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Effects of Blended NPS Fertilizer Rates on the Yield Components and the Yield of Bread Wheat Varieties (*Triticum aestivum* L.)

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Abstract

The use of improper fertilizer type and amount, the cultivation of unimproved, low-yielding varieties and poor soil fertility are among the main obstacles limiting the productivity of wheat in Ethiopia in general and in the study area in particular. A field trial was therefore initiated to evaluate the effects of blended NPS fertilizer rates on the yield components and the yield of bread wheat varieties and to identify economically justifiable amounts of blended NPS fertilizer in the study area. The experiment was set up in RCBD with three replicates in which three bread wheat varieties (Ogolcho, Jalane and Sanate) and five levels of mixed NPS fertilizers (0, 50, 100, 150 and 200 kg ha^{-1}) were assessed in a factorial combination. The results showed that all properties of the bread wheat varieties were significantly ($p < 0.01$) influenced by the main effects of the variety and the NPS fertilizer. The highest (0.43) and the lowest (0.36) harvest index were obtained from 150 kg ha^{-1} NPS. The interactions of the two main factors only affect the total number of tillers, the number of productive tillers, the aboveground biomass, the grain and straw yield. Similarly, the highest and lowest (11.04 and 1.13) agronomic efficiencies were obtained from the combination of 150 kg NPS ha^{-1} with the Sanate variety and 50 kg ha^{-1} with the Jalane variety. The highest profitability (82710 ETB ha^{-1}) and a higher MRR (2305.8%) are obtained from the Sanate variety with an application rate of 150 kg ha^{-1} NPS. Based on the results of this study, it can be concluded that the application of 150 kg ha^{-1} NPS and the cultivation of the Sanate variety could be the better choice of the farmers of the study area in order to achieve high yields with higher returns.

1. Introduction

Wheat is a self-pollinating annual plant that belongs to the grass family and the Hordeae tribe [1]. It is one of the three most widely grown grains in the world and occupies about a third of the world's arable land [2]. It ranks first in the world of cereal crops, which make up 30% of all grain foods worldwide, and is a staple food for over 7.6 billion people in no fewer than 43 countries around the world [3].

Wheat is an important cereal crop in Ethiopia that is grown at different altitudes [4]. Wheat can grow in the Ethiopian highlands, which are between 6° and 16° N and 35° and 42° E, at altitudes between 1500 and 3000 m above sea level. The most suitable altitude zones for wheat, however, are between 1900 and 2700 m above sea level [5]. Wheat is used in various forms such as bread, porridge, soup, and toasted grain, and wheat straw is used for animal feed, brood roofs, and bedspreads [6]. The two types of wheat are grown in Ethiopia; Bread wheat and durum wheat. Bread wheat production covered 15% in 1967 and 40% in 1991, but currently it covers around 60% of the total wheat area, while durum wheat accounts for around 40% [7].

In Ethiopia (CSA) reported that the observed increase in wheat production over the past decade was due to both the expansion of the production area and the introduction of improved technologies. For example, between 1995 and 2017 the area under wheat increased from 0.8 million ha to 1.69 million ha and the yield from 1.20 t ha^{-1} to 2.68 t ha^{-1} [8]. However, the large increase in wheat in terms of area and production is below the world average, which is around 3 t ha^{-1}. It is grown on about 1.69 million hectares and contributes about 4.54 million tons to the grain yield, which accounted for 13.49 percent of the total grain production of the country in the several harvest season 2017, which makes Ethiopia the second largest wheat producer in Sub-Saharan after South Africa - Africa makes Africa [8].

With 2.5 million tons from a production area of 872,252.80 hectares, the Oromia region is the largest wheat producer in Ethiopia [9]. In East and West Hararghe the total wheat production area was 18,289.94 hectares and 4,143.26 hectares, respectively. The zonal average wheat yield is 2.1t ha^{-1} for East Hararghe and 1.9 t ha^{-1} for the West Hararghe zone, which is less than the national average of 2.5 t ha^{-1} [9]. The national average yield for wheat is 2.5 tones ha^{-1}, which is lower than the global average (3.19 tones ha^{-1}) [10].

The yield gap between the land and the other world could be attributed to many biotic and biotic factors, such as disease and pests, poor management practices, poor soil fertility, and moisture stress [11], which hinder the potential production of the crop. Poor soil fertility and the cultivation of unimproved, low-yielding varieties, the use of unsuitable type and amount of fertilizer, an insufficient level of technology development and application are the main constraints limiting wheat production in Ethiopia and including the study area. Hence, adding nutrients such as N, P and S and developing a variety of wheat with lasting resistance to disease, insects and moisture stress and drought is important to increasing the yield and yield components of wheat, be it for consumption or industrial purposes. Among the several factors responsible for low yields in Ethiopia, the use of imbalanced fertilizers is an important agronomic practice, so research into these limiting factors is certain to result in high yields in wheat crops.

Nitrogen is the most important nutrient that affects wheat yield and quality. It has been reported that grain yields are roughly proportional to the amount of N applied [12]. An increased wheat yield occurs on all soils with an increased N application rate, but such increases are reported more frequently on heavy clay soils. Several reports have also indicated that increased use of N-fertilizers is viewed as the primary means of increasing wheat grain productivity in Ethiopia [13]. Nitrogen is considered to be the most deficient nutrient in the soils of Ethiopia [14]. An increase in the N fertilizer strongly influenced the grain yield and the quality of wheat, such as protein content, wet gluten and Zeleny values [15].

After nitrogen, phosphorus is the second most powerful limiting nutrient for plant production, and soils are also low in available phosphorus [16]. Plants with a lack of phosphorus are stunted and, in contrast to those with a lack of nitrogen, are often dark green. A lack of P in wheat resulted in reduced tillering, reduced leaf area and an increased susceptibility to a number of diseases. In addition, the maturity of P-deficient plants is often delayed compared to plants that are rich in phosphate [17].

Sulfur (S) is one of the essential nutrients for plant growth and, based on the dry matter, accumulates in the plant tissue by 0.2 to 0.5%. It is needed in a similar amount as phosphorus [18].The lack of sulfur leads to stunted growth, reduced plant height, tillering, spikelets and delayed maturity. Sulfur-deficient plants also have lower resilience to stressful conditions [19]. Wheat requires a relatively high amount of additional S due to the incompatibility of the conditions with its fastest growing phase, in which the rate of release of S from soil organic matter is quite slow [20]. Its fertilization promotes the uptake of N, P, K and Zn in the plant.
According to [21], in addition to N and P, it was reported that the deficiencies of K, S, Zn, B and Cu are low in the most important Ethiopian soils, especially in the investigated study area. In general, in most of the country,

and in Jarso district in particular, farmers have limited information on the effects of different types and amounts of blended fertilizers other than (100 kg urea and 100 kg DAP ha^{-1}) effects of blended NPS fertilizers on the yield components and yield of wheat unknown, although it is currently used by farmers in the study area. Improved wheat varieties are one of the factors that play an important role in achieving higher wheat yields [22]. In addition, the response of the wheat plant to fertilization varies with varieties, rainfall, soils, agronomic practices, and expected yield. Therefore, there is a need to make site-specific recommendations on fertilizer amounts for main varieties in order to increase the productivity of bread wheat. Therefore, this study is initiated with the following objectives: - to evaluate the effects of blended NPS fertilizer on the yield components and yield of bread wheat varieties and identify economically justifiable amount (s) of added NPS fertilizer in the study area.

