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COMPARISON OF RABBIT MANURE AS ORGANIC FERTILIZER, INORGANIC FERTILIZER AND RABBIT MANURE COMPOST ON THE GROWTH PERFORMANCE OF *PENNISETUM PURPUREUM* IN INFERTILE SOILS

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ABSTRACT: Livestock farming relies heavily on high-quality forage to ensure optimal animal health and productivity. *Pennisetum purpureum* (Napier grass) is a vital forage crop widely cultivated due to its high biomass yield and nutritional value. However, the productivity and quality of *P. purpureum* are influenced by soil fertility. Additionally, the prolonged use of chemical fertilizers also degrades soil health, disrupts microbial balance, reduces long-term crop productivity and contributes to environmental pollution. Therefore, this study aims to evaluate the effectiveness of rabbit manure as an organic fertilizer in improving the physical growth performance of *P. purpureum* cultivated in infertile soil. *P. purpureum* was grown in infertile soil with five different treatments: (1) control (no fertilizer), (2) rabbit manure as organic fertilizer, (3) chemical fertilizer, (4) compost, and (5) combination of organic and chemical fertilizers. The plants were cultivated in polybags and harvested on Day 30, 45, 60, 75 and 90. Growth parameters including plant height, number of tillers and leaf dimensions were measured at each of harvest intervals. This study demonstrated significant differences in growth parameters of *P. purpureum* across treatments and harvest intervals. *P. purpureum* treated with rabbit manure and compost showed consistent increase in number of tillers between Day 30 to Day 75. The height of *P. purpureum* treated with rabbit manure and compost recorded highest height on Day 75 compared to control and chemical fertilizer treated. However, *P. purpureum* treated with chemical fertilizer showed significant length of leaf compared to control and rabbit manure treated on Day 90. For leaf width, *P. purpureum* treated with compost demonstrated significant increase compared to other groups on Day 75. Additionally, *P. purpureum* treated with compost showed significant yield compared to other groups. This study concludes that organic amendments, rabbit manure and compost, significantly enhance the growth performance of *P. purpureum* in infertile soils. Organic fertilizers are recommended as sustainable alternatives to chemical fertilizers for enhancing *P. purpureum* growth. Future studies will examine soil improvements in microbial activity, micro- and macronutrient in contributing to long-term food security and sustainability.

KEYWORDS: *Rabbit manure, Pennisetum purpureum, Growth, Infertile soil.*

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1. INTRODUCTION

Napier grass (*Pennisetum purpureum*), widely cultivated in tropical regions including Malaysia, is valued for its high biomass yield and nutritional content, making it a primary forage crop for ruminants in the tropics. One source notes it comprises up to 80 % of cattle diets in many tropical and subtropical areas due to its productivity and adaptability even under low-input conditions [1]. However, yields and morphological growth can be severely restricted in infertile soils, where nutrient limitations and poor structure impede optimal performance. Studies show that fertilizer significantly increases both fresh and dry biomass yield compared to unfertilized plots—e.g., dry matter yield under rainfed conditions with fertilizer reached ≈ 16 t/ha versus ≈ 10 t/ha without fertilizer [2]. Such limitations in infertile soils reduce plant height, tiller density, nutrient uptake, and overall dry matter production, undermining the crop's value as livestock feed. Variation among genotypes under stress is documented, and under moderate to severe water or nutrient stress biomass and morphological traits decline markedly [3]. Improving *P. purpureum* productivity on poor soils is thus essential to support local livestock feeding strategies, reduce reliance on imported feed, and enhance food and nutrition security in tropical smallholder systems. Research emphasizes selecting high-yielding, nutrient-efficient genotypes and management strategies combining forage with legumes, biochar or soil amendments in degraded soils [4,5].

