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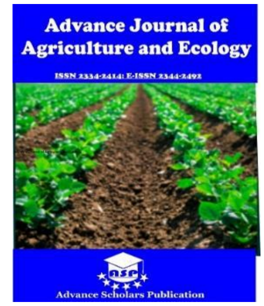


# RESPONSE OF TWO WHEAT (TRITICUM AESTIVUM L.) VARIETIES TO NITROGEN FERTILIZER RATES AT MAIDUGURI, SUDAN SAVANNA ECOLOGICAL ZONE, NIGERIA

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***Key words:*** *N Fertilizer, Wheat Varieties, Growth and Yield Parameters*

***Abstract:*** *Field trials were conducted at the Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri during 2019/2020 and 2020/2021 dry seasons to determine the effects of nitrogen fertilizer rates on growth and yield of wheat varieties. The treatments consisted of five rates of nitrogen (N) fertilizer (0, 120, 140, 160 and 180 kg $ha^{-1}$) and two wheat varieties (Kauz and Pastor). The experiment was laid out in a Randomized Complete Block Design replicated three times. The parameters measured were plant height, number of leaves per plant, total dry matter per plant, and number of spikelets per spike, number of grains per plant and grain yield per hectare. The results showed that application of N at 140kg $ha^{-1}$ recorded taller plants with more leaves than the control, while application of 160 kg $ha^{-1}$ recorded higher dry matter, significant increase in number of grains and grain yield but the number of spikelets were comparable to other N rates, except the control which was lower. Based on the findings of this research there were no significant differences in the application of N fertilizer at 160 and 180 kg $ha^{-1}$ for most of the parameters evaluated, therefore, the application of N at 160 kg $ha^{-1}$ and any of the variety (Kauz or Pastor) is being recommended for optimum wheat production in the Sudan savanna of Nigeria.*

## Introduction

Wheat (Triticum aestivum L.) is a cereal crop of the Graminaceae family, which include important cereal crops such as rice, maize, oats, sorghum, etc. (Belderok et al., 2002). It originated from the Levant region near

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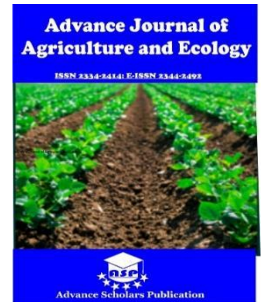


Ethiopian highlands but now cultivated Worldwide. Wheat is foremost among cereals and as a main source of carbohydrates and protein for both human beings and animals, it contains starch (60-90%), protein (11-16%), fat (1.5-2%) and vitamins (B-complex and vitamin E (Ayala et al., 2011). Wheat production covers global land area of more than 240 million hectares. The United States Department of Agriculture (USDA, 2016) projected that the global wheat production for 2016/2017 was744.72 million metric tons. The major producing countries and their yield values in metric tons include; European Union (143,574), China (128,000), India (90,000) and the United States of America (57,961). In Africa, Egypt tops the production list with an average yield of 8,800 metric tons (USDA, 2016). Wheat is an important crop in Nigeria, because the domestic consumption is 4,200,000 metric tons (LCRI, 2014), and Nigeria spends over US$4.0 billion foreign exchange annually on its import, but national production is only 300, 000 metric tons (LCRI, 2016). Thus, domestic production must be encouraged. Wheat differs from other cereals because of the high gluten 2 content in its grain which offers its flour special quality and dietary (nutritional), and medicinal values. It is extensively used for multifarious baked, fried and cooked products globally. Nitrogen is one of the key nutrients that limit crop growth of cereals in many production systems (Yilmaz et al., 2014), a key factor in achieving optimum grain yield (Ooroet al., 2011). The most important factor influencing grain yield of wheat was N fertilizer (Usman, 2020) because Nitrogen increased grain yield primarily by increasing the number of mature spikes (Campbell and Davidson, 1978). The content of protein compositions, gluten and glutenin macro-polymer (GMP) increased with an increase of N level (Yang, 2022). The importance of N fertilization in increasing wheat production has been well recognized but still it is difficult to determine the quantities to apply under water deficit conditions (Akram et al., 2014). The combined use of NPK fertilizers plays an important role in wheat production. Application of NPK in balanced share at proper time has great impact on wheat yield. Plant species, even varieties with in species vary in their behaviour to obtain and utilize NPK for grain production, (Malghani et al., 2010). In view of the above, wheat varieties have been developed with high potentials to meet our demands and also eradicate malnutrition. There is the need to conduct research in order to test different rates of N fertilizer above the recommended rate (120 kg ha$^{-1}$) in the study area on the growth and yield of wheat and to test for the productivity of two recently developed wheat varieties.

