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The Effect of Various Types and Fertilizer Dosages on King Grass (*Pennisetum purpuphoides*): Growth, Production, and Carrying Capacity

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The Effect of Various Types and Fertilizer Dosages on King Grass (*Pennisetum purpuphoides*): Growth, Production, and Carrying Capacity

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ABSTRACT
Animal manure is a renewable natural resource as a biological fertilizer whose quality can be improved through various strategies. Research on fertilization strategies was carried out to get the best level of cow manure-manure compost enriched with various types and inorganic fertilizers doses on growth, production, and king grass (*Pennisetum purpuphoides*) carrying capacity. The study consisted of 9 treatments, namely enrichment of inorganic fertilizers Urea, NPK, and ZA in dairy cow manure with several doses equivalent to urea as much as 100, 200, and 300 kg per hectare per defoliation. The study was carried out on plots measuring 2 x 1.5 m^2 which were carried out on the second defoliation. The variables studied included growth, fresh production, and carrying capacity for cattle or large ruminants. The data obtained were analyzed based on a completely randomized design. The significance of differences was tested by orthogonal and regression. The results showed that dairy cow manure can be enriched with inorganic fertilizers up to a level of 300 kg equivalent to urea and has provided growth, fresh production, and high carrying capacity of king grass (*Pennisetum purpuphoides*). The average plant height is 195 cm, the number of plants is 16.37 stems per clump, the production of fresh forage is 17.08 kg per 3 m^2 or 512,400 kg/ha/year and the carrying capacity for large ruminants is 40.67 animal units (AU).

Keywords: *Carrying capacity, Inorganic fertilizer, King grass, Manure.*

1. INTRODUCTION

King grass (*Pennisetum purpuphoides*) is a source of forage with a high production level, has the potential to provide a carrying capacity for livestock, so that it greatly supports the development of the ruminant industry [1]. To support the level of sustainable livestock production, it is necessary to always strive for the right strategy to maintain its production potential. One strategy that is easy to apply is fertilization activities [2]. Nyambati and Opala [3] stated that the use of organic and inorganic fertilizers is a good combination for soil benefits and plant growth. Furthermore, Madusari [4] reported that biofertilizers have certain advantages for the soil.

Biofertilizer from dairy cow manure compost as a renewable natural resource, has been commonly given by farmers to plants, especially grass [5]. but the quality still needs to be improved [6], among others, with a strategy of material enrichment that can be added as superior compost [7]. Inorganic fertilizers as inorganic fertilizers are materials made to plant growth and productivity, it is possible to add them in an effort to improve the quality of compost due to the presence of nutrients [8]. Both can be combined [9]. The successful use of biological fertilizers from dairy cow manure enriched with various types and doses of inorganic fertilizers can be tested on feed crops. Various parameters to obtain the characteristics of forage plants include aspects of growth, production and capacity for ruminants [10]. There are various superior grass plants such as king grass as a source of forage with a high production level and carrying capacity, preferred by breeders [1]. In this regard, a study was conducted on

the use of dairy cow manure biofertilizer enriched with various types and doses of inorganic fertilizers. They aresuch as Urea, NPK and ZA to obtain superior compost for king grass. The research parameters consists of plant height and number, fresh production and its carrying capacity for ruminants.

2. MATERIAL AND METHODS

King grass (*Pennisetum purpuphoides*) was planted in plots measuring 2 x 1.5 square meters at a distance of 30 x 80 cm. The distance between the plots is 1 meter. An experimental method was used to treat dairy cow manure at a dose of 30 tons per hectare per defoliation with enrichment of various inorganic fertilizers (urea, NPK and ZA) and three levels of fertilizer (equivalent to 100 kg urea, 200 kg and 300 kg per ha per defoliation). There were 9 treatments that repeated 3 times. The variables studied included aspects of growth (plant height and number), fresh forage production and its carrying capacity for large ruminants. The research activity took place in the second defoliation.

Data collection techniques. Data on plant height was obtained from plant height measurements in the plot, the number of plants from the number of plants per clump. Fresh production data obtained by weight at harvest per unit. The carrying capacity is obtained from the production of fresh forage divided by livestock consumption in one year per unit. Fresh forage consumption using the calculation of 35 kg per head per day. The data obtained were analyzed based on a Completely Randomized Design, the follow-up tests were Orthogonal and regression.

