



Effect of Different Dosage and Application Frequency of Liquid Organic Fertilizer in Dwarf Elephant Grass (*Pennisetum purpureum* cv Mott) to Ecological Characteristic of Vertisol Soil in Timor Leste



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Abstract

The growth of fodder plants is strongly influenced by environmental factors, namely soil as a provider of nutrients, soil temperature, soil moisture, sunlight energy for photosynthesis and air that provides CO₂ and O₂ for the needs of the plant itself. Related to this, a study was conducted to evaluate the dosage of Liquid Organic Fertilizer (LOF) made from cow feces with different doses and frequency of watering on dwarf elephant grass or kate's elephant grass (*Pennisetum purpureum* cv Mott) on soil temperature, soil moisture, soil organic and N-total vertisol in Timor Leste. The experiment used a Completely Randomized Design (CRD) with a factorial pattern with 2 factors: Factor A (LOF dose): P2 (1 liter LOF:2 liters of water), P4 (1 liter LOF:2 liters of water), P6 (1 liter LOF:6 liters of water), (1 liter LOF:8liters of water), and factor B is the frequency of LOF application consisting of W2 (LOF given every 2 days), W4 (LOF given every 4 days), W6 (LOF given every 6 days). The experiment used four replications so that there were 48 experimental units. The results showed that there was an interaction between dose of LOF and frequency of application of LOF on the variable soil moisture vertisol.

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1 Introduction

Timor Leste is a young country whose source of income and foreign exchange is highly dependent on increasing industrial development originating from the agricultural sector, tourism, and the oil/gas sector. Every year there is an increase in the number of residents and the number of tourists, and of course, will have an impact on increasing the need for consumption of meat and other agricultural products. Ruminant livestock is very dependent on the availability of forage so that it can be increased through the introduction of various superior feed crop cultivation technologies. One of the technologies that can be developed in Timor Leste to increase forage production and conservation of agricultural land is by providing nutrient inputs into the soil in the form of organic or inorganic fertilizers. By providing these inputs, it will directly provide benefits in the process of plant growth and production without reducing attention to external factors that are closely related to soil factors (edaphic factors). The successful growth of forage plants requires the support of the physical quality of the soil and ideal climate.

Kate's elephant grass, also known as dwarf elephant grass or *Pennisetum purpureum* cv Mott is very well known in Indonesia because it has advantages compared to other species of elephant grass (Kozloski et al., 2005; Kowitwiwat & Sampanpanish, 2020). Timor Leste began to introduce kate's elephant grass in 2018. The advantages of kate's elephant grass include fast growth, downy, soft leaves, soft stems and has high palatability for ruminants, 10-15% protein content, and low crude fiber. This plant gave a positive response to the addition of organic fertilizer with fresh forage production ranging from 46.35 to 99.28 tons and dry matter production from 13.04 to 26.11 tons⁻¹, with crude protein of 8.88 to 9.12% and crude fiber worth 32.02-32.70%. The productivity of kate's elephant grass as feed depends on the quality of the growing amount of nutrients available and utilized by kate's elephant grass to grow and produce.

To improve soil quality, one of the efforts that can be done is to add liquid organic fertilizer made from cow feces. One cow every day produces feces ranging from 8-10 kg per day or 2.6-3.6 tons per year (Huda & Wikanta, 2016). The potential of cow feces in Timor Leste is 996.432-1.379.675 tons per year. Cow feces is one of the potential ingredients for making organic fertilizers, including liquid organic fertilizers. Liquid Organic Fertilizer (LOF) is a liquid fertilizer that is processed from basic ingredients such as urine, feces, mixed with starter (EM4), with other ingredients and clean water used for fertilization, fertilizing plant, increasing plant productivity because it is a source of N nutrients, P, and K are very important for plant growth and development. The dose of LOF affects the growth and production of setaria grass (Toe & Koten, 2016), while Febriana et al. (2018), reported that the frequency of giving LOF at the time of its application to plants affected plant growth and production. The successful growth of forage plants requires the support of an ideal physical soil and climate environment (Urribari et al., 2005 cit Noralita et al., 2020). Furthermore, it is said that giving organic matter or organic fertilizer with high organic carbon has indirectly contributed to soil organic carbon so that soil C-organic also increases and can improve soil structure. The soil organic matter contained in the soil is only a little less than 3-5% of the weight of the representative mineral soil topsoil (Buckman & Brady, 1982). The total N value in the soil ranges from about 0.1 to 0.75% or more was strongly influenced by the activities of microorganisms, both free-living and symbiotic with plants. Based on the above background, the research was carried out to evaluate the dose of LOF made from cow feces with different doses and frequency of watering on kate's elephant grass (*Pennisetum purpureum* cv Mott) on soil temperature, soil moisture, soil organic matter, and N-total vertisol soil in Timor Leste (Borreani et al., 2019).

