**APPLICATIONS OF COW MANURE AND BAGASSE BIOCHAR ON THE GROWTH AND FLAVONOIDS OF PALMAROSA *(Cymbopogon martinii)***

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**ABSTRACT**

The utilization of cow manure and bagasse biochar is expected to increase the growth and yield of palmarosa (*Cymbopogon martinii*). This study aims to obtain the wheather there is no interaction between cow manure and bagasse biochar, the response of adding cow manure and bagasse biochar growth and flavonoids in palmarosa. This research was held in July 2022 - June 2023, located at the Jumantono experimental field, Jumantono Subdistrict, Karanganyar Regency. The method used was a completely randomized design with two treatment factors and 3 replications. The first treatment factor was cow manure dose (P0 = without treatment, P1 = 100 gram/polybag, P2 = 200 gram/polybag, and P3 = 300 gram/polybag) and the second treatment factor was bagasse biochar (B0 = without treatment, B1 = 80 grams/polybag, B2 = 160 grams/polybag, and B3 = 240 grams/polybag). The observed variables consisted of number of leaves, number of tillers, plant diameter, leaf area, dry weight of stover, and percentage of flavonoids of palmarosa. The data were analyzed using analysis of covariance with a 5% level test and if there was a significant difference it was continued with the Duncan's Multiple Range Test at a 5% level. The results showed that there was no interaction between cow manure and bagasse biochar. P3 (300 grams of cow manure) was the best treatment to produce the best number of leaves, number of tillers, plant diameter, and leaf area. The highest flavonoids were found in P1B3 treatment (100 grams of cow manure and 240 grams of bagasse biochar) which was 0.055%. The data were analyzed using analysis of covariance with a 5% level test and if there was a significant difference it was continued with the Duncan's Multiple Range Test at a 5% level. The results showed that there was no interaction between cow manure and bagasse biochar. P3 (300 grams of cow manure) was the best treatment to produce the best number of leaves, number of tillers, plant diameter, and leaf area. The highest flavonoids were found in P1B3 treatment (100 grams of cow manure and 240 grams of bagasse biochar) which was 0.055%. The data were analyzed using analysis of covariance with a 5% level test and if there was a significant difference it was continued with the Duncan's Multiple Range Test at a 5% level. The results showed that there was no interaction between cow manure and bagasse biochar. P3 (300 grams of cow manure) was the best treatment to produce the best number of leaves, number of tillers, plant diameter, and leaf area. The highest flavonoids were found in P1B3 treatment (100 grams of cow manure and 240 grams of bagasse biochar) which was 0.055%. P3 (300 grams of cow manure) was the best treatment to produce the best number of leaves, number of tillers, plant diameter, and leaf area. The highest flavonoids were found in P1B3 treatment (100 grams of cow manure and 240 grams of bagasse biochar) which was 0.055%. P3 (300 grams of cow manure) was the best treatment to produce the best number of leaves, number of tillers, plant diameter, and leaf area. The highest flavonoids were found in P1B3 treatment (100 grams of cow manure and 240 grams of bagasse biochar) which was 0.055%.

**Keywords:**fertilizers; biochar; medicinal plants; palmarosa; secondary metabolites.

**INTRODUCTION**

Palmarosa (*Cymbopogon martinii*) is a spice plant commodity that has many benefits and is prospective for cultivation in Indonesia. Palmarosa plants, both as herbal medicine and cooking spices, are useful for warming the body and maintaining immunity (Subositi & Wahyono, 2019). In other countries such as America, palmarosa is used as an alternative herbal medicine to relieve heartburn caused by wind in the stomach and strengthen digestion. Palmarosa in India is usually used for women's beauty treatments or as a cosmetic ingredient.

Palmarosa contains flavonoid compounds that are anti-cancer and have been tested as anti-oxidants (Shehna et al., 2022). Flavonoids are antioxidant compounds that act as inhibitors of tyrosine kinase activity, an enzyme that plays an important role in the development of cancer cells (Lee et al. 2019). Seeing the various prospects of flavonoids, efforts can be made to increase them by expanding production areas and improving quality at the cultivation stage, one of which is by intensive fertilization using manure and biochar.

The process of fertilizing plants using manure can increase the activity of microorganisms in the soil and improve soil structure by increasing the number and stability of soil aggregates, thereby facilitating root development. The use of manure, such as cow dung, apart from being environmentally friendly, is also able to minimize production costs and is an effort to implement sustainable agriculture. The presence of microbes contained in cow manure functions to increase the solubility of nutrients needed by plants, both from fertilizer and soil minerals and increases the ability of roots to absorb nutrients by forming more root hairs (Tallou et al., 2020). The doses of cow manure given are in accordance with the doses that have been determined as treatment, namely: 100, 200, and 300 grams/polybag.