3. RESULTS AND DISCUSSION

3.1. Resecarch Location Conditions

Limpakuwus Village, Sumbang District, Banyumas Regency is the location of the research. Based on the Subdistrict the research location has a height of 550 meters above sea level. At this altitude, it is possible to have good plant growth, but it is suspected that there are conditions of lower production levels related to humidity and sunlight [11, 12, 13]. The soil texture of the research site is sandy loam / Sandy Loam with an available nitrogen content of 0.270 %, phosphorus available 0.008 % P_2O_5, Potassium 0.248 %, while the degree of soil acidity (soil pH) is 6.7 which indicates neutral soil pH, supporting soil nutrients in good conditions. Ferreira *et al*. [13] stated that the soil of the research location was in good category conditions to support plant growth. As mentioned by Sindhu *et al*. [14], the physical properties of the soil that are easy to cultivate on the existing land structure can support the production of good forage plants.

3.2. Plant Height of King Grass

The average size of plant height is 195 cm, located in the range between 152 – 243 cm, which shows a wider range than the research from Hendarto *et al*. [15], with a range of 165 – 213 cm. It is suspected that the altitude factor is in Purwokerto with a height of 100 meters at above sea level results in lower plant height. The mean size of plant height shown in table 1 shows that the biofertilizer from dairy cow manure compost was enriched with inorganic fertilizers at a higher level, giving a higher average appearance than the lower level. On enrichment with ZA fertilizer, the dose equivalent to urea 300 kg/ha/defoliation showed the highest size (218.67 cm). However, NPK enrichment resulted in the highest average plant height (198.67 cm). Guenni *et al*. [10] mention the addition of a dose of nutrients to a certain limit, will increase plant growth and production.

The average size of plant height is influenced by various factors such as plant physiological and nutrient levels provided by the manager and the amount absorbed by plants. This, according to [16] and causes the plant energy obtained, which can be used for growth, including plant height and other aspects of growth. Meanwhile, competition for the use of the sunlight is also another competitive factor in producing energy from the photosynthesis process [17].

The results showed that the use of inorganic fertilizers in enriching organic fertilizers from dairy cow manure has shown an advantage. Dairy cow manure as a compound fertilizer enriched with inorganic fertilizers is ready to be absorbed by plants resulting in better plant vigor and supporting growth including plant height [18]. The use of dairy cow compost up to 30 tons/ha/defoliation enriched with various inorganic fertilizers from urea produced an average plant height of 192 cm, NPK 198.67 cm and ZA 194.33 cm. The act of fertilization will respond to plant growth to produce growth and production [19]. The use of compost from dairy cow manure with more complete nutrient elements coupled with enrichment of inorganic fertilizers can trigger plant growth significantly [20, 21]. Besides being useful for soil conservation efforts, it also maintains growth rates. and crop production [8].

Analysis of variance showed that the treatment had a very significant effect ($P<0.01$) on king grass height. The types of inorganic fertilizers were significantly different ($P<0.01$), while the level of fertilizer produced a linear equation graph that was significant ($P<0.01$) on plant height. The addition of levels of inorganic fertilizers from urea, NPK and ZA, has encouraged the growth performance of King grass, including plant height parameters. Xiangyang *et al*. [21] confirmed that the compound nutrients as growth triggers are found in compost and some types of inorganic fertilizers may have been able to support plant growth.

Table 1. Aspects of King Grass Plant Growth

Code	Inorganic fertilizer	Level (kg/ha/def)	Height (Cm)	Number of Plants (stem/clump)
RU1	Urea	100	164.67^{d}	13.00^{l}
RU2	Urea	200	198.67^{e}	15.33^{h}
RU3	Urea	300	212.67^{f}	19.33^{i}
Average			192.00^{a}	15.89^{j}
RN1	NPK	306	177.00^{d}	13.33^{h}
RN2	NPK	612	202.00^{e}	15.00^{i}
RN3	NPK	918	217.00^{f}	19.33^{j}
Average			198.67^{c}	15.89^{g}
RZ1	ZA	219	161.33^{d}	15.00^{h}
RZ2	ZA	438	203.00^{e}	16.67^{i}
RZ3	ZA	657	218.67^{f}	20.33^{j}
Average			194.33^{b}	17.33^{g}
all treatment average			195.00	16.37

Note: Different superscripts in the same column show a very significant effect ($P < 0.01$).
RU1, RU2, RU3 : urea treatment levels 100, 200, and 300 kg/ha/defoliation
RN1, RN2, RN3 : NPK treatment levels 306, 612, and 918 kg/ha/defoliation
RZ1, RZ2, RZ3 :ZA treatment levels 219, 438, and 657 kg/ha/defoliation

