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Research Article

Optimum Determination of NPSB Fertilizer Rates on Bread Wheat (*Triticum asetivum.L*) Varieties at Degam District of North Shewa Zone, Oromia

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Abstract

The field experiment was conducted at Degam district during main cropping season to investigate the response of bread wheat varieties to NPSB fertilizer rates and identify its economic benefit. Factorial combination of three improved bread wheat varieties (Danda'a, Hidase and Kakaba) and six fertilizer rates [Control, 50, 100, 150, 200 kg ha^{-1} NPSB fertilizer each supplemented with 92 kg N ha^{-1} and 64/20 kg NP ha^{-1} (Blanket recommendation)] were laid out in randomized complete block design with three replications. The highest NKS (54.9), AGBM (13.8 tons ha^{-1}), SY (9.4 tons ha^{-1}) and GY (4549kg ha^{-1}) were recorded from 200 kg NPSB fertilizer. Among the varieties the highest NKS (54.3) from Danda'a, TKW (49.3 g) and GY (3351kg ha^{-1}) were recorded from Hidase variety. Variety Kakaba score the highest PH (102.5 cm) and PNT (5 per plant) with combination of 200 kg and 150 kg NPSB fertilizer respectively and reached days to heading and maturity earlier than Danda'a and Hidase. In general, the economic feasibility of the fertilizer over varieties combination indicated that application of 200 kg NPSB $ha^{-1}$to all varieties Hidase, Danda'a and Kakaba resulted in maximum marginal rates of return 640.14 %, 604.81% and 481.47%, with a net benefit of 97993, 88596, and 82996 ETB respectively. Although, application of 200 kg NPSB ha^{-1} led to the highest MRR for the Hidase variety as compared to all other treatments and with about a total of 9397 ETB net benefit increment. Therefore, application of 200 kg of NPSB in supplement of 92 kg N ha^{-1} fertilizer with Hidase variety was the best producing economically profitable with acceptable grain yield.

Keywords

Bread Wheat, Economic Benefit, MRR, NPSB, Profitability, Varieties, Yield

1. Introduction

Wheat is a staple food that provides around 20% of protein and calories consumed worldwide [16]. The demand for wheat is expected to grow by 34 to 60% in 2050 in developing countries [30]. The FAO estimates that global commercial production of all types of wheat was 650.9 million metric tons in 2016, harvested from 217.0 million hectares; it is grown on around 4% of the planet's agricultural land [15].

Ethiopia is one of the largest wheat producers in the Sub-Saharan Africa with yearly estimated production of 4.6 million tons on 1.69 million hectare in 2017/18 with productivi-

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ty of 2.74 tons per hectare [9]. Wheat is mainly grown in the highlands of Ethiopia, which lie between 6-16° N and 35-42° E, at altitudes ranging from 1500 to 2800 meters above sea level and with mean minimum temperatures of 6°C to 11°C exclusively under rainfed conditions [11, 25]. Mean wheat yield increased from 1.3 tons ha^{-1} in 1994 to 2.74 tons ha^{-1} in 2017/18 [4], far below experimental yields of over 5 tons ha^{-1} [17, 23]. The average wheat productivity in SSA is 1.7 tons ha^{-1} [14], nearly 50% below the world average. The national wheat productivity in SSA varies across countries. It ranges from 0.7 tons ha^{-1} in Burundi to 3.4 tons ha^{-1} in Mali. The main wheat growing areas of Ethiopia are the highlands of the central, south-eastern and northwest parts of the country. However, Ethiopia's current wheat production is insufficient to meet domestic needs, forcing the country to import 30 to 50% of its wheat demand to fill the gap [24]. There are several factors that hindered the yield of wheat crops such as low soil fertility, lack of improved wheat varieties and lack of improved management practices. The low yield is primarily associated with the depletion of soil fertility due to continuous nutrient uptake of crops, low fertilizer use and insufficient organic matter application [21]. Continuous cropping and inadequate replacement of nutrients removed in crop harvest or lose through erosion and leaching has been the major causes of soil fertility decline [19, 31]. This is particularly evident in the intensively cultivated high potential areas that are mainly concentrated in the highlands of Ethiopia [19]. Nutrient balances in the highlands of Ethiopia, typically the high potential areas for agricultural productions are currently exposed to severe soil fertility depletion [31]. In addition, several factors such as improved varieties, adequate cultural practices like balanced fertilization and management of other biotic and abiotic factors are very important for higher productivity of wheat [2].

Yet, agricultural production is increasing which benefits farmers' livelihoods and contributes to food security of the country as a whole, but at the expense of the natural resource base [31]. The yield gap of over 3 tons ha^{-1}, suggests the potential for increasing production through improved soil and crop management practices, particularly increased use of fertilizers and adequate soil fertility maintenance program.

Varieties are one of the other major factors which play an important role in producing higher yield of wheat [2]. Wise use of fertilizers increases crop yield and production; the reverse will lead to decline in production and ecological imbalance. Fertilizer use efficiency of the crop depends on the performance specific variety. So that cultivar selection plays a very important role in determining grain yield and quality [7]. In most of the nutrient studies in Ethiopia, more emphasis was given to macronutrients, especially N and P, and micronutrients investigations had received little attention. However, Ethiopia is moving from blanket recommendations for fertilizer application rates to recommendations that are customized based on soil type and crop [26]. This is a move towards diversification and inclusion of other types of fertilizers apart from DAP and urea, which have long been the only types of fertilizer imported for grain crops.

