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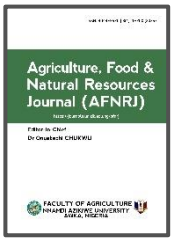

Original Article

Effects of commercial organic fertilizer and poultry manure on soil properties, yield and proximate composition of radish (*Raphanus sativus* L.)

OPEN ACCESS

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ABSTRACT

Organic fertilizer is known for its ability to improve soil fertility and enhance the availability of nutrients to the plant. To examine the impacts of commercial organic fertilizer (Agrodyke) and poultry manure on soil parameters, yield, and the proximate composition of radish (Raphanus sativus), as well as residual effects, a pot experiment was carried out at Bukola Farm in Oke Oyi, Kwara State, Nigeria. Ten treatments were used in the experiment: Control (T0), Agrodyke 10g (T1), Agrodyke 20g (T2), and Agrodyke 30g (T3) in 1.5, 3, and 4.5 litres of water respectively, Poultry manure – 90 kgN/ha (T4), poultry manure – 100 kgN/ha (T5), poultry manure – 110 kgN/ha (T6), poultry manure – 120 kgN/ha (T7), poultry manure – 130 kgN/ha (T8), and NPK (T9). Three replicates were used in the completely randomized design (CRD) of the experiment. Data collected were subjected to analysis of variance (ANOVA), and differences in the treatment means were separated using Duncan's Multiple Range Test (DMRT) at 5 % level of significance. Application of poultry manure at 130 kg N/ha (T8) resulted in maximum values of growth and yield attributes, viz., number of leaves (15.1), stem girth (32.39 mm), root yield (126.8 g), and leaves weight (47.4 g). The residual nutrients and proximate composition, viz., ash, moisture content, crude fiber, and crude fat, in roots were also reported maximum by the application of poultry manure at 130 kg N/ha. Therefore, it can be concluded that using poultry manure increased radish quality and had better residual nutrients than NPK and Agrodyke organic fertilizer.

KEYWORDS: *Fertilizer, Poultry manure, Raphanus sativus, yield,*

INTRODUCTION

The edible root vegetable radish (*Raphanus sativus* L.), belongs to the Brassicaceae family, is cultivated and eaten all over the world (Lanna, 2018). While the napiform tap root is the most often consumed part of the plant, the entire plant can be eaten, and the tops can be utilized as a leaf vegetable. It can be prepared as a vegetable or consumed raw as a salad. Radish boosts hunger, avoids constipation, and has a cooling impact. Patients with jaundice, liver problems, and piles are advised to take it. Fresh leaf juice has laxative and diuretic properties. (Kushwah *et al.*, 2019.) With 15–40 mg of vitamin C (ascorbic acid) per 100 g of edible material, radishes are a significant source of nutrients. Aluminum, barium, lithium, manganese,

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silicon, titanium, fluorine and iodine are among the trace elements found in radish (up to 18 u g/10 g) (Bose *et al*., 2000). Beside tender leaves which are used as greens are rich in vitamin-A and C. roots are also rich in carbohydrate and protein. (Kushwah *et al.*, 2019). Commercial organic fertilizer, such as Agrodyke, is 100% pure multipurpose organic fertilizer that is environmentally friendly and inhibits pests, fungi, insects, and bacteria (Oyewo, 2023). Chemical fertilizers decrease the quality of produce and are expensive too, resulting in reduction in net profit and returns to the farmers (Xu *et al*., 2022). Organic manures enable sustainable crop production and soil fertility, and farmers are being encouraged to use them due to the rising costs of chemical fertilizers and their negative effects on the environment, human health, and soil. Crop productivity benefits from the use of organic manures, such as poultry manure (Ning *et al* 2022).

The use of organic manures, such as poultry manure, to preserve soil fertility and increase crop yield has gained popularity (Kushwah *et al*., 2019). Rich in nutrients, poultry manure raises the soil's organic carbon content and enhances its physical characteristics (Agbede *et al*., 2008). Since radish is a crop with a limited growing season, its roots should grow quickly and continuously. Therefore, optimal nutrition through organic agriculture is crucial for sustainable development of high-quality radish. Recycling agricultural waste, animal dung, crop residues, and other organic materials is essential to organic farming methods. Because synthetic fertilizers are more expensive and contribute to poor soil and water quality, it is necessary to use less expensive alternatives such as commercial organic fertilizer (Agrodyke) and poultry manure manure (Oyewo, 2023).

