

Agronomic Performance of Food Barley (*Hordeum vulgare* L.) Varieties and Their Response to Seed Rate at Elfeta District, West Showa Zone, Oromia National Regional State

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Abstract

Barley is one of the most important, economically valuable and widely used cereal crops in Ethiopia. However, barley yield and productivity is constrained by lack of improved varieties, use of unimproved production packages among which seed rate is major one. Hence, an experiment was conducted to identify better performing food barley variety and determine the optimal seed rate at Elfeta district of West Showa Zone of Oromia National Regional State in 2017 main cropping season. The experiment was laid out in a Randomized Complete Block Design with three replications. The treatments were factorial combination of three improved (Cross41/98, HB19/65, HB19/66 varieties) and one local cultivar, and four seed rates (75, 100, 125 and 150 kg ha⁻¹). The result of the study revealed that food barley varieties significantly differ in phenological parameters, such as days to 90% heading, grain filling period, and days to 90% maturity. Yield and yield components of barley including plant height, spike length, thousand seed weight and harvest index were significantly ($p < 0.01$) influenced by the main effect of variety and seed rate. However, total number of tillers, number of effective tillers, grains per spike, and grain, straw, and biomass yields were significantly ($p < 0.01$) influenced by interaction effect of variety and seed rate. Variety HB19/66 and seed rate of 125 kg ha⁻¹ gave significantly high grain yield (6.23 tons ha⁻¹). The highest net benefit of ETB 38,923 ha⁻¹ with marginal rate of return of 933% and value to cost ratio of ETB 27 per unit investment was obtained from use of 125 kg ha⁻¹ seeding rate for food barley. Therefore, use of HB19/66 variety with 125 kg ha⁻¹ seeding rate is profitable and recommended to the study area.

Key words: *Barley varieties, seed rate, yield, yield component*

Introduction

Barley (*Hordeum vulgare* L.) is one of the most important, economically valuable and widely used cereal crops. It is the oldest cultivated crops and has been grown in the highland parts of Ethiopia and various sources agree that it has been in cultivation for at least the past 5000 years and it is cultivated in all regions of the country (Kemelew and Alemayehu, 2011; Girma, 2014). According to Hadado *et al.* (2010), landraces represent over 90% of the cultivated barley diversity of Ethiopia and reflect deeply rooted and ancient relationship between barley and Ethiopian farmers.

Barley is the fourth most important cereal crop in the world after wheat, maize and rice (FAO, 2017) and is among the top ten crop plants in the world. Ethiopia is ranked 21th in the world in terms of barley production with a share of 1.2%

of the world's total production and the second largest barley producer in Africa, next to Morocco and followed by Algeria, accounting about 25% of the total barley production in the continent (Samuel, 2016). In Ethiopia, barely is a dependable source of food in the highlands as it is produced during the main and short rainy seasons as well as under residual moisture (Malle *et al.*, 2015). The main cropping season in most parts of Ethiopia is from June to September in the south western and central parts of Ethiopia (Wosene *et al.*, 2015). There are two types of barley in Ethiopia: food barley for human consumption and malt barley which can be converted into malt.

During 2016 /2017, cropping season barley covered 959,273.36 ha of land which is about 7.63% of the total land devoted to cereal and about 2, 024,921.68 tons of production, equivalent to 6.97% of the total cereal

production in the country and produce average yield of 2.11 ton ha⁻¹ (CSA, 2017). In Oromia National Regional State, its area coverage was 454,662.78 ha with total production of 1,093,944.81 ton and average yield of 2.41 tons ha⁻¹ (CSA, 2017). Although West Showa Zone represents a significant barley producing area, it was cultivated in more than 62,064.53 ha with a total annual production of 145,136.32 tons, with an average yield of 2.34 tons ha⁻¹ (CSA, 2017). In Elfeta district, where the experiment was conducted, barley is the first most important cereal crop in area coverage and second in terms of production next to maize. It covers 4346 ha with a total production of 11,338.8 tons, and 2.61 tons ha⁻¹ average productivity (EANRO, 2016).