Different recent studies have showed 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 [4]. Most Ethiopian soils are deficit in macronutrients (N, P, K and S) and micronutrients (Cu, B, and Zn) [12]. Even though different types of blended are suggested by EthioSIS, farmers in most parts of the country have limited information on the impact of different types and rates of fertilizers except that of blanket recommendation which is nitrogen at a rate of 41 kg N ha^{-1} and phosphorus at a rate of 46 kg P_2O_5 ha^{-1}. Therefore, due to lacking of such information particularly on the use of appropriate fertilizer rate and best performing variety in the district, the study was conducted with the following objectives:

1) To investigate an optimum agronomic practice of NPSB fertilizer rates and bread wheat varieties on different yield components and grain yield.
2) To identify the most profitable NPSB fertilizer rates and bread wheat variety for wheat production at study area.

2. Materials and Methods

2.1. Description of Experimental Site

The experiment was conducted at Degam District during 2019 main cropping period. The district is located at 124 km North-West of Addis Ababa, and 12 km from Fitche, the capital city of North Shewa Zone, and Oromia Regional State. The district is bordered on the West by Kuyu, on the North-West by Hidabu Abote, on the North by Jama River which separates it from Amhara Region, on the North-East by Girar Jarso, and on the East by Yaya Gulele and Debre Libanos district (Figure 1). Geographically, the district extends from 9°34′ to 10°03′N latitudes and 38°29′ to 38°44′E longitudes. The site is located at 9°49′48.2″ North latitude and 38°33′43.8″ East longitude with an elevation of 3014 masl. The temperature varied in between 5.6°C to 23°C. The annual rainfall ranges from 800 mm to 1300 mm and the rainfall pattern is bi-modal; a short rainy season (Belg) from February to March, and a main rainy season (Kiremt) that extends from June to September. The study area is characterized by *Nitosol* which is locally known as '*Biye Dima* and *Biye Bore*' and Wheat is the major crop produced in the area [3].

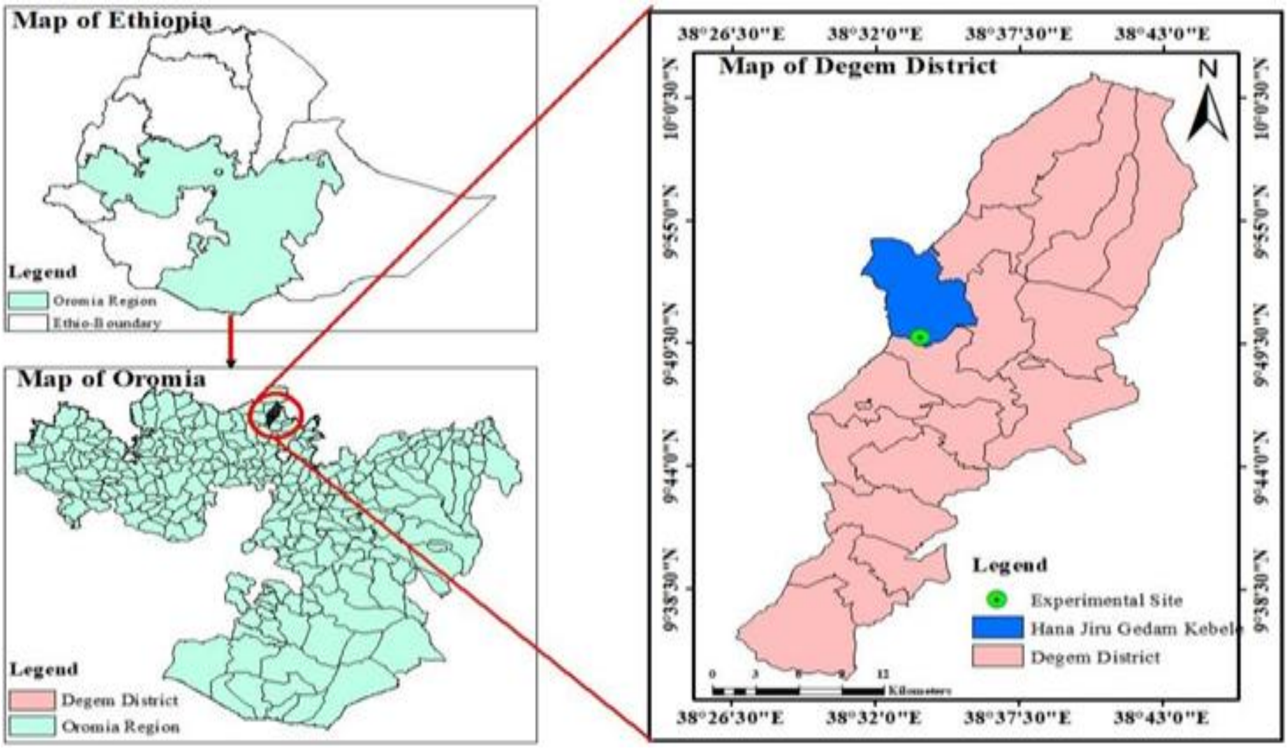

Figure 1. Location map of experimental site.

2.2. Experimental Materials

2.2.1. Plant Materials

Danda'a (Danphe#1), Hidase (ETBW5795) and Kakaba (Picaflor #1) were used for the research study. The details of the three varieties are indicated in (Table 1). Those varieties are selected based on yield, disease resistance, farmer's acceptance and popularity character to the district.

Table 1. Description of varieties used for the study.

№	Variety name	Pedigree	Released by	Year of release	Grain yield (tons ha^{-1})		Adaptation zone	
					On station	On farm	Altitude (masl)	RF (mm)
1	Danda'a	Danphe #1	KARC	2010	3.5-5.5	2.5-5	2000-2600	>600
2	Hidase	ETBW 5795	KARC	2012	4.4-7	3.5-6	2100-2800	>500
3	Kakaba	Picaflor #1	KARC	2010	NI	NI	1500-2200	500-800

Source: MoA, Crop Variety Register (1995-2013) and; MoA, Crop Variety Register, 2016 KARC=Kulumsa Agricultural Research Center, NI=Not indicated

2.2.2. Fertilizers Materials

NPSB fertilizer (18.9% N, 37.7% P_2O_5, 6.95% S and 0.1% B), Triple supper phosphate (TSP of 46% P_2O_5) and urea (46% N) were used as fertilizers source.