2. Experimental Procedure

2.1. Description of the Field of Study

The experiment was carried out in Afugug kebele (FTC), Jarso District, Eastern Hararghe Zone during the main rainy season from July 20 to December 5, 2019. Jarso District is one of the many districts in the Oromia National Regional State, which is located in the east of the country. It is located 561 km east of Addis Ababa and 36 km from the zonal capital Harar. Jarso Woreda is found at an altitude of 55.36'31 N and length 3858'91E at an altitude of 1050-3030 m above sea level. Jarso Woreda is found at an altitude of 55.36'31 N and length 3858'91E at an altitude of 1050-3030 m above sea level. The district borders in the south on the regional state of Harari, in the west on the district Kombolcha, in the north on the district Dire Dawa and in the east on the district Gursum. The administrative center of this district is Ejersa Goro. Afugug kebele is right on the south side of the main road to Chenaksen. The administrative center of this district is Ejersa Goro. Afugug kebele is right on the south side of the main road to Chenaksen.

The climatic conditions of the district are a humid humidity with a relatively shorter growing season. The area receives an annual rainfall of 650-950 mm with a bimodal pattern that extends from April to November. The average annual minimum and maximum temperatures are 18 °C and 30 °C, respectively. In terms of agroecology of the area, Highland, Mid Highland and Lowland account for 28%, 55% and 17% of the district, respectively. Afugug kebele is located 2 km from Ejersa Goro at a latitude of 09o29, 781 N and a longitude of 042º14.867 E at an altitude of (2340 m above sea level) [23].

2.2. Experimental Materials

The three types of bread wheat, namely; Ogolcho, Jalane, and Sanate were used for the experiment. The seeds of the varieties were obtained from Haramaya University's Wheat Enhancement Program.

Table(1). Descriptions of the bread wheat varieties.

No	Varieties	Year of release	Sources of Varieties Institution	Adaptation Zone		Maturity (days)	Yield under Research site (t ha^{-1})
				Altitude (m asl)	Rain fall (mm)		
1	*Ogolcho*	2012	KARC/EIAR	1500-2100	500-800	102	3.3-5.0
2	*Sanate*	2014	SARC/OIA R/	2300-2600	750-1500	109-117	3.4-6.7
3	*Jalane*	2017	HU	1790-2200	>650	141	2.7-3.2

Source: [24].
HU = Haramaya University, KARC / EIAR = Kulumsa Agricultural Research Center, Ethiopian Institute of Agricultural Research, SARC / OARI = Sinana Agricultural Research Center, Oromia Institute of Agricultural Research.

2.3. Soil Sampling and Analysis

Soil samples were taken in a zigzag pattern before they were planted and assembled at random from the test site at a depth of 0-30 cm above the test field using auger. The composite sample was then air dried in the shade at room temperature and the samples were mixed thoroughly to produce 1.0 kg of a representative composite sample. The assembled sample was submitted to the Haramaya University soil test laboratory. Then it was ground through a 2 mm sieve in the laboratory, while for the determination of organic carbon (OC) and nitrogen (N) the soil was ground through a 0.2 mm sieve. The soil sample was analyzed for selected physico-chemical properties, mainly soil texture, soil pH, cation exchange capacity (CEC), total N and available P and S according to standard laboratory procedures in the soil test laboratory of Haramaya University.

2.4. Treatments and Experimental Design

The treatments were arranged in a factorial combination of three bread wheat varieties (Ogolcho, Jalane and Sanate) and five levels of blended NPS fertilizer amounts (0, 50, 100, 150 and 200 kg ha^{-1}) and the currently recommended 100 kg ha^{-1} urea fertilizer was made applied uniformly out of control in shared application for all treatments. The experiment was set up in a randomized complete block design (RCBD) with three replications in a factorial arrangement of 3x5 = 15 treatment combinations. The treatments were assigned to the plots by lottery and each treatment appears only once within a replication. The gross size of each plot was 1.2m x 2.5m (3 m^2) consisting of six rows, and the spacing between adjacent plots and blocks was 0.5 m and 1 m, respectively.

Table (2). The combination of cultivars and fertilizers of experimental treatments.

Treatment code	Description of the treatments		Total Composition of Fertilizer in the treatment (kg ha^{-1})		
	Treatment combinations				
	Varieties	Fertilizer Treatments (kg ha^{-1})	N	P_2O_5	S
T1	Jalane	control	0	0	0
T2	Jalane	50 NPS + 100 Urea	55.5	19	3.5
T3	Jalane	100 NPS + 100 Urea	65	38	7
T4	Jalane	150 NPS + 100 Urea	74.5	57	10.5
T5	Jalane	200 NPS + 100 Urea	84	76	14
T6	Ogolcho	control	0	0	0
T7	Ogolcho	50 NPS + 100 Urea	55.5	19	3.5
T8	Ogolcho	100 NPS + 100 Urea	65	38	7
T9	Ogolcho	150 NPS + 100 Urea	74.5	57	10.5
T10	Ogolcho	200 NPS + 100 Urea	84	76	14
T11	Sanate	control	0	0	0
T12	Sanate	50 NPS + 100 Urea	55.5	19	3.5
T13	Sanate	100 NPS + 100 Urea	65	38	7
T14	Sanate	150 NPS + 100 Urea	74.5	57	10.5
T15	Sanate	200 NPS + 100 Urea	84	76	14

2.5. Experimental Procedures and Field Management

The trial field was prepared using hand tools (local plow akafa) following the farmers' conventional farming practices. The field layout was prepared according to the draft; the land was cleared and leveled, each treatment randomly assigned to the experimental units within a block. The sowing took place because the experiment planned 125 kg ha^{-1} in rows 20 cm apart manually by sowing on July 20, 2019 and covered it lightly with earth (at a depth of 3-5 cm). All of the NPS and half the dose of urea fertilizer were applied at the time of sowing, while the remaining half of the urea was applied in the middle tillering phase as top fertilization (33 days after sowing). The trial plots received uniformly different agronomic practices for all plot treatments.

2.6. Data Collection Measurements

2.6.1. Phenology and Growth Parameters

Days to heading (DTH): Days to heading was determined as the number of days taken from the date of sowing to the date of 50% of the heads of the plants of each plot by visual observation.

Days to Physiological Maturity (DTM): Days to Physiological Maturity were determined as the number of days from sowing to the date when 90% of the stalk turned a straw yellow color. It was recorded when no green color remained on the glumes and stems of the marked plants; H. when grains are difficult to break with the thumbnail

Plant Height (cm): It was measured from the bottom of the thorn to the tip of the thorn, excluding the awns of 10 randomly marked thorns from the net plot.

Lodging Percentage: The degree of lodging was assessed shortly before the time of harvest by visual observation using scales from 1-5, with 1 (0-15º) indicating no lodging, 2 (15-30º) indicating 25% lodging, 3 (30 -45º) stand for 50% lodging, 4 (45-60º) for 75% lodging and 5 (60-90º) for 100% lodging [25]. The scales were determined by measuring the angle of inclination of the main trunk from perpendicular to the trunk base by visual observation.

2.6.2. Yield Components and Yield

Number of Total Tillering: The number of total tillering was determined from 0.5 m length of two rows from the net plot and converted into per square meter of net plot at physiological maturity by counting the number of tillers.

