Effects of Blended NPSB Fertilizer Rates on Growth, Yield and Yield Components of Bread Wheat (*Triticum aestivum L.*) Varieties on Jimma Arjo District, Western Ethiopia

ABSTRACT

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in Ethiopia, however the yield of the crop is low mainly due to low soil fertility management, lack of using balanced fertilizer and lack of using improved wheat varieties. An experiment was conducted to determine the effect of varieties, fertilizer rate and their interaction on yield and yield components and to determine the economic feasibility of application of fertilizer for optimum yield of bread wheat varieties. The experiment was conducted in Jimma Arjo district with four levels of NPSB fertilizer rates (0, 50, 100, 150, and 200 kg ha^{-1}) and 64/20 NP and three bread wheat varieties (Ogolcho, Huluka and Hidase) combined factorially and laid out in a Randomized Complete Block Design with three replications. The soils of the experimental area exhibited high sand (36%) but relatively low clay fractions (30%). Before sowing, the soils of the experimental site showed mean soil pH (H_2O) value of 5.52, organic carbon content of 2.21%, total N (0.19%) available P (10.02%%), organic matter content (3.80%), and available boron of 0.99 ppm.. The main effect of varieties and NPSB fertilizer application were significant for all parameters of bread wheat varieties except harvest index and only seed per spike and thousand seed weight were significant for interaction. The highest mean grain yield of 5801 kg ha^{-1} was obtained for Huluka bread wheat variety with applications of 150 kg NPSB ha^{-1} and 200 kg urea ha^{-1} fertilizers. The lowest 1599 kg ha^{-1}grain yield was recorded from Hidase with no fertilizer. The highest net benefit ETB 154288 ha^{-1} with marginal rate of return of 3210% and value to cost ratio of ETB 66.19 per unit of investment for bread wheat production was obtained from application of 150 kg NPSB ha^{-1} and 200 kg Urea ha^{-1}. In conclusion, application of 150 kg ha^{-1} NPSB had enhanced bread wheat yield and, therefore, recommended for bread wheat production.

Keywords: Bread wheat, fertilizer rate, varieties, yield

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is a staple food that provides around 20% of protein and calories consumed worldwide [1] It ranks first in the world cereal crops accounting for 30% of all cereal food worldwide and is a staple food for over 10 billion people in as many as 43 countries of the world [2]. The demand for wheat is expected to grow by 34 to 60% in 2050 in developing countries [3]. The FAO estimates that global commercial production of all types of wheat was 650.9 million metric tons in 2016, harvested from 217 million hectares; it is grown on around 4% of the planet's agricultural land [4].

Ethiopia is one of the largest wheat producers in the Sub-Saharan Africa (SSA), with yearly estimated production of 4.6 million tons on 1.69 million hectares of land [5] yield per ha. Mean wheat yields increased from 2.764 tons/ha [6] to 2.97 t ha^{-1} in 2019/20 [7] the average wheat productivity in SSA is 1.7 t ha^{-1} [8], nearly 50% below the world average. The national wheat productivity in SSA varies across countries. It ranges from 0.7 t ha^{-1} in Burundi to 3.4 tha^{-1} in Mali. But, some of the world highest spring wheat yields are obtained in Africa. The highest biological and grain yield produced by the application of the highest Phosphorus fertilizer rate of 92 Kg P_2O_5 ha^{-1} and 184 kg N Kg ha^{-1} [9]. Similarly, [10] reported that the highest grain yield (3.77 t ha^{-1}) was obtained at a rate of 120 kg NPS ha^{-1} fertilizer than control treatments (2.5 t ha^{-1}) for tef. Varieties are one of the other major factors which play an important role in producing higher yield of wheat [11].

In most of the nutrient studies in Ethiopia, more emphasis was given to macronutrients, especially N and P, and micronutrients investigations had received little attention. Studies related to the micronutrient's status of Ethiopian soils on the other hand are scarce, although the role of micronutrients play in agriculture may be equally important. [12] Beginning from 1960's, Ethiopian agriculture depended solely on imported fertilizer products; only urea and Di-ammonium phosphate (DAP), as sources of N and P, respectively. However, recently it is perceived that the production of such high protein cereals like wheat can be limited by the deficiency of S and other nutrients. [13] However, Ethiopia is moving from blanket recommendations for fertilizer application rates to recommendations that are customized based on soil type and crop.[14] This is a move towards diversification and away from DAP and urea, which have long been the only types of fertilizer imported for grain crops. Different recent studies have showed that elements like N, P, K, S and Zn levels as well as B and Cu are becoming depleted and deficiency symptoms are being observed on major crops in different areas of the country .[15] Most Ethiopian soils are deficit in macronutrients (N, P, K and S) and micronutrients (Cu, B, and Zn).[16]

