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Response of Bread Wheat (*Triticum aestivum L.*) Varieties to Rates of NPS Fertilizer in Kebribeyah District of Fafen Zone, Somali Region Ethiopia

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ABSTRACT

Bread wheat is also one of the economically important crops in Ethiopia and wheat production is an emerging agriculture practice in the agro-pastoralist community in the Somali Region, Ethiopia. However, recommendations for improved varieties and rates of fertilizer are lacking in potential wheat-producing areas of the region including the *Kebribeyah* district of *Fafen zone*. Thus, this research was conducted to determine the effect of NPS fertilizer rates on the grain yield of bread wheat varieties to facilitate fertilizer rate recommendation for wheat production in the district. Three bread wheat varieties (*Fentale-1, Kingbird*, and *Wane*) and four rates of NPS fertilizer (0, 50, 100, and 150 kg ha^{-1}) in factorial combination were evaluated in a randomized complete block design (RCBD) in 2023 under rainfed condition. The results of soil samples of the experimental plot indicated that the soil had sandy clay loam in texture, moderate level of total nitrogen, and very low available phosphorus suggesting that the supply of the two nutrients is required to obtain a high yield of wheat. The results of the analysis of variance indicated wheat varieties, fertilizer rates and interaction of variety and fertilizer had significant effect on plant height and grain yield. Rates of NPS fertilizer and interaction of variety and fertilizer had significant effects on days to 50% Heading and 90% of maturity, several effective tillers/plant, and several kernels/plant, Variety and interaction of variety and fertilizer had a significant effect on spike length and thousand-grain weight (g) while rates of NPS fertilizer had a significant effect on biomass yield (t ha^{-1}) and harvest index(%). The growth and yield components of wheat were higher as the wheat varieties were supplied with NPS fertilizer as compared to the control plot of null fertilizer application. Moreover, *Fentale1* and *Kingbird* bread wheat varieties with the application of 150 kg ha^{-1} NPS fertilizer produced higher grain yields of 2.73 and 2.7 t ha^{-1} respectively, though it had no significant difference from yield obtained from some other treatment combinations. However, the obtained higher grain yield of bread wheat varieties with the application of the highest rate 150 kg ha^{-1} of NPS fertilizer was higher than the average national wheat yield. Thus, it is concluded the a need for further research on other wheat varieties with varied rates of Urea and NPS fertilizers to identify wheat varieties and rates of fertilizers to produce high yields with acceptable economic rate of return by producers in the study area.

Key Words: Economic rate of return, Grain yield, Growth, and Wheat production.

1. Introduction

Bread wheat (*Triticum aestivum L*) belongs to the grass family, Poaceae. Hexaploid bread wheat is one of the world's most important staple food crops, providing 20% of humanity's dietary energy supply and serving as the main source of protein in developing nations. It is a staple food for about one-third of the world's population. It is grown throughout the world in a great diversity of agro-ecologies from diverse and large number of varieties with diversity of utilization (MoANR, 2021) Bread wheat is also one of the economically important crops in Ethiopia (MoANR, 2016).

Ethiopia produced wheat at 1.7 million hectares of land which was the third largest in Africa and nearly 5 million tons of wheat produced annually makes the country the second-largest wheat producer in Africa. During the 2021/22 *Meher* season, 1,867,047.71 hectares of land were cultivated for wheat 5,807,822.052 tons were produced. The land cultivated for wheat (15.31%) was the third largest area cultivated for cereal crops which was exceeded by teff (*Eragrostis teff L.*) and maize (*Zea mays L.*) but it accounted for 17.71% of the total cereal crops production that was exceeded only by maize production (CSA, 2022). The total production of wheat is increasing due to high demand or increased demand for wheat.

However, there is a huge gap between wheat production and supply. This is due to the increasing demand associated with the increase in urban population that results in changes

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in food preferences such as bread, biscuits, pasta, noodles, and porridge which are easy and quick to prepare.

The wheat productivity increased from 2.971 to 3.111 t ha^{-1} or by about 4.71% within three years (2019/20 to 2021/22 Meher season) production. However, the average yield was low as compared to the yield attainable up to 6 t ha^{-1} at the research center. Many environmental factors or several abiotic and biotic stresses at different levels of intensity across rainfed and irrigated environments are contributing to the low yield. In rainfed environments, the most important abiotic stresses are drought, soil acidity, erosion, poor soil fertility, water-logging, and pre-harvest sprouting . Soil degradation and depletion of soil nutrients are among the major factors threatening sustainable cereal production in the Ethiopian highlands.

Understanding and prioritizing the main production constraints are important before embarking on the expansion of local wheat production. Wheat production in Ethiopia suffers from diseases (rusts, septoria, fusarium, etc.), soil acidity, declining soil fertility, terminal moisture stress, heat, mono-cropping, pre-harvest sprouting, and climate change. Furthermore, growing populations, increased rural-urban migration, low public and private investments, weak extension systems, inappropriate agricultural policies, and yield gaps because of low adoption of new technologies remain major challenges.

