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Effects of Seed Rate and Row Spacing on Yield and Yield Components of Bread Wheat (Triticum aestivum L.) in Dalbo Awtaru Woreda, Wolaita Zone, Southern Ethiopia

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Abstract
A field experiment was conducted to study the effect of seed rate and row spacing on yield and yield components of bread wheat at Dalbo Awtaro woreda, Wolaita Zone, on farmer's field during 2015 main cropping season. Four levels of seed rates (75, 100, 125 and 150 kg ha^{-1}) and three row spacing (20,25and 30 cm) were tried .The experiment was laid out as a randomized complete block design (RCBD) with a factorial arrangement and replicated three times. The results showed that using of different row spacing had no significant effect on parameters that have been taken except the plant height; however plant height, number of tiller per plant, spikelet per spike, grains per spike, biological yield, grain yield and straw were significantly affected by different seed rates. The interaction of seed rate and row spacing also did not show significant difference except for plant height. The use of 75 kg seed ha^{-1} resulted in the highest plant height(83.87cm),maximum number of tillers per plant(20.37)and productive tillers per plant(2.30),whereas 100kg seed ha-1 gave the highest biological yield(7.98tha^{-1}),maximum grain yield (2.78tha^{-1}) and straw(5.27t ha^{-1}).
Keywords: Wheat, *Triticum aestivum* , Seed rate , Row spacing

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the world and is a staple food for about one third of the world's population (Hussain and Shah, 200).Wheat is primarily used as a staple food providing more protein than any other cereal crop (Iqtidar *et al*.,2006). However, one challenge for global nutrition is to increase grain yield per unit area while maintaining its end use value (Cassman, 1996; Tilahun *et al*., 2002) .Wheat is grown on larger area than any other crop and its world trade is greater than for all other crops combined. Its world trade is greater than for all other crops combined. It is easily stored and transported (Slafer & Satorre, 1999).

Wheat is not only for making bread, biscuit and pastry products, but also for the production of starch and gluten. The raised bread loaf is possible because the wheat kernel contains gluten, an elastic form of protein that traps minute bubbles of carbon dioxide when fermentation occurs in leavened dough, causing the dough to rise (Hanson *et al*., 1982).

Wheat is one of the most important cereals cultivated in Ethiopia. It ranks fourth after Teff (*Eragrostis tef*), Maize (*Zea mays*) and Sorghum (Sorghum bicolor) in area coverage and third in total production (CSA, 2007). The average per capital consumption of wheat in Ethiopia estimated to be 39 kg/year during 1994-97 and 331,000 tons of wheat imported to meet the national wheat requirements during 1995-97 (CIMMYT, 2000).

In Ethiopia, it is largely grown in the highlands of the country and constitutes roughly 10% of the annual cereal production and plays an appreciable role in supplying the population with carbohydrates, protein and minerals (Schulthess *et al*., 1997). The crop is grown at an altitude ranging from 1500 to 3000 meters above sea level (masl), between 6-16^0 N latitude and 35-42^0 E longitudes. The most suitable agro- ecological zones, however, fall between 1900 and 2700 meters above sea level (Bekele *et al*., 2000).The major wheat producing areas in Ethiopia are located in Arsi, Bale, Shewa, Ilubabor, Western Hareghe, Sidamo, Tigray, Northern Gonder and Gojam zones (Bekele *et al*., 2000).

Among the factors responsible for low wheat yield, delay in sowing, traditional sowing methods, low seed rate and improper row spacing are very important (*Iqba et al., 2010*). Many farmers in developing countries prefer to use a higher seed rate than recommended, because they perceive it as a good strategy to control weeds and reduce the risks of crop production. Planting higher seed rate than the recommended rate is not encouraged because of its negative impact on seed quality, particularly on seed size and weight. Instead of using higher rates, farmers must pay close attention to all recommended seed production practices. Moreover, plant spacing determines the area available to each plant which in turn determines nutrient and moisture availability to the plant. Row spacing determines resource availability and utilization by individual plants in a given species. Planting decisions require that optimum row widths for the seed crop be determined. If the row is too wide, the crop is unable to rapidly shade the inter-row area to capture sunlight and weeds quickly become established. If the row is too narrow, inter-row crop competition results in poorer yields, difficulties in disease and insect control, and greater likelihood of lodging. Thus, the objectives of this study were:

- To evaluate the effect of seed rate and row spacing on yield and yield components of bread wheat.

