The Effect of Addition Azotobacter Microbial Culture on Cow Feces as a Plant Fertilizer

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Abstract. The purpose of this study was to analyze the effect of adding Azotobacter microbial culture on cow feces as plant fertilizer. The material used was 360 kg of cow feces, 20 kg of rice husk, 20 kg of rice bran and 750 ml of Azotobacter microbial culture, 30 liters of water, 9 liters of molasses, Odot (Pennisetum purporeum cv. Mott) grass cuttings, corn (Zea mays saccharata) seeds and Edamame (Glycine max L Meril) seeds. This research method is an experiment. The design was a Completely Randomized Design (RCD) with 4 treatments and 6 replications. The treatment was T0, namely the use of feces without the addition of Azotobacter microbial culture, T1 with the addition of 150 ml/100 kg of material, T2 with the addition of 250 ml/100 kg of material and T3 with the addition of 350 ml/100 kg of material. The variables observed were plant height, number of leaves, leaf width, number of branches and number of tillers. Plant height was significantly different (P<0.05) from treatment, for all plants. The addition of 350 ml/100 kg of material, gave the highest plant height on Odot grass, corn and Edamame by 33.60 cm, 86.8 cm, and 26.14 ± 1.89 cm, respectively. This is due to the highest element K which plays a role in maintaining turgor pressure and ensuring the continuation of cell elongation. From this study it can be concluded that the addition of Azotobacter microbial culture can increase the nutrient content of compost with cow feces material. When used as fertilizer, it can increase plant growth.

1. Introduction

Increasing cattle population in Indonesia will produce a lot of waste. Livestock waste (feces and urine) is easily decomposed organic material. This waste if not managed properly can cause environmental pollution both biological, chemical and physical. Improper management of livestock waste can cause pollution in water, soil and air which results in a decrease in the quality of the environment, the quality of life of farmers, livestock and trigger social conflict. Properly managed waste management provides economic value to livestock business. One of the uses of cow manure is to process it into manure or compost [1].

Cow feces cannot be given directly to plants, but there must be a process of destruction or composting in advance by microbes. This is to enhance the binding capacity of the soil to nutrients so that it can be easily absorbed by plants [2]. Composting is the process by which organic material decomposes biologically, especially by microbes that utilize organic material as an energy source. Compost is the result of partial or incomplete decomposition, artificially accelerated from a mixture of organic materials by populations of various microbes in warm, humid, and aerobic or anaerobic conditions [3]. Organic
compost can be used to improve soil properties. Compost can improve soil structure by increasing soil organic matter content and will also increase the ability of soil to maintain soil water content.

Basically, composting can occur naturally by requiring a long maturation time. Composting can be accelerated by adding microorganisms to the compost material. One of the microorganisms that can be added is *Azotobacter*. *Azotobacter* microbial culture is able to convert nitrogen (N\(_2\)) in the atmosphere into ammonia (NH\(_4^+\)) through the nitrogen binding process where the ammonia produced is converted into proteins needed by plants. Compost with the addition of *Azotobacter* can contribute in increasing the availability of N, P, K and organic compounds needed by plants. Using compost with *Azotobacter* microbial culture, compost can improve plant growth and production [4]. In the field of animal husbandry, compost with the addition of *Azotobacter* microbial culture can be applied to various animal feed plants as fertilizer or planting media.

2. Materials and methods

The method in this research is an experimental method. The design is a Completely Randomized Design (CRD) with 4 treatments and 6 replications. Each test consisted of 3 plants so that there were 72 experimental units.

The treatments performed are as follows:

- **T\(_0\)**: 90 kg Dry cow feces + 5 kg Husk + 5 kg Rice bran
- **T\(_1\)**: 90 kg Dry cow feces + 5 kg Husk + 5 kg Rice bran + 150 cc *Azotobacter* microbial culture
- **T\(_2\)**: 90 kg Dry cow feces + 5 kg Husk + 5 kg Rice bran + 250 cc *Azotobacter* microbial culture
- **T\(_3\)**: 90 kg Dried Cow Feces + 5 kg Husk + 5 kg Rice bran + 350 cc *Azotobacter* microbial culture

The addition dose of *Azotobacter* microbial culture was based on previous research by Cholis *et al.* [5], namely the addition of *Azotobacter* microbial culture to goat feces with different doses, consisting of: P0 (without *Azotobacter* microbial culture), P1 (150 cc *Azotobacter* microbial culture), P2 (250 cc *Azotobacter* microbial culture) and P3 (350 cc *Azotobacter* microbial culture). This proportion is used with consideration of the success of the addition of *Azotobacter* microbial culture used in goat feces so that its use is expected to have the same effect on cow feces. The use of husks and bran 5 kg is based on research conducted by Noor, Rusli, Yani, Halim and Reza [6] that a 95:5 ratio in composting shows the best results. For treatments with more chaff ratio shows a high initial C/N ratio because the carbon content in the husk is considered too much.