Wheat production in the country is adversely affected by low soil fertility and suboptimal use of mineral fertilizers in addition to diseases, weeds, erratic rainfall distribution in lower altitude zones, and water logging in the Vertisols areas (Gorfu et al., 2003). Many researchers researched the effect of blended NPS fertilizer on the growth and yield of bread wheat varieties. The authors reported the yield of wheat varieties was increased at varied levels due to the supply of high rates of fertilizers (Duressa and Ayana, 2020; **?**).

The production of wheat in the Somali Regional State is not as common as in the mid and high lands of Ethiopia. The data on total land cultivated, total production, and productivity of wheat is not available from the Ethiopian Statistics service. However, bread wheat is produced mainly in the mid to highlands of the Jigjiga plain, including Jigjiga, Tuli-guled, Haroreys, and Awbare woredas.

The research on wheat production and productivity has been given low attention in research and limited research has been done on the different fertilizer applications especially the effects of NPS rate on bread wheat varieties. Balanced fertilization not only guarantees optimal crop production, better food quality, and benefits for the growers but also provides the best solution for minimizing the risk to the environment the nutrient losses. It was reported that nitrogen and phosphorus are among the yield-limiting factors in Ethiopia and the application of inorganic fertilizers containing these nutrients has increased the productivity of wheat yield. In addition to N and P, it was identified K, S, Zn, B, and Cu are low in the most important Ethiopian soils and different blended fertilizers containing three or more of these nutrients were recommended to different parts of the country depending on survey studies and soil analysis report.

Balanced fertilization not only guarantees optimal crop production, better food quality, and benefits for the growers but also provides the best solution for minimizing the risk of nutrient losses to the environment. The use of blended NPS fertilizer is recommended to different districts of the Somali Regional State; however, there has been no recommendation for rates of fertilizers for improved varieties so far in dryland areas of Kebribeyah district in the Fafen administrative zone of the Somali region, Ethiopia.

This research was, therefore, conducted to determine the effect of NPS fertilizer rates on grain yield of bread wheat varieties to facilitate fertilizer rate recommendation in the Kebribeyah district in the Fafen zone Somali region. Therefore, this study was initiated with the following objectives: (i) to investigate the growth and yield response of bread wheat to blended NPS fertilizer rates in the study area, (ii) to evaluate the economic feasibility of the fertilizers for bread wheat production.

2. Materials and Method

2.1. Description of study site

This research was conducted in the Kebribeyah district of the Fafen administrative zone of the Somali regional state, of Ethiopia. Kebribeyah (Garbi) is located 50 km southeast of Jigjiga alongside the main road from Jigjiga to Dagahbour. Garbi Kebale is located approximately between 9016' to 430 12 E, latitude and 430 33.2'E longitudes N respectively, with an altitude of 1706 mals. A semi-arid and arid type of climate characterized the area, receiving bi-modal rainfall annually the long rains usually occur in the months of mid-April to mid-July, while the short rains usually come in May and September according to the meteorological agency in 2003. It receives from 500 to 700 mm of annual rainfall according to Central statistic and Authority. The minimum mean monthly temperature varies from 50C in November to 140C from July to September and the maximum mean monthly temperature varies from 250C from July to 290C from march to April forest hazard exist. In addition, high run-off rates coupled with high evaporation rates make the available rainfall insufficient, especially for crop production .

2.2. Experimental Design and Treatments

A field experiment was carried out in Randomized Complete Blocks Design (RCBD) with three replications. The treatments were four levels of NPS (0, 50, 100, and 150 kg ha^{-1}) and three bread wheat varieties (*Fentale-1, Kingbird*, and *Wane*) in a factorial combination. The bread wheat varieties were selected based on differences in their adaptability, morphological characteristics, and yield potential. The gross plot size of each experiment was 9m2 and the spacing of 30 cm and 10 cm between rows and plants respectively.

The distance between the plots and replications was kept at 0.5 m and 1 m apart, respectively. All plots except the

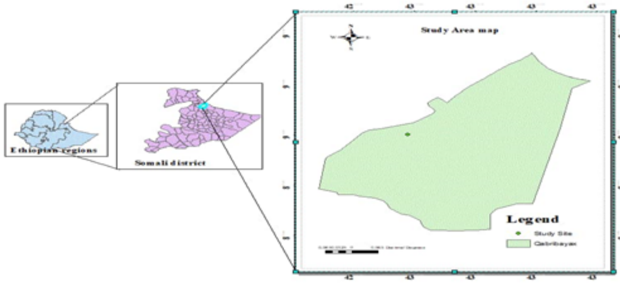

Figure 1: Map of Kebribeyah District and study area

control plot supplied half the recommended rate of Urea fertilizer (150 kg ha^{-1}) by banding at the time of sowing and the remaining half was applied at full tillering stages. The NPS was supplied at the time of sowing by banding and incorporated into the soil at the rate 50, 100, and 150 kg ha^{-1} of NPS fertilizer rates.