## MATERIALS AND METHODS

### Experimental site

The experiment was conducted during the dry season between the months of December, 2019 to March 2020 and December 2020 to March, 2021 at the Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri (Latitude

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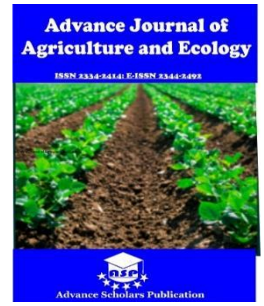


11.50'N and Longitude 13.40$^{o}$E, 350 m above sea level). The area is characterized by natural vegetation with sparse trees dominated by shrubs and grasses (Abubakar, 2002). It is also characterized by short and erratic rainfall (500 – 800 mm/annum), usually falling between the months of June and September, minimum and maximum temperature range from 16.8 – 41.3 °C and a reddish-brown soil, generally, described texturally as sandy and sandy loam with low organic matter content (Kabura et al., 2009; Muktar, 2021).

**Treatments and experimental design**

The treatments consisted of five Nitrogen rates (0, 120, 140, 160 and 180 kg ha$^{-1}$ while maintaining P and K at 60 kg ha$^{-I}$ each)and two varieties of wheat ((LACRIWHIT 9 (Pastor) and LACRIWHIT 10 (Kauz)) which were laid out in a Randomized Complete Block Design (RCBD) in three replications. Individual plots measured 2.0m x 2.0m (4.0 m$^{2}$) separated by an alley of 1.0 m between replicates and 0.5 m between plots. The seeds of varieties (LACRIWHIT 9 (Pastor) and LACRIWHIT 10 (Kauz)) were obtained from the Lake Chad Research Institute, (LCRI), Maiduguri.

**Land preparation and crop management**

The experimental site was cleared, harrowed and pulverized to enable water infiltration the root for proper growth. The field was prepared into gross plots measuring 2 x 2m (4m$^{2}$) and net plots of 2m x 0.8m (1.6m$^{2}$) and soil sample of the experimental site was collected and taken to soil science laboratory for physico-chemical analysis. Plots were irrigated to field capacity in the evening hours for three consecutive days before sowing. The seeds were sown using row drilling method at an inter-raw spacing of 40 cm in the evenings of 7$^{th}$ December, 2019 and 2$^{nd}$ December, 2020. The plots were initially irrigated daily for two weeks using watering can to enable good stand establishment, thereafter, irrigation scheduling was changed to two-day irrigation interval. Basal application of NPK fertilizer (20: 10: 10) was applied as per treatment at two split doses (3 and 6 weeks after sowing.$P_2O_5$ and $K_2O$ were applied at 60 kg ha$^{-I}$ each to all plots with the exception of the control treatments while Urea (46% N) was applied to balance for N where necessary. Weeding was carried out at 3 and 6 weeks after sowing (WAS) and this was done manually using a hoe. Ants were the most common pest noticed with devastating effect at seedling stage (2–3 WAS) and were controlled using Rambo insecticide powder. Harvesting was done manually at 13WAS using a sickle when the crop has reached maturity. Matured crops were indicated by browning and drying of leaves and grains became hard.

**Data collection and analysis**

**Plant height** (cm): The plant height was measured using a meter rule from the ground level to the tip of the tallest leaf from five randomly tagged plants in each plot at 8 WAS and the average height calculated recorded.

**Number of leaves per plant**: Number of leaves of five randomly tagged plants in each plot

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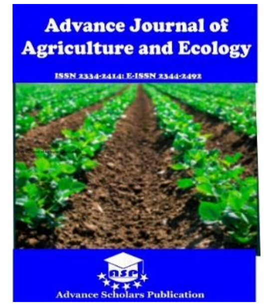


at 8 WAS were counted and the mean values were computed.

**Total dry matter per plant** (g): Three crops from each plot were up rooted and oven dried at constant temperature of 75 °C. The average dry weight for each plot was computed and recorded.

**Number of spikelets per spike:** This was obtained by counting the number of spikelet from twenty randomly sampled plants using a 0.5 $m^2$ quadrant and the averages were recorded.

**Number of grain per plant:** This was determined at harvest by counting the number of grains obtained from the twenty sampled plants after threshing and winnowing within the unit area and the value was divided by the total number of plants.

**Grain yield (kg per hectare):** This was determined after crops were harvested, threshed, winnowed and weighed on an electronic balance (MP 1002) and the result obtained from each net plot was later converted to per hectare basis.

Thus; Grain yield (kg ha$^{-1}$) =

$$\frac{\text{Grain yield/net plot} \times 10{,}000\ m^2}{\text{Net plot area } (m^2)}$$

Data collected were subjected to analysis of variance (ANOVA) to test for significant differences among the means using GENSTAT17$^{th}$ Edition. The treatment means were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability.

