Science Discovery Plants
2026, Vol. 1, No. 2, pp. 100–110
https://doi.org/10.11648/j.sdplants.20260102.14

Research Article

Effect of NPS and Urea Fertilizer Combined Application on Bread Wheat Yield at Bule Hora, Southern Ethiopia

Deme Megersa[1, 2, 3, *]

[1]Department of Horticulture and Plant Science, Jimma University, Jimma, Ethiopia
[2]Oromia Agriculture Research Institute, Addis Ababa, Ethiopia
[3]Yabelo Pastoral and Land Agricultural Research Center, Yabelo, Ethiopia

Abstract

Bread wheat is one of the key food crops in the study area and grown for home consumption, market and strategic crop to address food security in Ethiopia. However, the productivity and yield is mostly constrained by soil fertility and lack of better fertilizer rate in the study area. The study was conducted at Bule Hora District, southern Ethiopia during the main cropping season of 2023. The study was aimed to identify the optimum fertilizer for higher grain yield with the higher economic return. The treatments were: (0 NPS) negative control, 60Kg NPS, 120kg NPS, and 180 kg NPS) and (0N) negative control, 140kgN, 280kg N) and positive control (100/100kg ha^{-1} NPS/ N). The treatments were arranged in a randomized complete block design and replicated three times. Soil samples for the experimental site were taken before sowing and post harvesting for soil physicochemical analysis. Data of Yield was collected and analyzed using GLM procedure of SAS (Version 9.3) and means differences were tested for the significance with least significant difference (LSD) method at 0.05 probability level. The results of analysis of variance for yield indicated that the effect of fertilizer application rates were significant for the maximum above-ground biomass (AGB) (13.33 ton), straw yields (10.077 ton) were obtained from 60kg NPS ha^{-1} + 140kg N ha^{-1} fertilizer rate and grain yield obtained due to the application of 120/140 kg ha-1 NPS/Urea(N). The results of economic analysis indicated that the maximum net benefit of 213489.73 ETB ha^{-1} and marginal rate of return (MRR) of 121479.6% were obtained due to the application of 120/140 kg ha^{-1} NPS/Urea(N). Therefore, 120/140 kg ha^{-1} NPS/ urea(N) can be used by the farming community in the study area. However, the study is better conducted for more year in multiple locations to give conclusive recommendations.

Keywords

Bread Wheat, Bule Hora, Fertilizer Rate, Grain Yield

1. Introduction

Wheat is one of around 300,000 potentially edible plant species, with only little more than 100 being routinely grown. Rice, wheat, and maize account for almost 60% of all human calories, with wheat accounting for approximately 20% of all calories and protein [25]. Wheat is one of the world's most essential crops, feeding more than one-third of the population [12]. Furthermore, wheat is one of the world's most significant agricultural products, a staple food crop, and a key source of

---

[*]Correspondence: Deme Megersa (dememegersa2009@gmail.com)

Received: 2 March 2026; **Accepted:** 15 May 2026; **Published:** 27 May 2026

Copyright: © The Author(s), 2026. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

protein in developing countries [24]. In 2020, low-rainfall areas account for 30% of total worldwide production. The global average for bread wheat production and productivity (3.4 t ha^{-1}) reflects a 37% increase in yield [9]. The highlands of eastern Africa, which include Ethiopia, Eritrea, Kenya, Uganda, Rwanda, Burundi, and Tanzania, are key wheat-growing regions with summertime rain-fed production methods. Wheat harvests were produced in Egypt, South Africa, and Kenya, with yields of 67, 35, and 30 quintals per hectare, respectively, as opposed to Ethiopia's 28 qt/ha. Wheat is one of the world's most significant agricultural products. It now takes up more acreage than any other commercial crop and accounts for 19% of total calories consumed. Wheat is the world's most significant grain crop, accounting for more than 20% of all food consumed globally. It is a reliable source of food for approximately one-third of the world's population and ranks high in cereal output [15]. Similarly, it is one of the most important cereal crops farmed around the world, including Ethiopia, in a variety of agro ecosystems.

Wheat is a major grain crop used for both human and animal feed [1], and it is processed into a wide range of traditional and contemporary foods, such as injera and other industrially processed goods [33]. Ethiopia produces 5.5 Mt of wheat, accounting for 21.7% of total wheat production and 18.3% of harvested wheat area in Africa [36]. People use grain in various ways, both in rural and urban areas. Ethiopia is Africa's second-largest wheat producer, after Egypt. In addition, producers sell wheat grain to earn revenue and cover other expenses. Wheat straw, on the other hand, decomposes to be utilized as mulch, animal bedding, thatching for house roofs, and compost [8]. Wheat is also the primary grain crop in Ethiopia's highlands, which stretch from 1500 to 2800 meters above sea level and between 6° and 16°N and 35° and 42°E. Wheat, one of Ethiopia's most essential crops for food security, is predicted to produce a record yield of 2.85 tons per hectare. It is grown on 2.1 million hectares of land each year, yielding 6.7 million tons total [39]. Ethiopia is Sub-Saharan Africa's second-largest wheat-growing region, with almost 500,000 hectares. Ethiopia has two major wheat species: durum wheat (Triticum turgidum L.) and bread wheat (Triticum aestivum L.) [10]. Ethiopia ranks 25th in terms of productivity and area covered among the world's 125 wheat-producing countries. Ethiopia produces far less wheat than the Netherlands (90.936 qt/ha), New Zealand (98.633 qt/ha), and Ireland (101.746 qt/ha). Ethiopia's economy is dependent on agriculture, specifically subsistence and rain-fed farming [12].