2.3. Soil Sampling and Analysis

To characterize the experimental soils, composite soil samples were collected just before the implementation of the experiment from the site of the experiment on the upper top 20 cm depth using an auger. The collected composite soil samples were further analyzed in the soil laboratory for important physico-chemical properties including pH, CEC, and contents of organic carbon, total nitrogen, available phosphorous and exchangeable potassium following their respective standard methods and procedures. The bulk density of experimental soils was also determined by taking undisturbed core soil samples. The laboratory analysis results of the composite soil samples of the site verified the soil property and nutrient contents in the crop fields of the study area (Table 1). Soil profile analysis made at the research site showed that the soils of the experimental sites are Acrisols.

2.4. Agronomic data collected

On crop phenology such as days to 50% heading and days to physiological maturity were collected. Wheat crop growth-indicating parameters such as plant height, leaf area, and yield and yield components such as the number of tillers per plant, number of productive tillers per plant, number of grains per spike, and thousand-grain weight (g) were collected. In addition, grain yield (t ha^{-1}), above-ground dry biomass (t ha^{-1}), and harvest index (%) were recorded. Days to 50% heading were determined by counting the number of days taken from the date of sowing to 50% heading.

Days to physiological maturity were recorded when 90% of all plants per plot lost chlorophyll and turned yellow. This was determined on a visual basis. Plant height was determined from the base to the tip of the spike (awns excluded) of 10 randomly pre-tagged plants from the net plot area at physiological maturity leaf area of flag leaves (cm) was measured from 10 randomly pre-tagged plants from the net plot areas. It was calculated as length x maximum width X 0.68. The number of tillers per plant was determined from 10 randomly pre-tagged plants per plot at the heading. The number of productive tillers was determined at maturity by counting all spikes producing seeds of 10 plants/plot.

The number of grains per spike was the mean number of grains per spike computed as an average of 10 randomly taken spikes from the central unit area, threshed, and grains were counted using an electronic seed counter. Biomass yield (t•ha^{-1}) was obtained as the difference between the total above-ground plant biomass and grain yield of plants in the net plot area and converted into ton per hectare. Thousand-grain weight (g) was determined based on the weight of thousand grains sampled from the grain yield of each treatment by using an electronic seed counter and weighed with an electronic balance. Grain yield (t ha-1) was taken by harvesting and threshing the seed yield from the net plot area, adjusted to 12.5% moisture content, and expressed in ton per hectare using the following formula:

2.5. Data analysis

The collected data were subjected to analyses of variance (ANOVA) using SAS version 9.1. and software of GenStat 64-bit Release 15.1. Mean separation was done using the least significant difference (LSD) method at 0.05 level of significance depending upon the results of ANOVA.

$$Grainyield = (tha^{-1})X\frac{100-M}{100-D'} \quad (1)$$

where M is the measured moisture content in grain and D is the designated moisture content.

3. Result and Discussion

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

The results of laboratory analysis of selected physico-chemical properties of soil are presented in Table 1. Soil analysis results before planting showed that the soil of the experimental site is sandy clay loam in texture which has 35% sand, 30% clay, and 35% silt. The pH of the soil was 5.5, which could be categorized as moderately acidic to the rating. The soil of the study site had 3.31% organic carbon which could be classified as high according to the rating of (Landon, 2014), indicating the high potential of the soil to supply nitrogen to plants through the mineralization of organic carbon.

The soil sample of the experimental site was found to have a moderate level of total N (0.28%) (Landon, 2014) indicating that the supply of the nutrient is required to obtain a high yield of wheat in the study area. The available P content was 1.3 mg•kg-1 soil which was rated under medium (Hazelton and Murphy, 2016). However, in the study area, evidence of Mg-induced K deficiency under soils having higher exchangeable K was reported. The CEC content was 17.1 mol (+)• kg-1 of soil which was rated under the medium (25–40 cmol•kg-1) category Also the high amount of OC, which was ascribed due to adequate soil fertility management practices.

Table 1: Soil physico-chemical properties of experimental site soil before planting

Soil physiochemical property	Value	Rating/classification	Reference
Soil texture			
Clay (%)	30	Moderate	
Silt (%)	35	Moderate	
Sand (%)	35	Moderate	
Textural class	-	Sand Clay Loam	Tekalign (1991)
pH (12.5 H2O)	5.5	Moderate acidic	Tekalign (1991)
Organic carbon (%)	3.31	High	London (2014)
Total N (%)	0.28	Moderate	Landon (1991)
Available K (ppm)	16.4	High	
CEC (Meq/100gm soil)	17.1	Medium	Landon (1991)
Available P (ppm)	1.3	Very low	Tisdale et al.(2002)
Organic matter (%)	5.6	High	

N= Nitrogen, P= Phosphorus, K = Poyassium, CEC = Cation Exchange Capacity, mg/kg = Milligram to kilogram and cmo(+) kg^1soil = centimoles per kilogram.

