Dry matter production and quality of *Pennisetum purpureum cv. Taiwan* applied different fertilizer

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Abstract. *Pennisetum purpureum* cv. *Taiwan* is a tropical forage developed and used as a ruminant feed source. This grass not only high in production and quality but also grow well with sufficient fertilizer. The objective of this study was to determine the best response of fertilization on the production and quality of Taiwan grass. The research was conducted on pasture for 2 months at the Faculty of Animal Science, Universitas Hasanuddin. The study was arranged to completely randomized design with 6 treatments and 3 replications i.e. T0 = without any fertilizer inputs; T1= 100% of urea; T2 = 100% of compost; T3 = 75% of urea and 25% of compost; T4 = 50% of urea and 50% of compost; and P5 = of 25% urea and 75% of compost, respectively. Taiwan grass is used in the form of 2 pools in each polybag. The compost was applied in 2 weeks before planting and urea fertilizer was applied after 2 weeks of planting. The result showed that input of urea and compost fertilizer have a significant effect ($P<0.05$) on the production and quality of Taiwan grass. Therefore, the application of a combination of 50% urea fertilizer and 50% of compost fertilizer provided a better response to dry matter production and quality compared with other treatments.

1. Introduction

Livestock development can grow well if forage needs are available. One of the important factors in increasing the productivity of livestock is the sustainability of forage that has good production and quality. Forage in ruminant rations reaches 40-80% of the total dry matter of the ration or about 1.5-3% of the live weight of livestock [7].

The provision of forage and feed processing needs to be conducted to achieve optimal livestock growth. However, it is not only a lack in the sustainability of forage but also its quality decreases, especially during the dry season. This situation led to efforts in providing forage that has dryland conditions. The dryland generally has a limited soil nutrient. Therefore, to increase dryland productivity through fertilization input [27].

Urea fertilizer is a substance that helps growth plant with a high nitrogen content of 46%. Urea fertilizer contains nitrogen, N which is needed by the plant, especially in a growing period. Nitrogen helps plant metabolism. Generally, urea has a fairly rough texture [4]. Compost from chicken manure is useful for repairing soil structure damaged by excessive use of chemical fertilizers. Organic fertilizers help restore soil fertility, rebalance soil biological, physical, and chemical properties, and promote the

development of soil microorganism populations because organic matter plays an essential role in determining the ability of soil to support plant growth.

Taiwan grass (*Pennisetum purpureum* cv. Taiwan) is a tropical forage that is easy to cultivate, high production, has fairly large leaf size, plant height reaches 4-5 meters, adapts to various types of light soil textures and grow well by input fertilizer. The crude protein (CP) content of Taiwan Grass is more than 7% however CP increases in the mature stage around 13% and 45% of a chlorophyll content [20]. Currently, there is no information about the combination of organic fertilizers with inorganic fertilizers in the field for increasing growth, dry matter (DM) production, and forage quality. Therefore, this study was to determine the role of fertilizers in increasing DM production and the quality of Taiwan grass.

2. Research method

2.1. Material and method

This research was conducted from November 2019 to January 2020. This research consisted of two stages. The first stage was cultivation in the Pasture Laboratory and the second stage was analysis forage quality at the Animal Feed Chemistry Laboratory, Faculty of Animal Science, Universitas Hasanuddin, Makassar. The materials used in this study were Taiwan grass cuttings, fertilizer i.e. urea and chemical compost. used in the proximate analysis method. This study was prepared based on a completely randomized design (CRD) with 6 treatments and 3 replications [6]. The treatments consisted of T0 = (Control) without fertilization; T1 = urea100% (300 kg ha^{-1} = 1.5 gram/polybag); T2 = compost 100% (3 ton ha^{-1}= 15 gram/polybag); T3 = urea 75% (225 kg ha^{-1} = 1.1 gram/polybag) + compost 25% (0.75 ton ha^{-1} = 3.8 gram/polybag); T4 = urea 50% (150 kg ha^{-1} = 0.75 gram/polybag) + compost 50 % (1.5 ton ha^{-1} = 7.5 gram/polybag); P5 = urea 25 % (75 kg ha^{-1} = 0.4 gram/polybag) + compost 75 % (2.25 ton ha^{-1}= 11.3 gram/polybag), respectively.

2.2. Media for cultivation and providing seeds

Before cultivation, the land is homogenized first and then put 10 kg each into 20 polybags measuring 30 cm x 40 cm with a diameter of 15 cm. Taiwan grass seedlings are then planted in each polybag which already contains the soil with the grass seeds that have been mowed evenly.

