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Seeding Rate and Varieties Effect on Food Barely (*Hordeumvulgare spp. vulgare* L.) Yield and Yield Components at Duna District, Southern Ethiopia

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Key words: Food barely, Seed rate, Variety.

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Abstract

This study was to evaluate the effects of different row spacing and variety and to determine the optimum row spacing for maximum productivity of different food barleyvarieties; a study was conducted at Duna district, Southern Ethiopia from July to December 2018. Four barely varieties (Shadiho (3381-01), HB 1307, HB 42, and Shagee) and three seed rates (75,100 and 125kg ha^{-1}) and RCBD with three replication were used. The results showed that 50% heading, days to physiological maturity, spike length, number of kernel per spike, thousand kernel weight,grain yield andabove ground biomass were highly significantly ($P<0.01$) affected by the main effects of variety and seed rate whereas,grain filling period and harvest index (HI)were highly significantly ($P<0.01$) affected only by variety.Number of tillers, and number of productive tillers were highly significantly ($P<0.01$) affected by the main effect of the seed rate and interaction. Among the varieties, Shedho (3381-01) took longest days to heading (71), maturity (115.67) and grain filling (44), while the earliest was BH 1307 variety. This variety produced the longest spike (8.933cm), highest number of kernel per spike (51.33), highest grain yield (4.424 t ha^{-1}) and HI (38.7%). HB 42 gave the lowest 1000 weight (35.76g). Variety Shagee gave the highest biomass (14.52 t ha^{-1}), lowest grain yield (3.803 t ha^{-1}), and produced shortest spike (7.29cm). Furthermore, the interaction effect of variety and seed rate significantly affected plant height, number of tillers, and number of productive tillers. Based on the agronomic performance of this study variety HB 1307 of food barely at seed rate 125 kg ha^{-1} was recommended for Duna district.

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Introduction

Barley (*Hordeumvulgare spp. vulgare* L.) is one of the oldest crops cultivated in the world. Archaeological evidence from the Fertile Crescent suggests that the crop was domesticated from its wild ancestor some 10,000 years ago (Hordeuumspontaneum C. Koch).The crop is an important feed, malt, and food crop in Russia, Canada, Australia, Ukraine, Turkey, Spain, Morocco, Germany, Kazakhstan, Iran, Syria, USA, France, Polland, Ethiopia, and UK FAO (2008). It is one of the major cereal crops that are largely produced in the central and southeast mid- and high-altitudes of Ethiopia. It is the fifth most important cereal crop after tef, maize, wheat and sorghum CSA (2006). It is cultivated in almost all regions of the country having an altitude ranging from 1,400–over 4,000 meters above sea level. It is the most desirable crop in the highlands where there is a limited alternative crop (Yosef, Kebede and Senayit, 2011). Barley covers 10% of the land under crop cultivation (ICARDA, 2013). Barley is a hardy crop grown in a wide range of agro-climatic regions under several production systems that can be grown for providing food, beverages, and other necessities to millions of smallholder farmers. Barley is mostly farmed in Ethiopia as a low-input staple food crop at higher elevations, on steep slopes, degraded plains, and in moisture-stressed places. The diversity of barley ecologies is high, with a large number of folk varieties and traditionalpractices existing in Ethiopia, which enables the crop to be more adaptable in the highlands (Fikadu and Berhanu, 2002).

Duna district has suitable agro ecology for food barley productions. Its grain is used to make a variety of foods, including Injera, Kolo, and indigenous alcoholic beverages like Tela. The straw is also used asanimal feed, especially during the dry season Asresie *et al.*, (2015). However, the productivity of the crop hasbeen consistently much lower than its potential production due to lack of advanced agronomic managementpractice. Among the factors responsible for low crop yield are, delay in sowing, traditional sowing methods, lowseed rate, improved seed varieties and improper row spacing are-very important ATA, (2015). Appropriateagronomic practice play important role in boosting yield of crops because it influences solar radiationinterception, total sunshine reception, nutrient uptake, rate of photosynthesis and other physiological phenomenaand ultimately affects the growth and development of plant production Faisul *et al.,* (2013). Lack of improved varieties and inappropriate row spacing is a serious constraint in Duna district as far asfood barley production concerned. It is important to evaluate the agro-morphological traits in relation to yieldand yield components of the improved varieties.

