Nur Hidayat et al/Animal Production. 25 (3): 156-164, November 2023
Accredited by Kemenristek Dikti No 32a/E/KPT/2017. ISSN 1411-2027

Dynamics Superior Dairy Cow Compost Enriched with Inorganics Fertilizer On Yields and Nutritive Values of Pennisetum Grass Cultivars

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Abstract. The Fertilization step is the primary strategy for producing good plants. As a renewable natural resource, dairy cow dung is abundant and can be a source of additional income for farmers if it becomes superior compost. Through the enrichment of various types and doses of inorganic fertilizers, it is expected to have economic value, especially for feed crops. The study aimed to obtain a superior compost formula for dairy cow dung enriched with various types and dosages of inorganic fertilizers on the yields and nutritional value of Pennisetum grass. Using a nested design with the main group of three types of Pennisetum grass cultivars (King grass, Napier grass, and Dwarf Napier), the subgroup was enriched by three inorganic fertilizers (Urea, NPK, and ZA) with three dosages (equivalent to 100, 200 and 300 kg urea/ha/defoliation). Three replications were applied in this study. The study was conducted on plots measuring 1 m2 at the third defoliation growth. Parameters observed were fresh yields and nutritive values (crude protein, crude fiber, and extract ether). The data obtained were analyzed based on Nested Design, Tukey's test, or honestly significant difference (HSD). The results showed that compost fertilizer from dairy cow manure enriched with 300 kg of NPK and ZA fertilizers could obtain an average fresh biomass production of 5.78 kg/m2 or 57.75 ton/ha/defoliation, the crude protein of 11.26%, the crude fiber is 33.71% and ether extract is 3.68%. It can be concluded that dairy cow dung can be made into superior compost, enriched with 300 kg of NPK and ZA fertilizers equivalent to urea fertilizer, and this treatment has provided fresh forage production and good nutritional quality on all *Pennisetum* grasses.

Keywords: Dairy cow dung, grass production, nutritional quality, superior compost

Abstrak. Pemupukan merupakan strategi utama dalam menghasilkan tanaman yang baik. Kotoran sapi perah merupakan sumberdaya terbarukan yang melimpah jumlahnya dan dapat menjadi sumber pendapatan tambahan bagi peternak jika menjadi kompos unggul. Pemanfaatan kotoran sapi perah melalui pengkayaan berbagai jenis dan dosis pupuk buatan diharapkan mempunyai nilai ekonomis terutama pada tanaman pakan. Tujuan penelitian untuk mendapatkan formula kompos unggul pada kotoran sapi perah yang diperkaya berbagai jenis dan dosis pupuk buatan pada produksi dan nilai nutrisi rumput Pennisetum. Penelitian dilakukan menggunakan rancangan tersarang dengan perlakuan utama 3 kultivar rumput Pennisetum (rumput raja, rumput gajah dan rumput Odot), sub-perlakuan yakni pengayaan 3 pupuk buatan (Urea, NPK dan ZA) dengan 3 dosis (setara 100, 200 dan 300 kg urea/ha/defoliasi) dengan 3 kali ulangan. Penelitian dilakukan pada petak berukuran 1 m2 pertumbuhan defoliasi ketiga. Parameter yang diamati produksi hijauan segar dan kualitas nutrisi (kadar protein kasar, serat kasar dan lemak kasar). Data yang diperoleh, dianalisis berdasarkan Tukey. Hasil penelitian menunjukkan bahwa pupuk kompos dari kotoran sapi perah yang diperkaya dengan pupuk NPK dan ZA sebanyak 300 kg dapat menghasilkan produksi hijauan segar rata-rata 5,78 kg/ m2 atau 57,75 ton/ha/defoliasi, protein kasar 11,26%, serat kasar 33,71% dan ekstrak eter 3,68%. Disimpulkan bahwa kotoran sapi perah dapat dijadikan kompos unggul, diperkaya dengan pupuk NPK dan ZA sebanyak 300 kg setara pupuk urea dan mampu menghasilkan produksi hijauan segar dan mutu nutrisi yang baik pada seluruh rumput Pennisetum.

