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Periodic Biological, Yield, Nutrient Up Take and Use Efficiency of Bread Wheat as Influenced by NPSB and Urea Fertilize Rates in Gechi District, Southwestern Ethiopia

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Abstract: Bread wheat is one of the major staple crops in Ethiopia. In Gechi district, the productivity of bread wheat is below its potential due to poor agronomic constraints and lower soil fertiity. Balanced fertilization is one of the vital tools to defeat soil fertility problems and is thus responsible for improved food production. An experiment was conducted to determine optimum rates NPSB and Urea fertilizers on growth, yield and nutrient uptake and use efficiency of bread wheat in Gechi district. Three rates of NPSB (50, 100, and 150 kg ha^{-1}) and three rates of Urea (50, 100 and 150 kg ha^{-1}) were deliberately combined and tested with control. The treatments were arranged in a randomized complete block design with three replications. The results of the experiment indicated that maturity date, spike length, grain yield, harvest index and number of seed spike^{-1} were significantly affected by only the main effects of NPSB and Urea. The longest days to maturity (133.22 days), spike length (7.11 cm), grain yield (5305.60 kg ha^{-1}), harvest index (60.62%), and number of seed spike^{-1} (42.10 seed) were recorded at the highest rate of 150 fertilizer kg ha^{-1}. Longest day to heading (66.67 days), plant height (91.67 cm). The maximum number of total tillers (7.50 par plant), productive tillers (3.61 plant), biomass yield (10737.3 kg ha^{-1}), straw yield (4351.1 kg ha^{-1}), were obtained at combining application of 150 kg ha^{-1} NPSB with urea kg ha^{-1}. However, the higher value of Agronomic efficiency, physiological efficiency and Agronomic recovery of nitrogen was obtained at lowest Nitrogen rate. Theresult of economic analysis showed that combined application of 150 kg ha^{-1} NPSB and 100 Urea kg ha^{-1} of Urea gave economic benefit of 100328.24 Birr ha^{-1} with the marginal rate of return of 3838.76%. Thus, the use of 150 kg ha^{-1} of NPSB and 100 kg ha^{-1} of Urea can be recommended for better production of bread wheat in the study area.

Keywords: Bread Wheat, Nutrient Use Efficiency, Periodic Biological

1. Introduction

Wheat is the most important cereal crops worldwide and is a common component diet for more than one-third of the world's population [1]. It is a staple food for more than 35% of the world's population [2]. Globally, China, India and Russia are the largest wheat producers, while South Africa and Ethiopia are the largest wheat producers in sub-Saharan Africa (SSA) [3]. Ethiopia is one of the largest producers of wheat in sub-Saharan Africa [4].

Wheat is one of the most important cereals cultivated in Ethiopia [5]. Although the agro-climatic condition of Ethiopia is suitable for wheat production, productivity of the crop is low. The most suitable altitude range for wheat production is between 1900 and 2700 meters above sea level [6]. In all cases this is absolutely far below the world's average yield (3.52 t ha^{-1}) [7] and 6 t ha^{-1} (at research station) [8]. In addition to this research findings showed acute crop cultivation, complete crop residue removal and high nutrient depletion contribute to low productivity of wheat [9].

Until recently, the agricultural extension program has promoted a blanket recommendation of 100 kg ha^{-1} DAP and

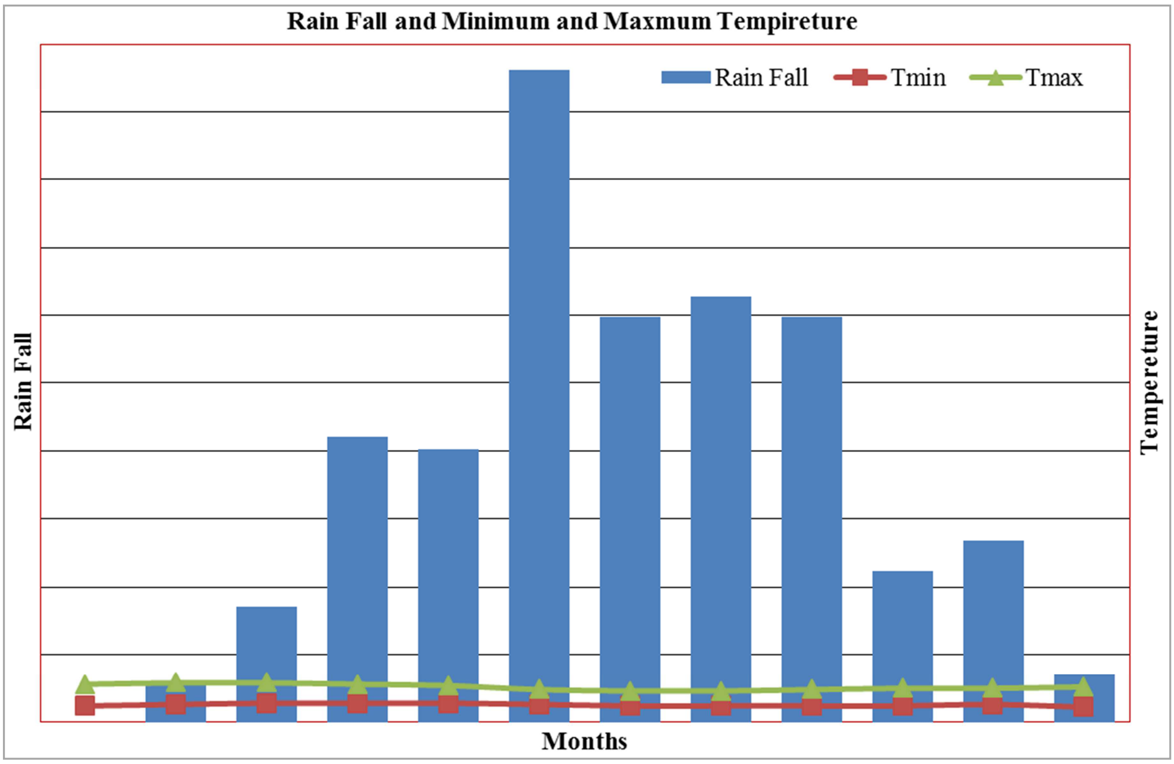
Urea for all cereal crops and soil types, but the actual application rate is 65 kg DAP and 45 kg ha^{-1} [10]. On the other hand, continuous application of DAP and Urea without consideration of other nutrients is known to cause depletion of secondary and micronutrients [11]. The depletion of soil nutrients, low level of chemical fertilizer usage, and poor management practices are among the major constraints for improving wheat yield in Ethiopia [12]. There are different mechanisms to improve the fertilizer use efficiency increasing the crop yield, cropping system, appropriate of use fertilizer, application rate, and time and soil and water management, which are among the main management options [13].

Fertilizer use efficiency should be improved through the application of a balanced and appropriate fertilizer mix, which could increase crop yield, improve the physical, chemical and biological condition of the soil, and increase the revenue from fertilizer application [14]. Moreover the application of multi-nutrient blended fertilizers is acknowledged for being able to enhance the productivity and nutrient use efficiency of crops [15]. Balanced fertilization not only guarantees optimal crop production, better food quality, and benefits for the growers but also provides the best solution for minimizing the risk of nutrient losses to the environment [16]. The soil fertility map of Ethiopia revealed that the deficiencies of most nutrients such as nitrogen (86%), phosphorus (99%), sulfur (92%), boron (65%), zinc (53%), potassium (7%), copper, manganese, and iron were widespread in Ethiopian soils [17]. Having considered the problems outlined above, the Ethiopian government has been promoting the use of multi-nutrient-based blend fertilizers since 2015.

Accordingly, Ethiopia is moving from applications of blanket fertilizer recommendations to recommendations that are customized based on soil nutrient analysis, soil type and crop nutrient requirements [18]. To supply nutrients such as sulfur and boron, the earlier used DAP was replaced by NPSB fertilizer. Since the composition of these newly introduced fertilizers differs from that of DAP, the appropriate rate is not determined for wheat production in the study area. Therefore, the objective of this study was to determine optimum rates of NPSB and Urea fertilizer rates on yield and related traits of bread wheat, to evaluate the nutrient uptake and use efficiency of wheat and to determine the economic feasibility of NPSB and Urea fertilizer rate in wheat production on the study in Gechi district, Southwestern, Ethiopia.

2. Material and Methods

An experiment was conducted under rain-fed condition in Gechi district, Buno Bedele Zone of Oromia regional state. The experimental site was located at $08^{0}18'19.0''$N latitude and $036^{0}26'25.0''$E longitude at an altitude of 2133 masl (Meter above sea level). Fifteen years (2005-2020) climatic data shows that the area receives a unimodal type of rainfall pattern, main rain occurring between May to September with mean total annual rainfall of 1970 mm. The mean annual minimum and maximum temperatures of the area are 13°C and 26°C, respectively.



