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Effect of Varying Rates of Poultry Manure on the Morphological Characteristics of Elephant Grass (*Pennisetum purpureum*)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Elephant grass is native to tropical Africa and the sub-Saharan region and has been introduced as a valuable and popular forage crop in many tropical and subtropical countries. Poultry manure is a valuable source of organic matter and nutrients that enhance soil fertility and promote the growth of crops. This study investigated the effects of varying rates of poultry manure on the morphological characteristics of elephant grass (*Pennisetum purpureum*) at the Department of Crop Science Teaching and Research Farm, University of Nigeria, Nsukka. The experiment employed a Completely Randomised Design (CRD) with five treatments: 0 (control), 5, 10, 15, and 20 tons of poultry manure per hectare, replicated five times. Morphological parameters, including stem height, stem girth, leaf length, and number of shoots, were measured weekly for eight weeks after planting. The data obtained were analysed using analysis of variance (ANOVA). Results demonstrated that poultry manure significantly ($P<0.05$) influenced elephant grass growth from weeks 2 to 8, while

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only stem height was significant in week 1. Although the application rates of 10 and 15 t/ha did not differ significantly (P>0.05), the 15 tons/ha application rate consistently produced the highest mean values across all morphological parameters, closely followed by the 10 tons/ha rate. Notably, the control treatment (0 tons/ha) exhibited the lowest growth responses, highlighting the critical role of organic amendments in soil fertility and plant development. The 20 tons/ha rate underperformed compared to moderate rates, suggesting potential nutrient toxicity or soil structure complications at higher application levels. The study concluded that moderate poultry manure application rates (10-15 tons/ha) optimise elephant grass establishment by providing an ideal balance of nutrients, improving soil moisture retention, and enhancing microbial activity. Ultimately, the research recommends a 10 tons/ha application rate for farmers, balancing cost-effectiveness, environmental considerations, and forage production efficiency.

Keywords: Elephant grass; poultry manure; tropical Africa; perennial grass; soil.

1. INTRODUCTION

"Elephant grass (*Pennisetum purpureum*) is a monocot belonging to the Poaceae family (grass family) and of the genus Pennisetum (Pennisetum Rich. Ex Pers.; fountain grass)" (Daher et al, 2002). "It is commonly called 'achara' by the Igbo-speaking people of southeastern Nigeria, 'ciyawagiwa' in Hausa, and 'fafa,wafa or korikoerin' in Yoruba. Elephant Grass is a tropical C4 bunchgrass with a high growth rate and biomass production. The plant has a wide geographic distribution range in the tropics and subtropics. Elephant Grass is usually associated with ecological zones prone to recurrent annual bushfires, particularly in transitions between forest belts and the savannah ecological zones" (Danquah *et al*., 2018; de Favare *et al*., 2019). "Elephant grass is native to tropical Africa and the sub-Saharan region" (Clayton *et al*., 2013; Creamers & Aranguiz, 2019) "and has been introduced as a valuable and popular forage crop in many tropical and subtropical countries" (FAO, 2013). "In 1913, this grass was introduced to the United States. In the 1950s, it was introduced into Central and South America and the West Indies, and in the 1960s into Australia. By 1971, it was already established in the natural areas of Florida. It is commonly naturalised and sometimes becomes invasive" (CABI, 2014). It is often regarded as a weed in crops, along roadsides, waterways, wetlands, floodplains, swamps, forest edges, disturbed areas, and wastelands.

