GSJ: Volume 9, Issue 8, August 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

Effect of Seed Rate and Blended NPSB Fertilizer on Yield and Yield Component of Bread Wheat (*Tiriticum Astivum* L.) in Ayehu Guagusa, North West Ethiopia.

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ABSTRACT

Bread wheat productivity is mainly constrained by high seed rate and lack of site-specific fertilizer (NPSB) recommendation in the study area. Hence, field experiment was carried out to assess the effect of NPSB blended fertilizer rates and seed rate on growth, yield and yield related traits of bread wheat. Factorial combinations of four blended NPSB levels (0, 50, 100 and 150 kg ha^{-1}) with four seed rates (125, 150, 175 and 200 kg ha^{-1}) were laid out in a randomized complete block design with three replications. All of the plots were supplemented uniformly with 200 kg urea ha^{-1}. Analysis of the results revealed that number of kernels per spike, grain yield and harvest index were significantly affected by main effects of NPSB fertilizer, seed rate and interaction. Whereas, Thousand's kernel weight was affected by seeding rates and interaction of blended NPSB rate and seed rates. The highest number of kernels per spike (49.5) were obtained from combined use of 125 kgha^{-1} seed rate and 150 kgha^{-1} blended fertilizer. The highest grain yield (4.857tha^{-1}) and the highest harvest index (48.99%) were obtained from interaction of 150kgha^{-1} blended NPSB rate and175kgha^{-1} seed rates.

Keywords: Bread wheat, Blended fertilizer, Seed rate, Main effect, Economic benefit

INTRODUCTION

Wheat (*Tiriticumastivum* L.) is an important staple food crop all over the world (Mathpal *et al*., 2015). Ethiopia is one of the largest wheat producers in the Sub-Saharan Africa, with yearly estimated production of 4.5 million tons on 1.69 million hectares of land CSA, 2019). It is one of the most important cereals cultivated in Ethiopia (Jemal *et al*., 2015).

Wheat is an important staple food crop in Ethiopia, especially in urban areas. It is a staple food in the diets of several Ethiopian, providing about 15 percent of the caloric intake for the countries over 90 million population (FAO, 2015a), placing it second after maize and slightly ahead of teff, sorghum, and enset, which contribute 10-12 percent each (Minot *et al*., 2015). In Amhara region, wheat is the third most important cereal crop next to tef and sorghum which cover 15.9% in area and 16.5% in production from cereal crops in the region (CSA, 2019). Thus, wheat is one of the most widely grown crops around the experimental site.

For the last four to five decades, Ethiopian agriculture depended solely on imported fertilizer products; only urea and Di-ammonium phosphate (DAP), as sources of N and P, respectively. Increasing N fertilizer greatly affected grain yield and quality of wheat protein content (Dawit *et al.,* 2015). Adequate phosphorus enhances many aspects of plant physiology like photosynthesis, flowering, seed maturity and seed development (Ziadi *et al.*, 2008). Sulfur is an essential nutrient required to build yield and achieve grain quality. Boron deficiency impairs grain setting in wheat, resulting in increased number of open spikelets and decreased number of grains per spike (Marschner, 1995).

Ethiopia is moving from blanket recommendations for fertilizer application rates to recommendations that are customize based on soil type and crop (Nicholas *et al.*, 2015). Recent studies have indicated that elements like N, P, K, S and Zn levels as well as B and Cu are becoming depleted and deficiency symptoms are being observed on major crops in different areas of the country (ATA, 2013).

Optimum seed rate is most important for maximum yield of crop. If more seed rate is used, plant population will be more and there will be competition among plants for water, nutrients and sunlight resulting in low quality and low yield. If less seed rate is, used yield will be less due to lesser number of plants unit area^{-1}(Hamid *et al*; 2002). The maximum grain yield was obtained with the increase in seed rate while minimum grain yield was produced by low seed rate (Shah *et al.,* 2011). High seed rate increases the competition among crops for common resource particularly water, nutrients and sunlight which resulting in low quality and low yield. If low seed rate is, used yield will be less due to lesser number of plants per unit area (Hameed *et al*., 2002 and Amare & Mulatu, 2017).

