**Agricultural and Biological Sciences Journal**
Vol. 6, No. 3, 2020, pp. 137-142
http://www.aiscience.org/journal/absj
ISSN: 2381-7178 (Print); ISSN: 2381-7186 (Online)

# Response of Bread Wheat (*Triticum aestivum* L.) Genotypes to Different Rates of Blended Fertilizer in Horro District, Western Ethiopia

**Desalegn Negasa Soresa*, Pichiah Gomathinayagam**

Department of Plant Sciences, Faculty of Agriculture, Wollega University, Shambu, Ethiopia

## Abstract

Bread wheat (*Triticum aestivum* L.) is an economically important wheat type in Ethiopia, encountering low yield due to minimum use of improved varieties, incidence of diseases, weeds, low soil fertility and lower rate of fertilizer application. Only nitrogen and phosphorous containing fertilizers have been used commonly. The use of economically feasible fertilizer recommendation including micronutrients with different varieties was not studied. Therefore, the study aimed at to identify the effect of blended fertilizers (NPSB) rates on yield and yield components of bread wheat cultivars. It was evaluated during the year 2016/2017 cropping season at Horro District, Western Ethiopia. The experiment was laid out in Randomized Complete Block Design with factorial arrangement in three replications and consisted of three blended fertilizers rate (which contain N, P, S and B) and 12 bread wheat cultivars including one standard check. The results revealed significant ($P<0.05$) main effect of genotypes. Among the yield related parameters genotype ETBW 7208 had the highest number of tillers per plant and productive tillers per square meter, with respect to kernel per spike and thousand kernel weight genotype ETBW 7264 was superior; moreover, genotype ETBW 7182 and ETBW7208 had the highest grain yield of 6.9 and 6.78 t $ha^{-1}$ respectively. In economic feasibility of the fertilizer over genotype combination, the lowest cost of production was recorded in the combination of all genotypes with blended fertilizers $T_2$ (100 kg NPSB with 100 kg Urea fertilizers) and a significance MRR obtained from the combination of ETBW 7252 with fertilizer $T_3$ (125kg blended fertilizer with 100kg of urea) as well as ETBW7182 with $T_1$ (blanket recommendation). In general, the effect of blended fertilizer was not significant on phenology, growth, yield components and grain yield of bread wheat, which might be due to the low level of difference in nutrient amount among treatments and their impact on quality as well as nutritional value needs investigation.

## Keywords

Blended Fertilizers, Interaction, Soil, Yield Component

Received: May 23, 2020 / Accepted: June 11, 2020 / Published online: July 7, 2020



## 1. Introduction

Wheat belongs to the grass family, Poaceae and to the tribe Hordea in which several flowered spikelets are sessile and alternative opposite side of the rachis forming a true spike. Wheat (*Triticum spp.*) is one of the major cereal crop grown in the highlands of Ethiopia and this region is regarded as the largest wheat producer in Sub-Saharan Africa [1]. The raised bread loaf is possible because the wheat kernel contains gluten, an elastic form of protein that traps minute bubbles of carbon dioxide when fermentation occurs in leavened dough, causing the dough to rise [2]. It is the best of the cereal foods and provides more nourishment for humans than any other food source. Wheat is a major diet component because of the wheat plant's agronomic adaptability, ease of grain storage and ease of converting

* Corresponding author
E-mail address: gemechubekam@gmail.com (D. N. Soresa), gomathinayagamprof@gmail.com (P. Gomathinayagam)

grain into flour for making edible, palatable, interesting and satisfying foods. Dough produced from bread wheat flour differ from those made from other cereals in their unique viscoelastic properties [3]. Wheat is the most important source of carbohydrate in a majority of countries. Wheat starch is easily digested, as is most wheat protein. Wheat contains minerals, vitamins and fats (lipids), and with addition of a small amount of animal or legume protein results a highly nutritious food. Predominantly wheat-based diet is higher in fibre than a meat-based diet [4].