"Elephant grass is a tall perennial grass with a luxuriant and rapid growth rate" (Akinola, 2021; Halim *et al*, 2013). "It has high productivity, regeneration capacity, tolerance to adverse conditions, and high adaptability, among other important agronomic characteristics" (Akah & Onweluzo, 2014). "*P. purpureum* has a vigorous root system developing from the nodes of a creeping stolon. It is very similar in appearance to sugarcane (*Saccharum officinarum*), but its leaves are narrower and its stems are taller" (DAFF, 2014). "Elephant grass is a summer-growing plant that grows under a wide range of conditions and systems; dry or wet conditions, smallholder and larger scale agriculture. It does well in places where the temperature ranges from 25ºC to 40ºC. One important feature of this grass is that it is tolerant to drought; therefore prefers well-drained soils and will grow well in areas where the rainfall range is 200-400mm. Elephant grass does better on rich, deep soils such as friable loams, but can grow on poorly drained clays with a fairly heavy texture or excessively drained sandy soils with a pH ranging from 4.5 to 8.5" (FAO, 2015). "It is a full sunlight species that can still produce under partial shade but does not withstand complete shade under a dense tree canopy. Elephant grass can grow up to 4-7m in height, branched above. Elephant grass forms dense, thick clumps (internode), up to 1m across. The leaves are flat, linear, and hairy at the base, up to 100-120cm long and 1-5cm wide, with a bluish-green colour. The leaf margin is finely toothed, and the leaf blade has a prominent midrib. The inflorescence is a stiff, terminal bristly spike, up to 15-20cm in length and yellow-brown to purplish. Spikelets are arranged around a hairy axis and fall at maturity. They are 4-6mm long and surrounded by 2cm long plumose bristles. There's little or no seed formation. When seeds are present, they are very small (3 million seeds/kg) therefore, propagation is usually by stem cuttings" (Heuzế *et al*., 2020). "Elephant grass is typically used as forage, an ornamental plant, and to prevent erosion. However, in some parts of Igbo land, it has been a traditional prehistoric delicacy. The young leaves and shoots are consumed in soups among these Igbo-speaking communities and can also be boiled to make tea or stew. Therefore, it has nutritional potential and is worthy of exploitation as a dietary resource. Also, infusions of the leaf and shoot can be used as medicines, and the whole plant can also be used as thatch" (Heuzế *et al*., 2020).

"Application of fertilisers supplements the soil with macronutrients needed by plants in large amounts, like nitrogen, potassium, and phosphorus. The use of inorganic fertiliser is limited by high cost and unreliable availability. Also, the recommended rates are not affordable to local farmers. Consequently, the need to explore organic fertilisers such as poultry manure as a good alternative. Poultry manure is a valuable source of organic matter and nutrients that enhance soil fertility and promote the growth of crops" (Teshale *et al*, 2022). "It is high in organic materials and contains nutrients essential for crop production. The application of poultry manure as organic fertiliser remains popular globally, and agricultural use of poultry manure is found to have a definite advantage in soil quality improvement. The application of poultry manure to the soil increased soil organic matter and other plant nutrients, thereby positively improving soil physical and chemical properties and crop yields" (Agbede & Oyewumi, 2022). "The organic matter in poultry manure enhances soil structure, water retention, and microbial activities; facilitating nutrient uptake by plants" (Telkamp, 2015). "Elephant grass accumulates a large quantity of dry matter (29kg DM/ha/year) in a single cut per year when growth is uninterrupted. Consequently, the use of poultry manure, which contains high potassium and phosphorus, and also a higher percentage of nitrogen as compared to other organic manure, may result in better production of this plant" (Girgiri et al., 2024). "In a country where food security is of utmost importance, elephant grass is an under-utilised crop as most people are not aware that it can be equally consumed by humans as it contains about 10% protein" (Dumadi *et al*, 2021; Akuru *et al*, 2015; Okaraonye & Ikewuchi, 2009). Research has focused more on its cultivation as a forage plant and its nutritional response to organic amendments, but there is a lack of specific information on how these organic fertilisers affect the grass morphologically. Also, despite the availability of poultry manure and its numerous benefits, there's limited knowledge on the most suitable application rates of this manure to elephant grass. Therefore, determining an ideal poultry manure rate for optimal growth of elephant grass is essential in order to maximise productivity and mitigate potential environmental risks such as nutrient runoff and groundwater contamination. With this in mind, further investigation and research are necessary to ascertain suitable recommendations that favour the growth of elephant grass.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out at the Department of Crop Science Teaching and Research Farm, University of Nigeria, Nsukka. It is characterized by lowland humid tropical conditions with a mean annual temperature of 29ºC to 31ºC. The Research farm is located at a latitude of 06º52N, a longitude of 07º24E, and an altitude of 477 meters above sea level (Anikwe, 2006).