3.1.1. *Analysis of variance*

The results indicated that the main factors effects of bread wheat varieties, fertilizer rates, and interaction had a significant effect on plant height and grain yield. The interaction of variety and fertilizer had significant effects on days to 90% of maturity, the number of effective tillers/plant, and several kernels/plant, Variety and interaction of variety and fertilizer had significant effects on spike length and thousand-grain weight. Fertilizers had a significant effect on biomass yield and harvest index (Table 2). This showed that almost all traits including grain yield of bread wheat were significantly influenced by one or two main factors and/or interaction of the two main factors and suggested to evaluate varieties with varied rates to identify the treatment combination(s) that increase the performance of wheat crop in the study area.

3.1.2. *Interaction Effect of Variety and NPS Fertilizer on Days to Heading and Maturity*

The interaction of the *Fentale1* variety and 150 kg ha-1 and *Wane* and 50 kg ha-1 NPS fertilizer showed 62.3 mean days to 50% heading which was earlier heading than other treatment combinations but had no significant difference with *Fentale1* and *Kingbird* varieties without fertilizer application. On the other hand, the interaction of the *Fentale1* variety and 50 kg ha^{-1} NPS fertilizer showed a delayed mean of 72.33 days to attain 50% heading, however, had no significant difference with the interaction of three varieties and varied rates of NPS fertilizer including *Wane* variety without fertilizer application.

All treatment combinations effects had mean days of 90% maturity in the range between 90 to 101 days without a significant difference except the *Wane* variety without fertilizer application had 85 days of 90% maturity significantly earlier maturity than all treatment combinations effects. *Kingbird* variety had delayed days to 50% heading (68.5) and days to 90% maturity (97) than the other two varieties while the application of 50 and 150 kg ha^{-1} NPS fertilizer resulted in delayed days to 50% heading (69.8) and days to 90% maturity (97), respectively. The bread wheat varieties without fertilizer application showed early days to 50% heading and days to 90% maturity (Table 3).

The results showed that the application of different rates of fertilizer on different varieties had different effects on days to 50% heading and to a lesser extent on days to 90% maturity. It was not observed clear trends of days to 50% heading and days to 90% maturity but it could realize that increasing the fertilizer rate up to 150 kg ha^{-1} NPS fertilizer prolonged days to heading in all varieties while the different varieties have different days to heading and days to maturity periods.

The prolonged period required by the plants to reach grain filling and delays physiological maturity at a higher rate of NPS may be attributed to the increase in leaf area duration, increased vegetative growth, and increased light use efficiency. The delay in maturity of bread wheat plants in response to the increasing NPSZnB and UREA applications might be because increased rate of nitrogen, which delays physiological maturity by promoting vigorous vegetative growth and development of the plants. It was (also reported application of fertilizer at higher doses promotes vegetative and lush growth thereby delaying the grain-filling period (Gupta and Sharma, 2000). According to (EL-HABBAL et al., 2010) grain filling period was significantly increased with increasing fertilizer rate and reached its maximum value for a wheat plant that received 150 kg N ha^{-1}. The present results also corroborated with the findings of (Pržulj and Momčilović, 2011) that the grain filling period is highly dependent on a variety of characteristics. Means in columns and rows under each trait followed by the same letter(s) are not significantly different at a 5% level of significance and LSD (5%) = Least significant difference at a 5% probability level.

3.1.3. *Interaction Effect of Variety and NPS Fertilizer on Plant Height and Productive Tillers*

The results showed that the highest mean plant height was obtained for the variety *fentale1* (82 cm) in combination with a fertilizer rate of 150 kg ha^{-1} of NPS which was statistically on par with the other two varieties *kingbird* and wane in combination with the same NPS fertilizer rate, while the lowest mean plant height (63.3cm) was obtained for the wheat variety *fentale1* with the combination of null NPS fertilizer application (Table 6). This indicated that increasing the dose of fertilizer rate from 0 to 150 kg ha^{-1} NPS increased significantly the mean plant height in all bread wheat varieties. Generally, increasing NPS fertilizer supplemented with nitrogen rates led to increases in plant height. The increased plant height at the highest level of NPS fertilizer could be attributed to the increasingly adequate supply of

Table 2: Mean squares from analysis of variance for phenology, growth, yield components and grain yield of bread wheat varieties as influenced by rates of NPS fertilizer in Kebribeyah district in Fafen zone, Somali Region, Ethiopia

Trait	Sources of variation					CV (%)
	Replication (2)	Variety (A) (2)	Fertilizer (B) (3)	A x B (6)	Error (22)	
Days to 50% of emergence	0.25	0.083^{NS}	0.037^{NS}	0.12^{NS}	3.2	10.6
Days to 50% of heading	11	9*	82.5**	36*	54	4.4
Days to 90% of maturity	2.5	1.4^{NS}	111**	33.2*	34	6.4
Plant height (cm)	21.5	83*	103*	45.3*	65.4	7.6
Effective tillers/plant	0.2	0.004^{NS}	1.2*	0.34*	2.5	5.2
Spike length (cm)	0.1	0.8*	0.2^{NS}	1.3*	3.2	9.5
Number of kernels/plant	1.1	1.2^{NS}	7.7*	3*	7.2	4.8
Thousand grain weight (g)	1.3	2.5*	0.4^{NS}	3.3*	4.8	5.4
Grain yield (kg ha-1)	0.53	5.4*	8.3-**	1.3*	3.4	6.5 4.7
Biomass yield (kg ha-1)	2.8	3.4^{NS}	6.9*	2.6^{NS}	3.9	5.4
Harvest index (%)	0.1	0.03^{NS}	0.4*	0.1^{NS}	0.4	4.2