Number of Productive Tillers: The number of productive tillers was determined at maturity by counting all seed-bearing ears of 0.5 m length in two rows from the net plot and converted into per square meter of net plot at physiological maturity.

Number of Grains per Ear: The mean number of grains per ear was calculated as the average of 10 ears picked at random from the net plot area.

Thousand Grain Weight (g): The thousand grain weight was determined based on the weight of 1000 grains taken from the grain yield of each net plot by counting using an electronic seed counter and weighing with a sensitive balance. Then the weight was adjusted to 12.5% moisture content.

Above-Ground Dry Biomass (kg ha^{-1}): The above-ground dry biomass was determined from plants that were harvested from the net plot area after sun drying to constant weight and converted into kg ha^{-1}.

Grain Yield (kg ha^{-1}): Grain yield was determined by harvesting and threshing the grain yield from the net plot area. The grain weight of each plot was recorded in kg and finally the yield per plot was converted into kg ha^{-1}. The yield was adjusted to 12. 5% moisture content. Adjusted grain yield =

$$\frac{(\mathbf{100-MC})\times\textbf{unadjusted grain yield}}{\mathbf{100-12.5}}$$

Straw Yield (kg ha^{-1}): The straw yield was determined as the difference between the total aboveground dry biomass and the grain yield.

Harvest Index (HI): The harvest index was calculated as the ratio of the grain yield per plot to the total aboveground dry biomass yield per plot.

2.7. Agronomic Efficiency (AE)

The agronomic efficiency of the fertilizer (kg kg^{-1}): is defined as the economic production achieved per unit of NPS. Agronomic efficiency was calculated using the method described by [26] as follows:

$$\mathrm{AE}\left(\frac{kg}{kg}\right)=\frac{Gf(kg)-Gu(kg)}{Na(kg)}$$

where; AE stands for agronomic efficiency, Gf and Gu for the grain yield in fertilized or unfertilized plots and Na for the amount of fertilizer applied.

2.8. Economic Analysis

The economic analysis was carried out using the methodology described in [27], in which the prevailing market prices were used for inputs at sowing and for outputs at harvest. All costs and services were calculated in Birr on a hectare basis. Unadjusted yield (UGY) is an average yield of each treatment. Adjusted Grain Yield (AGY) (kg ha^{-1}) Average yield was revised down 10% to reflect the difference between the experimental yield and the farmer's yield. The gross field benefit (GFB) (ETB ha^{-1}) was calculated by multiplying the field / farm price that farmers receive for the harvest when they sell it as an adjusted yield, as GFB = AGY ×field / farm price for the crop. The total variable cost (TVC) (ETB ha^{-1}) was calculated by adding up the various costs including the cost of NPS, urea, seeds and the cost of application. The net benefit (NB) was calculated as the difference between the gross utility and the varying total costs (TCV) using the formula NB = (GY x P) -TVC, where GY x P = gross field benefit (GFB), GY = adjusted grain yield per hectare and P. = Field price per unit of harvest. Marginal Rate of Return (MRR %): This refers to the net income generated by assuming unit costs for seeds and fertilizer rates. For each pair of ordered treatments based on net income, the marginal return on investment (MRR %) was calculated using the formula

$$\boldsymbol{MRR}(\%) = \frac{\textbf{change inNB}(\textbf{NBb} - \textbf{NBa})}{\textbf{change in TVC}(\textbf{TVCb} - \textbf{TVCa})} \times \mathbf{100}$$

where: NB_a = NB with the immediately lower, NB_b = NB with the next higher, TVC_a = the immediately lower TVC and TVC_b = the next higher TVC. The dominance analysis method described in [27] was used to select potentially profitable treatments from the range tested. The discarded and selected treatments using this technique were designated as dominated and non-dominated treatments, respectively. The treatment with the highest net benefit and a marginal rate of over 100% was then taken into account for the recommendation.

2.9. Statistical Data Analysis

All data collected were subjected to an analysis of variance (ANOVA) procedure using the Gen Stat 18th edition software [28] Comparisons between treatment means with significant differences for the signs measured were made using Fisher's proprietary Least Significant Difference (LSD) test at a level of significance of 5%.

3. Results and Discussion

3.1. Selected Physio-Chemical Properties of the Soil on the Test Site

The laboratory results of the analysis of the selected physico-chemical properties of the soil before sowing are shown in Table 3. The analytical results of the test soil showed that the soil texture class was clay loam with a particle size distribution of 16% sand, 36% silt and 48% clay. According to [4], the types of soil used for wheat production vary from well-drained fertile soils to water-indented heavy vertisoles. Thus, the soil of the test site is suitable for the production of wheat. The soil pH was 6.9, which is neutral [29]. The [30] reported that the preferred pH ranges for most crops and productive soils are 4 to 8. [31] reported an optimal pH range of 4.1 to 7.4 for wheat production. Thus, the pH of the test soil was in the range for productive soils for wheat.

The soil of the study area had 1.35% organic carbon (OC) (Table 3), which is low according to the assessment by [29], of soils with an OC value in the range of 0.5-1.5% as rated low. indicates that the soil has little potential to provide plants with nitrogen through the mineralization of organic carbon. The low amount of organic carbon in the soil could be due to the small addition of crop residues, as small farmers use the biomass of wheat in the study area as animal feed. [29] found the total N-content of the soil of <0.05% as very low, 0.05-0.12% as bad, 0.12-0.25% as moderate and> 0.25% classified as high. According to this classification, a moderate total N content (0.132%) was found in the soil samples (Table 3), which indicates that the nutrient is a limiting factor for wheat production in the study area.

The analysis showed that the available P of the soil was 13.64 mg kg^{-1} (Table 3). Indicative ranges of available phosphorus were found by [32], as <5 mg kg^{-1} (very low), 5-15 mg kg^{-1} (low), 15-25 mg kg^{-1} (medium) and > 25 mg kg^{-1} soil (high). Therefore, the soil at the trial site was considered to be low in the available P content. The low accessible phosphorus in the soil is not reasonable to get potential yield from the crop. Therefore, it is important to use phosphorus fertilizers from external sources according to the recommended amount. The analysis for available sulfur also showed that the test soil had values of 6.98 mg / kg, which is very low according to [21]. This suggests that the sulfur nutrient is a limiting factor for wheat production in the study area. This could mainly be due to poor sulfur-containing soil source material, soil degradation, removal of crop residues, crop intake, low soil organic matter, use of non-S-containing fertilizers (only N- and P-containing fertilizers used).

The cation exchange capacity (CEC) is an important parameter of the soil as it gives an indication of the type of clay mineral present in the soil and its ability to store nutrients against leaching. According to Landon (1991) topsoils with a CEC of more than 40 cmol (+) kg^{-1} are considered very high and 25-40 cmol (+) kg^{-1} are high and

15-25, 5-15 and <5 cmol (+) kg^{-1} soil are classified in the CEC as medium, low or very low. According to this classification, the soil at the test site had a high CEC (34.45 cmol (+) kg^{-1} soil), which indicates its high capacity for retaining cations (Table 3).

Table (3). Selected physico-chemical properties of the soil on the test site.

