COMPARATIVE ANALYSIS OF DIFFERENT SUMMER WHEAT VARIETIES PRODUCTIVITY IN KANO STATE, NORTHERN NIGERIA

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Abstract

Wheat production in Nigeria has remained a complex and persistent challenge over the past decades, largely due to unfavourable climatic conditions, particularly high temperatures that are unsuitable for optimal wheat growth, as well as generally low productivity levels. However, there is paucity of data and dearth in literature on the comparative analysis of wheat varieties in Nigeria. The aim of the study is to compare different summer wheat varieties productivity in Kano State, Northern Nigeria. The field experiment was conducted during the 2024 and 2025 dry seasons at the Agricultural Research Council of Nigeria (ARCN) in Kano State located within the Sahel Savanna agro-ecological zone of Nigeria. The experiment was laid out in RCBD with two wheat varieties (Borloug and Norman). The experiment was laid out in a 3-factor factorial arrangement (2 × 3 × 3) in a Randomised Complete Block Design (RCBD) with three replications. Treatments consisted of two wheat varieties (Borloug and Norman), three seed rates (100, 150, and 200 kg ha^{-1}), and three inter-row spacings (0, 15, and 30 cm). Based on the physiological maturity of Norman and Borloug, the study shows a significant difference in the days to physiological maturity between Norman and Borloug. Norman needs more time to reach maturity (115.82 days), unlike Borloug matured earlier (107.76). Borloug ($p<0.001$) outyielded Norman: 3.95 vs 3.28 t/ha. The 200 kg ha^{-1} seed rate maximized yield at 3.96 t/ha (49.73g 1000-grain weight); 150 kg ha^{-1} balanced efficiency at 3.67 t/ha. Wider 30 cm spacing enhanced yield (3.96 t/ha) versus narrow spacing (3.24 t/ha). Borloug at 200 kg ha^{-1} and 30 cm spacing achieved 3.96 t/ha, while Norman at 100 kg ha^{-1} and 0 cm spacing yielded 3.24

t/ha. The study concludes that Norman variety matured lately, while Borloug matured early.

Keyword. Wheat, variety, yield, seed,physiological maturity

INTRODUCTION

Background to the Study. Wheat (*Triticum aestivum* L.) belongs to the family Poaceae (Gramineae) and the subfamily Poideae. It is predominantly cultivated across temperate, sub-temperate, arctic, and humid regions of the world [6]. Owing to its superior baking properties, wheat serves as a major source of carbohydrates in human diets. Additionally, its ability to be stored for extended periods in various forms, such as whole grain, bread, cakes, and biscuits enhances its value as a convenient food source, particularly for urban populations. Wheat plays a critical role in addressing food insecurity and nutritional challenges, serving as both a staple for human consumption and an important component of animal feed [2; 6].

Low wheat production has remained a persistent challenge in Nigeria for several decades. Zubairu et al., [7] observed that domestic wheat output has consistently been insufficient to meet national demand. Empirical reports indicate that production remained relatively low at about 60,000 metric tons in 2016 and showed little improvement, remaining at the same level in 2018 [1; 4; 5]. Although a slight increase to approximately 67,000 metric tons was recorded in 2017, production declined again to about 60,000 metric tons in 2019 [5]. This trend highlights the stagnation and instability of wheat production in the country over time.

The significance of wheat in both global and Nigerian contexts is considerable, given the extensive area under cultivation and its diverse uses ([1; 7]. However, despite the large-scale cultivation efforts, domestic production remains insufficient to meet rising demand. Local wheat output is grossly inadequate, resulting in Nigeria spending over $3 billion annually on wheat imports [1; 4; 5].

Investigating varietal differences is a fundamental prerequisite for any crop improvement programme, as it facilitates the development of superior recombinant lines. Information on genetic diversity, varietal divergence, and trait correlations is also essential for informing effective breeding strategies. Therefore, this study is justified by the need to generate empirical evidence that can guide farmers, policymakers, and agricultural extension agents in the adoption of efficient and sustainable wheat production varieties within the Sahel Savanna region [7;8].

Wheat sowing in traditional production systems has largely been dominated by the broadcasting method, although there has been a gradual shift toward drill sowing in more modern agronomic practices [6]. While some studies have reported higher yields under broadcasting compared to drilling, varietal responses to planting methods and environmental conditions have been shown to differ significantly. In Nigeria, several wheat varieties have been released by the Lake Chad Research Institute (LCRI), each exhibiting varying yield potentials. This variation underscores the need for systematic evaluation of these varieties under different management conditions, particularly to compare their yield performance and identify the most productive options [4; 7].

