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RESEARCH ARTICLE

Evaluation of inorganic fertilizer rate on different bread wheat (*Triticum aestivum*) varieties at Kofele, Ethiopia

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Wheat is one of the globally produced and marketed cereal crops which cover 15% of the total sowing areas of cereal crops in the world. The low productivity of wheat in Ethiopia is mainly attributed to lack of improved agronomic practices. Nitrogen and phosphorus are the major important elements for crop yield. But there is lack of information on optimum fertilizer rate for wheat production in this area (Kofele district of West Arsi zone). Therefore, the objective of this research was to determine the optimum nitrogen and phosphorus fertilizer rate for wheat at Kofele district. This experiment was conducted for two consecutive years in 2016 and 2017 main cropping season. The treatment has two factors (three bread wheat varieties: Digalu, Dendea and Didase and fertilizer rates: 100 kg/ha of urea and 150 kg /ha of DAP, 150 kg/ha of urea and 225 kg/ha of DAP, 200 kg/ha of urea and 300 kg/ha of DAP and 100 kg/ha of urea and 181 kg/ha of NPS). The analyzed data indicated that plant height and seeds per spike of bread wheat was highly significantly affected by main effect of variety. Highest plant height (128.33 cm) and seeds per spike (42.1) were recorded from variety Dendea. Spike length was significantly affected by main effect of variety. The longest spike length (8.3) was recorded from variety Hidase. Wheat grain yield was significantly affected by interaction effect at ($p<0.05$). Variety Hidase produced the highest grain yield of 6904.4 kg/ha at 200 kg/ha of urea and 300 kg/ha of DAP. Above ground dry weight of wheat was significantly affected by interaction effect. The highest above ground dry weight 18869 kg /ha of wheat was produced from variety Digalu at 100 kg/ha of urea and 150 kg/ha of DAP. Therefore, to get the highest benefit farmers should grow variety Hidase by applying 200 kg/ha of urea and 300 kg/ha of DAP at this area.

Keywords: Grain Yield, Variety, Bread wheat, Fertilizer rate, Plant height.

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important of the cereal crops in the world. Wheat is thought to have first been cultivated in the Middle East spreading from Jordan, Palestine, and Lebanon to Syria, Turkey, Iraq, and Iran (Arzani and Ashraf, 2017). This crop is the staple food for most of the temperate and sub-tropical regions of the world. The most important of use of wheat is the flour for making bread, biscuits, cookies, chapatti, etc. Industrially, it is used in preparation of starch, gluten, malt, and distilled spirit. Wheat bran is rich in protein and used as valuable livestock feed. From straw corrugated board is prepared.

Wheat is one of the globally produced and marketed cereal crops which cover 15% of the total sowing areas of cereal crops in the world (Kiss, 2011). It is an important industrial and food grain which ranks second among the most important cereal crops in the world after rice and traded internationally (Asadallah, 2014 and Falola et al., 2017). In the marketing year of 2022/2023, the global production volume of wheat amounted to over 781 million metric tons. This was an increase as compared to the previous marketing year. China, India, and Russia are the three largest wheat producers in the world, accounting for about 41% of the world's total wheat production.

Ethiopia is one of the largest wheat producers in terms of total wheat area cultivated and total production. Wheat and wheat products represent 14% of the total calorie intake. Annual wheat production of Ethiopia is estimated to be 5,780,131 tons/ha in 2020/21 cropping season (CSA, 2012). The national wheat productivity is 2.89 tonn/ha (USDA, 2023) which is low compared to some other countries. The low productivity of wheat in Ethiopia is attributed to low soil fertility, lack of access to improved varieties, no improved agronomic practices and drought (Hei et al. 2017 and Semahegn et al. 2021).

In Ethiopia, wheat grain is used for preparation of food and local beverages like the traditional staple pancake ("injera"), bread ("dabo"), local beer ("tella"), and several others local food items (*i.e.,* "dabokolo","ganfo", "kinche") and its straw is used for animal feed and roof thatching.