Biochar is an organic waste that can increase soil fertility and provide a good habitat for soil microbes and can even retain water and nutrients so that they are more available to plants. Biochar is processed using a pyrolysis process which is carried out by exposing biomass to high temperatures without the presence of oxygen. One waste that is prospective to be used as biochar is sugarcane bagasse. Previous research explained that bagasse biochar was proven to be able to increase soil C levels from 21.2% to 27.1%, so this shows that there is a contribution of sugarcane bagasse biochar to the provision of soil nutrients for plants (Alves et al. 2021) The recommended biochar doses used in research are 80, 160 and 240 grams/polybag. This research aims to determine whether there is an interaction between cow manure and sugarcane bagasse biochar on the growth and flavonoid content of palmarosa.

**MATERIALS AND METHODS**

This research was conducted in July 2022 – June 2023 in the Jumantono experimental field at Sebelas Maret University, Jumantono District, Karanganyar Regency. The tools used include a hygrometer, Campbell stokes, destilator, oven, spectrophotometer, optilab, and plant photosynthesis meter. The materials used were water, palmarosa, cow manure, husks, polybags, NaOH solution, HCl, distilled water, aquabides, and bagasse biochar. The type of research used is the experimental method. Experimental research is research conducted to determine the effect of giving a treatment to research subjects, in this case is to determine the effect of cow manure and sugarcane bagasse biochar on the growth and production of palmarosa plants. The treatment of this study was arranged in a factorial completely randomized design (CRD) with two treatment factors and repeated 3 times in open land. The factors used were cow manure fertilization and the use of bagasse biochar with various fertilizer doses of 4 levels per factor. The first treatment factor was cow manure (P0 = no fertilizer, P1 = 100 grams/polybag, P2 = 200 grams/polybag, and P3 = 300 gram/polybag) The second treatment factor was bagasse biochar (B0 = without biochar, B1 = 80 gram/polybag, B2 = 160 gram/polybag, and B3 = 240 gram/polybag). Each treatment level was repeated 3 times and 48 trials were obtained. The factors used were cow manure fertilization and the use of bagasse biochar with various fertilizer doses of 4 levels per factor. The first treatment factor was cow manure (P0 = no fertilizer, P1 = 100 grams/polybag, P2 = 200 grams/polybag, and P3 = 300 gram/polybag) The second treatment factor was bagasse biochar (B0 = without biochar, B1 = 80 gram/polybag, B2 = 160 gram/polybag, and B3 = 240 gram/polybag). Each treatment level was repeated 3 times and 48 trials were obtained. The factors used were cow manure fertilization and the use of bagasse biochar with various fertilizer doses of 4 levels per factor. The first treatment factor was cow manure (P0 = no fertilizer, P1 = 100 grams/polybag, P2 = 200 grams/polybag, and P3 = 300 gram/polybag) The second treatment factor was bagasse biochar (B0 = without biochar, B1 = 80 gram/polybag, B2 = 160 gram/polybag, and B3 = 240 gram/polybag). Each treatment level was repeated 3 times and 48 trials were obtained. and B3 = 240 grams/polybag). Each treatment level was repeated 3 times and 48 trials were obtained. and B3 = 240 grams/polybag). Each treatment level was repeated 3 times and 48 trials were obtained.

The stages of the research started with land survey, land preparation, preparation of cow manure, manufacture of bagasse biochar, seeding, mixing of planting media as treatment, transplanting, treatment, watering, observation or data collection, OPT control, then after entering 24 MST stress was carried out. for 2 months before harvesting. This research used polybags measuring 40x40 cm as planting media containers, with a soil weight of approximately 7-8 kg/polybag. Data analysis in this research is quantitative analysis. Data from research on growth, physiological analysis, and plant yields were collected and then processed using quantitative analysis media and then interpreted and concluded.