2.3. Cultivation

Soil characteristic in this study was sandy clay (Latosol soil). The elements of the soil were analyzed in Laboratory of Chemistry and Soil Fertility, Faculty of Agriculture, Universitas Hasanuddin (2019) with 6.40 pH; 2.11% C; 0.13% N; 18% C/N; 19.63 mg 100 g^{-1} T_2O_5, and 9.64 mg 100 g^{-1} K_2O.

Polybags that have been filled with soil, then 2 numbers of the nursery of Taiwan grass with a height of 20-cm was planted in each polybag, subsequently. Furthermore, the polybags were placed at a distance of 50 cm. Watering was conducted every day for 2 weeks at the establishment stage. After the forage established, the next step was fertilizer input according to the treatment. The nutrient content of urea and compost was presented in table 1.

Table 1. Nutrient content of compost fertilizer.

pH	C	N	C/N	$T2O_5$	K_2O
	---------%-------			--mg 100 g^{-1}--	
6.8*	1.96	1.76*	12.24*	27.43*	3.22*
6.8-7.4**	0.50**	0.40**	9.80-32**	10-20**	0.20**

Description: *Results of compost analysis in the current study; **Standard of organic fertilizer according to SNI 19-7030-2004.

2.4. Parameters
The parameters were plant height, tiller number, leave a number, leaf area, dry matter production, chlorophyll content, crude protein content.

2.5. Statistical analysis
This study used statistically analyzed on a completely randomized design with 4 treatments and 3 replications. If the results of one way ANOVA are significantly different, then continue with the Duncan test [6]. The data obtained were analyzed using the Statistical Program for Social Science (SPSS) for windows.

3. Results and discussions
The average production and quality of Taiwan grass fertilized by urea and compost were presented in table 2.

Table 2. The production and quality of Taiwan grass fertilized by urea and compost.

Parameters	Treatment					
	T0	T1	T2	T3	T4	P5
Dry matter production (ton/ha)	15.43±0.50^{a}	17.13±0.76^{b}	17.09±0.71^{b}	18.12±1.03^{c}	20.15±3.12^{d}	18.10±1.05^{c}
Plant Height (cm/polybag)	80.10±1.97^{a}	85.46±2.02^{b}	84.20±0.70^{b}	86.35±7.86^{c}	95.90±2.26^{d}	86.33±0.30^{c}
Tiller number (plant/polybag)	19.50±0.70^{a}	22.33±1.15^{b}	22.00±1.00^{b}	25.75±3.94^{c}	33.67±4.04^{d}	25.55±1.00^{c}
Leaves number (leaf blade /polybag)	113.00±1.41^{a}	121.67±2.08^{b}	125.67±5.03^{b}	134.50±15.08^{c}	169.33±5.13^{d}	132.00±6.08^{c}
Leaf area (mm^2/polybag)	2.778±2.81^{a}	3.730±1.31^{b}	3.503±2.34^{b}	4.097±07^{c}	4.665±2.60^{d}	4.021±0.02^{c}
Leaf chlorophyll (unit)	31.66±1.74^{a}	42.93±0.49^{b}	40.60±4.43^{b}	46.90±1.20^{c}	49.70±2.17^{d}	46.63±0.98^{c}
Crude protein content (%)	9.96±0.68^{a}	10.87±0.40^{b}	10.86±0.60^{b}	11.79±0.09^{c}	13.65±0.24^{d}	11.28±0.70^{c}

Description: Different superscripts on the same row indicated significantly different treatment with a significant value ($P<0.05$); T0 = control, T1 = urea fertilizer 1.5 gram/polybag, T2 = compost fertilizer 15 gram/polybag, T3 = urea 1.1 gram/polybag+ compost fertilizer 3.8 gram/polybag; T4 = urea fertilizer 0.8 gram/polybag + compost fertilizer 7.5 gram/polybag; P5= urea fertilizer 0.4 gram/polybag+ compost fertilizer 11.3 gram/polybag

Table 2 showed that all the treatment had a significant effect ($P<0.05$) on plant height, tiller number, leave a number, leaf area, DM production, leaf chlorophyll, and CP content. All the parameter was significantly different ($P<0.05$) between no fertilizer was imposed (T0) with other treatment.

3.1. Plant height
The results of the research on plant height in table 3 using a combination of 50% urea fertilizer and 50% compost (T4) fertilizer are the best treatment combinations among existing treatments. This is probably because the urea fertilizer and compost is given can meet the nutrient needs of plants. In this case, the content of compost supplemented with urea fertilizer is complementary. This is following by the opinion [23] that compost as an organic fertilizer is included in the category of complex fertilizers, which contain the macro and micronutrient so that the nutrients needed by plants are more complete and available. The availability of nutrients needed by plants will further support plant growth and production. Although the application of 100% urea fertilizer is not different from the application of 100% compost (T2), the resulting plant height is higher when using 100% urea (T1). This may be because the availability of nutrients for the needs of Taiwan grass has been met and the same levels of N provided are useful in cell division which allows for plant height increase. Taiwan grass responds well by absorbing fertilizer through the roots. Well-developed plant roots can absorb the nutrients needed from the soil which are

then used to produce dry matter from photosynthesis in leaves, photosynthate, which is then translocated to plant parts such as seeds. The increase in plant height and number of leaves does not escape the important role of nitrogen in stimulating vegetative growth.