West Arsi zone is the main producer of wheat in Ethiopia (Minot et al., 2015)]. Like other regions of Ethiopia yield of wheat is also low in West Arsi zone. This is mainly due to low management of soil fertility. Nitrogen and phosphorus are the major important elements for crop yield including wheat yield increment. But there is lack of information on optimum fertilizer rate for wheat production in this area (Kofele district of West Arsi zone). Therefore the aim of this research is to determine the optimum nitrogen and phosphorus fertilizer rate for wheat at Kofele district.

Materials and Methods

Study sites description

This Experiment was conducted for two consecutive years in 2016 and 2017 main cropping season. This experiment was conducted in Oromia regional state Kofele district in Kulumsa Agricultural Research Center (KARC) sub-station compound. This site is located at 07º04'27''N latitude and 38º46'45''E longitude, 2660 meters above sea level. The distance from capital city of Ethioipia (Addis Ababa) is 274 kilometers. The average annual minimum and maximum temperatures area are 7.9°C and 16.6°C, respectively. The area has bimodal rain fall distribution and receives annual rain fall of 1211 mm (Tamene, 2017). Soil type of the area is pellic vertisol (IUSS Working Group WRB, 2014).

Experimental design and treatments

The treatment has two factors (three bread wheat varieties: Digalu, Dendea and Hidase and fertilizer rates: 100 kg/ha of urea and 150 kg /ha of DAP, 150 kg/ha of urea and 225 kg/ha of DAP, 200 kg/ha of urea and 300 kg/ha of DAP and 100 kg/ha of urea and 181 kg/ha of NPS). Variety was assigned to main plot while fertilizer rate was assigned to sub-plot. The experiment was conducted in randomized complete block design with split plot treatment arrangements and replicated three times (Table 1).

Table 1. Source of seeds.

Varieties	Source	Year of release
Digalu	Kulumsa Agricultural Research Center	2005
Dendea	Kulumsa Agricultural Research Center	2010
Hidase	Kulumsa Agricultural Research Center	2012

Experimental procedures

The field was ploughed by disc plough and harrowed using tractor before planting. Then it was leveled manually using hand tools.

Recommended seed rate of wheat (125 kg ha^{-1}) was used for this experiment. The crop was planted in row in which the inter row spacing was 20 cm and seeds was drilled by hand.

Growth parameters and yield data collection

The collected growth parameters were, yield and yield components were plant height, spikes per 50 centimeter, spike length, seeds per spike, grain yield, above ground dry weight and Harvest Index (HI). Hectoliter Weight (HLW) was recorded as quality parameter.

Statistical analysis

The collected data was subjected to Analysis Of Variance (ANOVA) using SAS software 10 (SAS Institute Inc. 2004). Significant difference among treatment means were assessed using the Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Agronomic parameters and yield

The analyzed data indicated that plant height of bread wheat was highly significantly affected by main effect of variety ($p<0.01$). The highest plant height (128.33 cm) was recorded from variety Dendea whereas; variety Hidase produced the shortest plant height of 119.25 cm. This result is similar to the finding of Jemal, et al., who reported that plant height was significantly affected by variety. This is the result of genetic variation among different varieties. But plant height of bread wheat was not significantly affected by fertilizer rate and interaction effect. This indicates that plant height is affected mainly by wheat genetics than fertilizer rate. Similarly, seeds per spike of wheat was highly significantly affected by variety ($p<0.01$) and not significantly affected by fertilizer rate and interaction effect. The highest number of seeds per spike was recorded from variety Dendea, which is 42.1 seeds/spike of wheat. Variety Digalu produced the lowest number of seeds per spike which is 39.2 seeds/spike of wheat. This result is in agreement with Jemal, et al., who reported that varieties showed significant difference with respect to the number of kernels per spike.

