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Evaluation of Advanced barley lines set-II for major barley growing of Tigray, Northern Ethiopia

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ABSTRACT

An experiment evaluation of advanced barley lines set-II for major barley growing of Tigray, Northern Ethiopia food barley genotypes with the objective of improved the production and productivity of food barley there by contribute to the improvement of household food security and farm income of the small holder farmers through the selection of well adapted genotypes were tested Demhay#1, ERETH07-40#1, ERETH07-61#1, ERETH07-86, Eritera07-49, Eritera 07-62#1, ERITERA07-82, Fetina, ISEBON-0#2, ISEBON-11#2, ISEBON-67 and TselimEkli#1. The trial were conducted three districts of eastern and south eastern zone of Tigray viz Gulomekeda and Atsbi-wonberat (eastern zone) and Dugua Tebien (south eastern zone). The design was conducted randomized complete block design with three replication, all parameters exhibited significant difference among the varieties. The correlation coefficient of grain yield with biomass yield, harvest index and plant height highly correlated ,moderately with spike length and seeds per spike and weakly correlated with days to heading, days to maturity and 1000 seed weight.

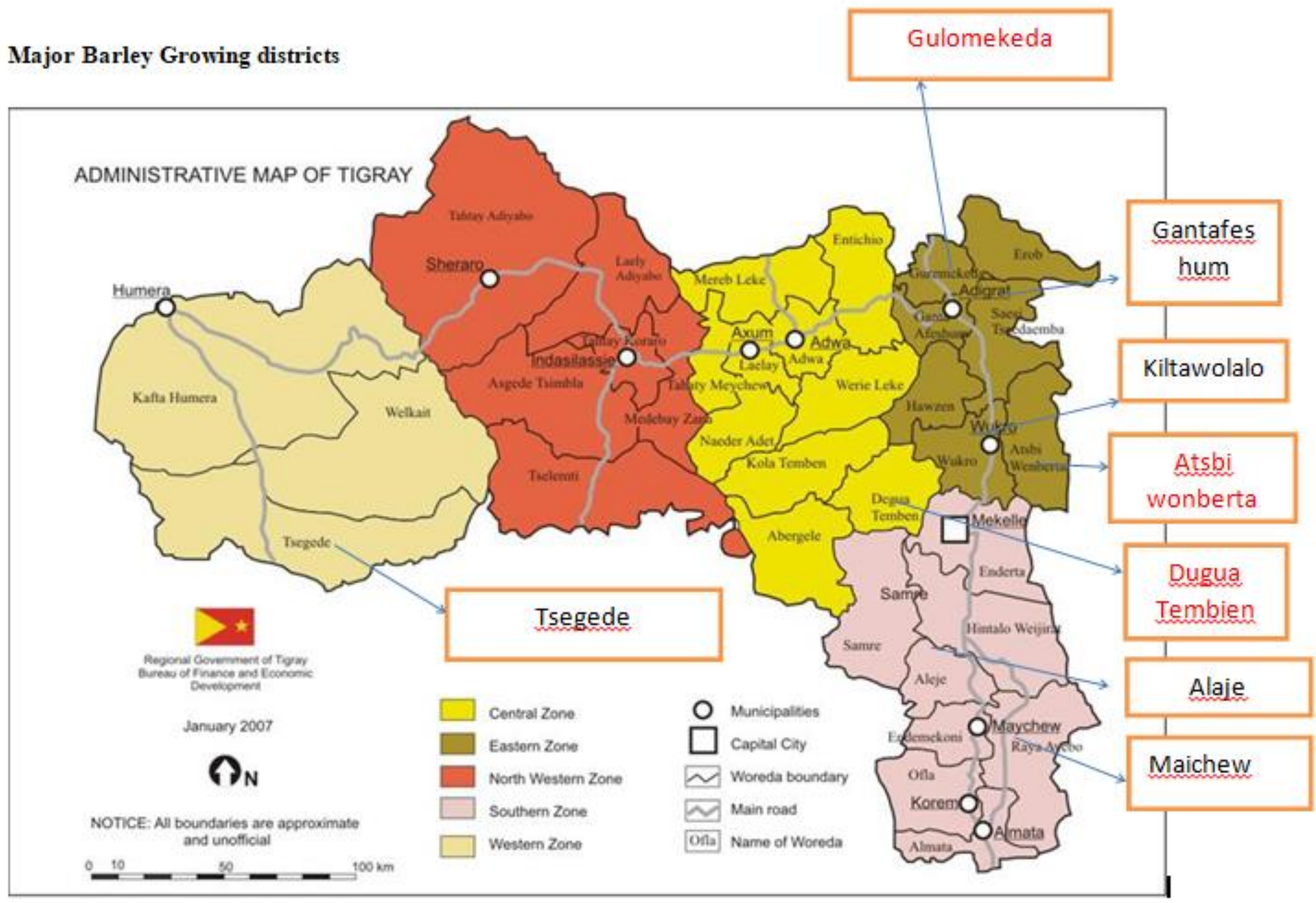
Key words: Environment, genotype, interaction and grain yield.