Despite its importance and cultivation, the yield and productivity of barley in the country is low compared to its potential (Berhane *et al.*, 1996). Several abiotic and biotic factors have contributed to low productivity, such as poor crop management practices, use of inappropriate seed rate, use of low yielding cultivars, limited availability of improved varieties, poor soil fertility, pests and the inherently low yield potential of the existing local varieties (Woldeyesus and Chilot, 2002; Bayehe and Stefania, 2011).

Seeding rate is one of the most important factors in crop production. Higher grain yield with better quality requires appropriate seeding rate (Soomro *et al.*, 2009; Ali *et al.*, 2010). Increase in seed rate above optimum level may only enhance production cost without any increase in grain yield (Sajjad *et al.*, 2010). The optimum seed rate depends on different factors, the most important factors include: location, climatic conditions, soil, sowing time, and varieties. Since cultivars genetically differ for yield components, individual varieties need to be tested at a wide range of seeding rates to determine their optimum seeding rate (Wiersma, 2002). Therefore, the objectives of this study were to identify the better performing barley variety and to determine the economic optimum level of seed rate for barley production in the study area.

Materials and methods

Description of the study area

The study was conducted at Elfeta district, West Showa Zone of Oromia National Regional State, on farmer's training center during 2017 cropping season. Elfeta district is located 126 km far from Addis Ababa towards the West and 68km from Ambo to the North. The research was conducted at Falecha *kebele* which is 12 km far from Beke town in South West direction. The annual minimum and maximum temperatures of Elfeta area were 13 and 27 °C, respectively, with average temperature of 20 °C (EANRO, 2015). The main rainy season starts early June and goes up to end of September with total annual rainfall of 900 -1300 mm (EANRO, 2015). Geographical location of the study site lies between 8-9°N latitude and 37-38°E longitude at an altitude ranging from 1900–3100 m.a.s.l. Its soil type is Nitosol.

Treatments and Experimental Design

The experiment consisted of three food barley varieties (Cross 41/98, HB19/65, and HB19/66) and one local cultivar, and four seed rates (75, 100, 125, and 150 kg ha⁻¹). The treatment was laid out in Randomized Complete Block Design (RCBD) in factorial arrangement with three replications. Fertilizer was applied at the rate of 100 kg of NPS and 75 kg N/ha as per the recommendation of Ethiopia Ministry Agriculture (EMA, 2011). The full dose of NPS (18-38-7.5) and one third of N in the form of urea was applied at planting time close to seed drilling line. The remaining 2/3 of the nitrogen was applied at tillering stage (Getachew *et al.*, 2011). The fertilizer was applied uniformly to all plots. The plot size was 3 m * 2 m (6 m²) consisting of 10 rows of which one row is left as a border row on both sides of the plot to reduce the border effects. The yield data was collected from the eight central rows with a net plot size of 4.8 m², while other growth parameters were recorded from randomly selected pre-tagged 5 plants from those central rows in each plot. The spacing between rows and plots were 0.2 and 0.5 m, respectively. All agronomic practices were done following improved food barley production system.

Data collection and measurements

Data was collected on days to 50% of emergence, total number of tillers per plants, number of effective tillers per plants, days to

90% heading, grain filling period, days to 90% maturity, plant height, spike length, number of grains per spike, thousand seed weight, straw yield, biomass yield, grain yield and harvest index.

Statistical Analysis

The data was subjected to analysis of variance following Generalized Linear Model procedure of SAS software version 9.0 (SAS, 2004) and the interpretation was made following the procedure of Gomez and Gomez (1984). Significance differences between treatments were separated using the (LSD) test (Steel and Torrie, 1980) at 5% level of significance. Further analysis like correlation analysis was made to determine relations between phenological growth parameter, and yield and yield components.

Economic Analysis

The partial budget analysis was done following CIMMYT (1988) to determine the economic feasibility of seed rates of food barley varieties.

