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Research Article

Effects of Growth Characters, Biomass Production, and Nitrogen Uptake of Elephant Grass by Different Liquid Fertilizers as a Ruminant Feed

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Abstract | The objective of this study was to determine the effect of applying liquid organic fertilizer on the growth and biomass production of elephant grass (*Pennisetum Purpureum*). This study used a completely randomized design consisting of 4 treatments and 4 replications. The study treatment was liquid organic fertilizer (LOF) from various manufactured products, namely Genetic-plus and Bio-love, and as a comparison, LOF Bio-urine produced from the biogas process. The research treatment is as follows: T0 = Without using LOF (Control); T1 = Using LOF Genetics-plus; T2 = Using LOF Bio-love; T3 = Using LOF Bio-urine. Parameters measured were (1) plant growth, namely plant height and tiller number, (2) biomass production, namely fresh matter weight, dry matter weight and leaf blade percentage and (3) nitrogen uptake. The results showed that the treatment had a very significant effect (P<0.01) on growth and biomass production, and a significant effect (P<0.05) on nitrogen uptake. The highest yield for plant height growth reached 446 cm and the growth of tiller number reached 39 tillers. The highest yield in the production of fresh matter weight was 40 kg/m2 and dry matter weight was 688.2 gr/m2. The highest leaf blade percentage obtained was 65% in LOF Bio-love. In summary, using liquid organic fertilizer on elephant grass was more effective and efficient on LOF Bio-urine compared to Genetics-plus and Bio-love. In short, The use of manufactured liquid organic fertilizer also has a positive effect on increasing growth and elephant grass biomass production.

Keywords | Biomass production, Elephant grass, Liquid organic fertilizer, Ruminant feed

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INTRODUCTION

Forage is the main feed source for ruminants in order to survive, produce and reproduce. Feed was identified as the major contributor to the land occupation, primary production use, acidification, climate change, energy use, and water dependence (Sjofjan and Adli, 2021). High livestock production needs to be supported by the availability of sufficient and sustainable forage. The main source of forage is grass. One of the grasses that has great potential and is often given to ruminants is elephant grass (*Pennisetum purpureum*). Elephant grass contains nutrients that are useful for sustaining livestock life. Using elephant grass production has been carried out by forage researchers, such as elephant grass which has high production and nutritional content so that it is able to meet the forage needs of ruminants (Mukhtar, 2020). Elephant grass is able to grow in unfavorable soil conditions, produces high biomass on fertile soils and is very responsive to fertilization. Elephant grass biomass production can reach 150 - 200 tons/ha/year (Mukhtar, 2006; Mukhtar, 2020). Until now there have been several varieties of elephant grass, both normal varieties such as Merkeron, Wruk wona, Cipelang and dwarf

varieties such as *Cv. Mott*, dwarf-early, dwarf-late, and others. This dwarf variety aims to facilitate breeders in grazing (Mukhtar, 2007). Elephant grass also has a high response to fertilization both organic and inorganic fertilizers and in solid or liquid form.

The application of liquid organic fertilizer is a solution resulting from the decomposition of organic materials originating from plant residues, animal waste (feces and urine) and humans, which contain more than one element (Bahri et al., 2022). These elements are: Nitrogen (N) for the growth of shoots, stems and leaves. Elements of Phosphorus (P) to stimulate the growth of fruit roots and seeds. Elements of Potassium (K) to increase plant resistance to pests and diseases. The content of N, P and K is much needed by plants which can affect the quality of plants such as the content of crude protein, crude fiber (Setiawan, 2010; Lasamadi et al., 2003). One of the best liquid organic fertilizers (LOF) to use is bio-urine. Bio-urine is produced from the process of biogas from cow faces.

Using liquid organic fertilizers extracted from various types of plants, especially legumes, which are extracted manually or manufactured packaged by researchers who aim to have a positive effect on growth and increase in the production of forage biomass for livestock by administering different doses. The level of application is based on the nutritional content of each type of liquid organic fertilizer plant in the manufacturer's packaging by comparing liquid organic fertilizer in the form of beef cattle bio urine. Based on these conditions, it is very important to study the effect of using the LOF of manufactured products by comparing the LOF of biogas that has been used by the livestock community.