The use of urea and compost in treatment T3 and P5 was not different, but the results obtained were higher in treatment T3. This is probably because urea in the T3 treatment is absorbed more quickly by plants. Whereas in P5 treatment it is slow because it contains a lot of compost so that the absorption process is slow / takes a long time to decompose in the soil. This opinion is supported by research [3] that the use of manure on mahogany has a little slower growth. This slow growth is because manure is not easily broken down in the soil in contrast to the use of urea. Further argued by [21] that chemical fertilizers can increase soil productivity in a short time, while organic fertilizers are natural fertilizers and release nutrients slowly so that they have a residual effect in the soil and are beneficial for subsequent crops.

3.2. The number of tillers

The combination of 50% urea fertilizer and 50% compost per polybag (T4) resulted in the highest number of plants (33.67 stems). This is probably because the nutrient balance in the soil for plants is fulfilled and this combination is complimentary. One of the effects that occur when the use of fertilizers has a balance of nutrients in the soil which can increase plant growth, including the number of plants. The use of manure from manure in an integrated manner gives a better effect on the soil in aspects of conservation and plant growth [2].

3.3. The number of leaves

The highest response of Taiwan grass in all treatments was achieved with a combination of 50% urea and 50% compost (T4). This is probably because the content of urea and compost has balanced macronutrients especially nitrogen so that it can increase vegetative growth such as stimulating the growth of young leaves, if the number of leaves produced by plants is high, the amount of chlorophyll absorbed by the leaves is also high so that can increase crop yields. Nitrogen functions to compile amino acids (proteins), nucleic acids, nucleotides and chlorophyll in plants so that with the presence of nitrogen, plants will feel the following benefits to make greener plants accelerate plant growth (plant height, number of tillers, number and number of branches), and increase the protein content of plants [17].

The application of 100% urea fertilizer (T1) is not different from the application of 100% compost (T2), but the number of leaves produced is higher when using 100% urea. This is probably because urea and water are immediately hydrolyzed into ammonia and carbon dioxide which are easily absorbed by plants for vegetative growth such as leaves, stems and roots [16]. If urea has turned into ammonium, it will be absorbed by soil particles and easily available to plants. Further argued by [26] that urea fertilizer after being applied in the soil is rapidly hydrolyzed by the urease enzyme to become ammonium. Meanwhile, organic fertilizers in the form of compost must go through a process of aminization, ammonification and nitrification.

Nitrogen in organic fertilizers immersed in the soil is a form of humus that cannot be absorbed directly by plants. However, it is necessary to undergo mineralisation first, which includes amination, ammonification and nitrification. Nitrogen that is available quickly in the soil will cause the synthesis of carbohydrates in plants to speed up as well. Carbohydrates produced through photosynthesis using higher nitrogen are used to form vegetative growth so that plants grow taller, the number of leaves and the number of tillers are increasing [19].

3.4. Leaf area

The average leaf area of Taiwan grass that was given 50% urea and 50% compost (T4) in table 3 was higher than other treatments. This may be due to the ability of the T4 treatment combination to better absorb or stimulate plant organ growth. This is following the opinion [11] which states that leaf area affects the metabolic processes of plants, especially in the process of photosynthesis, so that the more

liquid organic fertilizer levels are given which can stimulate the cellular metabolic processes that occur in the meristematic tissue at the point of leaf growth.

The ability of light intensity received by plants to absorb greater light results in a larger leaf area formed. According to [24] that leaf area is influenced by the ability of plants to absorb light intensity, the wider the surface area of the leaves, the greater the ability of the plant to receive light because the chlorophyll in the leaves which captures sunlight increases the rate of photosynthesis to form carbohydrates for cell division and causes the leaves to grow more, big and wide.

One of the factors that influence leaf area according to [25] is environmental factors. These environmental factors include nutrients, temperature, humidity, soil acidity, biotic factors, radiation energy and the ability to absorb the food reserves of each plant. It was further stated by [5] that leaf area is influenced by light capture capacity. Light under the optimum will cause the number of branches to decrease and result in leaf characteristics, especially in the leaf area.

