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RESEARCH ARTICLE

Response of Bread Wheat (*Triticum aestivum* L.) Varieties to Blended NPSB Fertilizer Levels in Sori Saylem District, South-West Ethiopia

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Abstract

In Ethiopia, bread wheat (*Triticum aestivum* L.) is an important source of food and income for smallholder farmers. However, its productivity is very low, which is attributed to poor agronomic and soil fertility management practices. Wheat production in most areas of Ethiopia is affected by (macro and micronutrient) deficiencies that affect soil fertility and crop yield. Therefore, a field experiment was carried out in order to ascertain the response of bread wheat varieties to different levels of blended NPSB fertilizer at Sori Saylem district during the year 2020–2021. The experiment was consisted of four rates of blended NPSB (0, 50, 100 and 150 kg ha^{-1}) and three varieties (Simba, Ogolichu, and Shorima) with factorial configuration in a randomized complete block design, three times replicated and analysed by using SAS 2015 (version 9.4). The results showed that the application of NPSB fertilizer rate and bread wheat cultivars significantly affected the plant height, total number of tillers, effective number of tillers, spike length, kernel per spike, biomass yield, grain yield, 1000-kernel weight, and straw yield. As a result, 150 kg ha^{-1} blended NPSB fertilizer application with Shorima variety yielded the maximum grain yield (5,952.38 kg ha^{-1}) and highest net benefit (122,267 ETB ha^{-1}) with low marginal rate of return. The correlation analysis also shows positive values in all parameters except the harvest index. Therefore, 150 kg ha^{-1} blended NPSB fertilizer with Shorima variety can be recommended in the district.

Keywords: Effective tiller, Grain Yield, Shorima variety, Significant, Partial budget.

Introduction

On a global cereal crop ranking, bread wheat (*Triticum aestivum* L.) is second only to maize in production and productivity as a staple diet source (Pant *et al.,* 2020). Food consumption in developing countries is dominated by wheat, followed by rice (Braun *et al.,* 2010). In developing countries, about 2.5 billion people directly or indirectly depend on wheat crops (FAO, 2010). Global production is estimated to be 728.3 million tons, with East Africa producing 5.7 million tons, of which Ethiopia contributed 4.6 million tons (FAO, 2019). As of 2050, there will be an increase of 60% in demand for wheat in the developing world due to its contribution to alleviating food insecurity problems due to its provision of more nourishment than any other crop (Abebaw and Hirpa, 2018; USDA, 2019). Wheat is also a strategic commodity in Sub-Saharan African countries, generating farm income for small-scale farmers (Amentae *et al.,* 2017).

There are 1.7 million acres of cultivation in Ethiopia, followed by 0.5 million acres in South Africa (Wuletaw *et al.,* 2018). There are approximately 5 million Ethiopian farmers who cultivate 1.8 million hectares of land and produce 5.3 million tons of wheat each year (CSA, 2020; Shewaye and Mohammed, 2021). In terms of total production and area covered, it ranks third after teff and maize. Wheat is grown in the majority of Ethiopia's highlands in the north, centre and south-east (CSA, 2017). The production potential of wheat

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Table 1: Bread wheat varieties

No	Variety	Year of release	Breeding center	Maturity (days)	Rainfall (mm)	Altitude (m)	Yield (t ha^{-1})
1	Simba/HAR 2536/	2000	KARC	100-150	>600	2000-2600	3.0-5.0
2	Shorima (ETBW5483)	2011	KARC	105-150	600-900	1900-2600	4.4-6.3
3	Ogolcho (ETBW5520)	2012	KARC	102	400-500	1600-2100	3.3-5.0

Source: MoANR (2016)

in Ethiopia is low compared to world production potential. CSA (2018) as well as Berhanu and Shimelis (2021) reported that Ethiopia's national average wheat yield is 2.77 tons ha^{-1}, compared with 3.32 tons ha^{-1} globally (USDA, 2017).