MATERIALS AND METHODS

This study used a completely randomized design consisting of 4 treatments and 4 replications. The research treatment was the application of liquid organic fertilizer (LOF) from various manufactured products, namely Genetika Plus and Bio-Love, and as a comparison, LOF Bio-urine produced from the biogas process. The basis for the concentration of application is Bio-urine as much as 200 ml/plant/week. In terms of giving LOF Genetics Plus and Bio-love, namely 20 cc/week/plant. This 20 cc liquid is dissolved in 500 cc (0.5 liter) water. The research treatment is as follows:

T0 = Without using LOF (Control); T1 = Using LOF Genetics-plus; T2 = Using LOF Bio-love; T3 = Using LOF Bio-urine.

Measurement of nitrogen uptake

The percentage of nitrogen uptake is calculated using the following formula:

$$Eh(N) = \frac{Sp(N) - Sk}{Hp(N)} \times 100\%$$

Eh(N) : The amount of nitrogen uptake by plants
Sp(N) : The amount of nitrogen in solid fertilizer
Sk : The amount of nitrogen in the tiller before planting
Hp(N) : Nitrogen (N) levels in plants after harvest/defoliation

The results of the analysis of nitrogen content in soil and elephantgrass plants are shown in Table 1.

Statistical Analysis

The data were analyzed statically by analysis of variance and the difference in the mean value was calculated by the list significant difference (LSD) method at 1% and 5% level by following (Adli et al., 2023; Ardiansyah et al., 2022)

RESULTS AND DISCUSSION

Elephant grass plant growth characters

Plant height (PLH) and tiller number (TN) of elephant grass treated with liquid organic fertilizer (LOF) from manufactured products and biogas products as a comparison are shown in Figure 1. The results of the analysis of variance showed that the application of LOF to elephant grass showed a very significant effect ($P<0.01$) in increasing PLH and TN both using LOF Genetics-plus, LOF Bio-love and LOF Bio-urine. The highest achievement of PLH and TN in the treatment was LOF Bio-urine followed by LOF Bio-love and LOF Genetics-plus (Table 1). Plant height growth using both factory LOF and Bio-urine reached a growth peak in the second defoliation and tended to decrease in the third and fourth defoliation during the rainy season. The high growth character of this plant showed the same average increase in all treatments from the first defoliation to the second defoliation, and an almost the same decrease from the third to the fourth defoliation.

Plant height growth without LOF only reached an average of 2 meters at the peak of growth, while Genetics-plus LOF reached 3 meters, Bio-love and Bio-urine LOF application reached 3.5 meters, this shows that plants experience elongated stems after growth organs get high plant nutrition, likewise after defoliation there are additional nutrients so that the re-growth process can occur faster and increase.

The growth of the tiller number increased linearly from the first defoliation to peak yields on the fourth defoliation in both the LOF Genetic-plus and Bio-love as well as the LOF Bio-urine resulting from the biogas process. In the

Table 1: Results of analysis of nitrogen (N) content in soil and elephant grass before being treated with liquid organic fertilizer (LOF).

Type of Samples	Amount of Titration (ml)	Percentage of N Titration (%)
Soil	23.467	0,215
Elephantgrass	21.300	0.518

Source: Chemistry Laboratory, Department of Animal Science, Gorontalo State University.