The NPSB fertilizer & seed rate and its effects on bread wheat yield and yield components have not been studied extensively. The application of NPSB fertilizers to improve yield and yield components has become necessary in Ethiopia. Information is particularly lacking on effects of NPSB fertilizer rate on wheat yield and yield components. However, limited research has been done to elucidate the response of bread wheat to mineral NPSB fertilizer rates application and seed rate in the study area. Therefore, this study was undertaken with the objective: To evaluate the interaction effects of rates of NPSB fertilizer and seeding rate on yield and yield components of bread wheat.

MATERIALS AND METHODS

Description of the Study Site: The experiment was conducted in chebachebasa kebele farmers training center, Ayehu Guagusa district Awi Adminstrative Zone in Amhara National Regional State of Ethiopia under rain fed condition from end of July to the end of November 2019 cropping season. It is situated at latitude$10^{0}45$ N and longitude $36^{0}51$ E with an elevation of 2117 meters above sea level. The experimental site receives minimum annual rainfall of 1200 mm and maximum 1500 mm and minimum and maximum temperatures of 17.5^{o}C and 20^{o}C, respectively. The soil of the experimental site is nitosol type (Arc GIS Arc map, 2012).

Treatments and Experimental Design: The treatments were consisting of four rates of NPSB fertilizer: (0, 50, 100 and 150 kg NPSB $ha^{-1)}$ and four seed rates (125, 150, 175 and 200 kg seed rate ha^{-1}), arranged in a randomized complete block design (RCBD) with three replications. The Gross aera of each plot size will be 2 m x 3 m ($6m^2$). There are 10 rows in each plot 20 cm inter row spacing. The spacing between adjacent plots and blocks were 0.5m and 1m respectively.

Experimental Materials: The bread wheat variety Picaflor *(kekeba*) was used as planting material. The variety was selected based on its adaptability to agro-ecological conditions of the area. *Kakaba* is the most common and widely distributed bread wheat variety in the country and in the study area as well. The blended NPSB fertilizer rates (18.9% of N, 37.7% of P_2O_5, 6.95% of S and 0.1% of B) were used as the fertilizer source. Urea as source of Nitrogen (46% N) was apply uniformly to all treatments.

Experimental Procedures and Field Management: The experimental field was ploughed with tractor and oxen to a fine tilth five times and the plots were leveled manually. Then, a field layout was made and each treatment was assigned randomly to the experimental units within a block. Bread wheat seed was sown at the assigned treatment seed rate of rows of 20 cm spacing manually by drilling. The whole amount of blended (NPSB) was applied at sowing and the $2/3^{rd.}$ and $1/3^{rd}$ of nitrogen was applied at the time of sowing and top-dressed at tillering (38 days after sowing) respectively. Weeding was done 3 times; and harvesting and threshing was done manually.

Data Collection: Number of kernels per spike, Thousand kernels weight (g), Grain yield (t ha^{-1}) and Harvest index.

Statistical Analysis: Data were subjected to analysis of variance (ANOVA) by using the methods described by Gomez and Gomez (1984) using SAS computer software 9.3. The comparisons among treatment means with significant difference for measured characters was done by LSD test at 5% level of significance.

RESULTS AND DISCUSSION

Number of kernels per spike: The number of kernels per spike was highly significant affected ($P<0.001$ by main effects of blended NPSB fertilizer, seed rate and interaction of two factors. Increasing the rates of blended NPSB fertilizer, increased the number of kernels produced per spike. Seed rate $125kgha^{-1}$ produced the maximum numbers of kernels per spike (41.68) whereas the minimum number of kernels per spike (36.77) was produced for seed rate$200kgha^{-1}$. The highest number of kernels (46.45) produced from the highest rate of NPSB fertilizers (150 kg ha^{-1} NPSB) whereas the minimum number of kernels per spike (32.03) was produced at nil NPSB rate. The data also indicated that interaction of seed rate and NPSB rate was highly significant ($P<0.01$) affected number of kernels per spike (Table 3). Data showed that highest number of kernels per spike (49.5) were noted, when 125 kg ha^{-1} seed rate & 150 kg ha^{-1} NPSB rate. While lowest number of kernels per spike (30.17) were noted from plots in which 200 kg seed ha^{-1}& zero fertilizer was used (Table 3).