NS variation represents degree of freedom, Fertilizer = blended NPS fertilizer and CV (%) = percentage of coefficient of variation., * and **, nonsignificant, significant at P<0.05 and P<0.01, respectively. Number in parenthesis in each source of NS variation represents degree of freedom, Fertilizer = blended NPS fertilizer and CV (%) = percentage of coefficient of variation., * and **, nonsignificant, significant at P<0.05 and P<0.01, respectively. Number in parenthesis in each source of

Table 3: Interaction effect of variety and blended NPS fertilizer rate on days to heading and maturity of wheat in Kebribeyah district in Fafen zone Somali region Ethiopia

Traits	**Days to 50% Heading**				**Mean variety**	**Days 90% Maturity**				**Mean variety**
Treatment	NPS fertilizer rate kg ha-1					NPS fertilizer rate kg ha-1				
Variety	0	50	100	150		0	50	100	150	
Fentale1	62.3^{d}	62.6^{cd}	70.3^{ab}	72.33a	66.9	91^{a}	101^{a}	$101a$	93.3^{a}	96.4
Kingbird	65.0^{bcd}	68.0^{abc}	70.7^{ab}	71.3^{ab}	68.5	90^{a}	96.7^{a}	101^{a}	101^{a}	97
Wane	62.3^{d}	68.3^{ab}	68.3^{ab}	70.0^{a}	67.5	85^{b}	93.3^{a}	94.3^{a}	98^{a}	91.8
Mean NPS	63.2	66.3	70.1	71.3	67.64	91.8	96.9	93.4	97	95.1
LSD (5%)	4.5				13.7					

Means in columns and rows under each trait followed by the same letter(s) are not significantly different at 5% level of significance and LSD (5%) = Least significant difference at 5% probability level.

NPS nutrients, which helped, in high vegetative growth and development of plants in all bread wheat varieties. This result is in agreement with that of (Khan et al., 2000) who reported that increasing fertilizer rates increased the wheat plant height; and **(Marschner, H. 1997)** reported that the beneficial role of NPS cell division and elongation as well as the root growth and dry matter content of wheat plants. (Schefe et al., 2008) also reported significant increments in the height of wheat plants in response to increasing the rates of fertilizer.

The result of the analysis revealed that the mean highest productive tillers (8.4) was obtained for the variety *kingbird* combined with a fertilizer rate of 150 kg ha^{-1} of NPS and it was statistically par with *fentale1* and wane bread wheat varieties with the combination of the same rate of NPS fertilizer rates, while the mean lowest productive tillers (6.6) was obtained for the variety *fentale1* combined with the null NPS fertilizer application which was statistically in par with the same variety combined with the 50 kg ha^{-1} of NPS fertilizer rate (Table 6). This indicated that by increasing the dose of fertilizer rate from 0 to 150 kg ha^{-1} NPS mean number of productive tillers increased significantly. The interaction between bread wheat varieties and NPS fertilizer rate increment was consistent from both *fentale1* and *kingbird* while the wane variety declined at 100 kg ha^{-1} of NPS fertilizer rate and then increased again at 150 kg ha^{-1}. The present result is also in line with the findings of (Firehiwot, 2014) who reported increase in the number of productive tillers produced in response to the increased rates of NPS fertilizers may be attributed to the synergic roles in enhancing productive tillers production by the plant. Similarly, (Hameed et al., 2002)also reported that the application of NPS at the rate of 100 kg ha^{-1} produced a higher number of productive tillers per unit area as compared to the nil NPS (no NPS) treatment.

3.1.4. Interaction Effect of Variety and NPS Fertilizer rate on Spike Length and Kernel/spike

The results showed that the highest mean value for spike length (8.23 cm) for wheat variety *fentale1* combined with 150 kg ha^{-1} NPS fertilizer rate, was statistically par with the wheat variety *kingbird* combined with the same NPS fertilizer rate, while the lowest (6.7cm) recorded from wheat variety wane at null rate of NPS fertilizer (Table 4). This shows that increasing the application of NPS fertilizer increased spike length and thereby increased the productivity of wheat. Generally, all three varieties had minimum spike length at zero application of NPS and they are statistically in par. The present results are in line with the results of (Hussain et al., 2006) who reported that with increasing fertilizers rate of organic and inorganic application to wheat the spike length increased. According to increasing the level of fertilizer application both macro and micronutrients increases the spike length due to the application of those nutrients. Regarding the number of spikelets per spike the result of the study showed that the highest mean value (44.9)