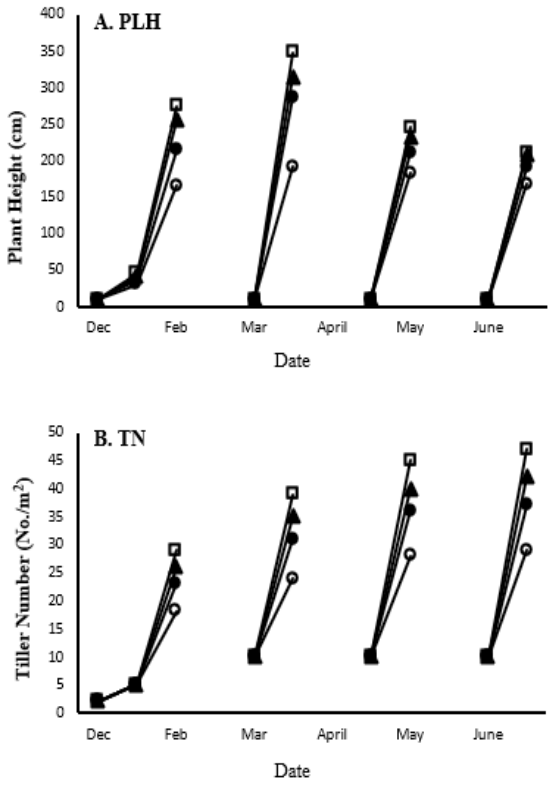

Figure 1: Growth characteristics of elephant grass plants treated with liquid organic fertilizer (LOF) from manufactured products and biogas products.
T0 = Without using LOF (control, ○)
T1 = Using LOF Genetika Plus (●)
T2 = Using LOF Bio-Love (▲)
T3 = Using LOF Bio-Urin (□)
Figures with different letters denote the significant difference among LOF at 1 % level.

LOF Genetic-plus and Bio-love treatments there was no visible difference in results, but compared to the LOF Bio-urine treatment there was a significant difference, this was due to the different nitrogen content, the nitrogen content of LOF Bio-urine was higher than the factory LOF. This shows that the high nitrogen content will greatly help and influence the regrowth process and the formation of new tillers even though it was treated with several times of defoliation.

Elephant grass Biomass Production

Fresh matter weight, dry matter weight and percentage of elephant grass leaves treated with liquid organic fertilizer (LOF) from manufactured products (Genetics-plus and Bio-love) and biogas products (Bio-urine) as a comparison are shown in Figure 2. Results analysis of variance showed that the LOF treatment on elephant grass showed a very significant change ($P<0.01$) in increasing fresh matter weight and dry matter weight as well as the percentage of leaves using LOF Genetics-plus, Bio-love and Bio-urine, but had no effect significant in percentage of leaves ($P>0.05$) (Table 2).

Table 2: Total fresh matter weight (TFMW) and total dry matter weight (TDMW) of elephant grass treated with liquid organic fertilizer (LOF).

Variables	Treatments			
	T0	T1	T2	T3
	---------- gr/m² ----------			
1. Total fresh matter Weight (TFMW)	4161.1± 0,1[d]	5882.8± 0,3[c]	8069.6± 0,2[a]	7273.2± 0,3[b]
2. Total dry matte Weight (TDMW)	1664.4± 0,2[d]	2353.1± 0,1[c]	3227.8± 0,2[a]	2909.3± 0,3[b]

Description: T0 = Without using LOF (Kontrol)
T1 = Using LOF Genetika Plus
T2 = Using LOF Bio-Love
T3 = Using LOF Bio-Urin
Tables with different letters denote the significant difference among LOF at 1 % level.

Both fresh matter production (FMW) and dry matter production (DMW) increased from the first defoliation to the second defoliation and tended to decrease in the third and fourth defoliation at each LOF used. In contrast to growth characteristics, biomass production tends to achieve the best results at factory LOF compared to biogas LOF, although the yield of biomass is inconsistent in each defoliation period. The yield percentage obtained for fresh matter production (FMW) and dry matter production (DMW) ranged from 35% for the first and second defoliation, and around 25% for the third and fourth defoliation. Total fresh matter weight (TFMW) and total dry matter weight (TDMW) treated with liquid organic fertilizer (LOF) from manufactured products (Genetics-plus and Bio-love) and biogas products (Bio-urine) as a comparison are shown in Table 2. The production of TFMW and TDMW among the 3 LOFs in this study during the rainy season was achieved by LOF Bio-love followed by LOF Bio-urine and the lowest LOF Genetics-plus with total biomass of 80.7 tons/ha, 72.7 tons/Ha and 58.6 tons /Ha, respectively. The yield of biomass without using LOF is 41.6 tons/Ha. The results of the achievements of TFMW and TDMW

will change in the dry season considering the low rainfall that falls in the Gorontalo Province area. The achievement of biomass yields in this study was lower than the results of research conducted by Sumarsono (2009) using solid organic fertilizer on elephant grass during the rainy season where the yields obtained were 52.93 tons/Ha.