Conventional fertilization employing synthetic nitrogen, phosphorus, and potassium inputs can significantly enhance crop yields in the short term [6]. However, excessive or imbalanced use of chemical fertilizers often leads to soil acidification, disruption of microbial communities, reduction in soil organic carbon, and poor soil structure, collectively undermining long-term soil health [7–9]. These practices are increasingly linked to nutrient leaching, water pollution (e.g. eutrophication), heavy metal accumulation, and elevated greenhouse gas emissions such as nitrous oxide [9,10]. Consequently, although chemical fertilizers deliver immediate productivity gains, their persistent overuse heightens environmental degradation and contributes to declining soil fertility and ecosystem functioning [8,11]. In contrast, organic amendments such as rabbit manure offer a sustainable approach to enhancing soil fertility by increasing microbial activity and improving nutrient cycling [12].

Rabbit manure, either in compost or compost-tea form, supplies labile organic carbon and nutrients while stimulating beneficial microbial biomass and enzyme activities, thus enhancing soil structure and fertility [12,13]. Additionally, integrated strategies that combine organic amendments with inorganic fertilizers (e.g., NPK), lime, or biochar have received growing attention, particularly for remediation of marginal or degraded soils [14,15]. These integrated approaches have been shown to substantially improve microbial biomass carbon and nitrogen, phosphatase and dehydrogenase enzyme activities, soil pH, available phosphorus, and crop growth metrics in Ultisols and other low-fertility tropical soils [14,15]. Tailored soil improvement strategies such as combining rabbit manure biochar with compost or inorganic inputs are increasingly being advocated for managing infertile or marginal soils, offering both improved yield and soil health resilience [12,16]. Therefore, this study determined to evaluate the effect of five different soil treatments, including control (no fertilizer), rabbit manure as organic fertilizer, chemical fertilizer, soil amendment, and combined organic-inorganic application, on the morphological growth parameters of *P. purpureum* cultivated under infertile soil conditions. The goal was to determine the most effective strategy to support growth and biomass accumulation over five harvest intervals (Day 30 to 90).

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2. MATERIALS AND METHODS

2.1 Materials used in the study

Napier cuttings of Pakchong strains were obtained from Malaysian Agricultural Research and Development Institute (MARDI) in Muadzam Shah, Pahang at the age of 45 days. The rabbit manure and rabbit manure compost were supplied by Malaysian Institute of Sustainable Agriculture (MISA) from Gombak, Selangor. The inorganic fertilizer used in this field experiment is Nitrophoska Green 15:15:15.

2.2 Methodology

A randomized complete block design (RCBD) was implemented with four blocks and five treatments (T1–T5) replicated across 75 polybags. Each polybag contained homogenized infertile soil subjected to one of the following treatments: T1 (control-no treatment), T2 (organic fertilizer using rabbit manure), T3 (inorganic fertilizer), T4 (soil amended with rabbit manure compost), and T5 (combined organic-inorganic fertilizer). *P. purpureum* stem cuttings were planted at a 45° angle and cultivated under uniform conditions. Morphological growth parameters including plant height, number of tillers, leaf length, leaf width, and yield were monitored across five harvest points (30, 45, 60, 75, and 90 days after planting).

Plant height was measured from the base of the plant to the tip of the tallest leaf and measurements were taken from the same point on each plant to maintain consistency. The number of tillers, or shoots emerging from the base of the plant, was counted manually by visually inspecting the plant to assess the plant's growth development. Leaf length was measured from the base to the tip of the leaf using a ruler, while leaf width was measured at the broadest part of the leaf. These measurements were taken from a representative sample of leaves from each plant to ensure accuracy and consistency. Data were analyzed using ANOVA, and significant differences among treatments were determined using Tukey's HSD post-hoc test at $p<0.05$.

3. RESULTS AND DISCUSSIONS

The plant growth parameters of P. purpureum under different treatments are summarized in Table 1. Significant differences in plant height were detected as early as Day 30, with all treated groups outperforming the control. By Day 75, plants receiving rabbit manure (T2) and compost (T4) recorded the greatest height increases compared to the control and inorganic fertilizer treatment. On Day 90, all treated plants exceeded 250 cm, while the control reached only 125.93 ± 12.03 cm, confirming the limited natural fertility of the soil. The strong positive response of P. purpureum to organic amendments is consistent with previous findings showing that organic inputs improve nutrient availability, root development and morphological traits in Napier grass grown in nutrient-poor or stressed environments [1–5].

