International Journal of Applied Agricultural Sciences
2022; 8(1): 24-40
http://www.sciencepublishinggroup.com/j/ijaas
doi: 10.11648/j.ijaas.20220801.14
ISSN: 2469-7877 (Print); ISSN: 2469-7885 (Online)

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

Mathewos Misgana[1], Habtamu Ashagre[2], Tadesse Debele[2]

[1]Ethiopian Institute of Agricultural Research, Assosa Agricultural Research Center, Assosa, Ethiopia
[2]Department of Plant Science, Ambo University, Ambo, Ethiopia

Email address:
matewos.misgana@gmail.com (M. Misgana)

To cite this article:
Mathewos Misgana, Habtamu Ashagre, Tadesse 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. *International Journal of Applied Agricultural Sciences.* Vol. 8, No. 1, 2022, pp. 24-40. doi: 10.11648/j.ijaas.20220801.14

Received: December 6, 2021; **Accepted**: January 21, 2022; **Published**: January 28, 2022

Abstract: Bread wheat (*Triticum aestivum* L.) is the most important cereal crop in the Poaceae (*Gramineae*) family originated in the Near-Eastern Fertile Crescent in the Middle East. It is the second most influential staple food crop after rice, grown in 89 countries with climates ranging from temperate to tropical but the production did not meet demand. The field experiment was conducted during 2020 cropping season in Mao-Komo District, western Ethiopia to evaluate the effects of blended NPSZnB fertilizer on bread wheat varieties. The experiment consisted of five levels of NPSZnB (0, 100, 150, 200, 250 kg ha^{-1}) and four bread wheat varieties Kingbird, Danda, Shorima and Ogolcho combined factorially and laid out in Randomized Complete Block Design with three replications. Days to 90% maturity were delayed with increased rates of fertilizer for all varieties. The highest mean plant height (81.4cm), number of grains per spike (52.5), and harvest index (39%), leaf area (30.15cm^2), total tillers (6.29), productive tillers (6.1), grain yield (3.54), thousand grain weight (33.83g) and hectoliter weight (81.2) were obtained at 200 kg ha^{-1} NPSZnB with Kingbird variety. Moreover, the highest straw yield (7.53t ha^{-1}) and spike length (8.2 cm) were recorded at 200 kg NPSZnB ha^{-1} with Danda variety. The highest biomass (9.97 tha^{-1}) and hectoliter weight (81.2) were obtained at 250 kg ha^{-1} NPSZnB with Ogolcho and Kingbird varieties, respectively. The maximum net benefit (85047ETB ha^{-1}) was obtained due to use of 200 kg ha^{-1} NPSZnB with Kingbird bread wheat variety. Due to soil acidity of the study area, use of integrated soil fertility management practices is important to improve the production and productivity of bread wheat.

Keywords: Blended Fertilizer, Economic Feasibility, Grain Yield, Straw Yield, Variety

1. Introduction

Bread wheat (*Triticum aestivum* L.) is the most important cereal crop in the Poaceae (*Gramineae*) family originated in the Near-Eastern Fertile Crescent in the Middle East about 10,000 years ago [28, 58]. It is the second most influential staple food crop after rice, grown in 89 countries with climates ranging from temperate to tropical [41]. It is produced on about 221 million hectares of land, resulting in 728.9 million tons of food grains with a global productivity of 36.2 q ha^{-1} [41].

Accordind to [58], Africa produces more than 25 million tons of wheat from 10 Mha. Sub-Saharan Africa (SSA) produced about 7.5 MT of wheat from a total area of 2.9 Mha, accounting for 40 and 1.4 percent of Africa's and the world's wheat production, respectively [35]. Based on the level of production, many African countries are producing wheat for both consumption and sales. Ethiopia, South Africa, Sudan, Kenya, Tanzania, Nigeria, Zimbabwe, and Zambia are the most dominant wheat producing countries in SSA [2].

In Ethiopia, bread wheat is the fourth most important cereal crop by area coverage, with 1.70 million ha after *tef*, maize, and sorghum [21]. Bread wheat accounts for about 80% of the wheat area in Ethiopia, while tetraploid wheat (durum wheat and landraces) produced in regions [56]. For instance, Ethiopia harvested 4.6 million metric tons of wheat in SSA in 2017 [23]. Wheat is grown in Ethiopia at altitudes ranging from 1500 to

3000 meters above sea level, and it is grown entirely by rain. The best sites, however, ranges between 1900 and 2700 meters above sea level [57].

Wheat production in the country is primarily of dominated by a subsistence character, dominated by the country's numerous smallholder farmers, home consumption and less for market and produced with low inputs in puts under rain feed conditions [45]. It is apparent that Ethiopia's wheat production has been dominated by subsistence farming, with low productivity and production.

Farmers in Ethiopia had been using blanket fertilizer recommendations such as 100 kg Urea + 100 kg DAP ha^{-1} to grow cereal crops such as bread wheat. Mineral fertilizer applied in a balanced manner has been shown to increase crop yields while reducing nitrogen (N) and phosphorous (P) losses to the environment [46]. Chemical fertilizers, notably DAP and Urea, were employed for major crop production, including wheat, in Ethiopia for decades. Taking this into account, Ethiopia's Agricultural Transformation Agency [30] advised that the soil fertility management system be improved overall by including more nutrients in the fertilizer program. The ATA, for example, recommended NPS, NPSB, NPSBCu, NPSCu, and NPSZnB blended fertilizers for use in several parts of the country, including the Benishangul Gumuz region [30].

The rate of blended fertilizer required for wheat production in western parts of Ethiopia is not determined and need more effort. Moreover, essential micronutrients required for successful plant growth and good productivity have never been included in the fertilizer program of Ethiopia. Furthermore, unbalanced application of plant nutrients may exacerbate the depletion of other important nutrient elements in soils such as K, Mg, Ca, S and micronutrients [66]. As a result of the widespread adoption of wheat varieties, the average yield of wheat-producing farmers is around 2.7 tons per hectare [21], which is significantly lower than the yields achieved at research stations and on farms, which is 7 and 6 tons per hectare, respectively [48]. In a similar trend, from Benishangul Gumuz regional State, Mao-komo district is one of the potential district for bread wheat production about 2.76 tons per hectare of average yield which shows lower than potential yield due to nutrient deficiency problem [22].

Out of 20 districts of the region, Mao-komo district has huge potential in wheat, sorghum, maize and other cereal crop production. However, traditional ways of production system is the dominant practice in the district that lead to low productivity crops. Recent acquired soil inventory data from Ethiopian Soil Information System (EthioSIS) revealed that in addition to N and P, nutrients such as S, B, and Zn are deficient in most soils of Ethiopian including Asossa area [30]. Therefore, the objective of this study was to determine the optimum blended fertilizer rate for potential bread wheat variety production in potential district of Benishangul Gumuz area of Western Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was conducted in Mao-Komo district around Assosa Agricultural Research Center (ASARC) at about 687 km to west direction of Addis Ababa, Ethiopia. Its geographical location is 9°23'12.93 N longitude and 34° 24'27.81 E latitude, representing a medium altitude at 1600-1900m above sea level with an average rainfall of 900mm-1320 mm per annum. The mean annual average temperature range was 24.3-26.6°C [7].

2.2. Experimental Materials

2.2.1. Plant Materials

Seeds of four bread wheat varieties namely (Kingbird, Danda (DANPHE1), Shorima (ETBW 5483) and Ogolcho (ETBW 5520)) were used for the study. All varieties were obtained from Kulumsa Agricultural Research center (KARC) except Danda (DANPHE1) which was used as standard check. They have relatively the same area of adaption and growing period (Table 1).

Table 1. *Images of bread wheat varieties used for the study.*

SN	Genotypes	Breeder Center	Year of release	Recommended Agro-ecology zone	
				Alti (masl)	RF (mm)
1.	Ogolcho (ETBW5520)	KARC	2012	1600-2100	400-500
2.	Danda'a (Danphe#l)	KARC	2010	2000-2600	>600
3.	Kingbird	KARC	2015	1500-2200	500 – 850
4.	Shorima (ETBW 5483)	KARC	2011	1900-2600	600-900

Source: Ministry of Agriculture and Natural Resources, Crop Variety Register (2016).

2.2.2. Fertilizer Materials

Blended fertilizer NPSZnB (17.8N%, 35.7 P_2O_5%, 7.7S%, 2.2Zn% and 0.1B%) and Urea (46% N) were used as the sources of fertilizer.

2.3. Treatments and Experimental Design

The treatment consist of five rates of NPSZnB fertilizer (0, 100, 150, 200 and 250kg/ha) and four bread wheat varieties (Danda'a (standard check), Kingbird, Shorima, and Ogolcho). The experiment was laid dawn in Randomized Complete Block Design (RCBD) with factorial arrangement (5*4) in three replications.

2.4. Experimental Procedures

The experimental field was prepared following the conventional tillage practice ploughed by tractors, and harrowed to make the land level. The area of the plot was 3*3 m with a spacing between plots and blocks 0.5 and 1m, respectively. All treatments were arranged in three blocks by lottery method. Sowing was done by hand drilling of the seed with spacing 20 cm between rows and at a seed rate of 125 kg ha^{-1}. NPSZnB fertilizers was applied at time of sowing based on the treatments. While N in the form of urea was applied as recommended by Assosa Agricultural Research Center (69 kg Nha^{-1} to all treatments except the control plots in two splits, half at time of sowing within the rows of plant combined with NPSZnB fertilizer, and the remaining half at the mid-tillering crop stage by side dressing). Agronomic data were also collected from middle 13 rows by excluding the one outer row from both sides of each plot to minimize border effects. All agronomic practices were done to all treatment as per the bread wheat crop recommendations.

2.5. Soil Sampling

Representative soil samples were collected from the experimental field before sowing at a depth of 0 - 20 cm using auger in zigzag pattern. About 10 soil sub-samples were collected from different spots to form a composite soil sample. The sub-samples were thoroughly mixed together on flat plastic sheet and collected in clean new plastic bags. The composite soil samples were labeled with necessary information and transported to the laboratory. The soil samples were then air dried, and ground and sieved with a 2 mm size sieve, in preparation for analysis of the envisaged soil physicochemical properties.