2 Materials and Methods

This experimental research was carried out in Hera Village, Metinaro Sub-District, Dili Municipality, Timor Leste, for 4 months (May-September 2018). The materials used were kate's elephant grass cutting (*Pennisetum purpureum* cv Mott), Liquid Organic Fertilizer (LOF) based on cows feces, vertisol-type soil as a planting medium, SP 36 (36% P_2O_5) basic fertilizer, Urea (45% N), and KCL (60% K_2O), polybag measuring 20 x 50 cm with a diameter of 22 cm, insecticide brand "Dursban" (Kozloski et al., 2006; Tonga et al., 2017).

The equipment used is a greenhouse measuring 12 x 8 m (96 m²), a set of agricultural tools, a soil sifter with a diameter of 0.5 cm, a Camry brand spring scale with a capacity of 10 kg and having its sensitivity of 1 g to weigh the soil, a Sartorius digital scales with a capacity of 200 g and with the smallest scale of 0.0001 g for weighing fertilizers, a Sartorius digital scales has a capacity of 2600g and with the smallest scale of 0.1 g for weighing forage, a meter for measuring plant height, scissors, liters for measuring the amount of watering water and liquid organic fertilizer (LOF).

Research procedure

The greenhouse is made as a place to put polybags, which have been filled with 15 kg pot⁻¹ of soil, procurement of grass cutting, preparation of tools and materials, making LOF according to Toe et al. (2016), namely using dried cow feces and then mixed evenly with fresh Gamal leaves that have been chopped in a ratio of 2:1 (20 kg feces and 10 kg Gamal leaves). Next put it in a plastic drum, then add water in a ratio of 2 liters of water for 1 kg of material weight (60 liters): EM4 (600 ml), granulated sugar (600 g), and rice flour (600 g). After that, the drum is mixed closed and left for 21 days. Polybags are placed in the greenhouse with a distance of 0.5 x 0.5 meters. Planting 2 cuttings polybag⁻¹ followed by watering, replanting, and maintenance. Provision of basic fertilizer, namely SP 36 (36% P_2O_5) with a dose of 50 kg ha⁻¹ at the time of planting, Urea fertilizer (45% N) given at a dose of 50 kg ha⁻¹ when the plant was 14 days old, and KCL fertilizer (60% K_2O) with the dose of 50 kg ha⁻¹ was given 2 times, namely, 25 kg ha⁻¹ was given at the time of planting to stimulate early growth and the remaining 25 kg ha⁻¹ was given to plants aged 14 days. All fertilizers are given by immersing them at a distance of ± 5 cm from the planting hole (Sly et al., 2002; Eriksson et al., 1997). Provision of LOF according to the treatment once a week until harvest. Weed handling is done when there are weeds. Harvesting when the plant is 60 days old by cutting the plant 15 cm above the soil surface. The forage harvester is separated from the stems and leaves, weighed and the sample is prepared and analyzed.

