Effects of seed rate and inter row spacing on yield and yield components of food barley in Semen Ari Woreda, Ethiopia

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A B S T R A C T

A field experiment was carried out for two successive cropping seasons in 2017 and 2018 at Shama Bulket, Semen Ari Woreda, South Omo Zone, Southern Ethiopia, to determine optimum seed rate and inter-row spacing for food barley production. The experiment involved a factorial combination of three seed rates (80, 100 and 120 kg ha^{-1}) and three inter-row spacing (20, 30 and 40 cm). The experiment was conducted using a randomized complete block design with three replications. The results indicated the treatments had significant effect in all parameters except plant height and spike length. Based on the result of this study, use of 30 cm inter-row spacing and 120 kg ha^{-1} seed rate is superior in grain yield (4481 kg ha^{-1}) and total biomass (14.6 t ha^{-1}). Therefore, use of 30 cm inter row spacing with seeding rate of 120 kg ha^{-1} can be recommended for food barley production at Shama Bulket kebele and its vicinity.

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Introduction

Barley is an annual cereal crop, which belongs to grass family Poaceae, tribe Hordeae and genus *Hordeum* in which spikes have a zigzag rachis. Ethiopia and Asia have been suggested as probable centers of origin of barley (Martin and Warren, 1971).

Barley is one of the most important small cereal crops which ranks fourth after wheat, maize and rice in the world (Onwueme and Sinha, 1991) and third in Ethiopia both in terms of area coverage and production after teff and maize (Alemayehu, 1994). The mean area under barley production in Ethiopia has been estimated to be 892,500 hectares (ha) during the period 1980-1989 (Berhanu *et al.*, 2005). Barley is the most important food crop after teff (*Eragrostisef* sp. L.) and sorghum (*Sorghum bicolor* L.). Barley-based human food accounts for about 90% of grain, while the rest is used for beer making and animal feeds (Kiros, 1993). Barley straw is used as animal feed, thatching roofs and bedding (Kiros, 1993). The average national yield of barley is in the range of 0.8 to 0.9 tons ha^{-1} (CSA, 2002). Farmers in Semen and Debub Ari Woredas food barley used for human food (such as "kollo", "kineto" and "besso") and animal feed (barley straw).

Increased food barley production involves use of different agronomic practices such as improved variety, seed rate, spacing, fertilizer rate, and pesticide application at the recommended rate. When, assessing grain yield of a set of cultivars in different width of row spacing and seed rate changes are commonly observed in the relative yield performance with respect to each other.

In the high land parts of Semen and Debub Ari Woredas that are mostly under cereal cultivation, farmers plant barley with inappropriate row spacing or blanket recommendation. Barley productivity in Debub Omo zone is low because farmers have limited awareness on the appropriate planting row spacing and improved varieties (Biruk *et al.*, 2018). Therefore, in order to minimize this constraint, determination of appropriate row spacing and seed rate trails should be conducted. Therefore, the objective of this study was to identify the optimum row spacing and seed rate for food barely that would enhance the productivity of food barley.

Materials and Methods

Description of the study area

This experiment was conducted at Shama Bulket kebele, Semen Ari Woreda South Omo Zone for two successive cropping seasons in 2017 and 2018. Shama Bulket is located about 840 km from Addis Ababa, and 610 km from SNNPRS capital city (Hawassa), in South Omo zone, which is in the south part of the country. It lies at

036°39' 08" E longitude and 006° 11' 35" N latitude at an altitude of 2570 masl. The study area has a mean annual rainfall and temperature ranging from 800-1000 mm and 18-32.1°C, respectively. The annual rainfall ranges from 1400-2300 mm. Average max and min temperature 22°C and 11°C.

Experimental treatments and procedures

The experiment involved a factorial combination of three seed rates (80, 100 and 120 kg ha⁻¹) and three inter row spacing (20, 30, 40 cm). The experiment was conducted using a randomized complete block design with three replications. The test crop was food barley (variety called HB 1307).

The experimental field was prepared following the conventional tillage practice before planting. In accordance to the design, a field layout was prepared and each treatment was assigned randomly to experimental plots within each block. The gross plot size was 7.2 m² (2.40 m × 3.00 m).

