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Evaluation of late maturing food barley varieties in Gamo highlands of southern Ethiopia

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ABSTRACT: The field experiment was conducted on thirteen improved food barley varieties and one local check at Chencha district of Gamo highland during 2015 main cropping season. The main objective of the study was to identify, select and recommend well adaptable and high yielding variety for targeted area. The experiment was laid in Randomized Complete Block Design (RCBD) with three replications in the net plot size of 1.2 m x 2.5 m. Days to 50% heading (DH), days to 50% maturity (DM), plant height (PH), panicle length (PL), tiller number (TN) and grain yield (GY) were collected as agronomic traits. Significant variations were recorded among the tested varieties for the measured traits over the locations except for tiller number. The highest average grain yield (2427.8 kg/ha, 2077.8 kg/ha and 1972.2kg/ha) were obtained from varieties HB1307, Shege and EH1493 without significant differences between them respectively and the lowest grain yield was obtained from local check (1166.7kg). Based on the results obtained under these study HB1307, Shege and EH1493 could be used for demonstration, popularization and pre-scaling up in Chencha district and in the farming communities of similar agro-ecologies.

Keywords: Adaptability, grain yield, varieties.

INTRODUCTION

Barley (*Hordeum vulgare L.*) is the fifth most important cereal crop after teff, wheat, maize and sorghum. It is the staple food especially for highland of Ethiopia who produces the crop with indigenous technologies and it performs well in the northern and central highlands of the country. The productivity of barley in the country has been stagnant for a long time due to high soil degradation and low farm input supplies such as fertilizer and improved variety (Asfaw, 2000). It is largely produced on sloppy and eroded areas where poor soil fertility, frost, water logging, low pH and rain fall variability are predominant problems (Berhane et al., 1993). It is produced both in the main rainy season (meher) and short rainy season (belg). In SNNPRS, barley occupies an area of 76,763.65 ha with total production of 1,323,560.26 quintal and its productivity was 17.24 q/ha (CSA, 2015). Majority of the farmers grows local varieties/landraces that are low yielders and its productivity is below 1800 kg/ha.

As a result of existence of genetic variability for various economic traits in the country and favorable access to international germplasm exchange, barley breeders have so far developed many barley varieties. Some varieties of barley were released by the different national and regional research centers in Ethiopia; however, most of them were not evaluated around areas of southern Ethiopia of Gamo Zone in the case of Chencha distirct. Therefore, among the released food barley varieties HB1307, Shege, HB42, Ardu1260B, Dimtu, Cross41/98, EH1493, Yedogit, Estayish, Tiret, Shedeho, harbu agegnehu, Abdane and local checks are the dominant ones (Abtew et al., 2015). Hence, the objectives of this study were to evaluate and select improved barley varieties which are adaptable and high yielding in Gamo highlands of southern Ethiopia to identify the most superior varieties in food barley to

recommend for further production.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Chencha district (Doko tsida and Gindo gimbela) during 2015 main cropping season. Chencha district is found in Southern Nation National Regional State, south part of Ethiopia. The district is located about 553 km from Addis Ababa and 320 km from Hawasa the capital of Southern Nation National Regional State. Doko tsida and Gindo gimbela is found within 2358 and 2117 m above sea level respectively. The rainfall regime of Chencha district is bimodal. The first round of rain occurs between March to April. The second round of rain occurs from June to August. The annual rainfall distribution in the district varies between 27 to 1412 mm. The minimum temperature in the district varies between 12 to 14°C, while the maximum temperature is in the range 20 to 24°C.

Experimental treatments and design

Thirteen recently released food barley varieties were brought from Kulumsa Agricultural Research Center and one local check of the respective sub-testing locations were evaluated as experimental materials. These varieties include Agegnehu, Harbu, Yedogit, Ardu1260B, Dimtu, Shedho, Cross41/98, Abdane, Estayish, HB-1307, Shege, EH-1493, HB42 and Local check (Table 1). These varieties were randomly assigned to the experimental block and the experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications.