This indicated that the number of kernels per spike was more enhanced by NPSB, which might be because P is essential in development of grains. This may be due to the reason that Boron plays a vital role in grain setting of wheat. Therefore, the supply of boron contains fertilizer helps in grain filling and ultimately sterility is reduced and number of grains per spike increased. These also showed the synergistic effect of the fertilizers resulting in increased kernel number per spike and grain production.

In agreement with this result, Denekenesh (2018) reported the highest number of kernels (43) produced from the highest rate of NPSB fertilizers (183 kg ha^{-1} NPSB) whereas the minimum number of kernels per spike (35) was produced at nil NPSB rate. In line with this, Usman (2018) the effect of fertilizer also showed that the highest number of kernels per spike (48.3) was recorded from NPSB fertilizer rate of 150 kg ha^{-1}. Similarly, Seyoum (2017) also reported that increasing the rates of both NPSB and N increased the number of kernels produced per spike where the maximum numbers of kernels per spike (49.5) was produced at the combination of highest rate of NPSB fertilizers (200 kg ha^{-1} NPSB) and N rates of 23 and 46 kg ha^{-1}. Similarly, Tilahun *et al.* (2017) also reported higher number of kernels per spike for durum wheat (28.39) at the highest rate of N (92 kg N ha^{-1}). Likewise, Bereket *et al.* (2014) reported that B treatments resulted a significant improvement in the number of kernels per spike show a range of 29.8 to 38.5.

In agreement with this result, Amare & Mulatu (2017) reported Maximum number of kernels $spike^{-1}$ (41.33) was obtained from the plot that received seed rate of 100 kg $ha^{-1}$and minimum number of kernels $spike^{-1}$ (37.03) obtained from the plot that received seed rate of 150 kg ha^{-1}. As the seed rate was increased from 100 kg ha^{-1} to 150 kg ha^{-1}, the number of kernels per spike decreased by 10.42%. This is because at higher plant density most grains would fade at early stage because of competition between growing grains to absorb preserved matters and as the result low grains per spike would be produced (Rahim *et al.*, 2012). The result of this study is consistent with the findings of Rahim *et al.* (2012) who reported that higher seed rates produced significantly decreased number of grains (kernels) $spike^{-1}$. Similarly, Jemal *et al.* (2015) reported that seed rates up to 150 kg ha^{-1} gave the higher number of kernels per spike across varieties while seed rates of 175 and 200 kg ha^{-1} gave fewer kernels per spike.

Thousands of kernels weight: Main effect seed rate and the interaction effect was showed significantly ($P < 0.05$) effect on thousand kernels weight, whiles main effect of NPSB rate not significant ($P > 0.05$). Seed rate 125kgha^{-1} produced the maximum thousands of kernels weight (36.08) whereas the minimum thousands of kernels weight (36.08) was produced for seed rate200kgha^{-1}. The data also indicated that interaction of seed rate and NPSB rate was significantly ($P<0.05$) affected on thousand kernels weight (Table 3). Data showed that highest on thousand kernels weight (40) were noted, when 125 kg ha^{-1} seed rate & 150 kg ha^{-1} NPSB rate. While lowest on thousand kernels weight (34.67) were noted from plots in which 200 kg seed ha^{-1}& zero fertilizer was used (Table 3).