In a similar line, one of the most significant crops in the world and the most often farmed kind of wheat is bread wheat (Triticum aestivum) [20]. Bread wheat constitutes over 80% of Ethiopia's wheat area and serves as a staple, supplying more than 15% of the caloric intake for its 90 million people, ranked after maize and ahead of teff, sorghum, and inset, which contribute 10-12% of total calories [6]. It is farmed at elevations ranging from 67° north to 45° south, although it is less common in tropical regions [26]. Furthermore, bread wheat accounts for more than 80% of the country's total wheat area and is a staple food for many Ethiopians, providing over 15% of the caloric intake for the country's approximately 90 million people, trailing only maize and slightly ahead of teff, sorghum, and Inset, which together account for 10-12% of total calories [7]. Bread wheat (*Triticum aestivum*) is one of numerous cereal crops grown in Ethiopia's highlands. It is mostly grown in the southeast, central, and northwest of the country, accounting for more than 85% of Arsi, Bale, and East Shewa's production. Bread wheat, or Triticum aestivum L., is a major food crop in the study area. It is planted for both home and market consumption, and it is a significant crop for addressing Ethiopia's food security. It is also a prominent crop in the West Guji Highlands, where it grows in a variety of agro-ecologies and contributes to both food security and revenue generation [11]. Maize, haricot bean, common bean, wheat, and barley are the main crops grown in the West Guji highlands and midlands. Bread wheat (*Triticum aestivum L.*) is an important crop for farmers since it provides food, cash, animal feed, and compost as it decomposes. Nonetheless, this region produces very little bread wheat. The research area's current bread wheat yield is 32.23 qt/ha [11], with an average output and productivity of 2.5 t/ha [9]. This is insufficient for the Guji region's highlands. Several factors contribute to this, including most yield-limiting agronomic practices, farmers' insufficient fertilizer use, crop management, diseases, a scarcity of disease-resistant and adaptable varieties, low soil fertility, the absence of organic manure, a lack of knowledge about fertilizer application rates, improper land preparation, planting time, and plant density. Soil fertility is one of the challenges associated with agricultural output. Soil fertility is the most complex soil attribute that closely resembles plant feeding management. To maximize crop nutrition both temporarily and permanently, as well as to achieve sustained crop output, soil fertility, which is a controlled soil attribute, must be properly managed. Soil productivity refers to a soil's ability to support crop output and is determined by a number of physical, chemical, and biological factors. It is the aspect of total soil productivity concerned with the availability of nutrients in the soil and its ability to supply nutrients for crop production from both internal reserves and external inputs. It takes into account a variety of soil properties, all of which influence nutrient availability and dynamics. A good crop requires soil with a high level of natural or improved fertility. Soil may promote plant development and increase agricultural output. It is one of the primary factors influencing crop yield and quality [35]. It also has a significant impact on crop quality and output [16]. Soil fertility can be improved with both inorganic and organic fertilizers. Soil fertility challenges, such as greater concentration, intensification, and specialization of crop and livestock production without sufficient consideration of natural site-specific soil and climate conditions, resulted in significant deterioration and partially permanent soil damage. These processes included soil compaction, water, and wind erosion. Soil fertility refers to the soil's ability to sustain plant growth and enhance agricultural output. It can improve this using both organic and inorganic ingredients. Limited application of chemical fertilizers, inadequate understanding of fertilizer timing and dosage, advancements in cultivars, and the absence of additional contemporary crop management tools reduced wheat production due to weather, water, fertilizer management, and cultivars with lower soil fertility [28]. One of the most significant concerns hurting Ethiopia's agricultural yield and output is declining soil fertility. The following elements contribute to the loss of soil fertility. Soil erosion, deforestation, and continued cultivation in the same area, insufficient use of organic and inorganic fertilizers, and the reduction or abandonment of successful traditional soil restoration practices are the primary barriers to sustainable grain production in Ethiopia's highlands. Grain quality and economic yields are limited by inadequate soil fertility and a lack of site-specific fertilizer recommendations; Ethiopia's low agricultural output and food insecurity are mostly caused by soil fertility loss [12, 31]. Lower agricultural yields [27] may be the result of highly soluble nitrogen fertilizers, such as urea, being lost from the soil-plant system.

Fertilization is one of the key artificial methods for boosting soil fertility and agricultural productivity, and it can increase crop yields by at least 30 to 50% [19, 30]. Fertilizer is an important agronomic strategy and a vital agricultural component that increases productivity [38]. Fertilizer, when administered correctly, has the potential to improve crop quality and yields [43], as well as promote agricultural expansion. The desire for higher agricultural output without balanced fertilizer use resulted in soil fertility collapse. In addition to being substantially responsible for improvements in food production, inorganic fertilizers have shown to be an important tool in combating soil fertility difficulties [37]. The application of fertilizer in accordance with crop requirements is a crucial element in long-term crop output [23]. The use of various amounts of mixed NPS and urea fertilizer has a significant impact on all yield components of bread wheat [37]. Balanced and appropriate soil nutrient management is an important approach for increasing bread wheat yields, and the yield component is economically viable. Wheat yield increases with enhanced field fertilization, which includes 91% N, 63% P, and 176% N N+P2SO5. Fertilizers are frequently applied to fields in order to attain crop-appropriate soil fertility levels. It is critical to remember that constant fertilizer application is required for crops to maintain peak yields. Nitrogen and phosphorus are the most crucial components for plant growth and agricultural production; however, most tropical soils, particularly Ethiopian soils, have poor nitrogen and phosphorus availability, resulting in decreased crop yields [32]. Nitrogen (N) is the most limiting nutrient for crop output in many parts of the world, and it is a necessary component of cereal production systems. Sulfur is an essential component of plant growth, accumulating between 0.2 and 0.5% in plant tissue on a dry matter basis. It is also required in the same quantity as phosphorus [22]. Crops cannot achieve their full yield or protein content potential unless they have enough S. Many researchers discovered that frequent fertilization and other factors affect soil nutrients and crop growth, resulting in differences in crop output and soil nutrient content. Sulphur is becoming a critical limiting component for agricultural output in Ethiopian soil, as well as a building block of protein and a key factor in chlorophyll creation. West Guji zone, Bule Hora District in the Oromia region is among those where the proper fertilizers have not been widely applied up to this point, most likely because of the issues mentioned above. In particular, the absence of the proper fertilizer prevents the area's potential for bread wheat from being abused. The improved yield and production status of the bread wheat production in the area are not specifically mentioned in the available information. Consequently, it became necessary to find a more productive NPS and urea fertilizer and start using inorganic fertilizers (NPS and urea) in the study area to increase agricultural yields. The study is needed to identify the optimum fertilizer for higher grain yield with higher economic return in the study area.