2.3. Experimental Treatments and Research Design

Treatment combinations of three improved varieties (Danda'a, Hidase and Kakaba) and five NPSB fertilizers rates [0, 50, 100, 150, 200 and NP (64/20) kg ha^{-1} of local control] with supplementation of 92 kg N for all treatment except of blanket recommended NP and the control were used for treatments (Table 2). The experimental field study was arranged with a total of 18 treatments in a factorial combination with a complete block design (RCBD) in three replications.

Table 2. Combination of Nutrients and fertilizer rates used.

Fertilizer rates	Nutrient contents			
	N	P_2O_5	S	B
Control	0	0	0	0
50 kg NPSB + 92 kg N	101.45	18.85	3.475	0.05
100 kg NPSB + 92 kg N	110.9	37.7	6.95	0.1
150 kg NPSB + 92 kg N	120.35	56.55	10.425	0.15
200 kg NPSB + 92 kg N	221.8	75.4	13.9	0.2
64/20 kg NP	64	46	0	0

2.4. Experimental Research and Management Practices

The field was prepared and ploughed manually by oxen three times to fine tilth of the soil before planting. Then according to the design, the treatment combinations were applied to respective research units/plots within a block. The three selected improved varieties of bread wheat were sown at the recommended seed rate of 150 kg ha^{-1} in rows of 20 cm spacing manually by drilling method during at onset of rainfall on 03 July, 2019 of cropping season. The whole amount of NPSB blended and TSP fertilizers was applied at sowing time whereas, half, one-fourth and one-fourth of nitrogen was applied at a time of sowing and top dressed at knee height and tillering of the crops, respectively in order to reduce N fertilizer loss through denitrification and volatilization. Weeding and all necessary agronomic management as per the recommendation practice had been undertaken for all treatments.

2.5. Data Collected

Growth Parameters and Yield

Days to 50% heading, 90% maturity, Above ground dry biomass yield, straw yield and grain yield were recorded and estimated and measured at standard in plot basis. Plant height, Number of total tillers, Number of productive tillers, number of kernel per spike, Thousand kernels weight were measured and determined on plant basis.

2.6. Statistical Analysis

All data collected and recorded were subjected to the procedure of analysis of variance (ANOVA) using of R-Software. The comparisons among and within treatments means were employed by using of Duncan multiple Range test (DMRT) at 5% and 1% significant level.

2.7. Partial Budget Analysis

Economic feasibility analysis was conducted following the methodology and guideline described by [8] in which prevailing the value of market prices for inputs at planting and that of outputs at harvesting time. The economic advantages of applied NPSB and nitrogen fertilizers were carried out using partial budget analysis. In this experiment, the costs that vary were calculated by adding costs of fertilizer and labor for fertilizer application. In addition the prices incurred for purchasing of improved bread wheat varieties was also considered in total variable cost during economic feasibility analysis.

Following the CIMMYT partial budget analysis methodology, total variable costs (TVC), gross benefits (GB) and net benefits (NB) were calculated. To identify treatments with maximum return to the farmer‘s investment marginal analysis was performed on non-dominated treatments. For a treatment to be considered as a worthwhile option to farmers, the marginal rate of return (MRR) need to be at least between 50% and 100%. Accordingly, in the experiments like fertilizer trials the MRR above 100% was the most benefit earned and best recommendation for farmers [8].

3. Results and Discussion

3.1. Selected Physico Chemical Properties of Experimental Soil Before Sowing

Results of research field soil anlysis before sowing for some physico-chemical properties showed the range level and nutrient contents as indicated below before the application of fertilizer to the field (Table 3).

Table 3. Physico-chemical properties of the experimental field soil before sowing.

Soil physico chemical properties	Result	Rating	References
pH-H_2O (1:2.5)	5.57	Slightly acidic	[27]

Soil physico chemical properties	Result	Rating	References
Sand (%)	34.98		
Clay (%)	35.66		
Silt (%)	29.36		
Texture Class	Clay loam		
CEC (meq/100 gm of soil)	38.67	High	[22]
Organic Carbon (OC) (%)	2.01	Moderate	[27]
Total Nitrogen (TN) (%)	0.25	Moderate	[27]
Available P (mg P_2O_5 kg^{-1} soil)	27.60	Medium	[20]
Available B (mg kg^{-1} soil)	0.59	Medium	[20]
Available S (Av.S) (mg kg^{-1} soil)	362.81	Very high	[13]

3.2. Effects of NPSB Fertilizers on Phenological Traits and Growth Parameters

3.2.1. Days to Heading

Days to 50% heading was highly significantly ($P < 0.01$) affected by the main effect of NPSB fertilizer and variety while the interaction effect did not statistically influenced the parameter ($P < 0.05$) (Table 4).

