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Research Article

Effect of Blended NPSB and Nitrogen Application rates on Growth, Yield, and Yield Components of Bread Wheat (*Triticum aestivum* L.) at Gitilo Dale Research Site of Wallaga University, Western Ethiopia

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Wheat (*Triticum aestivum* L.) is a very important cereal crop widely produced and consumed in almost all parts of Ethiopia. However, due to abiotic and biotic stresses, its productivity is low as compared to the world average. Among these, soil fertility and unbalanced application of plant nutrients are the major constraints that limit the productivity of the crop in sub-Saharan African countries especially Ethiopia. As a result, an experiment was carried out at the Gitilo Dale Research Site of Wallaga University to determine the combined impact of blended NPSB and urea fertilizers on the growth, yield, and yield-related variables of bread wheat. The experiment used a factorial-arranged in randomized full block design with two factors with four levels each: NPSB (0, 100, 150, and 200 kg·ha–1) and nitrogen (urea) (0, 31.1, 71.65, and 112.2 kg·ha^{-1}) (RCBD). With three replications, there were sixteen treatments. A test crop of the bread wheat variety liben (ETBW 5653) was grown. The phonological and growth parameters of bread wheat were significantly affected by NPSB and nitrogen applications as well as their interactions except for days to 50% emergence. The primary and interaction impacts of NPSB and nitrogen rates affected the yield and all of its constituents, except the number of kernels per spike. The application of 200 kg·ha^{-1} NPSB plus 112.2 kg·ha^{-1} nitrogen treatment resulted in the highest above-ground biomass production of bread wheat (12481.00 kg·ha^{-1}), grain yield of 5182.51 kg·ha^{-1}, and a straw yield of 7298.40 kg·ha^{-1}. Hence, to maximize the yield of bread wheat, applying 200 kg·ha^{-1} of chemically blended NPSB with 112.2 kg·ha^{-1} nitrogen is recommended rather than applying any straight and complex fertilizers having only macronutrients.

1. Introduction

One of the significant cereal crops and a member of the poaceae family is wheat, which is mostly grown in Ethiopia [1]. Three types of wheat are widely grown and consumed in practically all regions of Ethiopia: bread wheat (*Triticumaestivum*), durum wheat (*Triticum durum*), and emmer wheat (*Triticumdicoccum*) [2, 3]. Staple cereals like wheat are an important food security crop and a major source of calories and proteins in middle-income countries [4]. The wheat grain kernel has 2.2% crude fiber, 12% water, 2% fat, 12% protein, and 70% carbs [5]. Phosphorus, magnesium, manganese, zinc, selenium, iron, potassium, and copper are also added to it [6]. Along with preventing and treating various digestive issues, the dietary fibers in wheat bran help lower the chance of developing colon cancer [7]. It is mostly used to make pasta and couscous, but it is also used to make other semolina-based foods including farik, burghul, and unleavened bread. Although wheat is used to make pasta (macaroni, spaghetti, and noodles), it is also utilized in

Ethiopia to make injera, a fermented flatbread, as well as other traditional food preparations [8]. In Ethiopia, traditional meals such as "*Injera*," "*Dabo*," "*Dabo kolo*," "*Genfo*," "*Kinche*," "*Nefro*," and other food varieties and beverages are prepared with bread and wheat.

Despite the crop's significance to the nation, domestic wheat production meets only 75% of the demand, and the remaining 25% is imported commercially and through food aid [9]. Many studies have been carried out to improve wheat yield, but the national average yield reported in the 2020 year is less than the global average yield of 3.0 t·ha^{-1}, or about 2.7 t·ha^{-1} [10, 11]. Inadequate supply of improved seeds, diseases, insect pests, and weeds are examples of biotic (diseases), abiotic (poor soil fertility, moisture stress, unbalanced application of plant nutrients, suboptimal use of mineral fertilizer, recurrent drought) factors are among major constraints accounting for low yields in wheat production [12, 13]. Inappropriate cropping systems like crop yields have decreased as a result of soil deterioration, nutrient depletion, monocropping, and crop residue removal from the fields [14, 15]. Additionally, Ethiopian grain crops receive a lot of urea and di-ammonium phosphate (DAP), which only contain nitrogen and phosphorus, but that alone has not contributed to the expected yield increase due to the lack of other macro and micronutrients [16].