Macronutrients as well as micronutrients are of primary importance in our agriculture system but due to unawareness of the farmers about importance of applying micronutrients and unavailability, the soils are becoming deficient in micronutrients [17]. Micronutrients are essential for plant growth and play a vital role in increasing crop yields as they develop plant nutrition and increase soil efficiency [18] Even though different types of blended are suggested by EthioSIS, farmers in most parts of the country have limited information on the impact of different types and rates of fertilizers except that of blanket recommendation which is nitrogen at a rate of 41 kg N per ha and phosphorus at a rate of 46 kg P_2O_5 per ha. This translates to the use of 50 kg Urea and 100 kg DAP per ha for wheat while according to the soil fertility map made over 150 districts most of the Ethiopian soils lack about seven nutrients (N, P, K, S, Cu, Zn and B) [19] The effect of blended fertilizers types and rates on yield components and yield of bread wheat are unknown, even if a new blended fertilizer such as NPS, NPSB etc., are currently introduced to the country. Similarly, farmers of the study area have been using this blended fertilizer in similar trends and equivalent ratio with that of their previous information they have used and awareness in the last four to five decades on blanket recommendation of DAP and Urea fertilizers, which is 100 Kg DAP and 100 kg of urea ha^{-1}. Yet now there is no research on related bread wheat varieties with blend fertilizer rates on study area.

2. MATERIALS AND METHODS

2.1 Description of the Experimental Site

The experiment was conducted on farm field in Jimma Arjo District during 2020 cropping season. Jimma Arjo is found in East Wollega zone of Oromia National Regional State (Figure 1). It is located 379 km to West of Addis Ababa and 48 km from Nekemte town (the capital city of East Wollega Zone). The altitude ranges from 1500-2600 meter above sea level.

2.1.1. Climate

The climate of the district is classified traditionally into three main agro-climatic zones. This agro-ecology of the study area includes highland, mid-altitude, and low land. About half of the district (49.7 %) is categorized under the mid-altitude agro ecological zone. The remaining 26.7 % and 23.6 % of the areas are found under the agro-ecologies of lowland and highland, respectively. According to the agro-climatic classification of Ethiopia, the relief of the study area

Can be grouped into three major physiographic units based on their elevation. The lowlands with 2300 meters above sea level which is strongly suitable for teff, wheat, bean, pea, with 30%, 58% and 12% coverage respectively. The mean temperature and the annual rainfall of the study area is $15^0{}_C$ and 2800 mm respectively (Jimma Arjo Agriculture and Natural Resource office, 2019). The main soil group of most of the East Wollega zone is Nitisols .[20] The study area is known by production of cereal crops such as wheat, maize, teff, and sorghum.

2.2 Experimental Materials

Three bread wheat varieties: Hidase (ETBW5795), Ogolcho (ETBW5520), and Huluka (ETBW5496) which were released by Kulumsa Agricultural Research Center in the year of 2012 used for the study. These varieties were selected based on yield, disease resistance, farmer's acceptance and adaptability to the agro ecology of the study area. Blended NPSB (18.9% N, 37.7% P_2O_5, 6.95% S and 0.1% B), and urea were used as fertilizer sources. Nitrogen fertilizer obtained from urea (46% N) was applied uniformly to the all treatments at 92 kg N of recommended rate in the study area except for the control treatment.

2.3 Treatment and Experimental Design

The experimental study was arranged with a total of 18 treatments in a factorial combination with a complete block design in three replications. The treatment combinations were three improved wheat varieties (Hidase, Ogolcho and Huluka) and five NPSB fertilizer rates 0, 50, 100, 150, 200 and recommended NP (64/20) kg ha^{-1} used as control) with supplementation of 92 kg N for all treatments except control . The gross plot size was 2-meter length*3-meter width=6 m^2 with 10 rows. The spacing of between rows, plots and blocks will be 0.30 m, 0.5 m and 1 m respectively.

2.4 Experimental Procedures and Field Management

The experimental field was prepared and ploughed manually by oxen three times to fine tilth of the soil before planting. Then according to the design, a field layout was made and each treatment were assigned randomly to the experimental units/plots within a block. The three selected improved varieties of bread wheat were sown at the recommended seed rate of 150 kg/ha in rows of 30 cm spacing manually by drilling method during at onset of rain fall most probably at mid-June of 2020 cropping season. The whole amount of NPSB blended and fertilizers were applied at sowing time whereas, urea was applied in two splits (half at planting and the remaining half at knee height). Weeding and all necessary agronomic managements as per the recommendation practice will be undertaken.

2.5. Soil Sampling and Analysis

One representative of composite soil sample was taken at a depth of 0-20 cm from ten randomly selected sub-samples of soil across experimental field by zigzag method using of auger. Then the sample was air dried under shade, grind using a pestle and a mortar and allowed to pass through a 0.5 mm for total nitrogen, and in 2 mm sieve for others. The sample was analyzed for selected physicochemical properties, such as texture, soil pH, total nitrogen, available phosphorus, and Boron.

2.6 Data Collected

Plant height: In case of [21] ten plants were randomly selected and tagged from the net plots area of each experimental unit. Then the height was measured from the selected plant from the ground to the tips of spike (excluding of awns) using of ruler and the mean value was determined in respective to each plot.

Spike length: As .[21] Spike length was determined by taking ten effective tillers randomly from each plot at the time harvesting and can be measured from the bottom of spike to the tip of the spike excluding of the awns. Then, the mean value was determined for each plot experimental unit from the recorded data in centimeter.

Number of tillers per plant: According to [21], number of tillers per plant was measured by taking of ten plant samples randomly from each plot at full tillering stage of crops by counting the total number of tillers and then the mean value was determined.