The Nigerian government’s renewed commitment to achieving wheat self-sufficiency and reducing reliance on imports highlights the need to enhance productivity through improved agronomic practices [1; 4; 5]. In particular, optimizing seed rate and plant population density is expected to improve resource-use efficiency, lower production costs, and strengthen the resilience of wheat production systems to climatic variability. The findings of this study are therefore expected to support the development of sustainable agricultural practices, improve farmers’ livelihoods, and contribute to enhanced food security in northern Nigeria.

Purpose of the research is to compare the productivity of different summer wheat varieties in Kano State, Northern Nigeria.

Material and the methods

The field experiment was conducted during the 2024 and 2025 dry seasons Agricultural Research Council of Nigeria (ARCN) in Kano State. located within the Sahel Savanna agro-ecological zone of Nigeria. The area is characterized by a semi-arid climate with low annual rainfall and high evapotranspiration, necessitating irrigation for wheat production. Before planting each season, composite soil samples were collected from the experimental field at a depth of 0–30 cm and analysed for key physical and chemical properties such as pH, organic carbon, total nitrogen, available phosphorus, and exchangeable potassium. These analyses provided baseline information for nutrient management and interpretation of crop performance.

The experiment was laid out in RCBD with two wheat varieties (Borloug and Norman). Wheat seeds obtained from Lake Chad Research Institute, Maiduguri were treated with Apron star at the rate of 10 g to 10 kg of seeds and sown by the dibbling at row spacing of 30 cm x 25 cm on the 15 of November each year. Due to the texture of the soil (silt- clay) and the period (dry season), water was applied to the field at 7-day intervals commencing at sowing and irrigation continued until the grain filling reached the hard stage. Post-emergence application of Bentazone at -1 -1 1.5 kg ai ha (2.5 L ai ha) was applied at 4 weeks after sowing as recommended (LCRI, 2015).

The experiment was laid out in a 3-factor factorial arrangement (2 × 3 × 3) in a Randomised Complete Block Design (RCBD) with three replications. Treatments consisted of two wheat varieties (Borloug and Norman), three seed rates (100, 150, and 200 kg ha^{-1}), and three inter-row spacings (0, 15, and 30 cm). Each treatment combination was assigned to a plot measuring 5 m × 3 m, resulting in 18 treatment combinations and 54 experimental units in total. Land preparation involved ploughing, harrowing, and levelling to create a fine, uniform seedbed. Seeds of each

variety were sown manually in rows at the designated spacing and seed rates. Fertiliser was applied based on regional recommendations for irrigated wheat, at a rate of 120 kg N, 40 kg P_2O_5, and 40 kg K_2O ha^{-1}. Half of the nitrogen and all of the phosphorus and potassium were applied at planting using NPK 15:15:15, while the remaining nitrogen was top-dressed as urea

at the tillering stage.

Land Management Practices was done according to the [2-4].

Data Collection. Data were collected on key agronomic and yield parameters, including days to heading, plant height, number of spikes per square meter, spike length, number of grains per spike, 1000- grain weight, grain yield per plot, and grain yield per hectare according to [2-4; 7]

All collected data were subjected to Analysis of Variance (ANOVA) using GenStat (17th Edition) to determine treatment effects. Where significant differences were detected ($P < 0.05$), means were separated using the Student-Newman-Keuls (SNK) test to compare treatment combinations for variety, seed rate, and spacing effects [2].

RESULTS

Effect of Variety on Growth Characteristics of Wheat. The effect of variety on plant height, days to heading and days to physiological maturity is presented in Table 1. The study shows that there is a significant variation in plant height between Norman and Borloug ($p \leq 0.001$). Norman shows a significant greater plant height (91.36 cm) than Borloug (80.30 cm), and this is an indication that Norman is characterized by robust vegetative growth and suggest better biomass accumulation and greater competitiveness for sunlight. In contrast, Borloug is shorter compared to Norman and demonstrates compact growth characteristics, and this may have benefit to adapt under high-density planting or in a condition vulnerable to lodging.

