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Full Length Research Paper

Effect of Seed Sources and Rates on Productivity of Bread Wheat *(Triticum Aestivum* L. *)* Varieties at Kersa, Eastern Ethiopia

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Abstract

The experiment was conducted with the objectives of evaluating the effect of seeds sources, seed rates and varieties on yield and yield related traits and to determine seed quality of different sources of bread wheat varieties. This experiment consisted of laboratory and field experiments. Laboratory experiment was conducted at Haramaya University in Seed Science and Technology laboratory using Completely Randomized Design (CRD) with four replications in factorial arrangement of two bread wheat varieties (Digalu and Qulqulluu) and 10 seed sources (seeds obtained from Haramaya University, Kersa Local Seed Business Project and seeds collected from 8 Farmers). The analysis of variance showed that, the interaction of seed source and variety had significant effect on all physical and physiological seed quality parameters. The field experiment was laid out by means of Randomized Complete Block Design (RCBD) with three replications in factorial arrangement of two varieties, three seed sources (seeds obtained from Haramaya University, Kersa Local Seed Business Project and Farmers) and three seed rates (100, 125 and 150 kg ha^{-1}). The highest yield (5.652 t ha^{-1}) and (5.162) were recorded from Kersa Local Seed Business Project seed source and seed rate of 150 kg ha^{-1} respectively. Thus, bread wheat variety (Qulqulluu) obtained from Kersa Local Seed Business Project sown at the seed rate of 150 kg ha^{-1} showed better yield response as compared to other seed sources. However, it is necessary to conduct the experiments considering more number of seed sources, seed rates and varieties at major wheat growing areas for more than one cropping seasons to make conclusive recommendation.

Keywords: Germination, Grain Yield, Physical Purity, Seed Vigour

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Introduction

Wheat *(Triticum aestivum* L.*)* is one of the most important world cereal crops and is a staple food for about one third of the world's population (Hussain and Shah, 2002). It is major source of food grain and high adaptation of this crop as well as its diverse consumptions in the human nutrition lead to present, especially in developing countries (Farzi and Bigloo, 2010) .It has the highest content of protein of all the staple cereals and contains essential minerals, vitamins, and lipids. It is the primary source of protein in developing countries where 1.2 billion people are dependent on wheat for survival (CIMMYT, 2011).It grown on 220 million hectares (Singh and Trethowan, 2007) constituting 15.4 percent of the world's arable land (more land area than any other crop) and it is grown in almost all countries and climates (Curtis, 2002).

World wheat production increased dramatically from 1951-1990, mainly due to an increase in grain yield per hectare rather than an increase in production area. In Eastern Africa, Ethiopia ranks first both in terms of area harvested (1,627,647 ha) and total wheat production (3,434,706 tons) (FAOSTAT, 2013). In 2013/2014 cropping season, out of the total grain crop area, 79.38% (9,848,745.96 hectares) was under cereals. From this area, wheat took up 13.52 % (1,677,486.33 hectares) of the grain crop area. Among cereals, wheat accounts for 15.60% (3,925,194 tons) grain (CSA, 2014). However, the productivity of the crop remains low (2.4 tons ha^{-1}) in the country as compared to the world average yield (3.19 tons ha^{-1}) (FAOSTAT, 2013). In east Hararghe total grain crop area in 2013/14 crop season was (202,717.60 hectares) and (447,174.2 tons) production was under cereals. From this area, wheat took up (19,935.77 hectares) and 15.60% (36,349.5 tons) (CSA, 2014).This low yield might be due to unavailability of adaptable varieties as well as the use of farmer saved poor quality seeds of local cultivars and use of inappropriate seed rates as a major problem. Thus, the study was conducted with the objectives to evaluate the effect of seed sources, seed rates and wheat varieties on yield and yield related traits, and to determine seed quality of different sources and its associations with yield and yield components of bread wheat varieties.

Materials and Methods

Experimental materials, treatment and design

Seed samples of two bread wheat (Qulqulluu and Digalu) varieties each from ten seed sources [seed samples obtained from Haramaya University Wheat Research Program (HU), Kersa local seed business (LSB) project, seeds obtained from eight farmers (F_1 to F_8)] were collected and used as treatments (2 x 10 factorial arrangements) in four replications. The experiment was conducted at Haramaya University Seed Science and Technology laboratory, which was carried out as per International Seed Testing Association rules and procedures (ISTA, 2008). The experiment was laid out as Completely Randomized Design (CRD).

