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(RESEARCH ARTICLE)

Growth of dwarf elephant grass (*Pennisetum purpureum* cv. Mott) planted in a mixed media of soil and *closed house litter*

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Abstract

Dwarf elephant grass (*Pennisetum purpureum* cv. Mott) is a potential forage for ruminants. Efforts to improve the growth of this grass can be achieved by improving the growing medium with organic materials (*closed house litter*). This study aimed to determine the growth of dwarf elephant grass planted in a mixture of soil and *closed house litter* and to determine the best growing medium mixture. The study used a completely randomized design (CRD) with 4 treatments and 7 replications: A = 100% soil + 0% *closed house litter*, B = 75% soil + 25% *closed house litter*, C = 50% soil + 50% *closed house litter*, and D = 25% soil + 75% *closed house litter*. The variables observed included: plant height, number of leaves, number of tillers, leaf color, leaf chlorophyll content, leaf area pot^{-1}, and stem diameter. The results showed that the addition of *closed house litter* increase the growth of the number of leaves, the number of tillers, leaf chlorophyll content, and leaf area pot^{-1}, but had no effect on the growth of plant height, leaf color, and stem diameter. The mixture of planting media 25% soil + 75% *closed house litter*, the best growth with the number of leaves (61.43 strands), the number of tillers (6.00 tillers), leaf chlorophyll content (19.24), and leaf area pot^{-1} (7,948.42 cm^2). It can be concluded that mixture planting media soil and *closed house litter* enhances the growth of dwarf elephant grass, with the best growth achieved with a mixture of 25% soil + 75% *closed house litter*.

Keywords: Closed house litter; Planting medium; Growth; Dwarf elephant grass; Soil

1. Introduction

Forage is a crucial factor in ruminant livestock farming, so forage provision requires attention to ensure the sustainability of both quantity and quality throughout the year. Forage is a source of energy for ruminant livestock production. One potential forage is dwarf elephant grass (*Pennisetum purpureum* cv. Mott). Dwarf elephant grass is widely found in Indonesia due to its tropical climate and soil texture, which are ideal for its growth. Dwarf elephant grass is a superior grass species with high productivity and nutrient content, as well as high palatability for ruminants. Dwarf elephant grass contains approximately 8-15% crude protein, 28-35% crude fiber, and 55-70% total digestible nutrients (TDN), depending on harvest age and maintenance management. It is adaptable to various environmental conditions and can produce off spring continuously when mowed regularly [17]. Increasing forage production can be achieved through improving the growing medium, one of which is through the use of organic materials.

Planting media is a medium used by plants as a place for roots or root buds to grow and develop, and the function of planting media is to provide nutrients and water for plants [19]. Organic planting media plays a very important role in improving the physical, chemical, and biological properties of the soil and providing nutrients for plants [14]. The addition of organic materials can also improve soil structure, increase the soil's ability to retain water, and increase the activity of soil microorganisms in providing nutrients [1]. One alternative organic planting media is a *closed house litter*.

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The use of *closed house litter* as a growing medium not only helps reduce livestock waste, but also has the potential to increase soil fertility due to its high organic content. *Closed house litter* is a bedding material for broilers raised in a closed house system, consisting of materials such as rice husks mixed with chicken manure. *Closed house litter* contains a mixture of bedding materials, such as rice husks, chicken manure, leftover feed, and microorganisms accumulated during rearing in a closed house system, so it has a relatively high nutrient content, especially Nitrogen, Phosphorus, and Potassium. This nutrient content makes *closed house litter* potentially used as a source of organic material in growing media. Good growing media must be able to provide nutrients, retain water, and have good aeration and drainage systems [10], so the use of litter in the growing media mixture is expected to improve soil structure and support optimal plant growth.

The use of organic matter from livestock litter can increase the organic carbon content and nitrogen availability in the soil, thereby encouraging biomass production [13]. The use of organic matter as a mixture of planting media has proven to be more effective, because it can increase porosity, water holding capacity, and the activity of soil microorganisms [18]; [5]. Other studies also show that the composition of the planting media mixture with a balanced proportion of soil and organic matter tends to provide more optimal growth results than proportions that are too low or too high. Research by [20], the use of 50% organic matter (1:1 ratio) has a significant effect on plant height and the number of tillers.

2. Material and Methods

2.1. Research materials

The research was conducted at the Greenhouse of the Research Station, Faculty of Animal Husbandry, Udayana University, on Jalan Raya Sesetan, Gang Markisa, Denpasar. The research was conducted from September to November 2025, from preparation to slaughter.

2.2. Plant seeds

The plant seeds used in the research were cuttings of dwarf elephant grass, measuring 25 cm in height, obtained from the Research Station of the Faculty of Animal Husbandry, Udayana University, Jalan Raya Sesetan, Gang Markisa, South Denpasar.

2.3. Planting Media, Water, and Pots

The growing media used were soil and *closed house litter*. The soil was sourced from the Faculty of Animal Husbandry Research Station located in Pengotan Village, Bangli Regency, and the *closed house litter* was taken from the closed house enclosure of the Faculty of Animal Husbandry, Udayana University, Bukit Jimbaran. The water used in this study was well water located on the research site, while the pots used were plastic pots with a capacity of 4 kg, with a top diameter of 23.5 cm, a bottom diameter of 15 cm, and a height of 6.5 cm.