The soil samples were further ground to pass a 0.5 mm size sieve for the determination of organic carbon and total N contents. Standard laboratory procedures through sample collection that is a true representative of the area; chemical analysis, interpretation /Calibration of test result and recommendation on the bases of test for the following physico-chemical properties. The following physico-chemical analysis *viz,* texture, pH, CEC, OC, total N, available P, available S, available B, and available Zn. The analysis was done at Horticoop Ethiopia (Horticulture) PLC. Soil and Water Analysis Laboratory based on standard procedures.

The soil textural class distribution was determined using the Bouyoucos hydrometer method [24]. The pH of the soil was determined at 1:2.5 (weight/volume) soils to water dilution ratio using a glass electrode attached to digital pH meter [19]. Cation exchange capacity (CEC) was determined after saturating the soil with in ammonium acetate (NH4OAC) and displacing it with in NaOAC [17]. Organic carbon was determined by Potassium dichromate method [29]. Total nitrogen was analyzed by Micro-kjeldahal method [64]. Available phosphorus and sulfur were determined using the Bray II method [15] and turbid metric method [11], respectively. Moreover available Zinc and Boron were determined based on DTPA Extraction and using hot water extraction methods, respectively [44].

2.6. Data Collected

2.6.1. Phenological Parameters

Days to 50% seedling emergence: determined as the number of days from sowing to 50% crop emerged in each plot from the ground through visual observation.

Days to 50% heading: determined as the number of days from sowing to the time when plants from the middle rows in a plot reached to 50% heading based on visual observation.

Days to 50% physiological maturity: determined as the number of days from sowing to the time when the plants in a plot reached to 50% maturity based on visual observation. It was indicated by senescence of the leaves as well as threshing of grain from the glumes when pressed between the forefinger and thumb.

2.6.2. Growth Parameters

Leaf area (cm^2): was determined by using manual method (Linear model) with the following formula, A=b X Length X Maximum Width, where b is a coefficient (0.75 for wheat), A=leaf area, Length=leaf length, W=maximum leaf width, that sample of leaf was taken and dimensions of each sample were measured [16]. Then piece of flag leaf was placed on a plane page and its length and width were measured from two different positions of each plant and taken average area from ten plants in each plot at 50% flowering stage.

Plant height (cm): The plant height was measured at physiological maturity from the soil surface to the top of the spike excluding awns on ten randomly pre-tagged selected plants from the central harvestable rows. The total measured plant height was summed together and divided by the numbers of plant to get height per plant.

2.6.3. Yield and Yield Components

Total number of tillers: The mean numbers of tillers produced per plant was counted in ten randomly pre-tagged selected plants at physiological maturity stage.

Number of productive tillers per plant: The mean numbers of effective tiller was determined based on ten pre-tagged random selected plants of each harvestable raws (13 raws) per plot.

Kernels per spike: The mean number of kernels per spike was determined from ten randomly selected and pre-tagged spikes from the net plot areas which was $7.8m^2$ that contains 13 raws.

Spike length (cm): The mean number of spike length was obtained from ten randomly selected and pre-tagged plants of each plot.

Above ground biomass (tha^{-1}): At maturity, the whole plant parts, including leaves and stems, and seeds from the net plot area in each plot was harvested and sun dried for two days until constant weight achieved, then the aboveground biomass was weighed and expressed in t ha^{-1}.

Grain yield (tha^{-1}): Grain yield was measured from the harvested central unit areas of $7.8m^2$ and converted to tons per hectare. Grains were cleaned following harvesting and threshing, weighed using electronic balance, and to get actual grain yield the moisture content at harvest was adjusted to 12.5% moisture content since actual moisture content may increase or reduce grain yield by the following formula.

$$\text{GrainYield (t/ha)} = \text{Yield obtained(t/ha)} \times \frac{(100-\%\ \text{actual Moisture Content}}{100-12.5}$$

Straw yield (t ha^{-1}): Straw yield was calculated as the difference between total above-ground biomass and grain yield.

Harvest index (%): Harvest index was calculated as the ratio of grain yield to total above ground biomass yield per plot expressed in percent.

$$\text{Harvest index (\%)} = \frac{\text{Grain Yield Per plot}}{\text{Above ground dry biomass per plot}} \times 100$$

Stem lodging Percentage: Stem lodging was observed for all varieties by visual observation just before the time of harvest based on the scales (1-5), where 1 (0-15°) indicates no lodging, 2 (15-30°) indicates 25% lodging, 3 (30-45°) indicates 50% lodging, 4 (45-60°) indicates 75% lodging and 5 (60 - 90°) indicates 100% lodging [18].

2.7. Quality Parameters

Thousand kernel weight (g): was determined based on the weight of 1000 seeds sampled from the bulk grain yield of each treatment by counting using an electronic seed counter and their weight taken with an electronic balance and adjusted at 12.5% grain moisture content.

Hectoliter weight: Hectoliter weight was determined on free samples using a laboratory hectoliter weight apparatus [13].

Moisture Content (%): The grain moisture levels were measured by aparatus known as grain analysis computer (GAC 2100) at the time of one day of harvest.

2.8. Data Analysis

2.8.1. Statistical Data Analysis

The collected data were subjected to Analysis of Variance (ANOVA) using SAS version 9.0 statistical software program. Comparisons among treatment means with significant difference for measured and scored parameters were made using LSD at 5% level of significance. Correlation analysis was carried out between phenological, growth, yield and yield components.

2.8.2. Economic Analysis

The partial budget analysis was done for economic analysis as described by [20]. The economic advantages of applied blended NPSZnB and varieties were carried out using partial budget analysis. In this experiment, the costs that vary were calculated by adding costs of fertilizer and labor for fertilizer application. However, other management and fixed costs were assumed to be equal for all and not included in the calculation. The cost of blended NPSZnB was 25.50 birr kg^{-1}. Price of bread wheat grain was 28.00 ETB kg^{-1} and the straw was 3.0 ETB kg^{-1}. The average grain yield and straw yield were adjusted by 10% down wards to reflect the difference between the experimental yield and the farmers yield that farmers would expect from their field. It was estimated that per man-days 60 ETB calculated for two man per day were needed for application of 100 kg NPSZnB ha^{-1}. To identify treatments with the optimum return to the farmer's investment, marginal analysis was performed on non-dominated treatments. For a treatment to be considered as worthwhile to farmers, between 50% and 100% marginal rate of return (MRR) was the minimum acceptable rate of return [20].

3. Results and Discussion

3.1. Soil Physico-chemical Properties of the Experimental Site Before Sowing

3.1.1. Soil Physical Properties

The soil texture of the experimental site had 14% sand, 42% silt, and 44% clay (Table 2). Accordingly, the soil under the textural category of Silty clay suitable for wheat production [50]. Silty clay soil influence water holding capacity, water infiltration rate, aeration, root penetration and soil fertility which is favorable for cereal crop production [50].

3.1.2. Soil Chemical Properties

The soil pH of the experimental field showed that the field has a pH of 4.99, which is under very strongly acid category. According to [38], pH values classified as pH < 4.0 extremely acid, 4.0-5.5 very strongly and strong acid, 5.5-7.3 moderately acid slightly acid and neutral, 7.3-8.5 slightly and moderately alkaline, and pH values > 8.5 strongly and very strongly alkaline. Hence, soil pH is a very import soil property due to its ability to determine the availability of nutrients for plant uptake [38]. Different soil nutrients are available for uptake by plants at different soil pH levels. Some soil nutrients are available at acidic pH while others are available at alkaline pH levels. The Soil pH level that allows for a wider nutrient availability to crops is in the 5.5 to 7.5 range [19].

The CEC of the experimental site was 24.40 cmol kg^{-1} soil, which is under medium category [43] (Table 2). The soil organic carbon content of the study area was 2.76, which is under high range as described by [38]. Total nitrogen value was 0.22% (Table 2). According to [43] classified soil nitrogen as N content < 0.1% was rated as very low, 0.1-0.2% as low, 0.2-0.5% as medium (sufficient), 0.5-1.0% as > 1% is very high. The experimental site can be classified in medium (sufficient) range in its total N content range. Available P content of the experimental site was 18.86mg/kg of soil sample solution. According to [38], the range of phosphorus in Bray method is < 7, 8-19, 20-39, 40-58 and >59 was very low, low, medium, high and very high, respectively. Hence the study area was medium and no need phosphorous fertilizer.

Available sulf+ur value of the study area was 7.34 mg kg^{-1} (Table 2). According to [39], sulfur values categorized under medium range. The classification showed soils with value < 2 very low, 2-5 low, 5-20 medium and > 20 mg/kg high. Hence application of maintenance rate of sulfur fertilizer is needed for the study area.

Available boron value of the study area was also 0.032 mg kg^{-1} (Table 2). According to [13] report, the critical levels of boron value for most Ethiopian soils is 1.1 - 2 mg kg^{-1}, below this range indicated as boron deficiency whereas ranges low (0.3- 1 mg kg^{-1}), optimum (1.1-2 mg kg^{-1}), high (2.1- 4 mg kg^{-1}) and very high >4 mg kg^{-1}). Based on these common ranges the soil of the study area was deficit in its boron content that implies application of fertilizer which contains boron to fulfill the deficient level is crucial. Boron concentration and its bioavailability in soils is affected by several factors including parent material, texture, nature of clay minerals, pH, liming, organic matter content, sources of irrigation, interrelationship with other elements, and environmental conditions like moderate to heavy rainfall, dry weather and high light intensity [49].

Available zinc value of the study area was <0.23 mg kg^{-1} (Table 2). [12] classify the soil's zinc content as < 0.2 very low, 0.3-1 low, 1.1-2 optimum, 2.1- 4 high and >4.1 mg /kg^{-1} is very high. soil classification for zinc values < 1 indicates very low, 1-1.5 low, 1.5-10 optimum, 10-20 high and >20 mg /kg^{-1} (ppm) is very high. Hence, the study area lies on very low range and need application of appropriate rate of zinc fertilizer. This very low inorganic zinc content of the soil may be due to several soil factors (weathered parent material, nature of clay minerals, soil organic matter) that can cause deficiency of total Zn content and Zn availability to plant uptake [5].