The mean number of days required to 50% panicle heading ranged between 75 days for variety Kakaba and 83.3 days for variety Hidase. The earliest days to heading (77.9 days) was recorded with unfertilized plots and the longer days to heading (82.4 days) was recorded with maximum application of 200 kg ha^{-1} blended NPSB fertilizer (Table 4). Similarly, the shortest days to panicle heading (72.3 days) on variety Kakaba in unfertilized plot and the longest (85.3 days) on variety Hidase treated with 200 kg of NPSB supplemented by nitrogen fertilizer (Urea) were recorded (Table 4). The longest days to heading was observed for all varieties at 200 kg ha^{-1} of NPSB supplemented with nitrogen fertilizer (Urea). This difference in days to 50% panicle heading among varieties could be attributed to their genetic factor variability and amount of nutrient management (different rates of NPSB fertilizer supplemented with nitrogen fertilizer) provided for them especially due in fact that nitrogen fertilizer has favored vegetative growth stage and delayed the heading of crops. This result was in line with [10] who reported that, time to heading of bread wheat was significantly affected by different rate of nitrogen fertilizers. Similarly [1] reported that NPSZnB fertilizer and sowing methods was significantly affected days to heading by indicating that the application of (macro and micro) and Urea, resulting in higher rate of nitrogen nutrients which appeared to prolong vegetative growth stage of wheat and delay time to heading of crop.

3.2.2. Days to Maturity

Both the main and interaction effect influenced 90% of bread wheat physiological maturity highly significant and significant at ($P < 0.01$) and ($P < 0.05$) respectively (Table 5). The earliest mean days to maturity (141.0 days) was recorded on variety Kakaba in unfertilized plot, while the longest (171.0 days) was observed on variety Hidase in plots treated with 200 kg ha^{-1} of NPSB fertilizer (Table 5). The longest days to maturity was observed for all varieties treated with maximum rate of NPSB fertilizer supplemented with nitrogen fertilizer (Urea); whereas crops matured early in unfertilized (control) plots. The bread wheat varieties grown under 200 kg NPSB supplemented with nitrogen (Urea) fertilizers matured 11, 11 and 9 days later than crops grown under unfertilized (control) for varieties of Danda'a, Hidase and Kakaba respectively (Table 5). These variations in days to physiological maturity might be due to genetic makeup of the varieties and an adequate amount of nutrient that crops have got from NPSB as well as due to in fact that nitrogen fertilizer promotes greater vegetative development before the beginning of reproductive phase and there by delay the maturity. The result also inline with [10] who reported the longest days to maturity for variety Wane and Kingbird at maximum kg $ha^{-1}$of NPSB fertilizer application with supplementary urea.

3.2.3. Spike Length (cm)

The main effect of NPSB fertilizer was very highly significant ($P < 0.01$) on spike length while the main effect of variety and interaction were not significant (Table 4). As the rate of NPSB fertilizer increased there was an increased trend in spike length.

The highest rate of 200 kg ha^{-1} followed by 150 kg $ha^{-1}$of NPSB fertilizer which statistically similar with each other resulted in the longest spike length of 8.5cm and 8.3cm respectively; whereas the shortest spikes length of 6.7cm was obtained from unfertilized plants (Table 4). This nutrient available in the formulation of applied NPSB fertilizer as in fact that it have a great role in cell division and grain filling there by it attributes to spike length. All the treatment showed increasing tendency of spike length with increasing NPSB rates supplemented with nitrogen fertilizer. Similarly [10] found that the highest spike length (7.3cm) was recorded from the plot treated with 300 kg ha^{-1} of NPSB application which improved by 12% as compared to the shortest spike length (6.4cm) obtained from control plot indicating that; use of mixed blended fertilizer along with supplementary nitrogen had significant influence on the spike length.

Table 4*. Main effect of NPSB fertilizers and varieties on days to 50% heading, days to maturity, plant height and spike length of bread wheat.*

Treatments	DH	SL (cm)	NTT
NPSB Rate			
0	77.9c	6.7e	4.4c
50	80.2b	7.7c	4.9b
100	80.6b	8.0bc	5.2b
150	80.8b	8.3ab	5.1b
200	82.4a	8.5a	5.6a
64/20 NP	79.7b	7.3d	4.6c
LSD (5%)	1.14	0.43	0.26
Variety			
Danda'a	82.50a	7.8	5.0ab
Hidase	83.28a	7.8	4.8b
Kakaba	75.00b	7.6	5.1a
LSD (5%)	0.81	NS	0.18
CV (%)	1.5	5.8	5.5

Keys: Means with the same letter in a column for a trait are not significantly different at 5% level of significance's; DH= Days to Heading, SL= Spike Length, and NTT= Number of total tillers. LSD=Least significant differences at 5% and CV (%) =Coefficient of variation.

3.2.4. Plant Height (cm)

The result of analysis of variance showed that plant height was very highly significantly ($P < 0.01$) affected by the main effect of blended NPSB fertilizer supplemented with nitrogen fertilizer and varieties. The interaction effect of both factors also found highly significant ($P < 0.01$) for plant height of bread wheat in the study area (Table 5). The mean tallest plants height of 105 cm was observed with Danda'a variety under the application of 150 kg ha^{-1} NPSB which is statistically at par with 104.9 cm with Hidase variety under application of 200 kg ha^{-1} NPSB fertilizer. The shortest plant 77.9 cm was recorded with Danda'a variety under unfertilized plot (Table 5). The result showed that plant height increased with an increase of blended fertilizer rate supplemented by nitrogen fertilizer (Urea). This might be due to a total increase of nitrogen nutrient fertilizer provided for plants with the increase rate of blended NPSB fertilizer and adequate supply of other nutrients for the growth and development of plants thereby resulting in increment of plant height. In agreement with this result [10] found highest plant height of 95.5cm for bread wheat at a maximum application of 300 kg ha^{-1} NPSB fertilizer along with 100 kg ha^{-1} of urea and the shortest plant height was obtained from the control plots. Although different plant height was reported for different bread wheat cultivar with the tallest of 101.97cm for Digalu and 85.87cm for Hidase [32] who indicated that the difference was due to variety, nitrogen fertilizer level and genetic constitution of crops.