Table 4: Interaction Effect of varieties and NPS Fertilizer Rates on Plant height (cm) and effective tillers per plant

Plant height (cm)						**No/Effective tillers/plant**				
B/wheat variety	**NPS Fertilizer Rates** (kg ha^{-1})					**NPS Fertilizer Rates (kg ha-1)**				
	0	**50**	**100**	**150**	**Mean**	**0**	**50**	**100**	**150**	**Mean**
Fentale1	63.3^{d}	71^{bcd}	77^{ab}	82^{a}	**73.1**	6.6^{e}	6.8^{e}	7.7^{bcd}	8.1^{a}	**7.4**
Kingbird	69.7^{bcd}	74.3^{abc}	77^{ab}	80a	**74.8**	7.1^{de}	7.37^{cd}	7.6^{bcd}	8.4^{a}	**7.6**
Wane	67.7^{cd}	69.7	78^{ab}	81^{a}	**74.6**	7.2^{de}	7.6^{bcd}	6.97 ^{de}	8.2^{a}	**7.54**
Mean	**66.7**	**72.4**	**77.6**	**81.0**	**74.14**	**7.1**	**7.53**	**7.3**	**7.9**	**7.5**
LSD(0.05)	**7.6**					**5.2**				
CV(%)										

Table 5: Interaction Effect of varieties and NPS Fertilizer Rates on Spike length (cm) and Number of kernels/spike

Spike length (cm)						**No/kernels/spike**				
B/wheat variety	**Fertilizer Rates** (kg ha^{-1})					**Fertilizer Rate**(kg ha^{-1})				
	0	**50**	**100**	**150**	**Mean**	**0**	**50**	**100**	**150**	**Mean**
Fentale1	6.93^{abc}	6.95^{abc}	7.97^{ab}	8.3^{a}	**7.18**	41^{b}	42.7^{ab}	43.3^{ab}	44.9^{a}	**42.4**
Kingbird	6.7^{abc}	6.93^{abc}	7.17^{ab}	8.1^{a}	**7.2**	41.3^{b}	41.5^{b}	44.7^{a}	44.9^{a}	**42.3**
Wane	6.87^{abc}	7^{ab}	7.23^{ab}	7.27^{ab}	**7.5**	41.3^{b}	41.7^{b}	41.8^{ab}	42.3^{ab}	**42**
Mean	**7.14**	**7.22**	**7.4**	**7.34**	**7.3**	**41**	**41.9**	**43.7**	**43.1**	**42.2**
LSD(0.05)	**9.5**					4.8				

recorded for wheat varieties of *fentale1* and *kingbird* at 150 kg ha^{-1} NPS fertilizer rate and it was statistically in par for wheat variety *kingbird* with the combination of 100 kg ha^{-1} NPS fertilizer rate, while the lowest mean value for number of spikelets per spike was (41.3) for wheat variety wane in combination of null NPS fertilizer rate as a control treatment and it was statistically in par with *fentale1* and *kingbird* with the null NPS fertilizer rate (table 5). The mean highest number of spikelets per spike is significantly different and generally the number of spikelets per spike of wheat increases from 41.3 to 44.9 with increases in NPS fertilizer application up to a certain level of 150 kg ha^{-1} for all wheat varieties used in this study. These findings justified that N fertilizer application by itself does not have a significant effect on the spike length of wheat but in combination with phosphorus and sulfur elements. The present results are in line with the results of (Hussain et al., 2006) who reported that with increasing fertilizers rate of organic and inorganic application to wheat the spike length increased. According to increasing the level of fertilizer application both macro and micronutrients increase the spike length due to the application of those nutrients. reported that the optimum amount of fertilizer application has a significant effect on spike length growth. Similarly, (Smith and Hamel, 1999) reported that excessive application of N fertilizer has a toxic effect on wheat growth and results in stunted growth and reduced spike length

3.1.5. Interaction Effect of Variety and NPS Fertilizer on Thousand Grain Weight and Grain Yield

The result showed that the mean highest thousand kernel weight (44.5 g) recorded for *fentale1* with the combination of 150 kg ha^{-1} NPS fertilizer rate and it was statistically parred with the same wheat variety of *fentale1* combined with 100 kg ha^{-1} of NPS fertilizer rate, while the lowest mean thousand-grain weight was observed for wane (39 g), combined with the null NPS fertilizer rates for control treatment while there was an inconsistent trend of thousand while there was inconsistent trend of thousand (table 5). This indicates that increased NPS fertilizer rates increased also thousand kernel weights. Why; the result was in agreement with **(Tayebeh et al. 2011)** who reported number of seeds spike-1 and 1000 grain weight were significantly enhanced by increasing nitrogen levels. Generally thousand kernel weight of wheat increases with an increase in fertilizer rate up to a certain level for all varieties. The present results are in line with (Yoseftabar, 2013) who reported that an increase in the application of fertilizer rate had a positive impact on the yield component of wheat especially on thousand grain weight. This result is also in harmony with (Shuaib et al., 2009) which state when applying both micro and macronutrients and when NPS application increases there is a positive impact on yield components of wheat crop especially on thousand-grain weight. But, (Gooding and Davies, 1997) reported a non-significant effect of NPS application rate on thousand-grain weight.