Observation and measurement

Plant height (**PH**): The average height of five randomly selected plants from the net plot area of each plot was measured in centimeters from the ground to the top of spike.

Spike Length (SL): The spike length was measured at maturity from five randomly selected plants of the inner rows in centimeter and the mean length was recorded on each plot measuring from the base to the upper most part of the spike excluding awns.

1000-kernel weight (g): Thousand grains were counted after threshing randomly taken from each plot and weights were measured with sensitive balance.

Biomass yield (BY): Total biomass was measured by weighing the sun dried total aboveground plant (straw + grain) to constant weight from the net plot area of each plot.

Grain yield (GY): Grain yield was measured by taking the weight of the grains threshed from the net plot area of each plot and converted to kilograms.

Statistical Analysis

The collected data were subjected to ANOVA using SAS computer software (SAS Institute, 2000). Significance differences between and among treatments were delineated by LSD (least significance difference).

Results and Discussion

Response of food barley to seed rate and inter row spacing on plant height, spike length, grain yield, 1000-seed weight and total bio mass

Plant height

The main effects of seed rate and inter row spacing as well as their interactions did not affect plant height significantly. Similar with the present finding, Soomro *et al.* (2009) noted that wheat sown at higher seeding rate (175 kg ha⁻¹) produced greater plant height i.e. 101.25 cm followed by 150 kg ha⁻¹ i.e. 99.09 cm and 125 kg ha⁻¹ i.e. 94.27 cm. Another research finding by Worku (2008) also concluded that plant height increased consistently with increasing seeding rate from 72.7 cm at the seeding rate of 100 kg ha⁻¹ to 80.4 cm at the seed rate of 150 kg ha⁻¹.

Higher seeding rate caused change in plant height and stem thickness because of the lower light penetration in to the plants canopy bed and more inter specific competition to more absorption light. These factors (higher seeding rate and lower light penetration) increasing inter node length, reducing stem thickness and increasing plant height (Otteson *et al.*, 2007). Rahim *et al.* (2012) also reported that the significant difference on plant densities of 450 and 300 plants m² with highest and lowest plant height, respectively. Other researchers also reported in wheat that the height of plants grown at the lowest seeding rate was significantly lower than the height of plants grown at higher seeding rates (Haile *et al.*, 2013; Laghari *et al.*, 2011). Moreover, this result was in harmony with the finding of Fani *et al.* (2014) who indicated that with increasing density, plant height slightly increases and there after decreases that could be because restrictions on plant food sources therefore, in treatment 150 and 200 kg ha⁻¹, maximum plant height was observed.

Table 1. Effect of seed rate and inter row spacing on plant height and spike length in 2017 cropping season.

Treatments	PH (cm)	SPL (cm)
Seed rate (kg ha⁻¹)		
80	69.47	19.46
100	70.50	20.80
120	72.37	20.66
LCD (5%)	NS	NS
Inter row spacing (cm)		
20	72.3	20.21
30	70.6	19.18
40	69.8	19.10
LCD (5%)	NS	NS
CV (%)	12.10	19.30

Not significantly different (P < 0.05), PH=Plant height and SPL=Spike length.

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Spike length

The main effects of seed rate and inter row spacing as well as their interactions did not affect plant height significantly (Table 1). However, the lower seeding rate and wider row spacing the spike length was higher compared to higher seeding rate and the higher seed rate. 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. The current result is indirectly in agreement with the finding of Zewdie *et al.* (2014) in that plant height and spike length are negatively interrelated. Another research finding by Gafaar (2007) stated that increasing sowing density from 200 up to 400 grains m^{-2} significantly decreased spike length. Similarly, Seleiman *et al.* (2010) reported that the longest spikes were obtained from 250 and 300 grains m^{-2} but without significant differences between both of them.

Table 2. Effect of seed rate and inter row spacing on plant height and spike length in 2018 cropping season.

Treatments		PH(cm)	SPL (cm)
Seed rate (kg ha^{-1})			
80		100.37	20.26
100		101.61	19.86
120		102.37	20.36
LCD (5%)		NS	NS
Inter row spacing (cm)			
20		102.30	20.21
30		102.30	20.18
40		101.73	20.10
LCD (5%)		NS	NS
CV (%)		19.30	11.90

Not significantly different (P < 0.05), PH=Plant height and SPL=Spike length.