2. Materials and Methods

2.1. Description of Study Area

The experiment was carried out in Bule Hora District (Hera Lipitu Kebele) during the 2023 agricultural season (Figure 1). Geographically, it is located at 50°35'0" N latitude and 38°15'0" E longitude. West Guji is a zone in Ethiopia's Oromia Region. West Guji is located in southern Oromia and is bordered to the south by Borena, to the west by the Gedeo Liyu Zone, to the north by the Sidama Region, and to the east by the East Guji Zone. Bule Hora serves as its administrative center. Bule Hora Woreda has 39 kebeles, one of which is Hera Lipitu Kebele, located north of Gerba Town. Bule Hora town is a district in the zones. The study location was identified at an elevation of 2000 m. a. s. l., with a bimodal rainfall distribution pattern, an annual mean rainfall of 586.84 mm, an annual maximum temperature of 28.08°C, and a minimum temperature of 8.22°C. It also investigates the site soil, sandy loam soil type, and soil pH 5.8. Based on the soil analysis results, these ratings are more favorable for wheat production. The main field crops planted in the research areas are maize, enset, wheat, and barley.

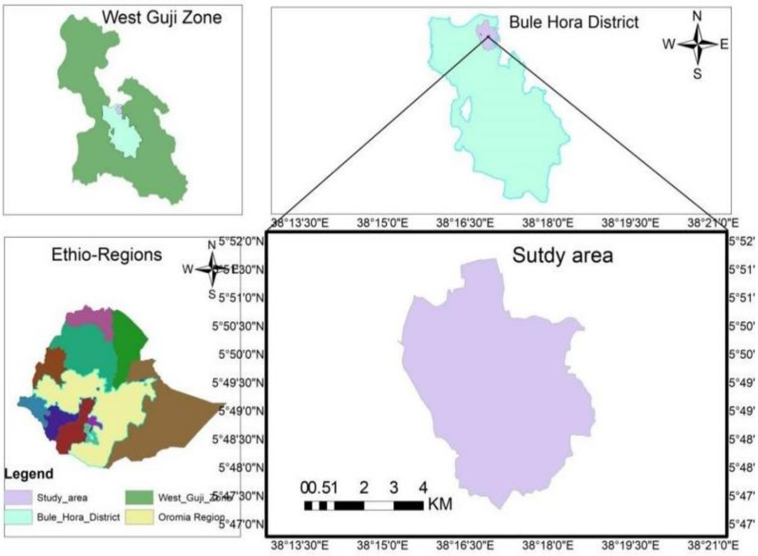


Figure 1. *Map of Study area.*

Metrological data

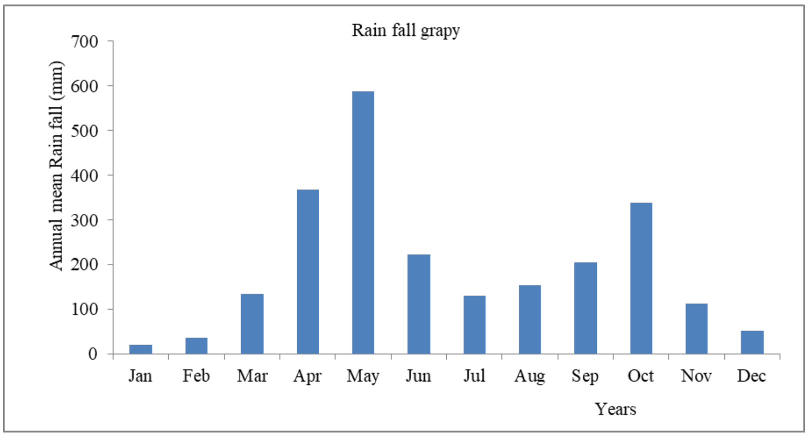
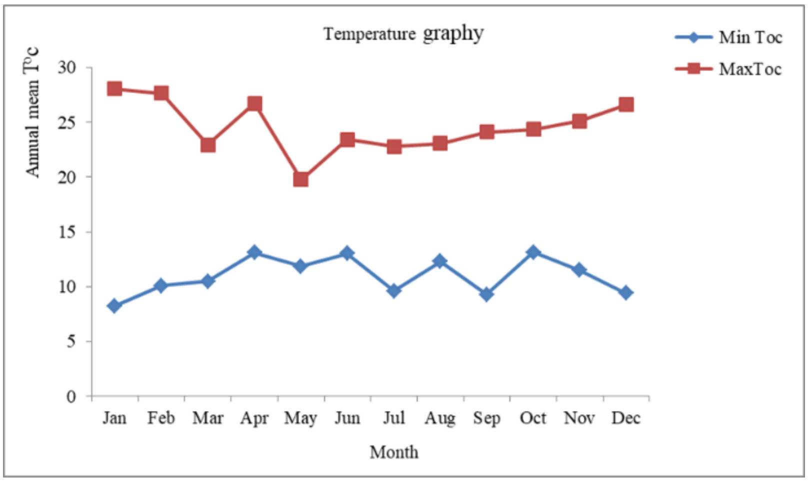


Figure 2. *The Study area rain fall pattern for the last monthly (2019-2023).*



Source: Ethiopia National Meteorology

Figure 3. *The Study area temperature for the last monthly (2019-2023).*

2.2. Experimental Materials

The study used one bread wheat type, Sanate, issued by the Sinana Agricultural Research Center in 2012. This variety was chosen based on yield, disease resistance, farmer acceptance, and adaptation to the agro ecology of the research location. Fertilizer sources used included blended NPS (18% N, 38% P_2O_5, and 7% S) and urea (N).

2.3. Experimental Design and Treatments

The experiment included thirteen fertilizer treatments as a single factor (Table 1). The treatments were developed using various rates of NPS and urea (N) fertilizers, as well as the fertilizer rate used by farmers as a local control. The experiment was set up in an RCBD with three replications. The gross plot size was 3 meters long by 1.2 meters wide, or 3.6 square meters, with three rows of six. The distance between rows, plots, and blocks was 0.20 m, 0.50 m, and 0.75 m, respectively.