INTRODUCTION

Background and Rationale

Barley (*Hordeum vulgare L.*) is an annual herbaceous plant with a fibrous root system. It is a member of the grass family Poaceae and descended from wild barley (*Hordeum spontaneum K*). Both forms are diploid with seven pairs of chromosomes (2n = 14) (Marcel *et al, 20*08).Barley was grown when agriculture was first developed in Mesopotamia, essential in ancient Egypt. It is the most important bread cereal of both the Greeks and the Romans. At present, barley is the fourth most cultivated cereal in the world, after wheat, maize and rice (Marwat *et al.*, 2012). The species is divided into three subgroups, six-row (*Hordeum vulgare*), two-row (*Hordeum distichum*) and intermediate (*Hordeum irregulare*), and both spring- and autumn-sown types are grown. Currently, in Ethiopia 948, 107.ha^{-1} of land was covered by both food and malt barley and 15,852,869.21 quintals were produced at national level.in Tigray, for 2011/12 Meher season barley production was 1,640,038.91 quintals produced from 99,453.31 hectares of land. Ethiopia is a country renowned for the diversity of its native barley types and is recognized internationally to harbor valuable barley genetic resources (Fetien *et al*., 2008). The crop is the fifth most important crop in Ethiopia after teff, maize, wheat and sorghum. It is also the fourth most essential crop in Tigray next to sorghum, teff and wheat (CSA, 2012). The regional average yield for barley is still much below the national average (CSA, 2012).The most important factors that reduce yield of barley in Ethiopia are low-yield capacity of farmers' varieties (landraces) and an inadequate number of improved varieties adapted to the different production systems and varied agro-ecological zones (Alemayehu, 2003), poor agronomic practices, poor soil fertility, low soil pH, drought, water logging and frost.

Tigray is a region characterized by an erratic rainfall and where heavy rain alternates with dry periods resulting in alternating floods and dry periods. The region receives the least rainfall compared to other parts of Ethiopia. the average annual rainfall for the period from 1961 to 1987 was 571 mm, which was 38% less than the national average (921mm) for the same period.the annual rainfall shows a high degree of variation ranging from 20% in the western to 49% in the eastern parts of Tigray (COSAERT, 1994).Moreover, agro-ecological characteristic of the specific study site look at Table 1. Barley is a main food crop in the highlands and marginal areas of Tigray where other cereals cannot grow, as well as animal feed and forage around the world. Barley plays an important role in ensuring food security, as it requires relatively low input. Its yield stability is far better than other cereals, making it a dependable source of food in bad seasons (Berhane et al., 1996). Therefore, food barley varieties of early set and high yielding which were released nationally could answer the problem of low yielding barley landraces that worsen food insecurity besides low rainfall. The performance of these varieties were tested at Mekelle agricultural Research center testing site and found were well adaptive and better in performed .The objective of evaluated and selected barley lines with increased grain yield and early maturity ones.