Grain yield

The analysis of data revealed significant difference due to interaction effects on grain yield in 2017 and 2018 cropping season (Table 3 & 4). The highest mean grain yield (4481 kg ha^{-1}) was obtained from 30 cm inter row spacing and 120 kg ha^{-1} seed rate, while the lowest mean grain yield (2811 kg ha^{-1}) was obtained from 40 cm inter row spacing and 80 kg ha^{-1} seed rate in 2018 (Table 4). Also, in 2017 cropping season the highest mean grain yield (2835 kg ha^{-1}) was obtained from 30 cm inter row spacing and 120 kg ha^{-1} seed rate, while the lowest mean grain yield (878 kg ha^{-1}) was obtained from 40 cm inter row spacing and 80 kg ha^{-1} seed rate (Table 3).

Table 3. Interaction effect of seed rate and inter row spacing on grain yield and total biomass in 2017 cropping season.

Treatments	GY (kg ha^{-1})	TBM (kg ha^{-1})
20 x 80	887.40[cd]	5581.60[g]
20 x 100	1802.00[b]	7483.70[d]
20 x 120	1372.70[bc]	6897.30[e]
30 x 80	1167.30[c]	5986.70[f]
30 x 100	1718.30[b]	8056.70[c]
30 x 120	2835.30[a]	9258.30[a]
40 x 80	878.50[cd]	5217.63[h]
40 x 100	1656.50[b]	8680.30[b]
40 x 120	2065.65[b]	7702.30[d]
LSD 5%	451.10	454.65
CV (%)	13.01	14.53

Mean values within column followed the same letters are not significantly different (P < 0.05), GY=Grain yield, TBM=Total biomass.

Based on the present study, increasing seeding rate results in increasing grain yield. Similar with the present finding, Worku (2008) reported that grain yield increased as seeding rate increased from 50 to 150 kg ha^{-1}. Moreover, Ali *et al.* (2010) concluded that grain yield was maximum at seeding rate of 150 kg ha^{-1} followed by 175 and 200 kg ha^{-1}, which are against the seeding rate of 125 kg ha^{-1}. The same result also reported by Iqbal *et al.* (2010) who concluded that seeding rate of 150 kg ha^{-1} produced significantly higher grain yield (4120 kg ha^{-1}) followed by 175 and 200 kg ha^{-1} seeding rates (3904 and 3785 kg ha^{-1}).

Table 4. Interaction effect of seed rate and inter row spacing on grain yield, 1000-seed weight and total biomass in 2018 cropping season.

Treatments	GY (kg ha⁻¹)	TSW	TBM (t ha⁻¹)
20 x 80	3218.8[de]	40.83[c]	9.63[de]
20 x 100	3868.4[bc]	42.5[bc]	11.3[bc]
20 x 120	3521.6[cd]	41.83[bc]	14.2[a]
30 x 80	3609.3[c]	42.00[bc]	10.26[cd]
30 x 100	4095.57[ab]	44.5[b]	12.46[b]
30 x 120	4481.53[a]	39.6[c]	14.6[a]
40 x 80	2811.43[f]	51.83[a]	7.63[f]
40 x 100	3022.8[ef]	49.6[a]	8.93[ef]
40 x 120	3570.74[cd]	52[a]	10.3[cd]
LSD 5%	388.74	2.97	1.31
CV (%)	25.9	12.9	19.6

Mean values within column followed the same letters are not significantly different (P < 0.05), GY=Grain yield, TSW=100 seed weight, TBM=Total biomass.

Thousand seed weight

The analysis of data revealed significant difference due to interaction effects on thousand seed weight (Table 4). The highest mean thousand seed weight (51.83 g) was obtained from 40 cm inter row spacing and 80 kg ha⁻¹ seed rate, while the lowest mean thousand seed (40.83 g) was obtained from 20 cm inter row spacing and 80 kg ha⁻¹ seed rate (Table 4).