The result of this study is consistent with the findings of Amare & Mulatu (2017) reported increasing seeding rate from 100 kg ha^{-1} to 125 kg ha^{-1} and 150 kg ha^{-1}, thousand kernel weights decreased by 4.2% and 5.6%, respectively. This could be due to high density caused to increasing total number of tillers and as a result competition would increase and little photosynthesis would be available to grain filling and finally thousand kernels weight would be reduced. The current result is in agreement with Spink *et al.* (2000), Baloch *et al*. (2010) and Laghari *et al.* (2011) who reported that the higher seed rate in bread wheat resulted in decreased 1000-kernel weight. Furthermore, Jemal *et al*. (2015) reported that increasing seeding rate significantly decrease 1000-kernel weight. Similarly, Abiot (2017) reported the highest thousand kernels weight (35.44 g) was recorded for seed sown at the seeding rate of 100 kg ha^{-1} whereas the lowest thousand kernel weight (33.04 g) was recorded at the seeding rate of 175 kg ha^{-1}.

The insignificance of NPSB rate might be due to good grain filling period and favorable environmental condition the there was no thousand seed weights differ among different rate. In line with this Bereket *et al.* (2014) also reported that increasing N rate from 92 kg N ha^{-1} to 138 kg N ha^{-1} decreased thousand kernels weight of bread wheat by about 3.7%. In contrary to this Mascagni *et al.,* (2008) also reported that 1000 kernels weight increased with the increase in nitrogen rate up to 100 kg ha^{-1}. Denekenesh (2018) also reported the maximum thousand kernels weight (44.8 g) was recorded at the NPSB rate of 183 kg $ha^{-1}$and it was statistically at par with the NPSB rate of 122 kg ha^{-1} (44.3 g) of durum wheat.

Table 3. Interaction effects of seed rate and blended fertilizer on Total tillers, Number of productive tillers, Number of kernels per spike and Thousands of kernels weight (g) of bread wheat

SR	NPSB	NKS	TKW
125	0	33.47^{jk}	36.67^{bcde}
	50	38.1^{gh}	38.33^{ab}
	100	45.67^{bcd}	37.33^{bcd}
	150	49.5^{a}	40^{a}
150	0	32.73^{kl}	37.67^{abcd}
	50	36.57^{hij}	35.67^{cde}
	100	44^{cde}	36.67^{bcde}
	150	46.73^{abc}	38^{abc}
175	0	31.73^{kl}	37.33^{bcd}

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	50	37.6^{ghi}	37^{bcde}
	100	43.53^{de}	35.33^{de}
	150	47.53^{ab}	37.67^{abcd}
200	0	30.17^{l}	34.67^{e}
	50	34.6^{ijk}	35.33^{de}
	100	40.27^{fg}	38^{abc}
	150	42.03^{ef}	36.33^{bcde}
CV (%)		4.1395	4.269
LSD (0.05)		3.1942	2.6623

LSD (0.05) = Least Significant Difference at 5% level; CV = Coefficient of Variation; NS= non-significant, means in column followed by the same letters are not significantly different at 5% levels of Significance

Grain yield: The ultimate goal in crop production is maximum economic yield, which is a function of individual yield components in response to optimum rate inputs used. Analysis of variance showed that the main effects of seed rate, NPSB fertilizer rate and the interaction effect of seed rate and fertilizers were highly significant effect ($p<0.01$) on grain yield.

175kgha^{-1} seed rate was produced the highest grain yield (3.537tha^{-1}) while the lowest biomass (2.865tha^{-1}) was produced from seed rate 125 kgha^{-1} (Table 4). The maximum grain yield obtained from the use of higher seeding rate might be due to high density of plants in rows and increased number of spikes per rows as a result number of grains and increased spike number in rows (Abiot, 2017). The highest grain yield (4.3tha^{-1}) was obtained at the application of the highest rate (150 kg ha^{-1} NPSB) whereas the lowest grain yield (2.31tha^{-1}) was produced under control treatment (Table 10). The data also indicated that interaction of seed rate and NPSB rate was highly significantly ($P<0.01$) affected on grain yield (Table 4). Data showed that highest grain yield (4.857 tha^{-1}) were noted, when 175 kg ha^{-1} seed rate & 150 kg ha^{-1} NPSB rate. However, it was statistically followed with in 4.413 tha^{-1} were noted, when 150 kg ha^{-1} seed rate & 150 kg ha^{-1} NPSB rate was used. While lowest grain yield (2.163tha^{-1}) were noted from plots in which 125 kg seed ha^{-1}& zero fertilizer was used (Table 4).