The grain yield of bread wheat was influenced by the interaction effect of varieties and NPS fertilizer rates. The results showed that the mean highest grain yield (2.73 t ha^{-1}) and (2.7 t ha^{-1}) recorded for *fentale1* and *kingbird* respectively at 150 kg ha^{-1} NPS fertilizer application for both and it was statistically on par with the mean values for *kingbird* and *wane* (2.6 t ha^{-1}) at 150 kg ha^{-1} (Table 5). The lowest mean grain yield (2.3 t ha^{-1}) was obtained for *wane* for nil NPD fertilizer rate as a control treatment (Table 5). Generally, the grain yield kg ha^{-1} of bread wheat varieties increases with an increase in fertilizer rate up to a certain level for all varieties and the study showed that the maximum yield was obtained in combination of 150 kg ha^{-1} with all varieties. The possible reason for this response could be due to an adequate supply of fertilizer application and their assimilation in grain filling which might have

Table 6: Interaction Effect of varieties and NPS Fertilizer Rates on Thousand Grain Weight (g) and Total Grain yield (t ha^{-1})

Thousand Grain Weight (g)						**Total Grain yield** (kg ha-1)				
B/wheat variety	**Fertilizer Rates** (kg ha-1)					NPS **Fertilizer Rates** (kg ha-1)				
	0	**50**	**100**	**150**	**Mean**	**0**	**50**	**100**	**150**	**Mean**
Fentale1	42.4[bcd]	43.1[ab]	44.1[a]	44.5[a]	**42.15**	2.33[cde]	2.47[abc]	2.53[abc]	2.73[a]	**2.4**
Kingbird	40[cd]	42.4[ab]	42.97[d]	43.6[ab]	**42.26**	2.43[abcd]	2.47[bcde]	2.5[ab]	2.70[a]	**2.45**
Wane	39e	42.2[ab]	41.8[cd]	42.4[ab]	**42.56**	2.3[de]	2.37[bcde]	2.43e	2.6[a]	**2.4**
Mean	**41.14**	**42.26**	**42.83**	**42.56**	**42.36**	**2.38**	**2.356**	**2.482**	**2.67**	**2.417**
LSD(0.5)	2.0					**3.2**				

played an important role in tillering, spiklets seed/spike, and overall plant growth. In line with the result of this study, (Haileselassie et al., 2014) reported that increasing the rate of nitrogen fertilization increased the grain yield of wheat.

3.1.6. *Main effect of varieties and NPS Fertilizer Rates on Biomass Yield and Harvest Index*

The mean highest aboveground dry biomass was obtained for the highest application rates of 150 kg ha^{-1} NPS fertilizer. The highest biomass yield in the present study was obtained for bread wheat variety *fentale1* (5.0 t ha^{-1}) which was statistically in par bread wheat variety *kingbird* also highest biomass yield was recorded at 100 kg ha^{-1} NPS application while the lowest was for *wane* (4.93 ha^{-1}) and for control treatment and it was statistically in par with mean biomass yield for *kingbird* (4.93 t ha^{-1}) at zero application of fertilizer. The possible reason for his response could be due to an adequate supply of fertilizer application and their assimilation in meristematic tissue which might have played an important role in tillering and overall plant growth. The results of the present study are similar to the research findings of **(Minale L., Alemayehu A., and Tilahun T. 2005)** who reported that as the fertilizer rate increased, the biological yield also increased. According to (Iqtidar Hussain et al., 2006). (Ehdaie and Waines, 2001) also pointed out that the increase in biomass yield as a result of increment in fertilizer rates explained that wheat plants used NPS to produce more biomass. The highest mean harvest index was obtained for fentale1 (50%) and the lowest (48%) zero kg ha-1 NPS fertilizer rate which was statistically on par with the mean harvest index of *kingbird* (48%) at zero kg ha-1 NPS application (Table 10). Generally the harvest index of wheat increases with an increase in fertilizer rate up to a certain level for all varieties. The result of the study agrees with the findings of (Sharar et al., 2003) who reported a higher harvest index under higher levels of nitrogen and phosphorus than application of lower levels of fertilizers in wheat plants. The results are in harmony with (Sharar et al., 2003) who reported that the application of NPS increased yield components of wheat especially on harvest index and grain yield.