Number of productive tillers: As [21] number of productive tillers was determined by counting all spikes which can bear kernels from the ten plant samples randomly selected at full tillering of the crop and the mean value was calculated from the recorded value.

Number of kernels per spike: According to[22] number of kernels per spike was determined and computed by taking ten spike head randomly from each plot at the time of harvesting. Then the spike was threshed separately and the seeds were counted carefully for the purpose of mean number of kernels per spike for each experimental unit.

Thousand kernel weight: was determined based on the weight of 1000 kernels grain yield sample by weighting with electronic balance and expressed in grams.

Dry biomass: was measured from the plant parts (stems, leaves and grain seeds) harvested from the net plot area for each treatment after sun drying for about 3 to 4 days and it's expressed in tons per hectare (tons/ha).

Grain yield: was determined for each treatment by harvesting and threshing of crops separately from the net plot area and then weighted by electronic balance. Then the grain yield was expressed by adjusting of it's to 12.5% of moisture content as:

Harvest index: was computed as the ratio of adjusted grain yield to total above ground dry biomass yield for each treatment in experimental plot and finally expressed in percent as:

HI (%) = (Grain yield/Above ground dry biomass) *100

Statistical Analysis

All data recorded and collected were subjected to the procedure of analysis of variance (ANOVA) using of SAS version 9.4 [23] The comparisons among and within treatments means was employed by using least significant difference test at 5% significant level [24]

2.7. Partial Budget Analysis

The partial budget was analyzed following a partial budget procedure of International Maize and Wheat Improvement Center [25] based on the existing cost of production. Economic analysis such as partial budget and marginal rate of return for wheat grain yield was valued at an average open market price of ETB 3000 per 100 kg Labour cost for field operation was 80 ETB per man-day. The yield was adjusted down by 10 % to reflect actual production conditions to adjust to the farmers' production status. [25] The cost of fertilizer (Urea and NPSB) was ETB 1411.19 and 1554.07 per 100 kg with the current market price, respectively.

3. RESULTS AND DISCUSSION

3.1. Soil physicochemical properties of the experimental site

The selected soil physicochemical properties of the experimental sites are presented in (Table 1). The textures of the soils in experimental sites were relatively high in sand, but moderate in silt and clay content and the soil textural class of experimental site were found to be clay loam in texture [26] (Table 1). The soil texture or the proportions of sand, silt and clay in the soil indicates the degree of weathering, aeration, nutrient and water holding capacity of the soil.

The soil pH value was 5.52 (H_2O) and strongly acid [27] The soil organic carbon and organic matter contents were 2.21 and 3.80% (medium range) according to [28] The total nitrogen of the soil was found to be 0.19% (low range) based on [27] ratings. The available P was 10.02 mg/kg soil, and found to be in the medium range [27].

3.2. Growth parameter

3.2.1. Plant height

The main effect of wheat varieties and blended fertilizer rates showed highly significant ($P < 0.01$) effect on plant height but their interaction was non-significant (Table 2). The results showed that the highest mean plant height was obtained for the variety Ogolcho (82.9 cm) while the lowest mean plant height was obtained for the variety Hidase but statistical par with variety Huluka (Table 6). In case of fertilizer highest (85.9 cm) plant height was obtained by application of 200 kg of NPSB but statistical at par with application of 150 kg NPSB (84.23cm) and with application of 100 kg NPSB (82.5) while the lowest (58 cm) plant height was obtained with control plot which followed by blanket application. Therefore, increasing plant height at the highest level of NPSB fertilizer could be attributed to the increasingly adequate supply of nitrogen, phosphorus and Sulphur nutrients, which helped, in high vegetative growth and development of plant. This result is in agreement with that of [29] who reported that increasing nitrogen rates increased the wheat plant height.

3.3. Yield and Yield Components

3.3.1. Spike length

The mean spike length of bread wheat was highly significantly ($P < 0.01$) affected by wheat varieties and NPSB rates but not by their interaction (Table 2). The results showed that the highest mean value for spike length was obtained from Ogolcho variety (7.93 cm) while the lowest spike length was obtained from variety of Hidase (6.84 cm) but statistical at par with Huluka variety (7.6). In case of Fertilizer rates, the highest spike length was recorded from the plot treated with 50 kg NPSB ha-1 (8.33 cm) but statistical at par with plot treated with100 Kg of NPSB (7.94 cm), plot treated with 150 Kg of NPSB (7.95) and also statistical par with plot treated with 200 Kg of NPSB (8.19) the lowest (5.37 cm) spike length obtained from 23 the control plot (Table 2) which followed by blanket fertilizer application. This shows that increasing application of fertilizer increased spike length and thereby increases productivity of wheat. All three varieties of bread wheat had minimum spike length at zero application of

NPSB. The present results are in line with the result of [30] who reported that with increasing fertilizers rate of organic and inorganic application to wheat the spike length increased. According to [31] with increasing the level of fertilizer application both macro and micro nutrient increase the spike length due to the application of those nutrients