2.2 Experimental Design

The experiment was laid out in a Completely Randomized Design (CRD). It consists of five treatments and a control replicated five times, giving a total of 25 experimental units. The treatments include:

- **Treatment 1 (T1):** 5 tons of poultry manure per hectare
- **Treatment 2 (T2):** 10 tons of poultry manure per hectare
- **Treatment 3 (T3):** 15 tons of poultry manure per hectare
- **Treatment 4 (T4):** 20 tons of poultry manure per hectare
- **Control (T0):** No manure will be applied

2.3 Experimental Materials

- Elephant grass shoots were sourced from a local farmers, growing it for human consumption within Nsukka, Enugu State. The shoots were cut into uniform lengths of approximately 25-30 cm, with at least 3 nodes per cutting.
- Cement bags (50kg) were used as planting containers. Each bag was filled with 17kg of topsoil.

- Topsoil was collected from the experimental site using a hoe (0-20cm).
- Poultry manure was sourced from the Department of Animal Science farm, University of Nigeria,Nsukka, and applied to the soil in each bag according to the treatment rates (5, 10, 15, 20, and 0 tons/ha).
- Other experimental materials include a weighing scale, measurement tape, hoe, and cutlass.

2.4 Data Collection

Data were collected based on the following parameters:

- **Stem height:** This was obtained in cm using a measuring tape from the base of the sprouted shoot to the tip of the stem.
- **Leaf length:** This was obtained using a measuring tape, also in cm.
- **Number of shoots per plant:** This was obtained by counting.
- **Stem girth:** This was obtained by measuring around the stem, 4cm above the ground using a measuring tape.
- **Days to 50% sprouting:** This is obtained by counting the number of days it took 50% of the shoot to sprout.

2.5 Statistical Analysis

- Data obtained from the experiment were subjected to analysis of variance using Genstat Release Discovery 12th Edition software for CRD design.
- Treatment means were compared using Fishers' Least significant difference (F-LSD) at a 5% level of probability (Obi, 2002)

3. RESULTS

The result in Table 2 shows the effect of different rates of poultry manure on some morphological traits of elephant grass a week after planting. 15 t/ha treatment significantly (P<0.05) recorded the highest stem height with a mean value of 10.90cm. Additionally, the application rate of 15 t/ha produced non-significantly (P>0.05) higher stem girth, leaf length, and the number of shoots with mean values of 4.00cm, 42.2cm, and 6.40 shoots, respectively. Similarly, the 10 t/ha application rate followed the 15 t/ha closely in all the traits. 5 t/ha application rate surprisingly produced the lowest mean value (6.90) for stem height one week after planting. Nevertheless, the 0 t/ha application rate produced the lowest mean values (3.50cm, 28.40cm, and 3.80) for stem girth, leaf length, and number of shoots, respectively, a week after planting.

Table 3 shows that at two weeks after planting, significant mean values (P<0.05) were observed on the studied morphological traits of elephant grass. The highest mean values (12.60cm, 6.10cm, 54.8cm, and 9.20) were all observed by 15 tons for stem height, stem girth, leaf length, and number of shoots respectively. Following closely the mean values of 15 t/ha is the application rate of 10 t/ha. Meanwhile, the application rate of 0 t/ha, which is the control treatment, significantly recorded the lowest mean values (6.30cm, 3.30cm, 31.3cm, and 3.60) for stem height, stem girth, leaf length, and number of shoots, respectively.

The effect of different poultry manure rates on a few morphological characteristics of elephant grass at three weeks after planting (WAP) is shown in Table 4. According to the result, the application rate of 15 t/ha recorded significantly (P<0.05) higher stem height, stem girth, and number of shoots with mean values of 13.52cm, 5.80cm, and 10.80. 10 t/ha application rate significantly (P<0.05) produced a higher leaf length with a mean value of 58.90cm, and 15 t/ha treatment followed closely. In contrast, the control treatment (0 t/ha) showed significantly lower mean values for every morphological trait examined, including number of shoots (3.60), leaf length (31.3cm), stem height (7.30cm), and stem girth (3.30cm).

