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Yield of *Pennisetum purpureum* cv. Mott planted on a mixture of soil and closed house litter

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ABSTRACT

Pennisetum purpureum cv. Mott, is a superior grass variety characterized by high productivity and nutrient content, as well as high palatability for ruminant livestock. It thrives in diverse environments, responds well to fertilization, and continues to produce tillers when harvested regularly.This study aimed to determine the yield of *Pennisetum purpureum* cv. Mott planted in a mixture of soil and *closed house litter*, and to identify the optimal mixture ratio for maximizing the yield. A completely randomized design (CRD) was employed, featuring 4 treatments and 7 replicates: 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 were dry weight (leaves, stems, and total forage), the ratio of leaf dry weight to stem dry weight, and the ratio of leaf dry weight to total forage dry weight. The results showed that the addition of *closed house litter* increased dry weights (leaves, stems, and total forage) as well as the ratios of leaf dry weight to stem dry weight, and leaf dry weight to total forage dry weight. A growing medium mixture of 75% soil + 25% *closed house litter* yielded the best results for stem dry weight (9.37 g), the ratio of leaf dry weight to stem dry weight (3.48), and the ratio of leaf dry weight to total forage dry weight (0.78). It can be concluded that mixing soil with *closed house litter* enhances the yield of *Pennisetum purpureum* cv. Mott, and that the mixture of 75% soil + 25% *closed house litter* is the optimal growing medium for increasing the yield of *Pennisetum purpureum* cv. Mott.

Keywords: *Closed House Litter*, Growing Medium, Soil, *Pennisetum purpureum*, Yield

1 INTRODUCTION

Forage crops are essential sources of green fodder for livestock survival. Livestock utilize forage to meet basic physiological needs, support growth, and generate energy, as well as to facilitate production and reproduction. Grass serves as the primary feed for ruminants, providing the crude fiber crucial for their digestive systems. However, the sustainable supply of forage remains unmet due to shrinking land availability and low soil fertility. Efforts to ensure an

adequate supply of forage involve cultivating grass varieties characterized by high productivity and quality, such as *Pennisetum purpureum* cv. Mott.

Pennisetum purpureum cv. Mott is a superior grass variety characterized by high productivity, substantial nutrient content, and excellent palatability for ruminant livestock. It thrives at altitudes up to 2,000 meters above sea level, in temperatures ranging from 25-40°C and with annual rainfall of 1,500 mm; it is adaptable to various locations, responds well to fertilization, and continues to produce tillers when harvested regularly [13]. While it grows best in full sunlight, the grass remains productive even under partial shade [5]. Its nutritional profile includes a crude protein content of 10-15% and low crude fiber, alongside high productivity it features a fine leaf texture, soft stems, and a high leaf percentage of 76% [14] with crude protein levels ranging from 13.3% to 13.9%, yields can reach 60 tons/ha/year [17]. Efforts to enhance the productivity of *Pennisetum purpureum* cv. Mott, focus on improving the growing medium.

The growing medium serves as the environment for plant growth and is a crucial factor to consider, as it influences plant growth and development in the pursuit of optimal yields [2]. Soil with a crumb structure is an excellent growing medium, as it contains organic matter that serves as a source of nutrients for plants. Organic growing media play a role in improving the physical, chemical, and biological properties of the soil while supplying nutrients to plants [12]. The addition of organic matter can also improve soil structure, enhance water-holding capacity, and boost the activity of soil microorganisms involved in nutrient supply [1]. One alternative organic growing medium is livestock *litter,* such as rice husks mixed with livestock manure.

In *closed house* systems, *litter* is the accumulated product of bedding materials and various organic residues generated during the chicken rearing process. *Litter* typically consists of rice husks, sawdust, or straw mixed with chicken excreta, feed residues, feathers, and water. In *closed house* systems, controlled ventilation and temperature conditions can influence the physical and chemical characteristics of the *litter* throughout the rearing period. Chicken excreta is the primary source of nutrients, as it contains organic compounds and minerals resulting from metabolic processes that are not fully utilized by the birds [9]. According to [6], the composition of *closed house litter* generally includes approximately dry matter (60-80%), organic matter (55-75%), organic carbon (25-40%), total nitrogen (1.5-4.0%), phosphorus (1.0-3.0%) and potassium (1.0-3.0%).

Research by [4], demonstrated that adding rice husk charcoal to the growing medium at a 1:1 ratio, yielded the best results regarding plant height, number of leaves, leaf length, leaf width, fresh weight, and edible weight for mustard greens (*Brassica juncea* L.). A study by [10], showed that a growing medium combination of soil and manure at a 1:1 ratio, had a significant effect on the yield components of "kailan" plants, resulting in a gross weight of 142.29 g, and an edible weight of 106.49 g. Research by [7], found that a growing medium composition ratio of 2:1:1 (soil : chicken manure : rice husks) produced the best results for plant height, fresh root weight, dry root weight, fresh shoot weight, and dry shoot weight in cocoa seedlings.