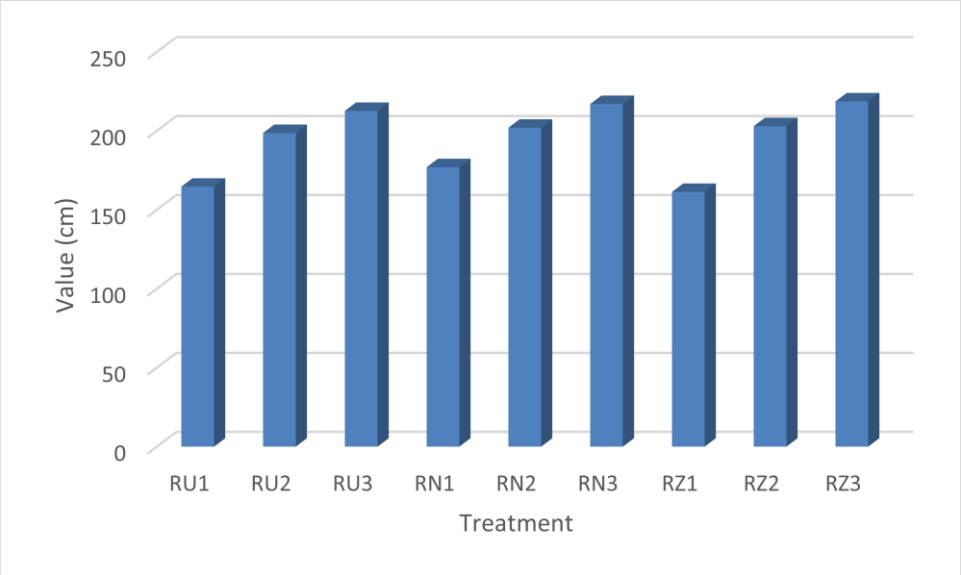

Figure 1. Diagram of the effect of dairy cow manuremanure compost enriched with various types and levels of inorganic fertilizers on the average size of King Grass height.

The additional of one level of inorganic result in a higher average plant height. The growth of king grass as superior grass, it shows reasonable conditions for the second defoliation growth on fertile land, well irrigated and the fertilization management pattern is good [5, 22].

3.3. Tillering number of King Grass

Fertilization treatment of dairy cow manure enriched with various types and levels of inorganic fertilizers, has obtained tillering number of king grass 16.37 plants per clump. Enrichment of ZA fertilizer at a dose equivalent to urea as much as 300 kg/ha/defoliation (657 kg/ha/defoliation) has given the highest number of plants (20.33 plants per clump). The least number of plants (13.33 plants per clump) was found in enrichment with urea fertilizer at a dose of 100 kg/ha/defoliation. ZA fertilizer is one of the fertilizers that are often used by farmers. ZA fertilizer is a chemical fertilizer containing 21% nitrogen (N) in the form of ammonium and 24% sulfur or sulfur (S). The chemical formula for

ammonium sulfate is NH_4SO_4. ZA fertilizer is shaped like salt and in the form of white crystals that are easy to mix with dairy cow manure compost. In general, farmers use ZA fertilizers to improve soils that are deficient in elemental sulfur or sulfur. In addition, the nitrogen content in ZA fertilizer also gives growth to plants. According to Mahdi *et al*. [23], dairy cow manure is compound fertilizer but contains relatively few nutrients and is not yet available to plants. Therefore, it requires a decomposition process so that the response to plants is relatively better. On enrichment according to Hendarto *et al*. [15] has been able to add nutrients in fertilizers resulting in an increase in the number of plants for clumped plants. King grass is a type of clump forage plant that can show that its vegetative growth period continues to increase the number of plants per clump. This amount, according to Kariuki *et al*. [17], is in accordance with its growth potential.

Analysis of variance showed that treatment had a very significant effect ($P < 0.01$) on the tillering number. The inorganic fertilizers used for enrichment of compost did not differ ($P > 0.05$), while the level of inorganic fertilizers produced a very significant linear equation ($P < 0.01$) for urea, NPK and ZA. The addition of levels of inorganic fertilizers has encouraged the growth performance of King grass, including the number of plant parameters. Xiangyang *et al*. [21] confirmed that nitrogen nutrients found in dairy cow manure and all types of inorganic fertilizers as growth triggers and have been able to support plant growth.