- To determine the proper seed rate and row spacing for wheat production.

2. Literature Review

2.1. Wheat Production in Ethiopia

Ethiopia is one of the principal producers and importers of wheat in East, Central and Southern Africa (Tanner and Mwangi, 1992). The two economically important wheat species grown in Ethiopia are tetraploid durum (*Triticum durum*) and hexaploid bread wheat (*T. aestivum*). The production of bread wheat dominates the peasant farming systems in the mid to high altitude zones (Tanner *et al*., 1994). Its production is increasing rapidly (Amsal *et al*., 1995; CSA, 2000) due to both a high local demand, and the availability of high-yielding, input-responsive cultivars adapted to heterogeneous environmental conditions (Hailu, 1991; Payne *et al*., 1996). Area coverage of bread wheat has substantially expanded (Payne *et al*., 1996) mainly by replacing unimproved, input non-responsive traditional cereal crops such as teff (*Eragrostistef*), durum wheat (*T. durum*) and barley (Hordeumvulgare) (Getachew*et al* ., 1993). Recently-released bread wheat cultivars are highly responsive to improved management systems, and, relative to older wheat lines, exhibit an economic response to higher rates of nutrient application (Tanner *et al*., 1993; Amsal *et al*., 1997).

2.2. History & Evolutionary Processes of Bread Wheat

The process, which began some ten thousand years ago, involved the following major steps. Wild einkorn *T. urartu* crossed spontaneously with *Aegilops speltoides* (Goat grass 1) to produce Wild Emmer *T. dicoccoides*; further hybridizations with another *Aegilops (A. taushi)*, gave rise to Spelt (*T. spelta)* and early forms of Durum Wheat (cultivated emmer); Bread Wheat finally evolved through years of cultivation in the southern Caspian plains. This evolution was accelerated by an expanding geographical range of cultivation and by human selection, and had produced bread wheat as early as the sixth millennium BC. Modern varieties are selections caused by natural mutation starting with emmer wheat up to husk less modern wheat. Cytological and cytogenetic evidences showed that wheat consists of diploid, tetraploid and hexaploid (two, four and six sets of chromosomes respectively) species with a basic chromosome set of x=7. Three genomes designated as A, B (G), and D was involved in the formation of the polyploidy series (Feldmann, 2001). *T. urartu* and *Aegilops squarossa* (syn. *Triticum tauschii*) are the diploid progenitors of the A and D genomes, respectively. It is believed that *T. monoccocum* naturally hybridized with the yet unknown B- genome donor to give rise to the tetraploid emmer group. Emmer wheat in turn hybridized with *Ae. squarossa* and a spontaneous chromosome doubling of the triploid resulted in the formation of hexaploid wheat (Feldmann, 2001).

The first to be domesticated. The other forms, such as *T. durum*, *T. turgidum* and *T. polonicum* might have originated from cultivated emmer through mutation or accumulation of mutations that reduced the toughness of the glumes to a point at which free- threshing was attained (Kimber and Sears, 1987). According to Mackey (1966) classification, at the tetraploid level, two main species have been recognized; *T. timopheevi* (AAGG) and *T. turgidum* (AABB). *T. durum* belongs to the latter group. There are many known wild and cultivated species in the genus *Triticum*. However, the principal wheats of commercial importance are *T. aestivum* and *T. durum* (Hanson *et al.*, 1982).