The average yield was adjusted downward by 10% to reflect the difference between the experimental yield and the yield farmers could expect from the same agronomic practices (CIMMYT, 1988). The analysis was done using the prevailing market prices for inputs at planting and for the output at the time of crop harvest. The net benefit was calculated as the difference between the gross field benefit (EB ha⁻¹) and the total costs (EB ha⁻¹) that varied.

Results and discussion

The Analysis of Variance showed that there was a significant ($P < 0.01$) effect of varieties on days to 90% heading, grain filling period and days to physiological maturity. Similarly both main effects of varieties and seed rate affect plant height, spike length, thousand seed weight, and harvest index ($P < 0.01$). Total number of tillers, number of effective tillers, number of grains per spike, grain yield, straw and biomass yields were significantly affected by the main effects of varieties and seed rate as well as by their interaction ($P < 0.05$; $P < 0.01$) (Table 1).

Table 1. Levels of significance for yield and yield components of food barley as affected by varieties, seed rate and their interaction.

Sources of Variation	DE	DH	GF	DM	NTT	TNET	PH	SL	TSW	HI	NGPS	GY	SY	BY
Varieties (V)	NS	**	**	**	*	*	**	**	**	**	**	**	**	**
Seed Rate (SR)	NS	NS	NS	NS	*	*	**	**	**	**	**	**	**	**
V x SR	NS	NS	NS	NS	*	*	NS	NS	NS	NS	**	**	**	**

DE = Days to emergence, DH = Days to heading, DF = Days to grain filling period, DM = Days to maturity, NTT = Number of total tillers, TNET = Number of effective tillers, PH = Plant height, SL = Spike length, TSW = Thousand seed weight, HI = Harvest index, NGPS = Number of grains per spike, GY = Grain yield, SY = Straw yield, and BY = Biological yield.

Days to 50% emergence: Analysis of variance indicated that days to 50% emergence of food barley was not significantly ($p < 0.05$) affected by varieties, seeding rates and their interaction (Table 1). Favorable soil environmental condition and suitable agronomic practice during the sowing time and good seed bed preparation might have contributed to similar date of emergence across the treatment combinations and their interaction. The same result was reported by Worku (2008) who concluded that seedling emergence was not

significantly affected by seeding rates and varieties.

Days to 90% heading, grain filling period and days to maturity: The days to 90% heading, grain filling period and days to physiological maturity of food barley was significantly ($P < 0.01$) influenced by main effects varieties (Table 1). However, seed rate and their interaction had no significant effect on days to 90% heading; grain filling period and days to maturity of food barley. The maximum day to heading was recorded on the variety Cross 41/98, while the

minimum was on the variety HB19/65 (Table 2). This could be due to genotypic difference between the food barley varieties. The result of this study agreed with the finding of Wosene *et al.*, (2015) who reported that genotypes differ in days to 50% heading.

Mean grain filling period of food barley which is the number of days from heading to maturity duration ranged from 35 to 52 days. The maximum (52) days to mean grain fuilling was observed in local cultivar, while HB19/66. Cross 41/98 and HB19/65 ranked second, third and fourth with mean value of 49, 44 and 35 days, respectively (Table 2). This result is supported by Smith and Hamel (1999) who reported genotypic variation in both duration and rate of grain filling.

Early heading permits a long grain filling period, during which photosynthetic components remain green improving grain filling leading to good grain yield of post anthesis assimilate which is important in cereals (Vaezi *et al.*, 2010). The local cultivar matured later (141 days) compared to other varieties, while Cross 41/98, HB19/66 and HB19/65 matured early (140, 140 and 119 days), respectively. This might be due to genetic improvement made on the released varieties and inherent genetic difference among the varieties of food barley. Similarly, Teshome (2017) reported considerable variation for days to maturity among different barley varieties when planted over years.