3.3.2. Tillers per Plant

The mean number of tillers per plant of bread wheat was significantly ($P < 0.05$) affected by wheat varieties and highly significantly ($P < 0.01$) affected by blended NPSB rates, but the interaction was not significant (Table 2).The results showed that the highest mean value for number of tillers per plant of bread wheat was obtained from variety Ogolcho (1.70) but statistical at pat with variety Huluka (1.38) while the lowest tiller per plant was variety of Hidase (0.92). In case of fertilizer effect highest tiller per plant was obtained from application of 150 kg of NPSB (1.82) but statistical at par with application of 200 kg of NPSB (1.75) and with application of 100 kg NPSB (1.64) while the lowest tillers per plant was obtained from control (0.41) which followed by blanket application (0.41) This might be attributed to different capacity of varieties in tillering .[32] reported that the main effect of blended NPSB fertilizer rate as well as their interaction were highly significant($p<0.01$) on total and effective tiller. [33] Also reported that the highest number of tillers per plant of bread wheat due to the combined application of 200/200 kg NPS/N ha^{-1} indicating the positive role of Nitrogen for tillering. The increase in the numbers of tillers in response to increasing the rate of NPSB blended fertilizer may indicate the importance of availability of balanced nutrients for better growth and development of the plant.

3.3.3. Seeds per spike

The main effect of NPSB rates was highly significant ($P < 0.01$) effect and the main effect of wheat variety was significant ($p<0.05$) effect on number of seed per spike. [21] Revealed that fertilizer showed significant ($p<0.05$) effect with respect to the number of kernels per spike and while the main effects of the varieties had highly significant ($p<0.01$) effect on number of kernels per spike and the interaction between the two factors was not significant. Similarly, by the finding of [34] number kernel per spike was highly significantly ($p<0.01$) affected by the main effect of blended NPS fertilizer application and Supplemental N fertilizer well as by interaction. But the two-way factors interaction did not have significant influence on the number of seeds per spike (Table 2).

Bread wheat variety Huluka produced the maximum (39.27) numbers of seeds per spike whereas the minimum (38.7) number of kernels per spike was produced for variety Ogolcho which was statistically pair with Hidase variety (Table 2). Number of seeds per spike associated with the number of spikes lets per spike, number of florets per spike let as well efficiency of pollination and seed developing in florets. These components are indirect connection with productivity of wheat. This might be due to the presence of genetic difference. Reports have shown the variation of number of seeds per spike as a function of barely genotype [35] Regarding fertilizer rates, the highest (42.94) number of kernels was produced from application of 150 kg NPSB ha^{-1} and 50 kg NPSB ha^{-1} rates whereas the minimum (28.05) number of kernels per spike was produced from control . This indicated that the number of kernels per spike was more enhanced by NPSB which might be due to the fact that P is essential in development of grains. This may be due to the reason that NPSB plays a vital role in grain setting of wheat.

3.3.4. Thousand Seed weight

Main effect of NPSB rate, varieties and their interaction showed highly significant ($P < 0.01$) effect on thousand kernel weight (Table 3). Among the varieties, Ogolcho had the highest (44.95 g) thousand kernels weight and the lowest (40.33 g) thousand kernels weight was obtained from Huluka variety (Table (3). This is may be due to the suitable genetic behavior of the variety with environmental factors which may led to an increased in photosynthesis process and accumulations of carbohydrate in kernel to produce heavy kernels and consequently increased kernels weight per spike. In case of fertilizer rates, the maximum (44.91 g) thousand kernels weight was recorded at the NPSB rate of 200 kg NPSB ha^{-1} and the lowest (36.79 g) thousand kernel weight was obtained from control (Table 3).

Mean thousand seed weight of a wheat increases with increase in fertilizer rate up to a certain level for all varieties. The present results are in line with [36] who reported that increase in application of fertilizer rate had a positive impact on yield component of wheat especially on thousand kernel weight. Likewise, [37] stated when applying both micro and macro nutrients and when N–level application increase there is a positive impact on yield components of wheat crop especially on thousand kernel weight. This might be due to the improvement of seed quality and size due to balanced nutrients application. In line with this result, similarly, [38] suggested that increase in fertilizer application results the significant variation in performance of bread wheat varieties on seed yield.

3.3.5. Biomass Yield

Main effect of NPSB fertilizer rate and varieties showed highly significant ($P < 0.01$) effect on mean biomass but non-significantly affected by the interaction of NPSB rate and varieties of bread wheat (Table 3). The results showed that mean dry biomass yield of wheat was the highest for Huluka (11407 kg ha^{-1}) and Ogolcho(11095 Kg ha^{-1}) varieties with application of 150 kg NPSB ha^{-1}, while the lowest biomass yield where obtained from Hidase variety (7747.2 kg ha^{-1}) . Similarly [39] reported that higher dry biomass yield was obtained from application of higher Urea and blended NPSB fertilizer rate as compared to control and recommended fertilizer.

The biomass yield of bread wheat increases with increase in NPSB fertilizer rate up to a certain level for all varieties. The possible reason for this response could be due to adequate supply of fertilizer application and their assimilation in meristematic tissue which might have played an important role in tillering and overall plant growth. Similarly [40] reported that as fertilizer rate increased, the biological yield also increased. [41] The highest biomass was obtained for the highest application rates of N levels. [42] Also pointed out that the increase in biomass yield as a result of increment in fertilizer rates explained that wheat plant used N to produce more biomass.