Table 5 displays the impact of varying rates of poultry manure on a few elephant grass morphological traits three weeks after planting (WAP). The results showed that the 15 t/ha application rate significantly (P<0.05) increased the number of shoots, stem height, and stem girth, with mean values of 10.80, 14.70cm, and 6.22cm. The 10 t/ha application rate significantly (P<0.05) increased the leaf length with a mean value of 62.60cm, and the 15 t/ha treatment came in a close second. However, for all morphological traits analyzed, such as number of shoots (3.40), leaf length (35.5cm), stem height (7.74cm), and stem girth (3.60cm), the control treatment (0 t/ha) displayed noticeably lower mean values.

The result in Table 6 represents the effect of the treatments on some morphological traits of elephant grass five weeks after planting (WAP). Significant mean values (P<0.05) were recorded with the application rate of 15 t/ha, showing higher stem height (15.80cm), stem girth (6.38cm), leaf length (63.1cm), and number of shoots (11.00). The 10 t/ha application rate produced the second-highest values for all the studied traits. On the contrary, the control treatment (0 t/ha application rate) produced significantly (P<0.05) the lowest mean values (8.00cm, 3.60cm, 37.7cm, and 3.40) for stem height, stem girth, leaf length, and number of shoots, respectively.

The result in Table 7 shows the effect of different rates of poultry manure on some morphological traits of elephant grass 6 weeks after planting (WAP). The result showed that the application rate of 15 t/ha produced significantly (P<0.05) higher stem height, stem girth, leaf length, and number of shoots, with mean values of 16.82cm, 6.84cm, 66.50, and 11.20 shoots, respectively. It was closely followed by the 10t/ha application rate for all the traits studied. On the other hand, the 0t/ha application rate, i.e. control treatment, recorded significantly lower stem height (8.20cm), stem girth (3.70cm), and leaf length (39.90cm). The control application also produced significantly lower number of shoots (3.60) than other application rates at 6 WAP.

Table 8 displays the impact of varying poultry manure rates on a few elephant grass morphological characteristics seven weeks after planting (WAP). With mean values of 16.76cm, 7.04cm, 69.0cm, and 11.20 shoots, respectively, the results indicated that the application rate of 15 t/ha resulted in significantly (P<0.05) increased stem height, stem girth, leaf length, and number of shoots, respectively. For every feature under study, the application rate of 10t/ha came in a close second. However, the control treatment, which was applied at a rate of 0 t/ha, showed noticeably reduced stem height (7.10cm), stem girth (3.00cm), and leaf length (33.80cm). Additionally, compared to other application rates at 7 WAP, the control application generated a noticeably lower number of shoots (3.00).

The effects of different levels of poultry manure on some elephant grass morphological traits eight weeks after planting (WAP) are displayed in Table 9. The findings showed that a 15 t/ha treatment rate significantly (P<0.05) enhanced the number of shoots (11.40), leaf length (70.20 cm), stem height (19.3 cm), and stem girth (7.24 cm). The 10t/ha application rate ranked second for all traits analyzed. With mean values of 7.50 cm, 3.24 cm, and 35.20 cm, respectively, the control treatment, which was administered at a rate of 0 t/ha, had significantly lower stem height, stem girth, and leaf length. Compared to the other application rates, the control application also produced significantly fewer shoots (2.80) at 8 WAP.

Compared to other poultry manure rates, the application rate of 15 t/ha had the shortest days to 50% sprouting and the shortest days to initial sprouting, according to the bar chart in Fig. 1. Days to 50% sprouting after 15 t/ha and days to first sprouting were shorter for the 10 t/ha treatment. Similarly, the control (0 t/ha) had the highest number of days to 50% sprouting and the longest number of days to first sprouting.