METHODOLOGY

Twelve food barley genotype with standard check viz Demhay#1, ERETH07-40#1, ERETH07-61#1, ERETH07-86, Eritrea07-49, Eritrea07-62#1, Eritrea07-82, Fetina, ISEBON-10#2, ISEBON-11#2, ISEBON-67 and Tselim Ekli#1 were tested at variety tested FTC three districts for each districts one FTC at Dugua Tembien (Anmberkeke FTC),Atsbi wenberta(Dera FTC) and Gulomekeda (Ambeset fekada) located contrasting soils and climatic zones during the period 2014 t0 2015 (2006 to2007 E.C.).At each location,12genotype included standard check for compassion were planted 3m^2 test plots (1.2mX2.5m) using randomized complete block design with three replications. The seed rate for all varieties was 80kg/ha .Fertilizer application was used blanket recommendation of 100kg/ha DAP (basal application) at planting and 50kg/ha Urea split application. Planting was done by hand drilling and weed was implemented hand weeding twice at vegetative and booting stages.an analysis of variance was done for the combined analyses of variance across the test environment location and years.

The data were collected: phonological data days to heading and days to maturity, growth parameter plant height and spike length, yield parameter biomass yield grain yield, 1000 seed weight, harvest index and farmers opinion . A combined ANOVA analysis was conducted using SAS software (Version 9.0) and Genstat software

Table1: Description of three locations used for evaluation of 12 food barley varieties included landrace

Testing location	AEZ	Geographical position		Altitude (m.a.s.l)	Annual Rainfall (mm)	Annual Temp. (°c)	
		latitude	longitude			Mini.	Max.
Atsbi-wemberta	SM2	13°52'N	39°44'E	2630	550	10°C	24°C
Gulo-mekeda	SM2-S	14°23''28.76N	39°23''59.97E	2528	552	7.72°C	24.14°C
Dugua Tembien		13°40''03.55'N	39°14''21.92'N	2412	884.6	8.7 °C	25.1 °C

Source: Abbadi(2008a.b) and New LocClim software (2006).version 1.06

RESULTS AND DISCUSSION

The analysis result of two year data most of them revealed highly significant difference among the genotype (Table2)

The result for phenological characteristic of the food barley genotypes is presented in Table 2,The analysis of variance for days to 50% heading revealed highly significant effects ($P<0.001$). The overall mean for days to heading showed that ERETH07-61#1andISEBON-11#2 (62 days). Genotype Eritrea07-49 on the other took longest days for heading (66 days) (Table 2). The days to 90% maturity also illustrated significant differences among the varieties an average of 104 days and 111 days (Table2). Days to maturity ranged from 104 days for ISEBON-11#2 to 111 days for Fetina and Eritrea07-49. This variation in maturity is brought due to genetic variation. Our candidate genotype less than standard check Fetina, therefore selected for verification in releasing purpose. According to Castro *et al*, (2008), phenology is a key factor in the adaptation of crop plants to environments and management practices. Heading (anthesis) date is a critical determinant of yield performance in barley (*Hordeum vulgare* subsp. vulgare) in Uruguay because heading date initiates the grain filling period, a trait that is a principal determinant of yield and quality (Castro et al., 2008) Other studies also reported that early materials are mainly needed in dry environments where moisture stress dramatically during critical crop stages especially at the grain filling period (Medimagh *et al.,* 2012).

In semi-arid environments, the critical period coincides with the time between heading and maturity. This period should be as short as possible to escape from water stress. Desired genotypes are those that fill the grain very quickly, that is, have short heading-maturity duration. Similar result was reported by Leistrumait *et al*. (2008) malting barley varieties were negatively impacted by the length of the growing period from germination to heading. Correlation coefficient of grain yield and days to heading was indicated negatively correlated that indicate that if heading time prolonged the yield adversity decrease also days to maturity weakly positively correlated (Table3).

Crop growth and yield component

Biomass yield (gm) per plant

The analysis of variance for biomass yield revealed highly significant difference among the varieties (Table2), biomass yield ranged from 4.26 tons per hectare (ISEBON-67) to 6.32tons per hectare (Eritrea07-62#1).