The result showed that seeding rate and row spacing had inverse relation in affecting thousand kernels weight. The lowest kernels weight was obtained from the highest seeding rate and this might be due to thickening of population density, which resulted competition among nearby plants nutrients and moisture. Similar with the present finding, Baloch *et al.* (2010) concluded that the higher the seeding rate in bread wheat resulted in decrease in 1000-kernels weight. Another research finding by Hiltbrunner *et al.* (2005) also noted that as seeding rate increased, 1000-kernel weight decreased. Similarly, Fani *et al.* (2014) showed that at high densities (250 and 300 kg ha⁻¹) thousand seeds weight declined whereas in low densities of 50 and 100 kg ha⁻¹, thousand seed weights increased..

Total biomass

The analysis of data revealed significant difference due to interaction effects on total biomass (Table 4). The highest mean total biomass (14.6 t ha⁻¹) was obtained from 30 cm inter row spacing and 120 kg ha⁻¹ seed rate, while the lowest mean grain yield (7.63 t ha⁻¹) was obtained from 40 cm inter row spacing and 80 kg ha⁻¹ seed rate.

The result showed that when seeding rate increased, the total biomass increased total biomass. Zewdie *et al.* (2014) reported a positive association between biomass yield and plant height and thus taller plants resulted higher biomass yield. Similar with the present finding, Jemal *et al.* (2015) also reported that higher biomass yield was recorded when seed rate increased from 200 and 175 kg ha⁻¹. Similarly, Iqbal *et al.* (2010) found that biological yield increased as seeding rate increased from 125 kg ha⁻¹ to 150 and 175 kg ha⁻¹.

Conclusion and Recommendation

From the present study, it is possible to conclude that both seeding rate and inter row spacing affect yield and yield related traits of food barley. The results indicated significant differences in all parameters except plant height and spike length. Based on the results, among treatments use of 30 cm inter row spacing and 120 kg ha⁻¹ seed rate is superior in grain yield (4481.53 kg ha⁻¹) in 2018 and (2835 kg ha⁻¹) in 2017 cropping season. Therefore, this study investigated and concluded that inter row spacing of 30 cm and seeding rate of 120 kg ha⁻¹ performed better and gave higher grain yield (4481.53 kg ha⁻¹) and (2835 kg ha⁻¹). However, the highest spike length and thousand kernel weight were recorded in the lowest seeding rate (80 kg ha⁻¹) and the wider inter row spacing (40 cm).

Therefore, use of 30 cm inter row spacing with seeding rate of 120 kg ha⁻¹ can be recommended for food barley producing farmers at Shama Bulket kebele and its vicinity.

References

Alemayehu, A. 1994. Drought stress during the belg season and selection of barley land races in the north Shewa, Ethiopia. Nile Valley and Red Sea Regional Program on season food legume and cereals, ICARADA/NVRSRP. Ethiopia. pp. 209-216.

Ali, M., Ali, L., Sattar, M. and Ali, M.A. 2010. Improvement in wheat (*Triticum aestivum* L.) yield by manipulating seed rate and row

spacing in vehari zone, Adaptive Research Farm, Vehari. *J. Anim. Plant Sci.* 20(4): 225-230.

Baloch, S.M., Shah, I.T., Nadim, M.A., Khan, M.I. and Khakwani, A.A. 2010. Effect of seeding density and planting time on growth and yield attributes of wheat. *J. Anim. Plant Sci.* 20: 239-240.

Berhanu, B., Fekadu, A. and Berhane, L. 2005. Food barley in Ethiopia. pp. 53–82, In: S. Grando and H. Gomez Macpherson (eds.). Food Barley: Importance, Use and Local Knowledge. Proceedings of the International Workshop on Food Barley Improvement, 14–17 January 2002, Hammamet, Tunisia. ICARDA, Aleppo, Syria.

Biruk, G., Wodajo, G. and Kedir, B. 2018. Identification of Major Crop Production Constraints in Debub Ari District, South Omo Zone, Southern Ethiopia. *Hort. Int. J.* 2(6): 383-388. https://doi.org/10.15406/hij.2018.02.00081

CSA. 2002. Ethiopian Agricultural Sample Environmental the Preliminary Results of Area, Production and Yield of Temporary Crop (Maher season Private Holding). Part I. Statistical Bulletin, Central Statistics Authority, Addis Ababa, Ethiopia. 200p.

