

Effects of Organic and Inorganic Manures on the Growth and Yield of *Triticum aestivum* L. (Wheat) in Jos Plateau State, Nigeria

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ABSTRACT

Wheat is widely cultivated globally, but its production in Nigeria faces challenges like poor soil nutrients, insufficient fertilization, and environmental incompatibility. This study aims to identify the best manure type and wheat variety for improved cultivation by comparing organic manures (cow dung, poultry dropping, rabbit dung) and inorganic fertilizer (NPK 20:10:10) on three wheat varieties. The experiment was conducted at the Federal College of Forestry, Jos, Plateau State, from February to May 2024. It involved 15 treatment combinations in a randomized complete block design with three replications. Significant differences were observed among varieties and manure types for germination count, plant height, stem girth, number of leaves, leaf length, and spikes per plant. Leaf width and seeds per plant varied significantly with manure type, while seeds per spike and seed weight differed with wheat variety. Borlaug100 showed superior performance in germination, plant height, leaf width, spikes, and seeds per plant. The local variety excelled in leaf number and length, while Rayna 15 had the highest stem girth, seeds per spike, and seed weight. Rabbit manure enhanced wheat growth and yield significantly. Rayna 15 had the highest yield of grains of wheat t/ha which was significantly higher than the other two varieties. Local variety recorded the lowest yield of grains t/ha while manures used did not record any significant difference, though wheat treated with no manure and cow dung had the highest mean number. This research highlights the effectiveness of rabbit manure for wheat cultivation in Jos Plateau State and identifies Borlaug-100 as a high-performing wheat variety.

Keywords: Wheat (*Triticum aestivum* L.), Organic Manure, Inorganic Manure (NPK), Growth and Yield



Article Information

Received 11 June 2025

Accepted 20 July 2025

Published 27 July 2025

<https://doi.org/10.26765/DRJAFS43258650>

Citation Satdom, S.M., Ipole, E., Odesina, I.S., Gyang, P.D., Egbaji, C.I., Andrew, Z.L. and Olatunji, O. S. (2025). Effects of Organic and Inorganic Manures on the Growth and Yield of *Triticum Aestivum* L. (Wheat) in Jos Plateau State, Nigeria. *Direct Research Journal of Agriculture and Food Science*. Vol. 13(2), Pp. 110-118.

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INTRODUCTION

Triticum aestivum L. (Wheat) is the most cultivated species of *Triticum*, widely grown throughout the world. They are also referred to as “common” or “bread” wheat owing to its widely-grown and nutritious characteristics, from the most primitive form of wheat to the species currently grown (FAOSTAT, 2020; Venske et al., 2019). Wheat was reported to have first been cultivated in the Fertile Crescent, about 10,000 years ago and has spread to all parts of the world through the first farmers, adapting the domesticated populations to different environments (Bonjean and Angus, 2001).

In Nigeria, wheat is grown in the northern region of the country; Borno, Yobe, Gombe, Bauchi, Jigawa, Kano, Katsina, Zamfara, Kebbi, Sokoto, Kaduna, Adamawa and Plateau State. Wheat is able to grow in temperate, Mediterranean, and subtropical regions of the two hemispheres, mainly due to its enormous genetic diversity. There are more than 25,000 varieties of *Triticum aestivum* L. adapted to different temperate environments (Shewry, 2009). Wheat can be classified according to when it is sown. Winter wheat is sown in autumn because the seedlings need a period during the vegetative phase when temperatures are between 0 and 5 °C. About 80% of the world’s wheat is winter wheat. Spring wheat is planted in spring and harvested in late summer or fall in South Asian countries or North Africa (Curtis and Halford 2014). Wheat belongs to the *Poaceae* family (Hawkesford et al., 2013), which includes the *Triticeae* tribe, the division with the most economically important cereals.