Based on the phenological character of varieties of wheat to days to heading, the study shows that days to heading differed significantly ($p \leq 0.001$) between Norman and Borloug. Norman has reached heading earlier (56.10 days) compared to Borloug days to heading to be (62.23 days). This indicates that Norman is an early-heading variety, while Borloug is a late-heading variety and Norman grows more rapidly from vegetative to reproductive stage. Based on the physiological maturity of Norman and Borloug, the study shows significant difference in the days to physiological maturity between Norman and Borloug. Norman need more time to reach maturity (115.82 days), unlike Borloug matured earlier (107.76).

It can be concluded that Norman variety matured lately, while Borloug matured early. It can be concluded that Norman variety is suited for high-input and longer-season environment, while Borloug variety is suitable for low-input or work better in a stress prone environment.

Table 1. Wheat Varieties, Plant Height, Days to Heading and Days to Physiological Maturity (2024 And 2025)

Variety (v)	**Plant Height**	**Days to Heading**	**Days to Physiological Maturity**
Borloug	80.30b	62.23a	107.76a
Norman	91.36a	56.10b	115.82b
p.value	≤.0001	≤.0001	≤.0001
SE+-	0.3009	0.0573	0.3569

Effect of Seed Rate (SR) on Growth Characteristics of Wheat. The effects of seed rate on plant height, days to heading and days to physiological maturity is presented in Table 2. The study shows that plant height increased slightly with increasing seed rate as show by 100 kg/ha resulted to 85.24 cm plant height, 150 kg/ha brings about 87.86 cm plant height and 200 kg/ha leads to 87. 19 cm plant height and the relationship on the effects of seed rate to plant height is found not to be statistically significant (p = 0.0612). This shows that 150 kg/ha produced the tallest plants. It can be concluded that plant height is relatively stable across seed rates for both Norman and Borloug.

On the effects of plant height and days to heading, the study shows that increasing seed rate delays heading and higher seed rates lead to a slight delay in maturity. For instance, at lower density of 100 kg/ha, plants develop faster and reach heading earlier, at higher density, (150-200 kg/ha), competition for light and nutrients may likely increase the growth of vegetation. This trend is applicable to both Norman and Borloug, however, Norman remains earlier than Borloug. There is significant effect of plant height and days to heading (p = 0.0135). On the relationship between seed rate and plant height, the result showed that seed rate had no significant effect on plant height (p = 0.0612). This is further demonstrated that 150kg/ha (87.86 cm) produced the tallest plants, followed closely by 200 kg/ha (87.19 cm), while 100 kg/ha recorded the lowest (85.24 cm). However, seed rate significantly influenced days to heading ($p \leq 0.001$). on the seed rate to days to heading, the lowest seed rate (100 kg/ha) resulted in the earliest heading (55.23days), while 200 kg/ha produced the highest days to heading of (62.71 days). In the same vein, the data further showed that there is a significant relationship between seed rate and physiological maturity ($p=0.0135$). The 150 kg/ha matured for (110.13 days) while 100 kg/ha matured earlier (109.28 days). This is an indication that higher plant density prolongs crop duration.

Table 2. The Effects of Seed Rate (r) on Plant Height, Days to Heading and Days to Physiological Maturity (2024 And 2025)

Seed Rate (Sr)	**Plant Height**	**Days to Heading**	**Days to Physiological Maturity**
100	85.24	55.23c	109.28b
150	87.86	60.36b	110.38a
200	87.19	62.71a	110.13a
p.value	0.0612	≤.0001	0.0135
SE+-	0.4585	0.0723	0.5225

Effect of Spacing (S) on Growth Characteristics of Wheat. The results on the effects of spacing on plant height, days to heading and days to physiological maturity of wheat varieties (Norman and Borloug) is shown in Table 3. The result shows that spacing has significant effect on plant height and days to heading ($p \leq 0.001$), however, there is no significant effect of spacing on physiological maturity ($p = 0.6753$). This further shows that wider spacing of 30 cm produced significantly taller plants of 89.57 cm, while closer spacing from 0 and 15 cm leads to shorter plants of 84.98 and 85.23 cm respectively. This is an indication that reduction in competition at wider spacing enhance plant growth. Furthermore, days to heading increased with spacing, as demonstrated by 30 cm spacing recording the latest heading 63.05 days followed by 15 cm (62.17 days), and the earliest at O cm (58.46 days).