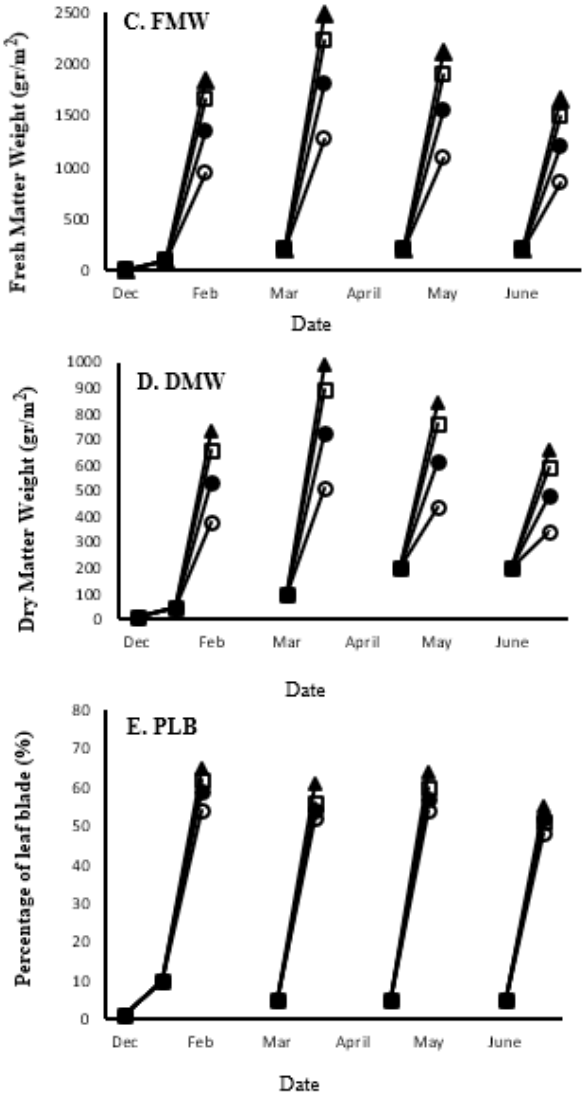

Figure 2: Change with time in fresh matter weight (FMW, C), dry matter weigth (DMW, D) and percentage of leaf blade (PLB, E) elephantgrass plants given different LOF. As for symbols in each treatment, refer to Fig. 1.

Elephant grass nitrogen uptake

The results of nitrogen uptake of elephant grass treated with liquid organic fertilizer (LOF) from manufactured products (Genetics-plus and Bio-love) and biogas products (Bio-urine) as a comparison can be seen in Table 3. The results of the analysis of variance showed that the application of LOF on elephant grass plants showed a significant effect (P>0.05) on nitrogen uptake. This real effect gives a positive correlation of plant growth results and elephant grass biomass production.

Table 3: The average percentage of nitrogen (N) absorption in elephant grass treated with liquid organic fertilizer (LOF).

Defoliation and date	Treatments			
	T0	T1	T2	T3
	----------N % ----------			
Def-1, 08 Feb-2022	1.90[c]	3.52[a]	3.42[a]	2.49[b]
Def-2, 20 Mar-2022	1.85[c]	4.75[a]	4.62[a]	3.36[b]
Def-3, 30 Apr-2022	1.67[c]	4.05[a]	3.93[a]	2.86[b]
Def-4, 28 Jun-2022	1.77[c]	3.17[a]	3.08[a]	2.24[b]

Description: T0 – T3 refer to Table 2.
Tables with different letters denote the significant difference among LOF at 5 % level.

