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Effects of Blended Fertilizer Rates on Bread Wheat (Triticum Aestivum L.) Varieties on Growth and Yield Attributes

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Abstract
Bread wheat (Triticum aestivum L.) is an important food crop and source of income for farmers at Tiyo district in Eastern Arsi, Ethiopia. Field experiment was conducted at Tiyo district on farmer's field in 2018 main cropping season to evaluate response of bread wheat varieties to blended (NPSB) fertilizer rates. Factorial combination of two improved bread wheat varieties (Wane and Kingbird) and eight treatments [Control, Recommended NP (150 kg ha^{-1} TSP (69%P_2O_5) + 158.7 kg ha^{-1} Urea (73 N)), 100 kg NPSB (18.1N + 36.1P_2O_5 + 6.7S + 0.71B), 100 kg NPSB + recommended urea (46 kg N) , 150 kg NPSB + recommended urea, 200 kg NPSB + recommended urea, 250 kg NPSB + recommended urea, 300 kg NPSB + recommended urea.] were laid out in randomized complete block design with three replications. Results revealed seedling density, plant height, and harvest index were significantly affected by the main effect of fertilizer rate. Days to heading, days to maturity, spike length, seeds per spike, thousand kernel weight and straw yield were significantly affected by the main effect of varieties and fertilizers rates. Grain yield, aboveground dry biomass and number of productive tillers were significantly affected by the interaction effect of varieties and fertilizer rates. The highest seeds per spike (53.9), thousand kernel weight (37.3 g), and straw yield (9071.7 kg ha^{-1}) were recorded from 300 kg NPSB ha^{-1} application along supplementary urea. Higher grain yield was harvested from Wane (4236 kg ha^{-1}) variety at 300 kg NPSB ha^{-1} fertilizer rate. Therefore, application of NPSB at the rate of 300 kg NPSB ha^{-1} in the production of Wane and 200 NPSB kg ha^{-1} in the production of Kingbird varieties was economically beneficial and recommended for around Kulumsa area.
Keywords: Blended fertilizers; economic benefit; yield; main effect
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1. INTRODUCTION

Wheat is one of the most important crop plants in the world. It grows under a broad range of latitudes and altitudes; it is not only the most widely cultivated crop but also the most consumed food crop all over the world (Mehraban, 2013). Wheat is one of the most important cereals cultivated in Ethiopia. Ethiopia is the largest producer of wheat in sub- Saharan Africa (SSA), over 1.8 million hectares annually (Abeyo *et al*., 2012). It ranks fourth after maize, tef and sorghum both in area coverage and production (CSA, 2018). Wheat production in the country is adversely affected by low soil fertility and suboptimal use of mineral fertilizers in addition to diseases, weeds, erratic rainfall distribution in lower altitude zones, and water-logging in the Vertisols areas (Amanuel *et al*., 2002).

Since its start in the early 1970's, fertilizer use in Ethiopia has focused mainly on the use and application of nitrogen and phosphorous fertilizers in the form of Urea and Di Ammonium Phosphate (DAP) for almost all crops and soil types. Such unbalanced and blanket application of plant nutrients may aggravate the depletion of other important nutrient elements in soils (Fayera *et al*., 2014). However, recently it is perceived that the production of such high protein cereals like wheat and legumes can be limited by the deficiency of S, B and other nutrients (Assefa *et al*., 2015). The current soil map based test of fertilizer recommendation indicated there is a need to add blended fertilizer under different formulation having micronutrients such as boron in Ethiopia. Boron assists absorption of nitrogen and other nutrients. Though their success rate vary from place to place, DAP was replaced by NPS since 2015 to supplement sulfur deficiency based on soil map tests.

Inappropriate cropping systems, mono cropping, nutrient mining, unbalanced nutrient application, removal of crop residues from the fields and inadequate re-supplies of nutrients have contributed to decline in crop yields (Nyamangara, 2001). Low soil fertility due to monoculture cereal production systems is recognized as one of the major causes for declining per capita food production. Declining soil fertility is also an important bottleneck for smallholder cereal growers in central western parts of Ethiopia (Tolera *et al.,* 2009). Continuous monocultures of cereals also result in reduction of yields and soil nutrients (Zerihun *et al.,* 2013; Kombiok *et al.,* 2008). Declining yield and soil fertility as a result of continuous mono-cropping have also been reported for finger millet (Shiningayamwe, 2012; Yusuf *et al.,* 2008).

In Ethiopia, soil degradation and nutrient depletion have gradually increased in area and magnitude and

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have become serious threats to agricultural productivity (Fasil and Charles, 2009). Low soil fertility is exacerbated by soil fertility depletion through nutrient removal with harvest, tillage, weeding, and losses in runoff and soil erosion (Bai *et al.*, 2008). Many farmers are unable to compensate for such losses, which resulted in negative nutrient balances (Cobo *et al.*, 2010). This situation is worsened by low input, continuous cultivation and overgrazing (Bai *et al.*, 2008). Supply of adequate and balanced nutrients is one way of achieving high bread wheat grain yield (Kassahun, 2004). Adequate and timely application of fertilizer should be aligned with fertilizer responsive varieties. This is directly associated with amount of yield harvested and thereby its end quality. Wane and Kingbird bread wheat varieties are released for their resistance against rust and early maturity. Besides genetic and environmental factors, crop management factors like fertilizer application determine productivity.