Kata kunci : kompos unggul, Kotoran sapi perah, kualitas nutrien, produksi rumput Pennisetum

Introduction

King grass (Pennisetum purpuphoides), Napier grass (Pennisetum purpureum), and Dwarf Napier (Pennisetum purpureum cv. Mott)are superior grasses of the Pennisetum genus and are widely known by farmers. Forage crops with a high production level are needed by the farming community because they support the development of ruminant livestock (Hendarto et al., 2022). In order to continue to encourage the level of livestock production, forage production needs to be pursued using fertilization (Umami et al., 2015). Maleko et al.

(2019), conveyed that fertilizer from livestock manure supports plant growth media, and inorganic fertilizers with the right ingredients can support plant growth. However, the combination pattern between them is necessary.

Dairy cow dung as a source of fertilizer has been given by farmers to crops (Hong et al., 2022) in conditions of low nutrient quality, so according to Hendarto et al. (2020), quality needs to be improved through a material enrichment strategy (Setyaningrum et al., 2019). Inorganic fertilizers as fertilizers with a nutrient are made to encourage crop production. They can be used to improve the quality of dairy cow dung as superior compost (Zhang et al., 2023). Both can be combined (Hendarto et al., 2022). Cow dung is able to provide balanced nutrients for the soil. The soil structure becomes fertile because cow dung will increase the number of microbes in the soil. Utilization of cow dung as fertilizer can increase plant production. According to Ghosh et al. (2004), cow feces contain C-organic 8.69-10.42%, organic matter 14.98-17.975, N-Total 0.68-0.88%, P-total 0.30%, K-total 0.36%. Macro nutrients are used for plant growth, so if they are not available, then plants will experience deficiencies. According to Shafer et al. (2001), organic fertilizer has the benefit of increasing soil fertility, increasing organic C, and improving soil structure and porosity. Organic fertilizer can also stimulate the growth of soil microorganisms that are beneficial to plants and are useful in increasing plant production.

Aspects of growth and production and nutritional quality can be used to assess the characteristics of forage plants (Torres-Lugo et al., 2022). In this regard, a study was conducted to obtain the best formula for enriching dairy cow dung with various types and dosages of inorganic fertilizers to obtain fine compost for Pennisetum grass plants in terms of production and nutritional quality.

Materials and Methods

The research was conducted on Badan Usaha Milik Desa (BUMDes), Limpakuwus Village, Sumbang District, Banyumas Regency, Central Java. The location coordinates are 7o 43' 12 6" South Latitude (SL) and 109o 29' 8 61" East Longitude (LB) with an altitude of 600 meter above sea level (MASL). The research location has a temperature ranging from 23^{o}C-31^{o}C, air humidity ranging from 75-92%, and light intensity reaching 1,300-9,800 lux. The soil used has a pH of 6.6 (neutral), nutrient C-organic 1.98%, total nitrogen 0.21%, phosphorus 15.43 ppm and 22.37 ppm, including low-medium fertility.

The research was carried out experimentally using the nested design treatment of grass species as the main group (King grass, Napier grass, and Dwarf Napier grass), And dairy cow dung as compost at a dosage of 30 tons per hectare per defoliation with enrichment of various inorganic fertilizers (urea, NPK, and ZA). The level of fertilizer (equivalent to 100 kg, 200 kg, and 300 kg of urea per ha per defoliation. The level of urea fertilizer is 100, 200, and 300 kg/ha/defoliation. The NPK enrichment level is 306, 612, and 918 kg/ha/defoliation ZA fertilizer and 219, 438, and 657 kg/ha/defoliation as a subgroup. There were 27 treatments, which were repeated three times. Grasses were planted in plots measuring 1 m2 at a distance of 30x70 cm. The distance between the plots was 1m.