The addition of inorganic fertilizer levels with nutrient content will increase plant growth. The king grass is able to produce an average number of plants which is always increasing. The addition of nutrient doses from inorganic fertilizers will always increase growth [21, 24, 25]. Increasing the number of plants will always affect the production of forage forage plants. Steps to increase crop production can be done with fertilization which is an important factor in the cultivation of feed crops.

3.4. Fresh Production of King Grass

The average fresh forage production of king grass is 17.08 kilograms per plot (3 m^2) or equal to 56.93 tons per hectare. This production is much higher than the research of Hendarto *et al*. [15] which is only about 2 kg per square meter, due to differences in the conditions of the research location. However, production is still lower than the production potential of king grass. Average production was in the range of 10.15 – 23.38 kg per plot spread overall treatments. The highest average fresh production was found in the NPK fertilizer enrichment treatment, the lowest was in the urea enrichment treatment. The enrichment treatments of inorganic fertilizers all contained nitrogen, but there were other elements of each type of inorganic fertilizer that caused differences in the response to the growth and production of king grass forage plants. This causes differences in the appearance of fresh forage production. However, the magnitude of the second defoliation production mentioned by Gunasekaran *et al*. 26] is in accordance with the production potential of king grass which will continue to increase in each defoliation period.

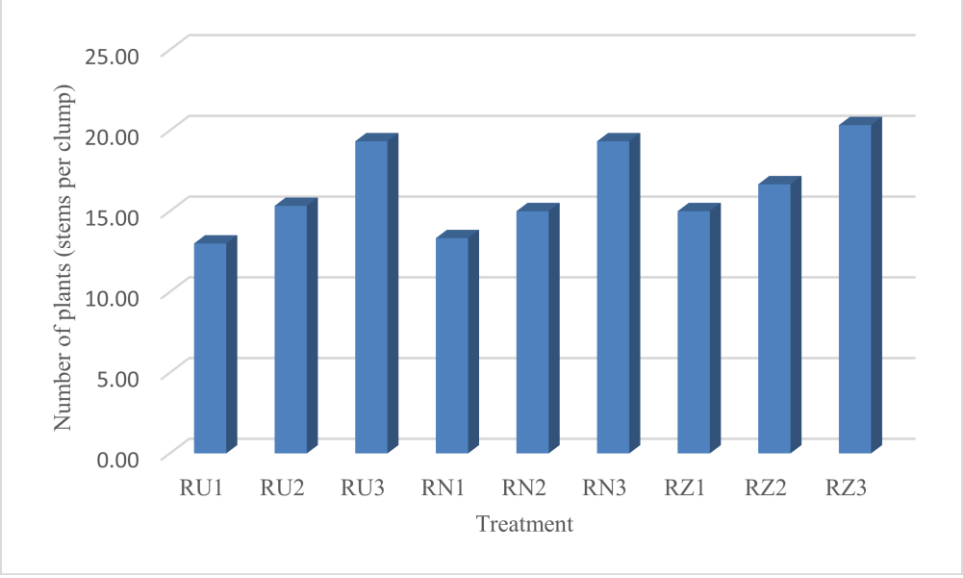

Figure 2. Diagram of the effect of dairy cow manuremanure compost enriched with various types and levels of inorganic fertilizers on the tillering number of King grass.

Table 2. Fresh Production and Livestock Capacity of King Grass Plants

Code	Inorganic fertilizer Ton/ha/def	Level (kg/ha/def)	Fresh production Kg/3m^2	Carrying capasity Animal unit/Ha/year
RU1	Urea	100	15.37^b	36.59
RU2	Urea	200	15.64^b	37.24
RU3	Urea	300	16.78^b	39.95
Average			15.93^a	37.93
RN1	NPK	306	15.70^c	37.38
RN2	NPK	612	18.88^c	44.95
RN3	NPK	918	20.39^c	48.55
Average			18.32^a	43.64
RZ1	ZA	219	13.98^d	33.28
RZ2	ZA	438	16.55^e	39.40
RZ3	ZA	657	20.43^f	48.64
Average			16.99^a	40.43
Average			17.08	40.67

Note: Different superscripts in the same column show a very significant effect ($P < 0.01$).
RU1, RU2, RU3 : urea treatment levels 100, 200, and 300 kg/ha/defoliation
RN1, RN2, RN3 : NPK treatment levels 306, 612, and 918 kg/ha/defoliation
RZ1, RZ2, RZ3 :ZA treatment levels 219, 438, and 657 kg/ha/defoliation