In conformity with this result, Abiot (2017) reported the highest grain yield (4462.10 kg ha^{-1}) was obtained at the seeding rate of 150 kg ha^{-1} and the lowest grain yield (3069.00 kg ha^{-1}) was obtained at seeding rate of 100kg ha^{-1}. Similar with the present finding, Haile Deressa *et al.* (2013) who reported that the lowest seeding rate (100 kg ha^{-1}) resulted in a grain yield of 3851 kg ha^{-1}, which was significantly lower than the yields obtained at the other seeding rates (150 and 175 kg ha^{-1}). Similarly, Hussain *et al.* (2010) and Worku Awdie (2008) reported that grain yield increased as seeding rate was increased from 50 to 150 and from 100 to 150 kg ha^{-1}, respectively.

Moreover, Ali *et al. (*2010) concluded that the three years average data showed that grain yield was maximum at seeding rate of 150 kg ha^{-1} followed by 175 and 200 kg ha^{-1} as 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}). However, seeding rate of 125 kg produced significantly lower grain yield (3.669 t). Another research finding by Nazir *et al.* (2000) also showed that 150 kg ha^{-1} seeding rate produced significantly the highest grain yield. Likewise, Jemal, *et al. (*2015) also reported that varieties Shorima and Kakaba gave maximum grain yield at seeding rate of 150 kg ha^{-1} and, variety digalu produced highest yield at seeding rate of 175 kg ha^{-1} as compared to 100, 125, and 200kg ha^{-1}. Seleiman *et al*. (2010) also confirmed that increasing seeding rates up to 350 or 400 grains m^{-2} increased grain yield.

In agreement with this result, Abebaw and Hirpa (2018) who reported among the treatments 200 $kgha^{-1}$ NPSZnB + 63.91 kg of urea /ha produced the highest grain yield (29.583 qt/ha), although statistically non-significant to treatments of 100 kg of NPSZnB fertilizer,150 kg of blended fertilizer, 200 kg of NPSZnB, 100 kg NPSZnB + 101.52 kg of urea. The lowest (12.125 qt/ha) and (18.194 qt / ha) was found plots treated with 0 kg fertilizer (control) and 100 kg DAP and 100 kg UREA, respectively. This result signifies that the response of the soil B, Zn and S blended was significantly higher. Comparable yield increment of the blended fertilizer over the DAP and urea source fertilizer could be associated with the additional nutrients involved in the blended fertilizer (Zn, B, and S) other than N and P (Abebaw and Hirpa, 2018).

Amjed *et al.* (2011) who said that the grain yield increase when apply both macro and micronutrients and when applying by increasing the level of nitrogen up to 150 kg of nitrogen per hectare. Similarly, Mulugeta Eshetu *et al.* (2017) reported that application of nutrients like K, S, Zn, Mg and B used in experiments significantly increased grain yield and yield component of bread wheat as compare to the control (no fertilizer). Bereket *et al.* (2014) reported that grain yield of bread wheat significantly increased due to the main effect of nitrogen and phosphorus fertilization and obtained highest grain yields (4443 kg ha^{-1}) and (3988 kg ha^{-1}) at application of 138 kg N $ha^{-1}$and 69 kg P2O5 ha^{-1}, respectively.

Harvesting index: Analysis of variance showed that the main effects of seed rate, NPSB fertilizer rate and the interaction effect of seed rate and fertilizers were highly significant effect ($p<0.01$) on harvesting index.

Seed rate of 175$kgha^{-1}$ was produced the highest grain yield (43.25) while the lowest harvesting index (38.699) was gained from seed rate 125 $kgha^{-1}$ (Table 4). The highest harvesting index (44.691) was obtained at the application of the highest rate (150 kg ha^{-1} NPSB) whereas the lowest harvesting index (2.31tha^{-1}) was produced under control treatment (Table 4). Data showed that highest harvesting index (48.99) were noted, when 175 kg ha^{-1} seed rate & 150 kg ha^{-1} NPSB rate. While lowest harvesting index (36.11) were noted from plots in which 200 kg seed ha^{-1}& zero fertilizer was used (Table 4).