Table 2. *Soil physical and chemical characteristics of the study area before sowing.*

Soil Physical Properties	Value	Rating	Range	References
Sand (%)	14	Moderate	10.0-25.0	Hazelton and Murphy (2007)
Silt (%)	44	Low	>50.0	Hazelton and Murphy (2007)
Clay (%)	42	High	10.0-25.0	Hazelton and Murphy, (2007)
Textural class	Silty clay	-	-	Day, 1965
Soil Chemical Properties				
pH (1:2.5 H_2O)	4.99	Medium	4.5-5.5	Chopra and Kanwar, 1976
TN (%)	0.22 mg kg^{-1}	Medium	0.2- 0.5%	Landon *et al*., 1991
OC (%)	2.76 mg kg^{-1}	High	0.6-1.0 mg kg^{-1}	Hazelton and Murphy (2016)
Av. Phosphorus mg kg^{-1}	18.86 mg kg^{-1}	Medium	17-25 mg kg^{-1}	Hazelton and Murphy (2016)
Av. Sulfur mg kg^{-1}	7.34 mg kg^{-1}	Medium	5-20 mg kg^{-1}	Horneck *et al*., (2011)
Av. Zinc mg kg^{-1}	<0.23 mg kg^{-1}	Very Low	1.1-2 mg kg^{-1}	Benton (2003)
Av. Boron mg kg^{-1}	<0.032 mg kg^{-1}	Low	1.1 - 2 mg kg^{-1}	Benton, (2003)
CEC cmol kg	24.4 cmol kg	Medium	15-25 cmol kg	Chapman, 1965

CEC=Cation exchange capacity, OC=Organic carbon, OM=Organic Matter, TN=Total nitrogen, Av.=Available

3.2. Crop Phenology

3.2.1. Days to 50% Emergence

Days to 50% emergence of bread wheat varieties were significantly ($P \leq 0.05$) affected by the main effect of blended fertilizer NPSZnB and variety, but non-significantly affected in their interaction (Appendix Table 2). As application of NPSZnB fertilizer rate increases, the mean days to 50% emergence decreased significantly ($P \leq 0.05$) (Table 3). The maximum days to reach 50% emergence (4.83 days) was recorded on the control treatment (0 kg ha^{-1} NPSZnB), while the minimum days to emergence (3.33 days) was recorded on treatment that received 250 kg ha^{-1} NPSZnB. The decrease in days to emergence as the result of increased in NPSZnB rate could be due to increment of boron which concerned with the water relations in cells that regulates the intake of water in to the cell, tissue development and differentiation, which is directly support seedling emergence [65]. Similarly [27] reported that the duration of days to 50% emergence of bread wheat prolonged as application of blended NPSZnB fertilizer rate reduced.

Kingbird, Danda and Shorima took more days days to reach to 50% emergence; while the minimum days to 50% was observed in variety Ogolcho (Table 3). The 50% emergence did not show significant difference at a rate of 100, 150 and 200 kg ha^{-1} despite the boron level increased this is due to boron rate was lower than the optimum and since the boron level increased almost to optimum level the days to 50% emergency reduced. The variation in days to 50% emergence among varieties might be attributed to the to the genetic variability of bread wheat varieties in absorption of moisture and stored food in the seeds. Likewise, [54] also reported varietal difference affected day to 50% emergence in wheat.

Table 3. *Effects of blended NPSZnB fertilizer rates and varieties on days to 50% emergence of bread wheat.*

Treatments	Days to 50% Emergence
NPSZnB (kg ha^{-1})	
0	4.83^{a}
100	3.83^{b}
150	3.83^{b}
200	3.75^{b}
250	3.33^{c}
Mean	3.90
LSD (0.05)	0.29
Varieties	
Kingbird	4.07^{a}
Danda	4.2^{a}
Shorima	4.07^{a}
Ogolcho	3.33^{b}
Mean	3.92
LSD (0.05)	0.26
CV (%)	8.98

Means followed by the same letters are not significantly different ($P \leq 0.05$)

3.2.2. Days to 50% Flowering

Days to 50% flowering was significantly ($P \leq 0.05$) affected by the main effects of NPSZnB fertilizer rates and interaction effect of main factors, however the bread wheat varieties did not differ significantly in days to 50% flowering. The maximum number of days to flowering (76.33 days) was observed at the rate of 200 kg ha^{-1} NPSZnB with Ogolcho variety, which was statistically at par with Danda and Kingbird with 250 kg ha^{-1} NPSZnB. While the minimum number of days to flowering (58.30 days) was observed at 0 kg ha^{-1} NPSZnB with Danda variety (Table 4). This result showed that the increment application of NPSZnB rate delays bread wheat to flower. Moreover N and P are major nutrients, which are important to enhance vegetative growth and delays flowering of crops. This finding is consistent with [1], who found that application of blend fertilizer (macro and micro) and urea prolongs the vegetative growth stage of wheat.

Similarly [26] suggested that blended fertilizer has a substantial effect on days to heading and maturity, accordingly at 300 kg of NPSZnB application with additional urea, the longest days to heading (71.7) and physiological maturity (113.0) were observed whereas the earliest dates to heading or flower and physiological maturity (61.3) and (106.2) recorded at control treatments respectively. On the other hand, [47] reported that with the increase in blended fertilizer rates of S, B, Zn, the number of days required for flowering, maturity and grain filling period increased.

Table 4. *Interaction effect of blended NPSZnB rate and variety on days to 50% flowering.*

Treatments	NPSZnB (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	66.67^{ef}	70.67^{cde}	71.00^{cd}	75.33^{ab}	76.30^{a}	72.00
Danda	58.30^{g}	72.00^{bcd}	75.33^{ab}	76.30^{a}	76.30^{a}	71.65
Shorima	64.67^{f}	69.00^{de}	71.67^{bcd}	72.00^{bcd}	73.33^{abc}	70.00
Ogolcho	63.67^{f}	70.33^{cde}	72.30^{abcd}	76.33^{a}	76.30^{a}	71.80
Mean	63.33	70.50	72.58	75.00	75.56	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	2.05	1.83	4.10
CV (%)	3.47		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.2.3. Days to 90% Physiological Maturity

The main effects of blended NPSZnB fertilizer rates and bread wheat varieties and their interaction effects were significantly ($P \leq 0.05$) affected days to 90% physiological maturity. The number of days required to achieve 90% physiological maturity ranged between 75 to 116.33 days among varieties. Days to 90% physiological maturity was delayed (116.33 days) at 250kg ha^{-1} NPSZnB with Danda variety; in contrast earlier physiological maturity (75 days) was observed at 0 kg ha^{-1} NPSZnB with Shorima variety (Table 5). The significant difference among the varieties to varying levels of fertilizer rates for observed physiological maturity might be due to varying response of varieties to applied fertilizer rates/ response to environmental conditions (Table 5).

Similarly, [10] reported significant difference among ten genotypes on both days to heading and maturity. Besides, the number of days required to attain 90% physiological maturity of bread wheat varieties proportionally increased with blended NPSZnB fertilizer rate. This could be due to the presence of N, P, S, Zn and B plant nutrients which played an important role in protein synthesis, formulation of some growth hormone that prolong crop on field duration and promote seed maturation and production. Similarly, [1] described application of a blend fertilizer (macro and micro) and urea, which has a higher rate of nitrogen nutrient, prolongs the vegetative growth stage of wheat.

Table 5. *Interaction effect of blended NPSZnB rate and variety on days to 90% physiological maturity.*

Treatments	NPSZnB rate (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	87.00^{i}	102.33^{fgh}	104.33^{efg}	108.00^{bcde}	113.00^{ab}	102.90
Danda	85.67^{i}	106.00^{ef}	107.33^{cdef}	112.33^{abc}	116.33^{a}	105.50
Shorima	75.00^{j}	102.33^{fgh}	105.00^{ef}	107.00^{def}	111.33^{abcd}	100.00
Ogolcho	85.00^{i}	97.67^{h}	99.33^{gh}	102.33^{fgh}	111.67^{abcd}	99.00
Mean	83.17	102.08	104.00	107.40	113.08	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	2.6052	2.33	5.21
CV (%)	3.09		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.3. Growth Parameter of Bread Wheat Varieties

3.3.1. Leaf Area

Leaf area of bread wheat was significantly ($P \leq 0.05$) affected by the main factors of NPSZnB fertilizer rate, bread wheat varieties and their interaction. The least leaf area (10.69 cm^2) was recorded from combination of 0 kg ha^{-1} NPSZnB with Danda variety, whereas the maximum leaf area (30.15 cm^2) was recorded at 200 kg ha^{-1} NPSZnB fertilizer rate with Kingbird variety (Table 6). This implies that as rates of fertilizer increased up to optimal level depending on varietal variability in response to applied nutrients, leaf area of plants increased, that plays a vital role in absorption of solar radiation that result in growth of crop, yield and yield components increment. The result was compatible with the research finding of [8], who reported NP increased leaf area and leaf area duration. The more leaf area produces the more production of dry matter and grain yield since leaf area is directly proportional with amount of sun light absorption that helps in total dry matter production.