The *Triticeae* tribe includes 14 genera, grouped into the subtribes *Triticinae* and *Hordeinae*. The markets and the processing industry depend on different varieties of wheat with different quality attributes that meet the needs of specific products. One of wheat’s main importance is the unique ability of wheat doughs to be processed into different types of bread and other bakery products (including cakes and biscuits), pasta, and other processed foods. Wheat is generally traded according to specific characteristics, namely, the grain protein content and hardness (Telma et al., 2021). These market requirements have led to a more comprehensive and thoughtful approach to wheat breeding so as not to neglect essential protein content and protein quality (Ribeiro et al., 2019). Fertilizers are amendments applied to promote plant growth. Nitrogen, phosphorus and potassium (NPK) are the most commonly used inorganic fertilizers for plant growth and yield improvement (Singh et al., 2020). Wheat yield in Nigeria has drastically decreased as wheat requires management of soil organic matter and use of organic inputs such as animal manures, crop residues, green manures, sewage sludge, and food industry wastes. Biological manure has many attributes. It supplies a wide variety of nutrients along with organic matter that improves the physical characteristics of soil. Its beneficial effects on plant growth are sometimes difficult to duplicate with other materials. There is a positive interaction between the

combination of organic manures and NPK fertilizer (Aruna, et al., 2020). Organic manures hold great promise for improving soil characteristics (Abbas et al., 2012; Verma et al., 2024). There is limited knowledge on manures and their application as regards wheat production in Plateau State and this contributes a negative effect on wheat production in Nigeria. The amount and availability of nutrients in organic materials vary widely, which makes interpretation of the value of nutrients supplied by these materials a difficult task (Rosen and Allen, 2007). This research was carried out to determine the effects of organic manure and inorganic fertilizer (NPK) on the growth and yield of *Triticum aestivum* L. (wheat) in Jos Plateau State.

MATERIALS AND METHODS

Three wheat varieties were used for this study to determine the effects of organic manure and inorganic fertilizer (N.P.K. 20:10:10) on the growth and yield of *Triticum aestivum* L. (wheat) in Jos Plateau State, Nigeria. It was conducted between the month of February and May, 2024. The research was conducted at Federal College of Forestry, Jos North Local Government Area of Plateau State. The three wheat varieties namely: local variety, Rayna 15 and Borlaug 100. They were obtained from the branch of Lake Chad Research Institute (LCRI) in Vom, Plateau State. Organic manures were gotten from livestock farmers in Jos metropolis. NPK (20:10:10) fertilizer was obtained from Plateau Agricultural Development Program (PADP). The experiment was carried out using Completely Randomized Design (CRD) consisting of 3 wheat varieties and 5 fertilizer treatments, which were factorially combined given a total of 15 treatment combinations with three replications.

A mixture of top soil and sharp sand with NPK (20:10:10) and different organic manures for the study (Cow dung, Poultry dropping and Rabbit dung) each separately in an empty planting bag in a ratio of 3:2:1. Mixture of only sharp and top soil was used as the control experiment. All the bags containing different treatment of soil mixture was arranged based on the field layout of the experimental design. Seeds were planted by drilling method at the depth of 2 cm and watered immediately after planting. Weeding was carried out every two weeks after planting by hand picking.

The growth and yield parameters assessed were Germination count, Plant height, Stem girth, Number of leaves, Leaf length, Leaf width, Number of spikes, Number of seeds per spike and Seed weight. The yield was extrapolated using the seed weight evaluated in each experimental unit. The collected data were subjected to Analysis of Variance (ANOVA) using the R programming software and means were separated using LSD (Least Significant Difference) at 5% level of probability.

Table 1. Effects of Variety and Manure on Germination Count of *Triticum aestivum* L (Wheat) at 2 weeks after Planting (WAP).

Treatment	2 WAP
Variety	
Local variety	2.47b
Rayna 15	3.00a
Borlaug 100	3.47a
Significance	**
LSD	0.63
Manures	
Control	3.78a
Cow dung	2.89b
Poultry dropping	2.67bc
Rabbit dung	3.00b
NPK fertilizer	2.22c
Significance	**
LSD	1.09

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability

ns: there is no significant difference.

*there is significant difference

RESULTS

Wheat germination count

Table 1 shows the effects of wheat variety and fertilizer treatments on the germination count of *Triticum aestivum* L. (Wheat) at 2 weeks after planting (WAP) in Jos Plateau State. The result shows that there was no significant difference between Rayna 15 variety and Borlaug 100 variety but the two were significantly different from local variety. Borlaug 100 had the highest mean number of germination count (3.47), while local variety had the least mean number of germination count (2.47), which mean that local variety had low germination rate. Control treatment (zero fertilizer) was significantly different from the rest of the manures used during this study. Cow dung, poultry dropping and rabbit dung were not significantly different from each other. Poultry had 2.67 mean number of germination count and was significantly the same with NPK fertilizer which had 2.22 mean number of germination count. Rabbit dung had 3.00 mean number of germination count and was significantly different from NPK fertilizer which had 2.22. Control (zero fertilizer) had the highest mean number of 3.78 germination count, while NPK fertilizer had the least mean number of 2.22 germination count.