There is a lack of updated information regarding the relative effects of poultry manure and commercial organic fertilizer (Agrodyke) on soil properties, yield, and the proximate composition of radish. This necessitated the conduct of this research. Therefore, the goal of the current study was to compare the effects of poultry manure and commercial organic fertilizer on the proximate composition, yield, and soil properties of radish.

MATERIALS AND METHOD

During the 2024 growing season, a pot experiment was conducted at a farm in Oke-Oyi, Ilorin East Local Government Area, Kwara State, Nigeria. The soil utilized in the pot experiment was collected from the surface layer (0 to 15 cm) at one of the experimental locations of Bukola Saraki Farm (Longitude 4° 42' 58" East and Latitude 8° 34' 57" North) Oke Oyi. This experiment compared the impacts of poultry manure and commercial organic fertilizer on radish yield, proximate composition, and soil properties.

For the experiment, control (zero addition), five rates of poultry manure rates at (90, 100, 110, 120, and 130 kg N/ha), three rates of commercial organic fertilizer (10 g of Agrodyke to 1.5 litres of water)- 10 g into 1.5 litres of water, Agrodyke 20 g into 3 litres of water, and Agrodyke 30 g into 4.5 litres of water and mineral fertilizer (NPK 15-15-15) 100 kg N/ha were employed (Gorakh *et al*., 2021). A completely randomized design (CRD) was utilized, with the experiment replicated three times. Poultry manure has the following nutrient content; 2.31% N, 5.02% P and 4.35% K. After being planted in pots with 25 kg of soil, four radish seeds were watered to 80% field capacity until the conclusion of the development phase. Two weeks later, the seeds were thinned to two healthy seedlings per pot. It was two weeks prior to planting when the organic fertilizers were applied. Weed control was managed manually by hand weeding throughout the trial. At 4 and 6 WAP, a sprayer was used to apply neembicidine, an organic pesticide, at a rate of 20 ml/ 10 litres of water to reduce insect pests

Soil Analysis

Before the experiment and again after harvest, a pre-cropping chemical analysis of the experimental soil utilized in the screen-house was conducted to ascertain the soil's residual effects. Soil pH was measured in 0.01M CaCl2, and the particle size distribution was ascertained using the hydrometer method (Bouyoucos, 1962). The Walkey and Black methods, as outlined by Sholeye *et al.* (2021), and the micro-Kjeldahl digestion method (Ever & Hughes (2002) were used to assess the soil organic carbon and total N, respectively. The method of Bray & Kurtz (1945) was used to extract the available P, and flame photometry was used to measure the concentrations of exchangeable bases (Ca, Mg, K, and Na) using neutral 1M NH4OAc at a soil solution ratio of 10. Magnesium and other micronutrients were determined using an atomic absorption spectrophotometer (AAS). An atomic absorption spectrophotometer was used to assess the micronutrients after they were extracted using 0.1 EDTA (Table 2).

Proximate Analysis

Proximate analysis was conducted on radish roots after harvest. After harvesting, radish root samples were taken from each fertilized plant and the control. In an oven set at 65°C, the samples were dried until their weight remained constant. A 0.5 mm sieve was used to filter the dried root samples before they were ground separately using a Wiley mill for tissue analysis. As stated by Chihoub *et al*. (2019), the total content of ash, fibers, crude proteins, dry matter, crude fat, and carbohydrate were examined.