Data on nitrogen uptake results show higher nitrogen uptake by plants in LOF Genetic-plus and LOF Bio-plus (manufacturer products) compared to LOF Bio-urine (biogas products). This is because the pure factory LOF contains nitrogen elements while the bio-gas LOF is still mixed with several other mineral elements. The average percentage of nitrogen uptake in elephant grass plants at LOF Genetics-plus, LOF Bio-love and LOF Bio-urine were 3.87%, 3.76% and 2.74%, respectively.

Nitrogen uptake increased from the first to the third defoliation and slightly decreased to the fourth defoliation, but tended to be inconsistent with all types of liquid organic fertilizer (LOF). The percentage of biomass production is highly dependent on the availability of nutrients in the soil, especially nitrogen and organic matter. It also has a direct effect on plant physiology such as respiration to stimulate nutrient uptake thereby increasing growth and biomass production (Supriyanto, et.al., 2014).

DISCUSSION

Elephant grass plant growth characters

Plant growth measured in this study was plant height and tiller number. Plant height and tiller number are two indicators of plant growth, besides that it is also an indicator of the plant's ability to absorb nutrients properly. The availability of nutrients in the soil can be absorbed by plants, both in the soil and given in solid or liquid form.

In the treatment using 3 types of liquid organic fertilizers (LOF), plant height growth was very high with the use of LOF Genetics-plus followed by LOF Bio-love and LOF Bio-urine. This is due to the high nitrogen content in LOF Genetic-plus and LOF Bio-love. Meanwhile, Bio-urine has a slightly lower nitrogen content compared to Genetic plus and Bio-love, due to the presence of a high water mixture in bio-urine, making it very difficult to predict the mixing.

Among the various nutrients, nitrogen is the element most needed in plant height growth because this element stimulates cell elongation and generative growth, besides that it will result in an increase in nitrate content. The size of the presentation of growth is very dependent on the availability of nutrients in the soil, especially nitrogen and organic matter also has a direct effect on plant physiology such as increasing respiration to stimulate nutrient uptake thereby increasing growth (Wadi A. et.al., 2003; Fitri et.al., 2007). The tiller number is one part that shows the growth and development of plants in the vegetative phase. The production of the tiller number can be used to estimate the high or low weight of the forage produced. One indicator of elephant grass productivity is the production of tiller number, where the more tillers, the more prospective parents. The number of tillers in question is all the young individuals that emerge from the soil surface in a plant clump.

In terms of the growth in the number of tillers, there is a slight difference between the LOF of Bio-urine and the 2 factory LOFs, namely Bio-love and Genetics-plus. Bio-urine obtained a slightly higher tiller number compared to Bio-love and Genetic-plus, but better than the control. Most likely this is influenced by the consistency of the nutrients that Bio-urine has where the other mineral content is more complete than the manufacturer's product, because the manufacturer's LOF only emphasizes N-P-K, especially nitrogen, while Bio-urine is more complete because it comes from livestock manure.

The results of research using bio-urine were reported by Nuriyasa (2012), where the application of bio-urine fertilizer to elephant grass plants showed a significant growth in the tiller number with the highest dose of 75,000 l/ha (200 ml/pot) which reached a height of 78.50 cm in 1 month, compared to using artificial organic fertilizer. This showed that the complete nutrients in bio-urine are very useful for plants for growth and development, including: making plant leaves fresher green and containing lots of green leaf grains (chlorophyll) which have a very important role in photosynthesis, accelerating growth number of children, branches and others.

Elephant grass Biomass Production

Biomass production measured in this study was fresh matter weight, dry matter weight and leaf blade percentage. Fresh matter weight and dry matter weight are the most important indicators in assessing elephant grass productivity. The production of this fresh matter weight indicates the quality and digestibility of the forage. High leaf blade percentage indicates high crude protein in forage and because the photosynthesis process is going well. The results of the analysis of variance showed a very significant effect ($P<0.01$) on the production of fresh matter weight and dry matter weight, but there was no significant effect on the percentage of leaf blade.

Fresh matter production and dry matter production, both are positively correlated. High fresh material production will also result in high dry matter production on the same plant species. Fresh matter production and dry matter production, both in this study showed the same and very high results in LOF Bio-urine, followed by LOF Bio-love, LOF Genetics-plus and the lowest in the control, while the percentage of leaf blade showed almost the same results in all liquid organic fertilizer treatments and those without using LOF (control).