Parameter	Values	Rating	References
Soil texture			
Clay (%)	48	-	-
Sand (%)	36	-	-
Silt (%)	16	-	-
Textural Class	Clay loam		[4]
pH (1 : 2.5 H_2O)	6.9	Neutral	[29]
Total N (%)	0.123	Medium	[29]
Organic Carbon (%	1.345	Low	[29]
CEC[Cmol (+) kg1 soil]	34.45	High	[33]
Available Phosphorus (mg/kg)	13.641	Low	[32]
Available Sulfur (mg /kg)	6.98	Very low	[21]

3.2. Effects of NPS Fertilizer Rates on Phenology and Growth Parameters

3.2.1. Days to Heading and Days to Maturity

Days to heading and days to maturity were highly significantly ($p < 0.01$) influenced by the use of mixed NPS fertilizers and varieties. However, due to the interaction of mixed fertilizer quantities and varieties, they were not significant (Appendix, Table 2). The delayed days to budding and maturity observed in plots receiving 200 kg NPS ha^{-1}, but the number of days required to budding did not differ significantly for plots receiving 0.50 kg ha^{-1} and 150 and 200 kg received ha^{-1} NPS. Likewise, the days to maturity in plots that were applied with 150 and 200 kg ha^{-1} NPS showed no significant difference. Sanate and Jalane varieties took substantially, noticeably higher duration to achieve days to heading than Ogolcho, whereas, Sanate had significantly delayed days to maturity than the two varieties. The 8.78 (near 9) and 11.3 days to heading and maturity differences noticed between the plants that did not supply fertilizer and which received the highest incidence of 200 kg NPS ha^{-1} fertilizer, respectively (Table 4).

Table (4). Influence of varietal differences and rates of blended NPS fertilizer on days to heading and ripening of wheat.

Blended NPS Fertilizer rate (kg ha^{-1})	Days to heading	Days to Maturity
0	58.78^{c}	112.4^{d}
50	60.22^{c}	114.8^{c}
100	62.67^{b}	118.0^{b}
150	66.00^{a}	122.0^{a}
200	67.56^{a}	123.7^{a}
LSD (5%)	1.966	1.818
Varieties		
Jalane	62.33^{b}	113.7^{b}
Ogolcho	59.60^{c}	102.7^{c}
Sanate	67.20^{a}	138.2^{a}
LSD (5%)	1.523	1.409
CV (%)	3.2	1.6

Means followed by the same letter within a column in each trait and treatments do not differ significantly at $P < 0.05$ and LSD (5%) = least significant difference at $P < 0.05$

The result of this study agrees with the results of [33], which show the significant influence of NPS mixed fertilizers on the days until the head and days until the physiological ripeness of bread wheat. The Sanate variety was delayed by 7.6 and 35.5 days compared to the Ogolcho wheat variety and by 4.87 and 24.5 days compared to the Jalane variety (Table 4). This indicated that either the maturity of the variety is a function of a genetic factor or the fertilizer applied. The delayed days to head and maturity tend to have higher NPS fertilization rates, although inconsistency and a linear relationship are absent. This indicated a higher N content in the NPS fertilizer, delaying days to head and ripening times. The inconsistently increasing trend with increased NPS fertilizer could be due to the counteracting effects of the P diet on the N diet, as N tends to increase vegetative growth while P accelerates it [35]. Similarly, [36] observed significant differences in plant maturity due to the application of nitrogen to wheat. [37] reported that greater use of the N fertilizer delays the ripening of barley varieties. [38] reported that five wheat varieties showed a significant difference in head and ripeness over a period of days.

3.2.2. Effects of Blended NPS Fertilizer Rates on Plant Height, Spike Length and Lodging Percent

Plant height and Spike length were highly significantly ($p<0.01$) influenced by the use of blended NPS fertilizer rates and significant (0.05) effect by variety. But Lodging percent was highly significantly ($p<0.01$) influenced by the role of blended NPS fertilizer rates and varieties. However, due to the interaction of mixed fertilizer quantities and varieties, they were not significant. Increasing the amount of mixed NPS rates significantly increased plant height. The maximum application rate of blended NPS (200 kg ha^{-1}) resulted in the highest plant height (81.38 cm). As the NPS fertilizer levels increased from 50 to 200 kg ha^{-1}, the plant height increased from 72.04 cm to 81.38 cm. While the application of blended NPS fertilizer quantities in most of the plots that received 0 and 50 kg ha^{-1} and 150 and 200 kg ha^{-1} fertilizer quantities did not show any significant differences.

The increased plant height in response to the increasing rate of mixed NPS application could be due to the critical role of N-fertilizer in promoting vegetative growth, resulting in a significant increase in plant height. The variety Sanate had a significant maximum plant height (78.36 cm), Jalane had the shortest plant height (74.94 cm); however, the mean plant height of this variety and Ogolcho showed no significant differences in most of the plots (Table 5). The differences in plant height between the cultivars could be attributed to the difference in their genetic makeup or the rate of cell division, which lead to a change in the plant height of different cultivars. In addition, this result is in line with the results of [39], who reported that the application of N and P fertilizers increased the plant height of bread wheat in a highly significant ($P <0.01$) and the highest height of 94.18 and 90.56 cm recorded for applications of 69 kg N ha^{-1} and 30 kg P ha^{-1}, respectively. In general, the blended fertilizer plant height increases for all varieties, with the exception of some fertilizer amounts, which to some extent did not show an increasing trend. NPS fertilizer makes a great contribution to vigorous vegetative growth and development. The current study result also agreed with the results of [33], who reported that the size of wheat plants is mainly related to the genetic makeup of the variety.

Significantly, the maximum mean ear length, which ranged from 7.89 to 8.67 cm, was recorded by the application of 100 to 200 kg ha^{-1} NPS fertilizer (Table 5). Treatment with 150 and 200 kg ha^{-1} NPS fertilizer showed no significant difference. The increment in spike length at the highest NPS rate might have been resulted from improved root growth, heightened uptake of nutrients and better growth owing to synergetic influence of the three nutrients. NPS fertilizer had the ability to positively increase the length of the spike. The highest spike length (8.10 cm) was recorded from the cultivar Ogolcho and the lowest (7.46 cm) was recorded from the cultivar Jalane (Table 5). This could be due to different varieties that have genetically different yields. This result agrees with [40] who reported that individual genotypes responded differently to spike length for different amounts of nitrogen in wheat.

Lodging is a factor in crop production that determines crop yield. Grain yield correlated negatively with crop lodging, which can decrease by more than 10% of wheat yield [41]. The lodging percentage was influenced highly significantly ($P <0.01$) by the main effects of the mixed NPS fertilizer amounts and types. However, the interaction between the blended NPS and the varieties was not significant (Appendix, Table 3). The highest lodging percentage (28.89%) was recorded when using 200 kg NPS ha^{-1} with no significant differences from 150 kg ha^{-1}. Whereas the lowest percentage of lodging (14.22%) was observed at zero blended fertilizer rates (Table 5). When the NPS fertilizer quantities increased from 50 to 200 kg ha^{-1}, the lodging percentage increased. However, the application of blended amounts of NPS fertilizer in most of the plots that received 150 and 200 kg ha^{-1} did not show any significant differences. The highest lodging percentage recorded at the highest NPS rates could be due to the longer internode length, tall plant height, and weak stems that are easily affected by wind. Overall, Sanate and Ogolcho varieties were little accommodation. The highest lodging percentage in Jalane could be due to the sturdy plant height and weak stem.

Table (5). Main impact of blended NPS fertilizer incidence and selection on spike length, plant height (cm) and lodging percent of bread wheat.