Compost making is based on Setyaningrum et al. (2019), with a composition of 100 kg of cow feces, 10% sawdust, 10% ash, 2% dolomite, and 0.25% activator. All ingredients are then mixed until homogeneous by making a mound 1 meter high. Turning the mound is done once a week until the 21st day. Then, spread the compost to a thickness of 10 cm and leave it until the 28th day. The Compost made contains 23.72% organic carbon, 1.78% nitrogen total, 12.58 ppm phosphorus, 3.4 ppm kalium and pH of 6.7. Plants were grown until the third defoliation was

carried out at the age of 2 months after the second defoliation.

Fertilization is carried out in every treatment. Grass harvesting is carried out at 20 cm from the ground surface. Then, each treatment was weighed as fresh weight. The harvested forage is then dried in the sun for two days and dried at an oven temperature of 60 for 48 hours to obtain the residual amount of dry material. Next, it was ground into flour with a size of 1 mm to continue with proximate analysis (AOAC, 2005). The nutrient profile observed consisted of crude protein (CP), crude fiber (CF), and extract ether (EE). The data obtained were analyzed based on the Nested Design Tukey test (Gomez dan Gomez, 1984).

Results and Discussion

Fresh Yields production

The average fresh forage production of Pennisetum grass was 5.78 kg/m2, or equal to 57.75 tons/ha. This production is much higher than the Napier grass plant from the research of Ernawati et al. (2023), which is only about 1 - 2 kg/m2. Location and environmental conditions are thought to affect the appearance of production, while the existing production potential is the average of king grass, Napier, and Dwarf Napier grass. However, production is still lower than the potential production of king grass. Average production is in the range of 1.50 – 10.00 kg/m2 spread over all treatments. The lowest average production came from Dwarf Napier grass, and the highest was kinggrass, which was caused by species differences (superior grass vs. shrubs) and response to fertilization.

King grass produced the highest average level of fresh forage production (8.21 kg/m2), followed by Napier grass (6.50 g/m2) and dwarf Napier grass (2.62 /m2). Enrichment with NPK fertilizer showed an average yield of 5.91 kg/m2, ZA fertilizer was 5.74 kg/m2 and with urea 5.68 kg/m2 which showed a very slight difference. Meanwhile, the higher the dosage, the higher the yields, which was quite sharp. This condition shows that the king grass (Pennisetum purpuphoides) resulted in the highest production on enrichment of all types of inorganic fertilizers at a dosage equivalent to 300 kg/ha/defoliation of urea fertilizer. Enrichment of dairy cow dung with inorganic fertilizers containing nitrogen; each fertilizer contains other elements that cause differences in response to the forage production. These results cause differences in the appearance of fresh forage production for each grass species.However, Hendarto et al. (2020) stated that the enrichment of manure as a compound fertilizer supports plant growth and production so that its application can plant growth production needs. Kariuki et al. (2016) added that at every level of enrichment in livestock manure. it has increased the amount of nutrients that are ready to be absorbed by plants and also helps maintain the physical and chemical quality of the soil.

Inorganic fertilizer enrichment in dairy cow dung results in high fresh yields on all types of grass, according to research by Hendarto et al. (2022). The third stage of defoliation growth cannot be used as a benchmark for the amount of production. However, the estimate can be calculated (Ernawati et al., 2023). The results showed that basically the compost from dairy cow manure enriched with inorganic fertilizers could increase the availability of soil nitrogen (Guo et al., 2016) and improve the soil's physical and chemical properties (Sindhu et al., 2016).

The results showed that differences in grass species had a significant effect ($P<0.01$) on fresh biomass production. Different levels of fertilizer treatment also effect on production ($P<0.01$). The Inorganic fertilizer not only contains large amounts of nitrogen but also other elements such as phosphorus, potassium, and sulfur.

