Journal of Innovative Agriculture: 9(2) : 1-4, 2022
DOI: 10.37446/jinagri/rsn/9.2.2022.1-4

Research Note

Adaptability study and yield performance of food barley (*Hordeum vulgare* L.)

Workineh Mekasa Buli

Researcher/Cereal Breeder, Ethiopian Institute of Agricultural Research (EIAR), Ambo Agricultural Research Center (AARC), Ethiopia.

Received: 17 December 2021
Accepted: 26 April 2022
Published: 30 June 2022

***Correspondence**
Workineh Mekasa Buli
wmekasa@gmail.com

A total of ten food barley varieties were evaluated to study their adaptability and yield performance and the combined analysis showed significant differences ($p<0.001$). Varieties HB-1966 and EH-1493 showed promising results and preferred among the tested varieties. The combined over locations' grain yield of the varieties ranged from 1589 to 2689 Kg ha^{-1}, while the range was from 1589 to 4713 Kg ha^{-1}. This shows that how big the effect of the environment is on the yield of the varieties. The highest grain yield was recorded for HB-1966 followed by EH-1493, where the lowest yield was recorded for Harbu variety. The principal component analysis of the varieties studied showed that the first two PCAs accounted for 85.17% of the total variability in grain yield. Genotypes 2, 5 and 7 are located near the concentric circle and are likely to be stable among the varieties studied.

Key words: *adaptability, food barley, yield, principal component analysis*

INTRODUCTION

Barley is a crop used for different purposes and better produced on degraded soil than other cereal crops. It is grown over wide environmental conditions. Barley has been produced as a major cereal crop for so long time period and it is the fourth important cereal crop of the globe after wheat, rice and maize (FAO, 2005). It is one of major cereal crops in Ethiopia with area coverage of 926,106.9 hectares with total production of 2,339,109.9 tones and ranks fifth in production following maize, wheat, Teff, and sorghum. The productivity of barley is 2.53 t ha^{-1} which has slightly increasing trend through years (CSA, 2016). Barley production makes Ethiopia among top ten producers of the world. The country is one of the center of diversity for the crop and it is estimated that there are about 16,000 barley accessions in the Ethiopian biodiversity institute. Ethiopian barley is given recognition for having typical botanical varieties. Besides, it has a group of inter-fertile lines distinguished by its spike patterns (Asfaw, 1988). Barley is a highly resilient crop, can be grown in various types of marginal environments, like in high altitude and latitude regions (Lister et al., 2018). Barley can be performed well in the low fertile and drought in the mountain slope while compare to other cereal crops (Ceccarelli et al., 1999). Barley can be adapted to altitudes from below 1000 to above 3000 masl. Nevertheless, the potential area for barley production is the altitude ranging from 2300 – 2800 masl. This altitudinal range is ideal area also for grain and other quality parameters of barley not only yield, since this area is accompanied by ample moisture with even distribution for efficient use of inputs and potential growth and productivity of the crop. The overall weather conditions determine the adaptability and yield performance of any crop. Climatic conditions represent major environmental variations like soil type, fertility and moisture status of grain development. It is possible to evaluate comparable or nearly similar grain samples of genotypes within similar growing conditions (Zecevic et al., 2004). The problem of crop breeding is the relationship between target environment and selection i.e whether the selection is for broad or specific adaptation

(Ceccarelli, 1989). Hence, adaptability study of barley varieties whether it is for wide or specific adaptation, was found imperative and released varieties of food barley varieties were studied at different locations in the highlands of West Shoa to study the adaptability and evaluate the grain yield and parameters contributing for yield in food barley varieties at different districts.

MATERIALS AND METHODS

Experimental design and materials

Ten food barley varieties including the local check (HB-1307, HB-1966, Harbu, Shege, HB- 42, Dimtu, HB-1965, Cross-41/98, EH-1493 and a local variety popular to the study areas, known as Balemi) were studied using RCBD in three replications at Mida-Kegn, Jibat, Cheliya and Dire-Inchini districts for their adaptability and yield performance. The trial was planted in six rows of 2.5m length each spaced with 0.2m inter row spacing. The seeds were drilled at a rate of 125 Kg ha^{-1} and fertilizer was applied at a rate of 100 Kg ha^{-1} DAP and 100 Kg ha^{-1} UREA each. Twice hand weeding was practiced and finally the four middle rows were harvested for yield data.

Data collection

Data were collected for yield and traits contributing for yield viz. grain filling period (GFP), plant height (PlH), stand percent, spike length (SL) and grain yield (YLD) on plant and plot basis. On plant basis, data were collected from five plants randomly selected from the four middle rows of each plot. The two side-rows were excluded as borders and the mean values of those five plants was computed and used as plot data for analysis, where the on plot basis data were collected from the four middle rows and finally harvested for the plot data. Spike length, plant height and number of kernels per spike were measured on plant basis; whereas days to 50% heading, days to physiological maturity, yield and stand count were recorded on plot basis.