Number of spikes per 50 centimeter was significantly affected by main effect of variety ($p<0.05$). The highest number of spikes per 50 centimeter was recorded from variety Hidase, which is 72.7. But, number of spikes per 50 centimeter was not significantly affected by main effect fertilizer rate and interaction effect.
Similar to that of number of spikes per 50 centimeter, spike length was significantly affected by main effect of variety ($p<0.05$). The highest spike length was recorded from variety Hidase (8.3 cm). But, spike length was not significantly affected by main effect fertilizer rate and interaction effect. This is in line with the finding of Amare and Mulatu who reported that spike length was significantly affected by bread wheat variety (Table 2).

Table 2. Effect of variety and fertilizer rate on plant height in centimeter (PH), Spikes Per 50 centimeter (SP), Spike Length in centimeter (SL) and Seeds per Spike (SS) of wheat at Kofele district.

Variety	PH	SP	SL	SS
Digalu	121.9B	64.3B	6.4B	39.2C
Dendea	128.33A	69.8A	8.2A	42.1A
Hidase	119.25B	72.7A	8.3A	40.8B
LSD	**	*	*	**
Fertilizer rate		4.9801		
100 kg urea and 150 kg DAP	122.89	70.022	7.6	40.6
150 kg of urea and 225 kg of DAP	122.78	67.467	7.7	40.2
200 KG of urea and 300 kg of DAP	124.44	67.467	7.6	40.8
100 kg of urea and 181 kg of NPS	122.56	70.800	7.6	41.2
LSD	ns	ns	ns	ns
CV	4.82	7.80	10.37	4.33

Note: Within each column, means with different letters are significantly different at $p < 0.05$; *(significantly different), ** (highly significantly different).

Wheat grain yield was significantly affected by main effects of variety, fertilizer rate and interaction effect at ($p<0.01$), ($p<0.05$) and ($p<0.05$), respectively. Among varieties variety Hidase gave the highest grain yield which is 5119.4 kg/ha. From the fertilizer rates 100 kg/ha of urea and 150 kg/ha of DAP gave higher grain yield (6187.2 kg/ha) of bread wheat. Variety Hidase produced the highest grain

yield of 6904.4 kg/ha at 200 kg/ha of urea and 300 kg/ha of DAP. This may be due to the highest number of spikes variety Hidase gave per a unit area than other varieties (Table 3). The lowest grain yield (3178.8 kg/ha) was recorded from variety Digalu at 200 kg/ha of urea and 300 kg/ha of DAP. This could be due to lowest number of seeds this variety produced. This study is agreed with the finding of Rut, et. al., who reported that grain yield of wheat was significantly affected interaction effect of variety and fertilizer rate. Above ground dry weight of wheat was significantly affected by main effect of fertilizer rate and interaction effect at ($p<0.05$) but, was not significantly affected by variety (Figure 1). The highest above ground dry weight 18869 kg/ha of wheat was produced from variety Digalu at 100 kg/ha of urea and 150 kg/ha of DAP. Harvest index was significantly affected by variety but not significantly affected by fertilizer rate at ($p<0.01$). Variety Hidase and variety Digalu gave the highest (38.6) and lowest (30.5) harvest index, respectively (Figure 2).

Table 3. Effect of variety and fertilizer rate on Grain Yield in kilogram (GY), above ground dry weight in kilogram BY), Harvest Index (HI) and Hectoliter Weight (HLW) of wheat at Kofele district.

Variety	GY	BY	HI	HLW
Digalu	4476.1B	14658	30.5C	73.500
Dendea	5877.2A	16498	35.5B	72.758
Hidase	6399.3A	16666	38.6A	73.817
LSD	**	ns	**	ns
Fertilizer rate				
100 kg urea and 150 kg DAP	6187.2A	17991A	34.781	74.0A A
150 kg of urea and 225 kg of DAP	5358.9B	14657B	36.443	73.4A
200 KG of urea and 300 kg of DAP	5013.7B	14798B	36.443	72.0B
100 kg of urea and 181 kg of NPS	5777.1AB	16318AB	35.323	73.8A
LSD	*	*	ns	*
CV	13.96	14.61	7.34	1.81