Plant height (cm)

Table 2 shows the effects of variety and fertilizer treatment on the plant height of *Triticum aestivum* L. (Wheat) at 2, 4, 6, 8, 10 and 12 weeks after planting (WAP) in Jos Plateau State. The results show that Borlaug 100 had the highest plant height (25.28 cm), it was the tallest variety, while Rayna 15 had the least plant height (9.60 cm) which was the shortest variety. The three (3) varieties were not significantly different from each other at 2 and 4 weeks after planting, but recorded levels of significance

differences at 6, 8, 10 and 12 weeks after planting. Local variety and Rayna 15 variety were not significantly different from each other during this experiment, but were significantly different from Borlaug 100 at 6, 8, 10 and 12 weeks after planting. The results on this table shows that control, cow dung, poultry dropping and rabbit dung were significantly different from NPK fertilizer, but were significantly the same with each other at 2 weeks after planting. At 4 weeks after planting, control, cow dung and poultry dropping were significantly the same, cow dung, poultry dropping and rabbit dung were also significantly the same, but differ from NPK fertilizer, however control and NPK fertilizer were statistically the same. Week 6, 8 and 10 showed non-significant results. Week 12 recorded significant differences; control, cow dung, poultry dropping and rabbit dung were significantly the same. Control, poultry dropping and NPK fertilizer were also significantly the same. The results in this table show that cow dung had the highest plant height (23.03a) while NPK fertilizer had the lowest plant height (7.94b).

Stem girth

Table 2 also presents the effects variety and different fertilizer treatment on the stem girth of *Triticum aestivum* L. (Wheat) at 2, 4, 6, 8, 10 and 12 weeks after planting (WAP) in Jos Plateau State. The result shows that Rayna 15 variety had the highest stem girth (1.71 cm), this mean that the plant stem of Rayna 15 variety was the thickest, while local variety had lowest stem girth (0.74). The three (3) varieties used were not significantly different from each other at 2, 4 and 6 weeks after planting, but recorded significant results at 8, 10 and 12 weeks after planting. Local variety was not significantly different from Rayna 15 and Borlaug 100 variety at 8, 10 and 12 weeks after planting. However, Rayna 15 variety was significantly different from Borlaug 100 variety. Control treatment (No manure), cow dung, rabbit dung and NPK fertilizer were

Table 2: Effects of Variety and Manure on Plant Height (cm) and Stem Girth (cm) at 2, 4, 6, 8, 10 and 12 Weeks after Planting (WAP).

Treatment	2WAP	4WAP	6WAP	8WAP	10WAP	12WAP
PLANT HEIGHT						
Variety						
Local variety	10.07a	13.53a	16.60b	17.95b	19.17b	20.40b
Rayna 15	9.60a	14.04a	16.95b	17.85b	18.73b	20.05b
Borlaug 100	9.62a	14.91a	21.22a	23.66a	24.62a	25.28a
Significance	ns	ns	***	***	***	***
LSD _(0.05)	-	-	2.96	3.03	3.03	2.72
Manures						
Control	9.66a	13.77bc	19.02a	20.07a	20.80a	21.61ab
Cow dung	10.17a	13.37ab	18.25a	19.72a	21.99a	23.03a
Poultry dropping	10.44a	14.73ab	18.37a	20.50a	21.50a	22.26ab
Rabbit dung	10.62a	16.84a	18.87a	20.88a	21.86a	23.02a
NPK fertilizer	7.94b	11.11c	16.78a	17.94a	18.98a	19.62b
Significance	**	**	ns	ns	ns	ns
LSD _(0.05)	2.18	4.93	-	-	-	-
STEM GIRTH						
Variety						
Local variety	0.74a	1.29a	1.45a	1.47ab	1.56ab	1.63ab
Rayna 15	0.78a	1.31a	1.80a	1.59a	1.65a	1.71a
Borlaug 100	0.77a	1.24a	1.34a	1.43b	1.48b	1.57b
Significance	ns	ns	ns	ns	*	Ns
LSD _(0.05)	-	-	-	-	0.16	-
Manures						
Control	0.81a	1.14c	1.75a	1.28c	1.39c	1.50bc
Cow dung	0.75ab	1.36b	1.43a	1.54b	1.56b	1.64ab
Poultry dropping	0.73b	1.36b	1.56a	1.66ab	1.72a	1.79a
Rabbit dung	0.79ab	1.56a	1.63a	1.74a	1.79a	1.80a
NPK fertilizer	0.74ab	1.00c	1.28a	1.28c	1.36c	1.46c
Significance	ns	***	ns	***	***	***
LSD _(0.05)	-	0.31	-	0.32	0.28	0.30

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability

ns: there is no significant difference.