Table 6. *Interaction effect of blended NPSZnB fertilizer rates and bread wheat varieties on leaf area (cm^2).*

Treatments	NPSZnB rate ($kgha^{-1}$)					
	0	100	150	200	250	Mean
Variety						
Kingbird	15.51^{k}	20.26^{efghi}	22.51^{cdef}	30.15^{a}	25.42^{b}	22.77
Danda	10.69^{l}	17.85^{ijk}	18.32^{hijk}	20.52^{defghi}	18.6^{hij}	17.20
Shorima	15.93^{jk}	19.35^{ghi}	19.37^{ghi}	22.92^{bcde}	21.06^{defgh}	19.73
Ogolcho	16.43^{jk}	19.93^{fghi}	21.71^{defg}	25.07^{bc}	23.17^{bcd}	21.30
Mean	14.64	19.35	20.48	24.67	22.06	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	1.43	1.28	2.86
CV (%)	8.55		

Means followed by the same letters are not significantly different at ($P \leq 0.05$

3.3.2. Plant Height

Plant height was significantly affected by the main effects of NPSZnB, variety as well as by the main effects of NPSZnB and variety. The highest plant height (81.4 cm) was from variety Danda'a at a rate of 200 kg ha^{-1} NPSZnB which was statistically at par with the application 250 kg ha^{-1} NPSZnB with the same variety. However, the shortest plant height (45.02 cm) was recorded from variety Kingbird under the control treatment (0 kg ha^{-1} NPSZnB) and it was statistically at par with varieties Danda'a, Shorima and Ogolcho at the control NPSZnB rate and at 100 kg ha^{-1} fertilizer rate with variety Danda'a (Table 7). Generally in this study plant height of the tested varieties increased as the amount of NPSZnB increased from 0 to 200 kg ha^{-1} which is optimum for all varieties except for Kingbird bread wheat variety.

The application of blended fertilizer to optimum level (200 kg ha^{-1} NPSZnB) significantly increased plant height as compared to the control (zero fertilizer plots). This could be due to genetic variation among varieties with respect to plant height with response to applied blended fertilizer since the variation at control treatments observed due to absence of fertilizer spetially due to lack of nitrogen fertilizer which promotes plant growth. The result was in agreement with the finding of other authors [6, 62] also, reported that macro and micro nutrients (nitrogen, phosphorous with sulfur and born) can increase plant height with increasing doses and combination based on varietal responses.

Table 7. *Interaction effect of blended NPSZnB rate and variety on plant height (cm).*

Treatments	NPSZnB rate ($kgha^{-1}$)					
	0	100	150	200	250	Mean
Variety						
Kingbird	45.02^{i}	49.05^{hi}	51.18^{gh}	63.1^{de}	66.2^{d}	54.91
Danda	48.51^{hi}	66.85^{d}	73.07^{bc}	81.4^{a}	79.37^{a}	69.84
Shorima	45.35^{i}	55.25^{fg}	57.68^{ef}	68.32^{cd}	67.17^{d}	58.75
Ogolcho	46.66^{hi}	59.93^{ef}	62.87^{de}	77.43^{ab}	77.03^{ab}	64.79
Mean	46.38	57.77	61.2	72.56	72.44	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	2.91	2.60	5.81
CV (%)	5.67		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.4. Yield and Yield Components

3.4.1. Total Numbers of Tillers

The analysis of variance showed that the main effect of blended NPSZnB fertilizer rate and varieties, and their interaction significantly ($P \leq 0.05$) affected the total numbers of tillers per plants. The highest number of total tillers (6.29 per plant) was obtained at 200 kg NPSZnB ha^{-1} with Kingbird variety, which was statistically at par with Danda variety with 200 kg NPSZnB ha^{-1} (6.2 per plant). However, the lowest total number of tillers per plant (1.52) was also recorded from Kingbird variety without NPSZnB fertilizer application (control treatment) due to lack of growth initiating nutrients (Table 8). The possible reason for increment in number of total tiller might be due to the effect of balanced fertilization in which readily soluble minerals help to the vegetative growth of the crop. In contradiction of this result, [42] reported that N and P fertilizer rate had on significant role in number of total and effective tiller production per plant of wheat that might be due to ecological or varietal difference.

Table 8. *Interaction effect of blended NPSZnB rate and variety on total number of tillers.*

Treatments	NPSZnB rate (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	1.52^{i}	4.18^{fg}	5.17^{cde}	6.29^{a}	5.46^{bc}	4.52
Danda	2.09^{hi}	4.52^{def}	4.96^{cde}	6.20^{a}	6.19^{a}	4.79
Shorima	2.45^{h}	3.73^{g}	4.5^{ef}	5.23^{cd}	5.26^{bc}	4.23
Ogolcho	2.63^{h}	3.85^{fg}	5.01^{cde}	5.96^{ab}	5.62^{abc}	4.61
Mean	2.17	4.07	4.91	5.92	5.63	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	0.36	0.32	0.72
CV (%)	9.61		

Means followed by the same letter are not significantly different at ($P \leq 0.05$)

3.4.2. Number of Productive Tillers

The number of productive tillers per plant were significantly ($P \leq 0.05$) influenced by the main effects of varieties and blended fertilizer rates, and their interaction. The highest mean number of productive tillers (6.1) was recorded from Kingbird variety with 200 kg NPSZnB ha^{-1} fertilizer rate (Table 9). Whereas, the lowest mean number of effective tillers (1.07) was recorded from control (unfertilized) plot with Danda variety, which was statistically similar with control treatment with Kingbird and Shorima varieties. The increment of effective tillers were depended on genetic variability of varieties and the increasing rate of the blended fertilizer rates. The increased in productive tillers on plots treated with blended fertilizer than in the unfertilized plot might be due to the profound effect of balanced nutrition for root development. This result is in agreement with that of [36, 33] who reported that application of blended fertilizer NPSZn brought significant increase in productive tillers. [34] also reported increase in the number of productive tillers produced due to blended fertilizers may be attributed to the synergic roles in enhancing productive tillers production by the plant. In addition [63] revealed that blended NPS was significantly influenced productive tillers of bread wheat.

Table 9. *Interaction effect of blended NPSZnB fertilizer rates and varieties on number of productive tillers of bread wheat.*

Treatments	NPSZnB rate (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	1.75^{ij}	4.02^{fg}	5.00^{cde}	6.10^{a}	5.25^{bcd}	4.42
Danda	1.07^{j}	2.71^{h}	2.90^{h}	3.40^{gh}	4.27^{ef}	2.87
Shorima	1.60^{ij}	2.99^{h}	4.03^{fg}	4.90^{cde}	4.37^{ef}	3.57
Ogolcho	1.93^{i}	3.40^{gh}	4.50^{def}	5.80^{ab}	5.40^{abc}	4.21
Mean	1.59	3.28	4.11	5.05	4.82	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	0.40	0.35	0.77
CV (%)	12.54		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.4.3. Spike Length (cm)

Spike length was significantly ($P \leq 0.05$) affected by the main effects of blended NPSZnB fertilizer rate and varieties, as well as their interaction. The highest spike length (7.38cm) was recorded from application of 200 kg of NPSZnB ha^{-1} fertilizer (Table 10). The longest spike length (8.2 cm) was observed on 200 kg NPSZnB ha^{-1} rate with Danda variety, which was statistically at par with 150 kg NPSZnB ha^{-1} with the same variety, and 200kg NPSZnB ha^{-1} with Ogolcho variety. Whereas the shortest spike length (5.01 cm) was produced at control (zero) NPSZnB fertilizer level with Kingbird variety. The increase in spike length at the 200 kg NPSZnB ha^{-1} rate with Danda variety could be due to improved root growth and increased uptake of nutrients and better growth as a result of synergetic effect of the nutrients and genetic varietal response. The result also indicated that macro nutrients (N, P,) and micro nutrients (S, Zn, B) increased spike length of plant, even though recommended N (69 $kgha^{-1}$) was equally applied to all plots except of control treatment. This is in agreement with [53, 25] who reported that spike length of wheat significantly increased as a result of applying Zn and B blended with macronutrients based on the responses of varieties. Similarly, [12] also reported that optimum amount of fertilizer application has significant effect on the growth of spike length.

Table 10. *Interaction effect of blended NPSZnB fertilizer rates and bread wheat varieties on spike length (cm).*

Treatments	NPSZnB rate (kgha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	3.62^{j}	6.00^{fgh}	6.10^{efgh}	6.73^{cde}	6.23^{defg}	5.73
Danda	5.57^{ghi}	6.27^{def}	7.55^{ab}	8.20^{a}	7.73^{ab}	7.06
Shorima	4.94^{i}	6.15^{defg}	6.33^{def}	6.82^{cd}	6.63^{cdef}	6.17
Ogolcho	5.43^{hi}	6.10^{efgh}	6.80^{cd}	7.77^{ab}	7.3^{bc}	6.68
Mean	4.89	6.13	6.69	7.38	6.98	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	0.34	0.30	0.68
CV (%)	6.37		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.4.4. Number of Grains Per Spike

The number of grains per spike was significantly affected by main effects of blended NPSZnB fertilizer and bread wheat varieties as well as their interaction. The highest number of grains per spike (52.5) was obtained on 200 kg NPSZnB ha^{-1} application with Kingbird variety. While the lowest number of grains per spike (24.1) was recorded on control treatment with Ogolcho variety, which was statistically at par with Danda (27.3) variety with control treatment (Table 11).

The number of grains per spike of a bread wheat increased with increase in fertilizer rate up to a certain level for all varieties. The variation in grain per spike observed among varieties was due to their genetic difference that hereditarily determines production capability of crops. This might be due to phosphorous and boron nutrient increment which are essential in development of grains and grain setting respectively. This finding is also supported by the result of [25] who reported that boron application results in significant improvement in the number of seeds per spike of wheat. Additionally, [5] reported that Zn fertilizer application on soils with low soil Zn content may increase the Zn concentration and grain yield of crops. Similarly, [52] reported that application of nutrients like S, Zn, and B and other micronutrients significantly increased yield component of bread wheat as compared to the control (no fertilizer) based on the genetic variability of varieties.