Seed physical and physiological quality test

Both Seed physical (physical purity, seed moisture content and hundred kernel weights) and physiological (Standard germination, Seedlings shoot and root length (cm), Seedling dry weight (g), Seed vigor index I and Seed Vigor index II) quality attributes were tested according to ISTA (2008) procedure.

Field experiment

The study was conducted at Kersa ISSD (integrated seed sector Development) project station of farmers' field during 2014 main cropping season from July to November 2014. Kersa is one of the Woredas of East Hararghe zone in the Oromia Regional state of Ethiopia. It was named after a river that flows through it. Kersa is bordered on the South by Bedeno, on the West by Meta, on the North by Dire Dawa, on the Northeast by Haramaya, and on the Southeast by Kurfa Chele Districts. Kersa district has wide amplitude of agro-ecologies ranging in altitudes from 1,740 to 2,660 meter above sea level (m.a.s.l.). The mean annual rainfall is 1150 mm while mean annual temperatures ranged from 11.2^{0}C to 29.6°C (Tsige Ketema and Ketema Bacha, 2013).

Experimental materials

The two bread wheat varieties viz. Digalu and Qulqulluu seeds were collected from different seed sources that were used as experimental materials. The seeds were collected from three sources; (1) Haramaya University Wheat Research Program (HU) which considered as quality seeds (C1), (2) Kersa Local Seed Businesses project (LSBs) from Kersa ISSD (Integrated Seed Sector Development) project station which represents certified seeds (C2) since the seeds were produced under close supervision and technical support of the project and (3) Farmers saved seeds from Kersa farmers. All collections of (Bread) wheat varieties were collected from seeds harvested in 2013/2014 cropping season. Farmers saved seeds were collected from eight farmers each consisted two bread wheat varieties in equal proportions as two different working samples. Half of the collected seed samples for each variety were mixed and used as one source (farmers saved seed) for field experiment while the remaining half was kept as separate samples for seed quality test under laboratory condition.

Treatments and experimental design

The treatments were included two Bread wheat varieties (Digalu and Qulqulluu), three seed sources (HU, LSB and farmers saved seeds) and three seed rates (100 kg ha^{-1}, 125 kg ha^{-1} and 150 kg ha^{-1}) a total of 18 treatments. The experiment was laid out in randomized complete block design (RCBD) in 2 x 3 x 3 factorial arrangements with three replications. The size of each experimental plot was 3 m long and 2 m wide which accommodates 10 rows spaced 20 cm apart having gross plot area of 6 m^2. Blocks and plots were separated by 1 m and 0.5 m respectively. All data except phenology of the crop were collected from the middle eight rows leaving the outer most two rows in both sides and plants that were grown in 0.2 m extreme most distance at both ends of rows in control against border effect. Thus, the net harvestable plot area was 4.16 m^2 (2.6 m x 1.6 m).

The experimental field was prepared following the conventional tillage practice. Sowing was done on July 25, 2014 by hand drilling in rows and covered lightly with soil (at a depth of 3-5 cm). All plots were received uniform fertilizer rates as per recommendation for Bread wheat in the area which is100 kg DAP ha^{-1} (46 kg P_2o_5 and 18 kg N) applied at sowing, while 100 kg Urea ha^{-1} (46 kg N) was applied in three splits (at sowing, mid-tillering and anthesis stage) as a source of nitrogen.

Data collection and Statistical analysis

The data of Phenological and growth parameters such as Days to 50% heading (DH), Days to 90% physiological maturity (DPM), Grain filling period (GFP) and Plant height (PH) and Yield components and yield parameters such as total Number of tillers (NT), productive tillers Number, Spike length (SL), Grain yield (GY), 1000 kernels weight (TKW), Biomass yield (BY) and Harvest index (HI) were collected and measured according to their procedures. The data were subjected to analysis of variance (ANOVA) as per the experimental designs for each experiment using GenStat 15th edition statistical software package. Least Significance Difference (LSD) test at 5% level of probability was used to determine differences between treatment means.