Because nitrogen (N) availability is frequently the main determinant of grain yield and protein concentration in wheat, sufficient N should be applied so as not to limit either grain yield or quality [5]. Based on the national soil data base, in addition to the macro-nutrients, due to long year of cultivation, some of the micro-nutrients like zinc, boron and copper are depleted from the soil from the major crop producing area of the country. Balanced fertilization not only guarantees optimal crop production, better food quality and benefits for the growers, but is also the best solution for minimizing the risk of nutrient losses to the environment. Nutrients such as Zn, B, S, and K can often be included relatively cheaply in new fertilizer formula; when targeted to deficient soils, these nutrients can dramatically improve fertilizer-use efficiency and crop profitability. Experience in Malawi provides a striking example of how N fertilizer efficiency for maize can be raised by providing appropriate micronutrients on a location-specific basis [6]. Supplementation by S, Zn, B, and K increased maize yields by 40% over the standard N-P recommendation alone. In fact, grain protein concentration has been shown to increase at N rates above those necessary to support maximum yields. However, excessive plant available N produces wheat plants more prone to lodging and disease development with subsequent reductions in yield and increased input costs [7]. The potential for elevated nitrate levels in ground and surface waters also increases with excessive N fertilizer applications. Late season N applications to wheat have increased nitrogen use efficiency and produced similar yields with fewer totals N by matching N application timing with plant demand [8].

Bulk blending is defined as the mechanical mixing of two or more granular fertilizer materials to produce mixtures containing nitrogen (N), phosphorus (P), potassium (K) and other essential plant nutrients. It allows small batches of high analysis soil and crop specific fertilizers to be mixed and transported in an economical manner contributing additional profit for farmers and improving the environment because it provides balanced fertilization [9] and [10].

In Ethiopian highlands, bread wheat has been produced by small-scale farmers since the introduction of the crop approximately about 5000 years ago. Its production and productivity is declining from time to time because of lack of input like improved seed, enough and recommended amount of fertilizers and management practices [11]. Even though there is national and regional recommendation for fertilizer especially N and P production is not yet constant as the fertility of the soil decrease from time to time due to different cases as limiting due to leaching during the heavy rain, evaporation at the time of hot season and highly used by many plants for many purposes compared to other plant nutrients. Different varieties or genotypes can respond differently to different rate of inorganic fertilizer. Hence, there is a need for evaluation of genotypes to different rates of blending fertilizer (NPSB) for yield performance in order to cope up with promising varieties which could generate high grain yield and quality.

Therefore the objectives of the study was:

To evaluate bread wheat genotypes for different rates of blended (NPSB) fertilizer in Horro district, Western Ethiopia.

## 2. Materials and Methods

Twelve genotypes including one standard check variety selected from 121 first trial, from 36 second trial materials grown in preliminary yield trials at Shambu, Horro Guduru Wollega Zone, Western Ethiopia during 2012 and 2013 cropping season respectively. The materials are originally obtained from Kulumsa Agricultural Research Centre, National wheat Research Coordination Centre. (Table 1) The twelve bread wheat genotypes were promoted based on the yield and other agronomic performances including diseases reactions in the previous season. Trial was conducted in factorial RCBD arrangement in three replications. Thus, 12 wheat genotypes and three rates of NPSB fertilizer also used. (Table 2)

The agronomic and yield data collected and used for evaluation includes: number of tillers, number of Productive tillers, number of spikelets per spike, kernel number per spike, grain yield per plot, Biomass yield and Harvest index were taken for comparisons.

**Table 1.** The experimental materials description and seed source.

| Entry No. | Genotype | Pedigree | Seed Source |
|---|---|---|---|
| 1 | ETBW 7238 | CROW‘S’/BOW’S’3-1994/95//TEVEE’S’/T | IESRRL # 177 |
| 2 | ETBW 7198 | VAN'S/3/CNDR'S'/ANA//CNDR'S'/MUS'S'/ | IESRRL # 84 |