*there is significant difference

significantly not different from each other. However, control (No manure) was significantly different from poultry dropping at two (2) weeks after planting. At 4 weeks after planting, control (No manure) and NPK fertilizer were significantly not different from each other, but was significantly different from cow dung, poultry dropping and rabbit dung. The five (5) treatments were significantly the same at 6 weeks after planting. At 8 weeks after planting, control (zero manure) and NPK fertilizer were significantly not different from each other, but was significantly different from cow dung, poultry dropping and rabbit dung. Also, there was no significant difference between poultry dropping and rabbit dung treatments. However, there was a significant difference between cow dung and rabbit dung. Control (No manure) and NPK fertilizer did not record any significant difference between each other, however, it was significantly different from cow dung, poultry dropping and rabbit dung at 10 weeks after planting. There is no significant difference between cow dung and poultry dropping. At 12 weeks after planting, the treatments—control (No manure), cow dung, poultry dropping and rabbit dung—exhibited significant differences compared to NPK fertilizer, but they were statistically similar to each other. Furthermore, there was no significant difference among the control, poultry dropping and NPK fertilizer. The results in the table also indicate that wheat plants treated

with rabbit dung had the highest mean stem girth (1.80 cm), while those treated with poultry dropping had the lowest mean stem girth (0.73 cm).

Number of leaves

Table 3 shows the effects of variety and different fertilizer treatments on the number of leaves of *Triticum aestivum* L. (Wheat) at 2, 4, 6, 8, 10 and 12 weeks after planting (WAP) in Jos Plateau State. The results indicate that the local variety recorded the highest mean number of leaves (20.77), while the Rayna 15 variety had the lowest mean number of leaves (6.50). The three varieties showed no significant differences in the number of leaves at 2, 4, and 6 weeks after planting. However, significant differences were observed at 8, 10, and 12 weeks after planting. At these later stages, Rayna 15 and Borlaug 100 were statistically similar to each other but significantly different from the local variety. The table indicates that wheat plants treated with poultry dropping produced the highest mean number of leaves (20.49), while those treated with NPK fertilizer had the lowest mean number of leaves (4.99). At 2 weeks after planting, control (no manure), cow dung and NPK fertilizer were statistically similar to each other but significantly different from rabbit dung. At 4 and 6 weeks after planting, cow dung, poultry dropping and rabbit dung

Table 3: Effects of Variety and Manure on Number of Leaves and Leaf Length (cm) at 2, 4, 6, 8, 10 and 12 Weeks after Planting (WAP).

Treatment	2WAP	4WAP	6WAP	8WAP	10WAP	12WAP
NUMBER OF LEAVES						
Variety						
Local variety	7.03a	7.77a	8.68a	18.92a	20.27a	20.77a
Rayna 15	6.50a	8.40a	9.49a	15.97b	16.92b	16.96b
Borlaug 100	6.78a	8.27a	9.13a	15.19b	16.43b	17.16b
Significance	ns	ns	ns	**	***	***
LSD	-	-	-	2.61	2.40	2.26
Manures						
Control	5.81bc	6.23b	7.09b	14.12c	15.33c	16.14c
Cow dung	6.42bc	8.94a	9.64a	15.53bc	16.92bc	17.29bc
Poultry dropping	7.63ab	9.06a	10.83a	18.31a	19.89a	20.29a
Rabbit dung	9.01a	10.27a	11.00a	17.72ab	18.56ab	18.43ab
NPK fertilizer	4.99c	6.23b	6.92b	17.78ab	18.67ab	19.12ab
Significance	*	*	**	**	**	**
LSD	4.09	4.69	4.32	4.53	4.16	3.91
LEAF LENGTH						
Variety						
Local variety	6.46a	10.41a	13.40a	16.83a	17.69a	18.45a
Rayna 15	6.97a	10.29a	12.40ab	15.15b	16.04b	17.11b
Borlaug 100	6.50a	10.23a	11.85b	13.35c	14.44c	15.29c
Significance	ns	ns	*	***	***	***
LSD	-	-	1.37	1.66	1.58	1.63
Manures						
Control	7.06a	9.70bc	11.92bc	14.07b	14.89c	15.64c
Cow dung	7.78a	10.60b	13.28ab	14.29b	15.12bc	15.82bc
Poultry dropping	7.09a	10.21bc	13.00ab	15.39b	16.57b	17.43b
Rabbit dung	6.46ab	12.03a	13.63a	14.19b	15.27bc	16.42bc
NPK fertilizer	4.84b	9.00c	10.92c	17.61a	18.44a	19.42a
Significance	*	***	**	***	***	***
LSD	2.87	2.11	2.37	2.88	2.73	2.82

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability

ns: there is no significant difference.