Results and Discussion

Seed purity test

Analysis of variance revealed that physical purity (%) was highly significantly ($P \leq 0.01$) influenced due to the main factor of seed source and interaction of seed source and variety. Generally, both bread wheat seeds obtained from Haramaya University Wheat Research Program and Kersa Local Seed Business Project had the highest pure seeds percentage as compared to seed samples collected from farmers (table 1). The proportion of pure seeds recorded for Digalu variety was in agreement with the results of Girma (2012) who reported mean percentage of pure seed (98.82%) for the same variety seed samples collected from different sources and the lowest percent 90.72% pure seeds were recorded for wheat varieties seeds obtained from farmers. In this study, none of the seed samples obtained from different sources had 1% inert matter. This showed that all sample seeds had percent inert matter less than the minimum prescribed standard set by the Quality and Standards Authority of Ethiopia (QSAE, 2000) for pre-basic (breeder) seeds.

Moisture content

The highest seeds moisture content (13.65%) was recorded for Digalu variety of sample obtained from farmer (F4) and (F1) and the lowest (11.05%) was for Qulqulluu variety obtained from Haramaya University Wheat Research Program. The result indicated that Digalu variety as compared to Qulqulluu had higher moisture content and had the ability to maintain high moisture content that takes longer time for drying of seed after harvest. This result was consistent with the finding of Girma (2012) who reported that the mean percentage of moisture content between varieties across formal seed system were 11.4% and 11.9% for Galama and Digalu wheat varieties, respectively while it was 11.9% and 13.2% for Galama and Digalu, respectively, for informal seed system.

Seed moisture content can tell about the physiological activities which are undergone within the seed while it was in the store or at harvest if the test was conducted within short period of time after harvest. According to “rule of thumbs” of Harington (1973), 1% reduction of seed moisture content doubles the storage life of the seeds. Therefore, even if the temperature and humidity are kept constant every 1% reduction in moisture content has an advantage of doubling the seed longevity. The regional quality report of United States hard red spring wheat ranges from 12 to 13 percent (RQR, 2013). In this experiment, most of the seed samples had moisture content <13% except for Digalu variety obtained from farmers (13.65%). Therefore, the seed samples are expected to be more stable during storage, more profitable to a miller and higher germination rates during planting. Similar result was reported by Strelec *et al.* (2010) that the reduced seed moisture content increase longevity and higher germination rates with different storage temperatures and relative humidity of stored wheat seeds.

Germination percentage

The laboratory experiment showed normal germination of seed samples obtained from each sources and variety incubated for eight days. The growth of plumule and radicle started after four to the last eight days of incubation; the highest germination of seeds observed at four and five days of incubation, then no germination observed after six days. The normal, abnormal and dead seeds were evaluated from four to the last eight days of incubation. Analysis of variance for germination percentage revealed that superiority of the seed obtained from Haramaya University Wheat Research Program and Kersa Local Seed Business Project over the farmer saved seeds in terms of germination percentage, abnormal seedling and dead seeds of bread wheat varieties. However, no variety of the sources recorded below minimum requirements set for germination percentage by the Quality and Standards Authority of Ethiopia (QSAE, 2000) which was 85% for certified seed class 4.

The highest and lowest germination of seeds indicated that the highest and lowest potential of vigoursity of the seed. Farmer seed sources from each variety showed the lowest germination percentage and highest abnormal seed percentage as compared to HU and LSB sources (Table 1). An immature seed leads to increase abnormality of seedlings (mechanically damaged, broken seeds). The normal seedling growth in the laboratory obtained from mature endosperm of food storage as seedlings after germination use the endosperm food for growth and development. The higher food reserve in the endosperm results higher kernel weight and leads to vigorous crop in the field. This result was in agreement with the results reported by Abdul *et al.* (2014) that the bread wheat variety sown with bolder seeds resulted in significantly higher seed germination of 95.29% as compared to the wheat variety sown with small sized seeds with 91.70% germination.

