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Evaluation of Improved Food Barley Varieties in the New Potential Areas of East Gojam Zone, Ethiopia

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Abstract

Barley is the main livelihood of farmers in East Gojam Zone particularly in Choke watershed. Choke watershed is home to more than 150,000 people living in six districts of east Gojam Zone. Smallholders in the area farm at the step sides of the mountain, and they practice the farming in a most traditional mechanism through oxen and horse plough. The farmers have no access for the improved varieties and they use their land races. The experiment was conducted at Aneded(research station)and Sinan (Wolekie kebele) districts during 2019-2021 main cropping season with objective of selecting the best adapting and performing varieties. Twelve varieties were laid out in a Randomized Complete Block Design with three replications. Plant height, spike length, above ground biomass and yield data have been collected and analyzed using Statistical Analysis Software (SAS, 9.4). Levene's test of homogeneity showed that p-value was significant ($p<0.00001$). As homogeneity test of variances result was significant the two experimental sites had no equal variances. Thus the results of the individual sites have been discussed separately. At research station, the grain yield of HB1966 was superior to the other varieties. The yield recorded for this variety was 4322.1 kg/ha followed by HB 42 (3570 kg/ha) and HB 1307(3522.1 kg/ha). At Wolekie IAR/H/485(3862.9 kg/ha) was superior followed by HB 1307(3350 kg/ha) and HB1966 (3306.6kg/ha). Thus the farmers, seed cooperatives and seed enterprises can use the varieties in respect to their tested locations or locations having similar or the same agro ecological environments.

Keywords: Barley; Variety; Adaptability; Performance; Yield

Introduction

Barley (Hordeum vulgare spp. vulgare L.) is one of the oldest crops cultivated in the world. Archaeological evidence from the Fertile Crescent indicates that about 10,000 years ago, the

crop was domesticated from its wild relative (Hordeum spontaneum C. Koch). The crop is an important feed, malt, and food crop in Russia, Canada, Australia, Ukraine, Turkey, Spain, Morocco, Germany, Kazakhstan, Iran, Syria, USA, France, Poland, Ethiopia, and UK [1].

Ethiopia is the second largest barley producer in Africa [2]. In Ethiopia by the year 2019/20 and 2020/21; 2,378,005 and 2,339,109.9 metric ton was harvested from the area of 950,738.95ha and 926,106.90 ha ; respectively [3]. The productivity of barley in 2019/20 and 2020/21 was 2.5 ton/ha and 2.53 ton/ha; respectively.

Barley cultivation is an old heritage in Ethiopia with a large number of farmers'varieties and traditional practices.

Approximately, 85% of land allocated for barley in Ethiopia is used for food barley production. On the other hand, nearly 150,000 hectares of land (15% of total barley land) is used for malt barley production, which is the major input for beer production [4].

Although there is a considerable potential for increased production of food barley, the production of food barley in Ethiopia has not expanded enough to benefit most barley growers. The major challenges are; limited number of food barley varieties and associated production technologies to farmers, biotic factors (mainly weeds, insect pests and foliar diseases), abiotic factors (low soil fertility, low soil pH, poor soil drainage, drought and poor agronomic practices), weak technology transfer, are identified as the main constraints responsible for low productivity and limited expansion of food barley [4].

The crop is produced in all regions of Ethiopia, however more than 85% of total production comes from Shewa, Gojam, Arsi, Gonder, Wollo and Bale [5].

Although East Gojam zone is one of the potential areas for food barley production, the productivity is low. The main reasons are; the farmers are not aware of the new varieties developed by the research institutes and thereby use their own land races.

In general, the barley production constraints in east Gojam zone are; lack of improved varieties, poor crop management, heavy disease and pest load, Absent or lack of inorganic fertilizer use, lack of integrated crop and pest management technologies, and absent of seed system sources (seed producer cooperatives and private seed producers).

The experiment was conducted with the objective of selecting the best adapting and performing varieties in the study area.