3.3.6. Grain yield

Main effect of NPSB rate and varieties showed highly significant ($P < 0.01$) effect on mean grain yield but non-significantly affected by the interaction of NPSB fertilizer rate and varieties of bread wheat (Table 3). The results showed that the highest mean grain yield of bread wheat was obtained from Huluka variety (4913 kg ha1) but statistical at par with Ogolcho variety (4455.6 kg ha1). While lowest grain yield was obtained from variety Hidase (3374 kg ha1) (Table 6).Regarding of fertilizer highest (5800 kg ha-1) grain yield was obtained by application of 150 kg NPSB kgha1 but statistical pair with application of 200 kg NPSB (5760 kg ha-1). While the lowest grain yield was obtained from control treatment (1598 kg ha-1) . The mean grain yield of bread wheat increases with increase in fertilizer rate up to a certain level for all varieties. The possible reason for this response could be due to adequate supply of fertilizer application might have played an important role in tillering and overall plant growth and reproduction. Likewise, [43] reported that the highest grain yield (6778 kg ha-1) of wheat 27 was obtained from application of 150 kg NPSZNB ha^{-1} and 150 kg ha^{-1} of urea in farm as compared with the farm 2,3,4 and combined over years. Significantly higher yield 4143 and 5127 kg ha^{-1} of wheat in farm 3 and 4 were obtained from application of 250 kg urea ha^{-1} with 200 and 250 kg NPSZnB ha^{-1}. Significantly higher yield 4968 kg ha-1 of wheat in farm 2 and combined over years was obtained from application of 250 kg NPSZnB ha^{-1} and 350 kg urea ha^{-1}.. Likewise, [9] reported that as fertilizer rate increased, the biological yield also increased. Similarly,

[44] also reported that increasing rate of nitrogen fertilization increased grain yield of wheat. Likewise [45] reported that application of urea and blended NPSB fertilizer rate was significantly ($p<0.05$) affected mean grain yield of bread wheat in two farms in 2018 and one farms in 2019 cropping season. Similarly [46] reported that application of 250/200 kg Urea and NPSZnB ha^{-1} was produced better yield and economical optimum for maize production in toke Kutaye district and similar agro ecology. Likewise [39] reported that the mean grain yield of maize was significantly affected by the application of Urea and NPSB fertilizer rate in three farms in 2018, 2019, cropping season and combined mean of three farms over year.

3.3.7. Harvest index

The result revealed that harvest index was not significantly affected by main effect of blended NPSB fertilizer rates, wheat varieties and interaction due to genetic makeup of the varieties .(Table 3). Similarly, [43] found that mean harvest index of wheat was non-significantly affected by application of blended (NPSZnB) fertilizer rates. In the reverse [44] reported that application of urea and blended fertilizer NPSB fertilizer rate was significantly (p<0.) affected harvest index of bread wheat varieties.(47) reported that the main effects of seed rate showed highly significant ($P<0.01$) difference on harvest index of wheat. However, the main effects of varieties and interaction effects seed rate and variety did not show significant difference [45] also reported that the highest application of blended and Urea fertilizer had significant ($p=0.05$) effects on harvest index of maize. The highest harvest index(34%) of maize was realized from application of 250/150,350/200 kg urea and NPSZnB while the lowest (28%) harvest index of maize was realized from application of 150/150 kg NPSZNB and Urea in 2018/2019 cropping season. Thus, application rate of blended fertilizer and urea had influenced the harvest index of wheat varieties.

3.4. Pearson Correlation between Yield and Yield component of Bread Wheat due to varieties and NPSB fertilizer

Correlation analysis between growth, yield and yield components of wheat varieties were revealed strong and positive association among all components except Harvest index of wheat varieties (Table 4). Positively significant association were observed between yield and yield components of wheat varieties. Significantly higher and positive correlation coefficient were observed between plant height with spike length (0.704), tiller (0.847), kernel per-spike (0.573), thousand kernel weight (0.675), dry biomass (0.821) and grain yield (0.760). Positively association between spike length with tiller (0.698), kernels/spike (0.586), thousand kernel weight ($r=0.346$), dry biomass (0.624) and grain yield (0.582). Tiller with kernel/spike (0.486), thousand kernel weight (0.52), dry biomass (0.83), and grain yield (0.763). Also, significant and positive correlation between kernels/spike with thou-send kernel weight (0.284), dry biomass, (0.527), grain yield $r=0.523$). Also, higher significant and positively associations with thou-send kernel weight and dry biomass (0.467) and grain yield (0.442).Higher significant positively correlation coefficient was observed between dry biomass and grain yield (0.940). No significant and negative correlation were observed on harvest index. In conclusion, yield and yield component of wheat varieties had strongly positive relationship with grain yield of wheat varieties indicated that yield components of wheat varieties directly influenced the grain yield of wheat varieties.