The addition of micronutrients like boron, sulfur, and zinc has been recommended by the current soil map-based fertilizer test [17]. Boron plays a critical role in ion absorption, translocation of sugars, fruit and seed formation, nucleic acid synthesis, and other biochemical process in plants [18, 19]. Crops express their highest yield potential when micronutrients like sulfur, boron, and zinc are applied together with nitrogen and phosphorus [16, 20–22]. According to [23], in their studies, applying micronutrients (zinc, iron, boron, and sulfur) along with nitrogen and phosphorus greatly boosted wheat production.

Except for the general advice of urea and DAP for cereal crops, notably wheat, the farmers in the majority of Ethiopia have little knowledge about the effects of different types and rates of fertilizers. Single mineral fertilizer application alone does not increase productivity despite the fact that blended micro- and micronutrients had increased the yield of teff (*Eragrostis tef* (zuccagni) Trotter) [20]. In order to determine the combined impact of chemically blended amounts of nitrogen, phosphorus, sulfur, and boron (NPSB), and urea on the growth, yield, and yield characteristics of bread wheat, this research was done.

2. Materials and Methods

2.1. A Description of the Test Site and the Materials Used. The experiment was carried out throughout the 2020-2021 growing seasons at the Wollega University Research location in Ethiopia's Gitilo Dale neighborhood. The site is 334 kilometers from Addis Ababa at 09^{0}32′299″N and 037^{0}03′911″E. The site is 334 kilometers from Addis Ababa at 09^{0}32′299″N and 037^{0}03′911″E. Sandy loam is the dominant soil type in the region. The location is located at a height of 2795 meters above sea level. The region's typical temperature is 22°C. The region experiences annual rainfall between 1650 and 1780 millimeters, with July and August being the wettest months. The main crops farmed there are pulses, vegetables, and cereals [2]. Based on its production, disease resistance, and farmers' approval, the Bako Agricultural Research Center's liben bread wheat cultivar was chosen for this study.

2.2. Analysis of Soil Samples. Before planting, the soil at the experimental site was examined. Prior to planting from the experimental site, composite surface soil samples (0–30 cm depth) were obtained from sixteen plots in a zigzag pattern using an auger across the experimental units and bulked into one sample. The bulked dirt was then used to extract a sample that weighed 1.0 kg, which was then air dried and pulverized in a pestle and mortar. Prior to analysis, the sample was screened using a 2-mm sieve for a number of chemical and physical soil parameters, including soil texture, pH, cation exchangeable capacity (CEC), organic carbon, total nitrogen, accessible phosphorus, and Sulfur. The Nekemte Soil Research Center conducted soil testing. In the supernatant suspension of 1 : 2.5 soils, soil pH was determined.

2.3. Land Preparation, Field Layout, and Plant Establishment. Oxen were used to prepare the experimental field before the ground was physically leveled and broken up into clods. Finally, spades were used to prepare the unit plots for sowing. As a test crop, the Liben bread wheat variety was sown in July 2020 using manual drilling at the indicated rate of 125 kg·ha^{-1} (about 1750 seeds per plot). While nitrogen in the form of urea was applied in two portions: one-third at sowing and the other at 30 days after sowing. The complete blended NPSB fertilizers were applied according to the treatments at sowing. Hand weeding was used to get rid of all grass and wide-leaf weeds. Additionally, late-emerging weeds were pulled to prevent them from competing with the agricultural plants for moisture and nutrients. There were 48 (16 × 3) plots in all, each measuring 3 m by 3 m (6 m^2) in size. The plot and block were separated by 0.5 and 1.0 meters, respectively. Each plot had 10 rows that were 20 cm apart. The experimental's total land size was 8 m × 55.5 m, divided into three blocks, each of which had sixteen plots (444 m^2). Each plot's eight central rows, each measuring 2.8 meters long, had a net central unit area that was harvested and used to calculate yield. As border plants, the two outermost rows were preserved.

2.4. Treatments and Experimental Design. Four levels of blended NPSB (0, 100, 150, and 200 kg·ha^{-1}) and four amounts of nitrogen make up the treatment (0, 31.1, 71.65, and 112.2 kg·ha^{-1}) or NPSB (0.06, 0.09 and 0.12 kg per plot) and nitrogen (0.02, 0.04, and 0.07 kg per plot) were used (Table 1). Each fertilizer treatment assigned for a plot was equally divided into ten (number of rows per plot) and it was applied using the band placement (application of fertilizers into the soil close to the seed) fertilizer application method.