Data collection and analysis

The following growth and yield parameters were measured: plant height, stem girth, and number of leaves—were recorded at 2, 4, 6, and 8 WAP. At harvest, the fresh weight of each plant's leaves, root diameter, and root yield were measured. Data were analyzed using the DSAASTAT version 1.101 statistical software. Duncan's Multiple Range Test (DMRT) was used at a 5% probability level to distinguish the treatment means if significant differences were present

RESULTS AND DISCUSSION

The results of the physical and chemical investigation of the soil under study are displayed in Table 1. The soil class was loamy sand and slightly acidic with pH of 6.1. The pH of most agricultural soils in tropics has been reported to range from 5.0 to 6.8 (Olowoake, 2017). The available phosphorus, calcium, magnesium, and total nitrogen are all quite low (Mustapha *et al* 2020). Calcium content was 2.56 cmol/kg, compared with the critical level; given as 2.6 cmol/kg (Olowoake *et al*., 2024). The requirement to improve radish performance is indicated by the low soil contents for the major nutrients. This implies that the soil in the zone is relatively low in both micro and macro elements and cannot support radish growth and yield without external amendments. Afe *et al*. (2024) reported that the continual farming and the indiscriminate use of synthetic fertilizers, which are prevalent among the farmers in the area, are the causes of low nutrient status of Savannah soils

Table 1. Physical and chemical properties of experimental soil

Parameters	Soil test value
pH (H_2O)	6.1
Org.C (%)	0.98
Total N (%)	0.11
P (mg/kg)	9
Exchangeable bases (cmol/kg)	
Mg	0.99
Ca	2.56
Na	0.28
K	0.41
Extractable micronutrients (mg/kg)	
Cu	1.22
Fe	118
Mn	127
Zn	1.06
Sand (%)	79
Silt (%)	13
Clay (%)	8
Textural class	Loamy sand

Effect of treatments on growth and radish yield parameters:

Table 2 displays the heights of the plants as impacted by NPK and organic amendments. After eight weeks of applying a treatment of 120 kg N/ha of poultry manure (PM), plant heights grew from the second week after planting (WAP) by approximately 86%. The values of plant height derived from the application of Agrodyke and NPK during the growing season showed significant differences ($p<0.05$). According to the results, the only fertilizer treatment that substantially varied from all other fertilizer treatments, including control, at the end of 8 WAP was poultry manure at 120 kg N/ha. Given the poor baseline nutritional status of the experimental soil and the high nutrient levels provided by the amendments, the favorable response of radish growth may be explained. Due to the influence of the mineral component on organic matter, poultry manure at 130 kg N/ha produced the maximum plant height of 29.1 cm. This is due to the fertilizer's nutrient mineralization favorable (Olowoake & Ojo, 2014). All of the fertilizer treatments had significantly different leaf counts ($p<0.05$) from the control.

Table 3 demonstrates how NPK fertilizer dramatically increased leaf yield from 2WAP to 4WAP, but at 130 kg N/ha, poultry manure raised the radish's height from 6 WAP to 8 WAP, and it continued the trend for the other treatments, including control, from 6 weeks until harvest. Regarding the number of leaves in pots treated with Agrodyke fertilizers, there were no notable variations in the number of leaves ($P<0.05$). Given that poultry manure produces 130 kg N/ha more leaves than NPK, this could be because the former releases nutrients more sustainably than the latter (Olowoake *et al*., 2022).

Radish stem girth response to NPK and organic fertilizer application is displayed in Table 4. Significant effects of the fertilizers were seen in the root vegetable. At 2 WAP, the radish's stem girth from NPK was considerably ($p<0.05$) greater than that from the control and other fertilizer treatments. However, the maximum stem girth of 32.39 mm, 48% higher than the control, was obtained at 8 WAP by using poultry manure at 130 kgN/ha. When compared to other fertilizers, the increased stem girth of radish plants after applying poultry manure may be related to the manure's constant supply of nutrients. This observation was in agreement to what Olowoake *et al*. (2024) reported.