Table 1. Yields and nutritive values of Pennisetum grasses

Grass	Fertilizer	Dosage	Fresh produce	Crude Protein	Crude fiber	Ether Extract
		(kg/ha/defoliation)	kg/m^2	% DM	% DM	% DM
King Grass	Urea	100	8.41	7.78	36.41	2.90
		200	8.60	9.66	35.82	3.32
		300	9.620	10.45	35.34	3.77
	Average		**8.88^{d}**	**9.30^{i}**	**35.86^{o}**	**3.33^{u}**
	NPK	100	6.50	9.16	34.24	2.98
		200	7.40	10,15	33.56	3.04
		300	8.74	10.66	29.44	3.53
	Average		**7.54^{e}**	**9.99^{j}**	**32.41^{p}**	**3,18^{v}**
	ZA	100	6.43	10.49	29.89	3.11
		200	8.10	11.54	29.01	2.98
		300	10.13	12.95	28.42	3.55
	Average		**8.22^{e}**	**11.66^{k}**	**29.11^{q}**	**3.21^{w}**
Average			*8.21 ^{a}*	*10.32 ^{f}*	*32.46 ^{l}*	*3.24 ^{r}*
Napier Grass	Urea	100	5.10	11.30	35.32	3.66
		200	6.01	11.33	35.21	3.63
		300	7.17	11.68	33.84	4.17
	Average		**6.10^{d}**	**11.43^{i}**	**34.78^{o}**	**3.82^{u}**
	NPK	100	6.32	10.91	35.79	2.88
		200	6.36	11.05	35,10	3.20
		300	8.36	11.68	34.41	3.40
	Average		**7.01^{e}**	**11.21^{j}**	**35.08^{p}**	**3.16^{v}**
	ZA	100	4.51	10.79	36.33	3.66
		200	5.87	11.60	35.68	4.13
		300	8.77	13.21	34.22	4.78
	Average		**6.38^{e}**	**11.87^{k}**	**35.41^{q}**	**4.16^{w}**
Average			*6.50 ^{b}*	*11.50 ^{g}*	*35.09 ^{m}*	3.72 ^{s}
Dwarf Napier	Urea	100	1.51	10.35	30.16	3.76
		200	2.13	10.76	30.00	3.70
		300	2.57	11.87	29.41	4.17
	Average		**2.07^{d}**	**11.00^{i}**	**29.86^{o}**	**3.88^{u}**
	NPK	100	2.38	10.25	35.54	3.56
		200	3.14	10.57	35.36	3.85
		300	3.98	11.69	34.56	4.58
	Average		**3.17^{e}**	**10.84^{j}**	**35.18^{p}**	**4.00^{v}**
	ZA	100	2.27	13.89	34.89	3.35
		200	2.59	14.13	34.65	4.43
		300	3.01	14.24	34.60	5.38
	Average		**2.62^{e}**	**14.08^{k}**	**34.71^{q}**	**4.39^{w}**
Average			*2.62 ^{c}*	*11.97 ^{h}*	*33.25 ^{n}*	5.38 ^{t}
Parameter mean			***5.78***	***11.26***	***33.71***	**3.68**

Note:^{abcde}Different letters in the same column have a significant effect (P < 0.01).

Anuradha and Singh (2021), stated that dairy cow manure provides a symbiotic enviromental in the soil needed by plants, while inorganic fertilizers (Mulatsih, 2003) encourage soil conditions and support plant growth. Liman et al. (2018), stated that inorganic fertilizers at existing dosages increased fresh forage production due to the increasing nutrient. The nutrient of dairy cow dung compost as organic and compound fertilizer with enrichment of inorganic fertilizers contributes to higher nitrogen and other elements (Guo et al., 2016) with the use of organic farming systems, crop productivity is getting better. This condition is

stated by evidence that the appearance of fresh production at higher levels gives better conditions (Sulok et al., 2014).

Crude Protein of Pennisetum Grass

Table 1 showed that the average crude protein (CP) of Pennisetum grass fertilized with dairy cow dung enriched with various types and dosages of inorganic fertilizers was 11.26%. Dwarf napier grass resulted in the highest crude protein (11.97%), followed by Napier grass (11.50%) and king grass (10.32%). The average CP is included in the high condition. Tuturoong et al. (2020), stated that grass generally has a crude protein of about 10%. The results showed the high crude protein of forage Pennisetum grass because the nitrogen in all fertilizer treatments had supported plant growth. Similar to Liu et al. (2011), nitrogen nutrients have been able to support plant growth, including forage production, namely crude protein levels. At the same time, some treatments contained phosphorus, potassium, and sulfur .