Source: Bedele Meteorological service

Figure 1. *Annual rainfall and average temperature of the study area.*

2.1. Treatments, Experimental Design and Procedure

The treatment consisted of three levels of NPSB (50, 100, and 150 kg/ha) and three Urea (50, 100, and 150 kg/ha) fertilizers. A total of 10 treatment combinations were considered including control plot. The experiment was laid out in a randomized complete block design (RCBD) in a factorial arrangement replicated three times. The total number of plots in the experiment were 30 (10× 3), each with 3 m × 3 m (9 m^2) size. The distances between plots and blocks were 0.5 m and 1.0 m, respectively. 100 kg ha^{-1} Urea (46% N) and 100 kg ha^{-1} of NPSB of (18.9% N, 37.7 P_2O_5%, 6.95 S%, 0.1% B) were used as fertilizer sources. NPSB was applied at planting time close to seed drilling line, while urea was applied in split application, at planting time and the remaining urea fertilizer was top dressed at 40 days after planting and second weeding in the form of urea. Bread wheat varieties Liban was drilled at the rate of 150 kg/ha in rows 30 cm apart.

Table 1. *Experimental treatment set up and their nutrient levels.*

NPSB and Urea Combination (kg ha^{-1})	Nutrient level (kg ha^{-1})			
	N	P_2O_5	B	S
Control	0	0	0	0
50+50	32.45	18.85	3.48	0.05
50+100	55.45	18.85	3.48	0.05
50+100	78.45	18.85	3.48	0.05
100+150	41.9	37.7	6.95	0.1
100+100	64.9	37.7	6.95	0.1
100+150	87.9	37.7	6.95	0.1
150+50	51.35	56.55	10.43	0.15
150+100	74.35	56.55	10.43	0.15
150+150	97.35	56.55	10.43	0.15

2.2. Soil Sampling and Lime Requirement Determination

Soil samples were collected from the depth of 0 to 20 cm using auger before planting. The sample was analyzed for selected physico-chemical properties mainly organic carbon, total N, soil pH, available phosphorus (P), available sulfur, available boron, cation exchange capacity and soil texture using the procedure at Bedele agricultural research center described below. Lime Requirement (LR) for the site was determined based on exchangeable acidity of the using the formula: LR = Exchangeable Acidity*1.5*10 kuntal ha^{-1} Where; LR = Lime Requirement. The lime recommendation on this study was based on the amount of exchangeable acidity measured by the lime requirement soil test. To avoid over liming, an adaptation factor was proposed that takes the Al sensitivity of crops into account: Factor = < 1 for Al-tolerant crops = 1.0 for moderately Al-tolerant crops = 1.5 for Al- sensitive crops [18].

2.3. Plant Sampling and Analysis

At maturity, ten plant samples were collected randomly from each plot (which was replicated three times) and partitioned into straw and grain for the determination of N concentration as well as for the calculation of N Agronomic efficiency, N Agronomic recoveries and N Physiological efficiencies. The samples collected from each replication of a treatment were bulked to give one composite plant tissue sample per treatment for straw and grain, respectively. Grain and straw N uptakes were determined by multiplying the N concentrations of each plant part by their respective dry matter weights. Grain and straw yield nutrient uptake were calculated by multiplying nutrient with respective straw and grain yield par hecter: NU = (NC*Y)/100; where, NU, NC and Y stand for nutrient uptake, nutrient concentration of grain or straw, and grain yield or straw, respectively. The N uptake use efficiency of wheat such as agronomic, physiological and apparent recovery efficiency of N were calculated as described by Fageria and Baligar [19]. Below equations also were used to determine N-uptake, apparent nutrient recovery and agronomic efficiency. Total uptake (kg ha^{-1}) = Nutrient uptake grain+ Nutrient uptake straw Agronomic Efficiency (Kg kg^{-1}): described as the economic production obtained per unit of Fertilizer applied and was calculated as: $AE = \frac{YF-Y0}{F}$ (Kg kg^{-1}). Where, YF is the grain yield of a fertilized plot (kg ha^{-1}), Y0 is the grain yield of the control plot (kg ha^{-1}), and F is the amount of N (kg ha^{-1}). Physiological Efficiency (Kg kg^{-1}): It represents the ability of a plant to transform N acquired from fertilizer into economic yield (grain) at maturity. It was calculated as: PE $(\text{Kg kg} - 1) = \frac{\text{Yf}-\text{Yu}}{\text{Nf}-\text{Nu}}$ (kg kg^{-1}). Where, Yf is the biological yield (grain plus straw) of the fertilized pot (kg); Yu is the biological yield of the unfertilized plot (kg); Nf is the nutrient uptake (grain plus straw) of the fertilized plot; and Nu is the nutrient uptake (grain plus straw) of the unfertilized plot (kg). Apparent Recovery Efficiency (%)**:** It indicates the quantity of nutrient uptake per unit of nutrient applied and was calculated as: $ARE = \frac{UF-U0}{F} * 100$. Where, UF is nutrient (N) uptake in above ground biomass of fertilized plots (kg/ha). U0 is nutrient (N) uptake in above ground biomass of the control plot (kg/ha), and F is the amount of N applied (kg ha^{-1}). Efficiency NUE (%) = Physiological Efficiency (PE) × Recovery Efficiency (RE)

2.4. Data Collection

All agronomic data's were collated and analyzed. Accordingly, phonological growth and yield data's' like Days to Heading (Days), Days to Maturity (Days), Plant Height (cm), Lodging Percent (%) Number of tiller par plant (Number), Number of productive tillers, Number of spikelet per spike, Spike Length (cm), Thousand Kernels Weight (g), Above Ground Dry Biomass yield (Kg ha^{-1}), Grain Yield (kg ha^{-1}) and Harvest Index (%) were collected..

2.5. Soil Analysis After Harvest

Soil sample were analyzed after harvest to evaluate changes in soil as a result of applied treatments. The soil samples were taken from each plot according to treatment and the composite were determined at Bedele Agricultural Research Center for pH, total nitrogen Cation Exchange Capacity, Organic Carbon, available phosphorus, available sulfur, and available boron.

2.6. Statistical Analysis

All the measured parameters were subjected were first checked for all assumptions of ANOVA. Then the data were subjected to Analysis of Variance (ANOVA) and simple correlation analysis was performed using SAS software (SAS Institute, 2012).

2.7. Partial Budget Analysis

The mean grain yields of the treatments were used in partial budget analysis as described by CIMMYT [20]. Total variable cost was calculated as the sum of all cost that is variable or specific to specific treatment against the control. Net benefit was calculated by subtracting total variable cost from the gross benefit. Marginal rate of return (MRR) was calculated as the ratio of differences between net benefits of successive treatments to the difference between total variable costs of successive treatments. Dominance analysis (D): This was carried out by first listing the treatments in order of increasing costs that vary. Any treatment that has net benefits which are less or equal to those of a treatment with lower costs that vary is called dominated.

3. Results and Discussion

3.1. Selected Soil Physical and Chemical Properties of the Site Befor Sowing

The analysis results indicated that clay textural class. The soil pH and exchangeable acidity (EA) were 4.48 (1:2.5 soil: water ratio H_2O) and 1.96.mg $100g^{-1}$, respectively. The pH was very acidic [21] which suggests the presence of substantial quantity of exchangeable H^+ and Al_3^+ ions. Soil organic carbon (OC) content was 4.813%, which is within the high range [21]. It has organic matter (OM) content of 8.29% which can be classified as high total nitrogen (TN) value of the experimental soil was mediem (0.198).

According to Ethio SIS [22], TN contents <0.1, 0.1-0.15, 0.15-0.3, 0.3-0.5, and >0.5 are regarded as very low, low, medium, high and very high, respectively. The laboratory analysis result also revealed that the available Phosphorus was very low (0.621 mg kg^{-1}). According to Bray [23], the ranges of phosphorus <7, 8-19, 20-39, 40-58 and >59 mg kg^{-1} represent very low, low, medium, high and very high levels, respectively. EthioSIS [22] suggested optimum phosphorus content for most Ethiopian soil as 15 mg kg^{-1}. Hence, the available phosphorous level of the soil is low and needs phosphorous fertilization.

This low phosphorous content could be due to intensive mining of the farm fields and fixation by heavy metal cations. Soil cation cxchange capacity (CEC) value of the study area was medium (15.791 cmol kg^{-1}) (Table 2). Landon et al. [24] have reported that CEC of soils >40, 25-40, 15-25, 5-15,< 5 cmol kg^{-1} are categorized as very high, high, medium, low and very low, respectively. According to the result obtained from the laboratory, the value of boron in the soil was 0.346 mg kg^{-1} (Table 2).