Materials and Methods

Description of test locations

The experiment was conducted in East Gojam Zone during the main cropping season from 2019 to 2020 at the research station in Aneded district, and from 2020 to 2021 at Wolekie kebele in Sinan district. The trial was conducted on experimental field stations in Aneded district and on farmers' field in Sinan district. In all locations the dominant soil type is brown soils, Nitisol and Alisol with slightly acidic. The elevation ranges 2460-2600m.a.s.l. The annual temperature varies between 11-27°C and the growing period between 120–180 days.

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Experimental treatments, design, and management

12 nationally and regionally recently released food barley varieties namely; Dimtu, Shege, HB 42, HB 1307, Cross 41/98, EH 1493, HB 1965, HB 1966, Miseratch, AHOR880/61, ARDU 12-60B and IAR/H/485; were laid out in a Randomized Complete Block Design (RCBD) with three replications in each location. The harvested plot size was 2.5m*1.2m, having six rows and 20cm row spacing. The distances between plot to plot and block to block were 1m and 1.5m, respectively. The varieties were planted at both locations in the third week to fourth week of June.

The seeds of the varieties were collected from Holeta Agricultural Research Center of Ethiopian Institute of Agricultural Research. The seed and fertilizer rate recommendations were adopted from the National Barley Research Program. The seed rate was adjusted for plots by using 85kg ha^{-1}. While the fertilizer application rates that were applied 182 kg ha^{-1} and 50 kg ha^{-1} for NPS and Urea; respectively. NPS was applied fully at planting but Urea was applied in spilt, half at planting and half at the vegetative growth stage before heading. Hand weeding was applied five times at every growth stage of the varieties depending on the weed density and severity. After full management of the trial, six rows were harvested, from the second week of October to the end of October in both testing years and locations. The harvested trials then dried, threshed, and cleaned.

Data collection

Plant height, spike length, above ground biomass, yield, and disease attributes such as scald, net blotch and spot blotch have been recorded.

Data analysis

The recorded agronomic data was subjected to the Analysis of Variance (ANOVA) using Statistical Analysis Software (SAS, 9.4) and the mean separation was computed using Least Significant Difference (LSD) test at 5% probability level.

Result and Discussion

Mean comparison for quantitative traits for individual locations. The requirement of homogeneity is met when the result is not significant. Levene's test of homogeneity showed that p-value was significant ($p<0.00001$). As homogeneity test of variances result is significant the two experimental sites had no equal variances. Thus the results of the individual sites have been discussed below.

Research on-station

The mean analysis for plant height ranged 91.43-120.9cm **(Table 1)**. Dimtu had the highest plant height followed by shege (114.17cm), and HB42 (112.23cm), respectively **(Table 1)**. The grand mean of height for the varieties was 106.99cm. The variation in height between Dimtu and the grand mean was 13.91cm.The longest spike length was recorded from HB1965 (7.71cm) followed by shege (7.69cm) and Cross 41/98(7.44cm); respectively. The grand mean for spike length of the varieties was 6.53cm. The difference between the highest spike length value and the grand mean was 1.18cm. The highest above ground biomass was obtained HB 42(10083.3kg/ha) followed by HB 1966(9916.7kg/ha) and EH 1493(9750kg/ha), respectively. In terms of yield HB1966 was superior to the other varieties. The yield recorded for this variety was 4322.1 kg/ha. The second and the third highest yield was obtained from HB 42 (3570 kg/ha) and HB 1307(3522.1 kg/ha). This variety has a yield advantage of 1137.27 kg/ha compared to the grand mean (3184.83 kg/ha). The yield obtained from Misratch(2163.1 kg/ha) was inferior to other varieties. The yield difference between the superior and the inferior variety was 2159 kg/ha. Except Misratch; all the varieties performed better than the national average yield (2500kg/ha). The yield advantage gained from HB1966, HB 42 and HB1307 over the national average yield was 72.8%, 42.8% and 40.8%, respectively.