3.3. Effects of NPSB Fertilizers on Yield Components and Yield

3.3.1. Total Number of Tillers

The main effect of NPSB fertilizer and varieties were highly significant and significantly influenced total tiller number of bread wheat respectively. However, the interaction effect of two factors was not significant (Table 4). The highest number of total tillers per plant (5.6) was produced from crops treated with 200 kg ha^{-1} of NPSB supplemented with nitrogen fertilizer while the lowest number (4.4) was recorded from unfertilized plots. Total number of tillers per plant responded differently to NPSB fertilizer with supplementary nitrogen and bread wheat varieties. This might be due to an increase in cell division, differentiation of growing cell which ultimately resulting from an adequate provision of sufficient nutrients by crops from blended fertilizer in addition to genetic makeup of cultivars. In line with this result [6] reported that the highest number of total tillers was produced by plants treated with the highest rate of combined application of (150/115 NPSB/N kg ha^{-1}) fertilizers and the lowest from unfertilized plots which stating that; the synergetic role of the four nutrients played in enhancing growth and development of the crop.

3.3.2. Number of Productive Tillers Per Plant

The result of analysis of variance showed that number of productive tillers was significantly ($P < 0.05$) affected by main effect of NPSB fertilizer and variety; whereas the productive tillers was highly significantly ($P < 0.01$) affected by interaction effect of both factors (Table 5). The maximum number of productive tillers (5.0) was obtained in Kakaba variety at application of 200 kg ha-1 of NPSB fertilizer followed by Danda'a variety treated with 150 kg ha-1 of NPSB fertilizer (4.9) although the difference between the two is statistically at par. While the minimum number of productive tillers 3.7 was obtained from unfertilized plot with Danda'a variety (Table 5).

Table 5. Interaction effect of NPSB fertilizer and varieties on days to maturity, plant height and number of productive tillers of bread wheat.

NPSB Rate (kg ha^{-1})	DM			PH (cm)			NPT		
	Varieties			Varieties			Varieties		
	Danda'a	Hidase	Kakaba	Danda'a	Hidase	Kakaba	Danda'a	Hidase	Kakaba
0	159.0^{g}	160.3^{fg}	141.0^{l}	77.9^{i}	77.6^{i}	79.1^{hi}	3.7^{h}	4.1^{d-h}	3.9^{gh}
50	162.0^{de}	162.3^{de}	143.0^{jk}	88.7^{efg}	84.0^{ghi}	96.7^{bcd}	3.9^{gh}	4.0^{e-h}	4.5^{bcd}
100	164.0^{c}	163.3^{cd}	144.3^{j}	98.7^{abc}	92.1^{cde}	98.2^{a-d}	4.4^{c-f}	4.3^{c-g}	4.5^{b-e}
150	167.0^{b}	168.3^{b}	146.0^{i}	105.0^{a}	91.7^{def}	100.0^{ab}	4.9^{ab}	4.3^{c-g}	4.3^{c-g}
200	170.0^{a}	171.0^{a}	149.7^{h}	104.9^{a}	99.9^{ab}	102.5^{ab}	4.6^{bc}	4.5^{b-e}	5.0^{a}
64/20 NP	162.3^{de}	161.7^{ef}	142.7^{k}	85.6^{fgh}	85.3^{fgh}	96.4^{bcd}	4.0^{fgh}	3.9^{gh}	4.2^{c-g}
LSD (5%)	1.50			5.98			0.38		
CV (%)	0.6			3.9			5.4		

Keys: Means followed by the same letter/s in columns and rows of each trait are not significantly different at 5% level of significance; DM= Days to Maturity, PH= Plant Height, NPT=Number of productive tillers, LSD=Least significance difference at 5% and CV (%) =Coefficient of variations.

The reason for differences on productive tillers by different levels of NPSB fertilizers might be due to provision of sufficient supply of essential nutrient and balanced fertilization of crops especially at a time of its emerging, growth and developmental period of crops which results in a higher number of total and productive tillers. The result in this study was in conformity with [29] who reported that the highest number of productive tillers 306.7 m^{-2} at 150 kg NPS ha^{-1} supplemented with 92 kg N ha^{-1} which indicate that the productive tillers was higher by 107.4% over that of control plots.

3.3.3. Number of Kernels Per Spike

The main effect of NPSB fertilizer and variety had highly significant ($P < 0.01$) effect whereas the interaction effects of both factors are found to be non-significant on number of kernels per spike (Table 6). The highest number of kernels per spike (54.9) was obtained at application of 200 kg NPSB fertilizer with supplementary nitrogen (urea) fertilizer whereas the lowest number of kernels (42.5) was recorded in unfertilized plot. The higher number of kernels per spike under different level of NPSB fertilizer could be due to an optimum nutrient provision for growth and development of crops from respective source of applied fertilizers as in fact phosphorus is essential for grain development and boron for grain setting and the difference among bread wheat varieties might be due to genetic variability of crops. So, the synergistic effect of nutrients supply in combination with genetic capacity of cultivar might ultimately results in increases of number of kernels per spike. Similarly the finding of [6] also found that the highest (50.07) and the lowest (34.73) number of kernel's per spike at combined application of 150/92 kg NPSB/N ha^{-1} fertilizer and unfertilized plots respectively; indicating that adequate application of NPSB and N fertilizer supply enables the crop to make rapid growth and to intercept more solar radiation and thus attribute for more number of kernel's per spike.

Table 6. Main effect of NPSB fertilizer and varieties on number of kernels per spike, thousand kernels of weight and above ground biomass yield of bread wheat.