There are no specific recommendations for wheat in the study area, but farmers use 100 kg of urea and DAP. These fertilizers only contain nitrogen and phosphorus, which may not meet crop nutrient requirements. To substitute DAP and urea, Agriculture Transformation Agency (ATA) tentatively recommended blended NPSB fertilizers, which contain N:P:S:B nutrients in the ratio of 18.1:36.1:6.7:0.7, respectively (ATA, 2016).

Due to the reduction of landholding capacity and continuous cultivation, declining farmland quality leads to increased application of mineral fertilizer rates to meet the nutrient requirements of wheat. However, the majority of farmers in the study area do not use optimal fertilizer levels with adaptive variety when they produce bread wheat. As a result of improper fertilizer application and a lack of improved bread wheat variety, the yield is very low. However, the adapted fertilizer application rate in the study area is not sufficient to meet the crop requirement to increase the yields of bread wheat. Application of an appropriate rate of blended fertilizer with adaptive wheat varieties is important to increase the growth and yields of bread wheat. Keeping these points in mind, different rates of NPSB fertilizer had been applied on wheat varieties to identify the optimum growth, yield and economics of wheat in the acidic soil of Saylem district, South-west Ethiopia.

Materials and methods

The study area's description

In the 2020/21, the experiment was conducted in Sori Kebele of Saylem district in Kaffa zone. Approximately 628 kilometers from Addis Ababa (the capital) lies the experimental site. At an altitude of 2225 meter above sea level, the site is located at 07051′-7067′ north latitude and 35050′-35059′ east longitude. The mean annual minimal and maximal rainfall and temperature ranges were 2001 mm and 2200 mm and 15.1°C to 20.0°C, respectively.

Experimental materials and treatment combination

Three bread wheat varieties named *Simba, Shorima and Ogolichu* (Table 1) were used as a test crop and blended NPSB fertilizer which contains N:P:S:B nutrients in the ratio of 18.1:36.1:6.7:0.7, respectively. A randomized complete block design (RCBD) was used with three varieties and four rates of blended NPSB fertilizers, namely 0, 50, 100, and 150 kg ha^{-1}. In August 2020, seedlings were planted by hand drilling in rows and lightly covering with soil at a depth of 3-5 cm. All plots had received NPSB fertilizer rates according to the treatments, which were applied at sowing time, while 100 kg ha^{-1} urea was applied in two splits on each fertilized plot. One-third of N fertilizer was applied combined with full rates of NPSB fertilizer at sowing time and by mid-tillering, the remaining N was side-dressed by two thirds and all experimental plots were uniformly subjected to other necessary agronomic management practices.

Soil sampling and analysis

Before planting, the soil of the experimental field was analyzed for its physical and chemical properties. A random zigzag pattern was used to collect soil samples at 0-20 cm depth during land preparation. The samples were composited, and one kilogram of experimental field soil was taken as a working sample. Then the samples were submitted to the Jimma Soil, Water and Plant Tissue Analysis Research Laboratory to determine soil texture, pH, total nitrogen, available phosphorous, cation exchange capacity, organic carbons, available sulphur, and boron.

Data collection

Data were collected on days to heading (DH), days to 90% physiological maturity (DPM), grain-filling period (GFP), plant height (PH), number of total tillers (NTT), number of effective tillers (NET), spike length (SL), *harvest index (HI) and grain yield (GY)*.

Partial budget analyses

To compile the statistical analysis of agronomic data, a partial budget of each treatment was subjected to a cost-benefit analysis. According to the procedure given by CIMMYT (1988), the economic evaluation, cost and return were calculated. A benefit ratio for various treatment combinations was calculated based on wheat prices, fertilizer costs, and labour costs. The treatment with the highest net benefit that was non-dominated and had a marginal rate of return (MRR) of greater than or equal to 100% was deemed economically profitable.