2.3. Effect of seed rate and raw spacing on growth, yield and yield components of wheat

Proper row spacing and seed rate are most important management factor affecting the agronomic characteristics of wheat (Ansari *et al*., 2006, Marwat *et al*., 2002, Chaudhary *et al*., 2000). Late seeding dates normally result in higher seeding rates because a delay in sowing normally reduces individual plant growth and tiller production (Gooding and Davies, 1997; Satorre, 1999). Suitable combination of seed rate and row spacing could increase grain yield of wheat (Marshall and Ohm, 1987.) whereas seeding rates alone did not influence the grain yield (Rafique, *et al.,* 1997) much. According to Ali *et al* , (1996), seed rate of 100-125 kg ha-1 with row spacing of 12.5 - 25 cm guaranteed maximum grain yield of wheat . They found that tillers were more in wider row spacing (37.5 cm) followed by 25 cm and 12.5 cm row spacing. Chaudhary *et al*, (2000) reported that seed rate of 150 kg ha-1 increased the number of grains spike-1 and depressed the number of fertile tillers m-2. Khan *et al.* (2001) reported higher wheat yield at seed rate of 100-150 kg ha-1 in 27 cm- 13.5 cm a part rows, respectively. Assenheimer *et al.* (1999) reported that row spacing of 20 cm resulted in significantly higher wheat grain yield in comparison with 30 cm row spacing; however, seed rate did not have effect on wheat yield. After conducting field trials on two wheat cultivars, Malik *et al*. (1996) concluded that grain and straw yields were high with 15 cm row spacing and decreased with increased row spacing while harvest index was not affected significantly by row spacing. Arif *et al.* (2003) suggested 150 kg ha-1 seed rate with 22.5 cm row spacing for maximum wheat yield. They also found that plant height, grains spike-1, and 1000-grain weight decreased with increase in seed rate, however, tillering increased with increasing seed rate. Research results reported by Anderson and Garlinge (2000) have shown that yields of wheat and barley increased as the spacing between rows is decreased similarly narrow row spacing consistently produced higher grain yield than wide row spacing (Chen and Neill., 2006. Johnson and Hargrove, 1988) whereas Ahmad *et al.* (2003) concluded that maximum grain yield and harvest index of wheat can be obtained with row spacing of 20 cm. Increasing seed rate of wheat from 100 to 200 kg ha-1 increased the grain and straw yields (Kumpawt, 1998).

2.4. Effect of seed rate on growth, yield and yield components of wheat

Seeding rate can impact on wheat tillering, grain yield and protein quality (Coventry *et al*., 1993: Staggenborg *et al*., 2003). Hence, achieving higher agronomic performance and better end-use quality requires optimizing and periodically reviewing management practices such as seeding rates (Brian *et al.,* 1615). It was reported that, in a dense wheat population, grain yield was decreased due to competition between plants that induced self-regulation (Jennifer *et al.,* 2006). However, in cultivars that produce fewer tillers, higher seeding rates compensated for reduced tiller and promoted more main stem spikes (Coventry *et al*., 1993: Staggenborg *et al*., 2003). Wheat quality was not reduced at higher seeding rates as protein content, kernel weight and test weight were unaffected (Jennifer *et al*., 2006: Bryan, 2001).On the other hand, it was stated that protein concentration declined as seeding rates and yields increased (Samuel, 1990: Geleta *et al.,* 2002).The decrease in plant height in response to lowering the seeding rate to 100 kg ha-1 may reflect formation of more secondary tillers in less populated stands, which tend to be shorter in stature. At the highest seeding density, the increased intra-plant competition may have also contributed to the reduction in plant height. Chaudhary *et al*, (2000) and Arif *et al, (*2003) reported that increased tillers with increase in seed rate. The results are also in line with Rafique *et al*., (1997), who observed linear increase in the number of tillers as the seed rate was increased. Whereas, the findings are not in accordance with Bellatore *et al*, (1985) who found decreased tillers as the seed rate was increased. The results are in line with Ali *et al*, (1996), Chaudhary *et al,* (2000) and Rafique *et al*, (1997) who explained that lower seeding rates significantly increased the number of grains and vice versa. By increasing seed rate the number of grains spike-1 is reduced (Khan *et al*, (2002) and Mehrvar and Asadi, 2006).Khan *et al*, (2002) and Mehrvar and Asadi (2006)concluded that by increasing seed rate the 1000- grains weight is reduced.These results are in analogy with the findings of earlier workers (Arif *et al*., 2003; Khan *et al*., 2001) who reported higher yield with seed rate of 150 kg ha-1, however disagree with those of Rafique *et al*. (1997) who concluded that seeding rates did not influence the grain yield of wheat.