The effect of spacing on plant height shows that widest spacing of (30 cm) produced significant taller plants than the closer spacing. This is an indication that maturity is an interplay of numerous factors such as genetic factors rather than spacing as showed that both Norman and Borloug have maintained their maturity pattern in respective of plant spacing. This indicates that wider spacing prolong the vegetative growth of wheat in the study area.

On the effects of spacing on days to heading, the study shows that 30 cm spacing took 63.05days and were the highest, followed by 15 cm spacing took 62.17 days to heading, and 0 cm took 58.46 days to heading and were the least. This shows that wider spacing delays heading. It can be concluded that less competition allows plants to remain longer in the vegetative stage, thereby delaying reproductive development. On the influence of spacing on days to maturity, 0-30 cm spacing took 110 days to matured. Although, there is a difference on the spacing and days to physiological maturity, however, there is no statistical difference between spacing and physiological maturity and this is an indication that maturity is largely influenced by genetic factors rather spacing itself.

Table 3. Effects of Spacing (S) on Plant Height, Days to Heading and Days to Physiological Maturity (2024 And 2025)

Spacing	**Plant Height**	**Days to Heading**	**Days to Physiological Maturity**
0	84.98b	58.46c	110.33
15	85.23b	62.17b	110.68
30	89.57a	63.05a	110.15
p-value	≤.0001	≤.0001	**0.6753**
SE+-	**0.4651**	**0.0541**	**0.5434**

Yield and Yield-related Components of Wheat. The results on the number of spikes per square meter, Spike length, and Number of grains per spike of Wheat varieties as affected by Seed rate and spacing are presented in Table 4. Based on the varieties of wheat and yield, the study shows that Borloug has 324.00 spikes m^{-2}, while Norman has 321.58 spikes m^{-2} and this shows that there is no significant difference between the two varieties in terms of spike density. This indicates that both Norman and Borloug produce a similar number of spikes per unit area, and shows comparable stand establishment and tillering capacity.

Based on the number of grains per spike, the study shows that Borloug produced 50.07 grains per spike, while Norman produced 57.02 grains per spike and Norman significantly produced more grains than Borloug ($p \leq 0.001$). It can be concluded that Norman has higher productivity due to better grain set or fertility of the spike.

Table 4. Number of spikes per square meter, Spike length and Number of grains per spike of Wheat varieties as affected by Seed rate and spacing (2024 And 2025)

Treatment	**Number of Spike** m^{-2}	**Spike Length (cm)**	**Number of Grains Spike-1**
Variety (v)			
Borloug	324.00	8.06	50.07b
Norman	321.58	7.63	57.02a
p.value	0.8405	0.6245	≤.0.001
SE+-	4.3169	0.3142	0.2100
Seed Rate	**Number of Spike** m^{-2}	**Spike Length (cm)**	**Number of Grains Spike-1**
100	352.34	9.45a	53.56a
150	338.27	9.42a	49.38c
200	326.28	8.63b	51.23b
p.value	0.1482	0.0092	≤.0.001
SE+-	0.6382	0.2671	0.3458
Spacing	**Number of Spike** m^{-2}	**Spike Length (cm)**	**Number of Grains Spike-1**
0	321.38	9.32b	47.21c
15	326.72	9.76b	55.32b
30	364.82	9.42b	59.07a
p.value	≤.0.001	0.007	≤.0.001
SE+-	4.4692	0.2556	0.3483
Interaction	**Number of Spike** m^{-2}	**Spike Length (cm)**	**Number of Grains Spike-1**
V×Sr	0.0407	0.0001	≤.0.001

V×S	0.0247	0.0004	≤.0.001
Sr×S	≤.0.001	0.0050	≤.0.001
V×Sr×S	0.5287	0.0624	≤.0.001

On the influence of seed rate on number of spike, the study shows that 100 kg/ha produced 352.34 spikes, 150 kg/ha produced 338.27 spikes, while 200 kg produced 326.28 spikes. This shows that the number of spike decreased with increased seed rate and there is significant difference in spike between Norman and Borloug ($p = 0.1482$). Based on the seed rate and spike length, 200 kg/ha produced 8.63 cm spike length, increased from 100 kg/ha to 9.42 cm spike length and further drops from 150 kg/ha to 9.42 spike length and spike length significantly reduced at higher seed rate of 200 kg ($p = 0.0092$).