Table 2. Main effect of varieties and seed rate on phenology of food barley at Elfeta district

Varieties	Days to 50% emergence	Days to 90% heading	Grain filling period	Days to 90% maturity
Cross 41/98	5.5	89.08 ^a	44.42 ^c	139.75 ^a
HB19/65	5.83	73.00 ^c	35.17 ^d	118.83 ^b
HB19/66	6.08	87.33 ^{ba}	49.00 ^b	139.67 ^a
Local	5.83	85.75 ^b	52.17 ^a	140.67 ^a
Mean	5.81	83.79	45.19	134.73
LSD (5%)	NS	2.10	1.49	2.54
CV (%)	10.52	3.01	3.96	2.26

Means with the same letter(s) in the same column are not significantly different at 5% probability level. NS = non-significant

Total number of tillers and Number of effective tillers: Main effect of varieties as well as seed rate, and their interaction had significant ($p < 0.05$) effect on total number of tillers and number of effective tillers plant⁻¹ (Table 3). The higher total number of tillers per plant (6.37) was obtained from the food barley HB19/65 variety from 75 kg ha⁻¹ seed rate, while the lowest number of total tillers per plant (2.2) was recorded from local variety from 150 kg ha⁻¹ seed rate. Similarly, the highest number of effective tillers per plant (6) barley was obtained from the combination of variety HB19/65 and 75 kg ha⁻¹ seed rate, while the lowest number of effective tillers plant⁻¹ (2) was recorded from the local variety planted using a seed rate of 150 kg ha⁻¹. Such increment in number of effective

tillers with low seed rate could be the attribute of the tillering capacity of variety combined with less competition for the available growth resources. The lower number of tillers plant⁻¹ from local variety under increased seed rates might be the result of high resource competition between plants in the growing season and inherent characteristics of the cultivar as well. Tiller production is considered as an inherent genotype features but it is limited by seed rate, which could be associated with resource sharing. Gomez (2001) reported that number of tillers plant⁻¹ is influenced by seed rate, nature of the cultivar and environmental factors.

Table 3. Interaction effects of variety and seed rate on total number of tillers and effective tillers of food barley varieties at Elfeta district

Varieties	Seed rate (kg ha ⁻¹)									
	Total number of tillers					Number of effective tillers				
	75	100	125	150	Mean	75	100	125	150	Mean
Cross 41/98	6.23 ^{ab}	5.73 ^{de}	5.3 ^{ef}	4.53 ^g	5.45	5.73 ^b	5.53 ^{bc}	4.4 ^{fc}	3.8 ^{hg}	4.87
HB19/65	6.37 ^a	5.8 ^{ba}	5.6 ^{bc}	5.2 ^f	5.74	6.2 ^a	5.2 ^{dc}	4.8 ^{dc}	4.13 ^{fg}	5.08
HB19/66	6 ^{bc}	5.47 ^{def}	4.77 ^g	4.13 ^h	5.09	5.8 ^{ab}	4.93 ^d	4.27 ^f	3.4 ^{hi}	4.60
Local	3.63 ⁱ	3.3 ⁱ	2.6 ^j	2.2 ^k	2.93	3 ⁱ	2.4 ^j	2 ^{kj}	1.67 ^k	2.27
Mean	5.56	5.08	4.57	4.02		5.18	4.51	3.87	3.24	
LSD			0.34					0.44		
(5%)										
CV (%)			4.18					6.31		

Means with the same letter(s) are not significantly different at 5% probability level

Plant height: The analysis of variance indicated that both variety and seeding rate had highly significant ($p < 0.01$) effect on plant height of food barley varieties (Table 4). Whereas, the interaction effect of variety and seed rates did not show significant effect on plant height. Variations of plant heights were observed among different varieties of food barley. The difference in mean plant height of food barley varieties was attributed to difference in their genetic makeup and seeding rate. The tallest plant height was recorded on the local variety (103 cm) followed by HB19/66 (97 cm), Cross 41/98 (94 cm) while HB19/65 was relatively the shortest (81 cm) in plant height. This finding agrees with El-banna *et al.*, (2011) who reported variations in plant height in different barley and

wheat genotypes. As seeding rate increased from the lowest (75 kg ha⁻¹) to the highest (150 kg ha⁻¹), the height of the food barley correspondingly increased from 90 to 97 cm (Table 4). When seeding rate was increased competition was also increased leading to weaker and taller stems. Similarly, Soomro *et al.*, (2009) noted that high seeding rate produced greater plant height compared to low seeding rate.