Treatments	NKS	TKW	AGBM (tons ha^{-1})
NPSB Rate			
0	42.5^{c}	46.0	6.9^{d}
50	47.7^{bc}	46.0	9.1^{c}
100	52.5^{ab}	48.2	9.9^{c}
150	48.12^{bc}	47.2	11.8^{b}
200	54.9^{a}	45.4	13.8^{a}

Treatments	NKS	TKW	AGBM (tons ha^{-1})
64/20 NP	48.7^{abc}	46.2	9.3^{c}
LSD (5%)	6.15	NS	1.41
Varieties			
Danda'a	54.3^{a}	46.3^{b}	10.1
Hidase	53.6^{a}	49.3^{a}	10.0
Kakaba	39.3^{b}	44.4^{b}	10.3
LSD (5%)	4.35	2.18	NS
CV (%)	13.1	6.9	14.5

Keys: Means with the same letter/s in column are not significantly different at 5% level of significance's; NKS= Number of Kernels per Spike, TKW= Thousand Kernels Weight, ABGB=Above Ground Biomass Yield, LSD=Least significant differences at 5% and CV (%) =Coefficient of variation.

3.3.4. Thousand Kernel Weight

Thousand kernel weight was very highly significantly ($P < 0.01$) affected by the main effect of variety. Whereas the main effect of NPSB fertilizer as well as the interaction effect of both factors were found to be non-significant (Table 6). Among varieties the maximum thousand kernels weight of 49.3 g was obtained by Hidase variety while the minimum of 44.4 g was obtained by Kakaba variety (Table 6). These differences in weight of kernels might be due to the genetic capacity of a variety to absorb light and the highest photo assimilate and nutrient use efficiency of the plants other than the nutrient management practices which there by attributes for more grain filling of the crops and increase in size of seeds as well as weight of crops. Similarly many research findings reported that too much amount of nitrogen fertilizer application had not significant effect on thousand kernels weight. i.e., it has a negative correlation on the parameter. For example, research finding [5, 18, 28] reported that the highest thousand kernels weight was obtained from application of 92 kg N ha^{-1} but, the value decrease as the rate of nitrogen exceeds above this rate.

3.3.5. Above Ground Biomass Yield

The result of analysis of variance showed that the main effect of fertilizer highly significantly ($P < 0.05$) affected the above ground biomass yield. However, the main effects of variety as well as the interaction effect of both factors were found to be non-significant (Table 6). The highest above ground biomass yield (13.8 tons ha^{-1}) was recorded under 200 kg NPSB ha^{-1} application followed by 11.8 tons ha^{-1} under application of 150 kg ha^{-1} of NPSB fertilizer while; the lowest biomass yield was recorded from unfertilized plot (Table 6). These increased in biomass yield with increase of NPSB fertilizer might be due to better crop growth rate, maximum accumulation of photo-assimilate and LAI in parallel with maximum days to maturity by the crop which ultimately results in highest biomass yield. In addition the highest biomass might also resulted from the synergetic effect of the nutrients which increased uptake of nutrients and root growth favoring better growth of above ground biomass yield. The present result is in agreement with [1] who reported that the highest biomass yield under application of 200 kg blended fertilizer and 63.91 kg of urea ha^{-1} followed by 150 kg blended fertilizer and 82.71 kg of urea ha^{-1} and the lowest was under no fertilizer application.

3.3.6. Straw Yield

The analysis of variance showed that the main effect of NPSB fertilizer highly significantly ($P < 0.01$) affected the straw yield whereas the main effect of variety and interaction effect of both factors were found to be not significant (Table 7). The highest straw yield (9.4 tons ha^{-1}) was obtained at the application of 200 kg ha^{-1} of NPSB fertilizer with nitrogen supplementation and the lowest straw yield (4.8 ton ha^{-1}) was from the control plot (Table 7). The highest straw yield from the highest NPSB rate of 200 kg ha^{-1} might be contributed from the synergetic effect of nutrients as in fact that the presence of sulfur increases the nitrogen use efficiency of crops which play a great role in promoting the vegetative growth and development thus by increases the straw yield of bread wheat. The result is consistent with that of [28] who reported increased in straw yield of bread wheat with the increase of NPSB and nitrogen from 150/115 to 100/92 NPSB/N kg ha^{-1} even if the yield is statically at par to each other.

3.3.7. Grain Yield

The analysis of variance showed that the main effect of NPSB fertilizer and varieties were highly significantly ($P < 0.01$) affected the grain yield of bread wheat. However, the interaction effects of the two factors were found to be non-significant (Table 7). The highest grain yield (4549 kg ha^{-1}) was obtained under application of 200 kg of NPSB ha^{-1} supplemented with nitrogen fertilizer whereas the lowest was under no fertilizer application. The mean of grain yield was increased with the increment of NPSB from 50 kg ha^{-1} to 200 kg ha^{-1}. Grain yield obtained at application of 200 kg of NPSB ha^{-1} with supplementary nitrogen increased grain yield by 38.62% and 54.51% as compared to blanket recommendation (64/20 NP) and control respectively (Table 7). The highest mean grain yield (3351 kg ha^{-1}) was recorded in Hidase variety whereas the lowest was recorded in Kakaba variety which is statically at par with Danda'a variety.

Table 7. Main effect of NPSB fertilizer and varieties on straw yield, grain yield and harvest index of bread wheat.

Treatments NPSB Rate	SY (tons ha^{-1})	GY (kg ha^{-1})	HI (%)
0	4.8^c	2069^e	30.7
50	6.4^b	2694^d	30.4
100	6.8^b	3125^c	32.6
150	7.8^b	3993^b	34.3
200	9.4^a	4549^a	34.2
64/20 NP	6.5^b	2792^d	30.6
LSD (5%)	1.45	217.5	NS
Varieties			
Danda'a	7.0	3125^b	31.9
Hidase	6.8	3351^a	33.7
Kakaba	7.1	3135^b	30.9
LSD (5%)	NS	153.8	NS
CV (%)	21.8	7.1	13.8

Keys: Means with the same letter in columns are not significantly different at 5% level of significance's; SY= Straw Yield, GY= Grain Yield, HI= Harvest Index, LSD=Least significant differences at 5% and CV (%) =Coefficient of variation.