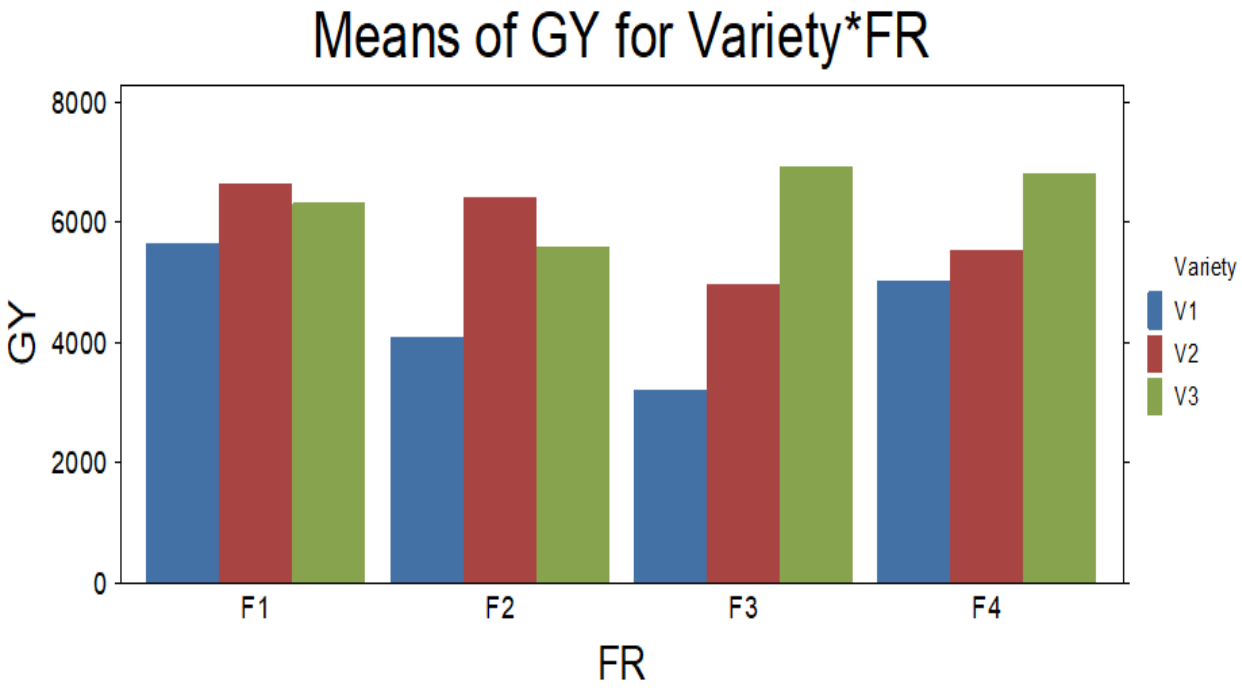

Fig. 1. Interaction effect of varieties and fertilizer rate on grain yield of bread wheat.

Note: F1: 100 kg urea and 150 kg DAP; F: 2150 kg of urea and 225 kg of DAP; F3: 200 KG of urea and 300 kg of DAP; F4: 100 kg of urea and 181 kg of NPS V1: Digalu; V2: Dendea; V3: Hidase.