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). Most Ethiopian soils are deficit in macronutrients (N, P, K and S) and micronutrients (Cu, B, and Zn) (EthioSIS, 2014).The farmers in most parts of the country have limited information on the impact of different types and rates of fertilizers except blanket recommendation of nitrogen (41 kg N ha^{-1}) and phosphorus (46 kg P_2O_5 ha^{-1}), *i.e.* 50 kg Urea and 100 kg DAP ha^{-1} for wheat while according to the soil fertility map made over 150 districts. Except blanket recommendation of nitrogen and phosphorus, the effect of other fertilizers on yield components, yield, and grain quality of bread wheat are unknown, even though new blended fertilizers such as NPSB are currently available. The response of wheat plant to application of fertilizer varies with varieties, rainfall, soils, agronomic practices, expected yield etc. Because of that, there is a need to develop location specific recommendation on the fertilizer rates to increase the productivity of wheat. Thus, this study was initiated to evaluate the effects of blended fertilizer rates application on growth, yield and yield components of bread wheat varieties.

2.MATERIALS AND METHODS

2.1.Description of the Study Area

The experiment was conducted at Tiyo district around Kulumsa Agricultural Research Center (KARC) on farmer field located at about 167 km South East of Addis Ababa, Ethiopia. Its geographical location is 8° 02' N latitude and 39° 10' E longitude, representing a medium altitude at 2200m above sea level with moderate rainfall of 862.7 mm per annum. The mean annual maximum temperature was 23.6°C and monthly values range between 21.3°C and 25.3°C. Mean annual minimum temperature was 11.8°C and monthly values range between 9.7 and 13.2°C. (KARC, 2018). It has a unimodal rainfall pattern with extended rainy season from March to September. However, the peak season is from July to August.

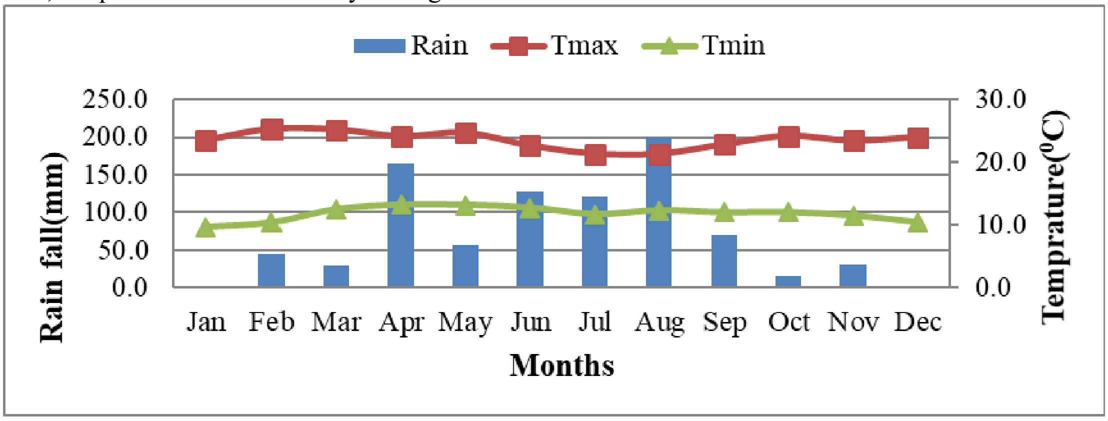

Figure 1. Mean monthly rain fall, maximum and minimum temperature of the study area in the year 2018.

2.2. Experimental Materials

2.2.1. Planting materials

Two bread wheat varieties (Wane and Kingbird) was used as planting materials. For recommend the appropriate application of NPSB blended fertilizer rate in the experimental area, these varieties were selected based on their adaptability to agro-ecological zone of the area, productivity and resistant for disease (Table 1).

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Table 1. Descriptions of the Bread wheat varieties to be used in the experiment

No	Varieties name	Year of release	Area of adaptation		Maturity days	Agro-ecology	On station productivity (q/ha)
			Altitude(m)	Rainfall (mm)			
1	Wane	2016	2000-2300	750-1500	120	Midland	50 - 65
2	Kingbird	2015	2000-2200	800-1000	133	Midland	40 - 50

Source:- Kulumsa Agricultural Research Center (KARC), Wheat breeding program (2017)

2.2.2 Fertilizer materials

The blended NPSB fertilizer rates (18.1% of N, 36.1% of P_2O_5, 6.7% of S and 0.71% of B) in 100 kg bags as shown in Tegbaru (2015), TSP (69% P_2O_5) and Urea (73% N) for recommended rate of NP and Urea (46% N) was used as the supplementary fertilizers for making NPSB optimum amount for the crop productivity. Farmers and other bread wheat producers use Urea (100 kg) and DAP (150 kg) for recommended NP (73% N and 69% P_2O_5). But in this time DAP was out of the market. For this research it used TSP instead of DAP fertilizer. 150 kg of DAP have (69% P_2O_5 + 27% N) but 150 kg TSP have only 69% of P_2O_5. For compensate the remaining 27% of N and fulfill the 73% N, add the Urea fertilizer until the recommended fertilizer was balanced.

2.3. Experimental Treatments and Design

The experimental design used for this experiment was Randomized Complete Block Design (RCBD) with factorial arrangement of two varieties (Wane and Kingbird) and eight fertilizer rate treatments with three replications. This gave a total of 16 treatment combinations. The treatment includes Control (without external fertilizer application), Recommended NP (150 kg ha^{-1} TSP (69%P_2O_5) + 158.7 kg ha^{-1} Urea (73 N)),100 kg NPSB (18.1N + 36.1P_2O_5 + 6.7S + 0.71B), 100 kg NPSB + Urea (100 kg), 150 kg NPSB + Urea (100 kg), 200 kg NPSB + Urea (100 kg), 250 kg NPSB + Urea (100 kg), 300 kg NPSB + Urea (100 kg), (Table 2). NPSB blended fertilizer rates are applied at sawing time for all plots except control. Supplementary nitrogen fertilizer in the form of Urea was applied in two splits times to maintain the N requirement of the crop. This means 1/3 of 100 kg Urea was applied two weeks after emergence and 2/3 of the rest Urea was applied before booting in all plots except the control and blended alone. The gross experimental area was 49.1m x 14m (687.4m^2), Gross Plot size of 4m x 2.6m (10.4m^2) and net plot size of 3 m x 2m (6m^2). The spacing between rows, plots and blocks were 0.20m, 0.5m and 1 m, respectively. By excluding the two outer rows from both sides of a plot and a 0.25m row length on both ends of each plant, row of each plot to avoid border effects resulting in to a net plot size.