Table 11. *Interaction effect of blended NPSZnB fertilizer rates and varieties on number of grain per spike of bread wheat.*

Treatments	NPSZnB rate (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	36.67^{f}	47.27^{bc}	47.47^{bc}	52.5^{a}	48.27^{b}	46.43
Danda	27.3^{h}	40.2^{e}	40.87^{e}	44.8^{cd}	42.77^{de}	39.2
Shorima	31.27^{g}	41.8^{de}	44.5^{cd}	46.5^{bc}	48.5^{b}	42.54
Ogolcho	24.1^{h}	42.8^{de}	46.5^{bc}	48.7^{b}	48.27^{b}	42.1
Mean	29.85	43.03	44.85	48.1	46.96	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	1.71	1.53	3.42
CV (%)	4.87		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.4.5. Above Ground Biomass Yield

Analysis of variance showed that above ground biomass yield was significantly ($P \leq 0.05$), affected by the main effects of blended fertilizer rates and interaction, however not significantly affected by the main effect of varieties. The highest biomass yield (9.97t ha^{-1}) was obtained on application of 250 kg NPSZnB ha^{-1} with variety Ogolcho, and application of 200kg NPSZnB ha^{-1} (9.91 t ha^{-1}) with Danda variety which were statistically at par application of 250kg NPSZnB ha^{-1} with Danda variety and application of 200 kg NPSZnB ha^{-1} with Ogolcho (Table 12). While the lowest biomass yield (4.6t ha^{-1}) was recorded with 0 kg NPSZnB ha^{-1}on Danda variety.

The biomass yield (t ha^{-1}) of a wheat increases with increase in fertilizer rate up to a certain levels for all varieties due to varietal difference on fertilizer requirement. The possible reason for this response could be due to adequate supply of fertilizer application and their assimilation in meristematic tissue which might have played an important role in tillering and overall plant growth. That might be also due to better crop nutrition through applied blended micronutrients (Zn and B) with macronutrients (N, P, and S), which may result in improved vegetative growth of crops. The result also indicated that even in the absence of K, the blend of fertilizer contributed to enhance the aboveground dry biomass yield of wheat plants grow in field experiment. [67] also indicated that above ground dry biomass yield was significantly affected by application of blended fertilizer and NPZnB. This result was similar to the research findings of [68] found that application of 150 kg NPSB ha^{-1} blended fertilizer increased the biomass by 11.5 t ha^{-1}. Similarly, these authors concluded that this might be due to better crop nutrition through applied blended micronutrients (Zn and B) with macronutrients (N, P, and S), which may result in improved vegetative growth of crops and specially due to sulfur that enhanced the formation of chlorophyll and encouraged vegetative growth and boron which helps in nitrogen absorption that plays great role in biomass increment in crop development.

Table 12. *Interaction effect of NPSZnB fertilizer rate and varieties on above ground mass (t ha^{-1}) of bread wheat.*

Treatments	**NPSZnB rate (kgha^{-1})**					
	0	**100**	**150**	**200**	**250**	**Mean**
Variety						
Kingbird	5.54^{i}	8.09^{fgh}	8.48^{def}	8.80^{bcdef}	9.07^{bcd}	8
Danda	4.60^{j}	8.42^{defg}	8.77^{cdef}	9.91^{a}	9.52^{abc}	8.24
Shorima	5.96^{i}	7.59^{h}	8.14^{efgh}	8.64^{def}	8.93^{bcde}	7.85
Ogolcho	6.11^{i}	7.66^{gh}	8.84^{bcdef}	9.58^{ab}	9.97^{a}	8.44
Mean	5.55	7.94	8.56	9.24	9.38	

	NPSZnB rate	**Varieties**	**NPSZnB rate * Varieties**
LSD (0.05)	0.40	0.36	0.81
CV (%)	6.00		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.4.6. Grain Yield

The analysis of variance revealed that grain yield of bread wheat was significantly ($P \leq 0.05$) affected by the main effect of blended NPSZnB fertilizer rate and variety as well as their interaction (Appendix Table 3). Increasing the rates of blended NPZnB fertilizer from 0 to 200 kg ha^{-1} showed consistent increase of grain yield while the yield was become declined at maximum application rates of blended fertilizer (Table 13). This indicated that the plants achieved its optimum application of blended NPSZnB which beyond that application the plant might not responded to fertilizer application and leads to yield reduction. The highest grain yield (3.54tha^{-1}) was obtained in response to application of 200 kg ha^{-1} blended NPSZnB fertilizer with Kingbird variety, while the lowest grain yield (0.55 tha^{-1}) was recorded on control treatment with Danda variety, which was at parity with all varieties with control treatment. The yield obtained from application of 200 kg NPSZnB ha^{-1} gave 32.8% grain yield increment with Kingbird variety over Danda variety (standard check) with the same rate of blended NPSZnB fertilizer.

An increase in the application of blended fertilizer to the optimum rates for improved wheat varieties enhance. The productivity of crop. This could be due to the contribution of balance nutrition (macro and micro nutrient) present in fertilizers which increased yield attributes through higher uptakes of all the nutrients and increased translocation of photosynthesis from source to sink. In conformity with this finding [59] reported that the highest grain yield of bread wheat was obtained at 200 kg ha^{-1} blended NPS supplemented with 92 kg N ha^{-1}. Similarly, [52] reported that application of nutrients like K, S, Zn, Mg and B significantly increased grain yield and yield component of bread wheat as compare to the control (no fertilizer).

Table 13. *Interaction effect of blended NPSZnB fertilizer rates and varieties on grain yield (t ha^{-1}) of bread wheat.*

Treatments	**NPSZnB rate (kg ha^{-1})**					
	0	**100**	**150**	**200**	**250**	**Mean**
Variety						
Kingbird	0.60^{ij}	2.59^{de}	2.89^{bc}	3.54^{a}	3.13^{b}	2.55
Danda	0.55^{j}	1.88^{h}	2.03^{gh}	2.38^{ef}	2.22^{fg}	1.81
Shorima	0.71^{ij}	2.06^{gh}	2.24^{fg}	2.61^{de}	2.57^{de}	2.04
Ogolcho	0.85^{i}	2.26^{fg}	2.71^{cd}	3.08^{b}	2.95^{bc}	2.37
Mean	0.68	2.20	2.47	2.90	2.72	

	NPSZnB rate	**Varieties**	**NPSZnB rate * Varieties**
LSD (0.05)	0.14	0.12	0.27
CV (%)	7.50		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.4.7. Straw Yield

Straw yield was significantly ($P \leq 0.05$) influenced by the main effect of blended fertilizer and varieties of bread wheat as well as their interaction. The highest straw yield (7.53t ha^{-1}) was recorded from the application of 200kgha^{-1} of NPSZnB with Danda variety, which was statistically at par with 250kg NPSZnB ha^{-1} with Danda variety, and 200kg NPSZnB ha^{-1} with Ogolcho variety (Table 14). However, the lowest straw yield (4.04t ha^{-1}) was obtained from the control (zero fertilizer) treatment with Danda variety. The highest straw yield recorded could be due to the combined effect of nutrients like N, P, S, Zn and B in blended fertilizer which might have advanced growth and development of crop and straw yield capability of bread wheat variety.

The significant increase in straw yield in response to the combined application of high rate of NPSZnB blended fertilizer rates with Danda variety might be attributed to the synergic roles of the nutrients in the fertilizer played in enhancing growth and development of the vegetative part of the bread wheat varieties. That is why the 200kg ha^{-1} NPSZnB blended fertilizer rate had 46% more straw yield increment over unfertilized Danda variety on their overall plots and same management practices. This result is in line with that of [61] who reported that, straw yield of teff was significantly affected by application of blended fertilizer which exceeds 49% over the control plots.

Table 14. *Interaction effect of NPSZnB fertilizer rate and varieties on straw yield (t ha^{-1}) of bread wheat.*

Treatments	NPSZnB rate (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	4.94^{i}	5.38^{ghi}	5.45^{fghi}	5.55^{fghi}	5.94^{efgh}	5.45
Danda	4.04^{j}	6.54^{cde}	6.73^{bcd}	7.53^{a}	7.29^{ab}	6.43
Shorima	5.25^{hi}	5.53^{fghi}	5.91^{efgh}	6.04^{defg}	6.36^{cde}	5.82
Ogolcho	5.26^{hi}	5.4^{ghi}	6.13^{def}	6.51^{cde}	7.04^{abc}	6.07
Mean	4.88	5.71	6.06	6.41	6.66	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	0.35	0.32	0.71
CV (%)	7.19		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.4.8. Harvest Index

Analysis of variance showed that the harvest index was significantly ($P \leq 0.05$) affected by both main effects of blended fertilizer rates and varieties, and their interaction. The maximum (39%) and minimum (10.89%) harvest index were recorded from the application of 200kg NPSZnB ha^{-1} and control treatment with Kingbird variety (Table 15). The variation in harvest index could be due to synergetic effect of blended fertilizer and genetic variability of bread wheat varieties in response to blended fertilizer. As [60] expressed, higher transfer of assimilates to the grain could increase the harvest index and minimize the proportion of dry matter produced. The result is also supported by the findings of [59], who suggested that harvest index was affected by the interaction effect of blended NPS and varieties.

Table 15. *Interaction effect of blended NPSZnB fertilizer rates and varieties on harvest index (%) of bread wheat.*

Treatments	NPSZnB rate (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	10.89^{j}	32.45^{cd}	33.50^{bc}	39.00^{a}	35.78^{b}	30.31
Danda	12.16^{ij}	22.41^{h}	23.20^{h}	24.04^{h}	23.26^{h}	21.01
Shorima	12.10^{ij}	27.20^{g}	27.40^{g}	30.18^{def}	28.83^{fg}	25.15
Ogolcho	14.18^{i}	29.18^{fg}	29.80^{efg}	32.11^{cde}	31.12^{cdef}	27.28
Mean	12.33	27.81	28.48	31.32	29.75	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	1.31	1.17	2.62
CV (%)	6.10		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.4.9. Lodging Percentage

The main effects of blended NPSZnB fertilizer rates and the varieties were significantly ($P \leq 0.05$) affected lodging percentage of bread wheat, while the interaction effect of the two factors was not significant. The highest lodging (11.92%) was obtained from application of 250kgha^{-1} NPSZnB, which was at par with 200kgha^{-1} NPSZnB; while the lowest lodging (8.17%) was recorded on control (zero fertilizer) treatment (Table 16). The marked increases in lodging percentage due to increased application of blended NPSZnB fertilize could be attributed from an increase of plant height since plant height and lodging percentage are positively correlated.