Wolekie site

As shown in table 1, the mean for plant height was ranged 75.3-113.83cm. The grand mean of height was 94.63cm.The highest score was recorded for the IAR/H/485(113.83cm) followed by shege (106.43cm) and ARDU12-60B(103.73cm). Miseratch(75.3cm) was inferior to other varieties. The maximum and the minimum spike length was 7.17cm and 4.89cm respectively. The longest spike length was recorded for IAR/H/485(7.17cm) followed by Cross 41/98(7.02cm) and Shege(7.01cm). The grand mean of spike length was 6.19cm. The above ground biomass yield was ranged 3166.7-9638.96 kg/ha.

Table1: Mean and ANOVA for yield and yield related traits of food barley varieties tested at Debremarkos Research Station and Wolekie.

S/No	Genotypes	Debremarkos (2019/20 and 2020/21)				Wolekie (2020/21 and 2021/22)			
		PLH(cm)	SL(cm)	AGB(kg/ha)	YLD(kg/ha	PLH(cm)	SL(cm)	AGB(kg/ha)	YLD(kg/ha)
1	Dimtu	120.9a	7.18ba	9416.7ba	2964cb	92.1dfe	6.056bc	5361.1dc	1776.7dc
2	Shege	114.17b	7.69a	9500ba	3169.4cb	106.43ba	7.01ba	8027.8ba	2543.8bc
3	HB 42	112.23cb	6.26dc	10083.3a	3570.8b	85.37fe	5.74dc	5305.6dc	1970.3dc
4	HB 1307	106.63ced	6.08dc	8416.7bc	3522.1b	94.77dce	5.54dc	8666.7a	3350ba
5	Cross 41/98	103.87ed	7.44a	9083.3ba	3175cb	95.97dc	7.02ba	7944.4ba	2925.4ba
6	EH 1493	105.57ed	7.42a	9750ba	3397.7b	94.37dce	6.5bac	5972.2dc	2511.1bc
7	HB 1965	96.5fg	7.71a	7416.7c	3232.5cb	83.03gf	6.52bac	4222.2de	1859.9dc
8	HB 1966	108.67cbd	6.32dc	9916.7a	4322.1a	93.83dce	6.26bac	8055.6ba	3306.6ba
9	Miseratch	91.43g	5.77d	6000d	2163.1d	75.3g	5.07d	3166.7e	1246d
10	AHOR880/61	102fe	3.87e	9000ba	3090.6cb	96.87dc	4.89d	6611.1bc	2947.5ba
11	ARDU12-60B	110.03cbd	6.62bc	8750bac	2640cd	103.73bc	6.5bac	9083.3a	3159.9ba
12	IAR/H/485	111.93cb	6.0d	9166.7ba	2970.6cb	113.83a	7.17a	9638.9 6a	3862.9a
Mean		106.99	6.53	8875	3184.83	94.63	6.19	6837.96	2621.67
CV		5.05	7.66	13.45	17.9	8.109	12.503	20.533	28.66
LSD		6.28	0.58	1386.8	662.43	8.92	0.899	1632	873
Significance level at P-value 5%									
Genotype		***	***	***	***	***	***	***	***
Genotype *year		***	***	***	***	ns	**	*	ns

The maximum above ground biomass yield was obtained from IAR/H/485(9638.96kg/ha) followed by ARDU12-60B (9083.3kg/ha) and HB 1307(8666.7 kg/ha). The grand mean of above ground biomass was 6837.96 kg/ha. The difference between highest scoring variety and the grand mean of above ground biomass 2801 kg/ha. The yield was ranged 1246-3862.9 kg/ha. IAR/H/485(3862.9 kg/ha) was superior followed by HB 1307(3350 kg/ha) and HB1966(3306.6kg/ha). Miseratch(1246 kg/ha) was inferior to others. The difference between the highest and the lowest yield was 2616.9 kg/ha. The grand mean of yield was 2621.67 kg/ha. The yield difference between the highest yield and the grand mean was 1241.23 kg/ha.

Conclusion and Recommendation

In general, the varieties tested in each location have shown significance difference. At on station, in terms of grain yield, HB1966, HB 42 and HB1307 were the best performed varieties while At Wolekie, IAR/H/485, HB 1307 and HB1966 best performed.

Thus the farmers, seed cooperatives, seed enterprises can use the varieties in respect to their tested locations or locations having similar or the same agro ecological environments.

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