The highest crude protein was indicated by the provision of enrichment from ZA fertilizer sources (12.54%), NPK (10.71%), and urea (10.57%). At the same time, the highest dose (ZA enrichment at a dose of 657 kg/ha/defoliation) also showed the highest protein (13.47%) of Pennisetum grass. This result shows that the presence of other elements (sulfur, phosphorus, and potassium) has encouraged nitrogen nutrients to provide the ability of Pennisetum grass plants to produce good rough protein levels. It can be observed at a low level, even the lowest protein level, compared to other treatments. According to Novo et al. (2016) the proteins are a major part of active tissues. Leaves contain more nutrients, including protein, than stalks, and if the plant gets more nitrogen supply from fertilizers from both dairy cow dung and enrichment, more protein is formed.

The treatment given showed that there was a very significant difference ($P<0.01$) in CP between types of Pennisetum grass, as well as for types of inorganic fertilizers. In contrast, the dose of administration showed a very significant effect ($P<0.01$). The high uptake of nitrogen can influence the protein in plants, which is expected to increase the dry weight of plants and yields. Based on this study, it can be assumed that Napier dwarf grass has a higher absorption capacity for fertilization, especially nitrogen, with the highest protein.However, observing the density of plants and the possible number of plant roots is necessary. Dwarf Napier grass has a higher density and number of roots, which causes the absorption ability and photosynthetic activity to be more optimal (Santana et al., 2018) than Napier and king grass. Finally, plant growth becomes better, which in turn produces good quality.

Urea, NPK, and ZA fertilizers as inorganic fertilizers that contain nutrients according to plant needs can be applied in the field by considering the provide for nitrogen nutrients that can impact the best crude protein. This is in accordance with the opinion of Hendarto and Suwarno (2017), which states that in the cultivation of forage, the quality of the nutrients contained in each fertilizer source is prioritized in aspects of growth, production, and quality of feed plants. Regarding the dose of fertilizer, Britz et al (2023), stated that increasing the fertilizer dose will positively affect the crude protein of forage.

Crude Fiber

Cow manure enriched with various types and doses of inorganic fertilizer produced an average of 33.71% CF for pennisetum grass (Table 1). The results show that it is higher than king grass with CF of 31.47% by Hendarto et al. (2020). The results showed that the CF of Pennisetum grass was quite high. The results indicate that penisetum grass has a tough stem and leaf structure. The high or low CF levels is one indicator that determines the quality of forage. The higher the CF, the more difficult the forage

is to be digested by livestock. This results in an increase in retention time in the rumen, thereby affecting livestock productivity. The CF is influenced by the availability of nutrients in the soil that are absorbed by plants. Increasing the fertilizer dose in this study caused a decrease in crude fiber. Muhtarudin et al. (2020), stated that the more nutrients a plant absorbs, the greater the opportunity for plant cells to arrange their cell wall fibers so that crude fiber, which is the main structure of the cell wall, becomes more efficient. Santana et al. (2018), also added that harvest age also influences forage crude fiber. Pennisetum grass should be harvested at the age of 40-60 days after defoliation.

Table 1 showed that the lowest CF was produced by king grass (32.46%) and the highest was Napier grass (35.41%). Enrichment of inorganic fertilizers led to the highest crude fiber content in NPK fertilizer (34.22%), followed by urea fertilizer (33.50%), and the lowest in ZA fertilizer (32.93%). In other hand, the higher of inorganic fertilizer dose will reduce the crude fiber produced by the plant. This condition shows that the level of inorganic fertilizer affects the crude fiber of Pennisetum grass. This is in accordance with the opinion of Sanchez-Gutierres et al. (2020) that the addition of nutrients to feed plants affects the growth and nutrition of the forage produced. The addition of inorganic fertilizer levels stimulates the growth of grass plants, improving the quality of forage through the metabolism of nutrients in plant tissue. Plants that lack nutrients will result in deficiencies in growth and cell wall formation. Plant Liu et al. (2011) emphasized that the nitrogen nutrient contained in dairy cow manure and all types of inorganic fertilizer as a growth trigger supports plant growth. Added by Tuturoong et al (2020), it is known that crude fiber in forage is very important to maintain overall feed quality so that livestock intake remains optimal.