Table 1: Description of treatment combinations.

Treatment combinations	NPSB (chemically blended nitrogen, phosphorus, sulfur, and boron) levels (kg·ha^{-1})	Nitrogen levels (kg·ha^{-1})
$NPSB_1N_1$	0	0
$NPSB_1N_2$	0	31.1
$NPSB_1N_3$	0	71.65
$NPSB_1N_4$	0	112.2
$NPSB_2N_1$	100	0
$NPSB_2N_2$	100	31.1
$NPSB_2N_3$	100	71.65
$NPSB_2N_4$	100	112.2
$NPSB_3N_1$	150	0
$NPSB_3N_2$	150	31.1
$NPSB_3N_3$	150	71.1
$NPSB_3N_4$	150	112.2
$NPSB_4N_1$	200	0
$NPSB_4N_2$	200	31.1
$NPSB_4N_3$	200	71.1
$NPSB_4N_4$	200	112.2

The components of fertilizer are urea (46 percent nitrogen) and NPSB (18.9 percent nitrogen, 16.4 percent phosphorus, 6.95 percent sulfur, and 0.1 percent boron) per 100 kg of NPSB. NPSB 150 kg·ha^{-1} was used as a recommended fertilizer for wheat production in some areas of the region and it was used as a benchmark for NPSB levels arrangement. A factorial arranged in randomized completely block design was used for the experiment. In order to prevent leaching, NPSB rates were administered at sowing, while nitrogen rates were divided to apply 1/3 at sowing and the remaining 2/3 at 30 days following sowing [24].

2.5. Data Collection

2.5.1. Bread Wheat Phenology and Growth Parameters. Days to 50% emergence were noted following 50% plant germination. After 90% of the plants had reached physiological maturity, the number of days till that point was calculated through eye inspection. Senescence, or the lightening of the leaves and other vegetative parts, serves as an indicator. At physiological maturity, the height of ten bread wheat plants that were randomly chosen from each plot was measured using a meter. From all head-bearing tillers grown in each plot's 1 m^2 of space, productive tillers were counted.

2.5.2. Yield and Yield Components of Bread Wheat. The distance between the spike's bottom and tip, in centimeters, was measured. From 10 major tillers selected at random from the net plot area of each plot, the number of kernels per spike was calculated. Using a delicate balance, one thousand bread wheat kernels from the net plot were weighed (in grams). The entire above-ground plant parts, including leaves, stems, and seeds, were gathered at maturity from the net plot area in each plot and sun-dried until a constant was achieved through the use of eye inspection. Using a precise balance, the above-ground biomass was measured and quantified in kg per hectare. The grain yield was adjusted to 12.5% as AGY (kg ha^{-1}) at 12.5% = grain yield obtained (kg ha^{-1}) × (100 – MC%)/(100 – 12.5), where, AGY = adjusted grain yield whereas MC = actual grain moisture content, and straw yield (kg) = above-ground biomass (kg) – grain yield (kg).

The Harvest Index (HI), which is shown in the equation below, was computed by dividing the total harvested biomass yield by the total harvested grain yield for each plot by 100.

HI = (Grain yield/Above ground biomass yield) × 100 , where grain yield was estimated at 12.5% moisture content and above-ground biomass yield = (straw + grain).

2.6. Partial Budget Analysis. Utilizing the technique outlined by [25], the economic analysis of the treatments was conducted using the market prices that were in effect at the time of planting and harvest. All expenses and gains were computed in Ethiopian Birr per hectare (ha). For the partial budget analysis, the mean grain yield for each treatment, the gross benefit (GB) ha^{-1} (mean grain yield for each treatment), and the fertilizer field prices (costs of blended NPSB and nitrogen and their application costs) were employed.

2.6.1. Gross Average Grain Yield. The average yield for each treatment was the gross average grain yield (kg·ha^{-1}). In order to account for the differences between experimental yields, which are frequently larger than the yields farmers may anticipate using the same treatments, adjusted yield (kg·ha^{-1}) was the average yield lowered downward by 10%. In order to account for this, farmers' yields are reduced by 10% in economic calculations [25].

2.6.2. Gross Field Benefit (GFB). By increasing the field/farm gate price that farmers receive for the bread wheat when they sell the grains, the gross field benefit was calculated.