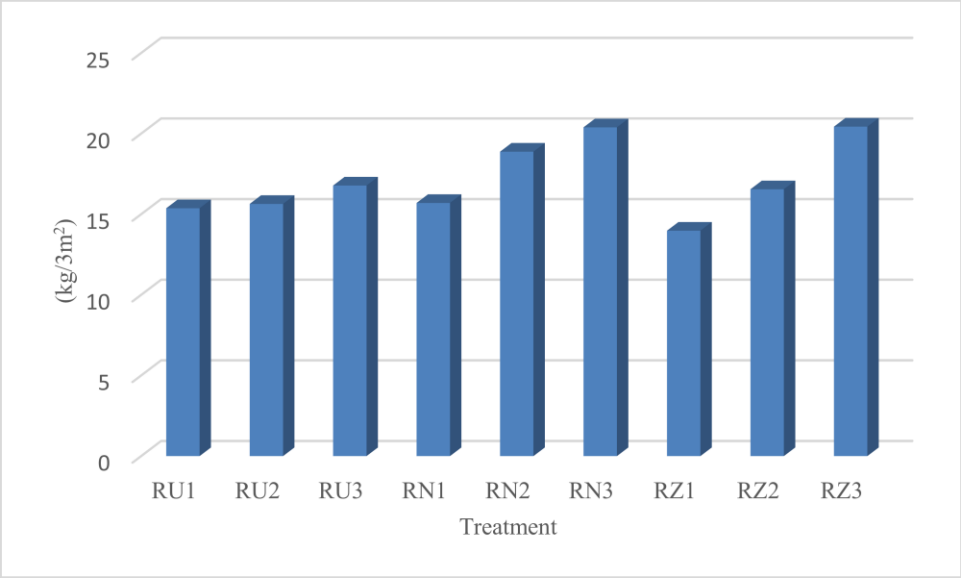

Figure 3. Diagram of the effect of dairy cow manure compost enriched with various types and levels of inorganic fertilizers on the fresh production of King grass.

According to Jan *et al*. [27] stated that dairy cow manure fertilizer is a compound fertilizer and its enrichment supports plant growth so that its application can meet the needs for plant growth which will increase with age. Illustrated by Kariuki *et al* [17], each additional level of inorganic fertilizer as an enrichment of biological fertilizer from dairy cow manure, has increased the supply of nutrients that are ready to be absorbed by the king grass plant after decomposition and also helps maintain the quality of the soil.

Treatment of inorganic fertilizer enrichment on dairy cow manure and its level showed high production (at an average of 17.08 kg per plot in the second defoliation according to Jamaran [1] research. In the calculation of harvest in one year as much as 9 times (harvest age every 40 days) then the production is 512,400 kg per hectare. Although in the second defoliation growth stage it cannot be used as a benchmark for the amount of production [20], the production level can be said to be high. The results show that basically compost from biological fertilizers can increase the availability of soil

nitrogen which causes nitrogen uptake by plants to also increase [11]. However, biofertilizers from dairy cow manure compost and enrichment of inorganic fertilizers can also improve the physical and chemical properties of the soil [14].

The treatment had a very significant effect ($P < 0.01$) on the results. These results show the condition of the average level of fresh production of king grass in a wide range. The types of inorganic fertilizers did not differ ($P>0.05$), while the level of each inorganic fertilizer had a very significant effect ($P<0.01$) resulting in a regression equation. This condition is due to the fact that every inorganic fertilizer used contains nitrogen, although there are other elements such as phosphorus, potassium and sulfur. Biological fertilizer from dairy cow manure can provide a symbiotic atmosphere in the soil needed by plants [23] while the inorganic fertilizer provides a stimulant to soil conditions and supports plant growth. The higher the level of inorganic fertilizers, there is an increase in the production of fresh forage is due to the higher element content. The resulting product is a contribution from plant growth components [12]. These components include plant height, stem diameter, the number of plants in each clump and a larger number of leaves.