Data analyses

Before analysis, the data was checked for normality. All data were subjected to ANOVA using SAS version 9.4 (SAS, 2015). The use of significant differences between treatments, mean

Table 2: Soil physicochemical properties of the experimental site before sowing

No	*Soil Property*		*Method*	*Values*	*Rating*	*References*
1	Particle size distribution (%)	Sand		61		Ethio SIS (2016)
		Silt		15		
2		Clay	Hydrometre	24		
	Textural class			Sandy Clay Loam		
3	pH(soil: water in 1:2.5)w/v		Potentiometric	5.00	Highly acidic	Ethio SIS (2016)
4	CEC(cmol (+) kg^{-1} soil)		Ammonium acetate	19.06	Medium	Ethio SIS (2016)
5	OC (%)		Walkley-Black	1.31	Low	Ethio SIS (2016)
6	TN (%)		Kjeldahl	0.26	Moderate	Ethio SIS (2016)
7	Available P (ppm)		Bray	3.46	Very low	Ethio SIS (2016)
8	Available S mg kg^{-1}		Turbid metric	2.03	Very low	Ethio SIS (2016)
9	Available B mg kg^{-1}		Hydrochloric acid	0.71	Low	Ethio SIS (2016)).

Where, OC= Organic carbon, TN= Total nitrogen, Av. p (ppm)= Available P in parts per million, CEC= Cation exchange capacity, S mg kg^{-1}= sulfur milligram per kilogram, B mg kg^{-1}= Boron milligram per kilogram

comparison, separation and LSD at a 5% level of significance was done.

Results

Pre-sowing physicochemical properties of experimental soil

Results revealed that the textural class of the soil of the site was sandy clay loam with a particle size distribution of 61% sand, 24% clay and 15% silt. The pH was highly acidic with a value of 5.0, the CEC (19.06 cmol kg^{-1}) of the experimental soil was in the range of medium whereas, organic carbon (1.31 %) and available phosphorous (3.46 ppm) were in the range of low. Total nitrogen (0.26%) was rated as moderate. The available sulphur (2.03 mg kg^{-1}) was reported very low. Available boron in the study area was 0.71 mg/kg which is low (Table 2).

Genotype and environment effects on phenology and growth of bread wheat

The longest days to heading (77.67 days) were observed when NPSB fertilizer (150 kg ha^{-1}) was applied to Shorima variety whereas; earliest days to heading (63·67 days) were recorded from zero fertilization with Simba variety (Table 3). *With 150 kg ha^{-1} NPSB fertilizer, the most days were recorded to reach 90% physiological maturity with Shorima variety, while with Simba variety without fertilizer, the earliest days were recorded to reach 90% maturity (117.67 days)* (Table 3). *Likewise,* the highest grain-filling period (117.33 days) was recorded by using the 150 kg ha^{-1} blended NPSB fertilizer with Shorima variety while, the lowest grain filling period (90.67 days) was recorded for Simba variety without fertilizer applications. A 150 kg ha^{-1} NPSB treatment with Shorima variety produced the tallest plant (95.5 cm), while an unfertilized plot with Simba variety produced the shortest one (77.5 cm). Using 150 kg ha^{-1} NPSB fertilizer with the Shorima variety, the maximum number of total tillers (338.67 tillers m^{-2}) was obtained, while the minimum number (275.33 tillers m^{-2}) was obtained with the Simba variety as the control plot. There were the highest number of productive tillers (274.67 tillers m^{-2}) in plots with 150 kg ha^{-1} NPSB and Shorima variety, followed by plots with 150 kg ha^{-1} NPSB and Ogolichu variety, while the lowest number of effective tillers (223 tillers m^{-2}) was observed on plots unfertilized with Simba variety. A combination of 150 kg ha^{-1} NPSB fertilizer using the Shorima variety resulted in a maximum spike length (12.13 cm), while a plot unfertilized with the Simba variety had a minimum spike length (8.06 cm) (Table 3).

Performance of studied genotypes for yield and related traits

ANOVA showed that NPSB and varieties significantly ($p<0.01$) affected the number of kernels per spike. Nevertheless, the interaction effect of both factors had a significant ($p<0.05$) impact on the number of kernels per spike, the weight of thousands of kernels, the harvest index, the aboveground dry biomass yield, the grain yield, and the straw yield.