Ethio SIS [25] reported that critical Boron value for most Ethiopian soils is 0.8 mg kg^{-1}. This shows that soils of the study area are deficit in Boron, suggesting application of fertilizer which contains Boron. Intensive cultivation in the area could be the reason for low Boron content of the soil. The mean sulfur value of the soil in the study area was 16.08 mg kg^{-1} (Table 2). Based on Ethio SIS [22] soil classification for Sulfur values, the result lies in the low range, as values < 9 regarded as very low, 10-20 low, 20-80 optimum, and > 80 mg kg^{-1} as high.

Table 2. *Selected Soil Physical and Chemical Properties of the Site Befor sowing of bread wheat*

Soil Properties	Value	Rating	Reference
Textural class	Clay	-	
Clay (%)	48	Very High	
Silt (%)	27	Low	
Sand (%)	25	Low	
Exch. K (cmol (+)/kg soil	1.24	High	
pH (1:2.5 H_2O)	4.48	Very Acidic	[21]
CEC [Cmol (+) kg^{-1} soil]	15.791	Medium	[21]
Organic Carbon (%)	4.813	High	[21]
organic Matter (%)	8.29	High	[24]
Total Nitrogen (%)	0.192	Medium	[22]
Available phosphorus (mg kg^{-1})	0.621	Very low	[23]
Available sulfur (mg kg^{-1})	16.08	Low	[22]
Available boron (mg kg^{-1})	0.346	Low	[22]

K = Potassium, pH = Power of hydrogen and CEC = Cation Exchange Capacity

3.2. 50% Heading Date (Day)

Table 3. *Interaction effect of NPSB and Urea fertilizer rate on Heading date (Day) of bread wheat.*

NPSB Fertilizer rates (kg ha1)	Urea fertilizer rate (kg ha $^{-1}$)		
	50	100	150
50	62.33^b	$63b^a$	62.67^{ba}
100	65^a	65.33^a	66^a
150	59^{bc}	64a	66.67^a
LSD(0.05)	3.25		
P-value	***		
CV(%)	2.94		
Treated plot VsControl			
Treated Mean	63.78^a		
Control mean	57^b		

Means followed by same letter(s) are not significantly different at 5% P level of significance; NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, CV (%) = Coefficient of variation; LSD (0.05) = Least Significant Difference at 5% P level

The main effect of NPSB and urea fertilizer rates were significant (P<0.05). Similarly, interaction of two factors NPSB and urea were also showed significant (P<0.05) effect on Days to 50% heading. The longest days to heading (66.67 days) was recorded by applying 150 kg ha^{-1} of NPSB and 150 kg ha^{-1} Urea while the earliest days to heading (57days) was recorded in the control (unfertilized) plot (Table 3). This might be due to the availability of high balanced nutrient at active growing stages of the plant which result in excessive vegetative growth that delays heading [26]. Similarly, increasing urea fertilizer from Control to 150 kg urea kg ha^{-1} delayed days' to heading.

This might be due to the fact that urea has promoted greater vegetative development for longer period of time before reproductive phase begins and hence might have caused delay in heading [18].

3.2.1. 90% Physiological Maturity (Day)

Days to maturity was highly significantly (P<0.05) influenced by the main effect of NPSB and urea fertilizer. However the interaction of NPSB and urea none significantly (P>0.05) influenced maturity date. Days to maturity were delayed by about 24.22 days by the application of 150 NPSB and urea Kg ha^{-1} as compared to that of unfertilized plot. This may be attributed to the physiological effect of the fertilizer NPSB and urea which increases vegetative growth of crops whereby it delays maturity time. The fact that Urea (N) is important for synthesis of major macro-molecules in plants including proteins, enzymes, pigments, growth promoting hormones, etc. which are important for maintaining and producing vegetative tissues and cell organelles which in turn contribute for the delay of maturity of plants [14].

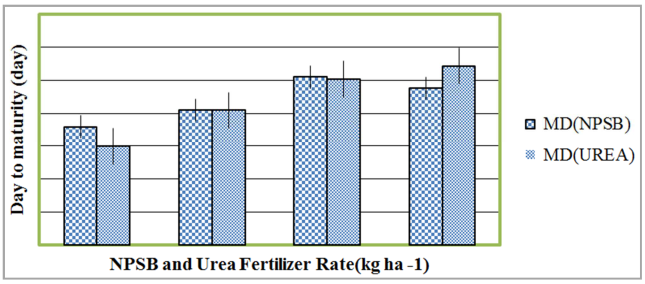


Figure 2. *MainEffectofNPSBandUreafertilizersonspikelengthofbreadwheat.*

NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, DM=Days to maturity Figure 2. Main Effect of NPSB and Urea fertilizers on spike length of bread wheat

3.2.2. Plant Height (cm)

The main effect of NPSB and urea fertilizer rates significantly affected the plant height at (p<0.01). Similarly, interaction effect NPSB and Urea were showed significant (P<0.01) Thus, the tallest plant (91.67 cm) was obtained at the highest rate of 150 NPS kg ha^{-1} and 150 kg ha^{-1} Urea where as shortest plant height (60.67cm) was recorded in control treatment (Table 4). The increment in plant height with NPSB and Urea might be due to the fact that urea improves plant height by increasing the synthesis of macromolecules (proteins, enzymes, pigments, hormones, etc.) and improving the rate of processes like photosynthesis on cell division and cell elongation, and finally increasing the internodes length. The increased plant height in response to increasing rate of NPSB fertilizer was due to the effect of N on the blended fertilizer, which has the vital role of Urea fertilizer in promoting the vegetative growth, and resulted in significant increase in plant heigh [27]. Tekle and Wassie [28] also found that application of blended fertilizers which significantly increased plant height as compared to the control.

Table 4. *Interactioneffect of NPSB and urea fertilizer rate on Plant height (cm) of bread wheat.*

NPSB Fertilizer rates (kg ha1)	Urea fertilizer rate (kg ha^{-1})		
	50	100	150
50	64.67^{c}	70.67^{cb}	72.00^{cb}
100	65^{a}	61.67^{c}	78.33^{b}
150	43.33^{d}	79.67^{b}	91.67^{a}
LSD (0.05)	6.65		
P-value	***		
CV (%)	5.51		
Treated plot Vs Control			
Treated Mean	69.7^{a}		
Control mean	60.67^{b}		

Means followed by same letter(s) are not significantly different at 5% P level of significance; NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, CV (%) = Coefficient of variation; LSD (0.05) = Least Significant Difference at 5% P level

3.3. Yield and Yield Components of Bread Wheat

3.3.1. Total Number of Tillers (Number)

The main effects of NPSB and Urea fertilizer rates were highly significant (< 0.01) for total number of tillers per plant. Similarly, the interaction of the two factors was also significant (P<0.05). The highest total number of tillers per plant (7.50) was produced by plants treated with the highest rate of combined application of 150 kg ha^{-1} NPSB and 150 kg ha^{-1} urea, whereas the lowest value 1.67 plants^{-1} was recorded for the unfertilized plot (Table 5). In general, combined application of 150 kg ha^{-1} of NPSB and 150 kg ha^{-1} of urea resulted in more than four (4) times incrementing total number of tillers over the control plot. The improvement in total number of tillers at the highest rates of combined application of blended NPSB and urea might be attributed to the synergetic roles of the four nutrients in enhancing growth and development of the crop. In line with this, it has been reported that Phosphorus found in NPSB is responsible for improved root development at early growth stage.

Table 5. *Interactioneffect of NPSB and urea fertilizer rate on total number of tillers (No)per plant of bread wheat.*

	Urea fertilizer rate (kg ha^{-1})		
NPSB Fertilizer rates (kg ha1)	50	100	150
50	4.13^{ed}	4.32^{d}	5.36^{c}
100	3.26^{e}	4.64^{d}	5.85^{b}
150	4.2^{d}	5.96^{b}	7.50^{a}
LSD(0.05)	0.45		
P-value	***		
CV (%)	5.21		
Treated plot Vs Control			
Treated Mean	5.03^{a}		
Control mean	1.67^{b}		

Means followed by same letter(s) are not significantly different at 5% P level of significance; NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, CV (%) = Coefficient of variation; LSD (0.05) = Least Significant Difference at 5% P level and No=Number

3.3.2. Number of Productive Tillers Per Plant (Number)

Number of productive tillers per plant was significantly

(P<0.01) influenced by both main and interaction effect of NPSB and urea fertilizer rates. Accordingly, the highest productive tiller (3.61) was recorded for combination of 150 kg ha $^{-1}$of NPSB and 150 kg ha^{-1} of urea (Table 6). The lowest numbers of effective tillers (1) was recorded for the control plot. The increase in the numbers of tillers in response to increasing rate of blended NPSB fertilizer indicated the importance of availability of balanced nutrients for better growth and development of wheat. The more availability of N at the highest rates of NPSB might have played a positive role in cytokinin synthesis and cell division and thereby accelerated the vegetative growth of plants.