In line with this study, [32] reported that the highest lodging percentage in the highest rate of NPK application. Moreover, Kingbird variety showed the highest lodging percentage (11.27%) which was statistically at par with Ogolcho variety, while the lowest lodging percentage (8.93) was recorded on Danda (standard check) variety (Table 16). The difference in lodging percentage among varieties might be due to their genetic variability.

Table 16. *Main effects of NPSZnB fertilizer rates and varieties on lodging percentage of bread wheat.*

Treatments	Lodging Percentage (%)
NPSZnB (kg ha^{-1})	
0	8.17^{c}
100	9.10^{bc}
150	9.50^{b}
200	11.10^{a}
250	11.92^{a}
Mean	9.95
LSD (0.05)	1.16
Variety	
Kingbird	11.27^{a}
Danda	8.93^{c}
Shorima	9.33^{bc}
Ogolcho	10.27^{ab}
Mean	9.95
LSD (0.05)	1.04
CV (%)	14.14

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.5. Quality Parameters of Bread Wheat

3.5.1. Thousand Seed Weight

The analysis of variance showed that the main effect of blended NPSZnB fertilizer rates and bread wheat varieties and their interaction significantly ($P \leq 0.05$) affected thousand seed weight (TSW). The highest TSW (33.83g) was produced by the application of 200 kg ha^{-1} NPSZnB blended fertilizer on Kingbird bread wheat variety, which was at par with Danda variety with the same rate. The lowest TSW (23.71g) was recorded from control (unfertilized treatment) with Shorima variety, which was at par with Danda (standard check) and Ogolcho varieties with control treatment (Table 17). The difference recorded between varieties on TSW was due to genetical difference in response to blended fertilizer treatments.

Application of blended fertilizer rates to the optimum rate increased seed size and seed dry matter contents that directly increase the amount of powder of bread wheat varieties. The higher the seed weight is the reflection of improved nutrient use efficiency as a result of optimum application of blended fertilizer. This similar with finding of [51], who reported that applying both micro (especially Zn and B) and macro nutrient have a positive effect on yield component of wheat crop especially on 1000 seed weight.

Table 17. *Interaction effect of blended NPSZnB fertilizer rates and variety on thousand seed weight (g) of bread wheat.*

Treatments	NPSZnB rate (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	26.7^{hi}	27.83^{gh}	28.9^{efg}	33.83 ^{a}	29.82^{cdef}	29.42
Danda	25.5^{ij}	29.7^{defg}	30.28^{cdef}	32.27^{ab}	31.05^{bcd}	29.76
Shorima	23.71^{j}	28.45^{fgh}	29.2^{defg}	29.51^{defg}	29.77^{cdefg}	28.13
Ogolcho	25.51^{ij}	29.72^{cdefg}	30.65^{bcde}	31.14^{bcd}	31.70^{bc}	29.74
Mean	25.36	28.93	29.76	31.69	30.58	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	0.99	0.89	1.99
CV (%)	4.11		

Means followed by the same letters are not significantly different at ($P \leq 0.05$)

3.5.2. Hectoliter Weight

Hectoliter weight (kg hl^{-1}) was significantly ($P \leq 0.05$) influenced by both main effects of blended NPSZnB fertilizer and varieties as well as their interaction. The highest hectoliter weight (81.2 kg hl^{-1}) was obtained from Kingbird variety with 250 kg ha^{-1} blended NPSZnB fertilizer rate, while the lowest hectoliter weight (60 kg hl^{-1}) was recorded from Danda variety with control treatment which was statistically equivalent with all tested varieties with control (unfertilized) treatment (Table 18). The higher HLW with the application of blended NPSZnB rate might be due to the role of balanced nutrients on quality of wheat such as flour yield, however differ with varieties [31, 3]. Similarly [9] also indicated that hectoliter weight ranged from about 57.9 kg hL^{-1} for poor wheat and to about 82.4 kg hL^{-1} for good quality wheat varieties. The hectoliter weight ranged from 60 to 81.2 kg hL^{-1} which is in good quality range. Moreover, the significant difference among bread wheat varieties could be due to genetic differences among varieties, biotic and abiotic factors.

Table 18. *Interaction effect of NPSZnB fertilizer rates and varieties on hectoliter weight (kg hL^{-1}) of bread wheat.*

Treatments	NPSZnB rate (kg ha^{-1})					
	0	100	150	200	250	Mean
Variety						
Kingbird	61.10^{g}	67.77^{ef}	72.83^{cd}	77.3^{ab}	81.2^{a}	72.04
Danda	60.00^{g}	60.63^{g}	61.13^{g}	63.03^{g}	67.53^{ef}	62.47
Shorima	60.40^{g}	60.53^{g}	63.83^{fg}	68.17^{e}	71.40^{de}	64.87
Ogolcho	60.20^{g}	67.5^{ef}	72.57^{cd}	73.17^{cd}	76.37^{bc}	69.96
Mean	60.43	64.12	67.59	70.42	74.13	

	NPSZnB rate	Varieties	NPSZnB rate * Varieties
LSD (0.05)	2.03	1.81	4.05
CV (%)	3.64		

Means followed by the same letters are not significantly different at ($P \le 0.05$)

3.5.3. Grain Moisture Content (%)

The analysis of variance result showed that the mean moisture content of bread wheat was significantly ($P \le 0.05$) affected by the main factor blended NPSZnB fertilizer rate and varieties, but not affected by their interaction. The treatment that received 250 kg NPSZnB ha^{-1} fertilizer rate had the highest grain moisture content (11.06%), which was statistically equivalent to treatment received 200 kgha^{-1} NPSZnB ha^{-1}. The control treatment (0kg NPSZnB ha^{-1}), was statistically equal to (100 kg NPSZnB ha^{-1}) and had the lowest grain moisture content (9.43%) (Table 19). The variation between treatments on moisture content would be the environmental condition at harvesting [55].

The maximum average moisture content (10.83%) was recorded from Kingbird variety, while the minimum average moisture content (9.89%) was obtained from Shorima variety which was at par with Danda (10.21%) and Ogolcho (10.19%) varieties (Table 19). The difference in moisture content among varieties was due to genetic variation. Moisture level of grains needed to be adjusted to low enough to inactivate the enzymes involved in seed germination as well as to prevent heat damage and the growth of disease causing microorganisms. Wheat harvesting begins when the crop reaches physiological maturity and the moisture content drops to 14%, but this can vary depending on management methods [55]. Along with management measures that might help increase agricultural output, the variability of grain yields is mostly determined by climatic conditions rather than fertilization or varieties [40].

Table 19. *Main effects of blended NPSZnB fertilizer rates and varieties on grain moisture content (%) of bread wheat.*

Treatments	Grain Moisture Content (%)
NPSZnB (kg ha^{-1})	
0	9.43^{d}
100	9.91^{cd}
150	10.34^{bc}
200	10.66^{ab}
250	11.06^{a}
Mean	10.28
LSD (0.05)	0.59
Variety	
Kingbird	10.83^{a}
Danda	10.21^{b}
Shorima	9.90^{b}
Ogolcho	10.19^{b}
Mean	10.28
LSD (0.05)	0.53
CV (%)	6.98

Means followed by the same letters are not significantly different at ($P \le 0.05$)

3.6. Correlation Analysis Between Yield and Yield Components of Bread Wheat

Significant positive correlation of grain yield with almost all the yield and yield components were observed which indicating that grain yield could invariably increase by increasing those characteristics (Table 20). Positive associations obtained between grain yield with number of total tillers produced per plant (r=0.86**), productive tillers produced per plant (r=0.93**), aboveground dry biomass yield (r=0.83**), harvest index (r=0.96**) spike length (r=0.62**), number of grain per spike (r=0.89*) and thousand grain weight (r=0.73**) (Table 4). The result shows that the applied fertilizers have positive contribution to the economic yield. The result of this study is in line with the findings of [61], who reported a highly significant positive association between grain yield and plant height, panicle length, panicle seed weight, straw yield, and harvest index, backed up this conclusion.

Table 20. *Correlation analysis between yield, yield related parameters and quality parameter of bread wheat.*

	DF	DM	LA	PH	TT	PT	SL	GPS
DF	1.00							
DM	0.78**	1.00						
LA	-0.36**	0.53**	1.00					
PH	0.48**	0.60**	0.42**	1.00				
TT	0.54**	0.65**	0.71**	0.79**	1.00			
PT	0.52**	0.66**	0.83**	0.55**	0.86**	1.00		
SL	0.44**	0.51**	0.44**	0.83**	0.80**	0.57**	1.00	
GPS	0.44**	0.60**	0.77**	0.53**	0.77**	0.83**	0.52**	1.00
HI	-0.33**	0.53**	0.81**	0.43**	0.76**	0.91**	0.48**	0.87*
LP	-0.43**	0.56**	0.65**	0.36**	0.51**	0.64**	0.31*	0.57*
TGW	0.36**	0.54**	0.58**	0.78**	0.75**	0.61**	0.70**	0.68*
HW	0.48**	0.67**	0.74**	0.35**	0.59**	0.80**	0.31*	0.70*
MO	0.41**	0.46**	0.54**	0.40*	0.53**	0.59**	0.35*	0.55*
BM	0.51**	0.64**	0.69**	0.77**	0.88**	0.72**	0.77**	0.74*
SYLD	0.44**	0.49**	0.35*	0.73**	0.65**	0.33**	0.69**	0.40*
GYLD	0.42**	0.62**	0.85**	0.57**	0.86**	0.93**	0.62**	0.89*

Table 20. *Continued.*

	HI	LP	TGW	HW	MO	BM	SYLD	GYLD
DF								
DM								
LA								
PH								
TT								
PT								
SL								
GPS								
HI	1.00							
LP	0.60**	1.00						
TGW	0.59**	0.47**	1.00					
HW	0.75**	0.67**	0.47**	1.00				
MO	0.58*	0.60**	0.49**	0.67**	1.00			
BM	0.68**	-0.46**	0.83**	0.55**	0.44**	1.00		
SYLD	0.22NS	-0.18NS	0.69**	0.19NS	0.18NS	0.87**	1.00	
GYLD	0.96**	-0.62**	0.73**	0.77**	0.59**	0.83**	0.45*	1.00

DF=days to flower, DM=days to physiological maturity, LA=leaf area, PH=plant height, TT=total tillers, PT=productive tillers, SP=spike length, GPS=grain per spike, HI=harvest index, LP=lodging percentage, TGW=thousand grain weight, HW=hectoliter weight, MO=moisture content, BM=above ground biomass, SYLD=straw yield and GYLD=grain yield.