The total area covered by barley in Ethiopia is 811,782.08 hectares and total annual production of about 1,767,518.447tons with the productivity of 2.177 t ha^{-1} in the 2016/2017main cropping season. In addition, the total area covered bybarley in Southern Region is about 238164.36 hectares with atotal production of 481,769.434 tons, and its productivity is2.023 t ha^{-1} CSA, (2016). According to the Hadiya zone reportin the 2017 main cropping season, the total productivity ofmalt barley is 1.98 t ha^{-1}. This shows that the zone's productivity is still lower below the national and regional averages. The main reasons for low yield of barleyare as follows: low-yielding capability by farmers and cultivars; dominant varieties in use; the influence of biotic andabiotic stresses; and the minimal promotion of improvedbarley production technologies. Several abiotic factors havecontributed to this low productivity, such as poor soil fertility;water logging, drought, frost, and soil acidity; humblecrop management practices; use of naturally low yield potentialof the predominant local varieties; and limitedavailability of the very few better-quality cultivars released and low level of technology Deressa *et al.*, (2005).

The low productivity of the crop could be due to lack of adoption of improved varieties and improved management practices such as using inappropriate seed rates. Barely being highly sensitive to poor agronomic practices, the selection of the topic for the present study assumed to be important by keeping in view that different wheat varieties and seeding rates could influence the production and productivity of the crop. Similarly, the growth, yield and yield components of barely can be tested under influence of seeding rate and varieties could address the current problem of wheat production in the study area. However, so far in the area, appropriate seeding rate of barely has not been reported. So this study is a paramount influence to introduce food barley varieties with the appropriate inter row spacing so as to increase theproduction and productivity of food barley in Duna district. Therefore, this study was initiated with the followingobjectives: - To evaluate the effects of different row spacing and variety on agro-morphological traits and todetermine the optimum row spacing for maximum productivity of different food barley.

Materials and methods

Study area description

The experiment was conducted at Kenkicho Keble farmers training center station in Duna district, Hadiya Zone of the Southern National Regional State during the 2018 main cropping season. The experimental site is located at 267 km away from Addis Ababa. The site is situated at 11°5` N latitude and 39° 44`E longitude with an elevation 2400 meters above sea level. The average maximum annual temperature is 26.12 °C and the average minimum temperature is 8.8°c. The rainfall in the area is characterized by bimodal distribution pattern and the main rainy season (*Meher*) is between June and end of September and (*Belg*) is from late February to late March/early April. The rain season occurs during June to September and the maximum rain is received in the month of July and August. The average annual rainfall was 1800 mm HZARDO. (2017)

Description of the Experimental Materials

Treatments and Experimental Design

Twelve treatment combinations of four food barley varieties (HB 1307, HB 42, Shagee, and Shedho (3381-01) and four seed rates (75, 100, and 125 kgha^{-1}) were tested. A factorial arrangement in Randomized Complete Block Design (RCBD) with three replications was used. The gross plot size was 11 rows (3 m×2.2 m = 6.6 m2) and the net plot consisted of 9 rows of 2.5 m length (2.5 m×1.8 m = 4.5 m2). The spacing between plots and blocks were 0.5 and 1 m, respectively and the spacing between rows was 20 cm.

Data collection and measurements

Days to heading: Days to heading was recorded whenabout 50% of the plants in plot-produced spikes.

Days to maturity: Days to maturity was recorded whenabout 90% of the plants reached physiological maturity.

Plant height (cm): It was measured at physiologicalmaturity from the soil surface to the top of the spike (awnsexcluded) from 5 randomly selected plants in the centralharvestable row.

