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Original Paper

Adaptability Study of Yield and Yield Related Trait Performance of Improved Food Barley (*Hordeum Vulgare L.*) Varieties in North Shewa Zone Oromia, Ethiopia

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Abstract

Barley is one of the founders, old world agriculture and the first domesticated cereal crop. It is a staple food, adapted to and produced over a wider range of environment . This trial was conducted on sixteen improved food barley varieties with one local check at Fitche Agricultural Research Center for two consecutive years. The objective was to identify adaptable, stable and high yielding varieties. The seed was sown in Randomized Complete Block Design with three replications. Nine agronomic traits data were evaluated. Analysis of variance detected significant difference among varieties for most observed traits both separated and combined analysis. Observation attained significant differences over years and locations for almost all traits. The combine ANOVA and the AMMI analysis for grain yield across environments revealed significantly affected by environments, hold 68.4% of the total variation. Genotype and genotype by environmental interaction were significant and accounted 12.1 % and 17.8 % respectively. Principal component 1 and 2 accounted 9.6% and 4.3 % of the GEI respectively with a total of 13.9 % variation. The interaction effect of variety by year and variety by location imposed significant effect on most traits. Among evaluated varieties; HB1307 and HB1966 had significantly higher mean value of grain yield. Moreover, the yield advantage of 32.9% and 38.8% were estimated for HB1307 and HB1966 respectively over the local check. Therefore, these varieties were suggested for further demonstration and popularization in the areas with similar agro-ecology.

Keywords

adaptability, AMMI, food barley, varieties

1. 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 (Bedasa, 2014). In Ethiopia, Barley is the fifth important cereal crop after Tef, Maize, Sorghum and Wheat in both total area coverage and annual production (CSA, 2020). It is cultivated at altitudes ranging from 1500 to 3500 above sea level and predominantly grown at elevation ranging from 2000 to 3000masl (Tamene, 2016). Being the most dependable and desirable crop for the resource poor highland farmers (Firdissa et al., 2010), 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 (Bekele et al., 2005).

In Ethiopia, the national average yield of food barley was estimated to be 25.01qt/ha^{-1}and similarly, average grain yield of 27. 58qt/ha^{-1} at regional (Oromia), 25.61qt/ha^{-1} (at North Shewa zone) was obtained (CSA, 2020), indicating below national productivity of the crop in the zones. The most important biotic and abiotic factors that reduce productivity of barley in Ethiopia include; low yielding varieties, insect, disease, poor soil fertility, soil acidity and weed competition (Bekele et al., 2005). Gradual increasing of these production constraints are held to be important for diminishing productivity of barley in the study areas. Evaluation of different food barley varieties is among alternative intervention approach through which productivity of the crop could be alleviated.

Environmental fluctuation and interaction with crop is also the major limitation for food barley production and productivity. Genotype by Environment Interaction (GEI) is the differential responses of different genotypes across a range of environments (Kang, 2004). In breeding, genotype x environmental interaction (G x E), cause many difficulties, while the environmental factors such as temperature and soil affects the performance of genotypes. Genotype x Environment (GE) interaction reduces the genetic progress in plant breeding programs through minimizing the association between phenotypic and genotypic values (Firdissa et al., 2010). Consequently, multi-environment yield trials are essential in assessing of genotype by environment interaction (GEI) and identification of superior genotypes in the final selection cycles (Kaya et al., 2006; Mitrovic et al., 2012). Phenotypes are a mixture of genotype (G) and environment (E) components and interactions (G x E) between them. G x E interactions complicate process of selecting genotypes with superior performance. Therefore, multi-environment trails (METs) are widely used by plant breeders to evaluate the relative performance of genotypes for target environments (Delacy et al., 1996). The Additive Main effects and Multiplicative Interaction (AMMI) model have also led to more understanding in the complicated patterns of genotypic responses to the environment (Gauch, 2006). These patterns have been successfully related to biotic and abiotic factors. Yan et al., 2000, proposed another methodology known as GGE-biplot for graphical display of GE interaction pattern of MET data with many advantages. GGE biplot is an effective method based on Principal Component Analysis (PCA) which fully explores MET data. It allows visual examination of the relationships among the test environments, genotypes and the GE interactions. The first two principle components (PC1 and PC2) are used to produce a two dimensional graphical display of genotype by environment interaction (GGE-biplot). If a large portion of the variation is explained by these components, a rank-two matrix, represented by a GGE- biplot, is appropriate (Yan et al., 2003).