Table 1. *Treatments used for the experiment.*

No Trt	**Fertilizer treatments**	**Nutrient contents**		
		N	**P_2O_5**	**S**
1	Control (negative)	0	0	0
2	140kg UREA(N)	64.4	0	0
3	280kg UREA(N)	128.8	0	0
4	60 kgNPS	10.8	22.8	4.2
5	60 kgNPS + 140kg UREA(N)	75.2	22.8	4.2
6	60 kgNPS + 280kg UREA(N)	139.6	22.8	4.2
7	120kg NPS	21.6	45.6	8.4
8	120kg NPS + 140kg UREA(N)	86	45.6	8.4
9	120kg NPS + 280kg UREA(N)	150.4	45.6	8.4
10	180kg NPS	32.4	68.4	12.6
11	180kg NPS + 140kg UREA(N)	96.8	68.4	12.6
12	180kg NPS + 280kg UREA(N)	161.2	68.4	12.6
13	100kgNPS+100kgUREA(N) control (positive)	64	38	7

2.4. Experimental Procedure

The experimental field was ploughed three times by oxen before planting, and a field layout was created, with each treatment assigned randomly to experimental plots within a block. The one selected enhanced variety of bread wheat was sown manually in rows of 20 cm spacing in the 31 March 2023 cropping season at the approved seed rate of 125 kg ha^{-1} using the drilling method. The entire amount of NPS blended fertilizers was applied at sowing time and placed near the seed, whereas urea (N) was applied half at sowing and the other half 30 days after emergence to a rapid development stage or tillering.

Soil Sampling and Analysis

Per sowing, a representative composite soil sample was collected at a depth of 0-30cm from six randomly selected soil samples across the experimental field using the zigzag method and an auger weighing 1kg. The obtained samples were then air dried at room temperature and submitted to the laboratory. For total determination, the soil was ground to pass through a 2 mm sieve, but for Organic Carbon (OC) and accessible nitrogen (N), the soil was ground to pass through a 0.025mm sieve due to its tiny size. This involves increasing surface area and solubility while decreasing soil size. Texture, soil pH, total nitrogen, organic carbon (OC), accessible phosphorus, organic matter (OM), and Cataine exchange capacity (CEC) were among the physicochemical characteristics examined in each sowing sample.

Post-harvest soil samples were taken from each treatment within the experimental plot (0 to 30 cm depth) after harvesting by zigzag methods using of auger and three soil samples (0.5 kg) was taken from each experimental unit and total 39 soil sample. Then both soil sample analyses were carried out at the soil laboratory of the Yabello Pastoral and Dry land Agriculture Research Center (YPDARC) and Jimma Agricultural research center (JARC) for sulphur analysis. After harvest, post-harvest soil samples were examined for soil pH, total nitrogen, available phosphorous (P), available sulfur (S), organic carbon (OC), organic matter (OM), and Cataine exchange capacity. The texture or particle size was measured using the hydrometry method. Organic carbon was assessed by the Walkley and Black oxidation method, while total nitrogen was analyzed by the Kjeldahl method [21]. The pH of the soil was tested using a 1: 2.5 water suspension (pH meter). Cation exchange capacity was assessed after saturating the soil with 1N ammonium acetate (NH_4OAC) and replacing it with 1N NaOAC [17]; available phosphorus was estimated using the Olsen technique [34], and available sulfur was determined using the turbid metric method.

2.5. Data Collection

All data parameters (yield and grain yield) were completed as recommended. Data on yield and grain yield were collected from the four central rows and eight randomly selected plants from each net plot area of the experimental plot, and the data were then analyzed. Aboveground dry biomass: dry biomass was measured from plant parts picked from the net plot area for each treatment after sun drying, with relative moisture of 86% dry weight, and expressed in tons per hectare. Straw yield: the difference between the total aboveground dry biomass yield and grain yield for each treatment in the experimental plot was computed and then expressed in t/ha. SBM = above ground dry biomass - Grain yield. Grain yield was calculated for each treatment by harvesting and threshing crops separately from the net plot area and then weighing them using an electronic balance. The grain yield was then represented as qt/ha after being adjusted to 12.5% moisture content.

2.6. Data Analysis

All data recorded and collected were subjected to analysis of variance (ANOVA) using SAS version 9.3 in accordance with the Generalized Linear Model (GLM), and interpretations were produced using the approach given by Gomez (1984). The least significant difference test was used to compare means across and within treatments at a significance level of 5%.

Partial Budget Analysis

The economic analysis was conducted using the methods outlined in [18], which used the current market pricing for inputs during planting and outputs at harvesting. All expenses and advantages were computed per ha in Birr. The partial budget study included the following concepts: the mean grain yield of each treatment, the gross benefit (GB) per hectare, and the field price of NPS and urea expenses, as well as application costs.

The marginal rate of return, which refers to the net income generated after incurring a unit cost of fertilizer and its application, was computed by dividing the net revenue in bread wheat yield owing to the application of each fertilizer rate. The marginal rate of return (MRR) was computed using.

$$MRR(\%) = \frac{ChangeinNB(NBb - NBa)}{(ChangeinTCVb)} x100$$

Where NBa = NB with the immediate lower TCV, NBb = NB with the next higher TCV.

TCVa = the immediate lower TCV and TCVb = the next highest TCV.

The fertilizer cost was calculated for the cost of each fertilizer of NPS and UREA during sowing time. The cost of NPS and Urea application and the average open price of bread wheat at area market is Birr per kg in during harvesting time and economic analysis such as partial budget and marginal rate of return for wheat grain yield was valued at an average open market price of ETB 5,000 per 100 kg, Labour cost for field operation was 75 ETB per man/day. The cost of NPS and Urea was ETB 3,980 and 3,850 per 100 kg with the current market price, respectively.

