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Research Article

Evaluation and Selection of Improved Food Barley (*Hordeum Vulgare* L.) Varieties in the Highland Areas of Western Guji, Southern Oromia

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Abstract

The field experiment was conducted on six improved food barley varieties and one local check at Bule hora woreda, western Guji during 2017, 2018 and 2019 main cropping season. The main objective of the study was to identify, select and recommend well adaptable and high yielding variety for western Guji. The seed were sown in Randomized Complete Block Design (RCBD) with three replications in the net plot size of 1.2mx2.5m. Number of effective tillers per plant (ETP), Number of Spikelet Per Panicle (SPP), Plant Height (PH), Panicle Length (PNL), Number of Grain Per Spike (GPS), Days to 50% Heading (DH), Days to 50% Maturity (DM, Thousand Seed Weight (TSW) and Grain Yield (GY) were collected as Agronomic traits. Combined analysis of variance detected significant difference among main effect of variety, year and location for most of agronomic traits considered. The interaction effect of variety by year imposed significant effect on all traits except for PNH, PH and PNH, DM and SPP, respectively. Likewise, variety by year by location had significant influence on all agronomic traits excluding PH. Among evaluated varieties; Guta (4.68 tone/ha) and Dinsho (4.51 tone//ha) had significantly higher mean value of grain yield over the rest and followed by Biftu (4.17 tone/ha). Therefore, the superior variety was suggested for further demonstration and popularization in western Guji southern Oromia and areas with similar agro-ecology.

Keywords: Barely; Evaluation; Highland; Selection; Variety

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Introduction

Barley (*Hordium vulgare* L.) is recognized as one of the world's most ancient food crop, which is believed to have first domesticated about 10,000 years ago from its wild relatives in the Fertile Crescent of the Near East and Center of diversity in Ethiopia [1]. In Ethiopia, Barley is the fifth important cereal crop after Tef, Maize, Sorghum and Wheat in both total area coverage and annual production [2]. It is cultivated at altitudes ranging from 1500 to 3500 above sea level and predominantly grown at elevation ranging from 2000 to 300 m.a.s.l. [3]. Being the most dependable and desirable crop for the resource poor highland farmers [4], in some regions it is cultivated in two district seasons: belg which relies on the short rainfall period from March to April and Meher which relies on the long rainfall period from June to September [5].

Barley area coverage, production, and productivity were estimated to be 959,273.40 ha, 2,024,921.70 tones, and 2.11 tones/ha, respectively, at the national level [6]. The absence of improved varieties, insect pest, disease, poor soil fertility, soil acidity, and weed competition are the most important biotic and abiotic factors that reduce barley productivity [5,7]. Gradual increases in these production constraints are thought to be important in the study areas' declining barley productivity. One alternative intervention strategy for increasing crop productivity is to evaluate different food barley varieties for significant yield increment. Therefore, the main objective of the study was to evaluate the performance of improved food barley varieties and to recommend the adaptable and high yielding variety/ies for highland aeas of West Guji Zones and areas with similar agro-ecologies.

Materials and Methods

Description of the study area

For three years, a field experiment was conducted in the western Guji of Bule hora woreda (2017 to 2019). The study sites were identified as having a bimodal rainfall distribution pattern at an elevation of 2100 masl. Maize (*Zea mays* L), wheat (*Triticum aestivum* L.), and Tef (Eragrostis tef (Zucc.) Trotter) are some of the major field crops grown in the study areas.

Experimental materials and design

Six improved foods barely varieties brought from Sinana Agricultural Research Center were compared to a local cultivar for grain yield and yield-related agronomic traits. Randomized Complete Block Design (RCBD) in three-replication with a net plot size of 1.2mx2m and spacing of 1.5m, 0.75m, and 0.2m between replications, plot, and row, respectively. Drilling method was used to sow seed at a rate of 125 kg/ha. The use of inorganic fertilizer is also advised. Every agronomic practice was carried out in the same manner.

Collected data

Plot based data

The data on the following attributes was collected on the basis of the central four rows in each plot.

i. Days to 50% heading (DTH): The number of days from date of sowing to the stage where 75% of the spikes have fully emerged.

ii. Days to 90% maturity (DTM): The number of days from sowing to the stage when 90% of the plants in a plot have reached physiological maturity.

iii. Grain yield (GY): Grain yield in grams obtained from the central four rows of each plot and converted to kilograms per hectare at 12.5% moisture content.

iv. Thousand kernel weights (TKW): Weight of 1000 seeds in gram.

v. Above ground biomass (BM): The plants within the four central rows were harvested and weighed in grams.