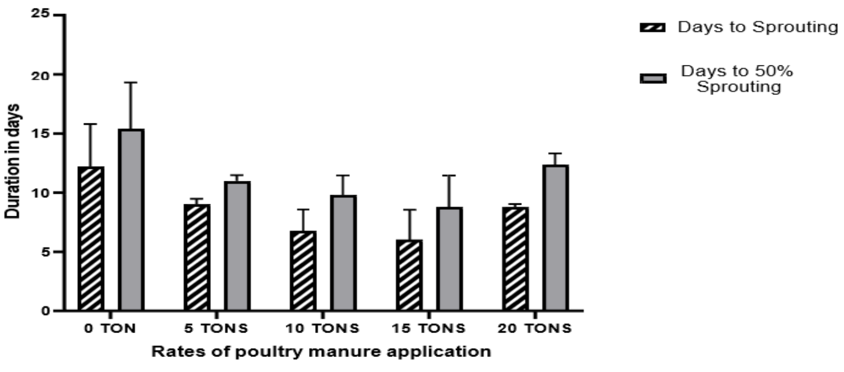

Fig. 1. Effects of different levels of poultry manure on days to first sprouting and Days to 50% Sprouting of Elephant grass (*Pennisetum purpureum*)

Table 1. Poultry manure and soil nutrient analysis before and after planting

Sample Description	Zn	Fe	H2O	KCL	%C	%OM	%N	$\%P^+$	K^+	Ca	Mg	CEC	CEC
Preliminary Soil test	0.36	0.24	5.7	5.1	2.777	4.788	0.056	21.14	0.16	1.4	0.607	7.2	7.2me/100g
Final soil test	0.44	0.32	6.6	6.2	4.118	7.099	0.07	35.67	0.2	2.2	1.2	10	10me/100g
Poultry Manure			8.2	7.4	11.332	19.536	0.701	0.21	0.44	0.8	2.88		

Table 2. Effects of different rates of poultry manure on the morphological parameters of Elephant grass (*Pennisetum purpureum*) one week after planting (1 WAP)

Manure Rates	SH(cm)	SG(cm)	LL(cm)	NS
0 TONS (Control)	7.40	3.50	28.40	3.80
5 TONS	6.90	4.20	31.60	5.80
10 TONS	10.20	3.90	39.10	3.80
15 TONS	10.90	4.00	42.20	6.40
20 TONS	9.10	3.90	30.80	4.00
LSD (0.05)	3.384	NS	NS	NS

Where SH= stem height, SG =stem girth, LL = leaf length, NS = number of shoots, LSD(0.05)= least significant difference at a 5% probability level.

Table 3. Effects of different rates of poultry manure on the morphological parameters of Elephant grass (*Pennisetum purpureum*) two weeks after planting (2 WAP)

Manure Rates	SH(cm)	SG(cm)	LL(cm)	NS
0 TONS (Control)	6.30	3.30	31.30	3.60
5 TONS	7.80	4.10	41.60	4.40
10 TONS	12.40	5.30	51.20	7.00
15 TONS	12.60	6.10	54.80	9.20
20 TONS	9.40	4.60	40.20	7.80
LSD (0.05)	3.960	2.005	19.85	4.646

Where SH= stem height, SG =stem girth, LL = leaf length, NS = number of shoots, LSD (0.05) = least significant difference at a 5% probability level.

Table 4. Effects of different rates of poultry manure on the morphological parameters of Elephant grass (*Pennisetum purpureum*) three weeks after planting (3 WAP)

Manure Rates	SH(cm)	SG(cm)	LL(cm)	NS
0 TONS (Control)	7.30	3.30	31.30	3.60
5 TONS	7.74	4.30	40.90	4.80
10 TONS	13.30	5.60	58.90	7.60
15 TONS	13.52	5.80	58.60	10.80
20 TONS	9.34	4.74	45.3	8.80
LSD (0.05)	4.60	1.704	21.01	4.908

Where SH= stem height, SG =stem girth, LL = leaf length, NS = number of shoots, LSD (0.05) = least significant difference at a 5% probability level.