3. Results and Discussion

3.1. Soil Physicochemical Properties

Pre sowing soil physico chemical analysis

The laboratory study findings revealed that the soil physicochemical parameters of the experimental location are shown in Table 2. The soil textures in the experimental site were sand, silt, and clay content (72.7%, 12.7%, and 14.6%, respectively), and the soil textural class was found to be sandy loam (Table 2). The soil textures, or the proportions of sand, silt, and clay in the soil, determines the soil's weathering, aeration, nutrient, and water retention abilities. The laboratory results revealed that the soil physiochemical characteristics of the pre-sowing soil pH value were 5.8 (H_2O) and moderately acid; the soil organic carbon (OC) and organic matter contents (OM) were 1.91 and 3.29%, low ratings; and the soil total nitrogen (TN) was 0.16%, low. The accessible phosphorus (AP) in the soil was 7.8 mg/kg, with poor ratings. Cation exchange capacity (CEC) was 5.6 meq/100 g of soil with very low ratings, while accessible sulfur was 0.036 mg/kg of soil with extremely low ratings, as shown in Table 2.

Post-harvest soil physico chemical analysis

The soil physicochemical results of the post-harvest study are provided in Table 2. The pH was 6.16 (H_2O), which is mildly acidic, with 3.01 percent organic matter. According to [42], organic matter levels are 2, 2-4, 4-10, 10-20, and >20; they are very low, low, medium, high, and very high, respectively. As a result, the soil at the trial location met the criteria for a low soil rating. Organic carbon content: 1.73%. The OC content grades of <1.1, 1.1-2.2, 2.2-4.2, 4.2-6, and >6 are based on the Walkley and Black (1934) approach. As a result, the organic carbon content of the experimental site soil was within the range expected for low-rated soils. Total nitrogen (0.17) has Kjeldahl method ratings of <0.050, 0.050-0.125, 0.125-0.225, and 0.225-0.300>0.300, representing extremely low, low, medium, high, and very high. The soil at the excremental site is in the range of medium soils [21]. The available P (45.63 mg/kg) is relatively high. The Olsen technique rates available P as <5, 5-10, 10-15, 15-20, and >20, indicating extremely low, low, medium, high, and very high levels, respectively. Therefore the excremental site soil has a very high [34] Cation Exchange Capacity (23.52 meq/100 g) medium rating.

Table 2. *Soil physicochemical properties of the experimental site before sowing and after harvest.*

Properties	Values		Ratings	
	Before	After	Before	After
Clay (%)	14.6			

Properties	Values		Ratings	
	Before	After	Before	After
Silt (%)	12.7			
Sand (%)	72.7			
Textural class	Sandy loam			
pH: (H_2O) 1: 2: 5	5.8	6.16	Moderately acid	Slightly acid
Organic Carbon (%)	1.91	1.73	low	low
Total nitrogen (%)	0.16	0.17	medium	medium
Available phosphorus (mg/kg soil)	7.8	45.63	low	Very high
Available Sulfar (mg/kg soil)	0.036	0.042	Very low	Very low
Cathane Exchange Capacity (CEC meq/100g)	5.6	23.52	Very low	medium

3.2. Yield

Aboveground dry biomass

The analysis of variance revealed a significantly significant ($P < 0.0001$) influence of fertilizer rate on above-ground dry biomass in bread wheat. The highest aboveground dry biomass yield (13.33 t ha^{-1}) was obtained with a fertilizer rate of 60 kg NPS + 140 kg urea (N) ha^{-1}, whereas the lowest aboveground dry biomass yield (5.2 t ha^{-1}) was produced with no fertilization (Table 3). This may be due to the application of urea fertilizer increasing biomass production and the increase in aboveground biomass with urea fertilizer rates, as well as sufficient nitrogen in the soil that favors vegetative wheat plant growth and more total dry matter production occurred at various growth stages.

The results were consistent with the findings of [29], who indicated that increasing the amount of applied NP fertilizer enhanced the biomass production of bread wheat and informed that vegetative development and biological yield are heavily reliant on the intake of chemical fertilizers. According to [4, 5], biomass yield grew as the rate of nitrogen treatment increased from zero to the maximum rate.

Grain yield

The effect of fertilizer rate was highly significant ($P < 0.0001$) on the grain yield of bread wheat. The maximum grain yield value (44.33 $qtha^{-1}$) was obtained from the application of 180 kg NPS + 280 kg urea (N) fertilizer rates ha^{-1} and followed (43 qt ha^{-1}) from 180 kg NPS + 140 kg urea (N) fertilizer rates ha^{-1}, whereas the minimum grain yield value (13.41) was obtained from unfertilized soil (Table 3). The grain yield from the treated treatment was higher by 8 qt ha^{-1} than local practices. This could be due to the effective tiller number, which is defined as the number of tillers that generate spikes and grain per spike, as well as other critical components of wheat grain, increasing with the application of NPS and urea fertilizers. This conclusion is consistent with the findings of [29], which found that increasing the application of NPS and urea (N) fertilizer rates resulted in enhanced bread wheat grain output. The highest grain yield was obtained by applying the maximum amount of 200 kg NPS ha^{-1} and 92 kg N ha^{-1} to durum wheat. [14] stated that the maximum grain yield of bread wheat was recorded at the highest application of the blended fertilizer rate. This discovery is consistent with the findings of [2, 3], who discovered that rising grain production of bread wheat was reported at the maximum blended fertilizer rate. The maximum grain production at the highest NPS and urea rates might be attributed to higher root development, increased nutrient absorption, and a superior growth favor as a result of the three nutrients' synergistic effects on yield components and yield. Balanced plant nutrition is one of the most significant aspects of increasing crop yield. A balanced supplementation of NPS nutrition is one of the most important productivity inputs for crops in both high- and lowland settings. The application of fertilizer rate influences bread wheat grain yield [8]; [1] said that the highest grain yield at the highest NPS rates might be attributed to higher root development, increased nutrient absorption, and better growth, all of which improve yield components and crop output. This finding contradicts [40], which claimed that the greatest grain yield (8.6 t ha^{-1}) obtained by applying 300 kg ha^{-1} NPSZnB was less than the 9.6 t ha^{-1} grain yield of the same variety obtained from an on-farm study using 100 kg ha^{-1} NPS. Fertilizers are administered to fields to achieve targeted soil fertility levels for crops cultivated.