| Entry No. | Genotype | Pedigree | Seed Source |
|---|---|---|---|
| 3 | ETBW 7220 | CHAM-4/SHUHA'S'/6/2*SAKER/5/RBS/AN | IESRRL # 135 |
| 4 | ETBW 7208 | CHAM-4/SHUHA'S'/6/2*SAKER/5/RBS/AN | IESRRL # 110 |
| 5 | ETBW 7252 | SAMAR-8/KAUZ'S'//CHAM-4/SHUHA'S' | IESRRL # 214 |
| 6 | ETBW 7264 | SERI 82/SHUHA'S'// SOMAMA-9 | IESRRL # 268 |
| 7 | ETBW 7215 | CHAM-4/SHUHA'S'/6/2*SAKER/5/RBS/AN | IESRRL # 117 |
| 8 | ETBW 7204 | SHA3/SERI//YANG87-142/3/2*TOWPE | IESRRL # 103 |
| 9 | ETBW 7199 | VAN'S/3/CNDR'S'/ANA//CNDR'S'/MUS'S'/ | IESRRL # 85 |
| 10 | ETBW 7182 | CHIL-1//VEE'S'/SAKER'S' | IESRRL # 58 |
| 11 | ETBW 7227 | IZAZ-2//TEVEE'S'/SHUHA'S' | IESRRL# 164 |
| 12 | Danda'a | Check | Breeder seed |

**Table 2.** Fertilizer rate used as treatment (Kg/ha) for each nutrient composition of the experiment.

| Fertilizer rate | N | P | S | B |
|---|---|---|---|---|
| $T_1$= 80 kg Blended fertilizer (NPSB) + 100 kg urea | 62.4 | 36.8 | 5.8 | 0.57 |
| $T_2$= 100 kg/ha blended fertilizer (NPSB) + 100 kg/ha urea | 64.8 | 38 | 7.3 | 0.66 |
| $T_3$= 125 kg/ha blended fertilizer (NPSB) + 100 kg/ha urea | 68.5 | 47.5 | 9.5 | 0.73 |

N=nitrogen, P = phosphorus, S= sulfur and B= boron.
$T_1$= treatment one, $T_2$= treatment two and $T_3$= treatment three.

# 3. Results and Discussion

## 3.1. Soil Physico-chemical Properties of the Experimental Site

According to the laboratory analysis, the soil texture of the experimental area is clay-silt. The soil texture (proportion of sand, silt and clay in the soil) controls water contents, water intake rates, aeration, root penetration, and soil fertility. The pH of the soil was analysed to be 6.5, which is slightly acidic [12]. The analysis for other soil chemical properties indicated that the experimental soil had values of 0.117%, 1.22%, 11.0 mg $P_2O_5$ /kg soil, 0.39 meq/l $SO_2$, 1.70 mg/kg soil for total nitrogen, organic carbon, available phosphorus, available sulphur and available boron respectively (Table 3).

**Table 3.** Selected physico-chemical properties of the soil of the experimental site before planting.

| No | Soil characters | Method | Values | Rating | Reference |
|---|---|---|---|---|---|
| 1 | Soil texture: | | | | |
| | Sand | | 33.29 | | |
| | Silt | | 18.40 | | |
| | Clay | | 48.30 | | |
| | Texture Class | | Clay loam | | |
| 2 | Bulk density (g cm-3) | | 1.44 | Medium | [12] |
| 3 | pH (by 1: 2.5 soil to $H_2O$ ratio) | Potentiometer | 4.77 | M. acid | [6] |
| 4 | Organic carbon (%) | Walkley black | 1.22 | Low | [12] |
| | Organic matter (%) | Walkley black | 2.10 | Low | [12] |
| | Total nitrogen (%) | From % °C | 0.11 | Low | [12] |
| | CEC (cmol(+) kg-1 of soil) | Ammonium acetate | 7.17 | Low | |
| 5 | Available phosphorus (ppm) | Bray II | 11 | Medium | [8] |
| 6 | Available K (mg kg-1) | | 182 | Medium | [12] |
| 7 | Available Sulfur (meq/l $SO_4$) | | 0.39 | Medium | |
| 8 | Available Boron (mg $kg^{-1}$) | | 1.70 | Medium | [13] |

## 3.2. Analysis of Variance

The result of analysis of variance depicts that genotypes were significantly different (P<0.05) for all characters. This indicates that the genotypes were having different genetic constituents from each other. In other case, levels of NPS fertilizer (keeping Urea level constant, 100+4kg/ha.) shows significant (P<0.05) only for productive tiller per plant and biological yield and the interaction effect of genotype and rate of NPS fertilizer was significant (P<0.05) only for tiller per plant and biological yield. This depicts that most of the characters respond the same level of NPSB fertilizer except for tiller per plant and biological yield.