*there is significant difference

were not significantly different from one another but were significantly different from control (no manure) and NPK fertilizer, which were themselves statistically similar. At 8, 10, and 12 weeks after planting, control (no manure) and cow dung were not significantly different but differed significantly from poultry dropping. During the same period, poultry dropping, rabbit dung and NPK fertilizer were statistically similar to one another but significantly different from the control (no manure).

Length of leaves

Table 3 also presents the effects of variety and different fertilizer treatments on the leaf length of *Triticum aestivum* L. (wheat) at 2, 4, 6, 8, 10, and 12 weeks after planting (WAP) in Jos Plateau State. The results indicate that the local variety recorded the highest mean leaf length (18.45 cm) at 12 weeks, demonstrating that this variety produces wheat plants with very long leaves. Conversely, the local variety had the shortest mean leaf length (6.46 cm) at 2 weeks after planting. At 2 and 4 weeks, no significant differences were observed among the three varieties. However, significant differences emerged at 6, 8, 10, and 12 weeks after planting. At 6 weeks, the local variety and Rayna 15 variety were statistically similar, but both differed significantly from Borlaug 100. By 8, 10, and 12 weeks

after planting, significant differences were observed among all three varieties. The results indicate that wheat treated with NPK fertilizer achieved the highest mean leaf length (19.42 cm), while rabbit dung recorded the lowest mean leaf length (6.46 cm). At 2 weeks after planting, there were no significant differences among control, cow dung, poultry dropping and rabbit dung. NPK fertilizer and rabbit dung were also statistically similar, but NPK fertilizer differed significantly from control, cow dung and poultry dropping. At 4 weeks after planting, control, cow dung and poultry dropping were statistically similar but differed significantly from rabbit dung. NPK fertilizer, poultry dropping and control also showed no significant differences. At 6 weeks after planting, cow dung, poultry dropping and rabbit dung were statistically similar but differed significantly from NPK fertilizer. Control and NPK fertilizer showed no significant difference. By 8 weeks after planting, control, cow dung, poultry dropping and rabbit dung were statistically similar but significantly different from NPK fertilizer. At 10 weeks after planting, control, cow dung and rabbit dung were statistically similar but differed significantly from NPK fertilizer. Poultry dropping and control were significantly different during this period. At 12 weeks after planting, cow dung, poultry dropping and rabbit dung were statistically similar but significantly different from NPK fertilizer. Control and NPK fertilizer also

Table 4: Effects of Variety and Manure on Leaf Width (cm) and Number of Spikes per Plant 8,10 and 12 weeks after Planting (WAP).

Treatment	2WAP	4WAP	6WAP	8WAP	10WAP	12WAP
LEAF WIDTH						
Variety						
Local variety	0.32a	0.68a	0.89a	1.00a	1.06a	1.12a
Rayna 15	0.38a	0.63a	0.88a	0.98a	1.05a	1.09a
Borlaug 100	0.43a	0.60a	0.86a	0.99a	1.03a	1.13a
Significance	ns	ns	ns	ns	ns	ns
LSD	-	-	-	-	-	-
Manures						
Control	0.34a	0.62b	0.86b	0.93b	0.99c	1.05b
Cow dung	0.38a	0.68ab	0.91ab	0.98ab	1.03bc	1.08ab
Poultry dropping	0.32a	0.62b	0.95a	1.03a	1.06ab	1.17a
Rabbit dung	0.35a	0.74a	0.93ab	1.02a	1.07ab	1.23ab
NPK fertilizer	0.35a	0.50c	0.74c	1.03a	1.08a	1.13ab
Significance	ns	***	***	*	**	*
LSD	-	0.18	0.18	0.16	0.08	0.17
NUMBER OF SPIKES						
Variety						
Local variety				1.61b	2.47b	2.99b
Rayna 15				3.20a	5.90a	6.63a
Borlaug 100				4.31a	6.56a	6.95a
Significance				**	***	***
LSD				1.74	2.27	2.26
Manures						
Control				2.99ab	4.16bc	4.66bc
Cow dung				2.18b	2.69c	3.12c
Poultry dropping				2.78ab	5.43ab	5.87ab
Rabbit dung				4.30a	6.78a	7.33a
NPK fertilizer				2.94ab	5.83ab	6.56ab
Significance				ns	**	**
LSD				-	3.93	3.91

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability

ns: there is no significant difference.