Table 2. Fertilizer treatment rates used and their nutrient contents for the experiment

Fertilizer rates	N	P_2O_5	S	B
Control	0	0	0	0
150 kg TSP + 158.7 kg Urea h^{-1}	73	69	0	0
100 kg NPSB + 0 kg Urea ha^{-1}	18.10	36.10	6.70	0.71
100 kg NPSB + 100 kg Urea ha^{-1}	64.10	36.10	6.70	0.71
150 kg NPSB + 100 kg Urea ha^{-1}	73.15	54.15	10.05	1.07
200 kg NPSB + 100 kg Urea ha^{-1}	82.20	72.20	13.40	1.42
250 kg NPSB + 100 kg Urea ha^{-1}	91.25	90.25	16.75	1.78
300 kg NPSB + 100 kg Urea ha^{-1}	100.30	108.30	20.10	2.13

N, Nitrogen; P_2O_5, di phosphorus pento Oxide; S,Sulfur; B,Boron; TSP, Triple Super Phosphate; and NPSB,Nitrogen
Phosphorus Sulfur and Boron

2.4. Management of the Experimental field

The land was ploughed two times by oxen including land clearing or removing unwanted materials from the field. 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 recommended seed rate was 125 kg ha^{-1} in rows of 20 cm spacing and sown in row of 3-4cm depth by using mechanical row marker and the seed was drilled manually in the rows at July 12, 2018. The whole amount of blended (NPSB) fertilizer and 1/3 of recommended Urea were applied at sowing and the rest of 2/3 of Urea was applied at booting time by top-dressing. Weeding was done two times and apply fungicide (Rexido). The crop was finally harvested on the basis of crop maturity stage of each variety from the net plot area and was threshed manually.

2.5. Data Collection and Measurement

Soil analysis for specific properties one representative sample was taken at a depth of 0-30 cm from five randomly selected spots diagonally across the experimental field using auger before sawing. The sample was air dried under shade. One composite soil sample was submitted to Kulumsa Agricultural Research Center, Agricultural Chemistry and Chemical Analysis Laboratory. These samples were preserved for chemical and physical analysis after drying. Collected soil samples was dried under shade, powdered using pestle and mortar, passed the powdered sample through 0.5mm for Organic Carbon and Total Nitrogen, but for other properties use 2 mm diameter sieve. Then samples was bagged, labeled then taken to the laboratory and was processed for soil analysis for the following soil physioc-chemical properties.

Data on crop phonology and growth parameters (Emergency, Date Seedling density, Number of productive tillers, Days to heading, Days to Physiological maturity, Spike length, plant height and leaf number), and yield and yield components (number of kernels per spick, Thousand Kernel weight, Grain yield, The above ground dry biomass, Straw yield and Harvest Index) were collected and analyzed

2.6. Data Analysis

All data collected were subjected to analysis of variance (ANOVA) procedure using GenStat (17^{th} edition) software (GenStat, 2014). The comparisons among treatments means with significant difference for measured characters was done by LSD test at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. Selected Physicochemical Properties of Experimental Soil before Sowing

Soil samples collected and analyzed from the experimental fields of the farmer at the depth of 0-30 cm before sowing for some selected soil properties were analyzed (Table 3). According to the initial soil laboratory test results, the soil reactions were found to be moderately acidic Vertisols with a pH value of 6.17. According to Ethio SIS (2013) pH values classified as < 4.5 strongly acidic, 4.5-5.5 highly acidic, 5.6-6.5 moderately acidic, 6.6-7.3 neutral, 7.4-8.4 moderately alkaline, >8.5 strongly alkaline. Mengel and Kirkby (1996) found that pH values ranges from 4.1 to 7.4 were recommended for wheat and barley production.

The area of soil organic carbon content was 1.76% having the organic matter content of 3.03% (with conversion factor of 1.724) which can be classified in medium range soil organic carbon percentages of < 0.60, 0.6- 1.0, 1.0 - 1.80, 1.80 - 3.0, and >3 as very low, low, medium, high, and very high, respectively EthioSIS (2013). According to Tekalign (1991) rating, organic matter content of the soil is very low (<0.86%), low (0.86 to 2.59), medium (2.59 to 5.17), high (>5.17), and very high (not given). Azlan *et al*. (2012) reported that soil texture influence the rate of soil organic matter (SOM) decomposition. The low organic matter content of the soil could influence the release and availability of nutrients in the subsequent cropping season (Table 3).

Total nitrogen value of the experimental soil was low (0.11). According to EthioSIS (2014) TN content <0.1, 0.1-0.15, 0.15-0.3, 0.3-0.5, and >0.5 was very low, low, medium, high and very high, respectively. The result also indicated the N is limiting factor for crop growth. The optimum N level needed for crop production under most soils of Ethiopia is reported to be <0.2 % according to EthioSIS (2013). Masresha (2014) also reported low amount of N content on soils which are cultivated repeatedly due to N leaching and N mining.

As indicated in Table 3, the laboratory analysis result also revealed that the available P was low (8.21) (Table 3). According to Bray (1954) the range of phosphorus in Bray method is <7, 8-19, 20-39, 40-58 and >59 was very low, low, medium, high and very high, respectively. EthioSIS (2014) suggest optimum P content for most Ethiopian soil as 15 mg kg^{-1}. Based on this, the available phosphorous of the study area is low and needs phosphorous fertilizer. This low phosphorous content is due to intensive mining of the farm fields and fixation by heavy metal cations. Masresha (2014) also reported low amount of P content on soils which are cultivated repeatedly due to P fixation and P mining. Similarly, Habtamu *et al*. (2015) reported that low contain of P was due to fixation problem.