Leaf morphological traits displayed treatment-specific responses. On Day 90, the inorganic fertilizer treatment (T3) produced significantly longer leaves compared to the control and rabbit manure treatment. This may be due to the rapid release and immediate uptake of nitrogen from chemical fertilizers, which enhances leaf expansion in the short term [6,7]. In contrast, compost (T4) resulted in significantly greater leaf width on Day 75 and Day 90 compared to other groups. Wider leaves indicate improved photosynthetic capacity and biomass accumulation, a pattern commonly associated with organic amendments that enhance soil structure, water retention and microbial activity [11–13].

Tiller production also showed clear improvements with organic treatments. Plants treated with rabbit manure (T2) and compost (T4) demonstrated consistent increases in tiller number from Day 30 to Day 75, whereas the control and inorganic fertilizer groups showed limited vegetative proliferation. On Day 90, compost (T4) produced the highest number of tillers (13.67 ± 0.58), compared to only 1.33 ± 0.58 in the control. This difference highlights the importance of soil organic matter in stimulating vegetative growth, likely through enhanced microbial biomass, nutrient cycling and improved soil physical properties [12,14,15].

In terms of forage yield, all treatments significantly outperformed the control from Day 30 onward. Compost (T4) yielded the highest biomass on Day 90 (5405.00 ± 93.87 g), followed by rabbit manure (T2) and the combined organic-inorganic treatment (T5). Inorganic fertilizer (T3) also improved yield but remained below the performance of compost and rabbit manure. The extremely low yield of the control (242.67 ± 63.06 g) confirms the severe nutrient limitations of the soil used. The superior performance of compost is consistent with studies showing that organic amendments substantially improve soil organic carbon, nutrient availability and long-term productivity in degraded or acidic soils [8–11,16].

Overall, compost (T4) demonstrated the strongest effect across all parameters, followed by rabbit manure (T2). The integrated treatment (T5) produced moderate enhancements but did not surpass compost alone. These results align with previous research indicating that organic amendments offer more sustained nutrient release, enhanced microbial activity and improved soil health compared to inorganic fertilizers, particularly in infertile soils [6–16]. The findings reinforce the role of rabbit manure—especially in composted form—as an effective soil amendment for improving the growth and biomass productivity of P. purpureum.

Table 1: Effects of Different Treatments on the Physical Growth of *P. purpureum*

Parameters	Group	Day 30	Day 45	Day 60	Day 75	Day 90
Plant height (cm)	T1	71.77 ± 13.97	85.67 ± 7.57	104.54 ± 9.08	111.87 ± 12.21	125.93 ± 12.03
	T2	111.40 ± 4.85*	158.53 ± 1.70*	195.40 ± 3.17*	230.90 ± 21.83*	270.13 ± 9.21*
	T3	118.47 ± 19.85*	141.43 ± 15.90*	204.33 ± 1.53*	181.00 ± 1.41*	306.25 ± 8.84*
	T4	103.83 ± 8.82*	140.80 ± 7.27*	215.80 ± 2.03*	261.67 ± 6.66*	295.25 ± 6.72*
	T5	100.03 ± 3.91	150.47 ± 5.65*	205.53 ± 17.82*	220.50 ± 14.85*	286.35 ± 40.09*
Leaf length (cm)	T1	55.00 ± 2.00	63.53 ± 1.38	60.70 ± 4.65	63.80 ± 5.12	64.20 ± 3.81
	T2	90.77 ± 9.75*	100.10 ± 3.80*	96.20 ± 6.43*	94.33 ± 0.58*	93.00 ± 2.65*
	T3	93.10 ± 4.83*	106.27 ± 4.62*	104.70 ± 0.26*	97.83 ± 8.43*	112.97 ± 3.89*
	T4	89.70 ± 2.21*	97.60 ± 5.86*	105.10 ± 0.56*	107.00 ± 5.29*	103.87 ± 5.54*
	T5	85.60 ± 5.23*	93.90 ± 3.97*	100.60 ± 5.90*	97.77 ± 2.66*	103.07 ± 3.52*
Leaf width (mm)	T1	14.00 ± 4.36	16.50 ± 1.50	21.33 ± 0.58	20.67 ± 1.53	19.33 ± 2.08
	T2	24.33 ± 2.08*	40.00 ± 1.00*	43.33 ± 4.93*	45.00 ± 5.00*	46.33 ± 0.58*
	T3	24.00 ± 3.00*	37.67 ± 2.08*	48.67 ± 2.31*	45.33 ± 1.53*	51.33 ± 3.79*
	T4	29.00 ± 5.57*	40.33 ± 2.52*	51.67 ± 1.53*	57.33 ± 0.58*	52.00 ± 0.00*