The maximum number of kernels in each spike (50.57 kernels) was taken from the treatment combination of 150 kg ha^{-1} NPSB and Shorima variety which was statistically similar to the result obtained from Simba and Ogolichu varieties with the application of 150 kg ha^{-1} NPSB fertilizer. Statistically, the response of the Simba (42.10 kernels) and Ogolichu varieties without fertilizer application was similar and it was minimum. With 150 kg ha^{-1} blended NPSB with the Ogolichu variety, the highest thousand-kernel weight (48.92 g) was achieved, which was statistically comparable with 150 kg ha^{-1} blended NPSB with Simba and Shorima varieties. Variety Simba with control treatment recorded the lowest kernel weight (46.40 g). Among treatments with 150 kg ha^{-1} blended NPSB fertilizer and the Shorima variety followed by Simba, the highest above-ground biomass (14293.7 kg

Table 3: Interaction effects of blended NPSB fertilizer rates and varieties on phenology and growth data of bread wheat

Treatments		*Phenology*				*Growth Parameters*			
NPSB(kg ha^{-1})	*Variety*	*DE(day)*	*DOH (day)*	*DPM (day)*	*GFP (day)*	*PH (cm)*	*NTT(tiller m^{-2})*	*NET(tiller m^{-2})*	*SL (cm)*
0	Simba	5.33	63.67^{d}	117.67^{d}	90.67^{d}	77.50^{e}	275.33^{f}	223.00^{f}	8.07^{e}
	Ogolchu	5.33	67.67^{c}	125.00^{c}	98.00^{c}	84.53^{cbd}	284.00^{ef}	230.00^{ef}	8.13^{e}
	Shorima	5.33	69.00^{cb}	127.67^{cb}	100.67^{cb}	82.10^{ed}	285.00^{efd}	231.00^{def}	8.60d^{e}
50	Simba	5.33	67.67^{c}	125.67^{c}	98.67^{c}	82.78^{cd}	291.67^{ced}	236.00^{cde}	9.03^{d}
	Ogolchu	5.67	68.33^{cb}	126.33^{cb}	99.33^{cb}	85.67^{cbd}	292.33^{ced}	236.67^{cde}	10.27^{b}
	Shorima	5.67	69.67^{cb}	129.00^{cb}	102.00^{cb}	83.33^{cd}	293.00^{ced}	237.33^{cde}	9.67^{c}
100	Simba	5.33	69.33^{cb}	128.67^{cb}	101.67^{cb}	85.37^{cbd}	297.0^{cebd}	240.3^{bcde}	10.37^{b}
	Ogolchu	5.67	69.33^{cb}	128.67^{cb}	101.67^{cb}	87.10^{cb}	299.33^{cbd}	242.67^{bcd}	10.50^{b}
	Shorima	5.33	70.33^{cb}	130.00^{cb}	103.00^{cb}	85.57^{cbd}	302.67^{cb}	245.33^{bc}	10.57^{b}
150	Simba	6.00	70.00^{cb}	129.33^{cb}	102.33^{cb}	86.30^{bcd}	300.33^{cb}	243.33^{bc}	11.73^{a}
	Ogolchu	6.00	71.00^{b}	131.67^{b}	104.67^{b}	88.67^{b}	311.00^{b}	251.67^{b}	11.83^{a}
	Shorima	6.00	77.67^{a}	143.67^{a}	117.33^{a}	95.50^{a}	338.67^{a}	274.67^{a}	12.13^{a}
Mean		5.58	69.47	128.61	101.67	85.37	297.53	241.00	10.08
Fertilizer		Ns	**	**	**	**	**	**	**
Variety		Ns	**	**	**	**	**	**	**
NPSB*Variety		Ns	*	*	*	*	*	*	*
LSD(0.05)		Ns	3.03	5.51	5.54	4.8	15.16	12.12	0.56
SE ±		0.5	3.61	6.66	6.77	5.14	17.22	13.99	1.39
Cv (%)		9.35	2.57	2.53	3.22	3.32	3.01	2.97	3.31