This indicates that increased plant density has adverse effect on spike development and this may be associated with competition for resources. Based on the number of seed rate and number of grains per spike, there is a significant influence of spike in the wheat varieties ($p <0.001$). The spacing of 100 kg/ha produced the highest 53.56 yields, followed by 200 kg/ ha spacing produced 51.23 grains, while 150 kg/ha spacing produced 49.38 grains and were the least. This indicates that seed rate has a strong effect on number of grains per spike and lower density enhance grain formation as a result of better resource availability per plant.

Based on the plant spacing and number of spikes, the study shows highly significant influenced of all spike traits ($p \leq 0.001$). The widest spacing of 30 cm produced the highest number of spikes per unit area (364.82 m^{-2}), while the narrowest spacing of 0 cm produced the lowest spikes per unit area (321.38 m^{-2}). This indicates that there is reduction of competition at wider spacing and this has multiplier effects in enhancing tillering and consequently leads to more productive spikes. Based on the spacing and spike length (cm), 15 cm spacing produced the longest spikes, while 0 cm produced the shortest spikes (9.32 cm) and the relationship between spacing and spike length is statistically significant ($p = 0.007$). This indicates that spacing has minimal effect on spike length.

Based on the spacing and number of grains per spike, grain number increased significantly with wider spacing ($p \leq 0.001$). The widest spacing of 30 cm produced the highest grain number (59.07a), while the narrowest spacing produced the lowest grain number (47.21c). This can be associated with the fact that lower plant density improves grain formation as a result of better availability of nutrients, moisture per plant and light among others.

Grain yield and 1000 seed weight. The results of grain yield, 1000 seed weight, grain yield per plot and grain yield at hectare is presented in Table 5. The study shows that both variety, seed rate and spacing significantly influenced 1000-grain weight, grain yield per plot and grain yield per hectare of wheat during 2025 dry season. Borloug consistently has better performance than Norman, producing significantly (<0.001) the harvest grains 46.27g and the highest grain yield per hectare (3946.07 kg ha^{-1}) compared to Norman of 41.37g harvest grains, and 3284.74 kg ha^{-1} lowest grain yield.

Table 5. Grain yield, 1000 seed weight, Grain Yield Per Plot and Grain Yield at Hectare

Treatment	**100 Grain Weight (g)**	**Grain Yield Plot**	**Grain Yield (kg ha)**
Variety (v)			
Borloug	46.24A	6.32a	3946.06a
Norman	41.37B	5.64b	3284.74b
p.value	≤.0001	≤.0002	≤.0001
SE+-	0.7322	0.1244	0.0873
Seed Rate (Sr)			
100	42.70c	5.38a	3242.62a
150	45.86b	4.96b	3674.53b
200	49.73a	6.10a	3962.23a
p.value	≤.0001	0.0011	≤.0001
SE+-	0.1007	0.1624	0.1172
Spacing			
0	42.62c	4.40b	3242.27a
15	45.74b	4.92a	3674.84c
30	48.21c	5.31	3962.01a
p-value	≤.0001	0.0052	≤.0001
SE+-	0.1002	0.1524	0.1070
Interaction			
V×Sr	≤.0001	0.7401	≤.0001
V×S	≤.0001	0.4123	≤.0001
Sr×S	0.0046	0.5961	≤.0001

V×Sr×	≤.0001	0.5121	≤.0001

This shows that Borloug's is superior to adapt and thrive to the Sahelian environment and produce better grains, while Norman in contrast, produced lighter grains and lower yield as a result of its longer growth duration and partly its susceptibility to late-season stress.

CONCLUSION

The major conclusion that can draw from the findings are associated with the fact that Norman variety matured lately, while Borloug matured early. Norman variety is suited for high-input and longer-season environment, while Borloug variety is suitable for low-input or work better in a stress prone environment. It can also be concluded that plant height is relatively stable across seed rates for both Norman and Borloug. Less competition allows plants to remain longer in the vegetative stage, thereby delaying reproductive development.

Furthermore, it can be concluded that maturity is less influenced by the combined effects of variety and seed rate. It is the extent at which plant height increased with wider spacing differs between Norman and Borloug. Variety plays a dominant role in determining growth and phenological traits; seed rate and spacing significantly influence crop development, particularly heading and interaction effects, and achieving optimal agronomic performance of wheat is an interplay of numerous factors such as application of variety, seed rate and spacing.

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