The main and final ultimate goal in every crop production is achievement in maximum economic profit in yield, which is a complex function of environmental condition, response of yield components and yield of the genetic potential of varieties, management practice and the interaction of all of these factors. The various differences in grain yield under different rates of NPSB fertilizers and varieties might be due to an adequate and sufficient supply of balanced nutrient from NPSB fertilizer for crops both in quantity and quality from respective increased rates of blended fertilizer for growth and development of crops thus by which attributes for increment of grain yield. This result was in agreement with the finding of [6] who reported that the highest mean grain yield of 5666 kg ha^{-1} was obtained at combined application of 150 kg of NPSB and 92 kg N ha^{-1}, whereas the lowest mean grain yield of 1960 kg ha^{-1} was obtained from unfertilized plots.

3.3.8. Harvest Index

The analysis of variance for harvest index showed that main effect of NPSB fertilizer rates, varieties and their interaction effects were found to be statically non-significant (Table 7).

3.4. Analysis of Correlation of Parameters

Days to heading and maturity, number of total tillers and number of productive tillers, number of kernels per spike and thousand kernels weight, above ground biomass yield and straw yield, grain yield and harvest index; and above ground biomass yield and grain yield showed strongly significant positive correlation. Furthermore, maturity date and number of kernels per spike, number of total tillers and number of kernels per spike and plant height with spike length were significantly positive correlations. Among those parameters considered; number of total tillers and thousand kernels weight, straw yield and grain yield as well as above ground biomass yield and harvest index had negatively significant correlation (Table 8).

Table 8. Correlation coefficient of various parameters of bread wheat.

	DH	DM	NTT	NPT	PH	SL	NKS	TKW	AGBM	SY	GY	HI
DH	1											
DM	0.87**	1										
NTT	0.17	-0.24	1									
NPT	-0.09	0.08	0.53**	1								
PH	-0.07	-0.15	0.19	0.15	1							
SL	0.06	0.1	0.07	0.01	0.46*	1						
NKS	-0.11	0.40*	0.38*	-0.19	0.14	0.05	1					
TKW	0.09	-0.17	-0.35*	0.25	-0.24	0.16	0.52**	1				
AGBM	-0.07	0.13	0.11	0.04	0.21	-0.1	-0.01	-0.04	1			
SY	0.07	-0.08	-0.12	-0.11	-0.05	0.04	0.07	-0.03	0.87**	1		
GY	0.02	-0.06	0.01	0.07	-0.19	0.24	-0.14	0.18	0.75**	-0.35*	1	

	DH	DM	NTT	NPT	PH	SL	NKS	TKW	AGBM	SY	GY	HI
HI	-0.06	0.15	0.04	-0.14	0.27	-0.22	0.11	-0.14	-0.37*	-0.12	0.84**	1

Keys: DH= Days to heading, DM= Days to maturity, NTT= Number of Total Tillers, NPT= Number of Productive Tillers, PH= Plant Height, SL= Spike Length, NKS= Number of Kernels per Spike, TKW= Thousand Kernels Weight, AGBM= Above Ground Biomass, SY=Straw Yield, GY=Grain Yield and HI=Harvest Index.

3.5. Partial Budget and Economic Analysis

In the present study, the prices for purchasing of the NPSB fertilizer, Urea, bread wheat and labor cost for fertilizer application were considered as variable cost where as other costs were constant for each treatment. In order to recommend the present finding in the study area, it is necessary to estimate the minimum rate of return acceptable to producers in the recommendation domain. It is quite evident from the result presented in Table 9, the partial budget analysis showed that mean highest net benefit of (97993) Birr ha^{-1} was obtained from variety Hidase that received 200 kg NPSB ha^{-1} with nitrogen fertilizer supplementation. However, the lowest mean net benefits of (39582) Birr ha^{-1} were obtained from the unfertilized treatment with the variety Danda'a.

This indicates that a bread wheat producers can get an extra of 9.60 ETB for 1.00 ETB investments in the NPSB and N fertilizers application on the rates less than or equal to 200/92 kg NPSB/N ha^{-1} fertilizers. According to partial budget analysis indicated, variety Hidase gave both the highest marginal rate of return (959.97%) and economic benefit of (97993 ETB ha^{-1}) at 200 kg NPSB ha^{-1} fertilizer rate followed by Danda'a variety which gave MRR (906.99%) and net economic benefit of (88596 ETB ha^{-1}) at 200 kg NPSB ha^{-1}which indicates us with net benefit increment about a (9397 ETB) by Hidase over Danda'a variety within the same rate of NPSB fertilizers per hectare. Additionally, as a third and fourth option both varieties namely Kakaba and Danda'a at 200 kg NPSB and 150 kg NPSB ha^{-1} fertilizer rate gave the maximum economic benefit of (82996 ETBha^{-1}) and (79459 ETB ha^{-1}) with marginal rate of return (722.02%) and (853.17%), respectively. Therefore, application of NPSB fertilizer at the rate of 200 kg with the supplement of 92 kg N ha^{-1} in the production of Hidase and Danda'a varieties was more economically beneficial and recommended as the best alternative option respectively for around Degam district area with similar soil types and agro ecologies.