2.5. Effect of raw spacing on growth, yield and yield component of wheat

It is well recognized that by keeping proper row spacing and inputs like varieties, fertilizers and seed rate etc. Fatyga (1991) reported that highest average yields of 2.85-2.92 t ha-1 were obtained with 25 cm row spacing. Rajput *et al,* (1989) reported that maximum grain yield was obtained when wheat was sown at row spacing of 30 cm. Kumar et *al.* (1991) reported that higher sowing rates coupled with decrease in row spacing increased the number of tillers m-2 and grain yields. Solie *et al*, (1991) investigated that decreasing row spacing significantly increased wheat yields .Tompkins et *al,* (1991) reported that grain yield increased as row spacing decreased. Grain weight was slightly higher with wide row spacing. Marko (1994) reported that increases in row spacing decreased grain yield from 6.37 t at a spacing of 0.06 m to 6.09 t ha-1 at 0.15 m. Ercoli and Masoni (1995) reported that aboveground biomass progressively decreased with increasing row spacing. Grain yield progressively decreased as row spacing increased, but was not affected by row spikes m^{-2} was the yield component most affected by row spacing.

3. Materials and Methods

3.1. Description of the Study Area

The experiment was conducted at Dalbo Awtaro woreda, Wolaita Zone, on farmer's field during 2015 main cropping season. The area is situated in the southern part of Ethiopia at a distance of 380 km from Addis Ababa. It lies an altitude of 2100-2300 meters above sea level. The mean annual rain fall is 1750mm.

3.2. Treatments and Experimental Design

The treatments consisted of three different raw spacing (20, 25 and 30cm) and four seeding densities (75, 100,125 and 150 kg ha^{-1}) .The experiment was laid out as a randomized complete block design (RCBD) with a factorial arrangement and replicated three times. The plot size was 4mx2m for 20 and 25cm row spacing whereas 4.2mx2m for 30cm row spacing .The distance between the plots and blocks was maintained at 0.5m and 1m respectively. All field activities (land preparation, planting, fertilizer application and weeding) were done according to local production practices. All data on growth, yield and yield component were measured from the central areas of each plot.

3.3. Data Collection and Measurement

Plant height (cm): Plant height was measured as the height from the soil surface to the top of the spike (awns excluded). It was recorded as the average of ten randomly selected main tillers from each plot at physiological

maturity.
Number of Tillers per Plant: The number of tillers per plant was counted from the sample plant.
Spike length=Ten spikes were randomly selected from each plots. Each spike was measured from the base of the spike to the apex to record the spike length in cm.
Number of Spikelet per spike: Number of spikelet was counted from each spike.
Number of grains per spike: each spike was threshed separately and grains of each spike were counted and average.
Biological Yield (t ha-1): crop each plots were harvested manually and tied into bundles. The biological yield was recorded in kg by weighting the bundles of each plot with the help of spring balance and then subsequently converted in to t ha^{-1}.
Thousand grains weight (g): 1000 grains were counted at random from each plot and their weights were taken sensitive balance.
Grain yield (t ha-1): wheat bundles of each plot were sun dried and then threshed separately. The grain weight of each plot was recorded in kg and then subsequently converted in to t ha^{-1}.

3.4. Statistical Analysis
The data were subjected to analysis of variance by SAS software. Significance of differences between samples was separated using the least significance difference (LSD) at 5% level of significance.

4. Results and Discussions
4.1. Plant height (cm)
Height of the crop is mainly controlled by the genetic makeup of a genotype and it can also be affected by the environmental factors (Shahzad *et al*., 2007). The analysis of variance of the plant height showed that highly significant difference($p<0.01$)for the row spacing(Table -2).As a result of mean plant height indicated in (Table-1),using diverse row spacing had significant effect on plant height. The plant height mean was observed to be in the ranges of 75.62-79.85cm .The highest plant heights (79.85) were recorded in wider row spacing of 30cm where as the shortest plant heights (75.62cm) were recorded in 20cm a part rows. The highest plant height were observed in wider row spacing, this might be due to more space, light and nutrients available to the plants in wider row spacing.

Table 1.Plant height (cm) as affected by seed rate and row spacing in wheat.