## 3.3. Yield and Yield Components

**Table 4.** Mean comparison of the genotypes and level of fertilizer (NPSB) for each character.

| Genotypes | PTPP | BY | SPS | GPS | GY | HI | TGW |
|---|---|---|---|---|---|---|---|
| ETBW 7208 | $2.7^{a}$ | $3.2^{a}$ | $15.5^{abcd}$ | $3.25^{abc}$ | $7.4^{a}$ | $0.41^{a}$ | $39^{a}$ |
| ETBW 7182 | $2.68^{ab}$ | $3.1^{a}$ | $16.8^{a}$ | $3.43^{ab}$ | $7.3^{ab}$ | $0.4^{abc}$ | $38^{ab}$ |
| ETBW 7252 | $2.5^{abc}$ | $2.8^{3ab}$ | $15.7^{abc}$ | $3.6^{a}$ | $7.2^{abc}$ | $0.4^{abc}$ | $36.5^{abc}$ |
| Danda'a (check) | $2.35^{bc}$ | 2.8ab | $16.2^{ab}$ | $3.5^{a}$ | $7.1^{abcd}$ | $0.37^{c}$ | $34c^{de}$ |
| ETBW 7181 | $2.33^{bc}$ | $2.67^{ab}$ | $14^{de}$ | $3.2^{abc}$ | $6.8^{de}$ | $0.33^{ed}$ | $33^{de}$ |
| ETBW 7220 | $2.17^{cd}$ | $2.66^{ab}$ | $15^{cde}$ | $3.3^{abc}$ | $6.9^{de}$ | $0.371^{bc}$ | $36^{abcd}$ |
| ETBW 7215 | $2.16^{cd}$ | $2.6^{ab}$ | $13.5^{e}$ | $3.4^{abc}$ | $7.0^{cde}$ | $0.38^{abc}$ | $36.7^{abc}$ |
| ETBW 7238 | $2.01^{d}$ | $2.6^{ab}$ | $15.1^{cde}$ | $3.25^{abc}$ | $7.0^{bcde}$ | $0.36^{dc}$ | $37.2^{ab}$ |
| ETBW 7227 | $1.75^{de}$ | $2.58^{ab}$ | $15.3^{bcd}$ | $3.41^{abc}$ | $7.0^{bcde}$ | $0.41^{abc}$ | $35^{bcde}$ |
| ETBW 7174 | $1.62^{de}$ | $2.57^{ab}$ | $14.8^{bcd}$ | $2.9^{c}$ | $6.7^{e}$ | $0.31^{e}$ | $32.2^{e}$ |
| ETBW 7198 | $1.3^{e}$ | $2.5^{b}$ | $15.6^{abc}$ | $3.5^{ab}$ | $7.01^{abcde}$ | $0.4^{ab}$ | $37^{abc}$ |
| ETBW 7264 | $1.02^{ef}$ | $2.4^{cb}$ | $14.3^{dec}$ | $3^{bc}$ | $7.0^{bcde}$ | $0.43^{a}$ | $32^{e}$ |
| CV% | 8.3 | 22 | 10.7 | 16 | 11 | 13 | 10.3 |
| LSD 5% | 0.51 | 0.56 | 1.5 | 0.51 | 0.32 | 0.05 | 3.4 |
| Rate/level NPSB fertilizer | | | | | | | |
| $T_3$ | 2.82 | 2.7 | 15 | 3.2 | 7.0 | 0.37 | 36.2 |
| $T_2$ | 2.25 | 2.62 | 15.1 | 3.36 | 7.12 | 0.38 | 35.8 |
| $T_1$ | 1.85 | 2.6 | 15.4 | 3.43 | 7. 25 | 0.39 | 35 |
| LSD5% | NS | NS | NS | NS | NS | NS | NS |

PTPP= No. of Productive tillers per Plant; BY = Biological yield; SPS = No. of Spikelets per Spike; GPS=No. of grains per spikelet; GY= Grain Yield; HI= Harvest index; TGW= Thousand grain weight.
$T_3$== 125 kg/ha Blended fertilizer + 100 kg/ha urea; $T_2$= 80 kg/ha Blended fertilizer + 100 kg/ha urea;
$T_1$= 125 kg/ha Blended fertilizer + 100 kg/ha urea, LSD= Least significant difference; CV= Coefficient of variation.