Table 6. *Interaction effect of NPSB and urea fertilizer rate on number of productive tiller plant^{-1} (Number) of bread wheat.*

	Urea fertilizer rate (kg ha $^{-1}$)		
NPSB Fertilizer rates (kg ha1)	**50**	**100**	**150**
50	1.84^{g}	2.55^{d}	2.76^{c}
100	1.95^{f}	2.31^{e}	2.54^{d}
150	2.37^{e}	3.18^{b}	3.61^{a}
LSD(0.05)	0.09		
P-value	***		
CV (%)	2.12		
Treated plot Vs Control			
Treated Mean	2.57^{a}		
Control mean	1.00^{b}		

Means followed bysame letter(s) are not significantly different at 5% P level; NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, CV (%) = Coefficient of variation; LSD (0.05) = Least SignificantDifference at 5% P level

3.3.3. Spike Length (cm)

The main effects of blended NPSB and Urea fertilizer rates were significant (P<0.01) in influencing the spike length of bread wheat. However, the interaction not showed significantly (P >0.05) interacted to influence spike length. The longest mean spike length (7.11cm) was recorded at application of 150 kg/ha urea whereas, the shortest spike length (5.00 cm) was recorded from the control (unfertilized) treatment. Tekulu *et al.* [29] reported the highest spike length (5.28 cm) in durum wheat at combined application of 92/46 kg N/P2O5 kg ha^{-1}.

3.3.4. Grain Yield (Kgha^{-1})

Main effect of NPSB and Urea rates significantly (P< 0.01) affected grain yield of bread wheat. Thus, the highest grain yield (5305.60 kg ha $^{-1}$) was obtained from application of 150 kg/ha of NPSB. Similarly, from application of 150kg/ha of Urea 5008 kg ha $^{-1}$graine yield. Whereas the lowest value (450 kg ha $^{-1}$) was recorded for the unfertilized plot (Table 6). The highest grain yield at the highest rates of NPSB and urea might have resulted from improved root growth, increased uptake of nutrients and better growth due to interaction/ synergetic effect of the four nutrients, which also enhanced the development of yield components.

3.3.5. Harvest Index (%)

Harvest Index (HI) was highly significantly (P<0.01) affected by NPSB and Urea. However, the interaction between NPSB and Urea was not significant (P>0.05). An increasing trend of harvest index was observed in response to application of higher rates of NPSB and urea fertilizer. The highest HI (60.22%) was obtained with application of 150 kg ha $^{-1}$ of NPSB whereas 59.23 % of HI was obtained from application of 150 kg ha $^{-1}$ urea. The lowest value (28.8%) was recorded for the control plot. The increment in harvest index at higher rate of NPSB and Urea might be attributed to greater photo assimilate production and its ultimate partitioning into grains compared to the straw part, i.e. proportionally higher grain yield than vegetative biomass yield.

3.3.6. Number of Seed Par Spike

The main effects of NPSB and Urea were highly significant (P < 0.01) for number of grains per spike of bread wheat. The highest number of Seed per spike (42.10) was recorded for application of 150 kg ha 1 of NPSB and 38.6 on taned from 150 kg ha 1 urea whereas the minimum value (35.00) was recorded for the control plot. Increases in number of grains per spike with increasing rate of NPSB might be due to the fact that P is essential in development of grains. Sigaye et a1 [30] has reported that B treatments resulted in a significant improvement in the number of kernels per spike. In general, number of seed per spike obtained from the fertilized plots exceeded the unfertilized/control plot by about 20 seeds.

Table 7. *Main effect o fNPSB and urea fertilizer rate on spikelength (cm), Grain yield (kgha^{-1}), Harvest Index (%) and Number of grain spike^{-1}(No)of bread wheat.*

NPSBfertilizerrate (kg ha $^{-1}$)	SL	GY	HI	NGPS (No)
50	5.61^{c}	3560.6^{c}	54.53^{b}	34.48^{c}
100	6.11^{b}	3898^{b}	50.99^{b}	37.08^{b}
150	7.11^{a}	5305.60^{a}	60.62^{a}	42.10^{a}
LSD (0.05)	0.47	214.7	3.49	0.86
P-Value	***	***	***	***
Ureafertilizerrate (Kgha1)				
50	5.89^{b}	2933.6^{c}	47.82^{c}	36.48^{c}
100	6.33b^{a}	4227.5^{b}	53.09^{b}	37.64^{b}
150	6.61^{a}	5008^{a}	59.23^{a}	38.53^{a}
LSD (0.05)	0.47	214.7	3.49	0.86
P-Value	*	***	***	***
TreatedmeanvsControl				
Treatedmean	6.28^{a}	4155.55^{a}	53.71^{a}	42.09^{a}
Control	5^{b}	450^{b}	28.8^{b}	37.6^{b}

NPSBfertilizerrate (kg ha $^{-1}$)	SL	GY	HI	NGPS (No)
LSD (0.05)	0.81	371.87	6.06	1.48
CV (%)	7.45	5.17	6.5	1.85

Means in the table followed by the same letter are not significantly different at 5% level of significance; No= Number, NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, DM=Days to maturity, SL=Spike Length, GY= Grain yield, HI=Harvest Index, NSPS=Number of seed Spike^{-1}, CV (%) = Coefficient of variation; LSD (0.05) = Least Significant Difference at 5% level of significance

3.3.7. Above Ground Biomass Yield (kg ha^{-1})

Both the main effects of blended NPSB and Urea and their interaction were highly significantly (P < 0.01) and significantly (P < 0.01), respectively, for aboveground dry biomass yield of wheat. The highest total aboveground dry biomass yield (10737.3 kg ha $^{-1}$ was recorded for plants supplied with 150 kg ha $^{-1}$ of NPSB combined with 150 kg ha $^{-1}$ of Urea. The lowest total aboveground dry biomass yield (5475 kg ha $^{-1}$) was obtained from the 50 kg ha $^{-1}$ of NPSB and 150 kg ha $^{-1}$ which is more than control (unfertilized) plot (1560). The increase in above ground dry biomass at the highest rates of NPSB and Urea might have resulted from improved root growth and increased uptake of nutrients, favoring better growth and delayed senescence of leaves of the crop due to synergetic effect of the four nutrients (NPSB). Generally, the increase in biomass yield with increasing rates of blended NPSB combined with Urea might be due to better crop growth rate, LAI and accumulation of photo-assimilate due to maximum days to maturity by the crop, which ultimately produced more biomass yield. Jasemi et al [31] have reported that vegetative growth and biological yields have much dependence on consumption of chemical fertilizers, as application of fertilizers led to increased biological yield of wheat.

Table 8. *Interaction effect of NPSB and urea fertilizer rates on aboveground biomass yield (kg ha^{-1}) of bread wheat.*

	Ureafertilizerrate(kgha1)		
NPSBFertilizerrates (kg ha $^{-1}$)	50	100	150
50	5475^{g}	7590^{d}	8225^{c}
100	5790^{f}	6880^{e}	7575^{d}
150	7062.7^{e}	9475^{b}	10737.3^{a}
LSD(0.05)	277.14		
P-value	***		
CV(%)	2.09		
Treated plot Vs Control			
Treated Mean	7545.56^{a}		
Control mean	1560^{b}		

Means followed by same letter are not significantly different at 5% P level; NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, CV (%) = Coefficient of variation; LSD (0.05) = Least Significant Difference at 5% P level

3.3.8. Straw Yield (kgha^{-1})

The result showed that straw yield of wheat was highly significantly (P < 0.01) affected by NPSB and urea rates. Similarly, the interaction of NPSB and urea was highly significant (P < 0.01) for straw yield. Higher straw yield (4351.1 kg ha $^{-1}$) was obtained from application of 150 kg ha $^{-1}$ of NPSB combined with 150 kg ha $^{-1}$ of Urea, whereas the lowest value (3015.70) was recorded from 50/50 kg ha $^{-1}$ NPSB/Urea which less than the control plot 3148.1 but statistically the same. Increase in straw yield in response to combined application of the highest rate of blended NPSB and Urea may be attributed to the synergetic roles of the four nutrients (NPSB) that played a significant role in enhancing growth and development of the crop

Table 9. *Interaction effect of NPSB and urea fertilizer rates on straw yield (kg ha^{-1}) of bread wheat.*

	Ureafertilizerrate(kgha1)		
NPSBFertilizerrates(kgha1)	50	100	150
50	3015.7^{b}	3921.4^{ba}	3671^{ba}
100	3019.5^{b}	2933.2^{b}	2598.3^{b}
150	3491.1^{ba}	4408^{a}	4351.1^{a}
LSD(0.05)	536.65		
P-value	***		
CV(%)	8.88		
Treatedplot Vs Control			
Treated Mean	3490.03^{a}		
Control mean	3148.1^{b}		