Table 4. Mean performances of varieties for seed rate on plant height of food barley at Elfeta district

Varieties	Plant height (cm)	Seed Rate (kg ha ⁻¹)	Plant height (cm)
Cross 41/98	94.15 ^c	75	90.35 ^b
HB19/65	80.93 ^d	100	91.93 ^b
HB19/66	96.9 ^b	125	95.00 ^a
Local	102.55 ^a	150	97.25 ^a
Mean	96.63	Mean	93.63

LSD (5%) = 2.63 CV (%) = 3.37

Means with the same letter(s) in the same column of the trait are not significantly different at 5% probability level.

Spike length, thousand seed weight and Harvest index: The analysis of variance indicates that spike length, thousand seed weight and harvest index of food barley were significantly ($p < 0.01$) affected by varieties and seeding rates but their interaction was non-significant (Table 5 and Table 6). HB19/65 variety ranked first followed by Cross 41/98, HB19/66 and local cultivar by producing 8, 7, 6 and 5 cm spike length, respectively. Likewise, Khan *et al.*, (2002) reported that varieties have different genetic potential regarding the spike length. The maximum spike length (7cm) was recorded from those plots which received seeding rate of 75 kg ha⁻¹ while minimum spike length (6cm) was obtained from plots which received seed rate of 150 kg ha⁻¹ (Table 6). This might be due to more free space between plants at the lower seed rates and less intra-plot competition among plants for available resources that resulted in higher spike length. The present result is agreement with the finding by Gafaar (2007) who stated that increasing sowing density significantly decreased spike length.

The present results also revealed the presence of variation in thousand seed weight among the varieties. The highest and lowest mean thousand seed weights were obtained from HB19/66 (49 g) and HB19/65 (38 g) barley varieties, respectively (Table 5). This may be due to the genetic behavior of HB19/66 variety favored by environmental factors which might led to an increased photosynthesis process and accumulations of carbohydrate in the grain to produce heavy seed and attributed to their inherent potential. The highest thousand seed weight (46 g) was recorded for seed sown at the seeding rate of 75 kg ha⁻¹ whereas the lowest thousand seed weight (41 g) was recorded at the seeding rate of 150 kg ha⁻¹ (Table 6). The result showed that when seeding rate increased from 75 to 100, 75 to 125 and 75 to 150 kg ha⁻¹, it decreased thousand seed weights by 3.12, 7.36 and 12.25%, respectively. This might be attributed to increased competition for resources within and between plants due to increased number of plants per unit area. Similarly, Baloch *et al.* (2010) reported that thousand seed weight decreased with increase in seeding rate.

Table 5. Mean performances of food barley varieties for spike length and thousand seed weight at Elfeta district.

Treatments	Spike length (cm)	Thousand seed weight (gm)	Harvest index (%)
Cross 41/98	6.89 ^b	39.55 ^c	40.20 ^a
HB19/65	7.59 ^a	38.20 ^c	37.22 ^b
HB19/66	5.83 ^c	49.42 ^a	41.22 ^a
Local	4.66 ^d	47.21 ^b	32.94 ^c
Mean	6.24	43.6	37.9
LSD (5%)	0.16	1.40	1.12
CV (%)	3.06	3.86	3.55

Means with the same letter(s) in the same column is not significantly different at 5% probability level