2.63. Total Variable Cost (TVC). The cost of fertilizers plus the cost of applying fertilizers made up the total variable cost. As they were consistent for all treatments, other inputs and production methods like labor, land preparation, sowing, weeding, and harvesting were not taken into account in the calculations.

2.6.4. Net Income (NI) or Net Benefit (NB). The amount of money left over after deducting all variable input costs (TVC) from total revenue (TR). NB = TR – TVC.

2.6.5. Marginal Rate of Return (MRR %). Calculated by subtracting the change in net gain from the change in all variable costs.

$$\text{MRR} = \frac{\text{Change of net benefit}}{\text{Change of total variable cost}} \times 100. \quad (1)$$

2.7. Data Analysis. For data analysis, SAS software 9.3 was chosen and applied. Following the steps in [26], the least significant difference test with a $P = 0.05$ probability level was employed to compare the treatment means.

3. Results and Discussion

3.1. Physico-Chemical Characteristics of Soils. The amount of sand, silt, and clay in the soil reveals the soil's potential to store water, hold nutrients, and weather. Sandal loam was the classification given to the surface soil sample that was taken from a depth of 0.30 cm (Table 2). [27] lists five categories for soil organic matter: extremely low (0.86%), low (0.86 to 2.59), medium (2.59 to 5.17), high (>5.17), and very high (not provided) (Table 2). The experimental site's organic matter was characterized as a high range (Table 2). Although the total nitrogen in the experimental soil samples was found to be 0.54%, the ideal nitrogen level for crop productivity in the majority of Ethiopian soils is 0.2% [28] (Table 2). The research area's available sulfur value was 11.53 ppm, which is in the low range [16] (Table 2). Low levels of accessible phosphorus (6.5 ppm) were found in the soil of the study area (Table 2). According to [16], the ideal phosphorus value for the majority of Ethiopian soil is $15\,\text{mg·kg}^{-1}$. This indicates that there is little accessible phosphorus in the research region and that more application is necessary (Table 2). Phosphorus fixing and mining are caused by the soil's [29] reportedly low phosphorus content in farms that have been continuously cultivated. Gitilo Dale soil had a cation exchange capacity of $33.39\,\text{cmol·kg}^{-1}$ (Table 2) [30]. The CEC of soils were divided into five categories: >40 = very high, 25 = high, 15 = medium, 5 = low, and 5 = very low cmol·kg^{-1}. The CEC that was determined from the soil analysis was classified as high (Table 2).

3.2. Phenological and Growth Parameters. In comparison to the unfertilized treatment (control), the administration of NPSB, nitrogen treatments, and their combinations considerably affected the phonological and growth characteristics of bread wheat (Table 3). The bread wheat crop treated with NPSB_4N_4 ($200\,\text{kg·NPSB·ha}^{-1} + 112.2\,\text{kg·N·ha}^{-1}$) was late to

Table 2: Before planting, the soil's physicochemical characteristics at the Gitilo Dale location in the Horro district.

Characters	Value	Rating
Particle size distribution		
Sand (%)	55	
Silt (%)	30	
Clay (%)	15	
Texture class	Sandy loam	
Chemical properties		
pH	4.89	Highly acidic
Organic carbon (%)	6.35	Very high
Organic matter (%)	10.95	High
Total nitrogen (%)	0.54	Very high
Available sulfur (S) (ppm)	11.53	Low
Available phosphorus (P) (ppm)	6.3	Low
CEC meq/100 g	33.39	High

50% heading and days to 90% physiological maturity (173 days), whereas the unfertilized plot produced early 50% heading and 90% physiological maturity (158 days) (Table 3). As a result, when NPSB_4N_4 ($200\,\text{kg·NPSB·ha}^{-1} + 112.2\,\text{kg·N·ha}^{-1}$) was applied, the number of days to heading was delayed by 8.5% days while the number of days to physiological maturity was delayed by 14.67% days when both were compared to controls (Table 3). According to [31], raising nitrogen fertilizer from zero to $92\,\text{kg·N·ha}^{-1}$ and then from zero to $115\,\text{kg·N·ha}^{-1}$ further extended the days before heading by 4.9% and 5.5%, respectively. This may be the result of nitrogen's promotion of stronger vegetative development for a longer period of time before the beginning of the reproductive phase, which may have delayed heading. The vegetative growth is improved and the days to heading are postponed when the fertilizer rate increases [32]. Both at the control treatment and low nitrogen application rates, bread wheat started heading and matured earlier (Table 3). This may be due to nitrogen's physiological effect, which causes crops to develop more vegetatively and prolong the days until heading and maturity. The synthesis of key macromolecules, mostly in crops, such as proteins and enzymes, which are important for maintaining and producing vegetative tissues in order to contribute to the delay in heading and maturity of plants, can benefit from the addition of nitrogen [31, 32]. Furthermore, [20] revealed that the physiological development of teff is delayed as nitrogen levels are increased. These findings contradict a report by [31] that claimed the application of S, B, and Zn in a blended form did not significantly impact the number of days before wheat reached physiological maturity.