Data analysis

The analysis was done using PROC GLM in SAS software version 9.4 (Gomez & Gomez, 1984). Mean was separated using t-test.

RESULTS AND DISCUSSION

The combined ANOVA showed the barley varieties showed highly significant differences statistically at ($p<0.001$) for all traits tested. The location by variety interaction was also significantly different, where it was non-significant for grain filling period (Table 1). The grain yield of the varieties for combined analysis over locations ranged from 1589 to 2689 Kg ha^{-1}, where the highest yield was recorded for HB-1966 followed by EH-1493. Nevertheless, the range of yield of varieties for individual locations is from 1589 to 4713 Kg ha^{-1}. This showed how big the effect of environment was on the yield performance of genotypes. It is important to take in to consideration the environmental condition like edaphic factors, the climate and others for the production and grain quality of barley crop (Buli & Ali, 2021). In this study, the stand percent of the varieties was observed strongly correlating with the grain yield (Table 2). Varieties with high stand percent were also seen to be high in grain yield. This result is in agreement with previous study of barley genotypes (Buli & Beyene, 2021). GGE biplot analysis is presented (Figure 1 & Figure 2) for grain yield using PCA1 and PCA2. The figure illustrates which genotype performs best where or which is best in which environment.

Table 1. Analysis of variance (Mean squares) for food barley characters

		Mean squares				
S.V	DF	PlH	GFP	Stand	SL	YLD
Loc	3	1948.21**	10.51^{NS}	4520.34**	3.19*	2877754.08**
Gen	9	543.95**	36.64**	479.89**	6.85**	202390.46**
Loc x gen	27	78.10**	47.73**	165.64**	1.31*	83210.53**
Error		7.18	3.46	38.60	0.45	8418.30
CV		3.18	2.79	7.46	10.42	14.33

Table 2. Growth, yield and yield related parameters mean values for food barley varieties

	Varieties' Mean Values				
	GFP	**PH**	**Stand**	**SL**	**YLD**
Harbu	57.3D	93.6E	67.5E	5.1F	386.2E
HB-1307	60.2AB	90.3F	82.1CD	6.2DE	702.2B
HB-1965	61.6A	88.2FG	85.8BCD	6.5 CD	643.6BC
Shege	57.8CD	87.4G	81.7CD	7.3AB	645.8BC
HB-42	59.0BC	108.8A	86.6ABC	5.7E	610.3C
Dimtu	55.5E	102.6B	83.6BCD	7.7A	476.7D
EH-1493	59.0BC	98.9CD	91.3A	6.4D	798.7A
Cross-41/98	58.8BC	99.8C	85.5BCD	7.0BC	693.7B
HB-1966	59.6B	94.4E	87.4AB	6.1DE	806.8A
Local check	57.0DE	97.0D	81.3D	6.0DE	637.8BC
Mean	58.6	96.1	83.3	6.4	640.2
LSD	1.5	2.2	5.1	0.6	74.9
CV	3.2	2.8	7.5	10.4	14.3