Plant base data

Ten plants were randomly selected from the four central rows for recording the following observations:

- Number of productive Tillers (TN): The average number of productive tillers with heading
- Plant height (PH): The average height in cm from ground level to the tip of the spike.
- Spikelet per spike (SPS): The average number of spikelets per spike.
- Spike length (SL): The average spike length in cm from its base to the tip.

Data analysis

Before computing the combined analysis, error variance homogeneity test was performed using the procedure suggested by Gomez and Gomez (1984). The collected data were organized and analyzed using SAS statistical package (SAS, 2006 version 9.03). Mean separation was done by using least significant difference (LSD) at 1% probability level through employing the procedure developed by Gomez and Gomez (1984). In the combined analysis of variance, over year were considered random and genotypes were considered fixed.

The mathematical model used for analysis of variance was:

$$Yijk = \mu + Gi + Yj + GYij + Bk(j) + Eijk$$

Where:

$Yijk$= observed value of genotype i in block k of year j

μ= grand mean

Gi= effect of genotype i

Yi=effect of year j

GYij=the interaction effect of genotype i, year j

Bk (j) = effect of block k in location/environment

Eijk= random error or residual effect of genotypei in block k of location j

Results and Discussion

Analysis of Variances (ANOVA)

Combined analysis of variance detected significant difference of variety and over the year analysis for all agronomic traits (Table 1). Over year analysis explained significant of variety for all agronomic traits except TSW. On the other hands, ANOVA exhibited presence of significant interaction effect of variety by year for all most all of agronomic traits except SPS, TSW (Tables 2 & 3). Thus, analysis of variance depicted the existence of significant effect of fluctuating weather condition on mean performance of most of the traits (Figure 1). The finding of the study supported previous report of [8-12].

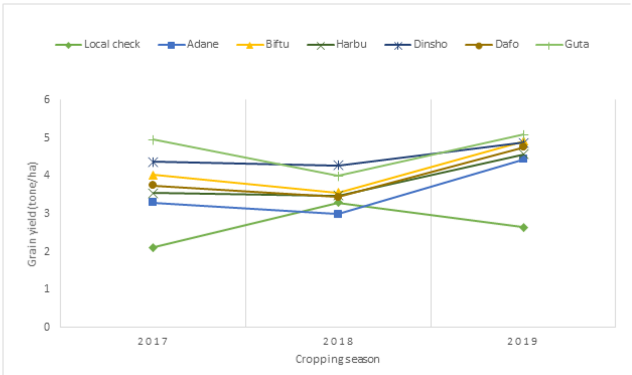

Figure 1: Performance of food barley genotypes across seasons Bule Hora, Southern Oromia.

Combined analysis of overall years

Based on cropping season productivity, the 2019 cropping season outperformed all others, with a high yield from the variety Guta (5.08 tone/ha), while the 2017 cropping season was less productive (4.28 tone/ha) grain output from the Dinsho variety (Figure 1). In both the 2017 and 2019 cropping seasons, the Guta variety produced higher yields, whereas the local check produced lower yields than all other types. As a result, we may infer that the cropping season of 2019 was better than all others, whereas the cropping season of 2018 was the worst cropping season for barely in study area (Figure 1).

Mean performance of varieties across years

Days to Flowering (DF)

Statistically significant variation ($P < 0.01$) was observed in days to flowering among tested varieties (Table 2). Mean value of flowering date varied from 79.56 (Local) to 68.89 (Dafo) with over all mean value of 72.62. Local barley varieties had the longest flowering date, while Dafo had shorter flowering date (Table 3). The result was considered with the finding of [9,11,13].

Days to 95% physiological maturity (DM)

Significant difference of variation was observed at ($P < 0.01$) in days to 95% physiological maturity (Table 2). The mean value of date of maturity ranged from 124.3 for Abdane to 115 for Dafo with over all mean value of 118.79. Abdane had significantly longer mean value of date of maturity (Table 3). The result supported by [12] who reported significant variation of variety for flowering and maturity date.