Where DE= Days to seedling emergence, DOH= Days of 50% heading, DPM= Days to 90% physiological maturity, GFP= Grain-filling period, PH= plant height, NTT= Total number of tillers, NET= Number of effective tillers, SL= Spike length, ns= Non-significant, LSD= Least significant difference at ($P<0.05$), CV(%) = Coefficient of variation, SE± = Standard error, Mean Values superscripted with the same letter(s) in the columns are not significantly different at 5% level of probability

ha^{-1}) was obtained. Unfertilized plots with Simba variety recorded the lowest biomass (6428.6 kg ha^{-1}). Likewise, both blended NPSB fertilizer rates and varieties had a significant effect on grain yield. Using the combination of 150 kg NPSB and Shorima followed by 100 kg NPSB and Shorima, a maximum grain yield of 5,952.38 kg ha^{-1} was achieved, while by applying the Simba treatment without fertilizer, a minimum yield of 3,055.56 kg ha^{-1} was obtained. There was a significant interaction effect between NPSB and bread wheat variety on straw yield. With a combination of 150 kg ha^{-1} NPSB and Simba, the highest straw yield (9,047.3 kg ha^{-1}) was achieved, followed by Ogolichu with 150 kg ha^{-1}. On the other hand, the Simba variety yielded the lowest straw yield (3,373.3 kg ha^{-1}) with zero NPSB. The combination of treatments using 150 kg ha^{-1} NPSB and Simba produced the highest harvest index (47.96%), whereas the treatment using 0 kg ha^{-1} NPSB and Simba produced the lowest harvest index (34.89%) (Table 4).

Partial budget analysis

According to Table 6, the 150 kg ha^{-1} NPSB fertilizer with Shorima variety produced the greatest net benefit/return of 122,267 ETB ha^{-1}, followed by 100 kg ha^{-1} NPSB fertilizer with same variety producing 107,122 ETB ha^{-1}. The MRR was conducted on the six dominant treatments (T1, T2, T3, T4, T6 and T8) and all other treatments (T5, T7, T9, T10, T11 and T12) were discovered to be non-dominated. The MRR for the 100 kg ha^{-1} mixed NPSB and Shorima was 6757.33%, which is higher than the required MRR of 100%. However, (T11) (6,757.3%), (T7) (2,191.5%), and (T12) (1,986.8%) had the highest marginal rates of return. This means that for every 1 birr ha^{-1} invested in the various treatments, the rate of return was 67.57 birr, 21.92 birr and 19.87 birr, respectively (Table 5).

Discussion

The longest days required for the heading of bread wheat were observed from the application of a blended 150 kg ha^{-1} NPSB fertilizer rate with Shorima variety. These may be attributed to the soil's availability of nitrogen, phosphorus, sulfur and boron from applied fertilizer as well as the genetic makeup of Shorima variety. This finding is in agreement with those of Demisew (2018) who observed significant variations among different levels of NPSB application for days to 50% heading in bread wheat. Rut-Duga et al. (2019) also stated that the increased application of NPSB with supplementary urea resulted in the longest days to heading (71.7 days).

The extended days to maturity were recorded due to increased application of NPSB fertilizers. These nutrients

Table 4: Interaction effects of blended NPSB fertilizer rates and varieties on yield component and yield of bread wheat varieties