Blended NPS fertilizer rates (kg ha^{-1})	Plant height (cm)	spike length (cm)	Lodging (%)
0	70.75^{c}	6.62^{d}	14.22^{d}
50	72.04^{c}	7.29^{c}	17.00^{c}
100	76.54 ^{b}	7.81^{b}	23.00^{b}
150	80.66 ^{a}	8.66^{a}	28.00^{a}
200	81.38 ^{a}	8.67^{a}	28.89^{a}
LSD (5%)	2.32	0.44	1.37
Varieties			
Jalane	74.94^{b}	7.46^{b}	25.00^{a}
Ogolcho	75.52^{b}	8.10^{a}	20.67^{b}
Sanate	78.36^{a}	7.86^{a}	21.00^{b}
LSD (5%)	1.79	0.34	1.06
CV (%)	3.1	5.7	6.4

Means followed by the same letters within a column do not differ significantly at $P < 0.05$ and LSD (5%) = lowest significance difference at $P < 0.05$

3.3. Effects of Blended NPS Fertilizer Rates on the Yield Components and the Yield of Bread Wheat

4.3.1. Total Tillers and Productive Tillers

The analysis of variance showed that the number of total tiller coverings and the number of productive tillers coverings per m^2 were influenced to a highly significant degree ($P < 0.01$) by the main effect of the NPS fertilizer quantities and types. However, the interaction effects on the number of total and productive tillers were found to be significant (0.05) (Appendix 1). The maximum number of total tillers (397.7 m^{-2}) and productive tillers (379.6 m^{-2}) determined. While the minimum number of total tillering (132.7 m^{-2}) and productive tillering (128.1 m^{-2}) from the combination of (0 kg NPS ha^{-1}) with the Jalane variety does not differ significantly from the Ogolcho or Sanate (Table 6). The highest number of tillers at the highest NPS rates could be due to the rapid conversion of synthesized carbohydrates to protein and, consequently, to the increase in the number and size of growing cells, ultimately leading to an increased number of tillers. The highest number of productive tillers at the highest NPS rates could be that an increase in NPS fertilizer favored more tillering as more fertile tillers were obtained.

The number of total tillers and productive tillers increases as the NPS fertilizer increases. This is due to nitrogen and phosphorus fertilizers, which increase the total number of tillage machines and productive tillage machines per unit of area. It is consistent with the [42] showed that a number of productive tillage machines / plants were hardly affected by NP fertilization. In addition, [43] reported that the increase in the number of fertile tillers with increasing nitrogen content could be due to the generally accepted role of nitrogen in accelerating the vegetative growth of wheat.

Accordingly, the Sanate variety performed better than the Ogolcho and Jalane varieties. The Sanate variety had 18.5% of the total number of tillers and 18% of the productive tillering as the Ogolcho variety and 26% of the total number of tillers and 27.25% of the productive tillering as the Jalane variety. The differences in the number of tillering types produced by different responses of different genotypes to different farming variables and environments in relation to growth characteristics could be due to the inherent nature of the variety which, given the given environmental conditions, would produce different numbers of productive tillers. Sufficient growth and development of plants due to the essential elements under mixed NPS fertilizer.

The present study also agrees with [44] observed that the varietal differences in terms of tillering capacity in rice harvests. Similarly, [45] also reported a significant difference between the bread wheat varieties in the number of total tillering and productive tillering. The varieties that had more of the productive number produce more ha^{-1} grain yield. Due to the number of productive tillers, this would be an important component of the yield that contributes directly to the final grain yield of the crops.

Table (6). Interaction effects of the NPS fertilizer and the variety on the total number of tillers/m^2.

Blended NPS Fertilizer kg ha^{-1}	Variety		
	Jalane	***Ogolcho***	***Sanate***
0	132.7^{f}	147.2^{ef}	153.1^{ef}
50	152.3^{ef}	177.2^{e}	214.0^{d}
100	237.6^{d}	235.7^{d}	289.8^{bc}
150	274.3^{c}	317.3^{b}	389.3^{a}
200	286.5^{bc}	308.3^{bc}	394.7^{a}
LSD		36.30	
CV		8.8	

Means in columns and rows followed by the same letters do not differ significantly; LSD = least significant difference at P <0.05

Table (7). Interaction effects of the NPS fertilizer and the variety on the number of productive tillers.

Blended NPS Fertilizer (kg ha-1)	Variety		
	Jalane	**Ogolcho**	**Sanate**
0	128.1f	138.1f	141.0f
50	141.0f	163.7f	203.9e
100	224.8de	224.3de	280.1bc
150	258.3cd	299.0b	379.6a
200	271.3bc	301.4b	376.0a
LSD		37.61	
CV		9.6	

Parameters followed by the same letters within a column do not differ significantly; LSD = least significant difference at P <0.05.

3.3.2. Kernels per Spike and a Thousand Grains Weight

Analysis of variance showed that the number of kernels per ear and the weight of a thousand kernels were influenced highly significantly (P <0.01) by the main effect of the NPS fertilizer rates and variety. However, the interaction effects of mixed NPS fertilizer and cultivar on the grains per ear and the thousand grain weight were found to be insignificant (Appendix 4). The Sanate variety had a significantly higher (9.6%) and (4%) number of seeds per ear than the Jalane and Ogolcho varieties (Table 8). The number of grains per ear is related to the number of spikelets per ear, the number of florets per spikelet, and the efficiency of pollination and seed development in the florets. This is due to varieties that have differences in their capabilities in terms of the number of grains per ear. This is in line with [46] who reported a significant difference between wheat varieties in terms of the number of grains per ear.

The application of 200 kg ha^{-1} NPS fertilizer increased the number of grains per ear by 35% than the treatment without fertilizer. The plots that received 150 and 200 kg NPS ha^{-1} showed no significant difference. The highest number of kernels per ear at the highest NPS rate could be due to a higher intake of wheat at higher levels which, due to its involvement in kernel formation and development, resulted in an increased number of kernels per ear. The likely reason for the increased number of kernels per ear with an increased NPS rate could be that phosphorus plays an important role in many physiological processes that take place within the developing kernel and in enzymatic reactions in the plant and during development the grains are involved. This showed that the NPS fertilizer has a stronger influence on factors that promote yield such as ear length, number of grains per ear and thousand grain weights. [47] showed that the application of 69/30 NP kg ha^{-1} fertilizer increased the number of seeds per ear up to (42.6) than control treatments (36.3) for barley. In agreement with this result, [48] reported the highest number of grains per ear of 69.85 with 90/45 kg N / P_2O_5 ha^{-1} for wheat. Similarly, [49] reported the maximum number of wheat kernels per ear (56.4) that were treated with 140 kg N ha^{-1} and 20 kg S ha^{-1} at the time of sowing and at the time of flowering. Likewise, [15] who reported the highest number of grains per ear (38.83) of wheat from the maximum fertilizer (138/115 N / P_2O_5 kg ha^{-1}).