The spacing between blocks and plots was 1.5 m and 1 m, respectively. The gross size of each plot was 3 m^2 (1.2 m x 2.5 m) having six rows with a row-to-row spacing of 20 cm. Planting was done by drilling seeds in rows with a seed rate of 100 kg ha^{-1} (30 g per plot). NPS fertilizer was applied at the rate of 100 kg ha^{-1} (30 g per plot) at the time of planting; and urea was also applied at vegetative stage before booting at the rate of 50 kg ha^{-1} (15 g per plot).

Data collected and analyses

Plant based data were collected from number of effective tiller per plant (ETP), plant height (PH), panicle length (PNL) and number of grain per spike (GPS).

Plot based data were considered for phenological traits including days to 50% heading (DH), days to 90% physiological maturity (DM) and for yield component of grain yield (GY).

Plant based data were recorded from five randomly selected and tagged plants from harvestable rows. 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).

RESULTS AND DISCUSSION

Doko tsida location (location-1)

The analysis of variance revealed that significant difference ($p \leq 0.05$) among treatment means for days to heading, panicle length, days to maturity and grain yield (Table 2). Similar results on the previous studies in the genetic variability in barley genotypes indicated that a significant difference exist for many of the traits like days to heading, days to maturity, panicle length and grain yield (Derbew et al., 2013). Mean of days to heading ranged from 68.0 to 80.6 days local to Cross41/98 respectively. Local check and EH1493 start heading and matured earlier than the other tested varieties. Longest maturity days were recorded from variety HB42 (126 days) and the shortest maturity days were recorded from variety EH1493 (111.6 days). The panicle length ranged from 6.5 to 15.6 cm Cross41/98 to HB1307 respectively. The highest tiller number recorded from variety Estayish (4.2) and the lowest number recorded from local (2.6) among tested varieties. In addition to this, the highest grain yield was recorded from HB1307 (2800.0 kg) and the lowest recorded from local variety (1500 kg) among tested varieties (Table 2). The highest mean grain yield was recorded from variety HB-1307 (2800.0 kg/ha), Shege (2488.9 kg/ha), Dimtu (2166.7 kg/ha) and the lowest mean grain yield was recorded from variety Agegnehu (1300 kg/ha). From the results, early matured varieties yield performance were low as compared to late matured varieties. In general, at Doko tsida, variety HB-1307, Shege and Dimtu have better yield performance among tested varieties. This study was in line with the previous work (Mekonnon, 2014). In the same way highest grain yield were obtained from HB-1307 at both locations giving 2800 and 2055.6 $kgha^{-1}$ at Doko tsida and Gindo gimbela in Ethiopia respectively.

Gindo gimbela location (location-2)

The analysis of variance showed that significant difference ($p<0.05$) among treatments for days to heading, days to maturity, plant height, panicle length tiller number and grain yield (Table 3). The longest and shortest heading days were recorded from variety HB42 (81.3) and Tiret (70), respectively and in similar way the longest and shortest maturity days were recorded from both HB42 (128) and Tiret (105.3) respectively. Among the varieties the longest plant height were recorded from HB1307 (127.6 cm) whereas the shortest plant height were recorded from local variety (68.3 cm). The highest panicle

Table 1. Description of research materials.

