	Variety	SL	NKS	TKW	GY
Location		0	-0.55	-0.32	-0.69	-0.82
Variety	0		-0.67	-0.86*	0.71	-0.54
SL	-0.55	-0.67		-0.93**	0.82*	0.75*
NKS	-0.32	-0.86*	0.93**		0.81*	0.71
TKW	-0.69	-0.71	0.82*	0.81*		0.95**
GY	-0.82*	-0.54	0.75*	0.71	0.95**	

*Correlation is significant at the 0.05 and ** at the 0.01 probability level

In both locations, the Pearson coefficients of correlation analysis indicated that there was significant and positive correlation spike length with thousand kernel weight and grain yield, but highly significant and negative correlation with number of kernels per spike; number of kernels per spike was showed highly significant and positive correlation with spike length and significant and positive correlation with thousand kernel weight. Thousand kernel weight was showed significant and positive correlation with spike length and highly significant and positive correlation with grain yield. Grain yield ha^{-1} had significant and positive correlation with spike length and highly significant and positive correlations with thousand grain weights (0.95). The presence of negative and significant correlation between grain yield and locations was reported by Rahman *et al.* (2016) in

wheat. However, variety with thousand kernel weight and number of kernel per spike with grain yield did not show any significant correlation (Table 5).

4. Conclusions

This study conducted to evaluate yield performance of malt barley variety under farmer's condition. The result revealed that there is yield difference among varieties in terms of grain yield and showed grain yield of IBON-174/03 variety advantage over the HB-1533 by 19 and 11.29% with similar management at Gumer and Alicho wuriro, respectively. On the other hand, ranking analysis indicated that IBON-174/03 variety was preferred by its seed color, early maturity and resistance to lodging under farmer's condition. Therefore, this variety was recommended for production at Alicho wuriro and Gumer districts and similar agro ecological conditions to improve malt barley production and productivity.

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