Plant height (cm)

The analysis variance exhibited highly significant difference among varieties (P<0.01). The mean length ranged between 62.47cm (ISEBON-11#2) to 75.69cm (Tselim Ekli#1). Plant height is strongly correlated with grain yield and significant (P <0.001) (Table2). OGTR (2008) stated that barley is annual grass that stands 60-120cm tall. Other study stated that plant height range between landrace populations was 52.0–113.0 cm at Holetta and 54.6–114.8 cm at Sheno (Berhane and Alemayehu, 2011).This research result laid down between the pervious studied outcomes.

Spike length (cm)

The analysis of variance for spike length revealed highly significant difference among varieties. The average spike length was 6.51cm, with a range 5.73cm (ISEBON-11#2) to 6.96cm (ERETH07-86). Spike length is positively and significantly correlated with grain yield (P <0.001) (Table3). According to Shafi *et al.* (2011) studied results indicated that lengthy spikes (18.25 cm) was produced by the application of 60 kg N per hectare, The present results of spike length was smaller than the literature indicated in both locations.

Harvest Index (HI)

The analysis of variance for harvest index not revealed significant differences among varieties (Table2). Since, the percentage of harvest index ranged from 30 %(Eritrea07-49) to 35 %(ISEBON-11#2). Similar study was reported by Savin et al. (2012) indicated that harvest index for barley is similar or only slightly lower than for wheat, and ranges from 45 to 50% for modern cultivars under favourable conditions. The present study is therefore in not agreement to the above study.

1000 seed weight (gm)

The analysis of variance for 1000 seed weight revealed highly significant differences among varieties (Table2). Since, the percentage of1000 seed weight ranged from 39(Eritrea07-49 and Tselim Ekli#1) to 45(Fetina).

Grain yield (t/ha)

Result of average yield of both testing site the first year results not revealed significant difference among the genotypes the yield was recorded the range of 15.3quintal per hectare (ISEBON-67) to 25.6 quintal per hectare (Eritrea07-62#1)(Table3). Second year results very low compared t0 first year by the reason of late starting of rain fall yield recorded ranged 6.2 quintal per hectare (ISEBON-67) to 22.4quintal per hectare (Eritrea07-62#1).result of two years not indicating consistent result varieties but average yields of superior genotype Eritrea07-62#1, ERETH07-86, ERETH07-40#1 and Tselim Ekli#1 (24, 21.5,21and 20.8 quintal per hectare) respectively.

Table 2: Analysis mean of days to heading, days to maturity, biomass yield, g rain yield, harvest index, plant height, spike length, seeds per spike and 1000 seed weight 2006-2007

Genotype	*DH*	DM	BY(t/ha)	HI	PH(cm)	SL(cm)	SP	TKW (gm)
Demhay#1	65	110	5.23	33	73.26	6.65	21	41
ERETH07-40#1	63	109	5.81	34	72.07	6.09	20	41
ERETH07-61#1	62	105	4.96	34	67.52	6.68	19	43
ERETH07-86	64	108	6.02	34	75.12	6.96	23	41
Eritrea07-49	66	111	5.2	30	72.59	6.87	20	39
Eritrea07-62#1	65	110	6.32	34	74.51	6.89	22	42
Eritrea07-82	65	109	5.61	32	74.65	6.79	23	41
Fetina	65	111	5.62	34	74.76	6.58	23	45
ISEBON-10#2	64	108	5.77	33	72.25	6.32	22	43
ISEBON-11#2	62	104	4.73	35	62.47	5.73	20	40
ISEBON-67	63	106	4.26	32	65.93	6.24	21	40
Tselim Ekli#1	65	109	5.62	32	75.69	6.34	20	39
p-value	***	*	***	ns	***	***	*	***
CV%	4.4	5.4	24.9	18.4	11.0	11.1	18.3	7.9

Table 3: Grain yield (qt/ha) data for Set-II food barley lines across years and locations