Year	Year of release	Maintainer	Altitude range (m.a.s.l)	Rain fall (mm)
Abdane	2011	Sinana Agricultural Research Center/OARI	2006-3000	-
HB-1307	2006	Holata Agricultural Research Center/EIAR	2000-3000	700-1000
Harbu	2004	Sinana Agricultural Research Center/OARI	2000-3000	-
Agegnehu	2007	Sinana Agricultural Research Center/OARI	2600-3000	900-1200
Shedho	2003	Sinana Agricultural Research Center/OARI	2200-2900	-
Shege	1995	Holata Agricultural Research Center/EIAR	2600-3000	-
Cross41/98	2012	Holata Agricultural Research Center/EIAR	2000-2600	700-1000
Estayish	2004	Sinana Agricultural Research Center/OARI	2600-3000	900-1200
Yedogit	2005	Sinana Agricultural Research Center/OARI	2000-3000	-
Ardu1260B	-	Holata Agricultural Research Center/EIAR	2200-2900	-
Dimtu	2001	Holata Agricultural Research Center/EIAR	-	-
EH1493	2012	Holata Agricultural Research Center/EIAR	2300-2800	700-1000
HB42	1984	Holata Agricultural Research Center/EIAR	2100-3000	-
Local cultivar	-	Available with Farmers	-	-

Source: Crop variety register book 2012-2016.

Table 2. Mean value of phonologic, yield and yield related components of late maturing varieties at Dokotsida.

Treatments	DH	DM	PH	PL	TN	GY
Abdane	73.0^{ba}	114.6^{ba}	104.4	8.7^{cb}	2.8^{ba}	1566.7^{ecd}
Agegnehu	73.6^{ba}	114.6^{ba}	92.8	7.8^{cb}	2.9^{ba}	1300.0^{e}
Shedeho	75.3^{ba}	120.0^{ba}	97.2	9.4^{cb}	3.0^{ba}	2055.6^{bcd}
Shege	76.0^{ba}	119.6^{ba}	101.6	8.3^{cb}	3.4^{ba}	2488.9^{ba}
Cross41/98	80.6^{a}	119.6^{ba}	102.4	6.5^{c}	3.2^{ba}	1500.0^{ed}
Tiret	71.6^{ba}	118.3^{ba}	99.9	9.3^{cb}	3.0^{ba}	1722.2^{ecd}
Harbu	74.0^{ba}	119.3^{ba}	100.6	10.2^{b}	3.6^{ba}	1500.0^{ed}
Estayish	75.3^{ba}	122.3^{ba}	99.8	8.8^{cb}	4.2^{a}	1833.3^{ecd}
Yedogit	77.6^{ba}	121.6^{ba}	93.6	8.9^{cb}	3.0^{ba}	1833.3^{ecd}
HB1307	79.3^{ba}	121.6^{ba}	106.1	15.6^{a}	3.7^{ba}	2800.0^{a}
Ardu1260B	76.0^{ba}	121.6^{ba}	105.5	8.9^{cb}	3.4^{ba}	1455.6^{ed}
Dimtu	74.6^{ba}	116.0^{ba}	100.8	9.2^{cb}	3.3^{ba}	2166.7^{bc}
EH1493	70.3^{ba}	111.6^{b}	100.4	9.0^{cb}	3.0^{ba}	1888.9^{becd}
HB42	77.3^{ba}	126.0^{a}	97.7	9.5^{cb}	2.8^{ba}	1722.2^{ecd}
local check	68.0^{b}	113.3^{b}	88.0	7.2^{cb}	2.6^{b}	1500.0^{ed}
LSD (0.05)	11.46	12.45	25.79	3.47	1.52	620.44
CV (%)	9.15	6.27	15.51	22.60	28.27	20.35

Means with the same letters within the columns are not significantly different at $p<0.05$.

length was recorded from variety HB1307 (15.6 cm) and shortest panicle length were recorded from local variety (5.6 cm). On the other hand, variety HB1307 exhibited maximum grain yield (2055.6 kg/ha) and the minimum grain yield was recorded from variety local (833.3 kg/ha). Even though the analysis of variance indicated that non-significant difference among varieties, but varieties Estayish, Yedogit and Ardu1260B were high yielder (1833.3, 1833.3 and 1861.1 kg/ha), respectively compared to other evaluated varieties. The yield advantage of HB1307 was 60% over the local check. This might be genetically variation between the varieties as stated by Abtew et al. (2015).