Seedling length and dry weight

Analysis of variance results indicated that the highest seedling length (28.08 cm) was recorded for seed sample of Qulqulluu seed obtained from Kersa Local Seed Business Project (LSB) and the lowest seedling length (23.00 cm) was recorded for seed sample of Digalu variety obtained from two farmers (F2 and F3). Variety Qulqulluu seed sample obtained from LSB had well-developed shoot and root systems that can withstand any adverse conditions and provide better seedling emergence and seedling establishment in the field. This result was in agreement with the findings of Gharineh and Moshatati (2012) who reported that more seedling length and seedling dry weight of the heavy seeds might be attributed to large food reserves of the seeds. The seed source and the interaction between seed source and variety had significant effect on seedling dry weight. The highest seedling dry weight (0.01762 g) was recorded for Qulqulluu variety seeds obtained from Kersa Local Seed Business Project and the lowest seedling dry weight (0.01358 g) was recorded for Digalu variety seeds obtained from farmer two (F2). Similarly, Zareian *et al.* (2013) reported that large seed size produce higher seedling dry weight and it was noticed that seedling dry weight in large seed sizes was related to more seed food storage in their endosperms.

Seedling vigour index

The result indicated in both cases (seed vigour-I and II), farmers saved seeds had lower seedling vigour index one and two as compared to Haramaya University Wheat Research Program (HU) and Kersa Local Seed Business Project (LSB) seed samples (Table 1). This is due to its lower standard germination percentages, hundred kernel weight, seedling length and dry weight of farmers saved seeds. Similarly, Basra (2002) reported that practical seed vigor test should give a good indication of field performance potential of the seed lot and the test results should be reproducible.

Table 1. Interaction effect of different seed sources and varieties on seed physical purity, standard germination percentage, abnormal seed, seed vigour index one and seed vigour index two.

Traits	PSP		SGP		ABS		SVI- I		SVI- II	
Variety	Qulqulluu	Digalu	Qulqulluu	Digalu	Qulqulluu	Digalu	Qulqulluu	Digalu	Qulqulluu	Digalu
HU	99.78^{ab}	99.86^{a}	97.50^{ab}	98.25^{a}	1.50^{de}	1.75^{cd}	26.14^{cd}	26.93^{b}	0.01418^{c-f}	0.01620^{ab}
LSB	99.79^{ab}	99.78^{ab}	98.25^{a}	98.25^{a}	1.00^{e}	1.75^{cd}	27.59^{a}	26.66^{bc}	0.01731^{a}	0.01621^{ab}
F1	99.40^{i}	99.69^{bcd}	96.50^{cde}	97.50^{ab}	2.50^{ab}	1.50^{de}	25.48^{ef}	25.74^{de}	0.01399^{c-f}	0.01516^{bc}
F2	99.49^{ghi}	99.25^{j}	97.25^{bc}	96.75^{bcd}	2.25^{abc}	2.25^{abc}	26.68^{bc}	22.25^{i}	0.01407^{c-f}	0.01314^{f}
F3	99.64^{c-f}	99.55^{fgh}	97.00^{bcd}	97.00^{bcd}	2.00^{bcd}	2.25^{abc}	24.01^{g}	22.54^{hi}	0.01454^{c-f}	0.01359^{c-f}
F4	99.30^{j}	99.45^{hi}	96.50^{cde}	96.62^{b-e}	2.50^{ab}	2.25^{abc}	23.61^{g}	25.66^{de}	0.01352^{def}	0.01400^{c-f}
F5	99.72^{bc}	99.58^{fgh}	97.00^{bcd}	96.25^{de}	1.50^{de}	2.50^{ab}	25.22^{ef}	24.96^{f}	0.01406^{c-f}	0.01347^{ef}
F6	99.66^{cde}	99.73^{bc}	95.75^{e}	97.25^{bc}	2.25^{abc}	2.00^{bcd}	22.40^{hi}	26.49^{bc}	0.01436^{c-f}	0.01361^{c-f}
F7	99.55^{fgh}	99.46^{hi}	96.25^{de}	96.75^{bcd}	2.50^{ab}	2.00^{bcd}	23.93^{g}	24.01^{g}	0.01491^{b-e}	0.01354^{c-f}
F8	99.70^{bc}	99.59^{d-g}	95.75^{e}	97.50^{ab}	2.75^{a}	1.50^{de}	22.95^{h}	26.21^{cd}	0.01340^{ef}	0.01510^{bcd}
LSD (5%)	0.101		0.93		0.73		0.55		0.001619	
CV (%)	0.1		0.7		25.5		1.5		7.9	