Spike length (cm): This was measured from the bottom ofthe spike to the tip of the spike excluding the awns from 5randomly selected spikes from each plot.

Number of productive tiller (m-2): This was determined bycounting all the spikes producing seeds in 1m^2 takenrandomly from two places in each net plot area.

Kernels spike-1: It was determined by counting the numberof kernels per spike from randomly selected five spikes per plot from harvestable rows.

Thousand kernels weight (g): thousand seeds was counted using seed counter and measured in gram to calculate the weight.

Above ground biomass yield (t ha^{-1}): This was determinedas the weight in t ha-1 of sun-dried above ground parts of theplants that was obtained from harvestable rows. Grain yield (t ha^{-1}): It was determined at physiologicalmaturity from the harvestable ten rows and converted in to t ha-1 after adjusting it at12% moisture content. Harvest Index (%): It was calculated as the ratio of grainyield to total above ground biomass yield.

Statistical Analysis

The data were subjected to analysis of variance (ANOVA) as per the experimental designs for each experiment using GenStat, (2012), 15th edition statistical software package General Linear Model (GLM). The Least Significance Difference (LSD) test at 5% level of probability procedure was used to determine differences between treatment means.

Result and discussions

Crop Phenology and Growth Parameters

Days to heading

Results showed that the main effect of variety and seeding rates had significant ($P<0.01$) effect on the number of days from sowing to heading. However, the interaction effect of seed rate and variety was not significant influence on days to heading of food barely variety (Table 2).

Variety HB 1308 reached days to heading significantly earliest (64.11days) while variety Shedho(3381-01) was significantly late (71.44 days) as compared to the other varieties (Table 3). The difference in days to heading among varieties was significant and this difference could be attributed to the genetic factor.

In line with this, varietal differences with respect to heading and flowering in rice crop were reported by Dingkuhn *et al*., (1999). Similarly, the result of this study agreed with the finding of Wosene *et al*., (2015) who reported that genotypes differ in days to 50% heading.

Table 1. Four bread wheat varieties were used.

Varieties	Adaptation area (m.a.s.l)	Maturity days	Yield t ha^{-1}	Year of release	Institution
Shedho (3381-01)	2400-3300	123-135	2.4-2.8	2002	KARC/EIAR
HB 1307	2000-2600	100-120	3.3-5.2	2005	KARC/EIAR
HB 42	2000-2300	120	2.3-3.5	1986	KARC/EIAR
Shagee	20200-3000	110-145	2.3-5.1	1996	KARC/EIAR

Source MoARD, (2014) KARC=Kulumsa Agricultural Research Center, EIAR= Ethiopian Institute of Agricultural research.

Increasing seeding rate from 75 kg ha^{-1} to 125 kg ha^{-1} increased number of days from sowing to 50% heading significantly. It could be due to the reason that growing wheat in low density shortened the vegetative growth period because of the availability of enough resources which resulted in acceleration of flowering and pushing plants towards reproductive phases after establishing good foliage. The present study agrees with that of Seleiman *et al*., (2010) who reported that increasing seeding rates from 250 seedsm^{-2}to 400 m^{-2} caused a significant increase in the number of days from sowing to 50% heading in wheat.

Days to physiological maturity

The main effect of variety and seeding rates had high significant ($P<0.01$) effect on days tophysiological maturity while the interaction effect of seed rate and variety did not show significant effect (Table 2). Variety HB 1307 reached significantly matured early, while variety Shadho (3381-01) was late as compared to others. Such variations in the duration of Phenological periods indicate the possibility of selecting genotypes that mature earlier and adapt well in moisture deficit environments of food barely. There were significant maturity period among the varieties.

Similarly, Teshome *et al*., (2017 reported considerable variation for days to maturity among different barley varieties when planted over years.

Grain filling period

The analysis of variance showed that the main factor of variety had significant ($P<0.01$) effect,but seed rate as well as the interactions (variety and seed rate)did not significantly affect (Table 2) grain filling period.