Experimental design

The experiment used the factorial pattern in a completely randomized design (CRD) with 2 factors, namely: Factor A (LOF dose): P2 (1-liter LOF:2 liters of water), P4 (1-liter LOF:2 liters of water), P6 (1-liter LOF:6 liters of water), (1 liter LOF:8 liters of water), and factor B is the frequency of LOF application consisting of W2 (LOF given every 2 days), W4 (LOF given every 4 days), W6 (LOF given every 6 days). The experiment used four replications so that there were 48 experimental units. The variables measured included: soil temperature, soil moisture, soil organic matter, and N-Total soil (Mitcham et al., 2004; Mafart et al., 2002). The experimental data were analyzed using Analysis of Variance (ANOVA) and continued with Duncan's Test using SPSS version 21.

3 Results and Discussions

3.1 General state of research

The experiment was carried out on vertisol soil, with a pH of 7.75 with a content of 0.02% organic C., 0.05% Total N, 2.95 ppm P_2O_5 , 2.45 g K_2O , 12.40 g CEC, with a texture of 31.93% sand, 52.36% dust, and 15.71% clay. LOF contains 42.46% organic C., 0.05% Total N, 0.10% P_2O_5 , 1.51% K_2O , with a pH of 7.7. The air temperature during this study ranged from 29.46 to 32.02°C with air humidity ranging from 48.91 to 51.25%. During the study, kate's elephant grass which received the first-factor treatment (P2=(1-liter LOF:2 liters of water), and

second-factor treatment W2 (LOF given every 2 days) gave better results than the combination of treatments P2W4, P2W6, P4W2, P4W6, P6W2, P6W4, P6W6, P8W2, P8W4, P8W6 on the variable of fresh weight, the number of tillers increase, plant height increase, clump circumference increase and stem diameter increase, respectively 700; 956.25 g/polybag, 8.43; 8.37 pcs/week, 6.92; 5.49 cm/week, 8.31; 7.68 cm/week and 2.75; 2.48 mm/week.

3.2 Soil Factor (edaptic factor) due to the treatment of LOF doses and different frequencies of giving on kate's elephant grass (*Pennisetum purpureum* cv Mott)

The value of soil in agriculture depends on the following factors: 1. Nutrient content and ability to hold; 2. Nutrient availability; 3. Acidity and alkalinity; 4. Soil physical condition; 5. Water holding capacity; 6. Soil depth; 7. Stability against erosion and soil organic materials (Sastrahidajat & Soemarno, 1991). All of these factors are also influenced by the ecological characteristics of the soil. Table 1 shows the results of the study on the effect of dose treatment of liquid organic fertilizer (LOF) made from cow feces, and the frequency of different applications of kate or dwarf elephant grass on soil temperature, soil moisture, soil organic matter, and N-total vertisol soil (Fa et al., 2005; Declerck et al., 2006).

Table 1
Effect of treatment on *Pennisetum purpureum* cv Mott on soil factors

Treatment/Variable	P2	P4	P6	P8	Average
Soil temperature (° C)					
W2	31.88±0.11	31.73±0.28	31.91±0.46	31.98±0.38	31.87
W4	31.88±0.12	32.01±0.51	31.68±0.20	32.10±0.38	31.91
W6	31.80±0.21	32.03±0.20	31.89±0.21	31.91±0.11	31.90
Average	31.85	31.92	31.82	32.00	
Soil moisture/humidity (%)					
W2	63.52±0.65	64.50±0.87	65.31±1.43	64.00±0.35	64.33 ^a
	B	AB	A	AB	
W4	65.75±2.30	63.526±1.98	62.88±1.26	64.00±1.71	63.97 ^{ab}
	A	AB	B	A	
W6	64.11±0.42	63.13±0.61	62.88±0.78	62.86±1.03	63.24 ^b
	A	AB	B	B	
Average	64.33	63.97	63.24	63.85	
Soil organic matter (C-organic)%					
W2	1.66±0.02	1.86±0.29	1.51±0.13	1.48±0.19	1.60 ^a
W4	1.58±0.03	1.64±0.08	1.41±0.09	1.31±0.01	1.48 ^{bc}
W6	1.57±0.09	1.59±0.10	1.55±0.11	1.50±0.17	1.55 ^{ab}
Average	1.60	1.71	1.49	1.43	
N-Total soil (%)					
W2	1.10±0.01	0.09±0.01	0.08±0.00	0.09±0.05	9.00
W4	0.09±0.01	0.09±0.01	2.04±3.97	0.08±0.01	0.57
W6	0.09±0.01	0.11±0.01	0.09±0.00	0.08±0.00	0.90
Average	0.09	0.09	0.73	0.01	