Similarly [46] reported that growth parameter plant height and spike length where positively correlated with effective tiller number(r=0.18, 0.29) number of kernels per spike(r=0.74) biomass yield (r=0.04) and harvest index (r=0.46) respectively. Also, as they reported grain yield was positively correlated with plant height (r=0.18) spike length (r=0.35) and significantly correlated with effective tiller number(r=0.6), kernel per spike (r=0.58), thousand kernel weight (r=0.7) biomass yield(r=0.96) and harvest index(r=0.8). Similarly [48] reported that grain yield had significantly positive correlated with plant height, total number of tillers, number of effective tiller and strong correlation with harvest index.

3.5. Effects of NPSB fertilizer rates on economic feasibility of wheat production

The maximum net benefit of ETB 154288 ha^{-1} with marginal rate of return 3210 % and value to cost ratio ETB 66.19 per unit of investment of bread wheat was obtained with application of 150/200 kg blended NPSB ha^{-1} with urea whereas the lowest net benefit ETB 43168 EB ha^{-1} was obtained from control (Table 5). The second and the third net benefit ETB 129347 and 107093 ha^{-1} with marginal rate of return 2864 and 8227 % and with value to cost ratio 82.23 and 137.82 per unit of investment of bread wheat production respectively was obtained by application of 200/100 kg urea/NPSB and 200/50 kg urea/NPSB ha^{-1}.

Likewise,{43] reported that application of 250/250 kg urea/NPSB ha^{-1} gave higher net return of ETB 54068 ha^{-1} with marginal rate of return 395and value to cost ratio of 7.58 EB followed by application of 250/100 and 150/100kg urea/NPSB ha. Therefore, application of 150/100kg urea/NPSB ha^{-1} was produced better grain yield and economic feasible and recommended for improved wheat production in Ultisols of Liben Jawi and similar agroecologies in western Oromia. In line with these result [49] 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 application of fertilizer rate 150 kg NPSB ha^{-1} were 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. CONCLUSION

Bread wheat (*Triticum aestivum* L.) is important food crop in Ethiopia. The soil of the experimental area, texturally high in sand, moderate in silt and clay in content, with pH of 5.52, organic carbon content of 2.21%, moderate total N (0.19%) low total P (10.02%), organic matter content (3.80%), and available boron 0.99 ppm. The main effect of varieties and fertilizer rate applications were significantly improved all parameters of bread wheat. Significant differences have been observed among the wheat varieties which could be due to their differences in genotypes. Application of different rates of NPSB had significantly improved all agronomic traits of bread wheat. The highest 5801 kg ha^{-1} and lowest 1599 kg ha^{-} mean grain yield of bread wheat was obtained with application of 150 kg NPSB ha^{-1} blended fertilizer rates and control. The highest net benefit ETB 154288 ha^{-1} with marginal rate of return of 3210% and value to cost ratio of ETB 66.19 per unit of investment for bread wheat production was obtained from application of 150 kg NPSB ha^{-1} on Huluka variety. Therefore, application 150 NPSB ha^{-1} was economically profitable and it can be recommended for farmers in study area and other areas with similar agro-ecological conditions. However, it is difficult to make definite conclusion based on the experiment of only one season and one location. Therefore, to give conclusive recommendation, the optimum blended NPSB fertilizer rates for the production of bread wheat in the study area further research over location and years should be conducted.

DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon request

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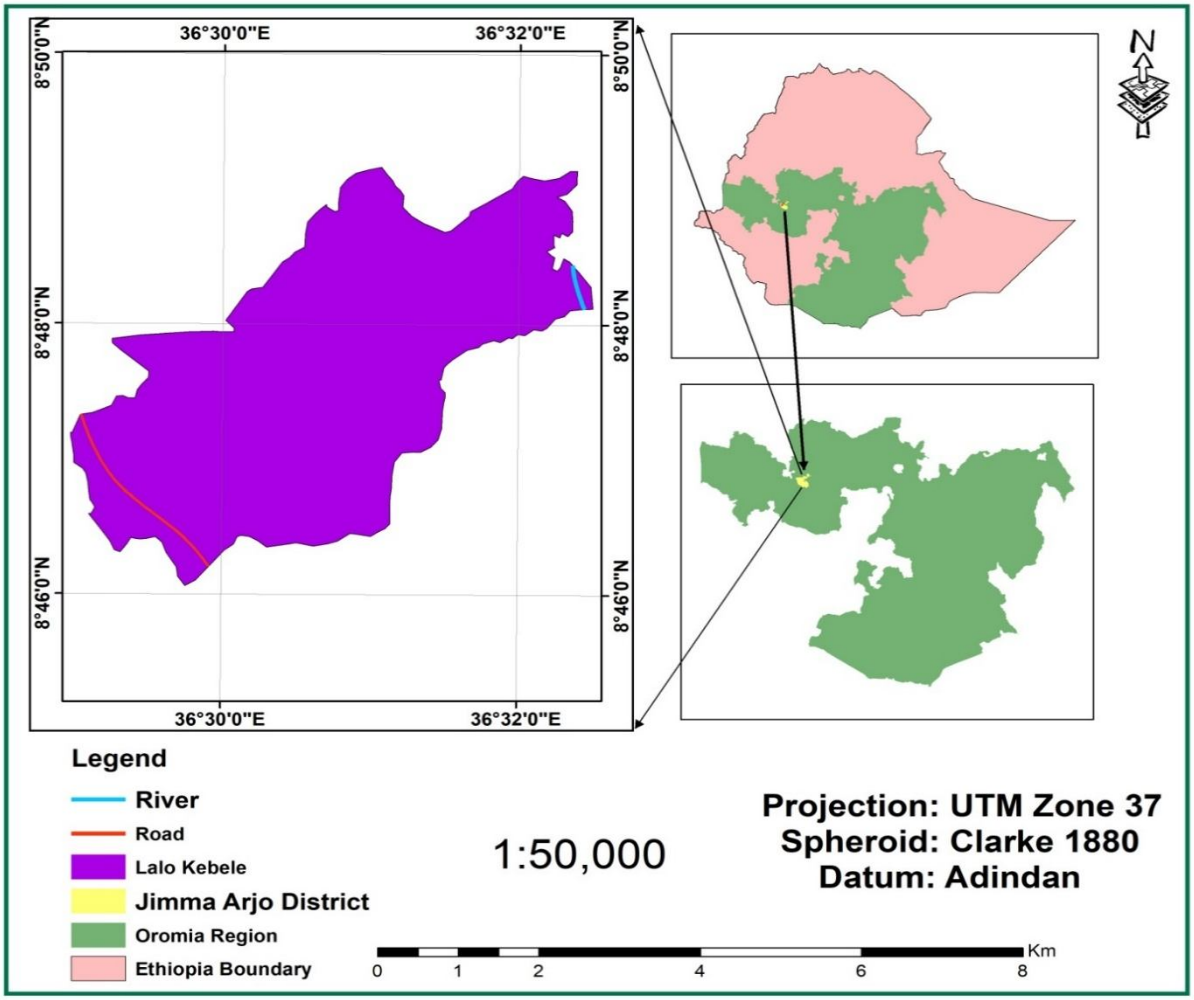