Row Spacing(cm)	Seed Rate(kgha^{-1})				
	75	100	125	150	Means
20	85.47	79.53	71.70	65.77	75.62c
25	80.90	78.93	76.57	75.20	77.9b
30	85.23	80.70	77.30	76.16	79.85a
Means	83.87a	79.72b	75.19c	72.38d	

LSD0.05 (Seed rate) = 0.43
LSD0.05 (Row spacing) = 0.37
Means followed by different letter(s) in a column and rows are significant at 5% level of probability.

Different seed rates significantly increased the plant height(Table-2), wherein, the use of 75kg seed ha^{-1} produced the tallest plants(83.87cm) followed by 100kg seed ha^{-1} which produced of 79.72cm plant height. The use of 75kg seed ha^{-1} produced the shortest plant height of 72.38cm.The data revealed that increase in the seeding rate resulted in decreasment in the heights of the plants. This might be due to by increasing seed rate per unit area, the inter competition for space, nutrient, moisture and sun light increases which results in shortest plant height. These results did not coincide with Sulieman (2010) who reported that increase in the seeding rate resulted in a slight increment in the heights of the plants. The data also indicated that interaction of seed rate and row spacing was significantly ($P<0.01$) affected plant height (Table-2) .Data showed that highest plant heights (85.47cm) were noted when 75 kg ha-1 seed rate and 20cm row spacing was used ,which was statistically similar to 75 kg ha-1 seed rate and 30cm row spacing apart(85.23cm), while shortest plant heights (65.77cm) were noted from plots in which 150 kg seed ha-1was used by 20cm apart rows(Table-1)

Table 2. Mean square of ANOVA's of plant height, spike length, number of tillers, productive tillers and spikelet spike $^{-1}$ in wheat.

Source of Variation	DF	Plant Height	Spike Length	Number of Tillers	Productive Tillers	Spikelet Spike^{-1}
Replicate	2	0.37	0.08	0.04	0.08	0.27
Row Spacing	2	53.25**	0.14^{NS}	0.05	0.01^{NS}	0.35^{NS}
Seed Rate	3	231.23**	0.04^{NS}	0.33**	0.27*	0.41^{NS}
Row Spacing X Seed Rate	6	31.57**	0.17*	0.02	0.02^{NS}	0.69*
Error	22	0.19	0.20	0.03	0.03	0.70
Total	35	-	-	-	-	-

NS=Non -Significant **=Significant at 1% Level of Probability *= Significant at 5% Level of Probability

4.2. Spike length (cm)

The length of spike plays a vital role in wheat towards the grains spike-1 and finally the yield (Shahzad *et al*., 2007). As far as row spacing is concerned, row spacing had no significant (P>0.05) effect on spike length (Table-2).The data showed that all treatments are statistically at par. So it can be concluded from these results that spike length is genetic characters of a variety, which is less influenced by agronomic practices. Khan *et al*. (2001) reported that varieties have different genetic potential regarding the spike length.Seed rate ,as well as its interaction with row spacing also did not show significant effect on spike length (Table-2).The current finding was corroborates the finding of Baloch *et al*.(2010)who reported that different seed rate had no significant effect on spike length.

Table 3.Spike length (cm) as affected by seed rate and row spacing in wheat

Row Spacing(cm)	Seed Rates (kg ha^{-1}) 75	100	125	150	Means
20	6.80^{NS}	6.63	6.90	6.33	6.67^{NS}
25	6.83	6.97	6.83	6.97	6.90
30	6.40	6.77	6.67	7.00	6.71
Means	6.68^{NS}	6.76	6.80	6.77	

4.3. Number of Tillers Plant^{-1}

The economic yield of most of the cereals is determined by the number of tillers. It has the great agronomic importance as this may compensate the difference in number of plants, partially or totally after crop establishment and may allow crop recovery from early frost (Acevedo *et al*., 1998). It is evident from the data that row spacing had no significant effect on the number of tillers per hill (Table-4). The current result did not in consonance with those of Iqbal *et al*.(2010)who reported that different row spacing affected significantly the number of fertile tillers and total tillers per square meter.