**RESULTS AND DISCUSSION**

Table 1 shows the effect of N fertilizer on plant height, number of leaves per plant and total dry matter per plant of two wheat varieties at Maiduguri for Combined 2019/2020 and 2020/2021 dry seasons. The result showed that taller plants were recorded on the application of N fertilizer at140 kg ha$^{-1}$ which were similar to application of 160 and 180 kg ha$^{-1}$. Similarly, number of leaves per plant was also affected by N fertilizer. Each increase in fertilizer from the control up to 140 kg ha$^{-1}$ resulted in significant increase in number of leaves of wheat. However, increase in fertilizer from 140 – 160 kg ha$^{-1}$ had no significant increase in this parameter. Further increase to 180 kg ha$^{-1}$ recorded comparable number of leaves to 160 but lower than 140 kg ha$^{-1}$. The result on dry matter per plant was also significantly affected on application of N fertilizer. The application of 160 and 180 kg ha$^{-1}$ resulted in higher but similar dry matter which were comparable to the application of 140 kg ha$^{-1}$ N. Significant interaction between N fertilizer rate and the varieties was observed at the plant dry matter. Table 2 shows the interaction between N fertilizer rate and wheat varieties on dry matter. The result shows that the interaction between N fertilizers at 60 kg ha$^{-1}$ and the two varieties (Kauz and Pastor) recorded the highest dry matter while the lowest dry matter was recorded at the untreated control by both varieties. This result showed that the plants height, number of leaves per plant and plant dry matter increased with increase in N. The result corroborated Maqsood et al., (1999); Maqsood et al., (2001) and Ayub et al., (2002) who also recorded higher growth parameters on application of N on cereals (maize, wheat). Table

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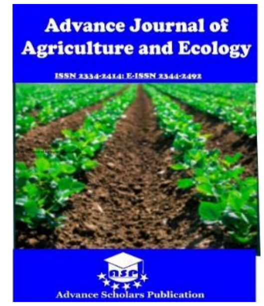


3 shows the effect of N fertilizer on number of spikelet per spike, number of grains per plant and grain yield per hectare of two wheat varieties at Maiduguri for Combined 2019/2020 and 2020/2021 dry seasons. The result showed that higher number of spikelet were recorded on application of N fertilizer at 160 which were at par with application of 120, 140 and 180 kg ha$^{-I}$ while the control recorded the lowest number of spikelet. The result further showed that the number of grains per plant was significantly affected by application of fertilizer. Each increase in N fertilizer rate from 0 - 160 kg ha$^{-I}$ resulted in significant increase in number of grains. Further increase in fertilizer rate had no effect on this parameter. The result on grain yield was also significantly affected on application of N fertilizer. Within similar vein the application of 160 and 180 kg ha$^{-I}$ recorded higher but similar grain yield per hectare while the control recorded the lowest. Significant interaction between the N fertilizer rate and the varieties was recorded at the grain yield. Table 4 shows the interaction between N fertilizer rate and wheat varieties on grain yield per hectare. The result shows that the interaction between N fertilizer (160 kg ha$^{-I}$) and the two varieties (Kauz and Pastor) recorded the highest grain yield while the lowest yield were recorded at the untreated control by variety Kauz. The increase in N fertilizer rates which resulted in increase in yield parameters were earlier reported by Maqsood et al. (1999); Ashgar et al. (2010) and Yang et al. (2022) who concluded that grain yield of maize and other cereals increased with the increase in N.

**Table 1.** Effect of nitrogen (N) fertilizer on plant height, number of leaves per plant and total dry Matter per plant of wheat varieties at Maiduguri for Combined 2019/2020 and 2020/2021 dry seasons.

| **Treatment** | **Growth Parameters** | | |
|---|---|---|---|
| | Plant height (cm) | Number of leaves plant$^{-1}$ | Total dry matter plant$^{-1}$ (g) |
| N fertilizer (F) (kg ha$^{-1}$) | | | |
| 0 | $33.75^{b}$ | $6.28^{c}$ | $19.12^{b}$ |
| 120 | $36.23^{b}$ | $6.87^{b}$ | $19.68^{b}$ |
| 140 | $47.13^{a}$ | $7.67^{a}$ | $20.03^{ab}$ |
| 160 | $46.48^{a}$ | $7.23^{ab}$ | $20.92^{a}$ |
| 180 | $50.25^{a}$ | $6.87^{b}$ | $20.95^{a}$ |
| SE± | 1.774 | 0.232 | 0.512 |
| Variety (V) | | | |
| Kauz | 42.07 | 6.92 | $20.07^{b}$ |
| Pastor | 43.47 | 7.05 | $20.71^{a}$ |
| SE± | 1.122 | 0.470 | 0.281 |
| Interaction | | | |
| F × V | NS | NS | ** |

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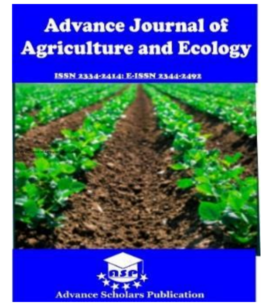


Means followed by the same letter(s) are not significantly different according to DMRT.
NS = not significant, ** = highly significant at 5% probability level.