Means followed by same letter(s) are not significantly different at 5% P level; NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, CV (%) = Coefficient of variation; LSD (0.05) = Least Significant Difference at 5% P level

3.3.9. Thousand Kernel Weight (g)

The analysis of variance showed that the main effects of NPSB and Urea as well as their interaction were highly significant (P < 0.01) on the number of kernels per spike. The two fertilizers interacted significantly to influence the number of kernels per spike of bread wheat (Table 10). Thus; in general, increasing the rates of both NPSB and Urea increased the number of kernels produced per spike even though it was not consistent. Generally, the maximum numbers of kernels per spike (50.3) was produced at the combination of highest rate of NPSB fertilizers 150 kg ha^{-1} NPSB and Urea rates of 150 kg ha $^{-1}$ whereas the minimum number of kernels per spike (32.27) was produced at the lowest rates of 50 kg NPSB kg ha $^{-1}$ + 50 kg ha $^{-1}$ of the two fertilizers. This indicated that the number of kernels per spike was more enhanced by NPSB than Urea fertilizers which might be due to the fact that P is essential in development of seed and fruit. These also showed the synergistic effect of the two fertilizers resulting in increased kernel number per spike and grain production.

Table 10. *Interaction effect of NPSB and urea fertilizer rate on thousand kernelweight (g) per plant of bread.*

NPSBFertilizerrates(kgha1)	Ureafertilizerrate (kgha^{-1})		
	50	100	150
50	32.33^{c}	35.33^{cb}	36^{cb}
100	21.67^{cd}	30.83^{c}	39.18^{b}
150	28.18^{cd}	39.83^{b}	50.33^{a}
LSD(0.05)	3.32		
P-value	***		

NPSBFertilizerrates(kgha1)	Ureafertilizerrate (kgha^{-1})		
	50	100	150
CV(%)	5.51		
Treated plot VsControl			
Treated Mean	34.85[a]		
Control mean	33.00[a]		

Means followed by same letter(s) are not significantly different at 5% P level of significance; NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, CV (%) = Coefficient of variation; LSD (0.05) = Least Significant Difference at 5% P level

3.3.10. Soil Characteristics After Wheat Harvest

The soil pH, OC %, values did not show significant difference due to application of NPSB and Urea fertilizers However, the status of pH, Organic Carbon increase after harvest on all treatments. This was due to the effect of liming, as lime reacts with water leading to the production of OH^- and Ca^{2+} ions which displace H^+ and Al^{3+} ions from soil adsorption sites resulting in an increase in soil pH and decrease in Exchangeable acidity. The analysis of variance indicated that there was no significant effect of blended NPSB and Urea fertilizer rates as well as their interaction on total nitrogen, available phosphorus, sulfur, and boron.

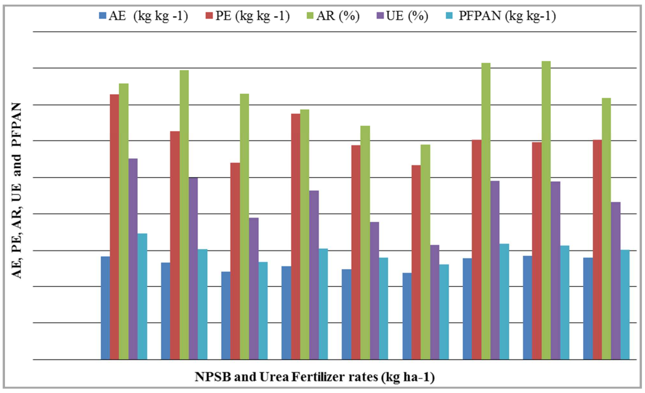


Figure 3. Effect of NPSB and Urea fertilizers on selected soil physicochemical properties after harvest.

TN=Total Nitrogen, AVP=Available Phosphorus, AVS=Availble sulfer, AVB=Anailable boron NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer

3.4. Nutrient Use Efficiency

3.4.1. Effectsof NPSB and Urea Nutrients Concentration in Grain and Straw

The results showed that the concentration of N in bread wheat grain and straw were significantly ($P \leq 0.01$) influenced by the application of NPSB and Urea (Table 2). The concentration of N in the grain varied from 1.2 % to 1.84% whereas, the concentration of N in straw was changed in a slimmer range to 0.20% to 1.56%. The maximum (1.84 % and 1.56%) N concentrations in grain and straw were obtained from the application of 100 kg ha^{-1} NPSB and 100 Urea fertilizers respectively (Table 11). However, the minimum N concentration in grain (1.20%) and straw (0.20 %) was obtained in the control or unfertilized treatment. This is due to increasing nitrogen fertilization also increased N concentration in grain and straw. This result also agrees with, Balemi et al [33] who found the use of fertilizers containing sulfur affects the greater the accumulation of N in the grain. Mean-while, Gebreslasie et al [16] stated that spring wheat fertilization with S resulted in a significant increase in N content in the straw compared with control. This is because of the interaction of these elements at the level of the many metabolic processes is reflected in the growth and development of crops, which ultimately affects the level and quality of their yield.

3.4.2. Effectsof NPSB and Urea on Grain Protein Content (GPC)of Bread Wheat

Protein content due to main and their interaction effect of NPSB and Urea showed highly significant ($P < 0.01$) difference. Application of NPSB at 150 and 150 kg ha^{-1} increased the grain protein content of wheat by 6.17 and 7.7% over control respectively. This indicates that application of NPSB different levels increased grain protein content of wheat over control. Similarly, grain protein content was varied with Urea levels. Accordingly, the highest protein contain (15.5%) was obtained from 150 kg ha^{-1} urea. While lowest (7.8%) was obtained from control plot. In case of NPSB the highest protein content (13.97%) obtained from treatment that received at 150 kg ha^{-1} of NPSB. The second highest protein content (13.96%) was recorded at 100 kg ha^{-1} NPSB but statistically similar with 50 kg NPSB ha^{-1} (13.04%). This implies that application of NPSB beyond 50 kg ha^{-1} not significantly increased grain protein content. In contrast the lowest protein grain content obtained in control.

The data on grain protein content influenced by NPSB and Urea interaction are presented on Table 11. The combined application of 100 kg NPSB ha-1 with 100 kg Urea ha^{-1} produced maximum grain protein content (16.22%). This treatment has a grain protein content increment of 8.42% over control treatment. The minimum grain protein content (7.8%) was recorded in control plot. This implies that combined application of NPSB with Urea improves grain protein content of bread wheat than individual application of NPSB and Urea.

Table 1. Effect of NPSB and urea fertilizer rate on Nutrient Concentration (Grain and straw)and Grain Protein content of bread wheat.

NPSBandUrea (Kg ha^{-1})	NCG (Kgha^{-1})	NCS (Kgha^{-1})	GPC (%)
0.00	1.20	0.20	7.80
50+50	1.11	0.73	10.49
50+100	1.18	1.09	12.89
50+150	1.42	1.35	15.75
100+50	1.20	0.82	11.48
100+100	1.32	1.17	14.19
100+150	1.38	1.47	16.22
150+50	1.28	1.06	13.32
150+100	1.31	1.16	14.06
150+150	1.30	1.25	14.53

NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, NCG=nutrient concentration ingrain, NCS=Nutrient concentration in straw and GPC= grain protein content

3.4.3. Nutrients Uptake in Grain and Straw

The results presented in Tables 3 indicate that the application of NPSB and different level of Urea fertilizers had significantly influence on the uptake of N in Bread wheat grain and straw. The maximum N uptake by grain (64.9 kg ha^{-1}) and Straw (47.5 kg ha^{-1}) was obtained from the application of 150 kg ha^{-1} NPSB and 150 kg ha^{-1} Urea fertilizers respectably (Figure 4). While the lowest N uptake by grain (10.76 kg ha-1) and straw (4.64kg ha^{-1}) were obtained from control or unfertilized treatment. This is because of a greater N uptake was observed when NPSB and Urea fertilizer rate was increased. Likewise, the results showed an evident NPSB and Urea synergism since the addition of S and B boosted N uptake as NPSB fertilizer rates increased. Also, the productivity of the crop is directly associated with the accumulation of N nutrient in the crop, the productivity of the crop i.e. treatment that accumulates maximum N nutrient gave the highest yield. The maximum yield associated with the highest dry matter production and straw N-uptake increased significantly with the optimum nutrient application. Mesfin et al., [35] reported that adequate and blended form of fertilizer absolutely enhances the total nutrient uptake of N. Nitrogen uptake is positively related to the grain yield in crops and understanding the N uptake yield relationship and quantifying N requirements would be of great benefit for optimizing N fertilization for annual crops [16].