Harvest index shows the efficiency of the distribution of photosynthetic materials between different plant organs. The result might have from direct relationship with when grain yield enhanced with seed and NPSB fertilizer rate. Harvest index increases with seed rate from 125 $kgha^{-1}$ up to 175$kgha^{-1}$. The result is in agreement with that of Abebaw & Hirpa (2018) who reported harvest index was significantly affected by the main effect fertilizer rate (blended). Among the treatments 200 kg blended fertilizer / ha, 100 kg blended fertilizer + 101.25 kg of urea / ha produced the highest harvest index. Although statistically identical to plots that receive 100 kg blended fertilizer / ha, 150 kg blended fertilizer / ha, 150 kg blended fertilizer + 82.71 kg of urea /ha and 200 kg blended fertilizer + 63.91 kg of urea /ha. However, the lowest harvest index was recorded from plots that receive 0 kg of fertilizer (control). This low harvest index might be associated with lack of nutrients and not easily available form for the crop to use. This result in harmony with Yosef (2013) and Mohammed *et al.* (2009), who reported that application of B, Zn with NPK increase on yield components of wheat especially on harvest index and grain yield. The analysis of variance for harvest index showed that main effect of blended fertilizer rates was significantly ($p<0.01$) affected, but not for varieties and their interaction effects (Diriba, *et al.* 2019).

Table 4. Interaction effects of seed rate and blended fertilizer on biomass yield (tha^{-1}), straw yield (tha^{-1}), grain yield (tha^{-1}) and harvesting index (%) of bread wheat

SR	NPSB	GY	HI
125	0	2.196^{gh}	39.71^{efgh}
	50	2.523^{efg}	37.84^{fgh}
	100	3.047^{d}	37.81^{fgh}
	150	3.707^{c}	39.44^{efgh}
150	0	2.513^{efg}	41.08^{def}
	50	2.727^{de}	38.65^{efgh}
	100	3.54^{c}	40.65^{defg}
	150	4.413^{b}	45.77^{abc}
175	0	2.377^{fgh}	39.4^{efgh}
	50	2.657^{ef}	36.33^{ghi}
	100	4.216^{b}	48.19^{ab}
	150	4.857^{a}	48.99^{a}
200	0	2.163^{h}	36.11^{hi}
	50	2.313^{gh}	33.38^{i}
	100	3.403^{c}	42.92^{cde}
	150	4.237^{b}	44.57^{bcd}
CV (%)		6.2667	6.4432

LSD (0.05)	0.3302	4.3929

LSD (0.05) = Least Significant Difference at 5% level; CV = Coefficient of Variation; NS= non-significant, means in column followed by the same letters are not significantly different at 5% levels of Significance.

CONCLUSION

The results showed that plant height, number of tillers per plant and productive tillers per plant were significant for seed rate, fertilizer rate and their interaction. Number of kernels per spike was significantly affected by seed rate and fertilizer rates. Seed rate of (175 kg ha^{-1}) combined with fertilizer rate 150 kg ha^{-1} produced the highest number of kernels per spike (47.53) the next number of kernels per spike (46.73) was produced with seed rate (150 kg ha^{-1}) combined with fertilizer rate of 150 kg ha^{-1}.

Grain yield was significantly affected by fertilizer rates, seed rate and interaction effect between variety and fertilizer rates. Seed rate (175 kg ha^{-1}) combined with fertilizer rate of 150 kg ha^{-1} produced the highest grain yield (4.875 tha^{-1}) the next number of grain yield (4.41 tha^{-1}) was produced with seed rate (150 kg ha^{-1}) combined with fertilizer rate of 150 kg ha^{-1}. The highest HI of 48.99% was obtained under the combined use of 150 kg ha^{-1} of NPSB fertilizer rates and 175 kg ha^{-1} seed rate.

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