Table 2. Effect of fertilizer types on height of radish

Treatment	------Weeks After Planting ------- (cm)			
	2	4	6	8
Control (T0)	3.2ab	7	9.7c	10.4d
Agrodyke 10g (T1)	4.1abc	7	15.2b	16.3d
Agrodyke 20g (T2)	4.7ab	8.6	18.5ab	19,2bc
Agrodyke 30g (T3)	4.8ab	8.5	14.7b	15.0d
Poultry manure – 90 kgN/ha (T4)	5.3ab	9.6	20.2ab	22.4b
Poultry manure 100 kgN/ha (T5)	5.3ab	10.5	22.2a	24.9b
poultry manure– 110 kgN/ha (T6)	5.1ab	10.5	18.9ab	19.6bc
poultry manure– 120 kgN/ha (T7)	4.1ab	8.2	20.8ab	29.1a
poultry manure– 130 kgN/ha (T8)	6.6a	8.7	24.2a	26.6b
NPK (T9)	4.7ab	9.2 ns	20.0ab	25.0b

Means having the same letter along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level

Table 3. Effect of fertilizer types on number of leaves of radish

Treatment	------ Weeks After Planting ---- cm			
	2	4	6	8
Control (T0)	3.3bcd	3.2e	6.0d	8.2e
Agrodyke 10g (T1)	3.3bcd	3.8d	7.3c	12.5c
Agrodyke 20g (T2)	3.5bcd	5.3c	7.6c	12.8c
Agrodyke 30g (T3)	3.7bcd	5.8c	7.8c	12.9c
Poultry manure – 90 kgN/ha (T4)	3.7bcd	7.3b	8.5b	11.1d
Poultry manure 100 kgN/ha (T5)	4.3bc	7.3b	8.5b	11.3d
poultry manure–110 kgN/ha (T6)	3.7bcd	7.3b	8.6b	13.6b
poultry manure–120 kgN/ha (T7)	4.3bc	7.5b	9.7a	13.5b
poultry manure–130 kgN/ha (T8)	4.7b	7.3b	9.7a	15.1a
NPK (T9)	6.2a	8.5a	9.8a	14.1b

Means having the same letter along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level

Table 4. Effect of fertilizer types on stem girth of radish

Treatment	------- Weeks After Planting ------ (mm)			
	2	4	6	8
Control (T0)	1.79f	3.53f	6.55f	16.89e
Agrodyke 10g (T1)	2.53def	4.30ef	11.31e	21.47c
Agrodyke 20g (T2)	2.65de	4.62de	11.76e	23.63b
Agrodyke 30g (T3)	2.85de	4.73de	11.87e	24.64b
Poultry manure – 90 kgN/ha (T4)	2.86de	5.13cd	14.53d	19.47d
Poultry manure 100 kgN/ha (T5)	3.12cd	5.75bc	14.59d	19.82d
poultry manure–110 kgN/ha (T6)	2.69de	5.58c	16.55c	21.08cd
poultry manure–120 kgN/ha (T7)	3.71bc	5.59c	16.67c	24.43b
poultry manure–130 kgN/ha (T8)	4.00ab	7.13a	20.95b	32.39a
NPK (T9)	4.56a	6.40b	21.64a	32.21a

Means having the same letter along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level

The effects of several fertilizer types on radish root yield parameters are presented in Table 5. Every treatment was significantly ($p<0.05$) different from the control. PM130 > NPK > PM120 > Agrodyke 3 > PM 110 > PM 100 > Agrodyke 2 > Agrodyke 1 > PM90 > Control was the order of the radish root weights. The radish root yield of poultry manure at 130 kgN/ha with pot treated with NPK did not change significantly ($p<0.05$). When compared to other radish root diameters from fertilizer treatments, NPK had the largest (43.70 mm). This was aligned to research by Kumar *et al.* (2017) and Kiran *et al.* (2016) they found that NPK increased radish root diameter.

Table 5 illustrates that the maximum radish leaf weight (47.4 g) was recorded under poultry manure at 130 kgN/ha. When compared to other fertilizer treatments, including control, poultry manure at 130 kgN/ha was significantly different. The control showed the least value for the weight of the radish leaves (13.1 g). High level of nitrogen causes the leaves to increased fresh weight. Nitrogen is converted into amino acids, which are included in complex proteins and contribute to the promise of opulent crop growth (Kushwah *et al*., 2019). Several scientists, such as Adekiya *et al*. (2018) and Kiran *et al*. (2016), have recommended the use of manures, citing significant improvements in plant growth and leaf weight of radish output when using organic manures.