No	Genotype	Location and year 2006(qt/ha)				Location and year 2007(qt/ha)				Grand mean
		Atsbi	D/T	Gulo	Mean	Atsbi	D/T	Gulo	Mean	
1	Demhay#1	33.9	20.6	11.9	22.1	11	6.5	37.9	18.5	20.3
2	ERETH07-40#1	25.1	25.3	12	20.8	10.4	11.4	42.1	21.3	21
3	ERETH07-61#1	29.5	19.7	11.8	20.4	12.3	5.6	23.1	13.7	17
4	ERETH07-86	32.5	28.2	13.2	24.6	7.6	13	34.3	18.3	21.5
5	Eritrea07-49	31.3	14.8	4.77	17	4.8	6.9	34.4	15.4	16.2
6	Eritrea07-62#1	37.9	27.5	11.6	25.6	10.1	8.6	48.4	22.4	24
7	Eritrea07-82	28.9	20.3	11.2	20.1	9.9	4.4	3.52	1.65	12.5
8	Fetina	31.4	22.1	7.97	20.5	8.9	11.1	26.9	15.6	18
9	ISEBON-10#2	28.2	28.2	8.63	21.7	9.7	11.8	35.9	19.1	20.4
10	ISEBON-11#2	29.1	18.2	9.65	19	11.3	6.3	25.9	14.5	16.7
11	ISEBON-67	26.5	10.9	8.6	15.3	5.6	2.8	10.3	6.2	10.8
12	Tselim Ekli#1	27	23.8	12.3	21	11.1	11	39.9	20.7	20.8
p-value		ns	***	ns	***	ns	ns	ns	ns	*
CV%		21.8	13.1	41.2	22.6	39.7	50.8	37.2	42.3	32.1

Combined analysis of variance of grain yield

Table 4: Combined analysis of variance of grain yield

Source	DF	SS	Mean Square
Replication	2	0.2012366	0.101
Genotype(G)	11	10.4472888	0.950*
Location(L)	2	17.0214730	8.511***
Year(Y)	1	7.1267229	7.127***
L*G	22	5.2817493	0.240^{ns}
Y*G	11	2.4775480	0.225^{ns}
Y*L	2	190.8100317	95.405***
Y*L*G	22	8.5336835	0.388^{ns}
Error	44	16.0830589	0.366
Corrected Total	215	298.9725263	

Table 5: Correlation matrix for grain yield, biomass yield, days to heading, days to maturity, harvest index, plant height, spike length, seeds per spike and 1000 seed weight

	GY(t/ha)	BY(t/ha)	DH	DM	HI	PH	SL	SP	TKW
GY(t/ha)	1								
BY(t/ha)	0.92	1							
DH	-0.31	-0.40	1						
DM	0.17	0.12	0.68	1					
HI	0.66	0.35	-0.04	0.13	1				
PH	0.54	0.66	-0.23	0.05	0.12	1			
SL	0.44	0.36	-0.10	0.09	0.37	0.43	1		
SP	0.07	0.07	0.18	0.15	0.04	0.05	0.03	1	
TKW	0.59	0.56	-0.47	-0.18	0.43	0.52	0.39	-0.17	1

The results of combined analysis of variance (Table 4) not showed significant differences for genotypes, environments and GE interaction indicating the effect of environment in the GE interaction, genetic variability and possibility of selection for stable entries. GE interaction was significant, therefore we can further proceed and calculate phenotypic stability (Jalilnejad, 2002) Therefore, present trial was not GXE Significant difference among the genotypes not needed future analysis for stability because all genotype suitable tested environments. Out of tested genotype, Eritrea07-62#1 selected for verification Trail.

CONCLUSION

The analysis results of yield for the two year data indicated that genotype Eritrea07-62#1,ERETH07-86,ERETH07-40#1 and TseliEkli#1 higher yield (24,21.5,21and 20.8) quintal per hectare compared standard check Fetina (18) quintal per hectare those genotype superior than 15.56% to standard check. Therefore, genotype Eritrea07-62#1 and Tselim Ekli#1 was selected for verification trial for future released purpose. Genotype Eritrea07-62#1 higher grain yield also days to maturity the range of acceptable ranges 3-4 months.

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