Variety HB19/66 and Cross 41/98 had the highest (41.22 and 40.20 %) harvest index relative to other genotypes while the local cultivar showed the lowest harvest index (32.94%) (Table 5). The presence of highest harvest index in variety HB19/66 revealed its capacity to efficiently distribute the dry matter produced to sink organ compared to other varieties. Harvest index is an indicator of plant efficiency to distribute dry matter in grain

(Shahryari and Mollasadeghi, 2011). Seed rates of 75 and 150 kg ha⁻¹ produced the maximum (40.6%), and minimum (35.11%) harvest index, respectively (Table 6). This could be due to competition of resource at high plant population under high seed rated treatments. The present result was in line with Zeng and Shannon (2000) who reported that at high density carbohydrate supply was limited, and thus resulted in the reduction of harvest index. Similarly, previous

results of Zaheer *et al.*, (2000) showed reduction of harvest index due to high seed rate per unit area.

Table 6. Mean performances of food barley varieties for spike length and thousand seed weight under different seed rates at Elfeta district

Varieties	Spike length (cm)	Thousand seed weight (gm)	Harvest index (%)
Seed rate (kg ha ⁻¹)			
75	7.02 ^a	46.22 ^a	40.61 ^a
100	6.46 ^b	44.78 ^b	38.57 ^b
125	5.95 ^c	42.82 ^c	37.29 ^c
150	5.55 ^d	40.56 ^d	35.11 ^d
Mean	6.25	43.6	37.9
LSD (5%)	0.16	1.40	1.12
CV (%)	3.06	3.86	3.55

Means with the same letter(s) in the same column is not significantly different at 5% probability level

Number of grains per spike and grain yield:

The analysis of variance indicated that the main effect of varieties, seed rate and their interaction significantly ($p < 0.01$) affected number of grains per spike and grain yield of food barley (Table 7). The combination of HB19/65 food barley variety with seed rate of 75 kg ha⁻¹ produced the highest number of grains per spike (72.9) while, a smaller number of grains per spike (29.7) was recorded from the local cultivar with seed rate of 150 kg ha⁻¹. This could be due to the effect of highest number of plant population in local cultivar at seed rate of 150 kg ha⁻¹ than number of plant population in variety HB19/65 at seed rate of 75 kg ha⁻¹. During grain filling period,

the foods translocated from leaf could be less because of high competition under highest seed rate, as a result low grains would be produced. Seed rates up to 100 kg ha⁻¹ gave higher number of grains per spike for all the varieties, while seed rates of 125 and 150 kg ha⁻¹ gave fewer grains per spike. This result agrees with finding of Essam and Abd (2014) who reported that the higher grain number was obtained in the lowest seed rate can be attributed to more light penetration through plant canopy. Many reports have also shown variation of number of grains per spike as a function of barely genotype (Alam *et al.*, 2007; Rashid and Khan, 2008).

Table 7. Interaction effects on number of grains per spike and grain yield of food barley at Elfeta district

Varieties	Seed rate (kg ha ⁻¹)									
	Number of grains per spike					Grain yield (ton ha ⁻¹)				
	75	100	125	150	Mean	75	100	125	150	Mean
Cross41/98	55.07 ^e	50.93 ^f	44.2 ^h	39.7 ^{ji}	47.48	4.7 ^g	4.98 ^f	5.4 ^{ed}	5.53 ^{ed}	5.15
HB19/65	72.87 ^a	64.53 ^b	61.13 ^c	57.5 ^d	64.02	4.47 ^g	4.72 ^g	5.19 ^{ef}	5.47 ^d	4.96
HB19/66	54.4 ^e	47.93 ^g	42.87 ^h	40.4 ⁱ	46.40	5.1 ^f	5.77 ^{cb}	6.23 ^a	5.96 ^b	5.77
Local	37.47 ^{jk}	35.67 ^{lk}	33.6 ^l	29.7 ^m	34.10	2.89 ⁱ	2.99 ^{ih}	3.12 ^{ih}	3.14 ^h	3.04
Mean	54.95	49.77	45.45	41.83		4.29	4.62	4.99	5.03	
LSD (5%)			2.46					0.25		
CV (%)			3.07					3.2		