*there is significant difference

differed significantly. Additionally, control, cow dung, and rabbit dung were statistically similar at this stage.

Leaf width

Table 4 presents the effects of different wheat varieties and fertilizer treatments on the leaf width of *Triticum aestivum* L. (Wheat) at 2, 4, 6, 8, 10, and 12 weeks after planting (WAP) in Jos Plateau State. The results indicate that Borlaug 100 had the highest mean leaf width (1.13 cm), while the local variety recorded the lowest mean leaf width (0.32 cm). No significant differences were observed among the three varieties at all growth stages (2, 4, 6, 8, 10, and 12 WAP). Wheat treated with rabbit dung achieved the highest mean leaf width (1.23 cm), while wheat treated with poultry dropping had the lowest mean leaf width (0.32 cm). At 2 WAP, there were no significant differences among the five fertilizer treatments. However, significant differences ($P \leq 0.05$) were observed at 4, 6, 8, 10, and 12 WAP. At 4 WAP, the control (no manure), cow dung and poultry dropping were statistically similar but significantly different from rabbit dung. Rabbit dung and poultry dropping were statistically comparable, but NPK fertilizer differed significantly from both rabbit dung and the control. At 6 WAP, the control, cow dung and rabbit dung were statistically similar but significantly different from NPK

fertilizer. Additionally, the control, poultry dropping and NPK fertilizer were significantly different from each other. At 8 WAP, poultry dropping, rabbit dung and NPK fertilizer were statistically similar but significantly different from the control. Similarly, the control and cow dung showed no significant difference. At 10 WAP, poultry dropping, rabbit dung and NPK fertilizer remained statistically similar but differed significantly from the control. The control and cow dung were also statistically similar but significantly different from NPK fertilizer. At 12 WAP, cow dung, poultry dropping, rabbit dung and NPK fertilizer were statistically similar, while the control differed significantly from poultry dropping. The control, cow dung, rabbit dung and NPK fertilizer were statistically similar across this stage.

Number of spikes

Table 4 presents the effects of wheat variety and different fertilizer treatments on the number of spikes of *Triticum aestivum* L. (Wheat) at 8, 10, and 12 weeks after planting (WAP) in Jos Plateau State. The results indicate that Borlaug 100 recorded the highest mean number of spikes (6.95), while the local variety produced the lowest mean number of spikes (1.61). At 12 WAP, there were no significant differences among the three varieties. However, significant differences were observed at 8 and 10 WAP.

Table 5: Effects of Variety and Manure on Number of Seeds per Spike (NSPS), Number of Seeds Per Plant (NSPPS) and Seeds Weight Per Plant (SWPP) (g) after Harvest.

Treatment	Number of Seeds Per Spike	Number of Seeds Per Plant	Seed Weight Per Plant (g)
Variety			
Local variety	12.13b	37.87b	3.27c
Rayna 15	23.00a	141.53a	9.73a
Borlaug 100	21.73a	140.47a	7.87b
Significance	***	***	***
LSD	5.43	52.59	1.55
Manures			
Control	18.44a	78.22b	6.89ab
Cow dung	20.67a	75.56b	7.78a
Poultry dropping	18.00a	120.67ab	6.44ab
Rabbit dung	19.00a	124.00ab	7.67a
NPK fertilizer	18.67a	134.67a	6.00b
Significance	Ns	Ns	ns
LSD	-	-	-

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability

ns: there is no significant difference.

*there is significant difference

At these stages, Rayna 15 and Borlaug 100 were statistically similar but significantly different from the local variety. In terms of fertilizer treatments, wheat plants treated with rabbit dung exhibited the highest mean number of spikes (7.33), whereas those treated with cow dung had the lowest (2.18). At 8 WAP, there were no significant differences among the control, cow dung, poultry dropping and NPK fertilizer, although rabbit dung significantly differed from cow dung. At 10 and 12 WAP, poultry dropping, rabbit dung and NPK fertilizer were statistically similar, while significant differences were observed between the control (no manure) and cow dung.