### 3.3.1. No. of Productive Tillers per Plant

The yield of crop is depend upon the combined effect of many factors. Among these factors, the number of tillers per plant has a vital position, controlling yield of wheat. The more the number of tillers, the better will be the stand of crop, which ultimately increase the yield [14].

The analysis of variance for number of tillers per plant and productive tillers per square meter revealed significant ($P < 0.05$) differences among the varieties, but no significant effect was observed due to blended fertilizers and interaction. Data on productive tillers per plant revealed that there was significant difference among the tested genotypes, the level of NPS fertilizer used and so the interaction effect of genotypes and NPS fertilizer used was also showed difference. In productive tiller per plant the genotype ETBW 7208 recorded the highest number (2.7) at the 3rd level (125kg per hectare) of NPSB fertilizer and genotype ETBW 7182 recorded the next (2.68). While, genotype ETBW 7264 and ETBW 7198 recorded the least (1.02 and 1.3) at the 1st NPSB level productive tiller in average. However, highest number of productive tillers per plant (2.82) was recorded for the 3rd level (125+5kg per hectare) of NPSB fertilizer and the lowest number of productive tiller per plant (1.8) was recorded from the 1st NPSB level 75+3kg per hectare. This indicates that as the amount of Phosphorus and Sulfur fertilizer increase, tiller number in wheat also increase. This result is synonym with that of [14]. This might be attributed due to different capacity of genotype in tillering, which was in agreement with [15] who reported significant difference among varieties for tillering.

### 3.3.2. No. of Spikelets per Spike

Data on Spikelet per spike revealed that there is significant difference among the genotypes but not showed significant difference between the NPSB levels of fertilizer used. So the interaction effect of the two factors also not showed difference. This can be due to the level of Nitrogen which is the most determining nutrient was almost not changed. This result is found similar with that of Genotype ETBW 7208 which recorded the highest number of spikelets per spike (16.5) and genotype ETBW 7182 recorded the next (16.2). While genotype ETBW 7264 recorded the least (14.3) productive tiller in average. But comparatively, highest number of Spikelet per spike (15.4) was recorded for the 1st level (125+5kg per hectare) of NPS fertilizer and the lowest number of Spikelet per spike (14.6) was recorded from the 3rd NPS level 75+3kg per hectare even though their difference was not significant. This result is also in agreement with past studies conducted by [15] and [16].

### 3.3.3. No. of Grains per Spikelet

Data from No. of grains per spikelet indicated that the genotype ETBW 7252 recorded high (3.6) and the variety used as a check become the next (3.5) while, genotype ETBW 7264 recorded the smallest number of grains per spike (3.00). Similar to No. of Spikelets per spike, highest number of grains per spike (3.56) was recorded for the 1st level (125kg per hectare) of NPS fertilizer and the lowest number of grains per spike (14.6) was recorded from the 3rd NPS level 75kg per hectare even though their difference was not significant. The results are also found in association with past studies conducted by [15].

### 3.3.4. Biological Yield, Grain Yield, Harvest Index and Thousand Grain Weight

The ultimate goal in crop production is to maximize economic yield, which is a complex function of individual yield components in response to the genetic potential of the cultivars and inputs used. In a broad sense, growth in cereals is directly related to grain yield. Grain yield is the product of the number of grains per unit area and the weight of individual grains [17].

The analysis of variance for above ground biomass, straw yield, and grain yield and harvest index showed significant ($P < 0.05$) difference among varieties while the main effect of blended fertilizer types and the interaction effect of fertilizer and variety were not significant.

Biological yield, grain yield, harvest index and thousand grain weight showed significant difference on the results of analysis of variance for genotypes, biological yield and thousand grain weight for level of NPSB fertilizer and their interaction. Nevertheless, level of NPSB fertilizer and the interaction of fertilizer and genotype was found non-significance for grain yield and harvest index.