The application of 200 kg NPS ha^{-1} increased by 15.9% compared to a treatment that received no fertilizer, with no significant difference from a treatment that provided 150 kg NPS ha^{-1}. The treatment that supplied with 0 to 100 and 150 with 200 kg NPS ha^{-1} had shown no significant difference in their means (Table 7). In general, the result showed that the weight of one thousand grains of the mixed NPS fertilizer increased significantly. This could be due to the provision of a balanced supply of nutrients, which results in an increased accumulation of assimilates in the grains and thus heavier wheat grains, an adequate and better nutrition of the plants, a good grain filling and the development of a better seed size. Similar to this finding, [50] who reported that in addition to the seed yield and the weight of a thousand grains, significant fluctuations also occur due to the increasing content of sulfur and nitrogen fertilizers. This could be due to the contribution of nutrients to the photosynthetic process and the movement of its photosynthetic products to storage organs (seeds). In contrast to the results of [18], who reported that nitrogen and phosphorus fertilizers had no significant influence on the thousand grain weight.

The Jalane variety had significantly the maximum thousand grain weight (47.33 g) than the Ogolcho and Sanate varieties. This could be due to the genetic nature of the culture, which may differ in performance during the grain filling phase that gives the highest thousand grain weight. This result is related to the findings of [51] who reported that the thousand grain weight is an important yield-determining component that is reported to be a genetic trait of wheat varieties.

Table (8). Influence of the variety difference and the NPS fertilizer on the number of grains per ear and the thousand grain weight (g) of wheat.

Blended NPS Fertilizer rates (kg ha^{-1})	**Kernels per Spike (nº)**	**Thousand Kernels Weight (g)**
0	44.56^{d}	40.33^{c}
50	50.67^{c}	41.67^{bc}
100	57.00^{b}	43.33^{b}
150	63.67^{a}	46.11^{a}
200	64.56^{a}	47.33^{a}
LSD (5%)	2.99	1.697
Varieties		
Jalane	53.33^{c}	47.33^{a}
Ogolcho	56.20^{b}	43.73^{b}
Sanate	58.73^{a}	41.93^{c}
LSD (5%)	2.317	1.315
CV (%)	5.5	4

Means followed by the same letters within a column do not differ significantly at P <0.05 and LSD (5%) = lowest significance difference at P <0.05

3.3.3. Above-Ground Dry Biomass Yield and Grain Yield

As the analysis of variance showed; the aboveground dry biomass yield and the grain yield were highly significantly (p <0.01) influenced by the main effect of cultivar, NPS fertilizer and interaction. The highest above-ground dry biomass yield (15,132 kg ha^{-1}) was achieved when the highest quantities (200 kg ha^{-1} mixed NPS fertilizer) were combined with the Sanate variety. In contrast, the lowest aboveground dry biomass yield (7617 kg ha^{-1}) was recorded in response to the application of zero mixed NPS fertilizer with the Jalane variety (Table 9). The above-ground yield of dry biomass had increased with the increase in NPS rates from control to the highest fertilization rates. This means that the plot that received 200 kg NPS ha^{-1} produced a 30% higher dry biomass yield above ground than the plot without fertilizer. The increase in above-ground dry biomass at the highest rates of mixed NPS Fertilizers could result from improved root growth and increased uptake of nutrients, which favors better growth and delayed aging of the leaves of the crop due to the synergistic effect of the three nutrients (NPS). The nitrogen and phosphorus fertilization promotes the vegetative growth of the wheat harvest and the number of tillers ultimately increases the biological yield with an increase in the straw yield. This is due to the biomass yield, which is reflected in growth parameters such as; Total number of plants, tillering per unit area and final plant height.

This result agrees with [15] who reported that the highest (11890 kg ha^{-1}) above-ground biomass yield from wheat comes from higher 138/115 kg N / P_2O_5 ha^{-1}. Similarly, [39] reported that increasing the N / P fertilizer amount from 46/20 kg N / P_2O_5 ha^{-1} to 69/30 kg N / P_2O_5 ha^{-1} for the wheat biomass yield from 10417 to 11233 kg increased ha^{-1}. Likewise, [15] who reported that increasing N from 0 to 184 kg ha^{-1} and from P from 0 to 138 kg ha^{-1} increased the above-ground dry biomass yield of wheat by about 70.1% and 40.6%, respectively. Similarly, [49] reported the maximum aboveground biomass yield of wheat (14,734.5 kg ha^{-1}) of 140 kg N ha^{-1} applied at sowing and 20 kg S ha^{-1} applied at Blossom.

Table (9). Interactions of NPS fertilizer and cultivar on the dry aboveground biomass yield of wheat.

Blended NPS Fertilizer rates (kg ha^{-1})	**Variety VVVVVVV**		
	Jalane	***Ogolcho***	***Sanate***
0	7617^{i}	9005^{gh}	9444^{fg}
50	7922^{i}	9689^{fg}	10384^{ef}
100	7765^{i}	10787^{de}	12226^{c}
150	7806^{i}	11105^{de}	14018^{b}
200	8298^{hi}	11819^{cd}	15132^{a}
LSD		1073.8	
CV		6.3	

Means in columns and rows followed by the same letters do not differ significantly; LSD = least significant difference at $P < 0.05$

The highest grain yield (6424 kg ha^{-1}) was achieved through the interaction of 200 kg ha^{-1} NPS with the Sanate variety without significant differences in plots with 150 kg ha^{-1}. The lowest grain yield (2870 kg ha^{-1}), on the other hand, was measured as zero for a mixed NPS fertilizer with the Jalane variety (Table 10). The result showed that the grain yield of wheat was increased due to the increase in mixed NPS fertilizer. The highest grain yield at the highest NPS rates could result from improved root growth and uptake of nutrients and growth, which was favored due to the synergistic effect of the three nutrients that improved the yield components and yield. Much research also showed the highest grain yields with maximum sulfur applications [52]. Similarly, [53] found that the grain yield of the improved wheat varieties increased with an increasing content of phosphorus fertilizers. The Sanate variety brought the yield of the Jalane and Ogolcho varieties by 32.15% and 7.87% kg ha^{-1}, respectively (Table 10). This difference in yield could be due to the high tillering capacity and genetic potential of the Sanate variety. Similarly, [54] reported the significant differences in the performance of bread wheat varieties in terms of seed yield.

The current result agrees with the findings of [55], who reported a maximum wheat yield (3557 kg ha^{-1}) using a ratio of 128 -128 kg ha^{-1} (NP) of 1: 1, which indicates the importance of phosphorus in its highest dose for achieving a maximum Indicated wheat productivity. Similarly, [15] reported that the highest grain yield (4890 kg ha^{-1}) was recorded with the highest nitrogen and phosphorus fertilization (138/115 kg ha^{-1} N / P_2O_5), while the lowest grain yield (4270 kg ha^{-1}) was recorded lowest measured (46/46 kg ha^{-1} N / P_2O_5). [39] also reported that an increase in the N / P fertilizer from (0/0 NP kg / ha) to 69/30 kg N / P_2O_5 ha^{-1} in wheat resulted in an increased grain yield from 2333 kg ha^{-1} to 4164 kg. ha^{-1}. The result also agrees with the result of [49] who stated the maximum grain yield of wheat (4463.5 kg ha^{-1}) as 140 kg N ha^{-1} and 20 kg S ha^{-1}.

Table (10). Interactions of the NPS fertilizer and the varieties on the grain yield of bread wheat.

NPS Fertilizer (kg ha^{-1})	**Variety**		
	Jalane	***Ogolcho***	***Sanate***
0	2701^{h}	3354^{f}	3508^{ef}
50	2870^{h}	3673^{e}	4062^{d}
100	2984^{gh}	4387^{c}	4937^{b}
150	3210^{fg}	4867^{b}	6262^{a}
200	3279^{fg}	4978^{b}	6424^{a}
LSD		318.1	
CV		4.6	

Means in columns and rows followed by the same letters do not differ significantly; LSD = least significant difference at P <0.05.