The high production of fresh matter weight and dry matter weight in LOF Bio-urine is because this LOF has a complete nutritional content in all macro-nutrients namely nitrogen (N), Phosphorus (P), Kalium (K), Magnesium (Mg), Calcium (Ca), and Sulfur. The use of bio-urine liquid organic fertilizer, where the nutrients are available in full, without starting the decomposition process is one of the factors accelerating the absorption and utilization of plants in the process of plant development producing fresh material and leaf production (Yani and Ahmad, 2008).

The results of research related to the use of liquid fertilizer on elephant grass plants also showed high results using bio-urine liquid organic fertilizer which was carried out by and stated that the application of liquid fertilizer at a dose of 2 litre/ha showed the highest production among other treatments where it reached 648.93 g/clump (Muhakka, 2014).

The production of fresh matter weight and dry matter weight as well as a high percentage of leaf blade is an assessment parameter in cultivating forages so that besides being able to guarantee the nutritional content of plants, it can also guarantee the continuous availability of forages. Elephant grass does have a high production but with the application of liquid organic fertilizer, both manufacturers and bio-urine from biogas, can further increase the productivity of elephant grass.

Elephant grass nitrogen uptake

The element nitrogen is one of the constituent elements of protein as a tissue builder in living things, while in the soil the element nitrogen is very supportive and determines plant growth. Nitrogen is required for the formation or growth of vegetative parts of plants such as leaves, stems and roots. Hsu, F.H. (1993) stated that nitrogen plays a role in accelerating the vegetative phase because the main function of nitrogen is to synthesize chlorophyll. Chlorophyll functions to capture sunlight which is useful for the formation of food in photosynthesis, sufficient chlorophyll

content can form or stimulate plant growth, especially stimulating the vegetative organs of plants.

The percentage of nitrogen absorption shows the high or low content of nitrogen absorbed by elephant grass plants. Nitrogen absorption both from the air and from the soil is assimilated in the process of reduction and assimilation. Air nitrogen is absorbed from free N2 through root nodule bacteria and NH_3 is absorbed through plant stomata, while nutrient absorption is carried out by plant roots and taken from soil absorption complexes or from soil solutions in the form of cations and anions.

CONCLUSIONS

Based on the findings in the study, it can be concluded that : (1) the use of liquid organic fertilizer (LOF) Bio-urine is more effective and efficient in fertilizing elephant grass plants, but the mixing of water must be controlled in the biogas process so that the concentrations are nitrogen (N), phosphorus (P) and potassium (K) did not change or the N-P-K content remained, (2) The use of liquid organic fertilizers Genetic-plus and Bio-love also had a positive effect in increasing the growth and production of elephant grass biomass, but the nitrogen concentration had to be increased to match the nitrogen content of LOF Bio -urine. The percentage of nitrogen uptake was better at LOF Genetic-plus followed by LOF Bio-plus and LOF Bio-urine.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

NOVELTY STATEMENT

The novelty in this study is the high level of absorption of nitrogen, phosphorus and potassium contained in liquid organic fertilizer (LOF) manufactured products as well as absorption in LOF resulting from the biogas process, thus providing a very large effect in the process of plant growth and achieving high biomass in elephantgrass as ruminant feed. The use of LOF Genetics-plus, Bio-plus or Bio-urine doses will be a recommendation to farmers and ranchers in cultivating elephantgrass plants as ruminant animal feed.

AUTHOR'S CONTRIBUTION

The main researcher as an expert in the field of forage biomass production for ruminants has contributed to studying several liquid organic fertilizers (LOF) of manufactured products by comparing the LOF of the results of the biogas process in order to explain the economic value of its use that can be used by the farming community. In addition, the main researcher and the second researcher play a role in designing research to produce journals that can be used as policy papers. The second and third researchers are tasked with disseminating information to the livestock community on how to wisely use LOF of manufactured products, as well as coordinating with the local government and the private sector.

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