Table 5; Effect of fertilizer types on yield parameters of radish

Treatment	Root yield (g)	Diameter of root (mm)	Weight of Radish leaves (g)
Control (T0)	24.6e	19.7f	13.1f
Agrodyke 10g (T1)	35.9d	23.9e	15.5e
Agrodyke 20g (T2)	36.3d	24.5e	17.5e
Agrodyke 30g (T3)	55.6c	25.5e	19.6e
Poultry manure – 90 kgN/ha (T4)	32.7d	23.3e	24.9d
Poultry manure 100 kgN/ha (T5)	42.1c	27.9d	28.3d
poultry manure–110 kgN/ha (T6)	48.9c	32.6c	32.3c
poultry manure–120 kgN/ha (T7)	63.1b	33.6b	36.9b
poultry manure–130 kgN/ha (T8)	126.8a	37.6b	47.4a
NPK (T9)	119.5a	43.7a	32.5b

Means having the same letter along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level

Proximate composition of Radish

Applying commercial organic fertilizer (Agrodyke) and poultry manure significantly influenced the radish's proximate composition in terms of ash, moisture, crude fiber, crude protein, crude fat, dry matter, and carbohydrates. Table 6 displays the information. The radish root's proximate composition was raised by applying 130 kg N/ha of poultry manure. Notably, radish roots from pots treated with 30 g of Agrodyke in 4.5 litres of water also showed elevated levels of ash and crude fat, although these were still lower than those treated with the highest poultry manure rate. This increase was due to the consequence of enough nutrients being available for plant uptake, which were then transferred to the proper sources

and divided into their corresponding sinks. Applying organic fertilizer to nutrient-limited soil enhanced the amount and quality of biomass and proximate elements of maize, according to Aboyeji, (2019). The radish roots treated with organic manure exhibited higher quality than those treated with inorganic fertilizer treated pots, (Subedi et al., 2018). This was evident in the increased levels of ash, moisture, crude fiber, crude protein, crude fat, dry matter, and carbohydrates in pots treated with 130 kg N/ha of poultry manure compared to radish roots from pots treated with NPK fertilizer. Adeleye et al. (2024) have shown similar outcomes in carrot.

Table 6. Proximate analysis of *Raphanus sativus*

Treatment	Ash	Moisture	Crude fibre	Crude protein	Crude fat	Carbohydrate	Dry matter
	---------- % ----------						
Control (T0)	1.20c	10.0f	2.5j	8.3g	15.8f	87.7ef	59.5c
Agrodyke 10g (T1)	1.30bc	10.4def	3.5i	9.1g	16.2f	90.0a	60.3b
Agrodyke 20g (T2)	1.4b	10.5def	6.9h	11.07f	18.6cd	89.5abc	61.53a
Agrodyke 30g (T3)	1.39b	11.0cde	7.6g	14.2e	19.3b	89.0bcd	46.51e
Poultry manure – 90 kgN/ha (T4)	1.31bc	12.1ab	9.8b	17.1c	18.1d	87.9ef	41.69g
Poultry manure 100 kgN/ha (T5)	1.4b	11.5bc	8.1f	15.0de	19.3b	88.5de	44.8f
poultry manure– 110 kgN/ha (T6)	1.35b	10.38ef	8.5e	16.0cd	19.0bc	89.62ab	54.77d
poultry manure– 120 kgN/ha (T7)	1.6a	12.5bc	8.8d	17.0c	21.2a	88.5de	39.9h
poultry manure– 130 kgN/ha (T8)	1.55a	12.55a	10.3a	21.0a	21.6a	87.45f	35.0i
NPK (T9)	1.37b	11.25cd	9.1c	19.0b	17.2e	88.75cd	40.08h

Means having the same letter along the columns indicate no significant difference using Duncan Multiple Range Test at 5% probability level.