The objective of this study was to identify adaptable, stable and high yielding food barley varieties for study and similar-agro ecologies.

2. Materials and Methods

2.1 Description of Locations

This experiment was conducted at three different rain fed locations for two consecutive years in North shewa zone of Fitche agricultural research center at Degem, Kuyu, Wachale,Debre Libanos and Jida research sub site during the 2020-2022 main cropping season, that represent the varying agro ecologies of the barley potential areas of the zones.

2.1.1 Experimental Material

Sixteen food barley varieties released from Regional and National Agricultural Research Center were evaluated against to local cultivar (Table 1). The varieties were selected based on average performance and agro-ecological adaptation.

Table 1. Description of Research Materials

Varieties	Year of release	Maintainer (Seed sources)
Abdane	2011	Sinana Agricultural Research Center/OARI
Adoshe	2018	Sinana ARC/ORARI
Agegnehu	2007	SRARC /ARARI
Biftu	2005	Sinana Agricultural Research Center/OARI
Cross # 41/98	2012	HARC/EIAR
Dafo	2005	Sinana Agricultural Research Center/OARI
EH 1493/F6.32H.3	2012	HARC/EIAR
Gobe	2012	KARC/EIAR
Guta	2007	SARC /OARI
Hagere	2018	Debere Birhan ARC/ARARI
HB1307	2006	Holata Agricultural Research Center/EIAR
HB1965	2017	Holetta ARC/EIAR
HB1966	2017	Holetta ARC/EIAR
Local cultivar		Available with Farmers
Mezezo		

Yedogit	2005	SRARC/ARARI

Whereas, OARI= Oromia Agricultural Research Institute, EIAR= Ethiopia Agricultural Research Institute.

2.1.2 Experimental Design and Management

Randomized Completed Block Design (RCBD) with three replications was used in all locations. Each experimental plot had six rows of 3m length and 20 cm apart with a plot area of 1.2 m x 3m. Drill planting by hand was used with the same seed rate for all locations. Fertilizer was applied at a rate of 100kg and 100kg ha^{-1} of NPS and UREA. All NPS and half of UREA were applied during planting, while the rest half splits were applied at tillering stages of UREA. Seed rate of 85 kg ha^{-1} was used. First weeding was carried out 35 days after emergence and the second one at 30 days after the first weeding. Weeding was done up to three times for all locations. The data considered for analysis was from the candidates of the net plot, thus the four central harvestable rows. The harvested varieties were sundried before being tested for moisture content where 12% was the preferred average moisture content using moisture tester. Grain yield data was then obtained by weighing the dried grain using a digital scale.

3. Data Collection Method

Twelve plants were selected randomly before heading from each row (four harvestable rows, which means three samples per rows) and tagged with thread and all the necessary plant based data were collected from these sampled plants.

3.1 Plot Basis

Days to Heading (DH), Days to maturity (DM), Grain Filling Period (GFP) Grain yield (Kgh^{-1})

3.1.2 Plant Basis

Plant Height (PH), Productive tillers, Spike Length (SL), Spiklete per sspike (Spkltspike) and Seeds per spike (SdSpike).

4. Statistical Analysis

Analysis of variance is calculated using the model:

$$Yij = \mu + Gi + Ej + GEij$$

Where Yij is the corresponding variable of the i^{-th} genotype in j^{-th} environment, μ is the total mean, Gi is the main effect of i^{-th} genotype, Ej is the main effect of j^{-th} environment, GEij is the effect of genotype x environment interaction.

$$Y_{ij} = \mu + g_i + e_j + \qquad ʎk\ Yik\ \delta jk + Ɛij$$

4.1 The AMMI Model Used Was

Where Yij is the grain yield of the i^{-th} genotype in the j^{-th}environment, μ is the grand mean, gi and ej are the genotype and environment deviation from the grand mean, respectively, Ʌk is the eigenvalue of the Principal Component Analysis (PCA) axis k, Yik and δjk are the genotype and environment principal component scores for axis k, N is the number of principal components retained in the model, and Ɛij is the residual term