The ability of varieties to partition the dry matter into economic (grain) yield is indicated by its harvest index, which was significantly varied among varieties but not by the blended fertilizer and their interaction. Genotype ETBW 7182 had the highest harvest index (0.42) while genotype ETBW 7264 had the lowest harvest index (0.33) (Tab le 4). Similar significant varietal differences on harvest index in rice were reported by [18]. [19] also reported that grain yield is proportional to harvest index and factors which make up grain yields such as grain weight and number of grains per spikelet have a relatively high effect on harvest index. This might be due to inherent differences between the varieties in the yield components like the number of tillers per plant, number of grains per spike and 1000 grain weight. These results are also found similar to those reported by [20], where significant difference obtained with wheat genotypes to nitrogen fertilization on yield and yield components study. [16] noted that wheat varieties significantly differed in grain yield and yield related traits.

The effect of blended fertilizer treatments did not show significant influence on grain yield which might be due to almost constant amount of N fertilizer and lack of substantial difference of the levels of P, S and B among treatments especially P, the major nutrients responsible for grain yield of a crop. Moreover, due to the medium availability of S and the medium availability of B in the soil the response of these micro nutrients is less (Table 3). Similarly, [19] reported that there is no significant difference between the application of 46 and 69 kg $P_2O_5$ $ha^{-1}$ rate on yield and aboveground biomass of wheat. While on the application of boron and zinc with a level of 0, 1, 2 kg $ha^{-1}$ of each nutrient has showed no significant difference on harvest index between the two varieties of wheat [21].

## 4. Conclusion

The yield of crop is depend upon the combined effect of many factors. Among these factors, the production and productivity is declining from time to time because of lack of input like improved seed, enough and recommended amount of fertilizers and management practices. Even though there is national and regional recommendation for fertilizer, production is not yet constant as the fertility of the soil decreases from time to time due to different causes as limiting due to leaching during the heavy rain, evaporation at the time of hot season and highly used by many plants for many purposes compared to other plant nutrients. The ultimate goal in crop production is to attain maximum economic yield, which is a complex function of individual yield components in response to the genetic potential of the cultivars and inputs used. In a broad sense, growth in cereals is directly related to grain yield. Different varieties or genotypes can respond differently to different rate of inorganic fertilizer.

The analysis of variance for above ground biomass, grain yield and harvest index showed significant ($P < 0.05$) difference among varieties while the main effect of blended fertilizer types and the interaction effect of fertilizer and variety were not significant.

Biological yield, grain yield, harvest index and thousand grain weight shows significant difference on the results of analysis of variance for genotypes, biological yield and thousand grain weight for level of NPSB fertilizer and their interaction. However, level of NPSB fertilizer and the interaction of fertilizer and genotype was non-significance for grain yield and harvest index. Data on Spikelets per spike revealed, as there is significant difference among the genotypes but not showed significant difference between the NPSB levels of fertilizer used. Therefore, the interaction effect of the two factors also not showed difference.

Data on productive tillers per plant revealed that there is significant difference among the tested genotypes, the level of NPS fertilizer used and so the interaction effect of genotypes and NPS fertilizer used was also showed difference.

Generally, effect of blended fertilizer treatments did not show significant influence on grain yield which might be due to almost constant amount of N fertilizer and lack of substantial difference of the levels of P, S and B among treatments especially P, the major nutrients responsible for grain yield of a crop. Moreover, due to the medium availability of S and the medium availability of B in the soil the response of these micronutrients is less.

## References


[1] Efrem, B., R. J. Pena and Demisse, M. 2002. Glutenin composition, quality characteristics, and agronomic attributes of durum wheat varieties released in Ethiopia. African Crop Science Journal, 10 (2): 173-182.

[2] Hanson, H., Borlaug, N. E. & Anderson, R. G. 1982. Wheat in the third world. Boulder, Co. USA, West view Press.

[3] Grant, C. A., Stobbe, E. H., and Racz, G. J. 1985. The effect of fall-applied N and P fertilizer and timing of N application on yield and protein content of winter wheat grown on zero-tilled land in Manitoba. Can. J. Soil Sci. 65: 621-628.