2 MATERIAL AND METHODS

2.1 Research materials

The growing media consisted of soil and litter from the closed house facility at the Faculty of Animal Science, Udayana University, Bukit Jimbaran. The soil and litter were air dried; the soil was then sieved through a 2x2 mm wire mesh to ensure homogeneity, while the litter was cleared of inorganic debris such as plastic. The results of the analysis of the soil and litter, conducted at the Soil Science Laboratory of the Faculty of Agriculture, Udayana University (2025), are presented in Table 1.

Table 1: Analysis results for soil and litter closed house

Parameters	**Unit**	**Soil**		***Closed House Litter***	
		Value	Criteria	Value	Criteria
pH (1:2.5)H_2O	-	6.42	Slightly acidic	7.68	Slightly alkaline
Electrical Conductivity	mmhos/cm	0.55	Very low	9.48	Very high
Organic Carbon	%	3.18	High	44.21	Very high
Total Nitrogen	%	0.22	Medium	0.23	Medium
Available Phosphorus	ppm	418.47	Very high	1214.84	Very high
Available Potassium	ppm	426.00	Very high	478.39	Very high

Air-dry	%	2.06	-	13.47	-
Field Capacity	%	13.45	-	31.88	-

2.2 Plant Seedlings

Plant seedlings derived from *Pennisetum purpureum* cv. Mott grass, cuttings measuring 25 cm in height. These seedlings were obtained from the Research Station of the Faculty of Animal Science, Udayana University, at Jalan Raya Sesetan, Gang Markisa, South Denpasar.

2.3 Equipment

The equipment used in this study consisted of: 1) wire sieve (2x2 mm) for homogenizing the soil; 2) a shovel for collecting soil; 3) a bucket for holding water; 4) a dipper to assist with watering; 5) a manual scale (15 kg capacity, 50 g sensitivity) for weighing soil and litter; 6) a digital scale (500 g capacity, 0.1 g sensitivity) for weighing plant parts such as leaves and stems; 7) paper bags; and 8) an oven for determining the dry weight of plant parts.

2.4 Experimental design

The experimental design used was a completely randomized design (CRD), consisting of 4 treatments and 7 replications, there were 28 experimental units. The treatment of a mixture of soil and *closed house litter* given to plants is: 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% *litter closed house*.

2.5 Preparation of Growing Media

The growing medium was prepared using soil and *closed house litter* according to the specific treatments, with a total weight of 4 kg polybag^{-1}. The treatments were: A = (4 kg soil + 0 kg *closed house litter* polybag^{-1}); B = (3 kg soil + 1 kg *closed house litter* polybag^{-1}); C = (2 kg soil + 2 kg *closed house litter* polybag^{-1}); and D = (1 kg soil + 3 kg *closed house litter* polybag^{-1}).

2.6 Observed variables

The variables observed in this study are:

- Leaf dry weight (g): obtained by weighing plant leaves per pot which have been dried in an oven at 700C until they reach a constant weight.
- Stem dry weight (g): obtained by weighing the plant stems per pot which have been dried in an oven at 700C until they reach a constant weight.
- Total dry weight of forage (g): obtained by adding up the dry weight of the leaves and the dry weight of the stem.
- Ratio of leaf dry weight to stem dry weight: obtained by dividing the leaf dry weight by the stem dry weight.
- Ratio of dry weight of leaves to total dry weight of forage: obtained by dividing the dry weight of leaves by the total dry weight of forage.

2.7 Data analysis

Data from the research results were analyzed using analysis of variance, 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 [11].

3 RESULTS AND DISCUSSION

The research results (Table 2), indicate that the use of a growing medium consisting of a mixture of soil and *closed house litter* can increase ($P<0.05$) the yield of Pennisetum purpureum cv. Mott grass.

The dry weights of leaves and stems of *Pennisetum purpureum* cv. Mott planted in a medium consisting of 100% soil + 0% *closed house litter* (A) were the lowest among all treatments. This is likely because the growing medium consisted solely of soil without the addition of *closed house litter*, resulting in relatively low nutrient availability particularly Nitrogen (Table 1). Consequently, vegetative growth specifically leaf and stem formation was suboptimal. Nitrogen is an essential nutrient involved in chlorophyll formation, protein synthesis, and cell division thus, a nitrogen deficiency can inhibit leaf area expansion, reduce the rate of photosynthesis, and limit the accumulation of photosynthetic products, ultimately resulting in lower dry weights for leaves and stems.