4.1.2 AMMI Stability Value (ASV)

ASV is the distance from the coordinate point to the origin in a two-dimensional plot of IPCA1 scores against IPCA2 scores in the AMMI model (Purchase, 1997). Because the IPCA1 score contributes more to the GxE interaction sum of squares, a weighted value is needed. This weighted value was calculated for each genotype and each environment according to the relative contribution of IPCA1 to IPCA2 to the interaction sum of squares as follows:

$$\text{ASV}=\sqrt{[(\text{SSIPCA1} + \text{SSIPCA2})\ (\text{IPCA1score})]2 + (\text{IPCA2score})2}$$

Where, SS_{IPCA1}/SS_{IPCA2} is the weight given to the IPCA1-value by dividing the IPCA1 sum of squares by the IPCA2 sum of squares. The larger the ASV value, either negative or positive, the more specifically adapted a genotype is to certain environments. Smaller ASV values indicate more stable genotypes across environments (Purchase, 1997)

4.1.3 Genotype Selection Index (GSI)

Stability is not the only parameter for selection as most stable genotypes would not necessarily give the best yield performance. Therefore, based on the rank of mean grain Yield of Genotypes (RYi) across environments and rank of AMMI stability value RASVi), Genotype Selection Index (GSI) was calculated for each genotype as:

GSIi = RASVi + RYi

A genotype with the least GSI is considered as the most stable (Farshadfar, 2008). Analysis of variance was carried out using statistical analysis system (SAS) version 9.2 software (SAS, 2008).

Additive Main Effect and Multiplicative Interaction (AMMI) analysis and GGE bi-plot analysis were performed using Gen Stat 15th edition statistical package (VSN International, 2012)

5. Result and Discussion

5.1 Analysis of Variance

Combined analysis of variance detected significant difference of variety for all agronomic traits (Table 2), while individual location analysis show significant difference among varieties for most of the traits Over year analysis also explained significant differences for most of the traits On the other hands, ANOVA exhibited presence of significant interaction effect of variety by year, variety by location for most of agronomic traits observed except for PH, SL and SdSpike and SL and SdSpike respectively (Table 2). Thus, analysis of variance shows the existence of significant effect of fluctuating weather condition on mean performance of most of the traits. The finding was in line with the study supported previous report of Bedasa (2014).

Table 2. Combined Analysis of Variance (ANOVA) for Grain Yield and Yield Related Traits

SV	DF	DH	DM	GFP	PH	SL	SdSpike	Spkltspike	ETP	YLDKgha
Yr	1	300.1**	1168.1**	2652.4**	6601.9**	40.96**	8327.8**	53967.2**	10.06**	68893827**
Loc	5	206.7**	239.4**	65.6*	4456.8**	17.8**	1901.2**	541.3**	2.0**	11329702**
Vrt	15	744.7**	669.8**	158.2**	574.6**	6.7**	1299.8**	765.5**	3.2**	1483786**
Yr*Vrt	15	75.4**	95.8**	143.4**	73.4ns	1.2ns	114.8ns	197.8**	0.89*	287030**
Loc*Vrt	75	34.4**	13.7*	39.9**	113.97*	1.2ns	94.4ns	70.99*	0.35ns	378976**

Where, DF= degree of freedom, DH= days to heading, DM= days to maturity, ETP= effective tiller per plant, GFP= grain filling period, PH= plant height, SL = spike length, YLDKgha = grain yield kg per hectare, Loc= location, Yr= year, Vrt= varieties, SdSpike= seed per spike, Spkltspike = spikelete per spike.