[4] Johnson, V. A., Briggle, L. W., Axtel, J. D., Bauman, L. F., Leng, E. R. & Johnston, T. H. 1978. Grain crops. In M. Milner, N. S. Scrimshaw & D. I. C. Wang, eds. Protein resources and technology, p. 239-255. Westport, CT, USA, AVI Publishing.

[5] Olsen S. R., C. W. Cole, F. S. Watanabe, and L. A. Dean, 1976. Estimation of available phosphorus in soils by extraction with sodium bicarbonate, circular 939, US. Department of Agriculture.

[6] Jones, J. B., 2003. Agronomic Handbook: Management of Crops, Soils, and their Fertility.

[7] Crook, M. J., and Ennos, A. R. 1995. The effect of nitrogen and growth regulators on stem and root characteristics associated with lodging in two cultivars of winter wheat. J. Exp. Bot. 46: 931-938.

[8] FAOSTAT (The Food and Agriculture Organization Corporate Statistical Database). 2013.

[9] Ghulam M. L. Fateh C. O., Shamasuddin T., Allah Wadhayo G., Muzzammil H. S., Allah W. o J. And Sono M. O. 1982. Growth, yield and nutrient uptake of various wheat cultivars under different fertilizer regimes. Sarhad J. Agric, Vol. 26, No. 4: 489-497.

[10] Farina M. 2011. An assessment of the current status of soil test calibration studies, regional laboratory efficiency, soil acidity management, and the soil fertility research agenda of federal and regional research institutes. Ministry of Agriculture Addis Ababa, Ethiopia.

[11] Genene Gezu, 2003. Yield and quality response of bread wheat varieties to rate and time of nitrogen fertilizer application in Kulumsa, Southeastern Ethiopia. An M.Sc. Thesis Presented to the School of Graduate Studies of Alemaya University, Alemaya.

[12] Tekalign T., 1991. Soil, plant, water, fertilizer, animal manure and compost analysis. Working Document No. 13. International Livestock Research Center for Africa, Addis Ababa.

[13] FAO (Food and Agricultural Organization of the United Nations), 2002. Organic agriculture, environment and food security. Scialabba N. E. and C. Hattam (eds.). Non-certified organic agriculture in developing countries p 122 box 6.

[14] Beena S., Hasina G, Amir Z. K., Nishat L. B. and Ayub K. 2012. Growth factors and straw yield of wheat cultivars in reaction with Nitrogen and sulfur fertilization. ARPN journal of Agricultural and biological science. Vol. 7, No 1: 13-21.

[15] Suleiman A. A., Nganya J. F. and Ashraf M. A. 2014. Effect of Cultivar and Sowing Date on Growth and Yield of Wheat (Triticum aestivum L.) in Khartoum, Sudan: Journal of Forest Products & Industries, 3 (4): 198-203.

[16] Kelley, K. W. 1993. Nitrogen and foliar fungicide effects on winter wheats. J. Prod. Agric. 6: 53-57.

[17] Esayas L, 2015. Effects of Blended Fertilizer on Yield and related Traits of Duram Wheat Varieties in Central Ethiopia. M.Sc. Theses. Haramaya University, Ethiopia.

[18] Brain, V. O., 2005. Rice yield components as affected by Cultivar and Seeding rate, University of Missouri - Columbia, Delta Research Centre, Columbia.

[19] Ortiz-Monasterio J. I., R. J. Pena, K. D. Sayre and S. Rajam, 1997. CIMMYT's genetic progress in wheat grain quality under four nitrogen rates. Crop Science, 37 (3): 892-898.

[20] Stoddard, F. L., and Marshall, D. R. 1990. Variability in grain protein in Australian hexaploid wheat. Aust. J. Agric. Res. 41: 277-288.

[21] Debnath, M. R., Jahiruddin M., Rahman, M. M. and Haque, M. A. 2011. Determining optimum rate of boron application for higher yield of wheat in Old Brahmaputra Floodplain soil. J. Bangladesh Agril. Univ. 9 (2): 205–210.