Fani, E., Kazemi, J.S., Khosravi, M. and Bahdarvand, M. 2014. The Effect of seed density on yield and yield components of irrigated wheat in the North East of Khouzestan. *Agric. Sci. Dev.*3(9):292-295.

Gafaar, N.A. 2007. Response of some bread wheat varieties grown under different levels of planting density and nitrogen fertilizer. *Minufiya J. Agric.* 32: 165-183.

Laghari, G.M., Oad, F.C., Tunio, S., Chachar, Q., Ghandahi, A.W., Siddiqui, M.H., Hassan, S.W. and Ali, A. 2010. Growth and yield attributes of wheat at different seed rates. *Sarhad J. Agric.* 27(2): 177-183

Haile, D., Nigussie, D., Abdo, W. and Girma, F. 2013. Seeding rate and genotype effects on agronomic performance and grain protein content of durum wheat (*Triticum turgidum* L. var. durum) in South-Eastern Ethiopia. *African J. Food Agric. Nutri. Dev*. 13(3): 7693-7710. https://doi.org/10.18697/ajfand.58.10555

Hiltbrunner, J., Liedgens, M., Stamp, P. and Streit, B. 2005. Effects of row spacing and liquid manure on directly drilled winter wheat in organic farming. *European J. Agron.* 22: 441-447. https://doi.org/10.1016/j.eja.2004.06.003

Iqbal, N., Akbar, N., Ali, M., Sattar, M. and Ali, L. 2010. Effect of seed rate and row spacing on yield and yield components of wheat (*Triticum aestivum* L.). Adaptive Research Farm, Vehari, *Pakistan. J. Agric. Res.* 48(2): 151-156.

Jemal, A., Tamado, T. and Firdissa, E. 2015. Response of Bread Wheat (*Triticum aestivum* L.) varieties to seeding rates at Kulumsa, South Eastern Ethiopia. *Asian J. Plant Sci.* 14(2): 50-58. https://doi.org/10.3923/ajps.2015.50.58

Kiros, M. 1993. Studies on barley scald (*Rhynchesporium secalis* (oud.) and evaluation of barley line for resistance to the disease in Ethiopia. MSc Thesis, Alemaya University of Agriculture, Ethiopia. .

Martin, J.H. and Warren, H.L. 1971. Principle of Field Crop Production. Mac Milan Company, London. 976p.

Onwueme, I.C. and Sinha, T.D. 1991. Field crop production in tropical Africa: Principles and practice. CTA, Wageningen, Netherlands. pp. 324–336.

Otteson, B.N., Mergoum, M. and Ransom, J.K. 2007. Seeding rate and nitrogen management effect on spring wheat yield and yield components. *Agron. J.* 99: 1615-1621. https://doi.org/10.2134/agronj2007.0002

Rahim, N., Abas, S., Hamid, K., Amir, M. and Kamvan, N. 2012. Effect of plant density on grain yield, yield components and associated traits of three-durum wheat cultivar in western Iran. *Int. J. Agric. Crop Sci.* 4(2): 79-85.

SAS Institute. 2000. SAS Users guide, Statistics version 8.2. edn. SAS. Inst., Cary. NC., USA.

Seleiman, M.F., Ibrahim, M.E., Abdel-Aal, S.M. and Zahran, G.A. 2010. Effect of seeding rates on productivity, technological and rheological characteristics of bread wheat (*Triticum aestivum* L.). *Int. J. Current Res.* 4: 075-081.

Soomro, U.A., Rahman, M.U., Odhano, E.A., Gul, S. and Tareen, A.Q. 2009. Effects of sowing method and seed rate on growth and yield of wheat (*Triticum aestivum* L.). *World J. Agril. Sci.* 5(2): 159-162.

Worku, A. 2008. Effects of nitrogen and seed rates on yield and yield components of bread wheat *(Triticum aestivum* L.*)* in Yelmanadensa district, northwestern Ethiopia. M.Sc. Thesis. The School of Graduate Studies of Haramaya University. Harar, Ethiopia.

Zewdie, B., Paul, C., Struik and Anthony J.G. Van Gastel. 2014. Assessment of on-farm diversity of wheat varieties and landraces: evidence from farmer's field in Ethiopia. *African J. Agril. Res.* 9(38): 2948-2963. https://doi.org/10.5897/ajar2013.7574

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