Soil CEC value of the study area was medium (22.86 cmol kg^{-1}) (Table 3). Landon *et al*., (1991) reported that soils having CEC of >40, 25-40, 15-25, 5-15,< 5 cmol kg^{-1} categorized as very high, high, medium, low and very low, respectively. According to the result obtained from soil laboratory, the value of boron in the soil was 0.43 mg kg^{-1} (Table 3). EthioSIS (2013), critical B value for most Ethiopian soils is 0.8 $mgkg^{-1}$. This shows that soils of the study area are deficit in B suggesting application of fertilizer which contains B. Intensive cultivation in the area was responsible for low B content of the soil.

The laboratory result revealed that the mean sulfur value of the soil in the study area was 2.09 mg kg^{-1} (Table 3). Based on EthioSIS (2014) soil classification for S values lies on very low range. The classification is < 9 very low, 10-20 low, 20-80 optimum, and > 80 mg kg-1 high. So addition of fertilizer which contains S is relevant. This low in sulfur content of the soil may be due to loss of OM and lacking of using S source mineral fertilizer. It was also related to continuous cultivation which result intensive mining of S from the soil.

Bulk density of the experimental site was 0.85 g cm^{-3} (Table 3). White (1997) stated that values of bulk density ranges from < 1 g cm^{-3} for soils high in OM, 1.0 to 1.4 g cm^{-3} for well- aggregated loamy soils and 1.4 to 1.8 g $cm^{-3}$for sands and compacted horizons in clay soils. Based on these soils of the study area were good for production with regarding to bulk density. Muhammad *et al*. (2011) who found decrease in bulk density as a result of nutrient and crop management.

Table 3. Selected soil physico-chemical properties of the Study areas before sowing

Soil Parameter	Unit	Value	Rates	Methology
Particle size distribution				
Sand	%	11.25		
Silt	%	39.75		
Clay	%	49.00		
Textural class		Clay		Hydrometer
BD	g/cm^3	0.85	Best	Core sampler
P^H	%	6.17	slightly acidic	Potentiometric
OC	%	1.76	Low	Walkley and Black
TN	%	0.11	Low	Kjeldak
AP	$mg\ kg^{-1}$	7.67	Low	Bray II
AB	$mg\ kg^{-1}$	0.43	Low	Hydrochloric Acid
AS	$mg\ kg^{-1}$	2.09	Low	Turbidimetric
CEC	meq/100 g	22.86	Medium	Ammonium acetate

BD, Bulk Density; OC, Organic Carbon; OM, Organic Matter; TN, Total Nitrogen; AP, Available Phosphorous; AB, Available Boron; AS, Available sulfur; CEC, Cation Exchange Capacity

3.2. Effects of Blended Fertilizer Rates and Variety on Phonological and Growth Variables

Days to heading and maturity were significantly ($P<0.01$) affected by the main effect of wheat varieties having longer days to heading (69.1) and Days to physiological maturity(112.3) period on kingbird variety as compared to Wane (63.9) and (107.3) respectively (Table 4). The longest days to heading (71.7) and physiological maturity (113.0) was observed at 300 Kg of NPSB application with supplementary urea. The shortest dates were observed for both varieties (61.3) and (106.2) at control, respectively. This difference could be attributed to their genetic makeup (Table 1). In line with this, bread wheat varietal differences with respect to heading were reported by, Jemal *et al*., 2015. Water stresses greatly affect the maturity dates of the varieties, because crop was forcedly matured in this cropping season (Figure 1). Tuteja and Sarvajeet, (2012) reported that plant sensitivity to drought and high temperature result in disturbed metabolic processes coupled with shorter plant life cycle which could be the reason for varietal differences in heading and maturity. These results were in line with Bekalu and Mamo (2016) who reported that, N fertilizer rate significantly affected days to maturity on wheat.

Main effect of blended fertilizer rates also significantly influenced seedling density, days to heading, days to physiological maturity and plant height (Table 4). The lowest results of these growth parameters were recorded from the control plot; but most seedling density, largest plant height and days to heading and physiological maturity were obtained from the highest NPSB (300 kg ha^{-1}) application along with 100 kg ha^{-1} of urea. Most of the growth parameters results were increased along the application rates of NPSB when supplemented with urea fertilizer. The highest plant height (95.5 cm) was recorded from the plot treated with the highest blended Fertilizer rate of 300 Kg of NPSB application, while the shortest plant height (75.6cm) was obtained from the control plot (Table 4). Tayebeh *et al.* (2011) and Sofonyas (2016) reported significant increments in plant height due to application of high nitrogen rate. Similarly, Bakala (2018) reported application of blended fertilizer under balanced N increased plant height of maize. Generally, increased combined application of N and blended fertilizer showed inconsistent increment plant height.

