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Original Research Article

THE GROWTH AND ANATOMICAL RESPONSE OF BLACK POTATO (PLECTRANTHUS ROTUNDIFOLIUS) TO FERMENTED COW, GOAT AND CHICKEN MANURE IN THE LOWLANDS

Ngadiani Ngadiani[1)*], Vivin Andriani[2)]
[1,2)]Biology Study Program, Universitas PGRI Adi Buana Surabaya

*Corresponding Author, E-mail : ngadiani@unipasby.ac.id

ABSTRACT

Introduction. *Food independence in Indonesia continues to be developed with other food crops to substitute the rice, one of it is by black potato. The productivity of lowland potato plants can be supported by the provision of nutrients. This research aims to determine the provision of fermented cow, goat and chicken manure on the growth, yield and anatomy of Black Potato Tubers (Plectranthus rotundifolius).* ***Method.*** *The method used was experimental with 12 treatments and repeated 3 times for each treatment, including control, 0 kg/plot, 5 kg/plot, 10 kg/plot, 15 kg/plot, and NPK. The parameters observed in this research were growth (plant height, number of leaves, number of branches) and anatomy (diameter of stems and stomatal density).* ***Results and Analysis.*** *The data were analyzed using Anova test with a significance of α = 0.05, and the difference test is conducted using Duncan when there is a difference in the test result.* ***Discussion.*** *The results showed that chicken manure had a better effect on the growth and anatomy of black potato plants compared to goat manure and cow manure.*

keywords: Anatomy, Black Potato, Growth, Manure, Yield

INTRODUCTION

Potato is one of the crops that is utilized by its bulbs for food needs besides rice in supporting food security. Potatoes also have prospects to support food diversification and export commodities due to the non-perishable nature of it (Karjadi and Buchory, 2008). Potato consumption in Indonesia based on Food Consumption Statistics states that potato production has decreased by 2,547 in 2020. The increase in potato consumption by the public indicates that potato production needs to be improved. Black potato is one type of potato that has not been developed in Indonesia, that though in 100 grams of black potatoes contain 21% carbohydrates, 1.4% protein, 0.2% fat, 0.7% fiber, 0.1% ash and 76% water and contain minerals and vitamins (Dayu Ardani, Edy Suminarti and Nugroho, 2017). Black potato also has potential as a natural antioxidant and antiproliferation because it contains *triterpenic acid* (Nugraheni, Hamidah and Auliana, 2017).

The propagation of black potato plants in Indonesia is less considered by farmers. The farmers have a high dependence on the use of chemical fertilizers because they are easily available without knowing the negative effects of it. To reduce the use of chemical fertilizers that can be a source of environmental pollution, the solution that must be considered is the use of organic fertilizers, one of it is animal manure. This research utilizes fermented animal waste fertilizers including cow manure, goat manure and chicken manure. Manure can improve the soil conditions and supplying the macro and micro nutrients (Hafizah and Mukarramah, 2017) stated that cow manure contains elements of Nitrogen, Phosphorus, Potassium and Carbon which can potentially increase the growth and yield of cayenne pepper plants. Meanwhile, goat manure contains 2.10% N, 0.66% P_2O_5, 1.97% K_2O, 1.64% Ca, 0.60 Mg, 233 ppm Mn and 90.8 ppm Ca (Semekto, 2006), and chicken manure contains 3.21% N, 3.21% P_2O_5, 1.57% K_2O, 1.57% Ca, 1.44% Mg, 233 ppm and 90.8 ppm Zn (Samekto, 2006). This research aims to determine the most appropriate use of fermented manure among three types of manure (cow manure, goat manure and chicken manure) to produce the best results on the growth and yield of black potatoes (Plectranthus rotundifolius) in the lowlands.

METHOD AND ANALYSIS

The research was conducted for 4 months, starting in June-September 2022 at Wiyung, Surabaya. The materials used in this research include black potato bulbs, livestock manure (cows, goats and chickens), EM4, Anthracol fungicide, and Kalebtin insecticide. The research was conducted experimentally by using RAK (Randomized Group Design) Factorial with 3 factors and 3 replications, including Factor of cow manure (S), goat manure (K) and chicken manure (A), each with 4 levels 0 kg/plot, 5 kg/plot, 10 kg/plot, 15 kg/plot, and NPK (Control -, S1, S2, S3, K1, K2, K3, A1, A2, A3, and control +). There were 5 plants per plot, spaced 45 x 50 cm apart. The data were analyzed using Anova test with a significance of $\alpha = 0.05$. In addition, the methods in this research include:

The fermentation of cow, goat and chicken manure

Fermentation-based fertilizer production using EM4 and each of gow, goat and chicken manure are prepared with 20 kg. Mix each manure with 1 liter of EM4, cover it with a gunny sack and open for every 3 days to remove the gas. After 4 weeks, the fertilizer is ready for use when it does not consist of water and does not smell.