NPSB Rate (kg ha^{-1})	*Variety*	*NKP (nu mber)*	*TSW (g)*	*ABM (kg)*	*SY (kg)*	*Y/H (kg)*	*HI (%)*
0	Simba	42.10^{e}	46.40^{e}	6428.6^{i}	3373.3^{h}	3055.56^{g}	47.96^{a}
	Ogolichu	42.37^{e}	47.33^{d}	8095.2^{h}	4742.0^{g}	3353.17^{gf}	41.48^{b}
	Shorima	45.93^{d}	47.99^{bcd}	8928.6^{gh}	5277.7^{fg}	3650.79^{ef}	41.43^{b}
50	Simba	46.50^{d}	47.51^{cd}	8988.1^{fg}	5297.3^{fg}	3690.48^{ef}	41.16^{b}
	Ogolichu	47.13^{cd}	47.52^{cd}	9781.7^{f}	6051.7^{ef}	3730.16^{ef}	38.13^{bc}
	Shorima	48.30^{bc}	48.00^{bcd}	10642.9^{e}	6714.3^{de}	3928.57^{de}	37.05^{bc}
100	Simba	49.30^{ab}	48.41^{ab}	11845.2^{d}	7702.7^{cd}	4142.86^{d}	35.02^{cc}
	Ogolichu	49.33^{ab}	48.63^{ab}	12480.2^{cd}	7817.3^{bc}	4662.70^{c}	37.39^{bc}
	Shorima	49.43^{ab}	48.23^{abc}	13095.2^{bc}	7956.3^{bc}	5138.89^{b}	39.27^{bc}
150	Simba	50.34^{a}	48.81^{a}	13888.9^{ab}	9047.3^{a}	4841.27^{bc}	34.89^{c}
	Ogolichu	50.41^{a}	48.92^{a}	13769.8^{ab}	8790.0^{ab}	4980.16^{bc}	36.13^{bc}
	Shorima	50.57^{a}	48.86^{a}	14293.7^{a}	8341.3^{abc}	5952.38^{a}	41.67^{b}
Mean		47.64	48.06	11019.84	6759.28	4260.58	39.298
Fertilizer		**	**	**	**	**	**
Variety		**	*	**	*	**	Ns
NPSB*Variety		*	*	*	*	*	*
LSD(0.05)		1.49	0.7432	845.66	1007.6	391.21	5.86
SE ±		2.95	0.83	2553.14	1826.65	856.5	4.73
Cv (%)		1.84	0.91	4.53	8.8	5.42	8.81

*Where, NKPS= Number of kernels per spike, TKW= Thousand kernel weight, AGBY= Above ground biological yield, GY= Grain yield, SY= Straw yield, HI= Harvest index, Y/H = Yield per hectare, * = Significant,** Highly significant, ns= Non-significant, SE ± = Standard error, CV= Coefficient of variation, Mean Values superscripted with the same letter(s) in the columns are not significantly different at 5% level of probability*

increase chlorophyll formation in bread wheat, which induces photosynthesis processes rather than the reproductive phase and delays the maturity of bread wheat. Based on Jemal et al. (2015) findings, genetic factors contribute to the differences in maturity days between different varieties. Lemi and Negash (2020) found that different fertilizer rates had different effects on different varieties. In spite of the fact that different varieties have different maturity periods and it was found that adding 150 kg ha^{-1} NPSZnB/Urea prolonged the days to 90% maturity in all varieties. According to Harfe (2017) and Bizuwork and Yibekal (2020), the highest doses of N delayed physiological maturity of bread wheat compared to the control.

The longer grain-filling period observed as a result of the increased rate of NPSB could be attributed to increased N availability in the soil as a result of applied fertilizers. Therefore, the availability of nitrogen increases vegetative growth and delays the reproduction period. This finding is consistent with the findings of Lemi and Negash (2020), who discovered that different fertilization rates elicited different responses in different varieties. All varieties experienced a longer grain-filling period when fertilizer rates were increased up to 150 kg ha^{-1}. Likewise, Tagesse and colleagues (2018) found that increasing NPS fertilizer rates from 100 to 200 kg ha^{-1} extended the grain-filling period. A blended NPSB fertilizer application increased cell elongation and vegetative growth, resulting in more plant height. There could be genetic differences between the varieties in terms of plant height. Many authors have also documented significant diversity in plant height across bread wheat genotypes (Obsa and Yared, 2017). Demisew (2018) and Diriba et al. (2019) discovered that the application of blended NPSB fertilizer had a substantial effect on bread wheat plant height, with the highest (95.5 cm) plant height seen at the highest blended NPSB fertilizer rate.

Because P in NPSB helped the radicle and seminal roots emerge during seedling establishment in wheat, its application may have encouraged the increase in both the number and size of growing cells as well as its effect on cytokine synthesis, which stimulates tillering. This increase in the total number of tillers at the highest rate of NPSB applied in the Shorima variety. There was a significant increase in the number of total tillers and effective tillers per plant following the application of the blended fertilizer according to Tilahun and Tomado (2019). Genetic differences between the wheat varieties may be the cause of the variations in the amount of tillers they generate (Dinkinesh *et al.,* 2020).