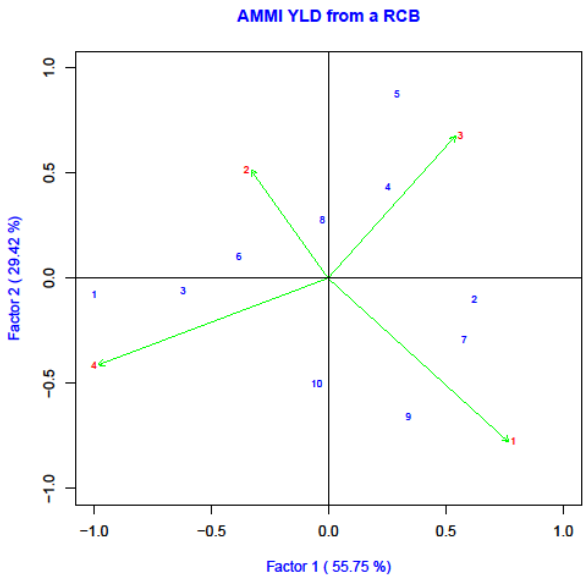

Figure 1. First and second PCA plot for ten food barley varieties

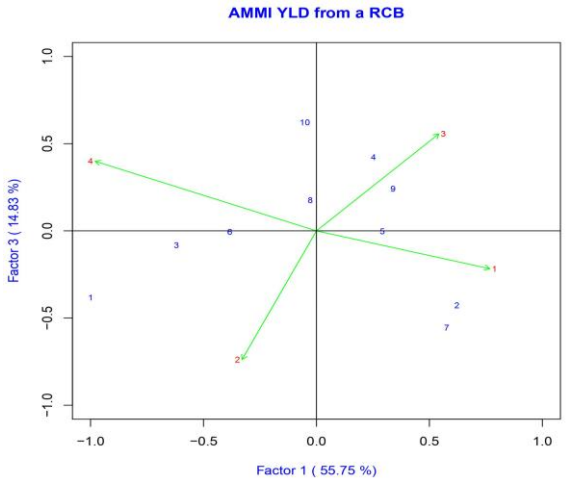

Figure 2. First and third PCA plot for ten food barley varieties

Accordingly, genotypes 2, 7, 9, 4 and 5 were with large positive scores, having the highest mean grain yield in the indicated order. The first two PCAs accounted for 85.17% (PCA1= 55.75% and PCA2=29.42%) of the total principal components. The first principal component on its own accounted above half of the variability in yield trait of the varieties studied. From the principal component analysis it was observed that genotypes 2, 5 and 7 were seen most likely to be stable. Varieties located near the concentric circle are more stable while those located far away from it are more responsive. Varieties that are located within the same quadrant interact positively while those that are located in the opposite quadrant have negative interaction (Laurentin & Montilla, 1999). Genotypes have different characters in growth habit, in stress tolerance or resistance and so have different reaction to varying seasons (Mahasi et al., 2006). Even the stable genotypes may react differently to varying seasons. In the current study, variety HB-1965 was the second highest yielder next to HB-1966 in 2019 where it has drastically fallen in 2020.

CONCLUSION

The barley varieties interacted highly by the environment and finally variety HB-1966 gave the highest yield followed by EH-1493. There was high genotype by environment interaction. The first PCA with 55.75% accounted for most of the variability in yield trait. The first and second PCAs added up to 85.17% of the total variability in yield trait.

AUTHOR CONTRIBUTIONS

Workineh Mekasa Buli planned and executed the experiment. The data management, analysis and interpretation was also carried out and finally the paper is written by the same author.

ACKNOWLEDGMENTS

I acknowledge Ethiopian Institute of Agricultural research for the financial support to execute the experiment. My acknowledgement also goes to Barley National Research Program and Mr. Niguse Tamene, senior Technical assistant in cereal crops research of Ambo Agricultural Research Center, for field management and data recording.

COMPETING INTERESTS

The author has no conflict of interests.

ETHICS APPROVAL

Not applicable

REFERENCES

Asfaw, Z. (1988). Variation in the morphology of the spike within Ethiopian barley, *Hordeum vulgare* L.(Poaceae). *Acta Agriculturae Scandinavica*, *38*(3), 277-288.

Buli, W. M., & Ali, H. M. (2021). Assessing genetic Variability in Malt Barley (Hordeum distichon L.) Genotypes in Southeastern Ethiopia. *International Journal of Research Studies in Agricultural Sciences (IJRSAS)*, *7*(8), 23-26.

Buli, W.M., & Beyene, M.M. (2021). Participatory varietal selection of malt barley (*Hordeum distichon* L.) genotypes. *Journal of Innovative Agriculture*, *8*(4), 43-46.

Ceccarelli, S. (1989). Wide adaptation: How wide?. *Euphytica*, *40*(3), 197-205.

Ceccarelli, S., Grando, S., Shevstov, V., Vivar, H., Yayaoui, A., El-Bhoussini, M., & Baum, M. (1999). The ICARDA strategy for global barley improvement. *Rachis*, *18*(2), 3-12.

Central Statistical Authority. (2016). *Report on area and production of crops: Agricultural sample survey.* Addis Ababa, Ethiopia.

Food and Agriculture Organization of the United Nations. (2005). *Estimates of world production and harvested area.*

Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research*. John wiley & sons.
Laurentin, H. E., & Montilla, D. (1999). Analysing genotype by environment interaction in sesame (*Sesamum indicum* L.) population. *Sesame and safflower newsletter*, (14), 27-32.

Lister, D. L., Jones, H., Oliveira, H. R., Petrie, C. A., Liu, X., Cockram, J., ... & Jones, M. K. (2018). Barley heads east: Genetic analyses reveal routes of spread through diverse Eurasian landscapes. *PloS one*, *13*(7), e0196652.

Mahasi, M. J., Pathak, R. S., Wachira, F. N., Riungu, T. C., Kinyua, M. G., & Waweru, J. K. (2006). Genotype by environment (G×E) interaction and stability in safflower (*Carthamus tinctorius* L.). *Asian Journal of Plant Sciences, 5*(5), 1017–1021.

Zecevic, V., Knežević, D., & Mićanović, D. (2004). Genetic correlations and path coefficient analysis of yield and quality components in wheat. *Genetika*, *36*(1), 13-21.