*Means with the same letter(s) in the same column of each trait are not significantly different at 5% probability level, LSD (5%) = least significant difference at 5% probability level, CV (%) = coefficient of variation in percent, HU = seed obtained from Haramaya University Wheat Research Program, LSB = seed obtained from Kersa Local Seed Business Project, F1 to F8 = seed samples collected from Farmer one to Farmer eight, PS= pure seed percentage, SGP= standard germination percentage, ABS= abnormal seedling, VI- I = seedling vigour index one and SVI- II = seedling vigour index two.*Field experiment

Days to 50% heading was significantly (P<0.01) affected by interaction of variety and seed sources (Table 3). The delayed in days to 50% heading (71.33 days) was recorded for Digalu variety seeds obtained from Haramaya University sown at rate of 100 kg ha $^{-1}$ and 125 kg ha^{-1} while Qulqulluu variety seeds obtained from the same source sown at rate of 150 kg ha^{-1} exhibited earliness to attain days to 50% heading (68.22 days). The earliness to days to heading might be due to the higher competition to resources as the result plants no longer to stay in vegetative stage. Earliness for days to heading had the advantage to escape terminal moisture stress and good character to cope up with the rainfall variability in growing area. This result is in agreement with the results reported by Tewodros *et al.* (2014) noted that days to heading showed significant difference among the genotypes. The mean for days to heading of tested genotypes ranged from 62 days (ETBW 5013) to 70 days (ETBW 5341).

Days to 90% physiological maturity showed significant differences between varieties, among seed sources and seed rates. The interaction of variety and seed source also showed significant (P<0.01) variation on days to 90% physiological maturity. In addition, Digalu variety grown from farmers saved seeds was found late maturing which took the longest duration (120.2 days) and Qulqulluu variety seeds obtained from Haramaya University took the shortest duration (117.6 days). This might be due to the loss of water content in seeds obtained from Haramaya as it was observed from the rapid change of plants from green color to yellowish at field evaluation. This result is in agreement with the results reported by Gary (1997) that physiological maturity occurs when the kernel has accumulated its highest content of dry matter, loose its water content, and changed green color to yellowish. Also Shahzad *et al*. (2007) reported that the days to physiological maturity of wheat cultivars also varies due to inherent differences between cultivars. The seed rate of 150 kg ha^{-1}

exhibited early maturity which might be due to the increased plant population that increased intra-plant competition for nutrients and light that plants stay no longer for heading and maturity. This may have also contributed to the reduction in grain filling period, because heading and maturity at higher seed rate hastened than lower seed rate.

Grain filling period

The analysis of variance indicated that the main factor of variety and the interaction of, seed source by seed rate had significant ($P<0.05$) influence on grain filling period (Table 2). Variety with the longest grain filling period might be due to genetic variation. This result agreed with the results of Bachubhai (2011) and Pržulj and Momcilovic (2011) who noted that the length of grain growth is a process that is highly varietal dependent. Determination of the genetic base of variety helps breeders to develop new cultivars and give the chance for growers to select the most appropriate cultivar for a specific environment. In this study, Bread wheat seed from Qulqulluu variety obtained from Kersa Local Seed Business Project, and seed rate increased from 125 to 150 kg ha^{-1} decreased duration of grain filling period by 6.46%. This might be due to genetic variation of the varieties in their phenology.