Tilahun *et al.* (2021) showed that spike length increased from zero to the highest rates of NPS. According to Lemi and Negash (2020), the highest spike length for the Ogolcho variety was obtained from the application of the highest NPSZnB and Urea. Similarly, Abebual *et al.* (2019) stated that

Table 5: Partial budget analysis as influenced by blended NPSB fertilizer rate and Variety of bread wheat

NPSB (kg ha^{-1})	Variety	GAY (kg ha^{-1})	ADY(kg ha^{-1})	GFB (ETB)	TVC (ETB)	NB (ETB)	Dominance	MC	MNB	MRR (%)
0	Ogolichu	3353.17	3017.86	72429	2000	70429		0		
	Shorima	3650.79	3285.71	78857	2150	76707	ND	150	6278	4185.33
	Simba	3055.56	2750	66000	2300	63700	D			
50	Ogolichu	3730.16	3357.14	80571	4470	76101	D			
	Shorima	3928.57	3535.71	84857	4620	80237	ND	2300	3530	142.91
	Simba	3690.48	3321.43	79714	4770	74944	D			
100	Ogolichu	4662.7	4196.43	100714	5312	95402	ND	692	15165	2191.47
	Shorima	5138.89	4625	111000	5462	105538	ND	150	10136	6757.33
	Simba	4142.86	3728.57	89486	5612	83874	D			
150	Ogolichu	4980.16	4482.14	107571	6154	101417	D			
	Shorima	5952.38	5357.14	128571	6304	122267	ND	842	16729	1986.82
	Simba	4841.27	4357.14	104571	6454	98117	D			

Where:, GAY= Growth average yield, ADY= Adjusted yield, GFB (ETB)= Gross field benefits with Ethiopian Birr TVC= Total variable cost (Birr ha^{-1}), NB= Net benefit, D= Dominated, ND= Non-dominated, MC= Marginal costs, MNB= Marginal net benefits, MRR= Marginal rate of return, Sale price of bread wheat grain Birr 24.00 Birr kg^{-1}, Cost of fertilizers NPSB (15.84 ETB kg^{-1}), Urea (15.28 ETB kg^{-1}),Cost of fertilizer application (100 Birr 100 kg^{-1}), 1 Ethiopian Birr=0.027USD

in comparison to the control, the application of blended fertilizer affected the spike length of bread wheat.

In this study, increased spike length leads to more kernels per spike and vice versa. In general, the number of kernels per spike increased significantly as the rate of blended NPSB increased up to 150 kg ha^{-1}. This increase in the number of kernels per spike could be attributed to metabolic role of P in promoting crop reproductive growth. This outcome is consistent with that of Tagesse et al. (2018), who discovered that the application of mixed NPS fertilizer greatly affected the number of kernels per spike of bread wheat. Usman et al. (2020) also discovered that the 150 kg ha^{-1} NPSB fertilizer rate produced the most kernels per spike (48.3 kernels). The genetic diversity among the varieties may be the cause of the variation between them. Demisew (2018) reported significant differences among the varieties of durum wheat in the number of kernels per spike. Other researchers have reported significant differences in genotypes for grain numbers per spike (Gebre *et al.,* 2017; Bayisa *et al.,* 2019).

The finding of Tagesse *et al.* (2018) suggested that the weight of a thousand kernels was significantly affected by the application of NPS fertilizer which markedly increased the thousand-grain weight of bread wheat. As a result, the highest (47.7 g) and the lowest (45.26 g) 1000-kernel weight of bread wheat were recorded resulting from the use of 150 and 100 kg ha^{-1} blended NPS, respectively. Similar to the current analysis, previous studies also discovered considerable variations between genotypes for the number of kernels or grain weights (Bayisa *et al.,* 2019; Mekonnen *et al.,* 2019; Poudel *et al., 2020*).