For this study, combined analysis of variance was done for the locations to evaluate the varieties for the studied parameters. Accordingly, combined data analysis revealed that there were significant ($p<0.05$) difference among varieties for days to heading, days to maturity, plant height, spike length and grain yield except tiller number (Table 4). These results are further supported by Mamo (2017) who

Table 3. Mean value of phonologic, yield and yield related components of late maturing varieties at Gindo gimbela.

Treatments	DH	DM	PH	PL	TN	GY
Abdane	77.0^{ba}	115.6^{ba}	127.07^{a}	8.4^{cb}	3.3^{cb}	1611.1^{ba}
Agegnehu	75.0^{ba}	108.6 ^{b}	97.7^{bc}	9.4^{b}	2.6^{cde}	1166.7^{ba}
Shedeho	75.3^{ba}	111.6 ^{b}	92.6^{bcd}	9.4^{b}	2.6^{cde}	1444.4^{ba}
Shege	74.6^{ba}	105.3 ^{b}	95.5^{bc}	9.1^{b}	2.3^{fde}	1666.7^{ba}
Cross41/98	77.3^{ba}	110.6 ^{b}	88.2^{cd}	9.3^{b}	3.0^{cd}	1888.9^{a}
Tiret	70.0^{b}	105.3^{b}	85.8^{cd}	10.2^{b}	2.9^{cde}	1666.7^{ba}
Harbu	74.0^{ba}	118.3^{ba}	94.4^{bc}	8.8^{b}	2.3^{fe}	1722.2^{ba}
Estayish	73.6^{ba}	110.7^{b}	81.1^{cd}	8.9^{b}	4.6^{a}	1833.3^{a}
Yedogit	75.3^{ba}	111.0^{b}	92.5^{bcd}	9.1^{b}	2.8^{cde}	1833.3^{a}
HB1307	76.0^{ba}	109.0^{b}	127.6^{a}	15.6^{a}	3.7^{b}	2055.6^{a}
Ardu1260B	74.0^{ba}	112.0^{b}	115.9^{ba}	9.2^{b}	2.7^{cde}	1861.1^{a}
Dimtu	72.3^{ba}	106.6^{b}	101.0^{bc}	9.0^{b}	3.0^{cd}	1611.1^{ba}
EH1493	70.6^{b}	107.0^{b}	84.0^{cd}	9.5^{b}	2.5^{fde}	2055.6^{a}
HB42	81.3^{a}	128.0^{a}	95.4^{bc}	9.1^{b}	2.4^{fde}	1277.8^{ba}
local check	76.3^{ba}	127.3^{a}	68.3^{d}	5.6^{c}	1.9^{f}	833.3^{b}
LSD (0.05)	9.1	14.42	25.58	2.85	0.69	951.62
CV (%)	7.27	7.66	15.84	18.10	14.44	24.79

Table 4. Combined mean value of phonologic, yield and yield related components of late maturing varieties at Dokotsida and Gingo gimbela.