Table 2. Interaction effect of variety, seed source and seed rate on grain filling period (days), plant height (cm) and harvest index of bread wheat varieties

Variety	Seed Source	Grain filling period			Plant height			Harvest index		
		Seed rate (kg ha^{-1})			Seed rate (kg ha^{-1})			Seed rate (kg ha^{-1})		
		100	125	150	100	125	150	100	125	150
Digalu	HU	47.67^{d}	49.33^{bcd}	49.00^{cd}	103.5^{f}	107.0^{de}	107.4^{d}	43.57^{ab}	38.89^{a-d}	31.35^{cde}
	LSB	48.67^{cd}	48.33^{cd}	49.67^{bcd}	105.9^{e}	107.4^{d}	109.7^{a}	34.32^{b-e}	40.66^{abc}	42.87^{ab}
	F	49.00^{cd}	50.00^{abc}	48.67^{cd}	106.6^{de}	107.7^{cd}	109.5^{ab}	29.04^{e}	31.56^{cde}	34.08^{b-e}
Qulqulluu	HU	49.67^{bcd}	49.00^{cd}	49.33^{bcd}	86.9^{h}	96.2^{g}	97.0^{g}	42.17^{ab}	44.93^{a}	42.58^{ab}
	LSB	51.33^{ab}	51.67^{a}	48.33^{cd}	108.9^{abc}	109.3^{ab}	110.2^{a}	39.04^{a-d}	38.94^{a-d}	38.94^{a-d}
	F	49.67^{bcd}	50.00^{abc}	49.33^{bcd}	108.1^{bcd}	109.4^{ab}	109.4^{ab}	36.27^{a-e}	31.96^{cde}	30.77^{de}
LSD (5%)			1.76			1.33			8.07	
CV (%)			2.2			0.8			13	

Means with the same letter(s) in the same column and row of each trait are not significantly different at 5% probability level, LSD (5%) = least significant difference at 5% probability level, CV (%) = coefficient of variation in percent, HU = seed obtained from Haramaya University Wheat Research Program, LSB = seed obtained from Kersa Local Seed Business Project, F = seed samples obtained from farmers, kg ha^{-1} = kilogram per hectare.

Plant height

The analysis of variance revealed that the three main factors (variety, seed source and seed rate) as well as all interaction effect of these factors significantly ($p \leq 0.01$) influenced plant height (Table 2). Higher seed rate caused to changing plant height and stem thickness because of the lower light penetrating in to plants canopy to soil and more inter specific competition to more absorption light. Similar to this finding, Rahim *et al.* (2012) reported that significant difference on plant densities of 450 and 300 plants /m^2 with highest and lowest plant height, respectively. Haile *et al*., (2013) and Ghulam *et al.,* (2011) also reported in wheat that the height of plants grown at the lowest seed rate was significantly lower than the height of plants grown at higher seed rates. The current study result was also in agreement with the results of Abdul *et al.* (2014) who reported that tallness in wheat plants is mostly associated with the genetic makeup of the variety.

Number of tillers

The number of tillers were significantly affected ($P<0.01$) by main effect of variety, seed source and seed rate. Interaction effect of variety and seed source had highly significant effect on number of tillers per 1 m length. The highest tillers might be due to tillering capacity of the variety, highest kernel weight and adaptation to agro ecology and thus resulted in early germination and production of more number of tillers and productive tillers. This result was in agreement with the results reported by Zareian (2013) that difference in yield components especially the number of tillers per unit area in different seed sizes could be effective. Therefore, it is assumed that plants grown from small size seed had less number of tillers and fertile tillers than those grown from large size seed. In this study, seed rate had also significant effect on number of tillers. This result was in agreement with those of Veselinka *et al.* (2014) who reported that in crops with a lower density, a greater number of secondary tillers is created, which produce small grains with less weight and lower quality.

Number of productive tillers

The main effect of variety, seed source and seed rate as well as the interaction effect of variety × seed source and variety × seed rate had significant effect on number of productive tillers per 1m row length. The higher population in 150 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 row length. This result is in agreement with the finding of Stoskopf (1985) who reported that early formed tillers better chance of survival rate and produce spikes developed before the onset of high temperatures that can elevate tiller mortality.

Spike length

The statistical analysis results revealed that spike length was significantly affected by seed rate. At the lower seed rate of 100 kg ha^{-1}, the spike length was higher compared to higher seed rate of 150 kg ha^{-1}. 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 current result is in agreement with the finding of Zewdie *et al*. (2014) who reported that shorter plant produce longer spike length and long plant produce shorter spike and higher biomass production. Similarly, Seleiman (2010) reported that the longest spikes were obtained from 250 and 300 grains per m^2 with no significant variation. However, the shortest spikes were recorded from the highest seeding rate which is 400 grains per m^2.