In comparison to the control, bread wheat's height and productive tillers dramatically increased with the combined application of NPSB and nitrogen rates (Table 3). Plant height and productive tillers of bread wheat are important yield parameters as green leaves and long plants aid photosynthetic activity and subsequently lead to more grain yield. The highest plant height and productive tillers of bread wheat were recorded by NPSB_4N_4 ($200\,\text{kg·NPSB·ha}^{-1} + 112.2\,\text{kg·N·ha}^{-1}$) while the unfertilized plot recorded the lowest plant height and productive tillers (Table 3). From these findings, as NPSB and nitrogen rates increased, the plant height and productive tillers also

Table 3: Wheat phenology and growth characteristics are influenced by the relationship between NPSB and nitrogen levels.

NPSB ($kg{\cdot}ha^{-1}$)	N ($kg{\cdot}ha^{-1}$)	Days to emergence (day)	Days to heading (day)	Days to physiological maturity (day)	Plant height (cm)	Productive tillers (m^{-2})
0	0	6	63^{j}	158^{h}	76.09^{l}	120.67^{g}
0	31.1	6	64^{i}	161^{g}	78.15^{k}	125.33^{fg}
0	71.65	6	65^{hi}	162^{fg}	80.17^{ij}	125.00^{fg}
0	112.2	6	65^{gh}	163^{f}	82.05^{gh}	131.00^{fg}
100	0	6	65^{hi}	163^{ef}	79.31^{jk}	126.00^{fg}
100	31.1	6	66^{fg}	163^{ef}	83.06^{fg}	133.00^{f}
100	71.65	6	67^{e}	166^{bcd}	85.63^{e}	153.33^{e}
100	112.2	6	69^{cd}	167^{bc}	88.06^{d}	155.00^{e}
150	0	6	65^{h}	163^{fg}	81.25^{hi}	133.66^{f}
150	31.1	6	66^{f}	165^{de}	83.83^{f}	148.67^{e}
150	71.65	6	68^{df}	166^{bcd}	86.79^{de}	166.00^{d}
150	112.2	6	69^{b}	167^{b}	89.48^{c}	192.33^{c}
200	0	6	66^{f}	163^{ef}	84.17^{f}	169.67^{d}
200	31.1	6	67^{de}	165^{cd}	86.15^{e}	194.33^{c}
200	71.65	6	69^{bc}	167^{b}	91.62^{b}	235.33^{b}
200	112.2	6	71^{a}	173^{a}	93.31^{a}	312.00^{a}
LSD (0.05)		NS	0.805	1.82	1.33	10.73
CV (%)			0.73	0.66	0.94	3.93

In the table above, the same letters that are superscripted are statistically equivalent at the 5% level of significance. NS stands for nonsignificant and CV for the coefficient of variation. LSD = least significant difference. NPSB = blend of nitrogen, phosphorus, sulphur, and boron.

increased. The increase in plant height, as well as the number of productive tillers in bread wheat, may be attributed to the application of adequate and stable nutrients of chemically blended NPSB which enhanced cell elongation and subsequently leads to more vegetative growth. These results agree with the findings by [20], who reported that increasing the rates of chemically blended NPK with Zn and B increased plant height and productive tillers in teff crops [33]. Similar results were reported by [34] in the bread wheat [35]. They also obtained significant wheat height with the application of boron. According to [36], increased nitrogen levels stimulate tillers by having a beneficial impact on the synthesis of cytokines, which promote cell division and shoot growth. Additionally, phosphorus promotes the development of fibrous rootlets and side roots [37] while sulfur facilitates the nutrient uptake that leads to an increase in crop growth and yield [38].