Table 5. Effects of different rates of poultry manure on the morphological parameters of Elephant grass (*Pennisetum purpureum*) at four weeks after planting (4WAP)

Manure Rates	SH(cm)	SG(cm)	LL(cm)	NS
0 TONS (Control)	7.74	3.60	35.50	3.40
5 TONS	9.10	4.50	46.00	4.80
10 TONS	14.10	6.20	62.60	8.20
15 TONS	14.70	6.22	61.40	10.80
20 TONS	9.60	5.10	45.90	9.60
LSD (0.05)	5.110	1.897	22.25	5.284

Where SH= stem height, SG =stem girth, LL = leaf length, NS = number of shoots, LSD (0.05) = least significant difference at a 5% probability level

Table 6. Effects of different rates of poultry manure on the morphological parameters of Elephant grass (*Pennisetum purpureum*) at five weeks after planting (5 WAP)

Manure Rates	SH(cm)	SG(cm)	LL(cm)	NS
0 TONS (Control)	8.00	3.60	37.70	3.40
5 TONS	9.64	4.60	48.90	5.80
10 TONS	14.54	6.20	62.80	9.00
15 TONS	15.80	6.38	63.10	11.00
20 TONS	10.30	5.20	47.00	9.40
LSD (0.05)	5.228	1.735	22.19	5.204

Where SH= stem height, SG =stem girth, LL = leaf length, NS = number of shoots, LSD (0.05) = least significant difference at a 5% probability level.

Table 7. Effects of different rates of poultry manure on the morphological parameters of Elephant grass (*Pennisetum purpureum*) at six weeks after planting (6 WAP)

Manure Rates	SH(cm)	SG(cm)	LL(cm)	NS
0 TONS (Control)	8.20	3.70	39.90	3.60
5 TONS	10.24	4.84	51.10	6.00
10 TONS	14.74	6.20	64.00	9.00
15 TONS	16.82	6.84	66.50	11.20
20 TONS	10.38	4.70	49.00	9.40
LSD (0.05)	5.299	1.592	21.74	5.204

Where SH= stem height, SG =stem girth, LL = leaf length, NS = number of shoots, LSD (0.05)= least significant difference at a 5% probability level

Table 8. Effects of different rates of poultry manure on the morphological parameters of Elephant grass (*Pennisetum purpureum*) at seven weeks after planting (7 WAP)

Manure Rates	SH(cm)	SG(cm)	LL(cm)	NS
0 TONS (Control)	7.10	3.00	33.80	3.00
5 TONS	10.80	4.80	53.00	6.20
10 TONS	14.84	6.30	61.50	8.80
15 TONS	16.76	7.04	69.00	11.20
20 TONS	10.88	5.10	49.50	9.20
LSD (0.05)	**5.749**	**2.003**	**24.36**	**5.103**

Where SH= stem height, SG =stem girth, LL = leaf length, NS = number of shoots, LSD (0.05)= least significant difference at a 5% probability level.

Table 9. Effects of different rates of poultry manure on the morphological parameters of Elephant grass (*Pennisetum purpureum*) at eight weeks after planting (8 WAP)

Manure Rates	SH(cm)	SG(cm)	LL(cm)	NS
0 TONS (Control)	7.50	3.24	35.20	2.80
5 TONS	11.20	5.00	54.40	6.20
10 TONS	16.10	6.50	65.80	8.80
15 TONS	19.30	7.24	70.20	11.40
20 TONS	11.30	4.60	50.20	9.00
LSD (0.05)	7.19	2.104	24.20	5.224

Where SH= stem height, SG =stem girth, LL = leaf length, NS = number of shoots, LSD (0.05)= least significant difference at a 5% probability level.

4. DISCUSSION

The findings of this study indicate that poultry manure significantly influences the morphological characteristics of *Pennisetum purpureum* (Elephant grass). During the first week, the only significant difference was in stem height. Because poultry manure contains a lot of nitrogen, phosphorus, and potassium, Hassan (2002) found that "it considerably increases plant height". This phenomenon during the first week may result from initial soil nutrient availability, which is consistent with the findings of Ndubuaku *et al*. (2014) that "poultry manure has a residual effect on crops planted later and releases nutrients gradually. Hence, elephant grass is susceptible to initial soil nutrient availability, as evidenced by the notable variation in stem height one week after planting".