2.1. Research stages

The compost used in the study was anaerobic composting with the basic ingredients of cow feces, rice bran, husks, molasses, *Azotobacter* microbial culture and water. The following is the procedure for making compost.

2.1.1. Compost raw material preparation

1. Cow feces are dried in the sun so that the texture becomes crumb and easy in the mixing process.
2. Feces of cattle that have dried and then mashed and then sieved so that the size uniform and avoid clumping feces (still wet).
3. Fine cow feces weight 90 kg, husk 5 kg and rice bran 5 kg. *Azotobacter* microbial culture was added according to the dose of each treatment, namely T\(_0\): without *Azotobacter* microbial culture, T\(_1\): 150 cc *Azotobacter* microbial culture, T\(_2\): 250 cc *Azotobacter* microbial culture, and T\(_3\): 350 cc *Azotobacter* microbial culture.

2.1.2. Compost making

The composting process is carried out indoors without direct sunlight. The room is quite spacious with good air circulation. The following is the sequence in the process of making compost:
1. Composting is done in layers to form a mountain-like pile starting from mixing cow and rice bran feces and then mixing with the previously weighed husk, then mixed until evenly for each treatment.

2. Sprayed with a mixture of Azotobacter microbial cultures that have been diluted before in a pile of cow feces, husks and bran. Mixing is repeated 2-3 times for husks and bran.

3. The compost material which has been added by Azotobacter microbial culture is then stored in a trash bag into 2 parts A and B then tightly closed and tied with string. The composting process is carried out under anaerobic conditions.

4. Fermented compost is then tested for N, P, K, C/N levels and C-organic levels and then used for planting tests. Samples were taken from one trash bag at each treatment because it was suspected that with the same treatment the compost produced the same content.

2.1.3. Planting implementation

Planting test are carried out in open fields, for Odot grass, Corn and Edamame. Land preparation until planting grass is done on the same day. Land is prepare and digged by making holes with a depth of ± 15 cm to put compost as a planting medium with a spacing of 40 x 60 cm [7]. Before it is used for planting, fermented compost media is aerated for one day to reduce heat and gas. Planting is done by putting compost into the prepared land of 3 kg each. Odot grass seeds come from healthy stem cuttings. Odot grass stems cut 3 buds from the base of the roots up. Furthermore Odot grass stem cuttings are inserted into the compost with the provision of one Odot grass seedling per compost on the land with a sloping position of ± 40°, consisting of 2 buds entering into compost and 1 budding top. Watering is done every day every afternoon.

Planting tests with corn were carried out in the following way. Selected corn seeds are good, whole, not hollow or broken. Prepared land using a hoe with a width of 0.5 m x 6 m and the distance between beds about 20 cm. Perforated beds with a depth of ± 15 cm to put corn seeds into a hole (1 hole, 1 seed) then closed and watered. Water supply for corn plants is by manual watering every 3 days and also relying on rain water. Other maintenance is carried out by cleaning weeds. Weed cleaning is done by pulling weeds by hand or using a hoe every 1 week. Insecticide spraying is also done to avoid the emergence of grasshoppers, caterpillars and ants that interfere with the growth of corn plants in the first month after planting seeds.

Preparations made for the Edamame planting test are by making beds with a width of 30 cm and a height of 20 cm, the distance between the beds by 20 cm and a spacing of 25 cm. Each bed is made holes with a depth of ± 15 cm as a place to put compost. Before it is used for planting tests, mature compost is aerated first to reduce heat and gas. Planting is done by inserting compost into the prepared holes. The compost used for the planting test is 3 kg. Edamame seeds are selected with a uniform size, intact and not defective. Edamame seeds are planted directly on compost at a depth of 1.5-2 cm and per hole is filled with 1 Edamame seed. Care is carried out every week by manually removing weeds using a hand or hoe. Since planting is carried out in the field so that environmental factors such as rain also influence, then watering is only done when the media is considered dry enough or watering is not done routinely.

2.1.4. Observation variable

Observations were carried out for 8 weeks with data collection every 1 week. Here are the measured variables.

1. Number of tillers: The number of tillers is measured by counting each tillers that grow every week then the average number of tillers is calculated [8].