5.1.2 Combined Mean Performance

Mean value of DH varied from 67.4 for Dafo and 68.6 for Guta to 89.4 for Cross#41/98 with the overall mean value of 77.47. Cross#41/98 had the longest DH, while Dafo and Guta had shorter DH. The mean value of DM ranged from 110.9 for Dafo to 129.3 for Cross#41/98 with over all mean value of 119.92. So Cross#41/98 had significantly longer mean value of DM even if statistically non significant with Agegnehu variety (Table 3). This result supported with Girma (2012), Wosene et al. (2015) and Tashome (2017) who reported significant variation of variety for DH and DM. The study also indicated significantly shorter for Adoshe and longer for Hagere varieties with mean value of PH which agreed with Bedasa (2014) who reported significantly difference in plant height. In this study, statistically non significant differences between Adoshe and Gobe, Yedogit and Gobe varieties in terms of plant height which is responsible for against lodging problem. In contrary to these, Hagere, HB1307, HB1966, Guta and Dafo varieties were recorded higher plant height that have a possibility of susceptible to lodging problem.

The mean value of grain yield varied from 570.99kgha^{-1} (Guta) to 1552.18 kgha^{-1} (HB1966) with the mean value of 1040.44kgha^{-1}, where HB1307 (1486.02 kgha^{-1}), HB1966 (1552.18 kgha^{-1}), Cross#41/98 (1383.83 kgha^{-1}) and Agegnehu (1376.55 kgha^{-1}) showed significantly higher mean of grain yield over the rest varieties (Table 3). Guta variety attained significantly lowest mean value of grain yield (Table 3), in line with this, Kemelew (2011) and Girma (2012) reported the largest mean value of grain yield for HB-1307.

Table 3. Combined Mean Performance of Grain Yield and Yield Attributing Traits

Varieties	DH	DM	GFP	ETP	PH	SL	Spkltspike	SdSpike	YLDkgha^{-1}
Abdane	74.1f	115.3f	41.3efg	1.69def	68.8bc	5.8def	29.5ed	33.2ef	885.65fgh
Adoshe	81.6d	119.6e	38.1i	1.59ef	53.0g	5.25f	34.6bc	38.8cd	810.92hi
Agegnehu	83.7c	127.8ab	44.2bcd	2.66a	67.3cd	6.5abc	35.0b	41.3bcd	1376.55b
Biftu	71.9g	115.8f	43.9bcd	1.6ef	67.9bcd	5.3f	30.3cde	33.4ef	1063.36d
Cross#41/98	89.4a	129.3a	39.9ghi	2.5ab	66.79cd	6.4bcd	35.9b	43.0bc	1383.83b
Dafo	67.4h	110.9g	43.5cde	2.43ab	70.49abc	5.25f	24.3f	25.2gh	789.19i
EH1493	87.1b	125.2cd	38.1i	2.48ab	65.7cd	6.88ab	37.4b	44.2ab	1247.97c
Gobe	72.6fg	118.4e	45.8abc	2.4abc	57.4fg	6.05cde	19.4g	20.9h	817.75ghi
Guta	68.6h	112.6g	44bcd	1.4f	69.3abc	5.3f	27.8ef	28.6fg	570.99j
Hagere	80.9d	119.3e	38.4hi	1.5f	74.2a	7.1a	42.6a	48.98a	1062.17d
HB1307	80.1d	126.3bc	46.3ab	2.5ab	70.9abc	6.3cd	34.95b	41.6bcd	1486.02a
HB1965	80.7d	124.4d	43.8b-e	2.2bc	63.4de	6.5abc	37.1b	42.9bc	976.28e
HB1966	79.9d	127.4b	47.5a	2.46ab	73.2ab	6.2cde	35.4b	42.4bc	1552.18a
Local	74.1f	114.5f	40.4ghi	2.27abc	68.1bcd	6.36bcd	19.3g	21.7h	818.06ghi
Mezezo	71.6g	112.4g	40.8fgh	2.1bcd	68.6bcd	5.6ef	28.4ef	31.6ef	908.08ef
Yedogit	75.9e	119.2e	43.3def	1.99cde	59.96ef	5.3f	33.3bcd	36.6ed	898.08efg
Mean	77.47	119.92	42.45	2.11	66.57	6.01	31.58	35.91	1040.44
LSD5%	1.8	1.86	2.5	1.97	5.3	0.61	4.47	5.3	83.18
CV%	3.54	2.35	9.11	30.51	12.2	15.55	21.51	22.37	12.16

Where CV = coefficient of variation, LSD = least significant difference, DH = days to heading, DM = days to maturity, GFP = grain filling period, ETP = effective tiller per plant, PH = plant height, SL = spike length, Spkltspike = spike lets per spike, SdSpike = seeds per spike YLDkgha^{-1} = yield kilogram per hectare.