2.4. Equipment

The equipment used are: 1) 2x2 mm wire sieve, to sift the soil to make it homogeneous; 2) shovel to take the soil; 3) bucket as a water container; 4) dipper as a tool to help water the plants; 5) manual scales with a capacity of 15 kg, sensitivity of 100 g, to weigh the soil and liters; 6) digital scales with a capacity of 500 g, sensitivity of 0.1 g to weigh parts of the plant (leaves, stems and roots); 7) knife and scissors; 8) ruler to measure the height of the plant; 9) paper bags, for research sample containers; 10) stationery, to record the results of the research; 11) calipers to measure the diameter of the stem; 12) chlorophyll meter, to measure the chlorophyll content of leaves; and 13) leaf color scale, to measure the color of leaves.

2.5. Experimental design

The experimental design used a completely randomized design (CRD), consisting of 4 treatments and 7 treatments, so there were 28 experimental units. The planting media mixture treatment given to dwarf elephant grass is as follows: A = 100% soil + 0% *closed house litter*; B = 75% soil + 25% *closed house litter*; C = 50% soil + 50% *closed house litter*; and D = 25% soil + 75% *closed house litter*.

2.6. Planting

The dwarf elephant grass seeds are in the form of stem cuttings which are planted in each pot as many as 3 cuttings, and after the seeds have grown well (about one week) then 1 plant seed is selected which has homogeneous growth and size to be observed.

2.7. Making planting media

Making planting media, consisting of soil and *closed house litter* with a planting media weight of 4 kg pot^{-1}. In treatment A = (4 kg soil pot^{-1} + 0 kg *closed house litter* pot^{-1}); B = (3 kg soil pot^{-1} + 1 kg *closed house litter* pot^{-1}); C = (2 kg soil pot^{-1} + 2 kg *closed house litter* pot^{-1}; and D = (1 kg soil pot^{-1} + 3 kg *closed house litter* pot^{-1}).

2.8. Plant maintenance

Plant maintenance in this study includes watering the plants every day, eradicating weeds, pests and diseases when necessary so that the plants can grow well.

2.9. Observed variables

- Plant height (cm): measured with a measuring tape from the base of the stem to the collar of the highest fully developed leaf.
- Number of leaves (blades): measured by counting the number of fully developed leaves.
- Number of tillers (tiller): measured by counting tillers with fully developed leaves.
- Leaf color: measured using a color scale and a color score ranging from 1-7, with higher values indicating a more intense leaf color.
- Leaf chlorophyll: measured by clamping a leaf with a chlorophyll meter until a number appears. This number represents the leaf's chlorophyll content.
- Leaf area pot^{-1} (LAP): was measured by randomly selecting four fully developed leaf samples, which were recorded as the leaf area sample (LAS), then weighed and recorded as the leaf weight sample (LWS), and then all leaves were weighed and recorded as leaf weight total (LWT). Leaf area pot^{-1} can be calculated using the formula:

$$LAP = LAS/LWS \times LWT$$

Description
LAP = leaf area per pot^{-1}
LAS = leaf area sample
LWS = leaf weight sample
LWT = leaf weight total

- Stem diameter (cm): is measured by clamping a vernier caliper in the center of the stem just above the soil surface. This measurement is performed weekly to monitor stem diameter growth.

2.10. Data analysis

Data from the research results were analyzed using analysis of variance (ANOVA), if the treatment showed a significant effect at a 95% confidence level ($P<0.05$), then the calculation was continued with the Duncan Multiple Range Test (DMRT) to determine the differences between treatments [16].

3. Results and discussion

The results of the research on the growth of dwarf elephant grass (*Pennisetum purpureum* cv. Mott) planted in a mixture of soil and *closed house litter* can be seen in Table 1.

Table 1 Growth of dwarf elephant grass (*Pennisetum purpureum* cv. Mott) planted in a planting medium of a mixture of soil and *closed house litter*

Variable	**Treatment** [1)]				**SEM**[2)]
	A	B	C	D	
Plant height (cm)	35.57[a]	38.14[a]	36.71[a]	36.29[a]	1.21
Number of leaves (blades)	32.14[b3)]	70.57[a]	61.43[a]	67.43[a]	6.47
Number of tillers (tiller)	2.71[b]	5.29[a]	6.00[a]	6.00[a]	0.36
Leaf color	5.43[a]	5.71[a]	6.14[a]	6.00[a]	0.26
Leaf chlorophyll	13.06[b]	12.37[b]	19.24[a]	19.94[a]	1.72
Leaf area pot^{-1} (cm^2)	2,122.48[b]	7,533.63[a]	7,948.42[a]	7,106.51[a]	546.40
Stem diameter (cm)	0.64[a]	0.59[a]	0.56[a]	0.56[a]	0.02

Description: [1)] A = 100% soil + 0% *closed house litter*, B = 75% soil + 25% *closed house litter*, C = 50% soil + 50% *closed house litter*, D = 25% soil + 75% *closed house litter;* [2)] SEM = *Standard error of the treatment means;* [3)] Values with different letters in the same row indicate significant differences (P<0.05).