Table 7: Main effects of biomass yield (t/ha) and harvest index

Treatments	**Total Biomass Yield (kg ha^{-1})**	**Harvest Index (%)**
Bread wheat variety		
Fentale1	49.67	50
Kingbird	49.67	48
Wane	49.25	49
Mean	49.53	49
LSD(0.05)	0.7	0.7
CV(%)	1.6	
Fertilizer rates	49.44	49
Fertilizer (0) rate	49.33	48
Fertilizer (50) rate	49.56	49.
Fertilizer (100) rate	49.78	48.6
Fertilizer (150) rate	49.5	49
Mean		
LSD(0.05)	0.8	0.9
CV (%)	1.6	1.2

3.2. Cost benefits Analysis

The result showed that the highest net benefit (68,435 birr•ha^{-1}) was obtained from bread wheat variety *fentale1* with the combination of 1150 kg•ha^{-1} NPS, whereas the least net benefit (62,100 birr•ha^{-1}) was obtained from the unfertilized treatment **(Table 11)**. The net return was about 8.9-fold higher than that of the control. Accordingly, the result showed that the highest MRR (i.e., 4252.6%) was obtained from the application of 150 kg•ha^{-1} NPS fertilizer and it was followed by MRR (i.e., 385%) recorded from 150 kg•ha^{-1} NPS **(Table 11)**. Therefore, the application of 150 kg•ha^{-1} NPS fertilizer followed by 100 kg•ha^{-1} NPS seemed economically profitable. In line with these results (Yohannes, 2014; Firehiwot, 2014)indicated that the estimated net income for mineral fertilizer is attractive as compared to growing wheat without application of fertilizer. In conclusion, the net benefit obtained by the use of improved bread wheat (*fentale1*) with a fertilizer rate of 150 kg ha^{-1} was found to be the most profitable and can be recommended for farmers in the study area and other areas with similar agro-ecological conditions.

4. Summary and Conclusion

Bread wheat production is an emerging agriculture practice in agro-pastoralist communities in Somali Regional, Ethiopia in both irrigated and rainfed conditions. However, the low yield in this cereal crop may be partially attributed to the low level of adoption of improved varieties and improved management techniques. Therefore, an experiment was conducted to determine the effects of improved variety, fertilizer rate, and their interaction on yield components and yield of bread wheat; and to estimate the economic feasibility of variety by fertilizer rate application for optimum yield of bread wheat. Also, little attention has been given to research

Table 8: Partial budget analysis for Bread wheat varieties NPS fertilizer rate application.

Treatment Combination	Yield (t/ha)	Adjusted yield (t/ha)	Gross return (Birr/t)	Total Cost (Birr/ha)	Net return (Birr/t)	Benefit/cost (B:C)
Fantale1 X 0kg of NPS	2.33	2.1	73,500	9500	64,000	6.74
Fantale1 X 50kg of NPS	2.47	2,223	77,805	12,255	65,250	5.2
Fantale1X 100kg of NPS	2.53	2.28	79,800	15000	64,800	4.32
Fantale1X 150kg of NPS	2.73	2.46	86,100	17,755	68,345	3.85
Kingbird X 0kg of NPS	2.30	2.07	72,450	9500	62,950	6.63
Kingbird X 50kg of NPS	2.47	2.223	77,805	12,255	65,250	5.4
Kingbird X 100kg of NPS	2.5	2.25	78,750	15000	63,750	4.25
Kingbird X 150kg of NPS	2.7	2.43	85,050	17,755	67,295	3.4
Wane X 0kg of NPS	2.3	2.07	72,450	9500	62,950	6.63
Wane X 50kg of NPS	2.37	2.133	74,655	12,255	62,100	5.1
Wane X 100kg of NPS	2.53	2.28	79,800	15000	64,800	4.32
Wane X 150kg of NPS	2.6	2.34	81,900	17,755	64,145	3.7

to generate information that could be recommended as agronomic technologies for high-yield production of wheat in potential areas of the Region. Therefore, an experiment was conducted to determine the effects of improved varieties and rates of blended NPS fertilizer on yield components and yield of bread wheat at Kebribeyah Woreda. Prior to sowing or fertilizer applications soil samples were taken and analyzed for physico-chemical contents of the experimental site. The results of soil sample analysis before sowing indicated the soil of the experiment site had moderate total N and low total P implying the importance of the application of inorganic fertilizer containing nitrogen and phosphorus to the soil to obtain a high yield of bread wheat.

The results of the research showed that all traits of bread wheat except days to 50% emergence were significantly influenced either by varieties or rates of NPS fertilizer or both factors and/or the interaction of the two factors. *Fentale1* and *Kingbird* bread wheat varieties with the application of 150 kg ha^{-1} NPS fertilizer produced higher grain yields of 2.73 and 2.7 t ha^{-1} respectively, though it had non-significant differences from yield obtained same other treatment combinations and it was higher than the average nation wheat yield of 2.675 t ha^{-1} produced in 2016/17 *Meher* season. Further, an analysis of the economic feasibility of fertilizer application at different rates on different varieties was carried out on farms. The results of the partial budget analysis showed that the maximum net benefit (ETB 68,345.00 ha^{-1}) was obtained from 150 kg NPS ha^{-1} fertilizer application, using the variety *fentale1*. Thus, it is concluded that further research is required on other wheat varieties with varied rates of NPS fertilizers to identify wheat varieties and rates of fertilizers to produce high yields with acceptable economic rates of return by producers.

Conflict of Interest

The authors declare that they don't have conflict of interest.

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