5.1.3 Mean Separation for Grain Yield

5.1.3.1 Yield Mean Performance over Year and Location

Grain mean performance of the tested food barely varieties indicated that fluctuation over growing seasons and tested environments (Table 4). It’s also noted that some varieties were consistently performed in a set of tested environments whereas some of them were fluctuated across locations. For instances, HB1307 recorded the highest grain yield (2065.7ha-1) in 2013 growing season at Degem location and recorded lower grain yield (98.7kgha^{-1}) at Wachale and medium grain yield (1047.8kgha^{-1}) at Kuyu sub site in the same year. In 2014 growing season, HB1307 variety was recorded medium grain yield (1528.5kgha^{-1}) and (2320.4kgha^{-1}) at Jida and D.Libanose sub site respectively, however, it recorded the highest grain yield at Kuyu in relative to other varieties and the overall grain mean performance was 1486kgha^{-1} .Grain yield and yield parameter performance fluctuation indicating high influence of over year fluctuating weather condition even on the same trait of single variety Girma (2012). In contrary to this HB1966 variety was almost constantly recorded grain yield performance over location and growing season and obtained over all mean grain yield of 1552.2kgha^{-1} this might be due to the genetic potential of the varieties (Mengistu et al., 2013). The difference in yield rank of varieties across the growing environments displays the prevalence of G×E interactions (Purchase et al., 2000; Yang et al., 2007). The yield advantage 38.8%, 32.9%, 23.8% and 23.1% was estimated for HB1966, HB1307, Cross # 41/98 and Agegnehu respectively over the local check which had a mean value of 1118.1kgha^{-1}. Therefore, these varieties were identified for better mean performance of grain yield and some yield contributing traits.

Table 4. Grain Yield (kg/ha) Across Location and Year

	Grain Yield kgha^{-1}							
	Year							
	2013			2014				
	locations							
Varieties	Degem	Wachale	Kuyu	Jida	D.Libanose	Kuyu	Mean	YLA (%)
Abdane	538.1fg	267.2e	567.3d	1842.8e	1765.1f	333.4def	885.7	-20.8
Adoshe	829.3de	257.5e	337.9ef	2070.4cd	1221.9g	148.3f	810.9	-27.5
Agegnehu	1200.7c	85.5gh	1172.4a	1811e	2971.9a	1017.8c	1376.6	23.1
Biftu	856d	637.8a	212.9gh	2401.8ab	1756.1f	515.6d	1063.4	-4.9
Cross # 41/98	1000cd	42.4h	1041.1b	2588.1a	2683.2abc	948.2c	1383.8	23.8
Dafo	487.9fg	493.5b	234.9gh	1445.4fg	1846.1f	227.4ef	789.2	-29.4
EH1493	863.9d	42.5h	804.9c	1854.7e	2812.1ab	1109.7bc	1248	11.6
Gobe	574.3fg	73.5gh	180h	2228.8bc	1555.3f	294.6def	817.8	-26.9
Guta	450.4fg	351.1d	182.2h	1487.4fg	729.3h	225.4ef	571	-48.9
Hagere	980.7d	82.8gh	632.1d	1174.6h	2181.7e	1321.1b	1062.2	-5
HB1307	2065.7a	98.7g	1047.8b	1528.5f	2320.4de	1855a	1486	32.9
HB1965	406g	184.5f	378.2e	1497.9fg	2431.3cde	959.8c	976.3	-12.7
HB1966	1615.7b	144.5f	1159.2a	1989.3de	2628.5bcd	1776a	1552.2	38.8
Local	542.4fg	410.4c	194.3h	1507.6fg	1841.5f	412.1de	1118.1	0
Mezezo	636.3ef	238.6e	292.2fg	1473.8fg	2381cde	426.7de	908.1	-18.8
Yedogit	525.8fg	315.2d	728.3c	1295.8gh	2269.7e	253.6ef	898.1	-19.7
mean	848.3	232.9	572.9	1762.4	2087.2	739.1		

LSD 5%	206.52	44.334	85.303	214.3	333.29	259.99
CV %	14.6	11.4	8.9	7.3	9.6	21.1

Key kgha^{-1} = kilogram per hectare, YLA = yield advantage, LSD = least significant difference, CV = coefficient of variation.