Land preparation

The area was weeded out and hilled to a depth of 20 cm first before being left for a day. Then, the threshing process was conducted before creating the plot.

Seedling preparation

The seedlings used were fresh potato tubers that were same in size. The seedlings were grown until 2 weeks old.

Manure application

Manure application was given after tillage according to the treatment and left for 1 week. After that, the potato seedlings were planted.

Planting process

The planting was conducted in the research plot with a distance of 45 x 50 cm with a hole depth of 8 cm, with the upright seedlings position.

Preservation

Plant preservation with watering and weed removal.

Data Collection

The data were collected at 90 HST (Days After Planting) including Growth (Plant height, Number of leaves, Number of branches) and Anatomy (Diameter of transport bundles (µm) and Stomatal density).

RESULT

Growth Response of Black Potato (Plectranthus rotundifolius) to Fermented Cow, Goat and Chicken Manure in the Lowlands

Based on the observations of black potato growth treated with three types of fermented manure, the results are presented in tables 1, 2 and 3 below.

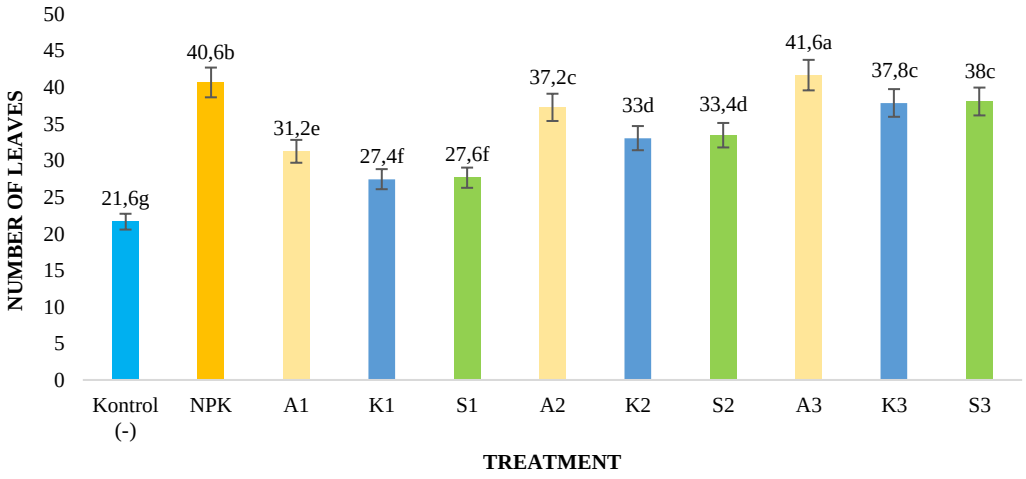

Figure 1. Number of Leaves of Black Potato 90 HST

Figure 1 shows that the application of three types of fermented manure treatment A3 (chicken manure 15 kg/plot) with an average number of leaves of 41.6 leaves is significantly different from the application of NPK and treatments with cow and goat manure on the number of black potato tubers.

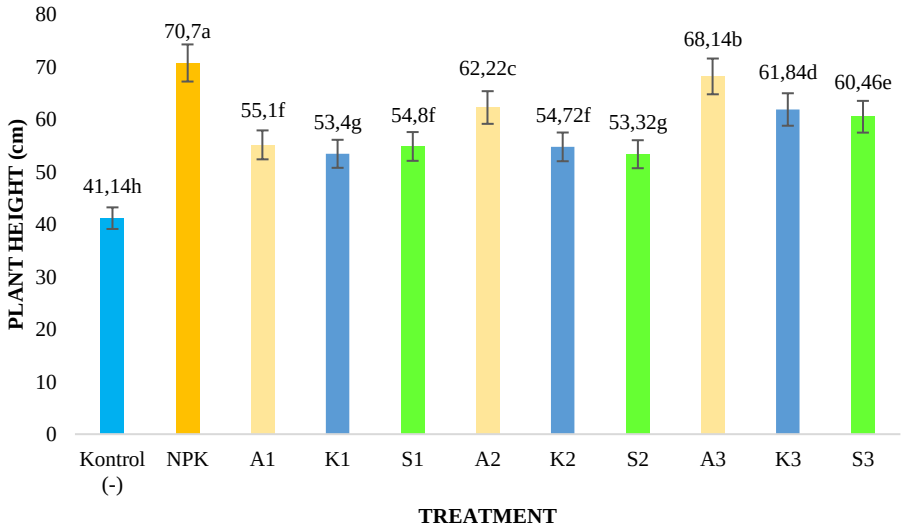

Figure 2. Plant Height (cm) of Black Potato 90 HST

Figure 2 shows that the additional of NPK gives good results on plant height of 70.7 cm and significantly different from the control (-) and treatment with chicken, goat and cow manure on black potato height. However, from the three types of manure treatments that produced the highest plant height was treatment A3 (chicken manure 15 kg/plot) with an average plant height of 68.14 cm compared to the goat and cow manure treatments.