Table 4: Effects of NPSB and nitrogen fertilizer amounts on the bread wheat spike duration.

NPSB (kg ha^{-1})	Spike length (cm) N ($kg{\cdot}ha^{-1}$)			
	0	31.1	71.65	112.2
0	5.49^{g}	5.87^{f}	6.15^{e}	6.36^{d}
100	6.30^{de}	6.30^{de}	6.42^{d}	6.66^{c}
150	6.31d^{e}	6.46^{d}	6.70^{c}	7.15^{b}
200	6.36^{d}	6.66^{c}	7.05^{b}	7.63^{a}
Lsd (5%)		0.194		
CV (%)		1.80		

The same letters that are superscripted are statistically equivalent at the 5% level of significance. Least significant difference (LSD) and CV = the coefficient of variance. NPSB = blend of nitrogen, phosphorus, sulphur, and boron.

3.3. Yield and Yield Components. The yield and yield-related elements of bread wheat as influenced by the application of chemically blended NPSB and nitrogen are presented in Tables 4–7. The treatment $NPSB_4N_4$ of bread wheat produced the largest and most significant spike length (7.63 cm), thousand kernel weight (44.96 g), above-ground biomass production (12481 $kg{\cdot}ha^{-1}$), straw yield (7298.4 $kg{\cdot}ha^{-1}$), and grain yield (5182.5 $kg{\cdot}ha^{-1}$) measurements (Tables 4–7). The unfertilized plot (control) produced bread wheat with the smallest spike length (5.49 cm), thousand kernel weight (34.09 g), above-ground biomass (12481 $kg{\cdot}ha^{-1}$), straw yield (7298.40 $kg{\cdot}ha^{-1}$), and grain yield (5182.5 $kg{\cdot}ha^{-1}$) (Tables 4–7). The $NPSB_4N_1$ treatment (200 $kg{\cdot}NPSB{\cdot}ha^{-1}$) produced the highest kernel number per spike (44.27), whereas the control treatment had the lowest kernel number per spike (34.51). $NPSB_3N_2$ recorded the lowest harvest index (39.49%) but was not significantly different from treatments $NPSB_1N_1$, $NPSB_1N_3$, $NPSB_2N_4$, $NPSB_3N_4$, $NPSB_4N_1$, $NPSB_4N_2$, $NPSB_4N_3$, and $NPSB_4N_4$ treatment combinations. Similarly, a significant improvement in harvest index (47.69%) was observed when bread wheat was treated with 150 $kg{\cdot}NPSB{\cdot}ha^{-1}$ + 31.1 $kg{\cdot}N{\cdot}ha^{-1}$ (Table 7).

In this study, the bread wheat crop had a positive relationship between NPSB and nitrogen in terms of yield and yield components. As the level of NPSB and nitrogen increased, the yield and yield components also increased. Applying $NPSB_4N_4$ (200 $kg{\cdot}NPSB{\cdot}ha^{-1}$ + 112.2 $kg{\cdot}N{\cdot}ha^{-1}$) enhanced bread wheat thousand-grain weight, spike length, above-ground biomass, the yield of straw, and grain yield by 18.72%, 20.92%, 33.24%, 33.26% and 33.23% correspondingly than check treatment (NPSB 150 $kg{\cdot}ha^{-1}$). These increments of yield and yield components are a result of the application of a higher rate of both chemically blended NPSB and nitrogen that makes nutrients sufficient and easily available to the bread wheat. A similar finding was reported by [20] in their study on teff that applying 200 $kg{\cdot}ha^{-1}$ of blended NPKSZnB (14N 21P2O5 15K2O 6.5S 1.3Zn 0.5 B)

TABLE 5: The main determinants of the number of kernels per spike of bread wheat are NPSB and nitrogen fertilizer levels.

Treatment	Number of kernels per spike
NPSB·kg·ha^{-1}	
0	34.51^{c}
100	38.44^{b}
150	39.90^{b}
200	44.27^{a}
Lsd (5%)	1.87
CV (%)	5.70
N·kg·ha^{-1}	
0	35.70^{d}
31.1	37.90^{c}
71.65	40.56^{b}
112.2	42.94^{a}
Lsd (5%)	1.87
CV (%)	5.70

In the table above, the same letters that are superscripted are statistically equivalent at the 5% level of significance. Least significant difference (LSD) and CV = the coefficient of variance. NPSB = blend of nitrogen, phosphorus, sulphur, and boron.