Figure 1. Map of Study Area

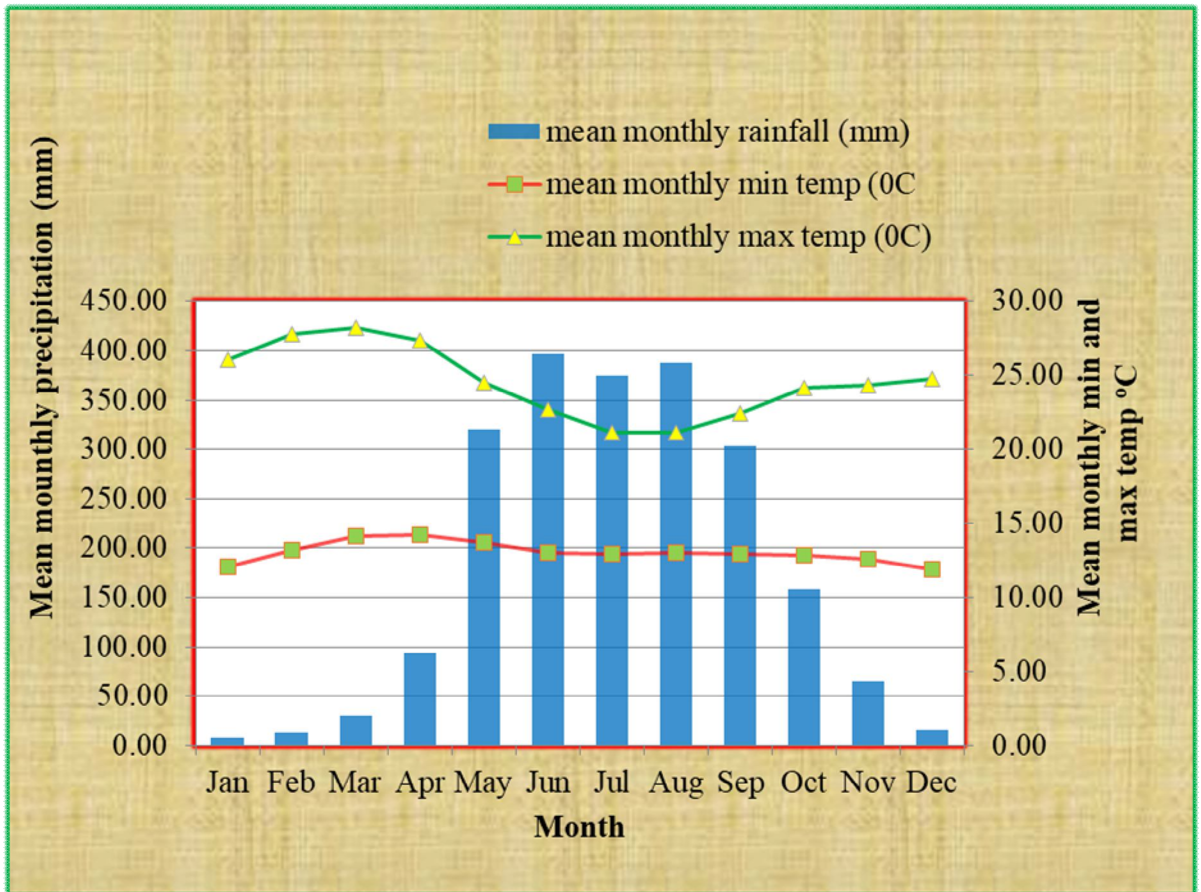

Figure 1: Mean monthly rainfall, maximum and minimum temperatures of the study area for the years 2006 – 2018. (Nekemte Meteorological Station).