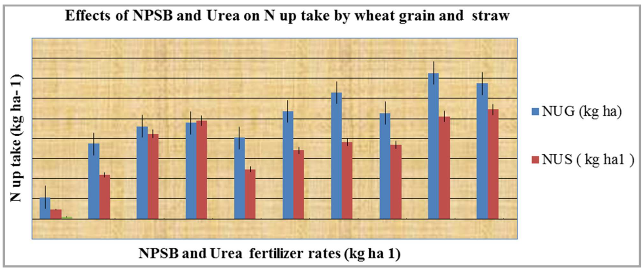


Figure 4. *Effect of NPSB and Urea fertilizers on Nutrient up take (grain and straw) kg ha $^{-1}$.*

NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, NUG=nutrient uptake by grain and NUS=Nutrient uptake by straw

3.4.4. Agronomic Efficiency (kg kg^{-1})

Main of NPSB was significant (p<0.05) for agronomic efficiency. Thus, the highest agronomic efficiency (28.30 kg kg^{-1}) was obtained from the lowest rate of 50 NPSB kg ha^{-1}) while the lowest agronomic efficiency of 23.70 kg kg^{-1} was recorded for application of urea at the highest rate 100 kg ha $^{-1}$ of NPSB (Figur 5). The result of the present study showed that agronomic efficiency tended to decrease in response to higher rates of NPSB and Urea Fertilizer application. This suggests that application of excess nutrients was not effectively utilized by the crop and the rate of production was lesser per unit of nutrient applied [36]. Similarly, Abdeta et al [18] have reported that agronomic efficiency of nitrogen exhibited a decreasing trend in response to higher rates of application. Zemichael et al [37] reported agronomic efficiency of applied Nitrogen exhibited a decreasing trend in response to higher Nitrogen application rates.

3.4.5. Physiological Efficiency (kg kg^{-1})

Main effect of Urea and interaction effects of NPSB and Urea fertilizer treatments were significant for physiological efficiency (P < 0.01). It was observed that application of 50 kg ha $^{-1}$ NPSB and Urea resulted in the highest physiological efficiency (73.83 kg kg^{-1}) whereas the application of 100 Kg ha $^{-1}$ NPSB fertilizers with 150 kg ha^{-1} were gave the lowest value (53.39 kg kg $^{-1}$) (Figur 5). The observed higher physiological efficiency at lower rates of fertilizer application might be due to relatively higher yield produced with low absorption of N. In line with this, Segaaye *et al*. [38] have reported that physiological efficiency of wheat was found to reduce progressively as the rate of nitrogen application increased. On the other hand, the lower physiological efficiency at higher fertilizer rates might indicate that the crop did not utilize the absorbed N for the production of maximum grain yield [18].

3.4.6. Apparent Recovery Efficiency (%)

Main effects of NPSB and Urea fertilizer were highly significant (p<0.01) for apparent recovery efficiency. The highest apparent recovery efficiency (78.47%) was obtained from 150 Kg ha^{-1} of NPSB (Figur 5) while 75.37% was obtained from 50 kg ha^{-1}. However, the lowest apparent recovery (63.98%) was obtained from 100 kg ha^{-1} of NPSB. The recovery of any nutrient applied shows the nutrient supplying capacity of soil and the inherent capacity of the plant to utilize nutrients. It also depends on the growing environment, plant population and method of application of fertilizer [39]. In agreement with the present result, Mulugeta *et* [40] and Gesesse [30] have reported that apparent recovery efficiency of wheat showed decreasing trend as N rates increase.

3.4.7. Utilization Efficiency (%)

Application of NPSB and Urea application rate interacted to significantly influence utilizationefficiency during growing season (Figur 5). The highest utilization efficiency of 55.14 kg kg^{-1} was obtained with the application of 50/50 kg ha $^{-1}$ NPSB/Urea where as lowest utilization efficiency 31.49 kg kg^{-1} with application of 100/150 NPSB/Urea kg ha^{-1}. The utilization efficiency obtained from the application 100 kg ha^{-1} and 150 kg ha^{-1} urea applied was statistically at par. However, utilization efficiency decreased with increasing rate of NPSB and Urea from 50 to 150 kg ha^{-1} application. Getaneh & Laekemariam, [42] reported Utilization efficiency declined sharply when N rate was raised from 60 to 90 kg ha^{-1}.

3.4.8. Partial Factor Productivity of Applied Nitrogen

The result revealed that partial factor productivity of applied N was highly significantly (P < 0.01) influenced by NPSB and urea. Partial factor productivity of applied nitrogen, decreased as the level of NPSB and Urea increased from the lowest to highest. Thus the highest Partial factor productivity of applied nitrogen (34.64 kg kg $^{-1}$) was obtained from the lowest 50/50 kg/ha NPSB/urea while the lowest (26.06 kg kg $^{-1}$) was recorded by 100/150kg ha $^{-1}$. As the NPSB fertilizer rate increased, there was decrease trend in partial factor productivity of N indicating a gradual loss of N efficiency [43]. Decline in partial factor productivity at higher level N may be attributed to nutrient imbalance and decline in indigenous soil N supply [42]. The current result is in Tasfeye Balemi [31] who reported that increase the level of nitrogen decrease partial factor productivity N of bread wheat.

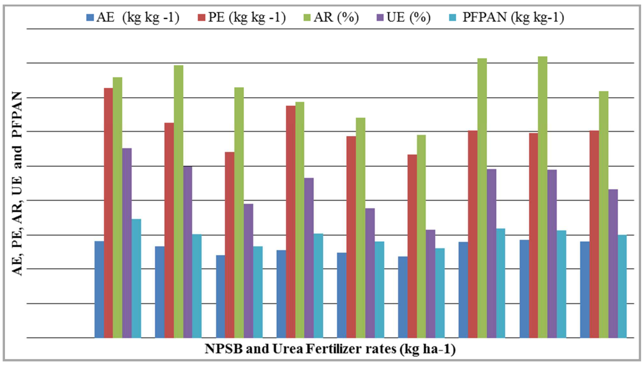


Figure 5. *Effect of NPSB and Urea fertilizer rate on Nitrogen Use efficiency.*

NPSB= Nitrogen, Phosphorus, Sulfur and Boron blended fertilizer, AE=Agronomic Efficiency, PE = Physiological Efficiency, AR=Agronomic Recovery, UE=Utilization efficiency, PFPAN= Partial factor productivity of applied Nitrogen

3.5. Correlations Coefficient of Selected Parameters

The result of correlation analysis revealed that there is positive and significant correlation among other parameters. Thus, grain yield has positive and strong association with Biomass yield (r=0.96***), Straw yield (r=0.74***), Total Nutrient content (r= 0.87***) protein content (r= 0.87***), nutrient up take by grain (r=97***), Nutrient Up take by straw (r= 0.92), Total nutrient uptake (r=0.98***), Agronomic Efficiency (r=69***). Again grain yield has positive and smoothly association with Physiological Efficiency (r=0.53**), Agronomic recovery (r=64**), Partial factor productivity of applied Nitrogen (r=0.61**) and week associated with utilization efficiency (r=0.47*) (Table 12). Similarly, Grain protein content was positively strongly associated with Nutrient uptake by grain (r=0.92***), nutrient uptake by straw (r=0.82***), total nutrient uptake (r=0.91***). On the same manner Agronomic efficiency positively strongly associated with physiological efficiency (r=0.94***), Agronomic Recovery (r=0.95***), Agronomic utilization efficiency (r=93***) and Partial factor productivity of applied Nitrogen (r=0.99***). In addition, Mengie et al [18] have found a positive and significant correlation between grain yield and those yield components parameters.