2. Number of leaves: The number of leaves is known by counting the number of leaves of the plant by counting the leaves that have fully developed [8].
3. Plant height: Plant height is measured from the surface of the compost or from the base of the stem above the soil surface to the highest leaf tip. Measurements were made with a meter and expressed in cm [8].

2.2. Data analysis
Data were analyzed statistically using Analysis of Variance. The analysis model is as follows:

$$Y_{ij} = \mu + \tau_i + \epsilon_{ij}$$

Where:
- $Y_{ij}$: Observations on the i-th test of the j-repeat test
- $\mu$: Average value
- $\tau_i$: Effect of i-th treatment
- $\epsilon_{ij}$: Experimental error from the i-th treatment, at the jth replication

If the results obtained are significantly different ($P < 0.05$) or very significantly different ($P < 0.01$) then proceed with Duncan's Multiple Range Test.

3. Results and discussions

3.1. Effect of Azobacter addition on compost quality
Quality compost is compost that contains good nutrients and can meet the nutrients needed by plants. In the research that has been done, cow feces compost produced by adding Azotobacter microbial culture ($T_1, T_2, T_3$) contains nutrients that are better than cow feces compost without the addition of Azotobacter microbial culture ($T_0$) can be seen in Table 1, below:

| Treatment | C-org. (%) | N (%) | P$_2$O$_5$ (%) | K$_2$O (%) | C/N (%) | BO (%) |
|-----------|------------|-------|----------------|------------|---------|-------|
| $T_0$     | 18.60      | 1.21  | 0.63           | 0.39       | 15      | 32.18 |
| $T_1$     | 18.99      | 1.27  | 0.68           | 0.45       | 15      | 32.86 |
| $T_2$     | 19.15      | 1.21  | 0.64           | 0.35       | 16      | 33.13 |
| $T_3$     | 19.44      | 1.24  | 0.70           | 0.46       | 16      | 33.63 |
| Cow Feces | 29.81      | 1.35  | 0.51           | 0.28       | 22      | 51.57 |

These nutrients indicate that the addition of Azotobacter microbial culture can improve the quality of compost as a planting medium. This is consistent with the statement of Faridah, Sumiyati, and Handayani [9] that to improve compost nutrients can be done by adding activators. Activator is a liquid containing microorganisms (microorganisms) that helps the process of decomposition of organic material that starts the process of physical and chemical change of an organic material into a product of a different nature for the better.

3.2. Effect of Azotobacter on the number of tillers
The number of tillers is one part that shows the growth and development of plants in the vegetative phase. Saplings are all young individuals who arise from the base of plants in a plant family [10]. The number of tillers can be used as a parameter in the planting test because it is able to show the effect of compost significantly. The results of the average number of Odot tillers from each treatment are presented in Table 2.
The results of the analysis of variance showed that the addition of Azotobacter in making cattle feces compost did not give a significant difference (P> 0.05) on the number of Odot tillers. This is presumably because the levels of nutrients in compost treatment are still within the normal limits of Odot grass needs. Laboratory test results also showed that the amount of nutrients contained in each treatment still showed differences that were not far from each other. Odot grass cell development is greatly influenced by the amount of nutrients that can be absorbed. When the nutrients absorbed are not enough, the Odot grass is not able to increase its development, especially during the formation of tillers. This is consistent with the opinion of Rena, Badat and Farid [11], that the provision of adequate nutrients can improve the absorption of nutrients for growth because the amount of nutrients absorbed by Odot grass is proportional to the existing nutrient content.

The results of research on the number of tillers treated with the addition of Azotobacter microbial culture gave a tendency to obtain higher yields when compared to control treatments. This is presumably because the level of N elements in compost with the addition of Azotobacter microbial culture is higher than the control treatment. Odot grass will grow well if given higher levels of nutrients but according to needs. Element N is able to influence the vegetative development of Odot grasses such as the number of tillers. This is in accordance with the opinion of Lasamadi, Malalantang, Rustandi and Anis [12], that nitrogen is very useful for plants, especially for growth and development. The nitrogen element can accelerate growth such as plant height, number of tillers, branches and increase plant protein content. Perwitasari et al. [13] added that plants that lack N elements will cause stunted growth, especially the growth of shoots to form saplings.