Table .1 Soil physicochemical properties of the experimental site before sowing

Properties	Values	Rating	Sources
Clay (%)	30		[26]
Silt (%)	34		
Sand (%)	36		
Textural class	Clay loam		
pH: H_2O	5.52	Strongly acidic	[27]
Organic Carbon (%)	2.21	Medium	[28]
Organic Matter (%)	3.80	Medium	(28)
Total nitrogen (%)	0.19	Low	[27]
Available phosphorus (mg/kg	10.02	Medium	[27]
Available B (ppm)	0.99	Low	[28]

Table 2.The main effect of varieties and NPSB fertilizer rates on mean values of plant height, spike length, number of tillers per plant and number of seeds per spike of bread wheat in Jimma Arjo district

Varieties	Plant heigh (cm)	Spike length (cm)	Number of tillers per plant	Number of seeds per spike
Huluka	76.2b	7.67ab	1.38b	39.27
Ogolcho	82.9a	7.93a	1.70a	38.7
Hidase	72.79b	6.84b	0.92c	38.93
LSD (5%)	3.8364	0.8444	0.29	Ns
NPSB (kg ha^{-1})				
0	58.27d	5.37c	0.37d	28.05b
50	77.74bc	8.33a	1.4bc	42.94a
100	82.5ab	7.94ab	1.64ab	39.65a
150	84.23a	7.95ab	1.82a	42.94a
200	85.9a	8.19ab	1.75ab	41.72a
64/20 Np	75.29c	7.08b	1.02c	39.01a
LSD (5%)	5.4255	1.19	0.41	5.59
CV(%)	7.33	16.69	32.56	15.00

Means followed by different letter(s) in a column and rows are significant at 5% level of probability

Table 3.The main effect of varieties and NPSB fertilizer rates on mean values of thousand seed weight, dry biomass yield, grain yield of bread wheat in Jimma Arjo district

Varieties	Thousand seed weight (g)	Dry biomass yield (Kg ha^{-1})	Grain yield (Kg ha^{-1})	Harvest index (Kg ha^{-1})
Huluka	40.33b	11406.7a	4913.4a	42.68
Ogolcho	44.95a	11095.8a	4455.6a	39.99
Hidase	42.48b	7747.2b	3374.3b	46.99
LSD (5%)	2.26	1834.3	746.13	ns
NPSB (kg ha^{-1})				
0	36.79b	4047d	1598.8d	39.14
50	41.77a	10000bc	3995.2bc	40.29
100	43.97a	11448ab	4848.2bc	50.64
150	44.38a	13140a	5800.7a	44.39
200	44.91a	13751a	5760.1a	41.56
64/20 Np	43.69a	8114c	3483.7c	42.28
-=LSD (5%)	3.20	2594	1055.2	ns
CV (%)	7.87	26.90	25.8	11.6

Means followed by different letter(s) in a column and rows are significant at 5% level of probability

Table 4. Correlation of growth, yield and yield component of bread wheat varieties due to application of blended NPSB fertilizer rates

Variables	SL	Til	KPS	TKW	BM	GY	HI
PH	0.704**	0.847**	0.573**	0.674**	0.821**	0.759**	-0.113
SL		0.689**	0.585**	0.345**	0.623**	0.581**	-0.084
Til			0.485**	0.520**	0.830**	0.762**	0.127
KPS				0.284*	0.526**	0.523**	-0.018
TKW					0.466**	0.441**	0.031
BM						0.940**	-0.158
GY							0.131

* and ** =Significant at the 0.05 and 0.01 probability level. PH=Plant height, SL=spike length, Til=Tiller, PS=Kernel per spikiest=Thousand Kernel Weight=Biomass=Grain Yield, HI=Harvest Index

Table 5. Effects blended NPSB fertilizer rates on economic feasibility of wheat production

NPSB Fertilizer (Kg ha^{-1})	Grain yield (Kg ha^{-}	Adjusted yield (Kg ha^{-1})	Gross field benefit (ETB ha-	Total Variable Cost	Net benefit (ETB ha^{-1})	Value to cost ratio	MRR (%)
0	1598.8	1438.92	43167.6	0	43167.6		
50	3995.2	3595.68	107870.4	777.035	107093.365	137.823	8227
100	4848.2	4363.38	130901.4	1554.07	129347.33	83.2313	2864
150	5800.7	5220.63	156618.9	2331.105	154287.795	66.1865	3210
64/20 NP	3483.7	3135.33	94059.9	2965.26	91094.64	30.7206	D
200	5760.1	5184.09	155522.7	3108.14	152414.56	49.0372	D

labor cost (ETB 80 man-day^{-1}), fertilizers cost (NPSB =1554.07 ETB 100kg^{-1} and urea =1411.19 ETB 100kg^{-1}) and wheat seed cost 25 ETB kg^{-1}, grain price of wheat = 30 ETB kg^{-1}, D=Dominated