Table 12. *Correlation coefficient between selected mean yield and yield components of wheat.*

	GY	BMY	SY	TNC	GPC	NUG	NUS	TNU	AE	PE	AR	UE	PFPAN
GY	1												
BMY	0.96***	1											
SY	0.74***	0.89***	1										
TNC	0.87***	0.81***	0.57**	1									
GPC	0.87***	0.81***	0.57**	1	1								
NUG	0.97***	0.91***	0.65***	0.92***	0.92***	1							
NUS	0.92***	0.98***	0.90***	0.82***	0.82***	0.87***	1						
TNU	0.980***	0.96***	0.78***	0.91***	0.91***	0.97***	0.95***	1					
AE	0.69***	0.77***	0.78***	0.66***	0.66**	0.63**	0.71***	0.68**	1				
PE	0.53**	0.63***	0.72***	0.49*	0.49*	0.43*	0.57***	0.51**	0.94***	1			
AR	0.64**	0.76***	0.85***	0.64*	0.64**	0.59**	0.74***	0.67**	0.95***	0.90***	1		
AU	0.47*	0.63**	0.79***	0.42*	0.42*	0.38*	0.59**	0.48*	0.93***	0.95***	0.96***	1	
FA	0.61**	0.69***	0.74***	0.58**	0.58**	0.53**	0.63*	0.59**	0.99***	0.97***	0.952***	0.96***	1

GY=Grain yield, BMY=biomass yield, SY=Straw Yield, TNC=Total nutrient concentration, GPC=Grain protein contain, NUG=Nutrient uptake by grain, NUS=Nutrient uptake by straw, AE=Agronomic Efficiency, PE=Physiological Efficiency, AR=Agronomic Recovery, UE=Utilization efficiency, PFPAN= Partial factor productivity of applied Nitrogen, *, ** and ***, significant higly significant and very higly significant respectively

3.6. Partial Budget Analysis

Partial budget analysis allows evaluating impact of a change in the production system on farmer's net income without knowing all his costs of production. Data related to partial budget analysis is given in (Table 13). The maximum net benefit (100328.24 ET Birr) was obtained from combined application of NPSB and Urea at the rate of 150 kg NPSB and 100 kg ha $^{-1}$ Urea and followed by rate of 100 NPSB kg ha $^{-1}$ and 150 kg ha $^{-1}$ Urea (96681.32 ET Birr). Minimum net benefit (10108.8 ET Birr.) was recorded in control.

Depend on dominancy analysis, treatments with 100 kg ha $^{-1}$ NPSB with 50 kg ha $^{-1}$ Urea, 100 kg ha $^{-1}$ NPSB with 100 kg ha $^{-1}$ Urea, 150 kg ha $^{-1}$ NPSB with 50 kg ha $^{-1}$ urea and control were dominated by the rest six treatments and they were also excluded from further economic analysis. Data regarding the marginal rate of return (MRR) revealed that maximum MRR (3818.76%) was obtained when NPSB and Urea was applied at the combined rate of 150 kg ha $^{-1}$ NPSB and 100 kg ha $^{-1}$ Urea followed by rate of 100 kg ha $^{-1}$ NPSB without 150 kg ha $^{-1}$ Urea (3262.55%). Minimum MRR was (2120.34%) recorded in treatment where application of NPSB at 50 kg ha $^{-1}$ with 50 kg ha $^{-1}$ Urea.

Data clearly revealed that non dominated treatments associated with MRR are greater than 100%. This implies that the six non-dominated treatments are economically feasible alternative to the other dominated treatments. The marginal rate of return, 38 19 % means the producer obtained an additional income of 38.19 Ethiopian birr per a unite cost they have invested. Generally, treatment combination of NPSB and Urea at 150 kg ha $^{-1}$ NPSB and 100 kg ha $^{-1}$ Urea gave better MRR value relative to the other six non-dominated treatments and profitability can be optimized by using this treatment.

Table 13. *Partial budget Analysis for NPSB and Urea fertilizers on the studied area.*

NPSB	UREA	AGY	ASY	GFB	TVC	NB	MRR%
0	0	405	999	10108.8	0	10108.8	D
50	50	2213.37	2714.13	51951.1	1884.5	50066.6	2120.34
50	100	3301.74	3529.26	76873.39	2779	74094.39	2686.17
100	50	2493.45	2717.55	58116.96	2874.5	55242.46	D
50	150	4098.6	3303.9	94133.88	3673.5	90460.38	4407.75
100	100	3552.12	2639.88	81314.5	3769	77545.5	D
150	50	3213.96	3142.44	74478.05	3864.5	70613.55	D
100	150	4479.03	2338.47	101344.82	4663.5	96681.32	3262.55
150	100	4560.3	3967.2	105087.24	4759	100328.24	3818.76
150	150	5747.4	3916.2	131142.24	5653.5	125488.74	2812.80

Note:- Ad GY=Adjusted grain yield kg ha^{-1}, GB= Gross Benefit, AdSY=Adjusted Straw Yield kg ha^{-1}, TVC= Total Variable Cost; NB: Net Benefit; MRR: Marginal Rate of Return, D: dominated

4. Conclusion and Recommendation

Understanding Fertilizer recommendation of a given area has vital role in enhancing crop production and productivity on sustainable basis. Extreme use of NPSB and Urea fertilizers is economically, unfavorable, because incremental increases in yield diminish with increasing amounts of NPSB and Urea applied, and it could lead to detrimental effects on the quality of soil and water resources. Therefore, application of NPSB and Urea fertilizer at the right rate is vital for the enhancement of soil fertility and crop productivity. The results of this study indicated significant effects of NPSB and Urea fertilizer rate on heading date, maturity date, spike length, plant height, seed spike $^{-1}$, grain yield, total aboveground biomass yield, harvest index, thousand kernel weight, nutrient concentration in gain, nutrient concentration in straw, nitrogen uptake by grain, nutrient uptake by straw N agronomic efficiency, N physiological Efficiency, N apparent recover and N utilization efficiencies and N protein concentration. Among the NPSB and Urea fertilizer application rates 150 kg ha $^{-1}$ was found to produce higher Yield and yield related parameter. Likewise, higher protein concentration and utilization efficiency by synchronizing of fertilization to the crop demand resulting into high yield. Increased NPSB and Urea application rate is considered as a primary means of increasing wheat grain protein concentration in relation to improving human nutrition and food security in which cereal grains are the major source of protein for human consumption in the study area. The results of the economic analysis indicated that applying 150 kg ha^{-1} NPSB and urea resulted in the highest rate of marginal return performed best. Therefore, 150 NPSB and 100 kg ha^{-1} urea guarantee higher wheat yield and provided the highest economic advantage and can be suggested for the farmers in the study area.

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Conflicts of Interest

The all authors declare that there is no conflict of interest regarding the publication of this article.

References

[1] A. K. Bhardwaj, D. Rajwar, R. K. Yadav, S. K. Chaudhari, and D. K. Sharma, “Nitrogen Availability and Use Efficiency in Wheat Crop as Influenced by the Organic-Input Quality Under Major Integrated Nutrient Management Systems,” Front. Plant Sci., vol. 12, no. May, pp. 1–12, 2021.

[2] M. Nigus, H. Shimelis, I. Mathew, and S. Abady, “Wheat production in the highlands of Eastern Ethiopia: opportunities, challenges, and coping strategies of rust diseases,” Acta Agric. Scand. Sect. B-Soil Plant Sci., vol. 72, no. 1, pp. 563–575, 2022.

[3] O. Erenstein, M. Jaleta, K. A. Mottaleb, K. Sonder, J. Donovan, and H.-J. Braun, “Global trends in wheat production, consumption and trade,” in Wheat Improvement: Food Security in a Changing Climate, Springer International Publishing Cham, 2022, pp. 47–66.

[4] T. Yimenu and B. Getachew Bekele, “Effect of Seed Rate and Blended NPSB Fertilizer on Yield and Yield Component of Bread Wheat (Triticum Astivum L.) in Ayehu Guagusa, North West Ethiopia,” vol. 9, no. 8, pp. 2688–2699, 2021.

[5] T. Gemechu and F. Tadese, “Participatory Evaluation and Demonstration of Bread Wheat (Triticum aestivum L) Varieties at Dugda and Lume Districts, Oromia Regional State, Ethiopia,” vol. 4, no. 7, pp. 26–30, 2018.

[6] T. Godebo, F. Laekemariam, and G. Loha, “Nutrient uptake, use efficiency and productivity of bread wheat (Triticum aestivum L.) as affected by nitrogen and potassium fertilizer in Keddida Gamela Woreda, Southern Ethiopia,” Environ. Syst. Res., vol. 10, pp. 1–16, 2021.

[7] B. Zemichael, N. Dechassa, and F. Abay, "Yield and Nutrient Use Efficiency of Bread Wheat (Triticum Aestivum L.) as Influenced by Time and Rate of Nitrogen Application in Enderta, Tigray, Northern Ethiopia," Open Agric., vol. 2, no. 1, pp. 611–624, 2017.

[8] T. Tanto and F. Laekemariam, "Impacts of soil and water conservation practices on soil property and wheat productivity in Southern Ethiopia," Environ. Syst. Res., vol. 8, no. 1, pp. 1–9, 2019.

[9] T. Tufa, T. Abera, T. Midega, A. Adugna, H. Legesse, and B. Tola, "Nitrogen Use Efficiency and Performance of Wheat Crop Through Application of Urea Stable and Conventional Urea in Vertisols of Ambo District," Plant, vol. 8, no. 3, p. 72, 2020.

[10] G. Agegnehu, C. Yirga, and T. Erkossa, Soil Acidity Management, no. February 2019.