Number of seeds per spike

Table 5 illustrates the effects of different wheat varieties and fertilizer treatments on the number of seeds per spike (*Triticum aestivum* L.) at harvest in Jos Plateau State. The results indicate that Rayna 15 recorded the highest mean number of seeds per spike (23.00), while the local variety produced the lowest mean number of seeds per spike (12.13). Rayna 15 does not differ significantly ($P > 0.05$) from Borlaug 100 but significantly different from the local variety at harvest. Regarding fertilizer treatments, wheat plants treated with cow dung exhibited the highest mean number of seeds per spike (20.67), while those treated with poultry dropping had the lowest (18.00). Statistically, there were no significant differences among the control, cow dung, poultry dropping, rabbit dung and NPK fertilizer at harvest.

Number of seeds per plant

Table 5 however, highlights the effects of wheat variety and fertilizer treatments on the number of seeds per plant (*Triticum aestivum* L.) at harvest in Jos Plateau State. The results indicate that Borlaug 100 achieved the highest mean number of seeds per plant (140.47), while the local

variety recorded the lowest (37.87). Rayna 15 and Borlaug 100 were statistically similar but significantly different from the local variety at harvest. In terms of fertilizer treatments, wheat plants treated with rabbit dung produced the highest mean number of seeds per plant (134.67), whereas those treated with cow dung had the lowest (75.56). Statistically, no significant differences were observed among the control (no manure), cow dung, poultry dropping and rabbit dung at harvest. However, significant differences were found between NPK fertilizer, the control and cow dung at harvest.

Seeds weight per plant

Table 5 also presents the effects of wheat variety and fertilizer treatments on the seed weight per plant (*Triticum aestivum* L.) after harvest in Jos Plateau State. The results show that Rayna 15 recorded the highest mean seed weight per plant (9.73 g), while the local variety had the lowest mean seed weight per plant (3.27 g). Statistically significant differences were observed among the local variety, Rayna 15 and Borlaug 100 after harvest. For fertilizer treatments, wheat plants treated with cow dung achieved the highest mean seed weight per plant (7.78 g), while those treated with NPK fertilizer had the lowest (6.00 g). Statistically no significant differences were found among the control (no manure), cow dung, poultry dropping and rabbit dung after harvest. However, significant differences were observed between NPK fertilizer and rabbit dung as well as cow dung.

Yield data

The analysis of variance on (Table 6) revealed that wheat variety had a highly significant effect ($P \leq 0.001$) on grain yield at harvest, whereas the effect of different manure types was not statistically significant. Among the wheat varieties evaluated, Rayna 15 produced the highest yield

Table 6: Effects of Variety and Manure on yield of *Triticum aestivum* L (Wheat) at harvest.

Treatment	Yield (t/ha)
Variety	
Local variety	8.17c
Rayna 15	24.33a
Borlaug 100	19.67b
Significance	***
LSD	0.63
Manures	
Control	19.44a
Cow dung	19.17a
Poultry dropping	17.22a
Rabbit dung	16.11a
NPK fertilizer	15.00a
Significance	ns

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability

ns: there is no significant difference.

*there is significant difference

of 24.33 t/ha, significantly outperforming the other two varieties. Borlaug 100 followed with a yield of 19.67 t/ha, which was significantly higher than the Local variety but lower than Rayna 15. The Local variety recorded the lowest yield of 8.17 t/ha. The Least Significant Difference (LSD) at 5% probability level for variety was 0.63, which confirmed clear varietal differences in yield. While for the manure treatments: Although Control (19.44 t/ha) and Cow dung (19.17 t/ha) yielded relatively higher values, followed by Poultry dropping (17.22 t/ha), Rabbit dung (16.11 t/ha), and NPK fertilizer (15.00 t/ha), the differences among them were not statistically significant (ns), indicating similar performance in terms of yield contribution under the conditions of this study. These results suggest that varietal selection plays a more critical role in enhancing wheat yield than the type of manure applied under the given experimental conditions. The superior performance of Rayna 15 highlights its potential as a high-yielding variety suitable for cultivation in the study area.