Table 4.Number of Tillers plant $^{-1}$ as affected by seed rate and row spacing in wheat

Row Spacing(cm)	Seed Rates (kg ha^{-1}) 75	100	125	150	Means
20	2.43^{NS}	2.37	2.07	1.93	2.20^{NS}
25	2.40	2.20	2.03	1.93	2.15
30	2.30	2.10	1.90	2.00	2.07
Means	2.37^{a}	2.22^{a}	2.00^{b}	1.96^{b}	

LSD0.05 (Seed rate) = 0.15

Means followed by different letter(s) in a column and rows are significant at 5% level of probability.

The perusal of the data (Table-2) on number of tillers per hill as influenced by different seed rates indicated significant difference (P<0.05).As the mean value of total tillers per hill indicated in (Table-4), the use of 75kg seed ha^{-1} produced maximum number of tillers per hill (2.37) which was, however at par with 100kg seed ha^{-1} which produced 2.22 of number of tillers per hill, whereas the lowest number of tillers per hill (1.96)was recorded at 150kg seed ha^{-1} which was also at par with 125kg seed ha^{-1}.The reduced number of tillers per hill in increased seed rate might be due to inter plant competition within the row. These findings are not in consonance with those of Kraft and Spiss (1988) who reported that increasing seed rate increased the fertile tillers and total tillers significantly. The interaction of seed rate and row spacing remained non-significant statistically (Table- 2). This might be the process of tillers mainly controlled by genetic and environmental factors.

4.4. Productive Tillers plant^{-1}

Different row spacing exhibited no significant difference (P>0.05) among the treatments in terms of productive tillers per hill (Table-2). Data presented in (Table-2) indicated that seed rate had significant ($P<0.05$) effect on the productive tillers. As the mean value of productive tillers indicated in (Table-5) , maximum productive tillers(2.30) were observed when plots were seeded with 75kg ha-1 , which was, however, at par with treatment that received 100kg seed ha $^{-1}$ (2.15), while minimum productive tillers (1.93) were recorded when 125 kg seed ha-1 was used ,which was ,however also at par with 150kg seed ha^{-1} (1.96).The productive tillers was higher at lower at seed rate, when compared with higher seed rates. This might be due to that the productive tillers decreased with increase in seeding rate, because, by increasing seed rate per unit area, the inter plant competition for space, nutrient, moisture and sun light increases which results in lower productive tillers. The current result was not agreed with those of Iqbal *et al*., (2010) who found maximum productive tillers at 200 kg ha-1 seed rates then at lower seed rates.

Table 5.Productive Tillers Plant $^{-1}$ as affected by seed rate and row spacing in wheat

Row	Seed Rates (kg ha^{-1})				
Spacing(cm)	75	100	125	150	Means
20	2.34^{NS}	2.29	1.91	1.93	2.11^{NS}
25	2.32	2.09	2.03	1.97	2.10
30	2.26	2.10	1.86	2.00	2.05
Means	2.30^{a}	2.15^{a}	1.93^{b}	1.96^{b}	

LSD0.05 (Seed rate) = 0.16

Means followed by different letter(s) in a column and rows are significant at 5% level of probability

The data also indicated that interaction between seed rate and row spacing remained non-significant statistically (Table-2)

4.5. Spikelet spike^{-1}

The data regarding spikelet spike^{-1} have been presented in (Table-6) showed that, seed rate and row spacing as well the interaction between seed rate and raw spacing differed non –significantly for Spikelet spike^{-1} .Kalwar *et al*.(1993),Muhamed *et al*.(1999) and Iqtidar *et al*.(2003) observed non-significant difference in number of Spikelet spike^{-1}.Morever Jan *et al*.(200) reported that Spikelet spike^{-1} is inherent character of a variety which is slightly influenced by environmental factors.