Straw yield

The fertilizer rate had a substantial ($P<0.001$) influence on straw production in bread wheat. The highest straw yields (10.03 t/ha) were achieved from 60 kg NPS + urea (N) and 140 kg/ha fertilizer rates, while the lowest straw yields (3.98 t/ha) were recorded from the unfertilized treatments of both

NPS + urea (N) fertilizer rates (Table 3). This might be because of a balanced supply of NPS nutrients, resulting in higher vegetative growth and dry matter buildup, which is directly associated with an increase in straw production. This finding was supported by [13], which found that increasing N rates boosted wheat straw production. Another study [41] revealed that applying nitrogen fertilizer increased straw output.

Table 3*. The effect of NPS and Urea (N) fertilizer rate on above ground biomass, straw yield and grain yield of bread wheat.*

No trt.	Fertilizer treatments	AGB (t/ha)	SY (t/ha)	GY (qt/ha)
1	Control (negative)	5.32d	3.98f	13.42g
2	140kg UREA(N)	11.81abc	8.84abc	29.67 f
3	280kg UREA(N)	12.02ab	8.68abc	33.50 de
4	60 kgNPS	11.11abc	7.94abcd	31.67 ef
5	60 kgNPS + 140kg UREA(N)	13.33a	10.02a	33.00e
6	60 kgNPS + 280kg UREA(N)	13.03a	9.66ab	33.67de
7	120kg NPS	11.19abc	8.03abcd	31.67ef
8	120kg NPS + 140kg UREA(N)	9.92 b	6.15de	37.67bc
9	120kg NPS + 280kg UREA(N)	10.23b	6.33de	39.50b
10	180kg NPS	10.23b	7.03cde	32.33ef
11	180kg NPS + 140kg UREA(N)	9.72c	5.42ef	43.00a
12	180kg NPS + 280kg UREA(N)	11.22 abc	6.79cde	44.33a
13	100kgNPS+100kgUREA(N) control (positive)	11.44 abc	7.8bcd	36.33cd
Means		10.82	7.43	33.83
CV%		12.03	17.07	6.87

Means within a column followed by the different letter are significantly different at 5% level of significance. LSD (0.05) = least significant differenced; CV= Coefficient of Variation

Partial Budget Analysis

As shown in Table 4, the partial budget analysis revealed that the highest grain yield attained with a rate of 120 NPS + 140 kg urea (N) ha^{-1} resulted in a higher grain yield benefit (33.90 qtha^{-1}) with a net benefit of 213,489.73 ETB ha^{-1} and an MRR of 121,479.6%. However, the unfertilized or control plot had the lowest net benefit. Thus, farmers in the study area should apply 120 kg ha^{-1} NPS of blended fertilizer plus 140 kg ha^{-1} of urea (N) for better bread wheat yield with a high economic benefit as compared to the other treatments in the study area because the highest net benefit and marginal rate of return were above the minimum level (100%). Who observed that applying a 50-185 kg N ha^{-1} fertilizer rate in wheat provides the best economic returns, whereas application rates above these ranges are both economically and environmentally unsustainable.

Table 4*. Summary of economic analysis.*

S.L. Trt	Fertilizer treatments	TVC (ETB) ha-^{1}	AGY Kgha-1	Price(ETB)	GBKgha-^{1}	NB (ETB) ha-^{1}	MRR%
T1	0 Negative control	0.00	1206.9	62	74827.8	74827.80	0
T2	140Urea(N)	11068.56	2669.4	62	176718.6	165650.04	1496.58
T3	280Urea(N)	13456.56	3014.1	62	202721.4	189264.84	988.89
T4	60NPS	15844.56	2850.3	62	220410	204565.44	640.73
T5	60NPS+140Urea(N)	22751.11	2970	62	165502.8	142751.69	D

S.L. Trt	Fertilizer treatments	TVC (ETB) ha-^{1}	AGY Kgha-1	Price(ETB)	GBKgha-^{1}	NB (ETB) ha-^{1}	MRR%
T6	60NPS+280Urea(N)	28141.11	3030.3	62	186874.2	158733.09	296.50
T7	120NPS	33819.67	2850.3	62	184140	150320.33	D
T8	120NPS+140Urea(N)	33871.67	3390.3	62	247361.4	213489.73	121479.6
T9	120NPS+280Urea(N)	36207.67	3555	62	176718.6	140510.93	D
T10	180NPS	38595.67	2909.7	62	180401.4	141805.73	54.22
T11	180NPS+140Urea(N)	39209.67	3870	62	187878.6	148668.93	1117.79
T12	180NPS+280Urea(N)	41597.67	3989.7	62	210198.6	168600.93	834.67
T13	100NPS+100Urea(N) +ve control	43985.67	3269.7	62	239940	195954.33	1145.45

ETBirr=Ethiopia birr, MRR= marginal rate of return, GB=Gross benefit, NB=Net benefit, TVC=total of vary cost. D = Dominated and Price of NPS and urea 39.8 and 38.5 ETB kg-^{1} grain price = 62 ETB kg-^{1}. AGY=average grain yield

4. Conclusion and Recommendation

Bread wheat is one of the key food crops in the study area. The productivity and yield is mostly controlled by soil fertility and lack of better fertilizer rate. The study was conducted at Bule Hora District, southern Ethiopia, and the main cropping season 2023 and aimed to identify the optimum fertilizer treatments for higher grain yield with higher economic return. The all data yield, above ground, and straw yield were collected and analyses and identified mean separation by least significant different and the analyzed data was interpreted. The pre and post-harvest soil sampling were analyses and interpreted the results. The partial budget analysis was done depended on variable cost and gross benefit. The net benefit and marginal rate of return were identified and recommended better fertilizer rate with higher economic return for farmers to increase bread wheat in the study area. Finally, the analysis results showed significant effects on all parameters, with the fertilizer rate significant affect above-ground biomass, and straw yields. A significantly higher (44.33 qt ha-1) grain yield of bread wheat was obtained with the application of 180 kg NPS + 280kg urea(N) ha^{-1} and 43.00 qt ha^{-1} following by application of 180/140kg NPS/urea(N) but, not an acceptable economic benefit. Therefore, on the basis of the result of the present study, it is indicative that better economic yield benefit obtained at Bule Hora and farmers can benefit more by application of 120 NPS/140 urea (N) ha^{-1} obtained higher grain yield with higher economic return, which is economically achievable and recommended for better bread wheat production in the sand loam soil of Bule Hora District and similar agro-ecological conditions.