Treatments	DH	DM	PH	PL	TN	GY
Abdane	75.0^{bac}	114.2^{ba}	116.0^{ba}	8.6000	3.1^{bc}	1588.9^{bedc}
Agegnehu	74.3^{bac}	111.6^{b}	95.3^{dec}	8.9400	2.8^{c}	1233.3^{ed}
Shedeho	75.3^{bac}	115.8^{ba}	94.9^{dec}	9.4400	2.8^{c}	1750.0^{bd}c
Shege	75.3^{bac}	117.2^{ba}	98.6^{bdc}	9.2733	2.8^{bc}	2077.8^{ba}
Cross41/98	79.0^{a}	116.0^{ba}	95.3^{dec}	9.2233	3.1^{bc}	1694.4^{bedc}
Tiret	70.8^{bc}	111.8	92.9^{de}	9.8000	2.9^{bc}	1694.4^{bedc}
Harbu	74.0 ^{bac}	117.1^{ba}	97.5^{dc}	9.5667	2.9^{bc}	1611.1^{bedc}
Estayish	74.5^{bac}	116.0^{ba}	90.5^{de}	8.8867	4.4^{a}	1833.3^{bc}
Yedogit	76.5^{ba}	116.3^{ba}	93.0^{dec}	9.0133	2.9^{bc}	1833.3^{bc}
HB1307	77.6^{ba}	115.8^{ba}	116.6^{a}	9.5100	3.7^{ba}	2427.8^{a}
Ardu1260B	75.0^{bac}	116.5^{ba}	110.7 ^{bac}	9.5967	3.1^{bc}	1658.3^{bedc}
Dimtu	73.5^{bac}	110.8^{b}	100.9 ^{bdac}	9.1633	3.1^{bc}	1888.9^{bac}
EH1493	69.3^{c}	109.3^{b}	92.2^{de}	9.3000	2.7^{c}	1972.2^{bac}
HB42	79.3^{a}	122.0^{a}	96.5^{dc}	9.3667	2.6^{c}	1500.0^{edc}
local check	73.3^{bac}	111.0^{b}	78.1^{e}	8.7833	2.3^{c}	1166.7^{e}
LSD (0.05)	7.0	9.65	17.79	1.64	0.86	570.92
Location 1	74.8^{a}	118.7^{a}	99.41^{a}	9.42^{a}	3.22^{a}	1822.2^{a}
Location 2	74.8^{a}	110.8^{b}	96.50^{a}	9.03^{a}	2.87^{b}	1635.2^{a}
LSD (0.05)	2.5	3.5	6.49	0.60	0.31	208
CV (%)	8.12	7.27	15.71	15.42	24.60	28.57

reported considerable variation in the days to maturity, plant height and panicle length, days to heading and grain yield of different food barley varieties when planted over location.

The results indicated that, there is genetic variability and varieties used in this study have different genetic potentials. Location also contributed significant effect on yield components for days to heading, days to maturity, plant height, panicle length, grain yield. The interaction of location by varieties indicated that significant effect on

days to maturity and number of tillers. The rest yield components not affected by the interaction of genotype by environment. Grain yield not affected by the interaction of environment and genotype means varieties was stable across locations. The average heading days ranged from 69.3 to 79 days and minimum and maximum days was recorded on varieties EH1493 (69.3 days) and Cross41/98 (79days). The average maturity days ranged from 109.3 to 122 days. Shortest maturity days were recorded on EH-1493 (109.3 days) and longest maturity days were recorded on HB42 (122 days) respectively. This result was in lines with the study of Tilahun et al. (2009).

Average plant height ranged from 78.1 to 116.6 cm. The lowest and highest average plant height was recorded on variety local (78.1 cm) and HB-1307 (116.6 cm). The lowest and highest tiller number were recorded on variety local (2.3) and Estayish (4.4), respectively. Finally, the tested varieties exhibited mean grain yield from 1166.7 to 2427.8 kg/ha. Lowest and highest mean grain yield was recorded on local check (1166.7 kg/ha) and HB-1307 (2427.8 kg/ha), respectively. These results indicated that, late matured varieties performed well and exhibited high yield. Therefore, the highest yielder variety HB1307, followed by Shege (2077.8 kg/ha) recommended for pre-scale up and seed multiplication, this result is similar with the finding of Lakew et al. (1997).

Conclusion and Recommendations

The analysis of variance at both locations showed a highly significant ($p \leq 0.05$) variation for the tested varieties of yield and for most of the yield related traits of food barley varieties. HB-1307 and Shege were the varieties with relatively high mean grain yield across locations and they are highly performing varieties to the area. HB-1307 and Shege showed yield advantage of 51.9 and 43.84% respectively over the local check. Therefore, those high yielder varieties are recommended for production in the tested environments and similar agro-ecologies of Gamo highland of southern Ethiopia.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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