Table 6.Spikelet Spike $^{-1}$ as affected by seed rate and row spacing in wheat

Row spacing(cm)	Seed Rates (kg ha^{-1})				
	75	100	125	150	Means
20	13.67^{NS}	13.92	13.87	13.25	13.67^{NS}
25	13.43	13.21	13.13	13.67	13.35
30	12.67	14.08	13.63	14.08	13.61
Means	13.25^{NS}	13.74	13.54	13.67	

4.6. Grains spike^{-1}

Grains spike^{-1} as influenced by row spacing did not show significant($P>0.05$) difference(Table-11).These results are in accordance with the results of Muhamed et al.(1999) who found Grains spike^{-1} are purely inherent character of wheat varieties and not affected by row spacing. Malik *et al.* (1996) also reported that number of grains per spike was not affected significantly by various row spacing.

Table 7.Grains Spike $^{-1}$ as affected by seed rate and row spacing in wheat

Row Spacing(cm)	Seed Rates (kg ha^{-1})				
	75	100	125	150	Means
20	44.54^{NS}	45.25	43.96	42.29	44.01^{NS}
25	44.33	46.00	43.42	46.54	45.07
30	42.45	46.33	42.96	46.04	44.44
Means	43.77^{NS}	45.86	43.44	44.95	

The results (Table-11) revealed that Grains spike^{-1} was not affected by different seed Rates. Conflicting to the findings of the present study, Iqbal *et al.* (2010) reported that wheat planted at 125kg ha^{-1} gave maximum Grains spike^{-1}. In the same way Shah (2011) reported that different seed rate had significant effect on seed spike^{-1} . The interaction of seed rate and raw spacing also did not show significant effect on grains spike^{-1}

4.7. Biological Yield (kg ha-1)

Biological yield is an important factor because farmers are also interested in straw in addition to grain. The use of different row spacing did not show significant difference on biological yield (Table-11). The current results contradict the findings of Iqtidar *et al*. (2003) who reported that biological yield was affected by different row spacing.

Table 8.Biological yield (tha^{-1}) as affected by seed rate and row spacing in wheat

Row Spacing(cm)	Seed Rate (kg ha^{-1})				
	75	100	125	150	Means
20	7.20	7.41	7.07	7.42	7.27^{ns}
25	7.00	8.36	7.09	6.95	7.35^{ns}
30	6.62	8.17	6.95	6.83	7.14^{ns}
Means	6.93^{b}	7.98^{a}	7.03^{b}	7.06^{b}	

LSD0.05 (Seed rate) = 0.84
Means followed by different letter(s) in a column and rows are significant at 5% level of probability

It can be inferred from the data showed in (Table -11**)** indicated that biological yield was significantly (P <.05) affected by various seed rate. The mean value of biological yield varied from 6.93t ha^{-1} to 7.98 t ha-^{1} in respect of all the treatments (Table-8).Maximum biological yield (7.98t ha-1) was recorded when plots were seeded with 100kg seed ha^{-1}whereas minimum biological yield (6.93t ha^{-1}) was recorded when 75 kg ha-1 seed rate was used, which was statistically similar with results obtained at 125kg and 150kg seed ha-1.The data also indicated that interaction between seed rate and row spacing did not have significant effect on biological yield (Table-11).

4.8. Grain Yield (t ha^{-1})

Analysis of the data presented in (Table -11) indicated that grain yield was significantly (P< 0.05) affected by different seed rate, where as row spacing differed non –significantly for grain yield.

Table 9.Grain yield (tha^{-1}) as affected by seed rate and row spacing in wheat

Row Spacing(cm)	Seed Rates (kg ha^{-1})				
	75	100	125	150	Means
20	2.22^{NS}	2.78	2.34	2.45	2.44^{NS}
25	2.50	2.87	2.64	2.72	2.68
30	2.38	2.69	2.68	2.89	2.65
Means	2.36^{b}	2.78^{a}	2.55^{ab}	2.68^{a}	

LSD0.05 (Seed rate) = 0.31
Means followed by different letter(s) in a column and rows are significant at 5% level of probability

The mean values on grain yield were observed to be in range of 2.36t ha $^{-1}$ to 2.78tha-^{1} (Table-9). The maximum grain yield 2.78 t ha^{-1} was obtained in plots seeded with 100kg seed ha^{-1} , however ,it was statistically at par with the result obtained in plots seeded with 150kg seed ha^{-1} .The use of 75kg seed ha^{-1} was produced the lowest grain yield of 2.36 t ha^{-1}.The current result are agree with those of Hameed *et al*., (2003) and Ijaz *et al*., (2003), who reported that grain yield increased as seed rate increased. The interaction of seed rate and row spacing was non-significant statistically (Table-11)

4.9. Straw (t ha^{-1})

Analysis of the data presented in (Table -11) indicated that straw was significantly (p<0.05) affected by different seed rate, where as row spacing differed non –significantly (p>0.05) for straw yield.