### Table 2. Average number of tillers

| Treatment | Average number of tillers |
|-----------|---------------------------|
| T₀        | 5.49 ± 0.538              |
| T₁        | 6.78 ± 0.611              |
| T₂        | 6.10 ± 0.905              |
| T₃        | 6.43 ± 0.974              |

3.3. Effect of Azotobacter addition on sweet corn (Zea mays saccharata) height

The difference in the proportion of Azotobacter microbial culture given in each treatment caused a difference in the amount of nutrients contained in it and had a significant effect on the height of sweet corn (Zea mays saccharata). Variance analysis results had a significant effect (P<0.05) on the average height of sweet corn plants. The average height of sweet corn plants in each treatment for 8 weeks is shown in Table 3, below:

### Table 3. Average height of sweet corn (Zea mays saccharata) for 8 weeks

| No. | Treatment | Average (cm) |
|-----|-----------|--------------|
| 1.  | T₀        | 81.24 ± 5.25<sup>a</sup> |
| 2.  | T₁        | 90.17 ± 4.59<sup>b</sup>  |
| 3.  | T₂        | 86.70 ± 2.26<sup>a</sup>  |
| 4.  | T₃        | 86.98 ± 5.51<sup>a</sup>  |

Note: a, b different superscripts in the same column show significant differences (P <0.05)

3.4. Effect of Azobacter addition on number of leaves in sweet corn (Zea mays saccharata)

The results of the analysis of variance in Appendix 4. state that the F count (0.51) is smaller than the F table (3.10). This shows that the difference in the concentration of Azobacter microbial culture given in each compost treatment has no effect on the average number of leaves in sweet corn plants (P> 0.05). The average yield of leaves at each treatment from the 1st week to the 8th can be seen in Table 4., below:

From the data it can be seen that the results of statistical analysis show no significant difference in the number of leaves (P> 0.05) but the addition of microbial cultures with increasing proportions tends to increase the number of leaves in corn. The highest number of leaves is in T₃ with an average number of leaves in the 1-8 weeks is 9.38 ± 0.45, then in T₁ is 9.34 ± 0.48, T₂ is 9.26 ± 0.18 and finally in T₀.
without the addition of *Azotobacter* microbial culture was 9.11 ± 0.42. The treatment without the addition of *Azotobacter* (*T_0*) microbes culture showed the lowest leaf growth yield compared to other treatments. The absence of a significant difference in the number of leaves in maize plants is thought to be due to the relatively equal content of nutrients present in compost, but the nutrient content in compost with the addition of *Azotobacter* microbial cultures (*T_1*, *T_2* and *T_3*) has an average value of the number of leaves which tends to increase because the nutrients contained slightly higher than *T_0* (without *Azotobacter* microbial culture content) can be seen in Table 1.

**Table 4.** Average number of sweet corn leaves (Zea mays saccharata) for 8 weeks

| No. | Treatments | Amounts of leaves |
|-----|------------|-------------------|
| 1.  | *T_0*      | 9.11 ± 0.42       |
| 2.  | *T_1*      | 9.34 ± 0.48       |
| 3.  | *T_2*      | 9.26 ± 0.18       |
| 4.  | *T_3*      | 9.38 ± 0.45       |

The nutrient that plays a major role in the growth and development of leaves is Nitrogen. The low leaf growth at *T_0* is thought to be due to the low content of N elements in compost, as stated by Bilman [14] that the low availability of N causes the activity of chlorophyll cells that play a role in photosynthesis activities to not be able to utilize solar energy optimally, so the photosynthetic rate will decrease and fewer photosynthates are produced. This condition will slow the rate of growth and development of plants, especially in the formation of new organs such as leaves. Phosphorus and Nitrogen are elements that must be provided in the early stages of growth to ensure good vegetative growth. A graph of the number of leaves added to sweet corn in the 1st to 8th week can be seen in Figure 1 below:

![Graph of the number of sweet corn leaves (Zea mays saccharata) for 8 weeks](image)

**Figure 1.** Graph of the number of sweet corn leaves (Zea mays saccharata) for 8 weeks

From the graph above it can be seen that the increase in the number of leaves increases significantly in each treatment every week. This shows that the addition of compost can improve the physical properties of the soil, the chemical nature of the soil and the biological nature of the soil which will directly affect plant growth, especially the formation of leaf numbers. Nutrient N is needed during the plant growth phase, but is most needed at the beginning to the middle of the primordial sapling phase of flowers [15]. In this research it is also known that the leaves at the bottom of the corn plant rarely die or dry out, so it can be concluded that the nutrient content carried by compost can maintain the growth and green color of the leaves of the corn plant itself, as stated by Marvelia, Darmanti and Parman [16] that in his research the positive impact of the use of compost on production can be seen in long-lived plants.
4. Conclusion

Based on research that has been carried out, it can be concluded that:

1. The addition of Azotobacter microbial culture can increase the nutrient content of cow feces compost and affect plant production.
2. Addition of Azotobacter microbial culture of 350 cc / 100 kg of cow feces is the best proportion to increase plant growth.