Number of kernels per spike

Analysis of variance revealed that kernels $spike^{-1}$ was significantly ($P<0.01$) affected by the interaction of variety and seed source (Table 3). Qulqulluu variety obtained from Kersa Local Seed Business Project gave maximum number of kernels $spike^{-1}$ (68.24), while seeds of Digalu variety obtained from farmers saved source gave minimum kernels $spike^{-1}$ (53.31). This implies that Kersa Local Seed Business Project (LSB) seeds showed superiority over seeds obtained from Haramaya University and farmer saved seeds because of good adaptability and management respectively. Similarly, maximum number of kernels $spike^{-1}$ (63.97) was obtained from the plot received seed rate of 100 kg $ha^{-1}$and minimum number of kernels $spike^{-1}$ (57.13) obtained from the plot that received seed rate of 150 kg ha^{-1}. The observed minimum grains $spike^{-1}$ in farmer saved seeds might be due to poor quality and management practices that lead to low number of kernels per spike. This result is in agreement with the results reported by Amir *et al*. (2007) that the minimum grains $spike^{-1}$ in farmer's wheat seed category might be due to aging of the seed, which resulted from poor quality seedling and poor management practices during its development. Significant difference was observed between plant densities of durum wheat cultivar in terms of grains per spike. The highest and lowest grains per spike observed at lowest and highest plant densities, respectively (Rahim *et al.,* 2012).

Table 3. Interaction effect of variety and seed source on days to 50% heading and number of kernels per spike of bread wheat varieties

Trait	DH (days)			NKPS		
Seed Source / Variety	HU	LSB	F	HU	LSB	F
Digalu	71.33[a]	70.56[a]	71.00[a]	63.33[b]	63.30[b]	53.31[d]
Qulqulluu	68.22[c]	68.89[bc]	69.22[b]	58.24[c]	68.24[a]	58.27[c]
LSD (5%)		0.864			1.289	
CV (%)		1.3			4.5	

Means with the same letter(s) in the same column and row of each trait are not significantly different at 5% probability level, LSD (5%) = Least significant difference at 5% probability level, CV (%) = Coefficient of variation in percent, HU = seed obtained from Haramaya University Wheat Research Program (HU), LSB = Seed obtained from Kersa Local Seed Business Project, F = seed samples obtained from Farmer, NKPS = number of kernels per spike

Thousand Kernel weight

The analysis of variance revealed that all the main effects (variety, seed rate and seed source) had significantly affected on thousand kernel weight (Table 4). The lowest kernels weight produced from highest seed rate might be due to high plant population density which resulted intra-completion of the nearby plants in absorbing nutrients and moisture that might leads to insufficient grain filling. 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; Dubis and Budzynski, 2006).

Grain yield

Analysis of variance showed that seed source and seed rate showed highly significant effect ($P < 0.01$) on grain yield. It was observed that seed sample from Kersa Local Seed Business found to have advantage yield increment by 23.14% and 11.57% over farmers saved seeds and seeds from Haramaya University respectively. With increased seed rate increased grain yield per plot and per hectare were observed (Table 4). The maximum yield obtained from the use of higher seed rate might be due to high density of plants in rows and increased number of spikes per rows. The result was in conformity with result of Haile (2013) who reported that the lowest seed rate (100 kg ha^{-1}) resulted in a grain yield was significantly lower than the yields obtained at the other seeding rates (150 and 175 kg ha^{-1}). Seleiman (2010) also noted that grain yield ha^{-1} was gradually and significantly increased as sowing density of bread wheat increased from 250 grains m^{-2} to 350 grains m^{-2} and then the rate of increase remain constant with increasing sowing density up to 400 grains 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.

Biomass yield

The result from analysis of variance indicated that, all the three main effects (variety, seed source and seed rate) as well as interaction of variety by seed source revealed significant effect on biomass yield. The maximum biomass yield obtained from LSB seeds of Qulqulluu variety might be due to the higher tillering capacity and higher plant height (Table 4). Higher tillers resulted in higher plants population and spikes per rows and plots which leads to increased grain and biomass yield ha^{-1}. The result is in agreement with the finding of Zewdie *et al*. (2014) who reported that taller plants height gave higher biomass yield.