3.3.4. Straw Yield and Harvest Index

Straw yield and harvest index were highly significantly (p <0.01) influenced by the main effect of NPS fertilizer and variety. The interactions of mixed NPS fertilizer quantities and types on the straw yield and the harvest index were significant **(0.05)** and not significant, respectively. The highest straw yield (6555 kg ha^{-1}) was achieved with the highest amount (200 kg ha^{-1}) of mixed NPS fertilizer, while the lowest straw yield (5502 kg ha^{-1}) was achieved in response to the application of zero amount of mixed NPS fertilizer. In addition, the straw yield increased with increasing NPS mixing rates for all varieties; but the application of 0 with 50 kg ha^{-1} was not a significant difference. The average straw yield was highest for all varieties with the highest NPS rate. In general, the straw yield of Sanate was higher than that of the Jalane and Ogolcho varieties. This difference could be attributed to the higher yield productivity and yield components of the varieties. This could help understand farmers' preference for the Sanate variety for animal feed.

The significant increase in straw yield in response to the highest application rate of mixed NPS fertilizer could have resulted in increased nutrient uptake and better growth, which was favored due to the synergistic effect of the three nutrients, resulting in a higher population of plants growing there and the yield components improved, resulting in the highest aboveground biomass yield. The current result agrees with the findings of [48], who reported an increased straw yield of wheat with an increase in the NP fertilizer quantities to 90/45 kg ha^{-1}. Similarly, [56] reported the highest straw yield from bread wheat (6827 kg ha^{-1}) with a phosphorus content of 92 kg P_2O_5 ha^{-1} and a nitrogen content of 138 kg N ha^{-1}.

The highest harvest index (0.43) was obtained with 150 kg ha^{-1} of mixed NPS fertilizer. The lowest harvest index (0.36), on the other hand, was 0 kg ha^{-1} NPS (control treatment) (Table 11). Plots that received 0 and 50 kg ha^{-1} NPS did not differ significantly. The Sanate variety has a higher mean harvest index (0.41) than the Ogolcho (0.40) and Jalane (0.38) variety. The harvest index tended to increase with increasing application of NPS fertilizer up to 150 kg ha^{-1}. This could be due to a higher production of photo assimilates and their eventual breakdown into grains compared to the breakdown in straw. This result is similar to the results of [57] who reported a higher harvest index (0.39) with a higher nitrogen and phosphorus content (180/130 kg N/P ha^{-1}) than with a lower fertilizer application. In contrast to this result, [15] reported no significant influence of the N and P rates on the harvest index of bread wheat. It is similarly in contrast to the results of [54], who reported that the harvest index was insignificantly influenced by wheat varieties.

Table (11). Effects of varietal differences and NPS fertilizer**s** on straw and harvest index of wheat.

Blended NPS Fertilizer (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
0	5502^{c}	0.36^{d}
50	5797^{bc}	0.37^{d}
100	6157^{b}	0.39^{c}
150	6197^{b}	0.43^{a}
200	6555^{a}	0.41^{b}
LSD (5%)	477.8	0.0126
Varieties		
Jalane	4873^{c}	0.38^{b}
Ogolcho	6229^{b}	0.40^{a}
Sanate	7202^{a}	0.41^{a}
LSD (5%)	370.1	0.0098
CV (%)	8.1	3.3

Means in columns and rows followed by the same letters do not differ significantly; LSD = least significant difference at P <0.05.

3.4. Agronomic Efficiency (AE)

As the analysis of variance showed, the agronomic efficiency was highly significantly (p <0.01) influenced by the main effect of the NPS fertilizer rates and variety. However, one interaction was significant (0.05). As the NPS level increased from 50 to 150 kg ha^{-1}, the agronomic efficiency increased from 3.69 to 11.04 kg of grain per kg of NPS in Sanate, from 2.13 to 6.05 in Ogolcho and from 1.13 to 2.04 in Jalane; however, it decreases with an application of 200 kg ha^{-1}. The highest agronomic efficacies were achieved with 150 kg ha^{-1} mixed NPS of the three varieties; in Sanate (11.04), Ogolcho (6.05) and Jalane (2.04). In contrast to [39] who reported that the agronomic efficiency decreased from 30.66 to 18.36 when the P content increased from 23 to 69 kg P/ha. Low agronomic efficiency (1.13 kg of grain per kg of NPS) was observed in the Jalane variety; suggesting that it produced a low grain yield per unit of NPS supply. The study showed that agronomic efficiency increases up to 150 kg / ha of NPS application rates, then beyond these levels decreased. According to this study, an increase in NPS above 150 kg/ha is not economical and leads to environmental pollution and is in line with [54] who reported that the delivery of wheat plants at 46 kg/ha produced the maximum grain yield per nitrogen unit increases; the highest agronomic efficiency with 34.47 kg grain per kg nitrogen, while the low agronomic efficiency 22.44 kg grain per kg N with high nitrogen contents, i.e. 69 kg/ha was observed. According to [26], a high agronomic efficiency would be achieved if the increase in yield per unit applied is high (Table 11).

Table (11). Effects of varietal difference and NPS fertilizer on straw and harvest index of wheat at Jarso 2019.

NPS Fertilizer rates (kg ha^{-1})	**variety**		
	Jalane	***Ogolcho***	***Sanate***
50	1.13^{fg}	2.13^{ef}	3.69^{c}
100	1.42^{fg}	5.17^{cd}	7.14^{b}
150	2.04^{ef}	6.05^{bc}	11.04^{a}
200	1.93^{f}	5.77^{bc}	9.72^{a}
LSD (5%)		1.95	
CV (%)		24.2.	

Means in columns and rows followed by the same letters do not differ significantly; LSD = least significant difference at P <0.05.

3.5. Partial Budget Analysis

A sub-budget analysis of net benefits, varying total costs, and marginal returns are shown in Table 13. The bread wheat yield has been revised downwards by 10% to reflect the experimental yield and the expected yield of farmers given the same treatment. The actual seed price was used to convert the adjusted yield into gross profit advantages (15 Birr kg^{-1}), fertilizer costs NPS (15.0623 Birr kg^{-1}) and urea (13.7878 Birr kg^{-1}). The result of the economic analysis showed that the highest net benefit of ETB (82710 ha^{-1}) and marginal return (2305.8%) were achieved by planting the Sanate variety with an application rate of 150 kg ha^{-1} blended NPS fertilizer. The net economic benefit of ETB (63,118.4 ha^{-1}) was determined by Ogolcho with 150 kg ha^{-1} and the marginal return (749.7%) and the net benefit of ETB (39,937.9 ha^{-1}) and the marginal return of. Achieved yield (315.7%) was obtained from the Jalane variety with an application of 150 kg ha^{-1} (Table 10).

According to the proposal of [27], the minimum acceptable marginal return should be more than 100%. In this study, even an application of 200 kg NPS ha^{-1} showed the maximum net benefit (Birr 84629.5 ha^{-1}) and the marginal return was (254.9%) from Sanate, but economically compared to the application of 150 kg ha^{-1} NPS not acceptable. Similarly, the net benefit of ETB (64173.9 ha^{-1}) and marginal return (140.2%) were obtained from the Ogolcho variety (Table 13). For economic reasons, the use of 150 kg ha^{-1} NPS would be best and most economical for the production of bread wheat in the study area and other areas with similar agro-ecological conditions.