5.1.3.2 AMMI Analysis for Grain Yield

The additive main effects and multiplicative interaction analysis (Table 5) of grain yield indicated, environment, and genotypes by environment interaction were highly significant ($P \leq 0.01$). Similar result was report by Ntawuruhunga et al. (2001). This indicates that one of the basic factors that affect GEI could either be genotypic or environmental in nature (Debelo et al., 2000; Anandan et al., 2009) also reported that 74.3% of the interaction sum of squares was explained by IPCA1.

Table 5. Additive Main Effects and Multiplicative Interaction Analysis of Variances (AMMI) for Grain Yield of 16 Food Barley Varieties Evaluated at Six Environments

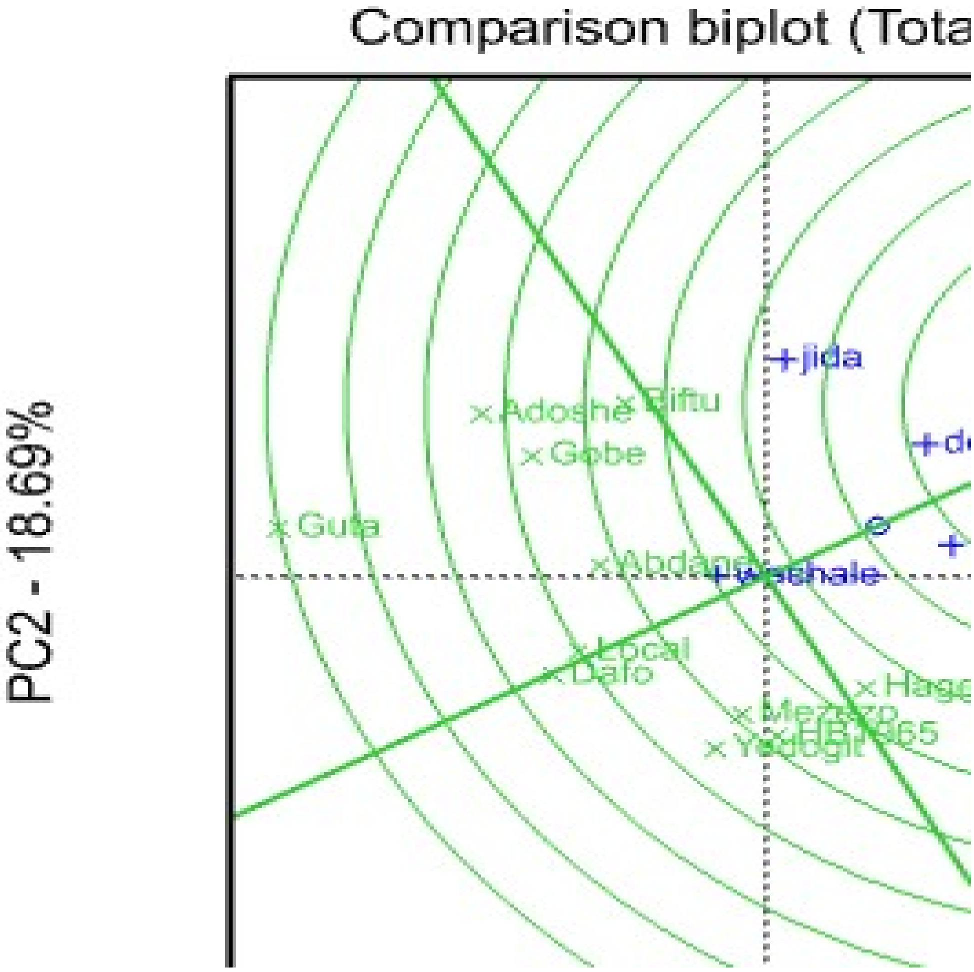
SV	DF	SS	EX. SS%	MS
Total	287	183570646	100	639619
Treatments	95	180527754	98.3	1900292**
Varieties	15	22256790	12.1	1483786**
Environments	5	125542335	68.4	25108467**
VxE	75	32728629	17.8	436382**
IPCA 1	19	17648144	9.6	928850**
IPCA 2	17	7890500	4.3	464147**
Residuals	39	7189985	3.9	184359**
Error	180	2983053		16573