Crude fiber consumed by ruminants and non-ruminants has their respective portions. This reason is because CF not only has a positive impact but also has a negative impact. The negative impact of high CF in ruminant feed can cause the feed to be left in the rumen longer and leave a feeling of fullness in livestock so that feed intake is low. As with ruminants, the high CF in non-ruminants slows the digestion and absorption of nutrients (Salfer et al., 2018).

The results showed that the type and dose of inorganic fertilizer had a significant effect ($P<0.01$) on the CF of Pennisetum grass forage. Apart from that, increasing fertilizer levels had a significant effect ($P<0.01$). Fahey et al. (2019), stated that forage that has low crude fiber is preferred by livestock and produces optimal performance. Higher crude fiber will affect digestibility. However, crude fiber is absolutely needed by ruminants in the digestive metabolic process, maintaining pH balance and the ecosystem in the rumen and can also act as a source of energy for livestock (Goldan et al., 2023).

Ether Extract

The average EE of Pennisetum grass forage in Table 1 is 3.68%. The crude fat is included in the high category as a forage feed. Maleko et al. (2019) stated that Pennisetum grass forage generally has an EE of 1-2%. Sabrina et al. (2013), added that leaves contain more fat than stems, and usually, seeds contain the most fat. As stated by Sindhu et al. (2016), the ether extract of a plant will be inversely proportional to the water. The older the plant, the water will decrease, but the crude fat will increase. Young plants have active cells to carry out the process of cell division and tissue formation. Old plants have thickening of the cell wall, which causes the dry matter to increase and the water to decrease.

Table 1 also shows that enrichment of NPK fertilizer in dairy cow manure as a compound fertilizer as much as 100 kg of urea equivalent per hectare per defoliation (306 kg/ha/defoliation) resulted in the lowest EE

(3.14% DM). In comparison, the application of ZA fertilizer as much as urea equivalent of 300 kg nitrogen per hectare per defoliation (657 kg/ha/defoliation) produced the highest EE (3.75%). This condition shows that the addition of inorganic fertilizer levels in the enrichment of dairy cow manure has increased the EE. The results of research by Maleko et al. (2019), also showed that the higher dose of fertilizer application caused the plant response to increase ether extract.

The results showed that the type and dose of inorganic fertilizer had a significant effect ($P<0.05$) on the ether extract content of Pennisetum grass species. This is supported by Goldan et al (2023), that providing nutrients with more complex fertilizer will determine the growth, production and quality of plant forage. The tendency to decrease EE is probably caused by the breakdown of complex triglyceride bonds into simpler bonds, including fatty acids and alcohol. Some of the fatty acids formed will evaporate so that the EE is reduced. This is in accordance with the opinion of Nisa et al. (2021); Shurson et al. (2021), that EE in feed ingredients consists of glycerol esters, fatty acids and volatile fat-soluble vitamins. According to Yu et al. (2018), fatty acids act as protectors of the epidermis, stems and leaves of plants. Apart from that, they act as activators and energy sources which are important for growth.

Conclusions

Based on the results, it can be concluded that compost fertilizer from dairy cow manure enriched with various types and doses of inorganic fertilizers (Urea, NPK, and ZA) can obtain an average fresh forage production of 5.78 kg/m^2 or 57.75 ton/ha/defoliation, the crude protein of 11.26%, the crude fiber is 33.71% and ether extract is 3.68%. Compost from dairy cow dung enriched with NPK or ZA fertilizer has been able to provide optimal production and quality of Pennisetum grass.

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