Abbreviations

AGB	Above-ground Biomass
AGY	Average Grain Yield
CEC	Cathane Exchange Capacity
CV	Coefficient of Variation
D	Dominated
ETB	Ethiopia Birr
GB	Gross Benefit
GLM	Generalized Linear Model
JARC	Jimma Agricultural Research Center
LSD	Level of Significance
MRR	Marginal Rate of Return
NB	Net Benefit
NPS	Nitrogen Phosphorus Sulfar
OC	Organic Carbon
OM	Organic Matter
TVC	Total of Vary Cost
YPDARC	Yabello Pastoral and Dry Land Agriculture Research Center

Author Contributions

Deme Megersa: Conceptualization, Resources, Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Writing – original draft, Writing – review & editing

Conflicts of Interest

The author declares that there is no conflicts of interest.

References

[1] Abera Donis, Dejene Getahun, Tadele Geremu, Dereje Girma, Abreham Feyisa, Lello Dejene, Meron Tolosa. (2021). Determination of NPS Fertilizer Rate Based on Calibrated Phosphorus for Yield of Bread Wheat in Wachale District, North Shewa Zone, Oromia, Ethiopia. American Journal of Plant Biology. Vol. 6, No. 3, pp. 73-77. https://doi.org/10.11648/j.ajpb.20210603.15

[2] Abera, D., Tana, T. and Dessalegn, T., (2020). Effects of blended NPSB fertilizer rates on yield and grain quality of durum wheat (Triticum turgidum L.) varieties in Minijar Shenkora District, Central Ethiopia. Ethiopian Journal of Agricultural Sciences, 30(3), pp. 57-76.

[3] Abera, T. and Adinew, A., 2020. Effect of blended NPS fertilizer supplemented with nitrogen on yield components and yield of maize (Zea mays L.) in Kachabirra district, Kembata Tambaro zone, southern Ethiopia. International Journal of Research in Agricultural Sciences, 7(3), pp. 2348-3997.

[4] Abera, T., Lemma, A., Hundesa, C. and Husen, A., (2021). Response of Yield Components and Yield of Bread Wheat (Triticum aestivum L.) to Blended NPS and N fertilizers Levels at Liban Chukala District, East, 8(1), pp. 1–9.

[5] Abera, T., Tola, B., Tufa, T. and Adugna, A. (2021). Effects of Blended (NPSB) and Urea Fertilizer Rate on Yield and Yield Components of Wheat in Ultisols of Liben Jawi District, Oromia, Ethiopia, (August). https://doi.org/10.5829/idosi.aejaes.2021.87.97

[6] Aboye, A. D. and Teto, A. M., (2022). Pilot review study on current research status and economic value limitations of bread wheat (Triticum aestivum L.) Production in Ethiopia. Economics, 11(4), pp. 137-166.

[7] Alemu, S., (2017). Effect of blended NPS and N fertilizer rates on yield components, yield and grain protein content of bread wheat (Triticum aestivum L.) in Bore district, Guji Zone, Southern Ethiopia (Doctoral dissertation, MSc Thesis. School of Plant Sciences, Haramaya University, Ethiopia).

[8] Arega, G. and Setu, B., (2014). Prevalence, Incidence and Severity of Wheat Rust, an Response of Wheat Cultivars to Rust Infection. International Journal of Agronomy and Plant Production, 5(1), pp. 13-19.

[9] Assefa, S., Haile, W. and Tena, W. (2021). Response of bread wheat to sulfur and phosphorus fertilizers in the north central, Agriculture & Food Security, pp. 1–10. https://doi.org/10.1186/s40066-021-00303-y

[10] Awash, M. (2019). Evaluation of Bread Wheat (Triticum aestivum L.) Genotypes for Yield Advances in Crop Science and Technology Evaluation of Bread Wheat (Triticum aestivum L.) Genotypes for Yield Potential and Related Traits Under High Temperature Stress Condition at Middle Awash, Ethiopia, (March). https://doi.org/10.4172/2329-88631000410

[11] Basha Kebede, G. A. and D. K., (2021). Popularization of Sanate Bread Wheat Variety in the Highlands of Guji Zone, Southern Oromia, Ethiopia (3), pp. 25–30.

[12] Beketa, H. J., Kefale, D. and Yoseph, T., (2020). Effect of Blended Fertilizer Types and Rates on Growth, Yield and Yield Components of Bread Wheat (Triticum aestivum L.) in Wondo District, Southern Ethiopia. International Journal of Agriculture Innovations and Research, 8(4), pp. 326-342.

[13] Bereket H, Dawit H, Mehretab H, Gebremedhin G., (2014). Effects of Mineral Nitrogen and Phosphorus Fertilizers on Yield and Nutrient Utilization of Bread Wheat (Tritcum aestivum) on the Sandy Soils of Hawzen District, Northern Ethiopia. Agriculture, Forestry and Fisheries 3(3): 189-198.

[14] Bizuwork Tafes. (2018). Growth, Yield and Grain Quality of Durum Wheat (Triticum turgidum L. var. durum) as Influenced by Rates of Blended NPSB and N Fertilizers at Debre Zeit, Central Ethiopia. MSc Thesis, Haramaya University.

[15] Brzegen, A. (2019) 'GROWTH AND YIELD RESPONSES OF BREAD WHEAT (Triticum aestivum L.) TO SEEDING AND NPS RATES IN BORENA DISTRICT, SOUTH WOLLO ADMINISTRATIVE ZONE, ETHIOPIA'. http://hdl.handle.net/123

[16] Chaparro., J. M., Sheflin, A. M., Manter, D. K. and Vivanco, J. M., (2012). Manipulating the soil microbiome to increase soil health and plant fertility. Biology and Fertility of Soils, 48, pp. 489-499.

[17] Chapman, H. D., (1965). Cation ‐ exchange capacity. Methods of soil analysis: Part 2 Chemical and microbiological properties, 9, pp. 891-901.