Table 9. *Partial budget and economic analysis of the effect of NPSB fertilizer rates supplemented with nitrogen fertilizer on bread wheat varieties at Degam District.*

Treatments		Total Yield		Net Income (ETB ha-1)						
NPSB Fertilizer (kg ha-1)	Varieties	AGY (kg ha-1)	ASY (kg ha-1)	Grain yield	Straw Yield	TGB (ETB ha-1)	TVC (ETB ha-1)	NB (ETB ha-1)	ΔNB (ETB ha-1)	MRR (%)
0	Danda'a	1875	4600	30000	12282	42282	2700	39582	39582	D
50	Danda'a	2625	5900	42000	15753	57753	5984	51769	12187	371.1
100	Danda'a	3083	6800	49328	18156	67484	6644	60840	21258	539
150	Danda'a	4042	8300	64672	22161	86833	7374	79459	39877	853.17
200	Danda'a	4375	10000	70000	26700	96700	8104	88596	49014	906.99
64/20 NP	Danda'a	2750	6300	44000	16821	60821	8669.38	52151.62	12569.62	D
0	Hidase	2250	4800	36000	12816	48816	2700	46116	46116	D
50	Hidase	2875	6000	46000	16020	62020	5984	56036	9920	302.07
100	Hidase	3208	6500	51328	17355	68683	6644	62039	15923	403.73
150	Hidase	4000	6800	64000	18156	82156	7374	74782	28666	613.31
200	Hidase	4979	9900	79664	26433	106097	8104	97993	51877	959.97
64/20 NP	Hidase	2792	6400	44672	17088	61760	8669.38	53090.62	6974.62	D

Treatments		Total Yield		Net Income (ETB ha-1)						
NPSB Fertilizer (kg ha-1)	Varieties	AGY (kg ha-1)	ASY (kg ha-1)	Grain yield	Straw Yield	TGB (ETB ha-1)	TVC (ETB ha-1)	NB (ETB ha-1)	ΔNB (ETB ha-1)	MRR (%)
0	Kakaba	2083	5000	33328	13350	46678	2700	43978	43978	D
50	Kakaba	2583	7400	41328	19758	61086	5984	55102	11124	338.73
100	Kakaba	3083	7000	49328	18690	68018	6644	61374	17396	441.08
150	Kakaba	3938	8300	63008	22161	85169	7374	77795	33817	723.51
200	Kakaba	4292	8400	68672	22428	91100	8104	82996	39018	722.02
64/20 NP	Kakaba	2833	6700	45328	17889	63217	8669.38	54547.62	10569.62	D

Keys: NPSB= Nitrogen, Phosphorous, Sulfur and Boron; NP= Nitrogen and Phosphorus; AGY= Adjusted Grain Yield; ASY= Adjusted Straw Yield; TGB= Total Gross Benefit; TVC= Total Variable Cost; NB= net Benefit; ΔNB= Change in Net Benefit; MRR= Marginal Rate of Return; ETB= Ethiopian Birr per hectare and D= Dominated.

4. Conclusions and Recommendations

The experimental research study indicated that application of balanced and sufficient soil nutrient management with high yielder improved variety is one of the best agronomic practice for increasing yield components and yield of bread wheat. Accordingly, analysis of the result revealed that 50% days to heading, total number of tillers, number of kernel per spike and grain yield were highly significantly affected by main effect of both varieties and NPSB fertilizers; Whereas spike length, above ground biomass yield and straw yield were significantly affected by the main effect of NPSB fertilizer rate while thousand kernels weight was affected only by the main effect of variety. However, the analysis of result study indicated that as days to 90% maturity, plant height and number of productive tillers were significantly affected by the interaction effect of both factors. The highest, maximum grain yield (4549 kg ha^{-1}), above ground biomass yield (13.8 tons ha^{-1}), straw yield (9.4 tons ha^{-1}), number of kernels per spike (54.9), total number of tillers (5.6), number of productive tillers (4.7), the longest days to heading (82.4 days), physiological maturity (163.6 days), highest number of kernels per spike (54.9) and highest plant height (102.4 cm) were recorded at the maximum NPSB rate application (200 kg ha^{-1}) supplemented with nitrogen fertilizers. While the lowest and minimum result for all parameters were recorded from unfertilized plot except for thousand kernels weight and harvest index. The result of economic analysis showed that combined production of 200 kg ha^{-1} blended NPSB fertilizer with Hidase variety gave economic benefit of 97993ETB ha^{-1} with the acceptable marginal rate of return (640.14%). Similarly, the grain yield also showed that statistically the highest grain yield (4979 kg ha^{-1}) was obtained from the combined application of 200 kg ha^{-1} of NPSB fertilizer with Hidase variety. Therefore, it could be concluded that application of 200 kg NPSB in supplement of 92 kg N ha^{-1} fertilizer with Hidase variety was temporarily the best producing alternatives and economically profitability and with acceptable grain yield of bread wheat production at the study area. Finally it is advisable to undertake further research across soil types, season and locations involving others best performing cultivar to draw sound recommendation on a wider scale and for longer duration and variable cropping systems.

Abbreviations

AGBM	Above Ground Biomass Yield
AGY	Adjusted Grain Yield
ASY	Adjusted Straw Yield
ANOVA	Analysis of Variance
CEC	Cation Exchange Capacity
CV	Coefficient of Variation
DH	Days to Heading
DM	Days to Maturity
DMRT	Duncan Multiple Range Test
ETB	Ethiopian Birr
EthioSIS	Ethiopian Soil Information System
FAO	Food Agriculture Organization
GY	Grain Yield
HI	Harvest Index
KARC	Kulumsa Agricultural Research Center
LSD	Least Significance Difference
MoA	Ministry of Agriculture
MRR	Marginal Rate of Return
NB	Net Benefit
NKS	Number of Kernel's Per Spike
NPSB	Nitrogen, Phosphorus, Sulfur and Boron

NTT	Number of Total Tillers
RCBD	Randomized Complete Block Design
SL	Spike Length
TGB	Total Gross Benefit
TKW	Thousand Kernel Weight
TVC	Total Variable Cost

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Conflicts of Interest

The authors declare no conflicts of interest.

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