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

Variety	Days to heading	Days to physiological maturity	Grain filling period (day)
Shedho (3381-01)	71.44[a]	115.67[a]	44.89[a]
HB 1307	64.11[d]	99.44[d]	39.67[b]
HB 42	69.78[b]	105.67[c]	36.89[c]
Shagee	68.11[c]	107.44[b]	37.89[c]
LSD (5%)	1.441	0.755	1.088
Seed rate (kg ha^{-1})			
75	66.92[c]	105.92[c]	39.25
100	68.17[b]	107.17[b]	40.08
125	70.00[a]	108.08[a]	40.17
LSD (5%)	1.248	0.654	Ns
CV (%)	2.2	0.7	2.8

Means with the same letter(s) in the same column are not significantly different at 5% probability level, LSD (5%) = least significant difference at 5% probability level, CV (%) = coefficient of variation.

The longest duration (44.89 days) of grain filling period was recorded for Shadho (3381-01) variety, while the shortest duration (36.89 days) was for HB 42 (Table 2).Variety with the longest grain filling period might be due to the time needed for plants to uptake the nutrient in the soil.This result is agreed by Smith and Hamel (1999) who reported genotypic variation in both duration and rate of grain filling.

Plant height

The analysis of variance showed that the main factors (variety and seed rate) and the interaction had high significant effect on plant height (Table 3).

The tallest (103.07 cm) and shortest (89.23 cm) plants were observed in the interaction between Shadho (3381-01) variety at seed rate of 125 kg ha^{-1} and Shagee variety which were sown at the seed rate of 75 kg ha^{-1} respectively (Table 3). The result shows that significantly longest plants were at the higher (125 kg ha^{-1}) seed rate.This might be due to high competition among wheat plants for common resources at higher seeding rate. For all varieties plant height increased as seeding rate increased. 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 (125 kg ha^{-1}) When seeding rate was increased competition was also increased leading too weaker and taller stems. Similarly, Soomro (2009) noted that high seeding rate produced greater plant height compared to low seeding rate.

Yield Components and Grain Yield

Number of tillers

The number of tillers was significantly ($P<0.01$) affected by seed rate, and the interaction effect showed significant effects ($P<0.05$) on number of tillers, but varieties did not show significant effect.The highest number of tillers (66.00) was obtained from the interaction between Shadiho (3381-01) variety and seed sown at the rate of 75 kg ha^{-1}, while the lowest (47.67) was recorded from the interaction between Shadho(3371-01), HB 1307 and Shagee varieties seeds sown at the rate of 125 kg ha^{-1} (Table 4). This implies that as seed rate increased from 75 to 125 kg ha^{-1} the number of tillers decreased by 27.8%.The decrease in number of tillers due to increased seed rate is it might be resource limitation at higher seed rate. Otteson (2007) reported that number of tillers plant^{-1} is influenced by seed rate, nature of the cultivar and environmental factors.

Number of productive tillers

The analysis of variance indicated that the main effect of seed rate and the interaction effect had significant ($P<0.01$) and significant ($P<0.05$) effect on number of effective tillers respectively, but variety showed non-significant effect (Table 5).

Table 3. Interaction effects of seed rate and varieties on plant height (cm).

	Seed rate (kg ha^{-1})		
Varieties	75	100	125
Shedho (3381-01)	106.6^{d}	107.7^{cd}	109.5^{a}
HB 1307	103.5^{e}	107.0^{cd}	107.4^{cd}
HB 42	108.1^{bc}	109.4^{ab}	109.4^{ab}
Shagee	86.9^{g}	96.2^{f}	97.0^{cd}
LSD	1.322		
CV %	0.8		

Means followed by the same letter case in a rowand column are not significantly different from each other at 5 % level of significance.