TABLE 6: Interaction effects of NPSB and Nitrogen fertilizer levels on thousand kernel weight (g) of bread wheat.

NPSB (kg ha^{-1})	Thousand kernel weight (g) N (kg ha^{-1})			
	0	31.1	71.65	112.2
0	34.09^{k}	35.11^{jk}	35.22^{jk}	35.38^{ij}
100	34.79^{jk}	36.53^{hi}	36.77^{gh}	37.55^{fgh}
150	37.87^{efg}	37.52^{fgh}	38.48^{ef}	39.03^{de}
200	40.12^{d}	41.47^{c}	43.35^{b}	44.96^{a}
Lsd (5%)		1.89		
CV (%)		2.99		

The same letters that are superscripted are statistically equivalent at the 5% level of significance. Least significant difference (LSD) and CV = the coefficient of variance. NPSB = blend of nitrogen, phosphorus, sulphur, and boron.

TABLE 7: Interaction effects of NPSB and nitrogen fertilizer rates on above-ground biomass yield, grain yield, straw yield, and harvest index.

Treatments NPSB (kg ha^{-1})	N (kg ha^{-1})	Aboveground biomass yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Harvest index (%)
0	0	5690^{l}	3309.5^{h}	2381.0^{k}	41.77^{cd}
0	31.1	7077^{k}	3890.9^{g}	3185.9^{j}	44.97^{b}
0	71.65	8190^{j}	4805.7^{e}	3384.3^{ij}	41.32^{cd}
0	112.2	8367^{hi}	4746.7^{e}	3620.6^{ghi}	43.27^{bc}
100	0	8263^{ij}	4715.8^{e}	3547.3^{hi}	42.93^{bc}
100	31.1	8484^{h}	4437.4^{f}	4046.2^{ef}	47.69^{a}
100	71.65	9771^{f}	5684.7^{d}	4086.2^{def}	42.17^{cd}
100	112.2	10297^{e}	6169.8^{c}	4127.3^{def}	40.08^{d}
150	0	9367^{g}	5476.8^{d}	3890.2^{fg}	41.53^{cd}
150	31.1	10523^{d}	6367.5^{c}	4155.6^{def}	39.49^{d}
150	71.65	10617^{d}	6264.9^{c}	4352.4^{cde}	40.99^{cd}
150	112.2	10839^{c}	6340.9^{c}	4498.4^{c}	41.49^{cd}
200	0	9398^{g}	5554.8^{d}	3842.9^{fgh}	40.89^{cd}
200	31.1	10524^{d}	6151.4^{c}	4373.0^{cd}	41.55^{cd}
200	71.65	11829^{b}	7003.8^{b}	4825.4^{b}	40.78^{cd}
200	112.2	12481^{a}	7298.4^{a}	5182.5^{a}	41.50^{cd}
Lsd (5%)		159.20	245.77	320.96	3.96
CV (%)		1.01	2.67	4.85	4.85

The same letters that are superscripted are statistically equivalent at the 5% level of significance. Least significant difference (LSD) and CV = the coefficient of variance. NPSB = blend of nitrogen, phosphorus, sulphur, and boron.

Table 8: Economic analysis of the effects of NPSB and nitrogen application on bread wheat.

NPSB (kg·ha^{-1})	N (kg·ha^{-1})	UGY (kg·ha^{-1})	AGY (kg·ha^{-1})	GFB (ETB·ha^{-1})	TVC (ETBha^{-1})	NB (ETB·ha^{-1})	MRR (%)
0	0	2381.0	2142.9	45000.9	0	45000.90	—
0	31.10	3185.9	2867.31	60213.51	497.60	59738.11	399.96
0	71.65	3384.3	3045.87	63963.27	1146.40	62880.41	517.08
0	112.20	3620.6	3258.54	68429.34	1795.20	66738.54	634.87
100	0	3547.3	3192.57	67043.97	1737.98	65425.99	1802.46
100	31.10	4046.2	3641.58	76473.18	2235.58	74379.38	188.33
100	71.65	4086.2	3677.58	77229.18	2884.38	74528.10	D
100	112.20	4127.3	3714.57	78005.97	3533.18	74697.19	D
150	0	3890.2	3501.18	73524.78	2606.97	71097.81	408.18
150	31.10	4155.6	3740.04	78540.84	3104.57	75638.47	955.15
150	71.65	4352.4	3917.16	82260.36	3753.37	78750.29	512.06
150	112.20	4498.4	4048.40	85016.40	4402.17	80898.70	353.53
200	0	3842.9	3458.61	72630.81	3475.96	69394.96	1304.56
200	31.10	4373.0	3935.70	82649.70	3973.56	78938.34	2007.44
200	71.65	4825.4	4342.86	91200.06	4622.36	86881.00	1307.00
200	112.20	5182.5	4664.25	97949.25	5271.16	93022.49	1010.61