Harvest index

Analysis of variance showed that seed source was significant (P < 0.01) affected (Table 4) while the three ways interaction (variety x seed source x seed rate) effect had shown significant effect (P < 0.05) on harvest index respectively (Table 2). Harvest index had interrelationship with grain yield and above ground biomass yield that the highest harvest index was the result of greater grain yield. Lowest harvest index was mainly due to increased plant height and increased biomass yield rather than grain yield which lead to decrease of harvest index. The result also agreed with the result of Reynolds *et al.* (2009) who found that wheat cultivars have high harvest index most likely have high grain yield under field conditions.

Table 4. Effect of seed rate, seed source and variety on grain yield (t ha^{-1}), thousand kernel weight, biomass yield and harvest index of bread wheat grown in 2014 at Kersa

Traits	GY (t ha^{-1})	TKW (g)	BY (t ha^{-1})	HI (%)
Seed rate (kg ha^{-1})				
100	4.607^{b}	43.47^{a}	12.56^{c}	37.4
125	5.162^{a}	41.74^{b}	13.79^{b}	37.82
150	5.539^{a}	39.27^{c}	15.20^{a}	36.77
LSD (5%)	0.3873	1.674	0.838	ns
Seed source				
HU	5.066^{b}	40.88^{b}	12.73^{b}	40.58^{a}
LSB	5.652^{a}	42.51^{a}	14.47^{a}	39.13^{a}
F	4.590^{c}	41.09^{b}	14.34^{a}	32.28^{b}
LSD (5%)	0.3873	1.183	0.3873	3.565
Variety				
Digalu	5.12	40.97^{b}	14.28^{a}	36.26
Qulqulluu	5.09	42.01^{a}	13.42^{b}	38.4
LSD (5%)	Ns	0.966	0.684	ns
CV (%)	11.2	4.2	8.9	13

Means with the same letter(s) in the same column of each trait are not significantly different at 5% probability level, LSD (5%) = least significant difference at 5% probability level, CV (%) = coefficient of variation in percent, HU = seed obtained from Haramaya University Wheat Research Program (HU), LSB = Seed obtained from Kersa Local Seed Business Project, F = seed samples obtained from Farmer, GY = grain yield, TKW= thousand kernel weight, BY=biomass yield, HI= harvest index

Conclusion

Wheat is one of the most important world cereal crops and is a staple food for about one-third of the world's population. It is one of the cereal crops produced in eastern Ethiopia where its production and productivity is low due to the use of farmer saved poor quality seeds, inappropriate seed rate and unavailability of adaptable varieties. This indicates that the need to conduct research and determine the optimal seed rate and use of quality seed of adaptable varieties in growing area as one of important agronomic managements to improve production and productivity of bread wheat. The study consisted of field and laboratory experiments of which laboratory experiment was conducted at Haramaya University Seed Science and Technology Laboratory. The field experiment was conducted at Kersa, Eastern Ethiopia. The field experiment was designed by randomized complete block design (RCBD) having 2 Bread wheat varieties (Digalu and Qulqulluu), 3 seed sources (Haramaya University, LSB and farmers as seed sources) and 3 seed rates (100, 125 and 150 kg ha^{-1}) factorial arrangements with three replications.

The two experimental results showed that, the presence of significance difference among seeds of different sources for seed quality which consequently resulted significance difference in crop phenology, growth, yield and yield components of the two bread wheat varieties. These results implies that the importance of using appropriate seed rate and quality seeds from reliable sources of improved varieties have paramount importance to increase yield of bread wheat in the study area. Thus, bread wheat variety (Qulqulluu) obtained from Kersa Local Seed Business Project sown at the seed rate of 150 kg ha^{-1} showed better yield response as compared to other seed sources. However, the experiments were conducted considering only two varieties, limited number of seed sources and seed rates and at one location which might be not represent all bread wheat growing areas of Eastern Hararghe. Therefore, it is necessary to conduct the experiments considering more number of seed sources, seed rates and varieties at major wheat growing areas for more than one cropping seasons to make conclusive recommendation that can be applicable in Eastern Hararghe.

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Conflict of Interests

Authors have not declared any conflict of interests.

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