[18] CIMMYT Economics Program, (1988). From agronomic data to farmer recommendations: an economics training manual (No. 27).

[19] Das, D. K. and Mandal, M., (2015). Advanced technology of fertilizer uses for crop production. Fertilizer Technology I Synthesıs. Sinha, S., Pant, KK, Bajpai, S. (Eds.). Studium Press, LLC, USA, pp. 101-150.

[20] Değirmenci, F. Ö., Ulaş, B., Kansu, Ç., Uluğ, A., Caneva, I., Asal, R. and Kaya, Z., (2023). The ancient DNA and archaeobotanical analysis suggest cultivation of Triticum aestivum subsp. spelta at Yumuktepe and Yenikapı Pottery Neolithic sites in Turkey. Genetic Resources and Crop Evolution, 70(2), pp. 657-676.

[21] Dewis, J. and Freitas, F., (1970). Physical and chemical methods of soil and water analysis.

[22] Dick W. A., Kost, D. and Chen, L., (2008). Availability of sulfur to crops from soil and other sources. Sulfur: A missing link between soils, crops, and nutrition, 50, pp. 59-82.

[23] Diriba Shiferaw, G., Rut-Duga, D. and Wogayehu, W., (2019). Effects of blended fertilizer rates on bread wheat (Triticum aestivum L.) varieties on growth and yield attributes. J Ecol & Nat Resour, 3(3), pp. 1-13.

[24] Duga, R. and Worku, W. (2019) 'Effects of Blended Fertilizer Rates on Bread Wheat (Triticum Aestivum L.) Varieties on Growth and Yield Attributes', (September). https://doi.org/10.23880/jenr-16000170

[25] Erenstein, O., Jaleta, M., Mottaleb, K. A., Sonder, K., Donovan, J. and Braun, H. J., (2022). Global trends in wheat production, consumption and trade. In Wheat improvement: food security in a changing climate (pp. 47-66). Cham: Springer International Publishing.

[26] Govindan, V., Gupta, O. P., Kumar, S., Mishra, C. N. and Singh, G., (2023). Wheat Nutraceutomics: Breeding, Genomics, Biotechnology, and Nanotechnology. In Compendium of Crop Genome Designing for Nutraceuticals (pp. 61-83). Singapore: Springer Nature Singapore.

[27] Hirel, B. and Lea, P. J., (2018). Genomics of nitrogen use efficiency in maize: From basic approaches to agronomic applications. The Maize Genome, pp. 259-286.

[28] Hoogenboom G.; Porter, C. H.; Shelia, V.; Boote, K. J.; Singh, U.; White, J. W.; Hunt, L. A.; Ogoshi, R.; Lizaso, J. I.; Koo, J., (2019). Decision support system for agro technology transfer (DSSAT) version 4.7. DSSAT Found. Gainesv. Florida. USA. Available.

[29] Ishete, T. A. and Tana, T., (2019). Growth, yield component and yield response of durum wheat (Triticum turgidum L. var. Durum) to blended NPS fertilizer supplemented with N rates at Arsi Negelle, Central Ethiopia. African Journal of Plant Science, 13(1), pp. 9-20.

[30] Itelima, J. U., Bang, W. J., Onyimba, I. A., Sila, M. D. and Egbere, O. J., (2018). Bio-fertilizers as key player in enhancing soil fertility and crop productivity: A review.

[31] Iticha, B., Mosley, L. M. and Marschner, P., (2024). Combining lime and organic amendments based on titratable alkalinity for efficient amelioration of acidic soils. Soil, 10(1), pp. 33-47.

[32] Menamo., M. (2016). The Effect of Application of Different Rate N-P Fertilizers Rate on Yield and Yield Attributes of Bread Wheat in Case of Chancha 6(5), pp. 63–66.

[33] Nigussie, Z., Tsunekawa, A., Haregeweyn, N., Adgo, E., Nohmi, M., Tsubo, M.,... & Abele, S. (2015). Farmers' perception about soil erosion in Ethiopia. Land degradation & development, 28(2), 401-411.

[34] Olsen, S. R. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate (No. 939). US Department of Agriculture.

[35] Selim, M. M. (2020). Introduction to the integrated nutrient management strategies and their contribution to yield and soil properties. International Journal of Agronomy, 2020(1), 2821678.

[36] Senbeta, A. F., & Worku, W. (2023). Ethiopia's wheat production pathways to self-sufficiency through land area expansion, irrigation advance, and yield gap closure. Heliyon, 9(10).

[37] Sigaye, M. H., Mekuria, R., & Kebede, K. (2022). Effect of NPS-B blended and nitrogen fertilizers application on bread wheat yield and economic profitability on Nitisol of Southern, Ethiopia. International Journal of Food Science and Agriculture, 6(2).

[38] Stewart, W. M., Dibb, D. W., Johnston, A. E., & Smyth, T. J. (2005). The contribution of commercial fertilizer nutrients to food production. Agronomy journal, 97(1), 1-6.

[39] Tadesse, W., Zegeye, H., Debele, T., Kassa, D., Shiferaw, W., Solomon, T.,... & Assefa, S. (2022). Wheat production and breeding in Ethiopia: retrospect and prospects. Crop Breeding, Genetics and Genomics, 4(3).

[40] Terfa, A. E., Mellisse, B. T., Kebede, M. M., Elias, E., & Yadessa, G. B. (2023). Effect of blended fertilizer application on bread wheat yield and profitability on andosols of southwestern highlands of ethiopian. Communications in Soil Science and Plant Analysis, 54(1), 73-82.

[41] Tilahun Abera Ishete, T. A. I., & Tamado Tana, T. T. (2019). Growth, yield component and yield response of durum wheat (Triticum turgidum L. var. Durum) to blended NPS fertilizer supplemented with N rates at Arsi Negelle, Central Ethiopia.

[42] Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil science, 37(1), 29-38..

[43] Xiang, Y. A. N., Jin, J. Y., Ping, H. E., & Liang, M. Z. (2008). Recent advances on the technologies to increase fertilizer use efficiency. Agricultural Sciences in China, 7(4), 469-479.