Genotypes	DF	DM	PH (cm)	SL (cm)	TN	SPS	BM (ton/ha)	TKW	GY (ton/ha)
2017 cropping season									
Local check	78.67a	120.00a	72.07c	10.07ab	2.00c	32.20c	8.03cde	38.81b	2.11e
Adane	76.67a	110.00b	88.47b	9.47abc	2.00c	43.93a	13.11a	40.90ab	3.29d
Biftu	71.67b	102.33c	102.73a	9.13bc	2.53c	42.87a	7.24de	42.30ab	4.03bc
Harbu	69.67b	101.33cd	103.87a	9.00c	3.33b	41.20ab	5.41e	41.46ab	3.55cd
Dinsho	69.00bc	98.00de	99.27a	10.20a	3.33b	34.00bc	11.84ab	42.43a	4.37ab
Dafo	66.00cd	96.67e	101.27a	10.00abc	4.40a	36.87abc	10.29abc	41.06ab	3.74cd
Guta	64.00d	97.67de	103.73a	10.17ab	3.40b	43.67a	9.66bcd	41.83ab	4.96a
Mean	70.81	103.71	95.91	9.72	3	39.25	9.37	41.26	3.72
CV	2.504	2.031	5.678	5.991	13.413	12.56	17.237	4.801	9.4
LSD	3.154	3.747	9.689	1.034	0.716	8.77	2.873	3.524	0.62
2018 cropping season									
Local check	82.00a	114.67c	78.07ab	10.43a	2.00b	33.67a	7.71a	38.47a	3.29bc
Adane	69.00b	122.67a	76.87b	10.00ab	2.33ab	33.78a	4.65bc	33.30b	2.99bc
Biftu	68.00bc	118.67abc	78.93ab	9.07b	2.67ab	40.67a	3.98c	29.96b	3.56b
Harbu	68.67b	120.67ab	87.80ab	9.67ab	2.67ab	32.00a	6.96ab	33.13b	3.48b
Dinsho	66.33cd	118.33abc	91.93a	10.20ab	3.00a	35.56a	7.95a	33.43ab	4.28a
Dafo	64.33e	117.33bc	88.07ab	9.87ab	2.67ab	42.89a	5.64bc	33.87ab	3.44b
Guta	65.67de	115.67c	86.20ab	9.93ab	2.67ab	44.33a	7.63a	33.50ab	4.00a
Mean	69.14	118.29	83.98	9.88	2.57	37.56	6.36	33.67	3.57
CV	1.599	2.117	9.357	6.717	19.598	21.992	26.259	8.419	6.77
LSD	1.967	4.455	13.98	1.181	0.897	14.693	2.971	5.042	4.31
2019 cropping season									
Local check	78.00abc	134.00a	82.73c	9.33b	4.33a	52.00a	6.36b	43.40a	2.64d
Adane	80.67a	140.33a	103.27ab	11.60a	4.33a	53.00a	9.96ab	41.40a	4.44c
Biftu	77.00bc	134.33a	107.87ab	11.93a	4.67a	51.00a	10.44ab	43.07a	4.91ab
Harbu	77.67abc	135.67a	109.93a	12.40a	4.67a	49.67a	9.65ab	42.50a	4.57bc
Dinsho	75.33c	131.67a	105.87ab	12.00a	4.00a	55.00a	9.36ab	43.63a	4.88abc
Dafo	76.33c	131.00a	100.87b	12.07a	4.00a	51.33a	9.72ab	42.17a	4.75abc
Guta	80.33ab	133.67a	102.47ab	12.37a	4.67a	57.33a	11.54a	42.50a	5.08a
Mean	77.91	134.38	101.86	11.67	4.38	52.76	9.58	42.67	4.47
CV	2.469	4.819	4.789	4.582	11.322	12.135	25.778	7.085	5.72
LSD	3.4212	11.52	8.677	0.951	0.882	11.39	4.392	5.378	4.54

Table 1: Mean performance of yield and yield related traits of Food barley Varieties during 2017, 2018 and 2019 main cropping season at Bule hora Woreda of western Guji Zone.

Key: DF=degree of freedom, FD=flowering data , MD= maturity date, PH=plant height, SL= spike length, TN=number of productive tillers, SPS=number of spikelet per spike, BM= biomass yield, TSW=thousand kernel weight, GY=grain yield

Source Variance	DF	FD	MD	PH (cm)	SL (cm)	TN	SPS	BM (ton/ha)	TKW	GY (ton/ha)
Replication	4	45.32ns	9.86ns	50.92ns	0.23ns	0.13ns	23.82ns	1.37ns	3.39ns	5.60ns
Year	2	454.62***	4941.40***	1740.48***	24.65***	18.78***	1458.60***	68.06***	492.07***	48.06***
Genotypes	6	124.74***	119.61***	572.75***	1.09*	1.13***	80.63ns	11.23*	3.80ns	3.97*
Year*genotype	12	38.71***	73.60***	96.60*	1.83***	0.86***	42.40ns	12.79**	10.56ns	5.51***
Residue	36	2.69	17.55	38.40	0.36	0.22	44.50	3.83	7.03	8.23
CV		2.2576	3.52	6.59	5.71	14.15	15.44	23.20	6.76	7.31

Table 2: Mean Square of Food Barley at Bule Hora, southern Oromia.