Table 10.Straw (t ha^{-1}) as affected by seed rate and row spacing in wheat

Row Spacing(cm)	Seed Rates (kg ha^{-1})				
	75	100	125	150	Means
20	4.98^{NS}	4.63	4.73	4.97	4.82^{NS}
25	4.49	5.66	4.45	4.23	4.71
30	4.24	5.54	4.27	3.94	4.49
Means	4.57^{ab}	5.27^{a}	4.48^{b}	4.38^{b}	

LSD0.05 (Seed rate) = 0.78
Means followed by different letter(s) in a column and rows are significant at 5% level of probability

Among seeding rates, the use of 100kg seed ha^{-1} was produced the highest straw yield of 5.27t ha^{-1} ,while the use of 150kg seed ha^{-1} gave the lowest straw yield of 4.38t ha^{-1} which was statistically similar with resulted obtained in the plots seeded with 125kg seed ha^{-1}(4.48t ha^{-1}.)

Table 11.Mean square of ANOVA's of grains spike^{-1} , biological yield ,grain yield ,straw and 1000-seed weight in wheat.

Source of Variation	DF	Grains Spike^{-1}	Biological Yield	Grain Yield	Straw	1000-Seed Weight
Replicate	2	4.41	0.76	0.02	0.94	7.44
Row Spacing	2	3.43ns	0.13ns	0.21ns	0.34ns	26.36ns
Seed Rate	3	11.10ns	2.13*	0.29*	1.49*	4.29ns
Row Spacing X Seed Rate	6	6.14ns	0.40ns	0.04ns	0.68*	11.66ns
Error	22	18.49	0.75	0.11	0.65	18.72
Total	35	-	-	-	-	-

NS=Non -Significant **=Significant at 1% Level of Probability *= Significant at 5% Level of Probability

4.10.1000 -seed weight

1000-grain weight is an important yield determining component of wheat. The (Table-12) witnessed that 1000-garin weight was not affected by various row spacing. Similar finding was reported with those of Malik *et al.* (1996), who found that 1000-grain weight was not affected significantly by various row spacing. It is evident that from the data various seed rate also had no significant on 1000-seed weight. Similarly interaction of row spacing and seed rates remained non-significant statistically (Table-11).

Table 12.1000- Seed weight (g) as affected by seed rate and row spacing in wheat

Row Spacing(cm)	Seed Rates (kg ha^{-1})				
	75	100	125	150	Means
20	40.33^{NS}	39.33	40.67	36.33	39.16^{NS}
25	40.67	40.33	41.67	41.67	41.08
30	43.00	39.67	41.00	44.67	42.08
Means	41.33^{NS}	39.77	41.11	40.88	

5. Summary and Conclusion

The field experiment was carried out during 2015 main cropping season at Dalbo Awtaro woreda, Wolaita Zone, on farmer's field to effects of seed rate and row spacing on yield and yield components of bread wheat). Four levels of seed rates (75, 100, 125 and 150 kg/ha) and three row spacing (20,25and 30 cm) were tried .The experiment was laid out as a randomized complete block design (RCBD) with a factorial arrangement and replicated three times.

The results showed that using of different row spacing had no significant effect on parameters that have been taken except the plant height; however plant height, number of tiller per plant, spikelet per spike, grains per spike, biological yield, grain yield and straw were significantly affected by different seed rates. The interaction of seed rate and row spacing also did not show significant difference except for plant height. The use of 75 kg seed ha^{-1} resulted in the maximum plant height(83.87cm),number of tillers per plant(20.37)and productive tillers per plant(2.30),however 100kg seed ha-1 gave the highest biological yield(7.98tha^{-1}),grain yield (2.78tha^{-1}) and straw(5.27t ha^{-1}).

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