Table 4. Main effect of variety and blended fertilizer rate on germination date, seedling density, days to heading, days to physiological maturity and plant height

Verities	GD	SD	DH	DM	PH(cm)
Wane	6.0	22.9	63.9^{b}	107.3^{b}	88.6
Kingbird	6.0	23.0	69.1^{a}	112.3^{a}	89.2
LSD (%)	**NS**	**NS**	**1.36**	**0.75**	**NS**
Fertilizer rates (kg ha^{-1})					
0 kg F ha^{-1}	6.2	21.1^{c}	61.3^{d}	106.2^{c}	75.6^{f}
150 kg TSP + 158.7 kg Urea h^{-1}	6.0	23.4^{ab}	68.0^{bc}	109.7^{b}	90.5^{cd}
100 kg NPSB + 0 kg Urea ha^{-1}	6.0	22.7^{ab}	61.0^{d}	106.7^{c}	83.0^{e}
100 kg NPSB + 100 kg Urea ha^{-1}	6.0	23.4^{ab}	63.3^{d}	108.8^{b}	87.6^{d}
150 kg NPSB + 100 kg Urea ha^{-1}	6.0	22.8^{ab}	66.5^{c}	109.8^{b}	92.3^{bc}
200 kg NPSB + 100 kg Urea ha^{-1}	6.2	23.2^{ab}	69.7^{ab}	112.3^{a}	92.6^{bc}
250 kg NPSB + 100 kg Urea ha^{-1}	6.0	23.4^{ab}	70.7^{a}	112.0^{a}	94.5^{ab}
300 kg NPSB + 100 kg Urea ha^{-1}	6.0	23.6^{a}	71.7^{a}	113.0^{a}	95.5^{a}
LSD (5%)	**NS**	**0.92**	**2.72**	**1.49**	**3.18**
P Value	**0.4600**	**0.0814**	**<.0001**	**<.0001**	**<.0001**
CV (%)	**3.26**	**3.25**	**3.30**	**1.10**	**2.89**

GD, Germination date; SD, Seedling density; DH, Days to heading; DM, Days to physiological maturity; PH, Plant height; TSP, Triple Super Phosphate; NPSB, Nitrogen Phosphorus Sulfur and Boron

3.3. Yield and Yield Components

3.3.1. Number of productive tillers per plant

Number of productive tillers per plant were significantly (P<0.01) influenced by the interaction effect of varieties and fertilizer rates. Accordingly, Wane variety had better performance than Kingbird variety (Table 5). The response of the crop in terms of number of effective tillers in Wane (7.7) and Kingbird (6.0) varieties were higher at 300 Kg of NPSB application with supplementary urea. Wane variety at 200 kg NPSB (7.0), 250 kg NPSB (7.3) and 300 kg NPSB (7.7) fertilizer rates with supplementary urea applications was statistically non-significant. The lowest numbers of effective tillers (4.4) were recorded for both varieties at control plot; which might be due to the role of N in accelerating vegetative growth of plants. The highest result of Wane and Kingbird were improved by 42.9% and 26.7% respectively as compared to the lowest number of productive tillers per plant at control. The results were in agreement with that of Abdullatif *et al.* (2010) who reported that increasing in the number of effective tillers with nitrogen fertilization. Bereket *et al.* (2014) and Abdollahi *et al.* (2012) also reported that nitrogen fertilization have significant effect on effective number of tillers of wheat.

Table 5. Mean values of the interaction effect of blended fertilizer rates and bread wheat varieties on productive tillers

Fertilizer rates (kg ha^{-1})	Number of Productive Tillers	
	Varieties	
	Wane	Kingbird
0 kg F ha^{-1}	4.4^{fg}	4.4^{fg}
150 kg TSP + 158.7 kg Urea h^{-1}	5.8^{bc}	4.8^{efg}
100 kg NPSB + 0 kg Urea ha^{-1}	4.8^{efg}	4.8^{efg}
100 kg NPSB + 100 kg Urea ha^{-1}	4.8^{efg}	5.2^{cde}
150 kg NPSB + 100 kg Urea ha^{-1}	5.1d^{def}	5.0^{defg}
200 kg NPSB + 100 kg Urea ha^{-1}	7.0^{a}	5.1^{def}
250 kg NPSB + 100 kg Urea ha^{-1}	7.3^{a}	5.5^{bcd}
300 kg NPSB + 100 kg Urea ha^{-1}	7.7^{a}	6.0^{b}
Grand mean	**5.47**	
LSD (5%)	**0.67**	
P value	**<.0001**	
CV (%)	**7.33**	

TSP, Triple Super Phosphate; NPSB, Nitrogen Phosphorus Sulfur and Boron; LSD, Least Significant Difference; CV, Critical Value. Means followed by the same letter(s) within a column are not significantly different from each other at 5% level of significance, ns: Not significant.

3.3.2. Spike length

Spike length was significantly (p < 0.01) influenced by the main effects of blended fertilizer rate and Varieties, but not for their interaction. Kingbird Variety (7.3 cm) had higher spike length as Compared to Wane variety

(6.5cm). The highest spike length (7.3 cm) was recorded from the plot treated with 300 kg ha^{-1} of NPSB application which improved by 12% as compared the shortest spike length (6.4 cm) obtained from the control plot (Table 6). According to the experiment the application of mixed blended fertilizer rates along supplementary nitrogen were significantly influenced as compared to the control plot. Bekalu and Mamo (2016) reported that optimum amount of fertilizer application has significant effect on spike length growth.

3.3.3. Number of seeds per spike

The analysis of variance showed that number of seeds per spike was significantly ($P<0.01$) affected by the main effects of blended fertilizer rates and varieties, but their interactions was no significantly influenced. Higher number of seeds per spike (45.2) was recorded from Wane variety as compared to Kingbird variety (43.1) (Table 6). Lower number of seeds per spike was recorded in control plot and recommended NPSB only (100 kg ha-1) as compared to those plots fertilized with NPSB along supplementary urea. Number of seed per spike becomes significantly increased as the rate of NPSB application increased from 0 to 300 kg ha^{-1}. When compared to the recommended rate of NPSB fertilizer and control, the blended fertilizer rates applied at 250 and 300 kg NPSB significantly increased number of seeds per spike by 35% and 38% and by 37% and 40%, respectively (Table 6). This might be due to the addition of blended fertilizer application rates in the experimental site there was increased the appearance of seeds in their spikes. The results were in conformity with that of Tayebeh *et al.* (2010) who stated that increasing N rates up to optimum level significantly increased number of seed $spike^{-1}$. Number of grain per spike is an important yield participating parameter and has a direct consequence on the grain yield of wheat (Tahir et al., 2009). The soil nutritional content of the farmer's land of the experimental site was poor (Table 3) and also there was a shortage of water in a cropping season after anthesis (Figure 1). Laura *et al*. (2007) was reported water stress during grain filling period greatly reduced grain yield, and the yield reduction resulted from a little decrease of the number of kernels per spike and a great decrease of mean kernel weight.