"From the second to the eighth week after planting, there were notable variations in all of the morphological parameters that were measured, including stem height, stem girth, leaf length, and the number of shoots per plant. Due to delayed mineralisation and release of the nutrients in poultry manure over time, the significant changes seen beginning in week two suggest that the impacts of poultry manure on plants were cumulative" (Ndubuaku *et al*., 2014). Because of nutrient deficiencies, poor soil structure, and decreased microbial activity, the 0 t/ha treatment produced the lowest growth response. Weak root development, reduced water-holding capacity, and poor soil aeration might have resulted from the lack of organic matter. Furthermore, there was little microbial activity, which promotes nutrient mineralization, further decreasing the availability of nutrients. The results highlight how crucial organic amendments are for increasing soil fertility, boosting nutrient uptake, and encouraging the best possible plant growth. This also aligns with the observations of Ibode *et al*. (2022) that "the absence of poultry manure, a nutrient-rich organic supplement necessary for enhancing soil fertility and promoting plant growth, is the cause of the consistently lower mean value shown in the 0 t/ha treatment".

The application rate of 15 tons of poultry manure per hectare outperformed the control, 5, 10, and 20tons treatments, yielding the highest mean value across all the growth parameters. Nevertheless, there was no significant difference between the application rate of 10t/ha and 15t/ha across all the weeks. This implies that the ideal ratio of macronutrients to micronutrients required for rapid growth was supplied to the plant by 10 and 15-ton treatments. Thus, the results are consistent with those of Girgiri et al. (2024), who found that "moderate amounts of poultry manure had a greater effect on the morphological characteristics of elephant grass. Similarly, 20 t/ha had a lower performance when compared to 10 and 15 t/ha. The 20 t/ha rate probably caused toxicity, problems with soil structure, and nutrient imbalances, all of which harmed plant growth. This explains why 10 and 15 t/ha fared better since they supplied enough nutrients without the drawbacks of applying too much manure. Because plants can only efficiently consume a certain amount of nutrients, more manure does not necessarily translate into better growth".

The application rate of poultry manure significantly impacts the sprouting of stem cuttings by affecting soil nutrient availability, moisture retention, microbial activity, and overall soil health. Nutrient supply for early growth is crucial, and low or no manure can slow sprouting. Moderate manure rates (10-15 t/ha) provide sufficient nutrients for rapid sprouting and vigorous shoot emergence. Excessive manure can lead to nutrient imbalances and potentially burn young shoots. Soil moisture retention is essential for sprouting, and moderate manure rates (10-15 t/ha) improve it. Microbial activity and root development are also influenced by manure, with low rates causing delayed sprouting and high rates causing nutrient toxicity, waterlogging, or microbial imbalances.

5. CONCLUSION AND RECOMMENDATION

The morphological characteristics of elephant grass were improved by the application of 5-20 t/ha of poultry manure. Moderate rates which were 15 t/ha and 10 t/ha had better growth response than the lower and higher rates. The 15 t/ha poultry manure rate performed best, indicating that this application level provided an optimal balance of nutrients, soil moisture retention, and microbial activity. Nevertheless, 20 t/ha did not perform better than 10 and 15 t/ha, most likely as a result of excessive organic matter accumulation, decreased aeration, or nutritional imbalances. The lowest mean values were found in the 0 t/ha group, indicating the importance of poultry manure in enhancing soil fertility and encouraging the establishment of elephant grass. The aforementioned results underscore the significance of organic amendments in sustainable forage production and the necessity of applying manure at suitable rates to optimize output while avoiding adverse soil effects.

Even though 15 t/ha had the highest mean values, there was no significant difference between its values and that of 10 t/ha. Therefore, 10t/ha to farmers and forage producers are recommended. Recommending 10 t/ha over 15 t/ha is based on cost-effectiveness, reduced environmental impact, and resource efficiency. Applying 10 t/ha reduces poultry manure needed, lowering input costs for farmers. It minimizes nutrient loss risks, maintains better soil health, and allows for more efficient resource utilization. If farmers have an abundant manure supply and no cost constraints, either rate can be used effectively. However, adjusting recommendations based on these factors is recommended. Avoid higher application rates, such as 20 t/ha, as they might cause excessive organic matter accumulation, decreased aeration, and nutritional imbalances. To increase nutrient availability and stop leaching, poultry manure should be thoroughly broken down and mixed into the soil before planting. Frequent soil testing and the application of organic amendments are necessary to sustain soil fertility over the long term. The long-term impacts of poultry manure on soil health and other forage species must be evaluated to improve manure application recommendations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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