Key: SV = source of variation, DF = degree of freedom, SS = sum of squares, MS = mean squares, IPCA = Interaction Principal Component Axis, EX. SS% = Explained Sum of square ns *, ** non-significant, Significant at the 5% and 1% level of probability respectively.

5.1.4 Genotype and Genotype by Environment Interaction (GGE) Biplot Analysis

The polygon is drawn by joining the varieties such as Guta, Yediogit, Agegnehu, HB1966, HB1307 and Adoshe that are located farthest from the biplot origin so that all other cultivars are contained in the polygon. These vertex cultivars are the highest-yielding cultivar in all environments that share the sector with it. Vertex cultivars in which any environments fell in their sectors were the poor performing varieties. Variety like Abdane located at the origin would rank the same in all environments and is not responsive to the change in environments. Varieties HB1307 and HB1966 was the best yielder among tested varieties and relatively stable varieties across various environments (Figure 1). Varieties like

Mezezo, Yedogit, Dafo and HB1965 were inferior in yield performance but stable Genotype-focused scaling considers stability and mean grain yield concurrently and environments as well as variety that fall in the central (concentric) circle of variety-focused scaling are considered as an ideal environments and stable variety, respectively (Gauch & Zobel, 1997). Varieties, HB1966, HB1307 and Cross # 41/98 fell in and around the center of concentric circle and therefore, ideal varieties (Figure 1)



Figuer 1. GGE bi-Plot Comparison of Varieties for Their Yield Potential and Stability

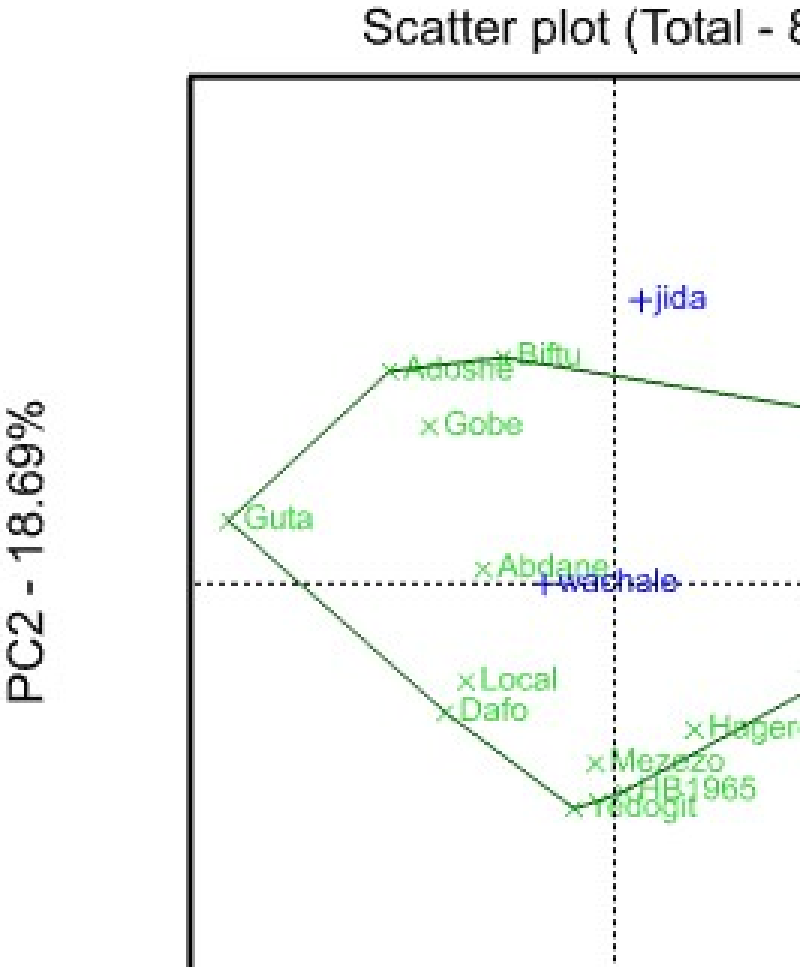


Figure 2. The Scatter Plots Showing the Which-Won-Where Pattern of the GGE Biplot