3.3.4. Thousand Kernel weight

The analysis of variance showed that the main effect of varieties and blended fertilizer rates significantly ($p<0.01$) affected thousand kernel weight (TKW), but there was no interaction effect. Wane Variety (37.0 gm) was recorded more than Kingbird variety (35.3 gm) in TKW. The highest TKW (37.3g) was produced by the application of 300 kg ha^{-1} NPSB while in most fertilizer treatments there was no significant difference (Table 6). The lowest TKW was recorded from control which was decreased by 9% and 8%, respectively from the highest thousand seed weight produced from those fertilized by 300 kg ha^{-1} NPSB. The application of increasing blended fertilizer rates in the experimental area increased the seeds size and the amount of powder of bread wheat varieties. Because of that TKW of each treatment were different. Tayebeh *et al.* (2011) who reported number seeds $spike^{-1}$ and 1000 grain weight were significantly enhanced by increasing nitrogen levels.

3.3.5. Straw yield

The main effect of variety and blended fertilizer rate exhibited significant ($p<0.05$) differences in straw yield, but their interaction was not significant. Wane variety (6349 kg ha^{-1}) was more productive than Kingbird variety (5970 kg ha^{-1}). The highest production of straw yield (9072 kg ha^{-1}) was recorded when fertilized by 300 kg NPSB and the lowest (3099 kg ha^{-1}) was from the control (Table 6). Wheat treated with 200 kg NPSB (7338 kg ha^{-1}) 250 kg NPSB (8056 kg ha^{-1}) and 300 kg NPSB (9072 kg ha^{-1}) fertilizer rates were significantly different from the recommended NP (6270 kg ha^{-1}) applied (Table 6). This difference might be attributed to the higher productivity of yield and yield components of Wane variety (Table 1). According to Abebe (2012), straw yield increased with increasing the fertilizer rates, whereby the lowest and nitrogen increases vegetative growth of plants, especially at higher doses. Besides, the significant increase in plant height, spike length and number of fertile tillers by N rate contributed to the significant increase in straw yield. Bereket *et al.* (2014) also reported that wheat straw yield increased with N rates.

3.3.6. Harvest index

The analysis of variance for harvest index showed that main effect of blended fertilizer rates were significantly ($p<0.01$) affected, but not for varieties and their interaction effects. The control treatment had resulted in the highest harvest index (40.1 %) and the lowest (30.4 %) was those fertilized by 300 kg NPSB (Table 6). Reductions in HI relative to the control were 8.5%, 15.2%, 20.2% and 24.2% due to recommended NP, 200, 250and 300 kg blended fertilizer rate treatments, respectively. Fertilizer rate treatments significantly reduced harvest index as compared to the control. According to Jemal *et al*. (2015), significant varietal differences on harvest index in bread wheat varieties were reported. A mean harvest index of about 50% with a positive trend due to increasing N rate was previously reported in Ethiopia (Taye *et al*., 2002). In contrast, Marcelo *et al.* (2013) reported that rates and sources of N did not affect harvest index of wheat.

Table 6. Main effect of variety and blended fertilizer rate on Spick length, Seeds per spike and thousand kernel weight

Varieties	SL (cm)	SPS (No)	TKW (gm)	HI (%)	SY (kg ha^{-1})
Wane	6.5^{b}	45.2^{a}	37.0^{a}	36.24	6349^{a}
Kingbird	7.3^{a}	43.1^{b}	35.3^{b}	36.17	5970^{b}
LSD	**0.14**	**0.75**	**0.73**	**NS**	**363.06**
Fertilizer rates (kg ha^{-1})					
0 kg F /ha	6.4^{d}	32.3^{e}	33.9^{c}	40.1^{a}	3099^{f}
150 kg TSP + 158.7 kg Urea h^{-1}	7.0^{ab}	48.2^{b}	36.9^{ab}	36.7^{bc}	6270^{c}
100 kg NPSB + 0 kg Urea ha^{-1}	6.6^{cd}	34.0^{e}	34.4^{c}	39.7^{ab}	4284^{e}
100 kg NPSB + 100 kg Urea ha^{-1}	6.9^{bc}	39.9^{d}	35.9^{b}	39.7^{ab}	5090^{d}
150 kg NPSB + 100 kg Urea ha^{-1}	6.9^{bc}	44.5^{c}	36.7^{ab}	37.1^{abc}	5867^{c}
200 kg NPSB + 100 kg Urea ha^{-1}	7.1^{ab}	48.3^{b}	36.8^{ab}	34.0^{cd}	7538^{b}
250 kg NPSB + 100 kg Urea ha^{-1}	6.9^{bc}	52.2^{a}	37.2^{ab}	32.0^{de}	8056^{b}
300 kg NPSB + 100 kg Urea ha^{-1}	7.3^{a}	53.9^{a}	37.3^{a}	30.4^{e}	9072^{a}
LSD	**0.30**	**1.49**	**1.45**	**3.28**	**726.07**
P Value	**0.0001**	**<.0001**	**0.0076**	**0.0106**	**<.0001**
CV (%)	**3.50**	**2.73**	**3.24**	**7.31**	**9.52**

SL, Spike length; SPS, Seeds per spick; TKW, Thousand kernel weight; HI, Harvest index; SY, Straw yield; TSP, Triple Super Phosphate; NPSB, Nitrogen Phosphorus Sulfur and Boron; LSD, Least Significant Difference; CV, Critical Value. Means followed by the same letter(s) within a column are not significantly different from each other at 5% level of significance, ns: Not significant.