Means with the same letter(s) are not significantly different at 5% probability level

The interactive effect indicated that the maximum grain yield (6.23 ton ha⁻¹) was observed when HB19/66 varieties planted with seed rate of 125 kg ha⁻¹, whereas minimum grain yield (2.89 ton ha⁻¹) was recorded when local cultivar planted with 75 kg seed rate ha⁻¹. The higher grain yield in the higher seeding rates

Straw yield and biomass yield: The main effect of variety, seeding rate and their interaction were significantly ($p < 0.01$) affected straw yield and biomass yield of food barley (Table 8). The highest (10.51 and 9.9 ton ha⁻¹) straw yield of food barley was observed from the HB19/66 and HB19/65 varieties with seeding rate of 150 kg ha⁻¹, while the lowest (5.38 ton ha⁻¹) straw yield was found from local cultivar with seeding rate of 75 kg ha⁻¹. There was a linear increase in straw yield as the seeding rate increased from the 75 to 150 kg ha⁻¹. This might be due to the fact that higher seeding rates resulted in more plant population and plant height which resulted in higher straw yield. This result is in harmony with Ali *et al.*, (2010) who reported that as seeding rate

was associated with higher spike number or plant population ha⁻¹. The present result is also in agreement with Haile *et al.*, (2013) who reported that grain yield reduced with low seeding rate depending on the variety, soil fertility, and the suitability of the growing environment.

increased, correspondingly straw yield increased due to higher stand number at crop establishment period.

The interaction result showed that the highest biomass yield (16.47 ton ha⁻¹) was produced when HB19/66 variety planted with seed rate of 150 kg ha⁻¹. On the other hand, the lowest biomass yield (8.26 ton ha⁻¹) was produced from the local cultivar with 75 kg ha⁻¹ of seed rate. The higher biomass yield with increased seed rate might be due to an increase in plant population and straw yield ha⁻¹. Similarly, Jemal *et al.*, (2015) reported that higher biomass and biological yields with the increased seeding rates.

Table 8. Interaction effects of varieties and seed rate on the straw yield and biological yield (ton ha⁻¹) of food barley at Elfeta district

Varieties	Seed rate (kg ha ⁻¹)									
	Straw yield (ton ha ⁻¹)					Biological yield (ton ha ⁻¹)				
	75	100	125	150	Mean	75	100	125	150	Mean
Cross41/98	6.46 ^g ^h	7.27 ^d ^f ^e	8.08 ^c	9.05 ^b	7.72	11.16 ^g	12.25 ^f	13.47 ^e ^d	14.58 ^c ^b	12.87
HB19/65	6.73 ^g ^h	7.96 ^d ^c	9.11 ^b	9.9 ^a	8.43	11.20 ^g	12.68 ^e ^f	14.3 ^c ^d	15.44 ^b	13.41
HB19/66	6.16 ^h	7.74 ^d ^c ^e	9.12 ^b	10.51 ^a	8.38	11.26 ^g	13.5 ^e ^d	15.35 ^b	16.47 ^a	14.15
Local	5.38 ^j	5.9 ⁱ ^j	6.56 ^g ⁱ ^h	7.08 ^g ^f ^e	6.23	8.26 ^j	8.89 ⁱ ^j	9.67 ^h ⁱ	10.22 ^h	9.26
Mean	6.18	7.22	8.22	9.14		10.47	11.83	13.20	14.18	
LSD (5%)			0.78					0.89		
CV (5%)			6.05					4.28		

Means with the same letter(s) are not significantly different at 5% probability level