Table 7. Effects of fertilizer types on some soil chemical and physical properties at harvest

Treatment	pH (H2O)	Organic carbon (%)	Total N (%)	Available P (mg/kg)	K (cmol/kg)	Sand	Silt	Clay
						_____(%)_____		
Control (T0)	6.3h	0.26d	0.52i	9.90d	0.22h	80cd	10bc	10ab
Agrodyke 10g (T1)	6.9f	0.20f	0.64g	16.8c	0.30f	81c	12a	7d
Agrodyke 20g (T2)	7.2d	0.22e	0.65g	17.7c	0.31f	88b	5d	7d
Agrodyke 30g (T3)	7.1e	0.38c	0.76f	19.7c	0.31f	80cd	9c	11a
Poultry manure – 90 kgN/ha (T4)	7.2d	0.16g	0.84e	22.5bc	0.39e	79d	12a	9bc
Poultry manure 100 kgN/ha (T5)	7.2d	0.16g	0.89d	21.8bc	0.44d	80cd	11ab	9bc
poultry manure– 110 kgN/ha (T6)	7.3c	0.42b	0.95c	22.6bc	0.46c	81c	9c	10ab
poultry manure– 120 kgN/ha (T7)	7.8b	0.42b	1.0b	27.4b	0.72b	87a	5d	8cd
poultry manure– 130 kgN/ha (T8)	7.9a	0.54a	1.15a	30.4a	0.88a	87a	6d	7d
NPK (T9)	6.5g	0.42b	0.59h	15.3cd	0.28g	81c	9c	10ab

Means having the same letter along the columns indicate no significant difference using Duncan Multiple Range Test at 5% probability level. Legend: TC- Tithonia compost

Effect of treatments on soil physical and chemical properties

The impact of the different fertilizer treatments on the soil's pH, total N, available P and K, and percentage of clay, silt, and sand at the time of radish plant harvest is shown in Table 7. When poultry manure was applied, the contents of N, P, K, organic carbon, and pH increased significantly ($p < 0.05$). The highest values were obtained when poultry manure was administered at 130 kg N/ha. Poultry manure application in this experiment led to comparatively significant increases in soil nutrient concentrations (such as total N), which was caused by the

amendments. The increase in soil pH could be explained by ion exchange reactions, which take place when organic anions like malate, citrate, and tartrate decomposition products of poultry manure replace the terminal OH^- of Al3+ or Fe2+ hydroxyl oxides (Duruigbo, 2007). The presence of basic cations in the poultry manure could also have contributed to the organic manure's capacity to raise the pH of the soil. According to Yan et al. (2022), microbial decarboxylation releases these basic cations. Increased microbial activity due to higher nitrogen concentrations caused the rise in soil available N levels following the application of poultry manure at 130 kg N/ha. This have led to more organic forms of nitrogen breaking down and becoming available. Poultry manure had the highest soil available P content (30.4 mg/kg), 50% more than the NPK pot's soil available P content. Compared to control pots or NPK fertilizer, the available P contents rose higher. This illustrates the large amount of P present in the manure. Olowoake et al. (2024) have reported an increase in P availability following poultry manure applications. The amount of soil organic matter has a direct correlation with the amount of residual K in the soil (Belay et al., 2002). In general, leaching in pots treated with NPK fertilizer could be the cause of the notable increase in soil nutrients, particularly N, P, K, and organic carbon, in organic additions as compared to NPK fertilizer (Adekiya et al., 2020).

CONCLUSION AND RECOMMENDATIONS

In terms of all radish growth parameters and radish plant quality, these results indicated that 130 kg N/ha of poultry manure was the most effective treatment. In comparison with other treatments, poultry manure also increased the amount of nutrients in the soil. Given its better results, poultry manure is highly appealing substitute for fertilizer, especially for annual crops like radish that have a short development cycle. Therefore, a more effective way to maintain soil fertility and productivity would be to use fertilizer made from poultry manure.

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Authors' Contributions

Author AAO wrote the manuscript first draft. Authors AIA, JAO & KOA managed data collection, interpretation of data, second draft of manuscript, material support, and review of manuscripts and wrote the first draft of the manuscript. Authors AAO, AAW, TAA & SKS managed the literature searches. AAO, JAO & TAA managed the development of methodology, data analysis. All authors read and approved the final manuscript.

Ethical Statement

Not applicable

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