3.3.7. Grain yield

The interactions between varieties and blended fertilizer rates were found to be significantly ($P < 0.05$) affected grain yield. These indicating that the varieties grain yield was differently influenced by fertilizer rate. Data for mean grain yield was presented (Table 7). The ultimate goal in crop production is maximum economic yield, which is a complex function of individual yield components in response to the genetic potential of the varieties and inputs used.

Wane variety showed better performance of grain yield (4236kg ha^{-1}) at the highest rate of 300 kg NPSB fertilizer application which might be due to the highest response of cultivars to N and use efficiency, and the lowest grain yield (2165kg ha^{-1}) was also recorded from control. But for Kingbird variety showed better performance of grain yield (3737kg ha^{-1}) at 200 kg NPSB fertilizer application and the lowest yield (1991 kg ha^{-1}) at control. The grain yield obtained from Wane variety at 200 kg NPSB (3966 kg ha^{-1}), 250 kg NPSB (4107 kg ha^{-1}) and 300 kg NPSB (4236kg ha^{-1}) fertilizer rates applications was statistically non-significant from each other but there was significant difference from the recommended NP (3562 kg ha^{-1}) (Table 7). Variety Kingbird was statistically not-significant difference between the treatments recommended NP (3647 kg ha^{-1}), 200 kg NPSB (3737 kg ha^{-1}), 250 kg NPSB (3499 kg ha^{-1}) and 300 kg NPSB (3682 kg ha^{-1}). The highest result of Wane and Kingbird were improved by 48.9% and 46.7%, respectively as compared to the lowest grain yield produced from control; and by 33.8% and 24.1% as compared to recommended NPSB alone for Wane and Kingbird varieties, respectively. Increasing the application of blended fertilizer rates on the production of bread wheat varieties produce different amounts of yield in the experimental site. Bereket *et al*. (2014) also reported that increasing rate of nitrogen fertilization increased grain yield of wheat. Similarly, Mulugeta *et al*. (2017) reported that application of nutrients like K, S, Zn, Mg and B significantly increased grain yield and yield component of bread wheat as compare to the control (no fertilizer).

In this cropping season the amount of yield production treated by different fertilizer rate was low when compared with the actual potential of varieties productivity. Because after anthesis to maturity in the cropping season of 2018, there was a shortage of rain (Figure 1). These factor was greatly affected the genetic potential of bread wheat varieties production capacity (Table 1) in the experimental sites. Grain yield is a complex polygenic trait influenced by genotype, environment and genotype x environment (GxE) interaction. According to Bukhat, (2005) moisture stress is known to reduce biomass, tillering ability, grains per spike and grain size at any stage when it occurs. So, the overall effect of moisture stress depends on intensity and length of stress. Water stress imposed during later stages might additionally cause a reduction in number of kernels/ear and kernel weight (Gupta *et al.,* 2001; Dencic *et al.*, 2000). Grain yield is a function of yield components, so that any stress on growth and development phase of these traits do have a cumulative effect on the final grain yield and productivity.

Hossain *et al. (*2013) also reported that plants have limited nutrient uptake capacity and photosynthetic efficiency under heat and drought stress. These stresses can also reduce organ size (leaf, tiller, and spikes) and growth period for various development stages (tillering, jointing, booting, heading, anthesis, and grain filling). Laura *et al.,*(2007) reported that water stress during grain filling period greatly reduced grain yield, and the yield reduction resulted from a little decrease of the number of kernels per spike and a great decrease of mean kernel weight. He demonstrated that post-anthesis water stress greatly reduced grain yield at all N rates.

3.3.8. Above ground biomass yield

The analysis of variance showed highly significant ($P<0.01$) differences in above ground biomass yield that affected by the interaction effect of blended fertilizer rates and varieties. The highest production of above ground biomass yield in Wane (14053 kg ha^{-1}) and Kingbird varieties (12009 kg ha^{-1}) were recorded from those plants fertilized with 300 kg NPSB and the lowest (5302 kg ha^{-1}) and (5303 kg ha^{-1}) was obtained from the control treatments of the two varieties, respectively (Table 7). The above ground biomass yield obtained from Wane variety at 300 kg NPSB (14053kg ha^{-1}) was significantly different from other fertilizer treatments. On the other hand, Kingbird variety was statistically not-significantly different between the fertilizer treatments of 200 kg NPSB (11498 kg ha^{-1}), 250 kg NPSB (11325 kg ha^{-1}) and 300 kg NPSB (12009 kg ha^{-1}) (Table 7). The highest result of Wane and Kingbird was improved by 62.3% and 55.8% respectively as compared to the lowest biomass produced on the control of each; and by 48.2%, 42.3 % and 31.8%, 16.3% as compared to recommended NPSB alone and recommended NP for both varieties respectively. Even though the application of recommended NPSB without supplementary urea and recommended NP fertilizer rate the production were low. Increasing the application of blended fertilizer rates increase the growth, vegetative condition and the production of yield and above ground biomass yield of bread wheat varieties in the experimental site. The application of fertilizer treatment rates were significantly improved the production of the biomass yield. According to Melkamu (2019) blended fertilizer supply had a marked effect on the aboveground biomass, grain yield, and straw yield. Jasemi *et al.* (2014) reported vegetative growth and biological yield has much dependence to consumption of chemical fertilizers, application of the fertilizers led to increasing biological yield of wheat.