Dairy cow manure compost as an organic fertilizer has nutrient content which increases with the enrichment of inorganic fertilizers and contributes to higher nitrogen content. Amino acids, amides, nitrogenous bases such as purines and pyrimidines and nucleoproteins are the building blocks of nitrogen. The results of the analysis of variance showed that inorganic fertilizers did not differ ($P>0.05$) on the production of fresh forage king grass. According to Suyitman [28] also stated that using an organic farming system, the productivity of King Grass is equal to the 100% level of N, P, and K fertilizers (200 kg urea/ha, SP-36 150 kg/ha, KCl 100 kg/ha). This condition is stated by evidence that the appearance of fresh produce at higher levels gives better conditions. In the soil there is organic matter that plays a role in providing nutrients, maintaining soil moisture [29].

3.5 Carrying Capacity of King Grass

The king grass fed with dairy cow manure enriched with various types of inorganic fertilizers at various levels has provided a capacity of 40.67 large livestock units. Large livestock that is considered include cows and buffalo, it is assumed to consume king grass as much as 35 kg per day per head. Approximately 60 to 70 percent of whole-plant king grass can be eaten by livestock [30]. The rest (30%) often contain large and hard stems that are not consumed. King grass as forage can meet the nutritional needs of ruminants well.

The highest capacity was 48.55 and 48.64 units of large livestock, according to the appearance of fresh forage production. Urea enrichment gives fresh forage production and lower capacity at the same level, it is suspected that NPK and ZA fertilizers contain other elements that provide an additional boost to plant growth and production. The number of capacities is higher than the results of the research by Hendarto *et al* [15] which was only on 18 livestock units.

Based on the production of fresh forage and its capacity, the use of biological organic fertilizer from dairy cow manure should be able to use enriched NPK

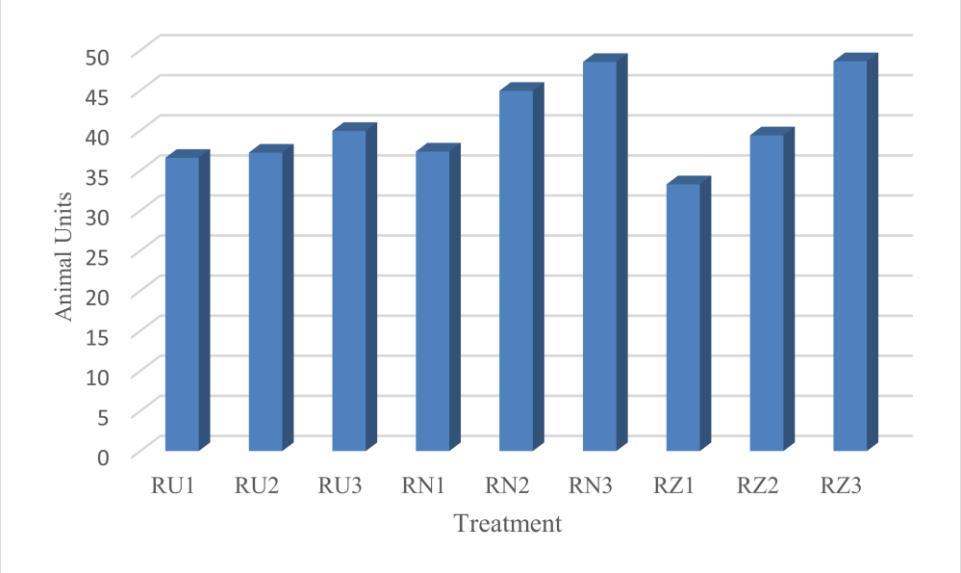

Figure 4. Diagram of the effect of dairy cow manure manure enriched with various types and levels of inorganic fertilizers on the carrying capacity of King grass. Note. please add the treatment's description.

or ZA fertilizers that contain elements other than nitrogen only. The presence of other nutrients (phosphor, potassium and sulfur) has been able to encourage better plant growth and production and can increase the benefits of dairy cow manure and improve the welfare of dairy farmers to produce fertilizer formulas from dairy cow manure enriched with NPK or ZA fertilizers.

4. CONCLUSION

Compost from dairy cow manure enriched with various inorganic fertilizers (Urea, NPK and ZA) can obtain plant height of 195 cm and number of plants of 16.37 plant stems per clump and fresh forage production of 17.08 kg per plot or or 512,400 kg per hectare per year and is able to provide a carrying capacity of 40.67 animal units (AU). Compost from dairy cow manure enriched with NPK or ZA fertilizer has been able to provide the best growth (plant height, number of plants), production and carrying capacity at the level of 918 kg per ha per NPK fertilizer defoliation or 657 kg per ha per ZA fertilizer defoliation.

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