[11] T. Tesfaye, F. Laekemariam, and A. Habte, "Response of Bread Wheat (Triticum aestivum L.) to Potassium (K) and Blended NPS Fertilizer Rates in the Nitisols of Southern Ethiopia," Appl. Environ. Soil Sci., vol. 2021, 2021.

[12] Y. Melaku, S. Singh, and W. Wondimu, "Agrophysiological changes caused by farmyard manure and NPS fertilizer enhance yield and economic return from maize (Zea mays L.) cultivation in acidic soil," Trop. Agric., vol. 98, no. 1, pp. 28–37, 2021.

[13] D. Abdisa Jalata, A. Gobena Roro, A. Hunduma Dabalo, F. Asefa Bebayehu, and A. T. Woticha, "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," Adv. Agric., vol. 2022, 2022.

[14] M. Misgana, H. Ashagre, and T. Debele, "Effect of Blended NPSZnB Fertilizer Rates on Yield and Yield Components of Bread Wheat (Triticum aestivum L.) Varieties in Mao-komo, Benshangule Gumuz Regional State," Int. J. Appl. Agric. Sci., vol. 8, no. 1, p. 24, 2022.

[15] N. Gebreslasie, T. Shimgabr, H. Alene, N. Tsegay, and W. Haftu, "Effects of Nitrogen on Yield and Yield Components of Wheat (Triticum aestivum L.) under NPSB Blended Fertilizer in Tsegedie and Welkait Districts, Western Zone Tigray, Ethiopia," Asian J. Soil Sci. Plant Nutr., vol. 6, no. 1, pp. 31–38, 2020.

[16] E. Elias, B. Teklu, and T. Tefera, "Effect of blended fertiliser application on bread wheat yield, agronomic efficiency, and profitability on Nitisols of Southern Ethiopia," South African J. Plant Soil, vol. 37, no. 4, pp. 292–299, 2020.

[17] A. Abdeta, S. Tulu, and G. Berecha, "Phenology, Growth, Yield, Nutrient use Efficiency and Economic Feasibility Response of Bread Wheat (Triticum aestivum L.) to NPSB and N Fertilize Rates Under Limed Condition in Gechi District, Southwestern Ethiopia," Int. J. Agric. Innov. Res., vol. 11, no. 1, pp. 8–23, 2022.

[18] N. K. Fageria and V. C. Baligar, "Improving nutrient use efficiency of annual crops in Brazilian acid soils for sustainable crop production," Commun. Soil Sci. Plant Anal., vol. 32, no. 7–8, pp. 1303–1319, 2001.

[19] C. E. Program, I. Maize, and W. I. Center, From agronomic data to farmer recommendations: an economic training manual, no. 27. CIMMYT, 1988.

[20] M. Tekalign and I. Haque, "Phosphorus status of some Ethiopian soils, II. Forms and distribution of inorganic phosphates and their relation to available phosphorus," Trop. Agric., vol. 68, no. 1, pp. 2–8, 1991.

[21] S. I. S. Ethio, "Soil fertility status and fertilizer recommendation Atlas for Tigray regional state, Ethiopia," EthioSIS, Addis Ababa, 2014.

[22] R. H. Bray, "A nutrient mobility concept of soil-plant relationships," Soil Sci., vol. 78, no. 1, pp. 9–22, 1954.

[23] A. Ayalew, S. Beyene, and F. Walley, "Characterization and classification of soils of selected areas in southern Ethiopia," J. Environ. Earth Sci., vol. 5, no. 11, pp. 116–137, 2015.

[24] M. T. Awulachew, "Grain quality and yield response of bread wheat (Triticum aestivum L.) varieties to different rates of blended fertilizer at Kulumsa, South-eastern Ethiopia," J. Agric. Sci. Pract., vol. 4, no. 4, pp. 120–133, 2019.

[25] S. Dargie, "Balanced fertilization increases wheat yield response on different soils and agroecological zones in Ethiopia," Exp. Agric., vol. 58, no. July, 2022.

[26] A. Feyisa Bededa, "Effects of Blended NPSB Fertilizer Rates On Growth, Yield Components and Yield of Bread Wheat (Triticum aestivum L.) Varieties At Degam District, Central Ethiopia." Haramaya University, 2020.

[27] K. Tekulu et al., "Evaluation of NPSZnB fertilizer levels on yield and yield component of maize (Zea mays L.) at Laelay Adiyabo and Medebay Zana districts, Western Tigray, Ethiopia," J. Cereal Oilseeds, vol. 10, no. 2, pp. 54–63, 2019.

[28] M. H. Sigaye, A. Nigussie, R. Mekuria, and K. Kebede, "Response of Bread Wheat (Triticum aestivum L.) to NPSB Blended and Urea Fertilizers on Nitisols of Bule District," Results Nat. Resour. Manag. Res., 2020.

[29] W. S. Gessesew, E. Elias, G. Gebresamuel, and W. Tefera, "Soil type and fertilizer rate affect wheat (Triticum aestivum L.) yield, quality, and nutrient use efficiency in Ayiba, northern Ethiopia," PeerJ, vol. 10, 2022.

[30] S. S. Jasemi, G. A. Akbari, G. A. Akbari, G. Najafian, and F. Moradi, "Nutrition management effects on grain yield, yield components and some physiological characteristics of bread wheat cultivars," Int. J. Appl. Agric. Res., vol. 5, no. 3, pp. 1–6, 2014.

[31] T. Balemi, "Yield Response and Nutrient Use Efficiencies under Different Fertilizer Applications in Maize (Zea mays L.) In Contrasting Agroecosystems," Int. J. Plant Soil Sci., no. August 2020, pp. 1–19, 2019.

[32] J. Rurinda, "Science-based decision support for formulating crop fertilizer recommendations in sub-Saharan Africa," Agric. Syst., vol. 180, p. 102790, 2020.

[33] T. Mesfin, W. Haile, and S. Kassa, "Effects of Nitrogen and Blended Fertilizers on Yield and Yield Components of tef [(Eragrostis tef (Zucc.) Trotter] in Central Highlands of Ethiopia," Int. J. Adv. Agric. Sci. Technol., vol. 6, no. 8, pp. 15–64, 2019.

[34] S. Mesfin, M. Haile, G. Gebresamuel, A. Zenebe, and A. Gebre, "Establishment and validation of site-specific fertilizer recommendation for increased barley (Hordeum spp.) yield, northern Ethiopia," Heliyon, vol. 7, no. 8, p. e07758, 2021.

[35] A. Sarker, A. Kashem, and K. T. Osman, "Influence of city finished compost and nitrogen, phosphorus and potassium (NPK) fertilizer on yield, nutrient uptake and nutrient use efficiency of radish (Raphanus sativus L.) in an acid soil," Int. J. Agric. Sci., vol. 2, pp. 315–321, 2012.

[36] M. H. Sigaye, R. Mekuria, and K. Kebede, "Effect of NPS-B Blended and Nitrogen Fertilizers Application on Bread Wheat Yield and Economic Profitability on Nitisol of Southern, Ethiopia," Int. J. Food Sci. Agric., vol. 6, no. 2, pp. 160–168, 2022.

[37] A. Kumar, "Does a plant growth-promoting rhizobacteria enhance agricultural sustainability," J. Pure Appl. Microbiol., vol. 9, no. 1, pp. 715–724, 2015.

[38] S. Mulugeta, "Effect of Time and Rate of Nitrogen Fertilizer Application on Growth and Yield Components of Bread Wheat (Triticum Aestivum L.) In Burie District, West Gojjam Zone, Northwestern Ethiopia." 2019.

[39] L. Getaneh and F. Laekemariam, "Response of Potato (Solanum tuberosum L.) to NPS Fertilizer Rates and Inter-Row Spacing in Kechi District, South Western Ethiopia," Appl. Environ. Soil Sci., vol. 2021, 2021.

[40] H. Feyisa, G. Mengistu, A. Biri, and T. Chimdessa, "Grain Yield and Yield Related Traits of Bread Wheat as Influenced by N and Seeding Rates and Their Interaction Effects in 2020 under Irrigation at Western and North of Oromia, Ethiopia," Int. J. Agron., vol. 2023, 2023.

[41] W. Assefa and M. Adhiena, "Agronomic and economic evaluation of nitrogen fertilizers types and levels on bread wheat (Triticum Aestivum L.) in the Vertisols of northern highlands of Ethiopia," J. Dryl. Agric., vol. 7, no. 4, pp. 60–66, 2021.

[42] M. H. Sigaye, "Nutrient uptake and use efficiency of food barley (Hordeum vulgare L.) as influenced by NPS and NPSB blended fertilizers," Int. J. Innov. Agric. Biol. Res., vol. 8, no. 3, pp. 7–16, 2020.

[43] A. E. L. Sabagh, "Potential role of plant growth regulators in administering crucial processes against abiotic stresses," Front. Agron., vol. 3, p. 648694, 2021.