Table 2: Yield of Pennisetum purpureum cv. Mott grass planted on a mixture of soil and closed house litter

Variable	Treatment[1)]				SEM[2)]
	A	B	C	D	
Leaf dry weight (g)	9.39[c3)]	32.33[a]	28.94[b]	26.77[b]	0.75
Stem dry weight (g)	4.94[b]	9.37[a]	8.99[a]	8.44[a]	0.45
Total dry weight of forage (g)	14.33[c]	41.70[a]	37.93[b]	35.21[b]	0.96
Ratio of leaf dry weight to stem dry weight	1.93[b]	3.48[a]	3.25[a]	2.57[ab]	0.35
Ratio of dry weight of leaves to total dry weight of forage	0.66[b]	0.78[a]	0.76[a]	0.76[a]	0.01

Description: 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% *litter closed house*.; SEM = *standard error of the treatment means;* Values with different letters in the same row indicate a significant difference ($P<0.05$)

The addition of 25%, 50%, and 75% *closed house litter* (B, C, and D) increased leaf and stem dry weights. This is attributed to the increased nutrient content in the growing medium, which optimized the plants vegetative growth processes. The *closed house litter* contains total Nitrogen (0.23%) and a very high level of organic carbon of 44.21% (Table 1). Nutrient availability promotes leaf and stem growth, enhances photosynthetic activity, and results in greater biomass accumulation. This view is supported by [3], who noted that sufficient Nitrogen enhances leaf growth, leaf area, and plant height, thereby improving the plant's light-capturing capacity. Optimal vegetative growth during the initial phase is a key determinant of the plant's growth and production potential in subsequent phases.

The dry weight of *Pennisetum purpureum* cv. Mott is also influenced by the growth in leaf number (32.14 leaves) and leaf area (2122.48 cm^2). A high number of leaves supports optimal photosynthesis According to [18], noted that a high leaf count facilitates maximal photosynthesis, yielding carbohydrates and proteins key components of plant dry weight whereby increased carbohydrate and protein content leads to greater dry weight.

The total dry weight of *Pennisetum purpureum* cv. Mott forage grown in a mixture of soil and *closed house litter* differed significantly ($P<0.05$) among treatments. Treatment A yielded the lowest total forage dry weight at 14.33 g (Table 2). This low yield is attributed to limited nutrient availability, which resulted in suboptimal rates of photosynthesis and vegetative growth. Nutrient availability particularly nitrogen significantly influences plant biomass formation, as it plays a crucial role in the synthesis of chlorophyll and proteins that support leaf and stem growth. Low nutrient availability can lead to reduced dry weight accumulation in plants. Treatment B produced the highest total forage dry weight (41.70 g); this outcome resulted from balanced growth between the leaves (photosynthetic organs) and stems (structural and storage organs). Adequate and balanced nutrient availability facilitates optimal vegetative tissue formation and biomass accumulation [15]. The use of *closed house litter* at specific levels can significantly increase total forage dry weight production.

The leaf to stem dry weight ratio of *Pennisetum purpureum* cv. Mott planted in a mixture of soil and *closed house litter* (B, C, and D) was significantly higher ($P<0.05$) than that of treatment A. This result was influenced by limited nutrient availability in the growing medium, which hindered optimal leaf growth. Leaves are the plant organs most responsive to increased nitrogen availability, a nutrient essential for chlorophyll formation, protein synthesis, and leaf tissue development. Furthermore, [8], noted that a low proportion of leaf growth can lead to a reduced leaf to stem dry weight ratio. A higher proportion of leaf dry weight compared to stem dry weight indicates superior forage quality, as leaves contain higher levels of nutrients and protein than stems. A higher leaf to stem dry weight ratio is associated with improved forage palatability and digestibility for livestock. According to [16], stated that a high leaf to stem dry weight ratio is a key indicator of forage quality, as it is closely linked to crude protein content and the level of intake by ruminant livestock.

In general, the results of this study indicate that using *closed house litter* as a component of the growing medium has a positive effect on the yield of *Pennisetun purpureun* cv. Mott grass. Applying the litter in appropriate quantities enhances soil organic matter and nutrient content, thereby optimizing the plant's vegetative growth. However, using an excessively high proportion of *litter* tends to reduce growth efficiency or results in incomplete decomposition of the *closed house litter*.

4 CONCLUSION

The use of a growing medium consisting of a mixture of soil and *closed house litter* increased the yield of *Pennisetum purpureum* cv. Mott, and the mixture comprising 75% soil + 25% *closed house litter* proved to be the best medium for enhancing the yield of *Pennisetum purpureum* cv. Mott.

Suggestion

Farmers and livestock breeders are advised to increase the yield of *Pennisetum purpureum* cv. Mott, used as a source of forage by planting it in a growing medium consisting of a mixture of 75% soil + 25% *closed house litter* from poultry facilities.

STATEMENTS ON 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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