	T5	26.67 ± 2.31*	39.00 ± 2.65*	45.33 ± 3.51*	46.33 ± 2.08*	50.00 ± 2.65*
Numbers of tillers	T1	0.00 ± 0.00	0.00 ± 0.00	1.67 ± 1.16	1.00 ± 0.00	1.33 ± 0.58
	T2	6.67 ± 2.08*	9.33 ± 1.53*	9.00 ± 1.00*	10.33 ± 2.08*	9.67 ± 1.16*
	T3	7.33 ± 0.58*	6.00 ± 1.00*	7.67 ± 0.58*	7.33 ± 1.53*	10.00 ± 2.65*
	T4	9.00 ± 1.00*	11.33 ± 0.58*	11.33 ± 0.58*	11.67 ± 1.53*	13.67 ± 0.58*
	T5	5.00 ± 1.00*	8.33 ± 0.58*	8.67 ± 0.58*	8.00 ± 3.00*	9.67 ± 1.53*
Yield (g)	T1	162.50 ± 10.61	218.00 ± 19.08	183.33 ± 36.17	201.67 ± 37.86	242.67 ± 63.06
	T2	867.50 ± 109.60*	1107.50 ± 74.25*	1872.50 ± 180.31*	2639.00 ± 79.20*	2878.33 ± 154.46*
	T3	724.33 ± 90.97*	1415.00 ± 155.97*	2298.00 ± 215.06*	1785.00 ± 212.13*	3830.00 ± 162.64*
	T4	553.33 ± 168.41*	1563.33 ± 50.08*	3520.00 ± 212.13*	5539.50 ± 413.66*	5405.00 ± 93.87*
	T5	655.67 ± 153.12*	1285.33 ± 103.74*	1658.00 ± 155.56*	2960.50 ± 415.07*	3381.50 ± 146.37*

Mean ± SD, *significantly different compared to control on respective days, with a post-hoc Tukey HSD test, $p<0.05$

4. CONCLUSION

The findings of this study demonstrate that organic and integrated soil amendments markedly improve the growth performance, tiller production, and forage yield of P. purpureum cultivated in infertile soil. Among all treatments, composted rabbit manure (T4) produced the greatest enhancement across all morphological parameters, underscoring its superior nutrient availability and soil-improving capacity. Raw rabbit manure (T2) also significantly improved plant growth and yield, confirming its effectiveness as a viable organic fertilizer. While inorganic fertilizer (T3) enhanced growth, its performance remained lower than the organic treatments, whereas the combined organic–inorganic treatment (T5) provided additional but not superior benefits compared to compost alone. The consistently poor performance of the control group highlights the severe nutrient limitations of the untreated soil.

Overall, the results clearly indicate that rabbit manure, particularly in composted form, is an effective, affordable, and environmentally friendly amendment for improving soil fertility and promoting sustainable biomass production of P. purpureum. Integrated nutrient management strategies such as T5 also show potential for improving forage yield in low-fertility soils. Future research should focus on evaluating how rabbit-manure amendments influence soil micro- and macronutrient dynamics to support long-term soil health and environmental sustainability.

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nutritional quality of *Penissetum purpureum* (Napier grass) silage stored at three different durations for determination of optimum storage duration of *P. purpureum* silage).

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