Where, NPSB = blended fertilizer of nitrogen, phosphorus, sulfur and boron; N = nitrogen; UGY = unadjusted grain yield; AGY = adjusted grain yield; GFB = gross field benefit; NPSB = NPSB Cost/NPSB application cost; NC/NAC = nitrogen cost/nitrogen application cost, TVC = total variable costs; NB = net benefit, MRR = marginal rate of return; ETB = ethiopian Birr; D = dominated treatment.

significantly improved grain yield. Micronutrients such as boron when applied at adequate levels improve metabolic activities and increase dry matter of bread wheat leading to an increase in grain yield [39]. The results are also in support of [31, 40], who had earlier reported the highest rate of NPSB and nitrogen application improved root growth and enhanced nutrient uptake for better growth and yield of durum wheat and malt barley, respectively. Blended fertilizer supply, according to [41], had a noticeable impact on above-ground biomass, grain yield, and straw output. In their study of bread wheat in Ethiopia, [42] found that adding nutrients such as K, S, Zn, Mg, and B greatly raised thousand kernel weight, spike length, above-ground biomass, and grain yield.

3.4. Economic Feasibility Analysis. The outcomes showed that blended NPSB and nitrogen fertilizer applied together produced superior results than the control. The partial budget analysis reveals that the application of 200 kg·ha^{-1} NPSB fertilizer with 112.2 kg·ha^{-1} nitrogen resulted in the highest net benefit of (93022.49 ETB·ha^{-1}) and an acceptable marginal rate of returns (1010.61%). This was followed by the use of 200 kg·ha^{-1} NPSB fertilizer with 71.1 kg·ha^{-1} Nitrogen (86881.00 ETB·ha^{-1}) with a respectable marginal rate of return (MRR) (1307.00%), but the control (without NPSB and N) produced the lowest net benefit (45000.90 ETB·ha^{-1}) (Table 8). In comparison to a check treatment (150 kg·ha^{-1}) and control, the application of 200 kg·ha^{-1} of NPSB fertilizer with 112.2 kg·ha^{-1} nitrogen provided 30.84% and 106.7% net benefits, respectively. Based on this finding, farmers in the study area chose to apply 200 kg·ha^{-1} NPSB along with 112.2 kg·ha^{-1} nitrogen fertilizer rates because it produced the highest adjustable grain yield (4664.25 kg·ha^{-1}) and was more cost-effective.

4. Conclusion

The study demonstrated the significance of applying 200 kg·ha^{-1} of NPSB and 112.2 kg·ha^{-1} of nitrogen fertilizers together in improving bread wheat's phenology, growth, yield, and yield components over other treatments, with the exception of the number of kernels per spike, days to 50% emergence, and harvest index. The days to 50% emergence were not significantly impacted by the blended NPSB and nitrogen interaction. The largest number of kernels per spike was seen when 200 kg of NPSB and 112.2 kg of N were applied every year. The combined application of 100 kg NPSB·ha^{-1} + 31.1 kg·N·ha^{-1} and 150 kg·NPSB·ha^{-1} + 31.1 kg·N·ha^{-1}, respectively, produced the highest harvest index and the lowest harvest index. The economic study showed that the combined application of 200 kg·NPSB·ha^{-1} and 112.2 kg·N·ha^{-1} produced the maximum net benefit/return (93022.49 ETB·ha^{-1}) and a marginal rate of return of (1010.61%), whereas the control treatment produced the lowest net benefit (45000.90 ETB·ha^{-1}). It is advised to use 200 kg·ha^{-1} NPSB and 112.2 kg·ha^{-1}·N (Urea) fertilizers together to boost bread wheat output and farmer income.

Data Availability

The raw data collected and used to support the findings of this study are available upon reasonable request from the corresponding author.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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