Note: Different upper and lower case letters in the same row and column indicate a significantly different (P<0.05). P2 (1-liter LOF:2 liters of water), P4 (1-liter LOF:2 liters of water), P6 (1-liter LOF:6 liters of water), (1-liter LOF:8 liters of water); W2 (LOF given every 2 days), W4 (LOF given every 4 days), W6 (LOF given every 6 days).

Soil temperature is one of the physical properties of the soil which mainly affects the processes that occur in the soil such as weathering and decomposition of the main material, chemical reactions, and can directly affect plant growth through soil moisture, aeration, microbial activity, availability of plant nutrients and others The optimal soil temperature for plants is between 26.67°C-32.2°C and is not different from the vertisol soil

temperature at the study site. Different doses and frequencies of LOF did not significantly affect changes in soil temperature. Vertisol soil temperature is still in the normal range. This is possible because the application of organic fertilizer will increase the organic matter content of the soil so that microbial activity will run well and thus the soil temperatures will be constant.

Analysis of variance for soil moisture showed the difference between treatment ($P < 0.05$) and Duncan's test results showed that frequency's single factor of LOF application (W2) was the best (64.33%) and there was an interaction between factors P2 and W2, this is consistent with the opinion of [Buckman & Brady \(1982\)](#), who said that the optimal soil moisture for plants is 60-80%. Giving LOF every two days causes the soil water content to be higher so that the absorption of nutrients becomes better and more efficient.

Organic matter of LOF serves to improve soil physical properties, namely improving soil structure, increasing water holding capacity, aeration porous and infiltration rate, and facilitating root penetration, so that land productivity and crop yields can be increased ([Sumarni et al., 2010](#)). This is closely related to the analysis of soil organic matter variance which showed a significant difference ($P < 0.05$) in the LOF dose factor and the LOF application frequency factor where Duncan's test showed that the single factor treatment P4 and W2 gave a better percentage value of 1.71% and 1.63% on vertisol soil, because organic matter directly affects plant physiology, increases soil biological activity and increases groundwater availability ([Kusumawati et al., 2016](#)). This is following [Shah \(2019\)](#), which states that the application of organic fertilizers can affect the chemical properties of the soil, by creating a nutrient balance in the soil to improve crop production.

Analysis of variance for N-total soil in vertisol soils did not show a significant difference even though liquid organic fertilizer made from cow feces was given because most of the vertisol soils lacked nitrogen. The loss of nitrogen from the soil may be caused by three main things, namely, nitrogen can be lost due to leaching with drainage water, evaporation, and absorption by plants. The presence of nitrogen in the soil greatly affects the vegetative growth of plants. Organic matter in the soil is closely related to N, if N is high then the organic matter in the soil will also be high and vice versa. The Carbon-Nitrogen (C/N) ratio is a way to show an overview of the relative Nitrogen content. The C/N ratio of organic matter is an indication of possible nitrogen deficiency and completion between microbes and higher plants for the use of available nitrogen in the soil. In addition to organic matter, soil texture and pH also affect the presence of nitrogen in the soil.

4 Conclusion

Based on the results and discussion, it can be concluded that: external factors (soil) namely temperature, soil moisture, and soil organic matter (C-organic) are influenced by the LOF dose and the frequency of LOF application. The interaction between dose and frequency of LOF giving only occurred in soil moisture variable and the best dose and frequency was *Pennisetum purpureum* cv Mott which received 1 liter of LOF in 2 liters of water (P2) with a frequency of once every 2 days (W2).

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