**RESULTS AND DISCUSSION**

**Number of Leaves**

Table 1 shows the results of further tests on the effect of fertilizer on the number of palmarosa leaves at 24 week. The application of cow manure had a significant effect on the number of plant leaves, whereas the treatment with bagasse biochar did not have a significant effect on the number of plant leaves.The number of leaves with the control treatment produced 6.17 leaves, not significantly different from the P1 treatment (100 grams/polybag) with 7.17 leaves and the P2 treatment (200 grams/polybag) which produced 8.25 leaves. However, the control treatment was significantly different from the P3 treatment (300 grams/polybag) with 9.33 leaves (51.21% increase from the control treatment). The number of leaves which is further related to assimilate production is influenced by N and P nutrients in manure of 1.57% and 1.45 ppm, respectively. Nutrient N is an important element in the composition of chlorophyll, while nutrient P has an effect on cell differentiation which is very important in the formation of leaves. Buntoro et al (2014) explained that leaves play a role in capturing light and are where the photosynthesis process takes place. The development of the number of leaves will also influence plant development. The more leaves can mean that more light can be captured so that the photosynthesis process will increase.

**Table 1.**Results of further tests on the treatment of doses of cow manure and bagasse biochar on the number of leaves

|  |  |
| --- | --- |
| Combination of Planting Media | Number of Leaves (pieces) |
| P0 | P1 | P2 | P3 |
| B0 | 6.33 | 7.33 | 8.67 | 9.00 |
| B1 | 6.00 | 7.00 | 8.00 | 9,33 |
| B2 | 6.33 | 7.00 | 8.00 | 9,33 |
| B3 | 6.00 | 7.33 | 8.33 | 9.67 |
| Average | 6.17a | 7,17ab | 8.25bc | 9,33c |

**Information**: Numbers followed by the same letter in one column are not significantly different in the DMRT test at 95% confidence level, (-) : There is no interaction. P0: without fertilizer, P1: 100 grams/polybag, P2: 200 grams/polybag, P3: 300 grams/polybag. B0: without biochar, B1: 80 grams/polybag, B2: 160 grams/polybag, B3: 240 grams/polybag.

**Plant Diameters**

Table 2 shows the results of further tests on the effect of fertilizer on palmarosa diameter at 24 week. Providing cow manure has a real influence on plant diameter. The diameter of the control treatment plants produced an average of 12.46 mm, which was not significantly different from P1 which produced an average of 15.64 mm or P2 which produced an average of 15.21 mm. However, the control treatment was significantly different from the P3 treatment which produced an average of 17 mm (an increase of 36.4% from the control treatment). The CEC on alfisol soil which has a value of 21.84 me% or is categorized as medium is thought to be able to retain the nutrients supplied by fertilizer and biochar because one of the characteristics of CEC is reducing the potential for leaching. This process is also supported by the C-organic content (22.11%) in the fertilizer (table 4. 2) which acts as a source of negative charge in the soil. Yuliana et al. (2015) added that cultivating medicinal plants in polybags will minimize the level of competition between plants, so that the nutrients contained in the planting medium have the potential to focus the uptake of available nutrients to carry out the vegetative growth process, one of which is growth in plant diameter.

**Table 2**. Results of further tests of treatment of doses of cow manure and bagasse biochar on diameter

|  |  |
| --- | --- |
| Combination of Planting Media | Plant Diameter (mm) |
| P0 | P1 | P2 | P3 |
| B0 | 11.97 | 16,33 | 16.07 | 15,3 |
| B1 | 13,10 | 15,47 | 14,47 | 16,27 |
| B2 | 13.37 | 14,17 | 14.73 | 17.87 |
| B3 | 11.40 | 16.60 | 15.57 | 18.57 |
| Average | 12,46a | 15,64ab | 15,21ab | 17.00b |

**Information**: Numbers followed by the same letter in one column are not significantly different in the DMRT test at 95% confidence level, (-) : There is no interaction. P0: without fertilizer, P1: 100 grams/polybag, P2: 200 grams/polybag, P3: 300 grams/polybag. B0: without biochar, B1: 80 grams/polybag, B2: 160 grams/polybag, B3: 240 grams/polybag.

**Number of Tillers**

Table 3 shows results of further tests on the effect of fertilizer on the number of tillers of palmarosa at 24 week. Providing cow manure has a real influence on the number of calves. The number of tillers in the P3 treatment produced an average of 3.08 tillers (200.08% increase from the control treatment), not significantly different from P2 which produced an average number of 1.83 tillers. However, the P3 treatment was significantly different from the P1 treatment with an average of 1.67 and the control treatment which produced an average of 1 tiller. The N content of 1.57% in manure contributes to the process of tuber formation through plant saplings. Prime et al.