DISCUSSION

The results provided in this research is the reflection of the effects of different fertilizer (organic manure and inorganic fertilizer) treatments on the three wheat varieties used in the experiment. Variety significantly influenced growth and yield of *Triticum aestivum* L. Anil *et al.* (2020) and Sanjay *et al.* (2020) reported that plant height of wheat is determined by type of variety used, and this can be seen in Borlaug 100 variety had mean number of 25.28 cm which was the tallest plant, while Rayna 15 had the least of 9.60 cm and was the shortest in height indicating that wheat plant height depends on the variety. Growth and yield parameters of wheat such as number of leaves, number of spikes and seed weight were also influenced by the variety used. Local variety produced the highest number of leaves, this was seen in the highest mean number of leaves that it had while Rayna 15 least number of leaves.

Control treatment recorded the least mean value of growth and yield parameters of wheat, this was due to low soil nutrients, hence, indicating that there is a need to incorporate fertilizer into soil in order to improve performance of growth and yield parameters in wheat and plants generally. This was in line with Moyin and Emmanuel (2015), who reported that organic fertilizer applied to soil increases the soil pH, N, P, K, Ca and Mg concentration increases in growth parameters such as leaves. The research results clearly present the positive impact of different organic manures on the growth and yield parameters of wheat. Wheat plants treated with cow dung organic manure were very tall, which indicates the resultant effects of organic manure. More so, the research showed wheat plants treated with rabbit manure produced the highest number of spikes, this is in line with Samira *et al.* (2017), who reported that cereal grains and straw yield increased by 37% and 40% respectively when fertilizer were incorporated compared to when there was no fertilizer application.

Generally, the significant increase in wheat stem girth, leaf width, number of spikes and number of seeds per plant obtained with the application of rabbit manure could be due to its rich and balanced nutrients (N, P, K, Ca, and Mg) and least C/N ratio which are important requisites for sustainable performance of the wheat plants. This is in agreement with the findings of Jubril and Fayam (2012), who reported that higher number of wheat tillers obtained with 7.5 t/ha of rabbit manure might be attributed to the more readily available nitrogen, which played a vital role in cell division. Mojid *et al.* (2012) reported that wheat has high requirement for nitrogen (N), potassium (K), phosphorus (P), zinc and sulphur. The deficiency of nitrogen either organic or inorganic forms to wheat leads to stunted growth and low yield. Amanda *et al.* (2020) reported that potassium is important in water conservation, grain filling and formation, strengthening of plant stem, enhancing flowering and yields. This evidence had significant increase in wheat stem girth, leaf width, number

of spikes and number of seeds per plant obtained with the application of rabbit manure compared to others might be due to its rich and balanced nutrients (N, P, K, Ca, Mg) and least C/N ratio which were made available to wheat crop very quickly for uptake and sustainable performance. Fertilizers are amendments applied to promote plant growth. Nitrogen, phosphorus and potassium (N.P.K) are the most commonly used inorganic fertilizers for plant growth and yield improvement (Dwaipayyan and Pramod, 2020), wheat requires use of organic inputs such as animal manures, crop residues, green manures, sewage sludge, and food industry wastes to promote growth and grain yield. The implication of this result is that farmers should go for an improved variety of wheat such as Borlaug 100, which has the highest plant height, highest leaf width, highest number of spikes and highest number of seeds as observed in the results of the experimence

Conclusion

The research revealed that rabbit manure had the most positive impact on both growth and yield parameters such as stem girth, number of leaves, leaf width and number of seeds of *Triticum aestivum* L. (wheat) while inorganic fertilizer (N.P.K 20.10.10,) had the least impact. Other manure used like cow dung and poultry dropping had moderate impact on both growth and yield of *Triticum aestivum* L. However, the rabbit manure is recommended to be the best organic fertilizer amendment for the cultivation of *Triticum aestivum* L. (wheat) in Jos Plateau State. And as regard to the variety, Borlaug 100 is the best wheat variety for cultivation of wheat in Jos, Plateau State.

Recommendation

Based on the findings of this research, wheat farmers in Jos Plateau State are encouraged to utilize rabbit dung as an organic manure amendment for the cultivation of *Triticum aestivum* L. (wheat). Additionally, I recommend conducting further studies to investigate the combined and comparative effects of organic manure and inorganic NPK fertilizer on wheat cultivation in Jos Plateau State.

Conflict of interest statement

The authors declare no conflicts of interest regarding the research, authorship, and publication of this study. The study was conducted independently, without any financial or personal relationships that could have influenced its outcomes or interpretations. All funding and resources utilized were from the authors, transparently disclosed and solely aimed at advancing the understanding of wheat cultivation

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