3.5. Dry matter production

The results in table 3 show that the highest weight of Taiwan grass was found in the T4 treatment combination compared to other treatments. Treatment P5 was higher than treatment T3, T2, T1 and T0. This is probably because the nutrients are treated properly and the nutritional needs of plants are well met. A high dose means that the nutrient content contained therein is also greater, it will increase the activity of assimilation and storage of dry matter in the vegetative part of the plant which is supported by increased production of fresh plant matter. Plant potential is closely related to crop production. The amount of production that can vary greatly depends on the frequency of defoliation, season and soil fertility [14].

The provision of N in fertilizers is needed in the process of forming plant protein to increase the vegetative growth of plants such as stems, leaves and roots. The increase in crop yield will be accompanied by an increase in the number of nutrients absorbed by the plant if these nutrients are not a limiting factor in the soil [15]. Fertilization needs a balance in the number of nutrients in the soil according to the plant's needs for these nutrients, therefore in carrying out fertilization, several things must be considered, namely the type of soil to be fertilized, the type of fertilizer used, the dose (amount) of fertilizer given, time of fertilization and method of fertilization [16]. Fertilizer source N or urea is given after the plant grows because if it is given at the beginning of growth it will be dangerous. The addition of nitrogen has an effect on forage yield and chemical composition when all other nutrients are available in the soil under optimum conditions [15].

3.6. Leaf chlorophyll

The chlorophyll of Taiwan grass leaves given a combination of 50% urea and 50% compost (T4) was the highest compared to other treatments (T0, T1, T2, T3, and P5). While the other treatments are low, this may be due to the availability of nutrients in the fertilizer combination, mainly the nitrogen content as an ingredient for chlorophyll formation. The low chlorophyll content is indicated by a yellow colour in plants. Meanwhile, the adequacy of chlorophyll is indicated by a dark green colour [10]. The adequacy of nitrogen in plants is characterized by high photosynthetic activity, good vegetative growth, and dark green colour.

The high chlorophyll is due to the combination of T4 treatment with water being able to synthesize chlorophyll in Taiwan grass leaves, thereby increasing the rate of photosynthesis [13]. The factors that influence the formation of chlorophyll in plants include genes, light, and the elements N, Mg, Fe as formation and catalysts in chlorophyll synthesis.

The average chlorophyll content of Taiwan grass in table 1 is 43.07, units or plants. This may be due to differences in the plants and fertilizers used. The higher the nitrogen content, the more chlorophyll content will increase [18]. The chlorophyll content in *Brachiaria brizantha* grass has a high average at high nitrogen doses. Nitrogen is an important component of plant organs that form nucleic acids, amino acids, and proteins. Nitrogen is absorbed by roots and transferred to plants mainly in the form of nitrate

(NO_3^-), ammonium (NH_4^+) and amino acids. Therefore, this liquid organic fertilizer can increase the chlorophyll content of leaves in plants.

3.7. Crude protein

The crude protein of Taiwan grass given a combination of 50% urea and 50% compost (T4) was higher than other treatments (T0, T1, T2, T3, and P5). This may be due to the nutrient content in the combination of urea and compost (T4), mainly nitrogen and chlorophyll content. The high and low crude protein produced in this study depends on the chlorophyll content produced in each treatment. Leaf chlorophyll is used to produce carbohydrates and provide energy. Carbohydrates produced in photosynthesis are converted into a dry matter which contains proteins, fats, nucleic acids and other organic molecules [1]. That chlorophyll is used for photosynthesis which produces carbohydrates and provides energy. Carbohydrates produced in the process of photosynthesis are converted into dry matter, where this dry material contains proteins, fats, nucleic acids and other molecules. The energy produced is used by plants in carrying outgrowth processes and the resulting carbohydrates contain dry matter which stores food substances in the form of protein and other substances. The higher the chlorophyll content, the photosynthesis rate will increase so that the quality and production produced will also increase [8].

Lingga et al [9] argued nitrogen promotes rapid growth as the leaves and stems become green and large, promoting vegetative growth above the soil. Further [23] added that nitrogen in plants acts as a protein constituent, which consists of amino acid chains linked by peptide chains. Proteins are enzymes that are very important in plant cells for metabolic processes. Lack of nitrogen element shows symptoms of plants becoming thin, decreased growth rate, chlorosis, leaves turning yellow to brown and eventually dying.

Nitrogen is absorbed by the roots in the form of nitrate or ammonium, but this nitrate is immediately reduced to ammonium through enzymes containing molybdenum. If more nitrogen is available than other elements, more protein will be produced. The higher the nitrogen application, the faster the carbohydrate synthesis is converted into protein and protoplasm. Giving a lot of N substance to leaf-producing plants will be very beneficial because it will produce a lot of leaves and stems [22].

4. Conclusion

Based on the research that has been done, it can be concluded that the application of urea and compost gave a good response to the production and quality of Taiwan grass. The combination of 50% urea and 50% compost is the best.

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