Table (13). Summary of the analysis of the partial budget and marginal return on bread wheat with mixed NPS fertilizers in Jarso District, Eastern Ethiopia.

Treatments		Wheat yield (kg ha^{-1})			Income (ETB ha^{-1})		GFB (ETB ha^{-1})	TVC (ETB ha^{-1})	NB (ETB ha^{-1})	MRR (%)
NPS rates	Varieties	AVGY	Ad GY	SY	Grain	SY				
0	Ogolcho	3353.8	3018.4	5651.6	45276	2825.7	48101.4	2062.5	46038.9	0
50	Ogolcho	3672.9	3305.6	6015.8	49584	3007.9	52592.3	4194.4	48397.9	110.7
100	Ogolcho	4386.7	3948	6400.3	59220	3200.2	62420.2	4947.5	57472.7	1204.9
150	Ogolcho	4866.7	4380	6238	65700	3119	68819	5700.6	63118.4	749.7
200	Ogolcho	4978.3	4480.5	6840.3	67207.5	3420.2	70627.6	6453.7	64173.9	140.2
0	Jalane	2700.7	2430.6	4916.7	36459	2458.3	38917.3	2062.5	35377.3	655.8
50	Jalane	2869.7	2582.7	5052.7	38740.5	2526.4	40933.8	4194.4	36739.4	D
100	Jalane	2984.3	2685.9	4780.7	40288.5	2390.4	42507.9	4947.5	37560.4	109
150	Jalane	3210.4	2889.4	4595.9	43341	2297.9	45638.6	5700.6	39937.9	315.7
200	Jalane	3279.2	2951.3	5018.5	44269.5	2509.3	46778	6453.7	40324.3	D
0	Sanate	3508.1	3157.3	5936.3	47359.5	2968.2	50327.2	2062.5	48264.7	180.8
50	Sanate	4062.5	3656.3	6321.5	54844.5	3160.8	58004.5	4194.4	53810.1	260.1
100	Sanate	4936.8	4443.1	7289.5	66646.5	3644.8	70291.9	4947.5	65344.4	1531.6
150	Sanate	6261.7	5635.5	7756.3	84532.5	3878.2	88410.7	5700.6	82710	2305.8
200	Sanate	6424.4	5781.9	8707.3	86728.5	4353.6	91083.3	6453.7	84629.5	254.9

Where, GFB=gross field benefit, TVC = total variable costs; NB = net benefit, MRR = marginal incidence of return; ETB ha^{-1}=Ethiopian ETB ha^{-1}, AVGY=average grain yield, AdGY= adjusted grain yield, SY= straw yield, D=dominated treatments. At sowing the Cost of bread wheat seed= Birr 16.50 kg^{-1}, NPS cost=15.0623 Birr kg^{-1}, Urea cost= 13.7878 Birr kg^{-1}. The labor cost for utilization of NPS 10 persons ha^{-1}, each 70 ETB day^{-1}), and Urea (12 persons ha^{-1}, each 70 ETB day^{-1}), Market price of bread wheat grain =15 Birr kg^{-1} and straw=0.5 Birr kg^{-1} in Ejersa Goro town at harvesting time in December 2019.

4. Conclusions

Bread wheat is one of the most important staple foods and one of the most important crops for food security in Ethiopia. However, the wheat yield in Ethiopia and in the study zone is low compared to the achievable yield, as wheat production is limited by poor soil fertility, cultivation of unimproved low-yield varieties, use of unsuitable type and amount of fertilizer, diseases, insect pests, poor management practices and moisture stress. In addition, the effects of mixed NPS fertilizers on the yield components and yield in the Jarso district have not been studied. Therefore, this research was initiated to evaluate the effects of blended NPS fertilizers on the yield components and the yield of bread wheat varieties and to determine an economically reasonable amount of blended NPS fertilizers in the Jarso district during the main growing season 2019.

The experiment was carried out at Afugug FTC in the Jarso District, East Hararghe Zone, Oromia Region. The trial was based on a factorial combination of the five NPS fertilizer levels (0, 50, 100, 150 and 200 kg ha^{-1}) with three bread wheat varieties (Jalane, Ogolcho and Sanate) and the currently recommended 100 kg ha^{-1} urea. The experiment was tested in a factorial arrangement in a randomized complete block design with three replicates. The analysis of the results showed that parameters such as 50% days to heading, 90% physiological maturity, number of total tillering, number of productive tillering, lodging percentage, number of grains per ear, thousand grain weight, aboveground biomass, grain yield, straw yield and harvest index heavily influenced by the main effect of NPS fertilizer rates and varieties. However, plant height and ear length were strongly influenced by the main effect of the NPS fertilization rates and a significant influence by the cultivars. However, all parameters were not significantly influenced by the interactions of the mixed NPS fertilizer amounts and the variety, with the exception of the aboveground biomass and grain yield, which were strongly influenced by the interactions. However, the total number of tillers, the number of productive tillers and the straw yield were significantly influenced by the interaction of both factors. The highest and lowest mean of days to head (67.56 and 58.78), days to maturity (123.7 and 112.4), plant height (81.38 cm and 70.75 cm), ear length (8.67 cm and 6.62 cm), grains per ear (64.56 and 44.56), lodging in percent (28.89% and 14.22%), Thousands of grain weights (47.33 and 40.33) were recorded due to the application of 200 kg ha^{-1} or from the control treatments. While the highest and lowest values of the harvest index (0.43 and 0.41) of 150 kg ha^{-1} were measured. In addition, the highest and lowest mean values of plant height (78.36 cm and 74.94 cm), grains per ear (58.73 and 53.33), straw yield (7202 and 4873) and harvest index (0.41 and 0.38). In addition, the interaction of NPS with the highest and lowest (379.6 and 128.1 respectively) mean values of the productive tillers from the combination of the Sanate variety with 150 kg ha^{-1} and the Jalane variety with zero kg ha^{-1} NPS was determined recorded. Similarly, the highest and lowest (11.04 and 1.13) agronomic efficiencies were obtained from the combined application rate of 150 kg ha^{-1} for the Sanate variety and 50 kg ha^{-1} fertilizer rate for the Jalane variety, respectively. The highest and lowest (6424 and 2701 kg ha^{-1} respectively) mean grain yield, however, was determined from the combined application rate of 200 and 0 kg ha^{-1} NPS fertilizer quantities with Sanate and Jalane varieties.

The research showed that both the variety and the amount of fertilizer added had a significant influence on the yield and the yield components. The use of 200 kg NPS ha^{-1} and the Sanate variety resulted in the highest grain yield with higher mean values for most of the yield parameters without any significant difference to 150 kg NPS ha^{-1}. The cultivation of the Sanate variety with the application of 150 kg NPS ha^{-1} had the highest marginal yield in percent (2305.8%) and net benefit (82710 Birr ha^{-1}) than all other treatment combinations (in economic comparison). Therefore, it can be concluded that applying 150 kg of NPS ha^{-1} in addition to 100 kg ha^{-1} of urea and growing the Sanate variety might be the better choice of the study area farmers to get high yields with higher return. However, since the trial was carried out for one season at one location, it is suggested that the trial be repeated over seasons and locations with this and other improved bread wheat varieties in order to provide a comprehensive recommendation.

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