The highest number of productive tillers per 1 m row length (47.33) was obtained from the interaction between varieties HB-1307 at seed rate of 75 kg ha^{-1}, while the lowest productive tillers per 1m row length (41.67) was obtained from the interaction between varietiesShagee at seed rate 125 kg ha^{-1} (Table 5). The higher population in 125 kg ha^{-1}might have resulted in more intra-specific competition for limited resources, thus late growing tillers might be died because of high competition and resulted in low number of productive tillers would formed per 1 m length row. Otteson (2007) reported that number of tillers plant^{-1} is influenced by seed rate, nature of the cultivar and environmental factors.

Spike Length

Analysis of variances showed that the main factors of seed rate and varieties had highly significant (P<0.01) effect on the spike length, but the interaction did not show significant effect (Table 6).

Variety HB 1307 produced significantly the longest spike length of 8.933cm while, variety Shagee produced significantly the shortest spike length of 7.289cm (Table 6). This result was in agreement with that of Jaama *et al.*, (1998) who reported that individual genotypes responded differently to spike length. Seeding rate 75 kg ha^{-1} and the 125 kg ha^{-1} produced significantly the longest and shortest spike length respectively. As seed rate increased from 75 kg ha^{-1} to 125 kg ha^{-1}, the spike length declined by 22.5 %. This might be due to more free space between plants at the lower seed rates and less intra-plant competition for available resources that resulted in higher spike length and shorter plant height.

The result was also in agreement with Jaama *et al.*, (1998) who reported reduced spike length, fewer spikelet per spike and kernels per spikelet of triticale with increased seeding rate or plant density. Similarly, Mosalem *et al.*, (2002) reported that increasing seeding rates decreased the number of spikelet's per panicle, spike length, number and weight of grains per spike in wheat. Furthermore, Gafaar, *et al.*, (2007) found that increasing sowing density from 200 up to 400 grains m^{-2}significantly decreased spike length.

Number of kernels per spike

The result of analysis of variance showed that the main effect of variety and seed rate had highlysignificant (P<0.01) effecton the number of kernels per spike, while the interaction was non-significant (Table 6).

Variety HB 1307 produced significantly the highest number of kernels per spike (51.32) while, the lowest (42.93) was recorded from the variety Shagee (Table 6). Igor (2013) also stated that the wheat genotypes did not influence the number of grains per ear obtained in distinct seeding densities. However, the current study result was in contrast from the result of Majid (2012) who reported that significant differences were found among cultivars in terms of the number of kernels spike^{-1}.The significantly highest (49.16) and lowest (43.38) kernel number were observed due to 100 and 150 kg ha^{-1}seed rate respectively. As the seed rate was increased from 75 kg ha^{-1} to 125 kg ha^{-1}, the number of kernels per spike decreased by 11.8%.This is due to increasing seed rate, increased competition to receiving nutrients and sun light at later stages, and finally most flowers would fade at early stages, because of competition between growing grains to absorbing reserved matters and as a result low grains would be produced. Many reports have also shown variation of number of grains per spike as a function of barely genotype Alam *et al.,* (2007).

Table 4. Interaction effects of seed rate and varieties on number of tillers.

	Seed rate (kg ha^{-1})		
Varieties	75	100	125
Shedho (3381-01)	66.00^{a}	53.00^{c}	47.67^{d}
HB 1307	62.00^{ab}	54.33^{c}	47.67^{d}
HB 42	60.33^{b}	52.67^{c}	52.00^{c}
Shagee	63.67^{ab}	51.67^{cd}	47.67^{d}
LSD	2.050		
CV %	4.4		

Means followed by the same letter.

Thousand Kernels weight

The analysis of variance indicated that the main effects of variety and seed rate had significant ($P<0.01$) effect on thousand kernel weight. However, the interactions did not influence significantly.