Key: DF=degree of freedom, FD=flowering data, MD= maturity date, PH=plant height, SL= spike length, TN=number of productive tillers, SPS=number of spikelet per spike, BM= biomass yield, TSW=thousand kernel weight, GY=grain yield, ns=non-significant

Genotypes	DF	DM	PH (cm)	SL (cm)	TN	SPS	BM (ton/ha)	TKW	GY (ton/ha)	Yield advantage %
Local check	79.56a	122.89ab	77.62c	9.94c	2.78c	39.29b	7.37b	40.23a	2.68e	0.00
Abdane	75.44b	124.33a	89.53b	10.36abc	2.89bc	43.57ab	9.24ab	38.53a	3.57d	24.93
Biftu	72.22c	118.44c	96.51a	10.04bc	3.29ab	44.84ab	7.22b	38.44a	4.17b	35.73
Harbu	72.00c	119.22bc	100.53a	10.36abc	3.56a	40.96b	7.34b	39.03a	3.87c	30.75
Dinsho	70.22d	116.00c	99.02a	10.80a	3.44a	41.52ab	9.72a	39.83a	4.51a	40.58
Guta	70.00d	115.67c	97.47a	10.82a	3.69a	48.44a	9.61a	39.28a	4.68a	42.74
Dafo	68.89d	115.00c	96.73a	10.64ab	3.58a	43.70ab	8.55ab	39.03a	3.98bc	32.66

Table 3: Combined ANOVA of food barley mean performance across all seasons Bule Hora, Southern Oromia.

Key: DF=degree of freedom, FD=flowering data , MD= maturity date, PH=plant height, SL= spike length, TN=number of productive tillers, SPS=number of spikelet per spike, BM= biomass yield, TSW=thousand kernel weight, GY=grain yield

Plant Height (PH)

The study also found significantly shorter for Local followed by Abdane and longer for Harbu, Dinsho, Guta, Dafo and Biftu for mean value of Plant Height (Table 2). The highest plant height was recorded for Harbu variety (100.53 cm) while the lowest plant height was recorded for local variety (77.62 cm) (Table 3). [10] found similar significant difference among different food barely genotypes in their study.

Spike Length (SL)

The analysis of variance showed that there was significant (P< 0.05) difference among the tested varieties in spike length (Table 2). The tallest spike length was recorded for Guta (10.82 cm), while Local check (9.94 cm) was the shortest (Table 3).

Productive Tiller Number (TN)

The analysis of variance showed that there was significant (P< 0.01) difference among the tested varieties in spike length (Table 2). The highest tiller number was recorded for Guta while the lowest was recorded for local check Table 3).

Above ground biomass (BM)

Statistically significant variation (P< 0.05) was observed in total biomass among tested varieties (Table 2). The highest biomass was obtained from Dinsho (9.72 tone/ha) while the lowest biomass was obtained from Biftu variety (7.22 tone/ha) (Table 3). Significant difference among genotypes in above ground bilmass was reported by on malty barely on their study of Malt Barley (*Hordeum vulgare* L.) Varieties evaluation for yield and quality traits in Eastern Amhara Regional State, Ethiopia.

Grain Yield (GY)

Statistically significant variation (P< 0.05) was observed in total biomass among tested varieties (Table 2). The mean value of grain yield varied from 2.68 tone/ha (Local check) to 4.68 tone/ha (Guta) (Table 3). The yield advantage 42.74%, and 40.58% was estimated for Guta and Dinsho, respectively over the local check. Different authors reported significant different among food barely genotypes [10,13-15].

Conclusion and Recommendations

The experiment was conducted for three consultive years (2017-2019) at location of Bule hora districts to select food barley varieties that have a good performance in terms of yield and other different parameters. From the Overall years result, Guta variety was found superior over all other varieties tested grain yield and other important parameters. Therefore, Guta variety was recommended for production at Bule Hora and other similar agro ecologies of southern Oromia.

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