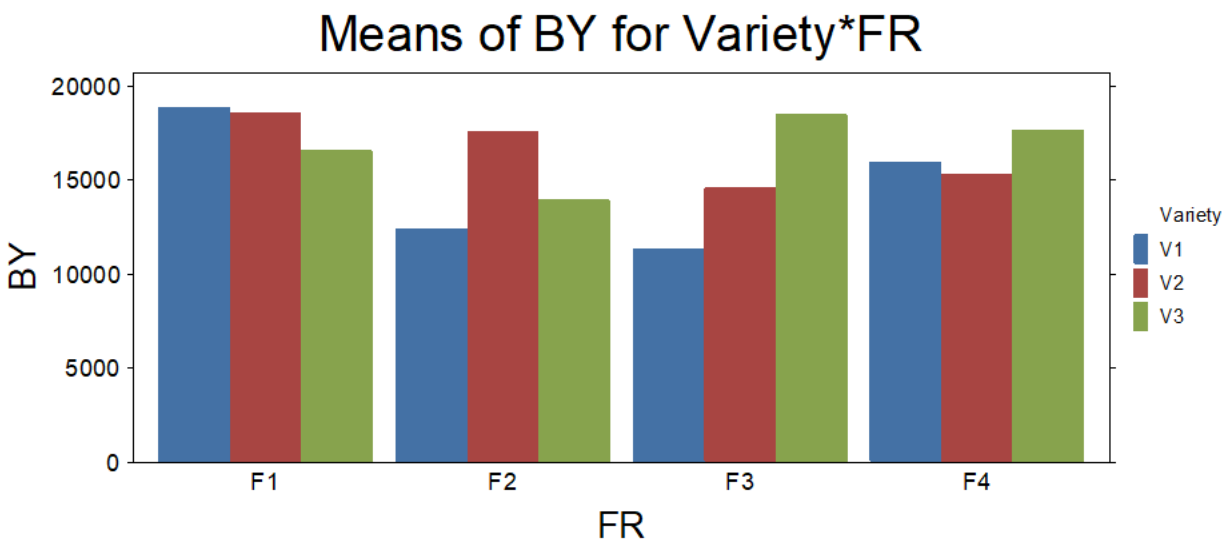

Fig. 2. Interaction effect of varieties and fertilizer rate on above ground dry weight of bread wheat.

Note: F1: 100 kg urea and 150 kg DAP; F: 2150 kg of urea and 225 kg of DAP; F3: 200 KG of urea and 300 kg of DAP, F4: 100 kg of urea and 181 kg of NPS V1: Digalu; V2: Dendea; V3: Hidase.

Conclusion

Wheat is an important cereal crop which covers 15% of the total sowing areas of cereal crops in the world. The three leading countries in wheat production are China, India, and Russia. Ethiopia is one of the largest wheat producers in terms of total wheat area cultivated and total production. The low productivity of wheat in Ethiopia is attributed to low soil fertility, lack of access to improved varieties, no improved agronomic practices and drought. Like other regions of Ethiopia yield of wheat is also low in West Arsi zone. This is mainly due to low management of soil fertility. Nitrogen and phosphorus are the major essential nutrient for crop yield. Therefore the objective of this research is to evaluate nitrogen and phosphorus fertilizer rate for wheat at Kofele district. This Experiment was conducted for two consecutive years in 2016 and 2017 main cropping season in Kofele district in Kulumsa Agricultural Research Center (KARC) sub-station compound. The analyzed data indicated that plant height and seeds per spike were highly significantly affected by main effect of variety while number of spikes per 50 centimeter and spike length were significantly affected by main effect of variety. The highest plant height (128.33 cm) and seeds per spike (42.1) were recorded from variety Dendea. But, the highest number of spikes per 50 centimeter (72.7) and highest spike length (8.3) were recorded from variety Hidase. Wheat grain yield was highly significantly affected by main effect of variety and significantly affected by main effects fertilizer rate and interaction effect. Variety Hidase produced the maximum grain yield of 6904.4 kg/ha at 200 kg/ha of urea and 300kg/ha of DAP. Above ground dry weight of wheat was significantly affected by main effect of fertilizer rate and interaction effect while, harvest index was highly significantly affected by main effects variety only. Accordingly the highest above ground dry weight (18869 kg/ha) was produced from variety Digalu at 100 kg/ha of urea and 150 kg/ha of DAP. Variety Hidase gave the highest (38.6) harvest index. According to this study, growing variety Hidase by applying 200 kg/ha of urea and 300 kg/ha of DAP at this area is advantageous than other at this district and similar agro ecological areas.

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