The highest thousand kernels weight (38.52g) was recorded from the variety HB 1307, whereas significantly the lowest (35.76g) was recorded from the variety Shagee (Table 6). It might be due to the early maturity of variety HB 1307 which might have prevented from unfavorable environmental condition at early growing season. The result showed that when seed rate increased from 75 to 125 kg ha^{-1}, thousand kernels weight decreased by 6.9%. The lowest kernels weight produced from highest seed rate might be due to decrease in seed size as a result of high plant density. In addition, the presence of higher spike number per rows might have resulted in small sized kernels because of inter plant competition to limited resources. The higher seed rate in bread wheat resulted in decreased 1000-kernel weight Spink (2000). Also other authors emphasized the influence of seed rate and plant density on 1000-kernel weight that as seed rate increased also number of spikes m^{-2} increased, but 1000 kernel weight decreased Hiltbrunner *et al.,* (2005).

According to Delessa (2007) there was a decreasing trend in thousand grain weight as the seeding rate was increased from 75 to 125 kgha^{-1} in rice. In conformity with these results, Jan (2000) who conducted an experiment on wheat reported that as the seeding rate was increased, the number of plants emerged per unit area also increased but thousand seed weight decreased.

Above ground dry biomass yield

Analysis of variance showed that the main effect of variety and seed rate had highly significant ($P<0.01$) effect on above ground dry biomass yield. However, the interactions did not show significant effect. Variety Shagee produced the highest (14.52 t ha^{-1}) above ground dry biomass yield, while variety HB 1307 produced significantly the lowest above ground dry biomass yield (11.89t ha^{-1}) (Table6).Higher tillers resulted in higher plants population and which might have resulted in spikes per rows and plots leads to increased grain and biomass yield ha^{-1}, also the higher biomass yield with increased seed rate might be due to an increase in straw yield ha^{-1} as seed rate increased. [33] also reported that the higher biomass yield 11629.6 and 11166.7 kg ha^{-1} was recorded on increased seed rate of 200 and 175 kg ha^{-1} respectively.

Table 5. Interaction effects of seed rare and varieties on number of productive tillers.

	Seed rate(kg ha⁻¹)		
Varieties	75	100	125
Shedho (3381-01)	45.33^{ab}	43.33^{bc}	43.33^{bc}
HB 1307	47.33^{a}	45.00^{ab}	42.00^{c}
HB 42	43.67^{bc}	43.67^{bc}	43.33^{bc}
Shagee	47.00^{a}	45.33^{ab}	41.67^{c}
LSD	1.167		
CV %	2.34		

Means followed by the same letter case in a rowand column are not significantly different from each other at 5 % level of significance.

Similar results were obtained by El-Hebbasha (2001) who found that biological yield was increased by increasing seeding rate in wheat. Moreover, Gafaar (2008) reported that the highest value of biological yield was obtained with increasing seed rate up to 400 grains m^{-2} in wheat crop. However, the current result in contrast with results reported by Allam (2003) that in higher seed rates, higher number of plants and tillers failed to produce higher biomass yield.

Grain yield

The analysis of variance showed that seed rates and varieties had highly significant at (P<0.01) and significant at (P<0.05) effect on grain yield respectively (Table 6). Interaction did not show significant effect. The highest grain yield (4.424 t ha^{-1}) was recorded from the variety of HB 1307, while the lowest grain yield (3.803 t ha^{-1}) was recorded from Shagee variety. The difference in the grain yield of food barely varieties might be due to the differences on their yield components. In other study, Sharshar *et al.,* (2006) noted that wheat varieties significantly differed in grain yield and most of yield related traits. The 75 and 125 kg ha^{-1} seeding rate gave significantly the lowest and highest grain yield, than 100 kg ha^{-1} respectively (Table 6). Seed rate of 125 kg ha^{-1} resulted in increasing yield by 14.03 %, over the lowest seed rate of 100 kg ha^{-1}.Grain yield significantly increased as seed rate increased.