3.7. Economic Analysis

The result of partial budget analysis showed that the maximum net benefit (85047 Birr ha^{-1}) with marginal rate of return (782.47 percent) was obtained from 200 kg blended NPSZnB ha^{-1} fertilizer application, whereas the lowest net benefit (30312 Birr ha^{-1}) among the treatments was on Control (0 kg ha^{-1} NPSZnB) treatment (Table 21). The result of economic analysis of the treatments using a partial budget method showed that net benefit income was higher as blended NPSZnB fertilizer rates increases up to certain level (200kg ha^{-1}).

In terms of advantage the result was showed a net advantage of Birr 54735.82 (64.40%) of 200kg NPSZnB ha^{-1} over control treatment. In line with these result [37], indicated that the estimated net income for mineral fertilizer is attractive as compared to growing wheat without application of fertilizer.

Table 21. *Economic feasibility analysis for fertilizer rates for grain yield of bread wheat.*

NPSZnB ($kgha^{-1}$)	Adj. Gyld 10% ($kgha^{-1}$)	Adj. Styld 10% ($kgha^{-1}$)	Rev. grain	Rev. Straw	TGB (birr ha^{-1})
0	612	4392	17136	13176	30312
100	1980	5139	55440	15417	70857
150	2223	5454	62244	16362	78606
200	2610	5769	73080	17307	90387
250	2448	5994	68544	17982	86526

Table 21. *Continued.*

NPSZnB ($kgha^{-1}$)	Ferti. Cost	Ferti Appli. Cost	TVC (birr ha^{-1})	NB (birr ha^{-1})	MRR%
0	0	0	0	30312	-
100	2550	120	2670	68187	1418.5
150	3825	180	4005	74601	480.5
200	5100	240	5340	85047	782.5
250	6375	300	6675	79851	D

Where, AGY=Adjusted grain yield, ASY=Adjusted straw yield, TGB=Total gross benefit, TVC=Total variable cost, NB=Net benefit, NPSZnB cost=25.50 Birr kg^{-1}, Labour cost=60 Birr perman-day's^{-1} and 2man ha^{-1}, sales of price of bread wheat grain=28 Birr kg^{-1}, Straw sales price=3 birr kg^{-1}, MRR (%)=Marginal Rate of Return, D=Dominated treatment, Control=Unfertilized treatment.

4. Conclusion and Recommendations

4.1. Conclusion

Application of blended NPSZnB fertilizer for all treatments except of control (0kg ha^{-1} NPSZnB) treatments significantly affected days to 50% heading, days to 90% maturity, plant height, spike length, number of total and effective tiller per plant, grains per spike, grain yield, biomass yield, harvest index, hectoliter weight and 1000-grain weight. Application of 200$kgha^{-1}$ NPSZnB with the Kingbird variety resulted in the maximum leaf area (30.15 cm^2), grains per spike (52.5), and grain yield (3.54t ha^{-1}).

The application of 200kg ha^{-1} blended NPSZnB fertilizer increased grain yield by 32.8% as compared to the control (zero fertilizer). The highest net return (85047 ETB ha^{-1}) with MRR of 782.47% was obtained with application of blended fertilizer 200kg NPSZnB ha^{-1} which is economically feasible for wheat production in the study area.

4.2. Recommendations

The results of this study showed that the highest grain yield (3.54 tha^{-1}) was recorded from application of 200$kgha^{-1}$ NPSZnB with Kingbird variety. The Kingbird bread wheat variety had better performances as compared to other varieties. Moreover, the highest net return (85047 ETB ha^{-1}) with MRR of 782.47% was obtained with application of blended fertilizer 200kg NPSZnB ha^{-1}. Hence the use of Kingbird variety with 200kg NPSZnB ha^{-1} is economically feasible and recommended for bread wheat production in the study area and similar agro-ecologies. Nevertheless, the study should be repeated in many locations and seasons for further recommendations for sustainable bread wheat production and productivity. Moreover soil of the study area is acidic with low soil fertility status; hence use of integrated soil fertility management practices like liming is recommended to improve the production and productivity of bread wheat in the study area and similar agro-ecologies.

Conflicts of Interests

The authors have not acknowledged any conflict of interests.

References

[1] Abebaw Tadele, and Hirpa Legese, (2018). Effects of fertilizer rate (blended) and sowing methods on yield of bread wheat (*Triticum aestivum* L.) and its economic profitability in Western Ethiopia. *Journal of Comprehensive Research in Biological Sciences,* 5 (7): 1-14.

[2] Adugnaw Anteneh and Dagninet Asrat., (2020). Wheat production and marketing in Ethiopia: Review study. *Cogent Food & Agriculture*, 6 (1): 1-14.

[3] Agegnehu Getachew, Lakew Berhane, and Nelson, P., (2014). Cropping sequence and nitrogen fertilizer effects on the productivity and quality of malting barley and soil fertility in the Ethiopian highlands. *Archives of Agronomy and Soil Science,* 60 (9): 1261-1275.

[4] Alloway, B., (2008). Zinc in soil and crop nutrition. Zinc in lant nutrition. *International Zinc Association, Bruselas*, 3 (7): 12-128.

[5] Alloway, B. J., (2009). Soil factors associated with zinc deficiency in crops and humans. *Environmental Geochemistry and Health*, 31: 537-548.

[6] Arif M, Ali S, Khan A, Jan T and Akbar M., (2006). Influence of farmyard manure application on various wheat cultivars. *Sarhad Journal of Agriculture,* 22 (1): 27-29.

[7] Asossa Agricultural Research Center (AsARC) (2020). Metrological station data report of Asossa. Unpublished.

[8] Assefa Menna, Johnson, Semoka, M. R., Nyambilila Amuri and Tekalign Mamo. (2015). Wheat Response to Applied Nitrogen, Sulfur and Phosphorous in three Representative Areas of the Central Highlands of Ethiopia. *International Journal of Plant and Soil Science,* 8 (5): 1–11.

[9] Atwell, W. A., (2001). Wheat Flour. Eagan Press Handbook Series, St. Paul, Minnesota, USA. 59-62.

[10] Aynewa, Y., Dessalegn, T. and Bayu, W., 2013. Participatory evaluation of malt barley (Hordeum vulgare L.) genotypes for yield and other agronomic traits at North-West Ethiopia. *Wudpecker Journal of Agricultural Research*, *2* (8): 218-222.

[11] Bardsley, C. E. and Lancaster, J. D., (1960). Determination of reserve sulfur and soluble sulfates in soils. *Soil Science Society of America Journal*, *24* (4): 265-268.

[12] Bekalu A. Mamo M., (2016). Effect of the rate of N fertilizer application on growth and yield of wheat (*Triticum aestivum* L.) at Chencha, Southern Ethiopia. *Inter. Jour. of Plant, Animal and Environmental Sciences,* 6 (3): 168-173.

[13] Benton, T. G., Vickery, J. A. and Wilson, J. D., (2003). Farmland biodiversity: is habitat heterogeneity the key? *Trends in Ecology and Evolution*, 18 (4): 182-188.

[14] Bettge, A. D., Morris, C. F., De Macon, V. L. and Kidwell, K. K., (2002). Adaptation of AACC method 56-11, solvent retention capacity, for use as an early generation selection tool for cultivar development. *Cereal Chemistry*, 79 (5): 670-674.

[15] Bray, R. H. and Kurtz, L. T., (1945). Determination of total, organic, and available forms of phosphorus in soils. *Soil Science*, *59* (1): 39-46.

[16] Chanda, S. V. and Singh, Y. D., (2002). Estimation of leaf area in wheat using linear measurements. *Plant Breeding and Seed Science*, 46 (2): 75-79.

[17] Chapman, H. D., (1965). Cation exchange capacity. *Methods of Soil Analysis: Part 2 Chemical and Microbiological Properties*, 9, 891-901.

[18] Chauhan, S., Darvishzadeh, R., Boschetti, M. and Nelson, A., (2020). Discriminant analysis for lodging severity classification in wheat using RADARSAT-2 and Sentinel-1 data. J*ournal of Photogrammetry and Remote Sensing*, *164:* 138-151.

[19] Chopra, S. L. "Kanwar. JS (1976). Analytical Agricultural Chemistry." *Kalyani Publishers, New Delhi. Journal of Tropical Forest Science* 6 (4): 408-442.

[20] CIMMYT (1988). Economics Program, International Maize and Wheat Improvement Center, *From agronomic data to farmer recommendations: An Economics Training Manual,* 27, 1-79.

[21] CSA, (2018). Agricultural sample survey report on area and production of major crops (Private peasant holdings, Meher season. The FDRE statistical bulletin, Volume I.

[22] CSA, (2020). Agricultural Sample Survey Volume I. Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season).

[23] CSA. (2019). Agricultural sample survey report on area and production of major crops (Private peasant holdings, Meher season). The FDRE statistical bulletin, Volume I.

[24] Day, P. R., (1965). Particle fractionation and particle-size analysis. Methods of Soil Analysis: Part 1 Physical and Mineralogical Properties, Including Statistics of Measurement and Sampling, 9: 545-567.

[25] Debnath R., Jahiruddin M., Rahman M. and Haque M., (2011). Determining optimum rate of boron application for higher yield of wheat in Old Brahmaputra Flood plain soil. *Journal of Bangladesh Agricultural Univ*iversity, 9 (2): 205–210.