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References

[1] Marlina E T, Hidayati Y A, Benito T and Juanda W 2013 Analisis kualitas kompos dari sludge biogas feses kerbau (The quality analysis of the compost of sludge biogas buffalo feces) Jurnal Ilmu Ternak 13(1) 31-34
[2] Haq A S, Nugroho W A and Lutfi M 2014 Pengaruh perbedaan sudut rak segitiga pada pengomposan sludge biogas terhadap sifat fisik dan kimia kompos Jurnal Keteknikan Pertanian Tropis dan Biosistem 2(3) 225-233
[3] Hamastuti H, Dwi E, Juliastuti S R and Hendrianie N 2012 Peran mikroorganisme Azotobacter chroococcum, Pseudomonas fluorescens, and Aspergillus niger pada pembuatan kompos limbah sludge industri pengolahan susu Jurnal Teknik Pomits. 1(1) 1-5
[4] Toago S P, Lapanjang I M and Barus H N 2017 Aplikasi kompos dan Azotobacter sp. terhadap pertumbuhan dan produksi tanaman cabai merah (Capsicum annum L.) E-J. Agrotekbis. 5(3) 291-299
[5] Cholis N, Setyowati E and Nursita I W 2016 Pengaruh penambahan kultur Azotobacter pada feses kambing terhadap kualitas media dan produktivitas cacing tanah (Lumbricus rubellus) Jurnal Ilmu-ilmu Peternakan 26(2) 30-41
[6] Noor E, Rusli M S, Yani M, Halim A and Reza N 2008 Pemanfaatan sludge limbah kertas untuk pembuatan kompos dengan metode Windrow dan Cina J. Teknik Industri Pertanian. 15(2) 67-71
[7] Wijana I N Y S G and Adnyana G M 2012 Aplikasi jenis pupuk organik pada tanaman padi sistem pertanian organik E-Jurnal Agroekoteknologi Tropika. 1(2) 98-107
[8] Muhammad A N, Trisnadewi A A A S and Suranjaya I G 2018 Pertumbuhan dan produksi beberapa jenis rumpot lokal pada berbagai panjang defoliasi Jurnal Peternakan Tropika 6(3) 904 – 920
[9] Faridah A, Sumiyati S and Handayani D S 2014 J. Teknik Lingkungan 3(1) 1-9
[10] Assiddiqi M H 2018 Pengaruh Dosis Papuk Nitrogen Terhadap Kandungan Ndf dan Adf Rumput Gajah Mini (Pennisetum Purpureum cv. Mott) Pada Usia Pemotongan 30 Hari Thesis (Mataram: Fakultas Peternakan, Universitas Mataram)
[11] Reny N H A, Badat M and Farid M W 2019 Pengaruh frekuensi pemupukan bio urin dengan penambahan zpt organik sebagai pupuk daun pada rumput odot (Pennisetum Purpureum cv. Mott) terhadap kandungan lemak kasar, serat kasar dan bahan ekstrak tanpa nitrogen Jurnal Rekasiwa Peternakan 1(1) 103-107
[12] Lasamadi R D, Malalantang S S, Rustandi and Anis S D 2013 Pertumbuhan dan perkembangan rumput Gajah Dwarf (Pennisetum Purpureum Cv. Mott) yang diberi pupuk organik hasil fermentasi EM4 Jurnal Zootek 32(5) 158-171
[13] Perwitasari B, Tripatmasari M and Wasonowati C 2012 Pengaruh media tanam dan nutrisi terhadap pertumbuhan dan hasil tanaman pakchoi (Brassica juncea L.) dengan sistem hidroponik 5(1) 14-25
[14] Bilman W S 2001 Analisis pertumbuhan tanaman jagung manis *(Zea mays saccharata)*, pergeseran komposisi gulma pada beberapa jarak tanam jagung dan beberapa frekuensi pengolahan tanah *Jurnal Ilmu-Ilmu Pertanian Indonesia* 3(1) 25-30

[15] Prasetyo W, Santoso M and Wardiyati T 2013 Pengaruh beberapa macam kombinasi pupuk organik dan anorganik terhadap pertumbuhan dan hasil tanaman jagung manis *(Zea mays Saccharata Sturt)* *Jurnal Produksi Tanaman* 1(3) 79-86

[16] Marvelia A, Darmanti S and Parman S 2006 Produksi tanaman jagung manis *(Zea Mays L. Saccharata)* yang diperlakukan dengan kompos kascing dengan dosis yang berbeda *Buletin Anatomi dan Fisiologi* 14(2) 7-19