**Table 2:** Interaction between N fertilizer rates and Wheat varieties on dry matter at Maiduguri, 2019/2020 dry season

| Treatment | N Fertilizer (F) (kg $ha^{-1}$) | | | | |
|---|---|---|---|---|---|
| Variety | 0 | 120 | 140 | 160 | 180 |
| Kauz | $15.03^{c}$ | $15.63^{abc}$ | $16.83^{ab}$ | $17.07^{a}$ | $16.30^{abc}$ |
| Pastor | $15.20^{bc}$ | $15.73^{abc}$ | $16.57^{abc}$ | $17.27^{a}$ | $15.77^{abc}$ |
| SE± | 0.724 | | | | |

Means followed by the same letter(s) are not significantly different according to DMRTat 5% Probability level.

**Table 3:** Effect of nitrogen (N) fertilizer on number of spikelet per spike, number of grains per plant and grain yield per hectare of two wheat varieties at Maiduguri for Combined 2019/2020 and 2020/2021 dry seasons.

| **Treatment** | **Yield Parameters** | | |
|---|---|---|---|
| | Number of spikelets $spike^{-1}$ | Number of grains $plant^{-1}$ | Grain yield (kg $ha^{-1}$) |
| N fertilizer (F) (kg $ha^{-1}$) | | | |
| 0:0:0 | $6.65^{b}$ | $44.4^{d}$ | $396.7^{d}$ |
| 120 | $7.90^{ab}$ | $72.2^{c}$ | $612.2^{c}$ |
| 140 | $7.87^{ab}$ | $113.3^{b}$ | $896.2^{b}$ |
| 160 | $8.30^{a}$ | $149.4^{a}$ | $1241.0^{a}$ |
| 180 | $7.78^{ab}$ | $150.9^{a}$ | $1234.7^{a}$ |
| SE± | 0.579 | 1.596 | 24.48 |
| Variety (V) | | | |
| Kauz | 7.47 | 106.96 | 881.1 |
| Pastor | 7.95 | 105.13 | 871.2 |
| SE± | 0.366 | 1.428 | 15.48 |
| Interaction | | | |
| F × V | NS | NS | ** |

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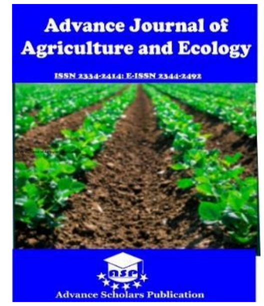


Mean followed by the same letter(s) are not significantly different according to DMRT.
NS = not significant, ** = highly significant at 5% probability level

**Table 4:** Interaction between NPK fertilizer and Wheat varieties on grain yield (kg Ha$^{-I}$) at Maiduguri, 2019/2020 dry Season

| Treatment | N Fertilizer (F) (kg ha$^{-I}$) | | | | |
|---|---|---|---|---|---|
| Variety | 0 | 120 | 140 | 160 | 180 |
| Kauz | 392.8$^{d}$ | 614.3$^{c}$ | 901.7$^{b}$ | 1251.3$^{a}$ | 1245.3$^{a}$ |
| Pastor | 400.6$^{d}$ | 610.6$^{c}$ | 890.7$^{b}$ | 1230.7$^{a}$ | 1224.1$^{a}$ |
| SE± | 34.62 | | | | |

Mean followed by the same alphabet(s) are not significantly different according to DMRTat 5% Probability level

## CONCLUSION AND RECOMMENDATION

Based on the findings of this research, different levels of N fertilizer enhanced growth and yield parameters of the two wheat varieties. The application of N at 160 and 180 kg ha$^{-l}$ recorded higher growth and yield and there were no significant differences between the two treatments for most of the parameters evaluated. Therefore, the application of N at 160 kg ha$^{-I}$ and any of the variety (Kauz and Pastor) might be recommended for optimum wheat production in the Sudan savanna of Nigeria.

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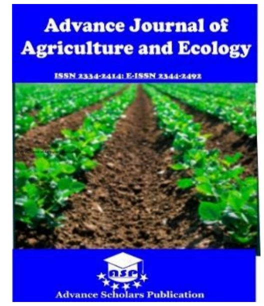


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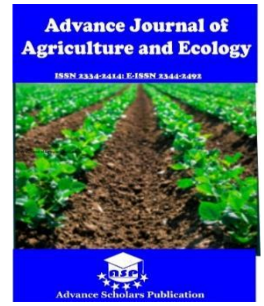


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