5.1.5 Stability Analysis

5.1.5.1 AMMI Stability Value (ASV)

Considering AMMI stability value (ASV) that takes into account the scores of the IPCA2, Varieties with least ASV scores are the most stable, whereas those with high ASV score are unstable (Farshadfar, 2008; Bantayehu, 2009; Issa, 2009). Accordingly, varieties (cross#41/98, Mezezo & Yedogit) were appeared to be among those showing low ASV and were the most stable. In opposite to these, varieties Guta and HB1307 indicate the highest ASV and were thus considered to be unstable. Stability by itself should, however, not be the only parameter for selection, as the most stable variety would not necessarily give the best yield performance (Mohammadi et al., 2007). Therefore, the study indicated that Mezezo and Yedogit were recorded the lower ASV (Table 6), but recorded lower yield (908, 898kgha^{-1} respectively). Therefore, if Mezezo and Yedogit will be selected based on ASV per se, there will be a risk of yield reduction. The stable varieties were followed with mean grain yield above the grand mean and this result was in agreement with Hintsa et al. (2013), who has used ASV as one method of evaluating grain yield stability of bread wheat varieties in Tigray and similar reports been made by Abay et al. (2009); Sivapalan et al. (2000) in barley in Tigray and bread wheat using AMMI stability value. A variety with the least of Genotype Selection Index (GSI) is considered as the most stable genotype (Farshadfar, 2008). As a result, cross#41/98, and HB1966 were more stable with the low of Genotype Selection Index (GSI) and higher mean grain yield (Table 6).

Table 6. AMMI Stability Value, AMMI Rank, Yield, Yield Rank and Genotype Selection Index (GSI)

Varieties	ASV	ASV rank	YLD	YLD rank	GSI	IPCAg1	IPCAg2
HB1966	35.56	12	1552	1	13	15.29	-9.53
HB1307	50.28	16	1486	2	18	19.85	-23.45
Cross#41/98	9.76	1	1384	3	4	1.12	9.43
Agegnehu	31.7	10	1377	4	14	13.55	9.12
EH1493	26.87	8	1248	5	13	11.21	9.58
Local	12.69	4	1118	6	10	-5.6	1.95
Biftu	38.99	13	1063	7	20	-17.39	-1.81
Hagere	33.74	11	1062	8	19	14.67	-7.69
HB1965	18.05	6	976	9	15	7	8.96
Mezezo	11.12	2	908	10	12	2.03	10.15
Yedogit	11.7	3	898	11	14	1.51	11.2
Abdane	19.03	7	886	12	19	-8.42	2.55
Gobe	30.88	9	818	13	22	-13.78	-0.73
Adoshe	39.5	14	811	14	28	-17.18	-8.89
Dafo	17.09	5	789	15	20	-7.36	4.51
Guta	40.04	15	571	16	31	-16.51	-15.36

6. Conclusion

Combined analysis of variance revealed significant effect of variety, location, year and their interactions for most of agronomic traits, indicating the significant influence of location and over year fluctuating weather condition on considered observation. The study found that HB1966, HB1307 and Cross#41/98 had shown significantly higher mean values of grain yield with the best yield advantage over the local check. On the contrary, Dafo, Guta and Mezezo showed the desired significantly earlier days to maturity over the two locations and across the two cropping seasons consistently. However, these varieties revealed lower mean values of primarily concerned trait which was grain yield. Therefore, demonstration and popularization of the three identified varieties viz. HB1966, HB1307 and Cross#41/98 were the important concern to improve food barley productivity in the study areas and other areas having similar agro-ecologies.

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