**Table 3**. Results of further tests on the treatment of doses of cow manure and bagasse biochar on the number of calves

|  |  |
| --- | --- |
| Combination of Planting Media | Number of Saplings (fruit) |
| P0 | P1 | P2 | P3 |
| B0 | 1.33 | 1.00 | 2.00 | 2,33 |
| B1 | 0.67 | 1.67 | 1.67 | 3.00 |
| B2 | 1.00 | 2.00 | 1.67 | 3.33 |
| B3 | 1.00 | 2.00 | 2.00 | 3.67 |
| Average | 1.00a | 1.67a | 1.83ab | 3.08b |

**Information**: Numbers followed by the same letter in one column are not significantly different in the DMRT test at 95% confidence level, (-) : There is no interaction. P0: without fertilizer, P1: 100 grams/polybag, P2: 200 grams/polybag, P3: 300 grams/polybag. B0: without biochar, B1: 80 grams/polybag, B2: 160 grams/polybag, B3: 240 grams/polybag.

**Leaf Area**

Table 4 showsresults of further tests on the effect of fertilizer on palmarosa leaf area at 24 week. The control treatment with a leaf area of ​​2777 mm2 was significantly different from P3 which produced a leaf area of ​​4083.7 mm2 (an increase of 47.05% from the control treatment), P2 with an average leaf area of ​​3572.2 mm2 and P1 with an average leaf area amounting to 3327.5 mm2. The cow manure used in this research is a type of solid manure, namely livestock manure in solid form, then composted, so that it can be a source of nutrients for plants, and can improve the chemical, biological and physical properties of the soil. Kusmarwiyah & Erni (2018), nutrient elements contained in cow manure such as N are able to support plant growth which is needed for the formation or growth of vegetative parts of plants such as leaves, stems and roots.

**Table 4**. Results of further tests on the treatment of doses of cow manure and bagasse biochar on leaf area

|  |  |
| --- | --- |
| Combination of Planting Media | Leaf Area(mm2) |
| P0 | P1 | P2 | P3 |
| B0 | 2819,8 | 2909,1 | 3916,9 | 4300.5 |
| B1 | 2573,3 | 3691.7 | 3292,0 | 3764,3 |
| B2 | 3084,3 | 3456,3 | 4078.6 | 4168.9 |
| B3 | 2630.5 | 3252.7 | 3001.2 | 4100.9 |
| Average | 2777.0a | 3327.5b | 3572,2b | 4083.7b |

**Information**: Numbers followed by the same letter in one column are not significantly different in the DMRT test at 95% confidence level, (-) : There is no interaction. P0: without fertilizer, P1: 100 grams/polybag, P2: 200 grams/polybag, P3: 300 grams/polybag. B0: without biochar, B1: 80 grams/polybag, B2: 160 grams/polybag, B3: 240 grams/polybag.

**Flavonoid Analysis**

The amount of palmarosa flavonoids by administering cow manure and sugarcane bagasse biochar can be seen in Figure 1.

**Figure 1**. Palmarosa flavonoids at 32 week by administering cow manure and sugarcane bagasse biochar



Source: Palmarosa Flavonoid Test Results at 32 week

Figure 4.15 shows that the highest yield of flavonoid content was in the P1B3 treatment (100 gram/polybag fertilizer and 240 gram/polybag biochar) of 0.055%. The formation of palmarosa secondary metabolites was affected by stress treatment for 2 months. Under stress conditions where the availability of nutrients and water is very low, it causes a plant response to unwanted conditions by activating secondary metabolites as a means of self-defense. Secondary metabolites have the potential to increase with increasing age of the plant, the older the plant, the higher the levels of secondary metabolites produced. According to Muflihah et al (2021), flavonoids as one of the antioxidants contained in palmarosa which are then extracted are influenced by geographical conditions, extraction conditions,

**CONCLUSIONS AND RECOMMENDATIONS**

**Conclusion**

1. The use of cow manure and bagasse biochar simultaneously did not significantly affect the variables in the study of growth and content of palmarosa flavonoids.
2. The dose of 300 gram/polybag cow manure has a significant effect on increasing the number of leaves, diameter, number of tillers, and leaf area.
3. The bagasse biochar treatment was better in several parameters than the control treatment. However, it has not been able to give a real effect on growth and palmarosa flavonoids.
4. The highest content of flavonoids was in the P1B3 treatment (100 gram/polybag fertilizer and 240 gram/polybag biochar).

**Suggestion**

Suggestions from the implementation of this research are that it is necessary to pursue further research regarding the effect of cow manure on other types of medicinal plants and the addition of sugarcane bagasse biochar doses on the growth of medicinal plants. In addition, it is necessary to pursue further studies regarding the increase in the main stress period in increasing secondary metabolite compounds in medicinal plants.

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