Correlation between growth parameters, yield and yield components of food barley

The correlation of food barley agronomic parameters was quantified and strong correlation was observed between some of barley yield components (Table 9). Grain yield showed positive and highly significant correlation with its components such as effective number of tiller (0.56), biomass yield (0.90) and thousand seed weight (0.80). Increment in the values of these parameters was associated with an increase of

grain yield as well and vice versa. In line with the present finding, Kiflu (2009) also reported significant and positive correlation between grain yield with harvest index, grain yield with biological yield, and thousand seed weight with grain yield. Biomass yield positively and highly significantly correlation with number effective tiller plant⁻¹ (0.59), number of grains per spike (0.90), grain yield (0.90) and plant height (0.62). Biological yield had positive correlation with grain yield, spike, spike yield and number of

grains per spike (Shahryari and Mollasadeghi, 2011). Straw yield was highly and positively correlated with biomass yield (0.91) and plant height (0.65) (Table 7). Similarly, harvest index was positively and highly significantly correlated with grain yield (0.61), effective

number of tiller (0.80) and straw yield (0.57). In agreement with the present finding, Riggs (1981) reported highly meaningful and positive correlation between harvest index and grain yield in barley.

Table 9. Correlation between yield and yield component of food barley at Elfeta. district

	GY	NET	BY	NGPS	SL	PH	HI	TSW	SY
GY									
NET	0.56**								
BY	0.90**	0.59**							
NGPS	0.37	-0.84**	0.90**						
SL	0.41	0.89**	0.29	0.93**					
PH	-0.28	-0.71**	0.62**	-0.92**	-0.86**				
HI	0.61**	0.80**	0.27	0.48	0.57**	-0.31			
TSW	0.80**	-0.20	-0.49	-0.38	-0.48	0.51	0.15		
SY	-0.63**	0.56*	0.91**	0.09	0.12	0.53*	-0.09	-0.63**	

GY = Grain yield, NET = Number of effective tillers, BY = Biological yield, SL = Spike length, PH = Plant height, NGPS = Number of grains per spike, HI = Harvest index, TSW = Thousand seed weight, and SY = Straw yield.

Effects of seed rates on economic feasibility of food barley production

The partial budget analysis result indicated that the highest net benefit ETB 38,976 ha⁻¹ with marginal rate return of 18% and with the cost-benefit ratio of 22 ETB per unit of investment was obtained from of 150 kg ha⁻¹ seed rate of food barley (Table 10). The second higher net

benefit of ETB 38,923 ha⁻¹ with marginal rate of return (933 %) and cost-benefit ratio of ETB 27 per unit investment was obtained from the use of 125 kg ha⁻¹ seeding rate for food barley. Therefore, use of 125 kg ha⁻¹ seeding rate for food barley was profitable and recommended for food barley production.

Table 10. Partial budget analysis of seed rate for food barley production at Elfeta district

Seed rate (kg ha ⁻¹)	Grain yield (kg ha ⁻¹)	Adjusted grain yield (kg ha ⁻¹)	Gross field benefit (EB ha ⁻¹)	Total variable cost (EB ha ⁻¹)	Net benefit (EB ha ⁻¹)	Value to cost ratio	Marginal rate of return (%)
75	4289	3860	34743	869	33874	39	–
100	4614	4153	37375	1159	36216	31	888
125	4984	4486	40372	1449	38923	27	933
150	5027	4524	40715	1739	38976	22	18

Cost of improved seed (14.68 birr/kg), local seed (8.5 birr/kg) and average cost of seed 11.59 birr/kg; 9 birr/kg was the value of barley at harvesting on local markets.

Conclusion and Recommendation

This study showed that there were large variations among improved food barley varieties in almost all the agronomic performances. However, variety and seed rate significantly affected plant height, spike length, thousand

seed weight and harvest index of food barley. Number of effective tillers, number of grains per spikes, grain and biological yields of food barley were highly influenced by the interaction effect of variety and seeding rate. HB19/66 variety gave maximum grain yield (6.23 ton ha⁻¹) in the present study area and hence can be

recommended for farmers to use at Elfeta district. Seed rate of 125 kg ha⁻¹ exhibited better agronomic performance and economic feasible, and hence it can be promoted to increase grain yield of improved food barley in the study area.

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