Table 7. Mean values of the interaction effect of blended fertilizer rates and bread wheat varieties on grain yield and above ground Biomass Yield

Fertilizer rates (kg ha^{-1})	GY (kg ha^{-1}) Varieties		BY (kg ha^{-1}) Varieties	
	Wane	**Kingbird**	**Wane**	**Kingbird**
0 kg F ha^{-1}	2165^{h}	1991^{h}	5302^{i}	5053^{i}
150 kg TSP + 158.7 kg Urea h^{-1}	3562^{cde}	3647^{cde}	9581de	10167^{cd}
100 kg NPSB + 0 kg Urea ha^{-1}	2806^{g}	2832^{fg}	7283^{gh}	6923^{h}
100 kg NPSB + 100 kg Urea ha^{-1}	3425de	3252^{ef}	8749^{ef}	8108^{fg}
150 kg NPSB + 100 kg Urea ha^{-1}	3489de	3375de	9905^{d}	8691^{ef}
200 kg NPSB + 100 kg Urea ha^{-1}	3966^{abc}	3737^{bcd}	11281^{bc}	11498^{b}
250 kg NPSB + 100 kg Urea ha^{-1}	4107^{ab}	3499de	12392^{b}	11325^{b}
300 kg NPSB + 100 kg Urea ha^{-1}	4236^{a}	3682^{cd}	14053^{a}	12009^{b}
Grand mean		**3361**		**9520**
LSD (5%)		**421.03**		**1136.1**
P Value		**<.0001**		**<.0001**
CV (%)		**7.53**		**7.18**

GY, Grain yield; BY, Biomass yield; TSP, Triple Super Phosphate; NPSB, Nitrogen Phosphorus Sulfur and Boron;
LSD, Least Significant Difference; CV,Critical Value. Means followed by the same letter(s) within a column are not significantly different from each other at 5% level of significance, ns: Not significant.

3.4. Partial Budget Analysis

Partial budget analysis is important to identify experimental treatments with an optimum return to the farmer's investment and to develop recommendation for the agronomic data. Experimental yields are often higher than the yields that farmers could expect using the same treatments; hence in economic calculations, yields of farmers are adjusted by 10% less than that of the research results (CIMMYT, 1988). As indicated in Table 10, the partial budget analysis showed that highest net benefit of (50536) Birr ha^{-1} was obtained for variety Wane that received 300 kg NPSB ha^{-1}. However, the lowest net benefits of (26496) Birr ha^{-1} were obtained from the unfertilized treatment with the variety Kingbird. In this study, Wane varieties gave economic benefit of (48540 birr ha^{-1}) with marginal rate of return (992.8 %) at 200 kg NPSB ha^{-1} fertilizer rate with supplementary urea but economic benefit of (50536 birr ha^{-1}) birr was obtained for the variety Wane at 300 kg NPSB ha^{-1} with about a (1996 birr ha^{-1}) net benefit increment (Table 5). whereas, in case of Kingbird variety at 200 kg NPSB ha^{-1} fertilizer rate gave the maximum economic benefit (46551 ha^{-1}) with marginal rate of return (546.3 %). According to

CIMMYT (1988) suggestion, the minimum acceptable marginal rate of return should be more than 100 %. Therefore, Wane variety at 300 kg NPSB ha^{-1} and for Kingbird variety at 200 kg NPSB ha^{-1} were economical and recommended for production of bread wheat in the study area and other areas with similar agro ecological condition.

Table 8. Summary of economic analysis of the effects of blended fertilizer (NPSB) rates on bread wheat varietie

Treatment		GY	SY	Income (ETB ha-1)		GFB	TVC	NB	MRR
Var	Fer	(kg ha^{-1})	(kg ha^{-1})	Yield	Straw	(ETB ha^{-1})	(ETB ha^{-1})	(ETB ha^{-1})	%
W	0	2165	3137	28140	627	28768	0	28768	-
W	100[a]	2806	4477	36479	895	37374	2070	35304	315.7
W	100	3425	5324	44524	1065	45589	3390	42409	538.3
W	150	3489	6416	45351	1283	46634	3600	42804	188.1
W	NP	3561	6020	46299	1204	47503	4266	43437	95.1
W	200	3966	7315	51557	1463	53020	4780	48540	992.8
W	250	4107	8285	53369	1657	55046	5130	49916	393.1
W	300	4236	9816	55072	1963	57036	6500	50536	45.3
KB	0	1991	3062	25884	612	26496	0	26496	-
KB	100[a]	2832	4091	36815	818	37633	2070	35563	438.0
KB	100	3252	4856	42279	971	43250	3390	40070	341.4
KB	150	3375	5317	43871	1063	44939	3600	41109	494.8
KB	NP	3647	6520	47405	1304	47709	4266	43743	395.5
KB	200	3737	7761	48579	1552	50131	4780	46551	546.3
KB	250	3499	7827	45481	1565	47046	5130	41916	D
KB	300	3682	8327	47861	1665	49527	6500	43027	81.1

Where, W, Wane; KB, Kingbird; [a] , without application of supplementary Urea; Var, variety; Fer, fertilizer; GY, grain yield; SY, straw yield; GFB, gross field benefit; TVC, total variable costs; NB, net benefit; MRR, marginal rate of return; ETB ha^{-1}, Ethiopian Birr per hectare; D, dominated treatments.

4. CONCLUSION AND RECOMMENDATION

The results of growth and yield attribute investigations showed that Wane variety had better performances as compared to Kingbird variety and interaction of varieties to NPSB fertilizer for the number of productive tillers, above ground biomass yield and grain yield had good performances at 300 kg ha^{-1}NPSB fertilizer treatment with supplementary urea on Wane variety; but at 200 kg NPSB fertilizer applied with supplementary urea from Kingbird. Therefore, application of NPSB at the rate of 300 kg NPSB ha^{-1} in the production of Wane and 200 NPSB kg ha^{-1} in the production of Kingbird varieties was economically beneficial and recommended for around Kulumsa area. In the future for keeping the soil health and improve the production of the yield, use of balanced nutrient application (macro and micro) for the farmer land is so important. Since this study was conducted in one location for one season, it should be repeated in more location and season for further recommendation in similar agro ecologies.

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