The average height of the dwarf elephant grass plant in treatment A was 35.57 cm, which was not significantly different (P>0.05) from treatments B, C, and D, respectively, by 7.23%; 3.21%; and 2.02% not significantly (P>0.05) higher than treatment A. This indicates that the response to the growth of dwarf elephant grass height to the planting media treatment was relatively slow. Plant height is greatly influenced by the availability of nutrients, especially Nitrogen, and the ability of plants to absorb nutrients. Organic materials from *litter closed house*, can only release nutrients gradually, so the response to plant height growth in all treatments was the same. According to [11], organic materials function as long-term nutrient sources and play a greater role in improving soil conditions than increasing plant height growth directly. Organic materials have slow release properties so that the effect on plant vegetative growth is relatively limited [12].

The number of dwarf elephant grass leaves in treatment A was 32.14, while in treatments B, C, and D, it was significantly higher (P<0.05), 119.64% each; 91.17%; and 109.90%, compared to treatment A. This indicates that organic matter in the *closed house litter* can increase nutrient availability to support leaf tissue formation. Research by [15], showed that varying the type of planting medium, such as a mixture of soil, sand, and other organic materials, significantly affects plant growth, including leaf number. This is because a good growing medium can increase the availability of water, oxygen, and nutrients to the roots, thus supporting overall vegetative growth. The growth of various plant species is greatly influenced by the right growing medium, through physical, chemical, and biological improvements to the growing medium, which ultimately impacts the number of leaves, leaf length, and leaf width.

In treatments B, C, and D, the number of tillers was significantly higher (P<0.05) at 95.20%; 121.40%; and 121.40% compared to treatment A which had 2.71 tillers. This indicates better growing media conditions, as the addition of organic *litter closed house* can support shoot growth. The increase in tiller numbers is thought to be related to nutrient availability and improvements in the physical, chemical, and biological properties of the soil due to the addition of organic matter. According to [3], the right growing media can improve soil physical conditions and increase aeration and water capacity, thereby supporting root growth and tiller formation in dwarf elephant grass. Furthermore, [15], stated that a good growing media structure will increase the plant's ability to absorb water and nutrients, which will stimulate the formation of lateral shoots.

The leaf color of elephant grass in treatments A, B, C, and D, respectively, was 5.43; 5.71; 6.14; and 6.00, but not statistically significantly different (P>0.05). This indicates that the organic matter in the *closed house litter* did not affect leaf color. These results align with research by [6], which found that plant leaf color is influenced not only by nutrient availability but also by environmental factors, such as light intensity and plant growth phase. Leaf color changes are more sensitive to micronutrient deficiencies and environmental stress than short-term organic fertilizer application [7].

The treatment with the addition of *closed house litter* resulted in higher leaf chlorophyll content than treatment A. This indicates that organic matter in the *closed house litter* can increase nutrient availability, which plays a role in leaf chlorophyll formation. These research results align with [7], who stated that adequate nitrogen plays a crucial role in chlorophyll synthesis and chloroplast formation. Furthermore, [9], stated that the right growing medium can increase

leaf chlorophyll content if the physical and chemical structure of the growing medium supports optimal nutrient absorption by plants. High quality growing medium can increase the efficiency of nutrient utilization by improving the physical, chemical, and biological properties of the soil, thus supporting plant photosynthesis [2].

The leaf area of pot^{-1} dwarf elephant grass grown in *closed house litter* increased compared to treatment A. This indicates that nutrient availability and better growing medium conditions can support optimal leaf formation and development. The increase in leaf area in pot^{-1} is thought to be related to increased photosynthetic activity due to the high leaf chlorophyll content. According to [4], a larger leaf area allows plants to capture more sunlight, thereby increasing the rate of photosynthesis. Furthermore, [8], stated that improving soil physical properties due to the addition of organic matter in *closed house litter* can increase plant vegetative growth, including leaf area development.

The results showed that the stem diameter of the dwarf elephant grass was not significantly different across all treatments ($P>0.05$). This indicates that the addition of organic matter to the *closed house litter* did not affect stem tissue growth. These results align with research by [8], which found that the addition of organic matter does not always significantly affect plant stem diameter during the early growth phase. Stem diameter growth is more influenced by genetic factors and plant age than by the short-term addition of organic matter [4].

4. Conclusion

Based on the research results, it can be concluded that: 1) a planting medium of a mixture of soil and *closed house litter* can increase the growth of dwarf elephant grass; and 2) a planting medium mixture of 25% soil + 75% *closed house litter* is the best planting medium to increase the growth of dwarf elephant grass.

4.1. Suggestion

It can be suggested to livestock farmers to use a planting media mixture of 25% soil + 75% *closed house litter* to increase the vegetative growth of dwarf elephant grass as a source of green animal feed.

Compliance with ethical standards

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Disclosure of conflict of interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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