The result of this study was in agreement with Kumar (2006) and Otteson (2007) who reported that increasing sowing rates resulted in increased grain yield, increasing seed rates up to 150 kg ha^{-1}. Furthermore, Baloch *et al.,* (2010) reported that the use of 150 kg seed ha^{-1} produced higher grain yield of 5103.3 kg ha^{-1} than other seeding rates (100, 125, 175, and 200 kg ha^{-1}) used. Jemal (2015) reported that the increased seed rate from 125 kg ha^{-1} to 150 kg ha^{-1} produced grain yield which was significantly increased by 7.3%. Seleiman *et al.*, (2010) also noted that seed yield ha^{-1} was gradually and significantly increased as sowing density of bread wheat increased from 250 seed m^{-2} up to 350 grains m^{-2} and then the rate of increase remain constant with increasing sowing density up to 400 seed m^{-2}.

The superiority of grain yield ha^{-1} in dense sowing could be attributed to the higher number of spikes per unit area which reverse the effect of the increasing in the grain yield spike^{-1} obtained as the sowing density was decreased.

Harvest index

Varieties had a highly significant (P0.01) effect on the harvest index (HI), however the seed rate and interaction were not.

In comparison to the other types, variety HB 1307 had the greatest HI of 38.40 percent, while variety Shagee had the lowest HI of 27.77 percent (Table 6). This could be related to the greater grain yield of HB 1307 compared to other varieties. Takeda *et al.,* (1983) also found significant varietal differences in harvest index in rice crops.

Table 6. Main effect of varieties and seed rate on Yield and yield related components of food barley.

Treatments	SL (cm)	NKPS	TKW (g)	BMY (t ha^{-1})	GY (t ha^{-1})	HI (%)
Variety						
Shedho (3381-01)	7.713^{b}	46.76^{b}	38.26^{a}	12.88^{b}	4.19^{ab}	32.45^{b}
HB 1307	8.933^{a}	51.32^{a}	38.28^{a}	11.89^{b}	4.42^{a}	38.70^{a}
HB 42	7.644^{b}	43.31^{c}	36.38^{b}	14.42^{a}	3.86^{b}	27.77^{c}
Shagee	7.289^{c}	42.93^{c}	38.02^{a}	14.52^{a}	3.80^{b}	29.43^{bc}
LSD	0.2987	1.906	1.529	1.265	0.471	4.229
Seed rate kg ha^{-1}						
75	8.385^{a}	49.16^{a}	38.99^{a}	12.48^{b}	3.52^{c}	30.35
100	7.875^{b}	45.70^{b}	37.74^{ab}	13.42^{ab}	4.06^{b}	31.78
125	7.425^{c}	43.38^{c}	36.47^{b}	14.38^{a}	4.63^{a}	34.13
LSD	0.2587	1.650	1.324	1.096	0.4084	ns
CV (%)	3.9	4.3	4.2	9.7	11.9	13.5

Means with the same letter(s) in the same column of each treatments are not significantly different at 5% probability level, LSD (5%) = least significant difference at 5% probability level, CV (%) = coefficient of variation in percent, ns = non-significant.

Similarly, Delessa (2007) found that the major influence of sowing rate on harvest index was not significant. These findings are consistent with those of Brain.*et al.*, (2005), who found that the influence of sowing rate on harvest index was not significant. Seed rate, on the other hand, had no significant influence, according to Mollah. (2009).

Conclusion

The main effects of variety and seed rate were highly significantly (P0.01) affected by days to heading, days to physiological maturity, spike length, number of kernels per spike, thousand kernel weight, grain yield, and above ground biomass, whereas grain filling period and harvest index (HI) were highly significantly (P0.01) affected only by variety. The primary effect of the seed rate and interaction had a highly significant (P0.01) effect on the number of tillers and the number of productive tillers. Shedho (3381-01) had the longest days to heading (71), maturity (115.67), and grain filling (44), while the BH 1307 variety had the earliest. This variety has the tallest spike (8.933cm), the most kernels per spike (51.33), the highest grain production (4.424 t ha-1), and the highest HI.Based on the agronomic results of this study, the food barely variety HB 1307 was recommended for Duna district at a seed rate of 125 kg ha-1.

Data availability

Data of this manuscript was free available for those who request with reason.

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