Aboveground biomass mostly increased with the further increments in the rate of NPSB. This above-ground biomass increment could be due to improved crop nutrition through the use of blended fertilizers. The micro and macro nutrients found in the form of NPSB are very likely to enhance the bread wheat crop's vegetative growth, promoting more tillers which, in turn, tends to increase biological yield. This outcome is consistent with the results of several studies. For instance, Tilahun et al. (2021) revealed that the usage of blended fertilizer had a substantial impact on the yields of aboveground biomass. The 200 kg and 100 kg ha^{-1} NPS applications, respectively, produced the largest (17,129 kg ha^{-1}) and lowest (16,130 kg ha^{-1}) aboveground biomass yields, respectively, Furthermore, Abebual *et al.* (2019) working with wheat plants grown in a field experiment with blended NPSK fertilizer application, found increased aboveground dry biomass yield by 322% over the control treatments.

The grain yield increased by 61.98% as fertilizer rates increased from zero to 150 kg ha^{-1}. This yield increment is due to the application of the highest rate of blended NPSB. This could be attributed to the improvements in yield-contributing character traits such as the number of effective tillers, increased root growth which increased nutrient and water uptake, favouring better overall growth as a result of the NPSB nutrients' synergistic effect which increased yield components and yield. Sulfur results in greater response to applied N, showing positive synergism between N and S. This finding confirms the results of different studies. For example, According to Tagesse et al. (2018), fertilizing with nitrogen and phosphorus greatly boosted the grain yield of bread wheat. As a consequence, in comparison to the control treatment, the highest grain yield was achieved at the highest fertilizer application. According to Tilahun *et al.* (2021), increments in blended NPS fertilizer rates from 0 to 100 kg ha^{-1} and N rates from 0 to 92 kg ha^{-1} tend to result in a consistent increase in grain yield, while the yield had declined at maximum application rates of both fertilizers. In another study, according to Jemal et al. (2015), yield-related characteristics and grain yield varied significantly among wheat varieties. Different wheat varieties may produce different amounts of grain due to variations in yield-related factors such spike length, kernels per spike, effective tiller count, and other factors. Because of this, the genetic variability in the grain production potential of the cultivars examined in this study was substantial. Other researchers have also found significant differences in grain yield between varieties (Gebreegzibher *et al.,* 2018; Bayisa *et al.,* 2019; Mekonnen e*t al.,* 2019).

In general, the straw yield showed a significant increment at the combined application of increased rates of NPSB with variety. This might be because a sufficient amount of NPSB fertilizer application enhanced the vegetative growth, the total number of tillers per unit area, and the plant height of the wheat crop, which collectively increased straw yield. Similar to this, Ghafari et al. (2017) discovered that there were substantial differences in the straw yield of bread wheat among the varieties. This outcome is consistent with the results of several investigations. For instance, Abebual et al. (2019) discovered that the control treatment drastically reduced straw yield when compared to the blended fertilizers. Likewise, according to Godebo *et al.* (2021), N fertilizer application has been reported to have a greater contribution to the production of higher straw yield.

According to Bizuwork and Yibekal (2020), the application of 115 kg ha^{-1} of nitrogen produced the highest HI (47%) and the lowest (32%) result was reported at 46 kg ha^{-1} nitrogen. Additionally, Tagesse et al. (2018) discovered a statistically significant difference between various rates of NPS blended fertilizer on the bread wheat harvest index. According to Abebual et al. (2019), blended fertilizer considerably altered the harvest index of bread wheat compared to the control treatment, which produced the highest (45%) and lowest (14%) harvest indices.

Conclusion

It is concluded from the results that blended NPSB fertilizer at the rate of 150 kg ha^{-1} with Shorima variety had a highest yield (5,952.38 kg ha^{-1}), minimum acceptable marginal rate of return, highest net benefit (122,267 ETB ha^{-1}) and relatively small total cost of production is recommended for wheat production in the study area. NPSB applied at the rate of 100 kg ha^{-1} with a similar variety can be considered as the second alternative.

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