[26] 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. *Journal of Ecology and Natural Resource,* 3 (3): 1-13.

[27] Duressa, L. A. and Ayana, N. G., (2020). Effects of Variety and Fertilizer Rate on Yield of Bread Wheat (*Triticum aestivum*, L) Varieties in East Wollega Zone, Western Ethiopia. *Journal Agricultural and Biological Sciences*, 6 (2): 60-71.

[28] El Baidouri, M., Murat, F., Veyssiere, M., Molinier, M., Flores, R., Burlot, L., Alaux, M., Quesneville, H., Pont, C. and Salse, J., (2017). Reconciling the evolutionary origin of bread wheat (*Triticum aestivum*). *New Phytologist*, *213* (3): 1477-1486.

[29] El-Attar, H. A. and Jackson, M. L., (1973). Montmorillonitic soils developed in Nile river sediments. *Soil Science*, *116* (3): 191-201.

[30] Ethiopian Agricultural Transformation Agency (ATA), (2015) Soil Fertility mapping and Fertilizer Blending.

[31] Fageria, N. K., Filho, M. B., Moreira, A. and Guimarães, C. M., 2009. Foliar fertilization of crop plants. *Journal of Plant Nutrition*, *32* (6): 1044-1064.

[32] Fayera, A., Adugna, D. and Muktar, M., (2014). Evaluation of Teff [*Eragrostis tef (Zucc*) *Trotter*] Responses to Different Rates of NPK Along With Zn and B in Didessa District, Southwestern Ethiopia. *World Applied Sciences Journal*, 32 (11): 2245-2249.

[33] Fenta A., (2018). Effect of tef variety and rates of nitrogen fertilizer application on growth and yield components under Jimma condition. *ARPN Journal of Agricultural and Biological science,* 13 (3): 34-42.

[34] Firehiwot Getachew (2014). Effect of Vermicomposting and Inorganic N and P Fertilizers on Growth, Yield, and Quality of Bread Wheat (*Triticum aestivum* L.) in Eastern Ethiopia, MSc Thesis, Haramaya University, Haramaya, Ethiopia.

[35] Giraldo, P., Benavente, E., Manzano-Agugliaro, F. and Gimenez, E., (2019). Worldwide research trends on wheat and barley: A bibliometric comparative analysis. *Agronomy*, *9* (7): 352.

[36] Haftamu, G., Mitiku, H. and Yamoah, C. F., (2009). Tillage frequency, soil compaction and N-fertilizer rate effects on yield of teff (*Eragrostis tef* (zucc) Trotter) in central zone of Tigray, Northern Ethiopia. *Momona Ethiopian journal of Science*, 1 (1): 82-94.

[37] Haile, D., Nigussie, D. and Ayana, A., (2012). Nitrogen use efficiency of bread wheat: Effects of nitrogen rate and time of application. *Journal of Soil Science and Plant Nutrition*, 12 (3): 389-410.

[38] Hazelton, P. and Murphy, B., (2016). Interpreting soil test results: What do all the numbers mean?. *CSIRO publishing,* 31: 419-436.

[39] Horneck, D. A., Sullivan, D. M., Owen, J. S. and Hart, J. M., (2011). Soil test interpretation guide, *Journal* A*dministrative Report*, 1478: 1-11.

[40] Jonfia-Essien, W., Navarro, S., Villers, P. Hermetic storage, (2010). A novel approach to the protection of cocoa beans. *African Crop Science Journal*, 18 (2): 59-68.

[41] Khan, A. Q., Robe, B. L. and Girma, A., (2020). Evaluation of wheat genotypes (*Triticum aestivum* L.) for yield and yield characteristics under low land area at Arba Minch, Southern Ethiopia. *African Journal of Plant Science*, *14* (12): 461-469.

[42] Lakew, A. (2019). Influence of N and P fertilizer rates on yield and yield components of bread wheat (*Triticum aestivum* L.) in Sekota District of Wag-Himira Zone, North Eastern Ethiopia. *Archives of Agriculture and Environmental Science*, 4 (1): 8-18.

[43] Landon JR. (1991). Booker Tropical Soil Manual: a handbook for soil survey and agricultural land evaluation in the tropics and subtropics. John Wiley & Sons Inc., New York.

[44] Lindsay, W. L. and Norvell, W. A., (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of America Journal*, *42* (3): 421-428.

[45] Matouš, P., Todo, Y., & Mojo, D. (2013). Roles of extension and ethno-religious networks in acceptance of resource-conserving agriculture among Ethiopian farmers. *International Journal of Agricultural Sustainability*, 11 (4), 301–316.

[46] Melkamu J., (2010). Long-term effect of balanced mineral fertilizer application on potato, winter rye, and oat yields; nutrient use efficiency and soil fertility. *Archives of Agronomy and Soil Science,* 56 (4): 421-432.

[47] Mesfin, T., Haile, W. and Kassa, S., (2019). Effects of Nitrogen and Blended Fertilizers on Yield and Yield Components of tef [(*Eragrostis tef* (Zucc.) Trotter] in Central Highlands of Ethiopia. *International Journal of Advances in Agricultural Science and Technology*, 6 (8): 15-64.

[48] Ministry of Agriculture and Natural Resources, Crop Variety Register of Ethiopia, (2016).

[49] Moraghan, J. T. and Mascagni Jr, H. J., (1991). Environmental and soil factors affecting micronutrient deficiencies and toxicities. *Micronutrients in Agriculture*, 4, 371-425.

[50] Muhaimeed, A. S. and Jaf, D. R., (2016). Land suitability for wheat production under dry farming system in erbil plain using remote sensing and GIS. *International Journal of Research*, 3 (8): 1-9.

[51] Muhammad T, Asefa T, Tajamol H, Wasoya A., (2009). Yield response of wheat to Boron application. *Pakistan Journal of Life and Social Sciences,* 7 (1): 39-42.

[52] Mulugeta Eshetu, Shure Sebboka, Tilah for Br un Chibsa, Chala Chimdessa, Negash Bedasso (2017). Optimization of Fertilizer Recommendations ead Wheat at Sinana District of Bale Zone, Southeastern Oromia, Ethiopia. *International Journal of Sciences and Qualitative Analysis,* 3 (6): 55-60.

[53] Nasser K. and Gizawy B., (2009). Effect of Planting Date and Fertilizer Application on Yield of Wheat under no till System. *World Journal of Agricultural Sciences*, 5 (6): 777-783.

[54] Pandey, B. K., Verma, N. K., Devi, S., Jalikatti, V. N., Kumar, A. and Kumar, P., (2021). Effect of Varieties and Irrigation Methods on Growth and Yield of Wheat (*Triticum aestivum* L.). *International Journal of Agriculture Innovations and Research*, 9 (4): 304-307.

[55] Shamsollah Abdollahpour, Armaghan Kosari-Moghaddam, Mohammad Bannayan (2020). Prediction of wheat moisture content at harvest time through ANN and SVR modeling techniques. *Information Processing in Agriculture*, 7 (4): 500-510.

[56] Shiferaw, B., Kassie, M., Jaleta, M., and Yirga, C., (2014). Adoption of improved wheat varieties and impacts on household food security in Ethiopia. *Food Policy*, 44: 272-284.

[57] Sime B and S Tesfaye, (2020). GGE bi plot analysis of genotype by environment interaction and grain yield stability of bread wheat genotypes in Oromia, Ethiopia. *International Journal of Agriculture and Bioscience*, 9 (6): 284-290.

[58] Tadesse, W., Bishaw, Z. and Assefa, S., (2019). Wheat production and breeding in Sub-Saharan Africa. *International Journal of Climate Change Strategies and Management*, 11 (5): 696-715.

[59] Tagesse, A., Belete, K. and Tana, T., (2018). Effect of blended NPS fertilizer supplemented with nitrogen on yield components and yield of bread wheat (*Triticum aestivum* L.). *Journal of Natural Sciences Research*, 8 (11): 90-17.

[60] Tahir M., Tanveer A, Shah T, Fiaz N, and Wasaya A., (2009). Yield response of wheat (*Triticum aestivum* L.) to Boron application at different growth stages. *Pakistan Journal of Life and Social Sciences,* 7: 39-42.

[61] TeklayTesfay and Girmay Gebresamuel (2016). Agronomic and economic evaluations of compound fertilizer applications under different planting methods and seed rates of tef [*Eragrostis tef* (Zucc.) trotter] in Northern Ethiopia. *Journal of the Dry Lands*, 6 (1): 409-422.

[62] Teklu, A., Gebremaryam, Y. and Meles, B., (2019). Effect of Different Blended Fertilizer Rates on Yield and Yield Components of Bread Wheat (*Triticum aestivum*. L) in Central zone of Tigray. *Tigray Agricultural Research Institute (TARI) Agricultural Growth Program-II (AGP-II)*, *7*: 58.

[63] Tilahun Abera and Tamado Tana, (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): 9-20.

[64] Walkely, A. and 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 Sciences*, *37* (2): 1-10.

[65] Wallace, T., (1961). Essential Points in the Nutrition of Plants: The Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms, 3rd Edn., Her Majesty's Stationary Office, London, PP. 17.

[66] Wassie H, Shiferaw B., (2011). Response of Irish Potato (*Solanum tuberosum*) to the Application of Potassium at Acidic Soils of Chencha, Southern Ethiopia. *International Journal of Agriculture and Biology, 13: 595-598.*

[67] Woldetsadik, A., Tena, W. and Melese, A., (2019). Effect of Different Blended Fertilizer Formulation on Yield and Yield Components of Bread Wheat (*Triticum aestivum* L.) in Siyadebrenawayu District, North Shewa, Ethiopia. *Journal of Biology, Agriculture and Healthcare*, 9 (15): 13-23.

[68] Woubshet D. Selamyihun K. and Cherukuri V. (2017). Effect of integrated use of lime, blended fertilizer, and compost on productivity, nutrient removal and economics of barley (*Hordeum vulgare* L.) on acid soils of high lands in West Showa Zone of Ethiopia. *International Journal of Life Science,* 5 (3): 311-322.