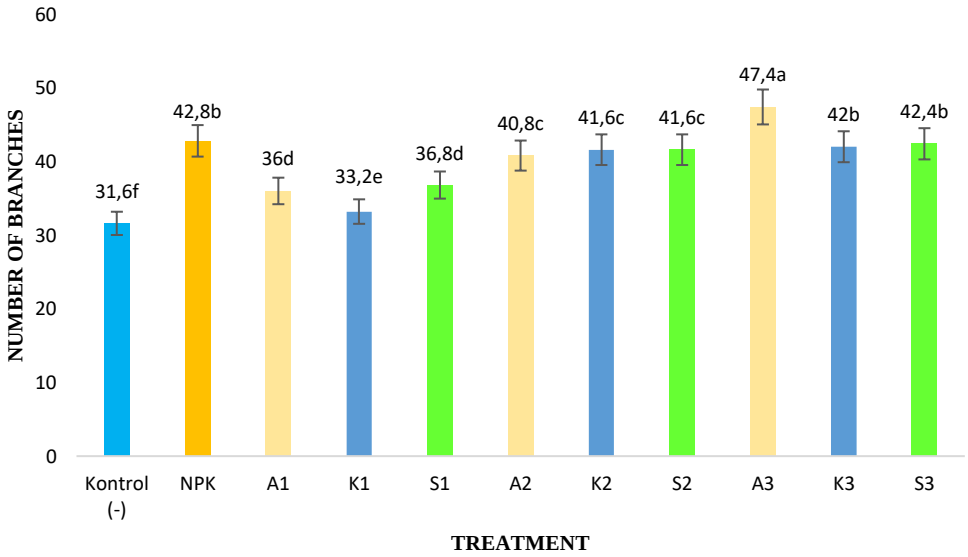

Figure 3. Number of Black Potato Branches 90 HST

Figure 3 shows that the application of three types of fermented manure A3 treatment (chicken manure 15 kg/plot) gave the average number of branches of 47.4 branches and significantly different from the application of NPK and treatment with cow and goat manure

on the number of branches of black potatoes.

Anatomical Response of Black Potato (Plectranthus rotundifolius) Stems to Fermented Cow, Goat and Chicken Manure in the Lowlands

Based on the observation results of stems anatomy and stomatal density of black potatoes treated with three types of manure fermentation are presented in tables 4 and 5 below.

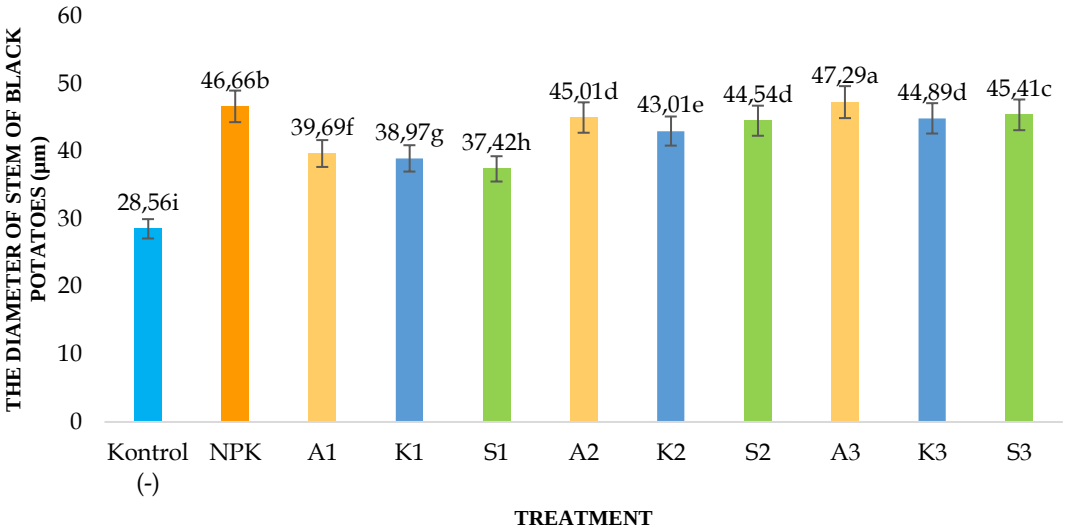

Figure 4. Diameter of Stem (µm) of Black Potato 90 HST

Figure 4 shows that the application of three types of fermented manure in treatment A3 (chicken manure 15 kg/plot) gave better results on the diameter of black potato stem compared to the application of NPK cow and goat manure.

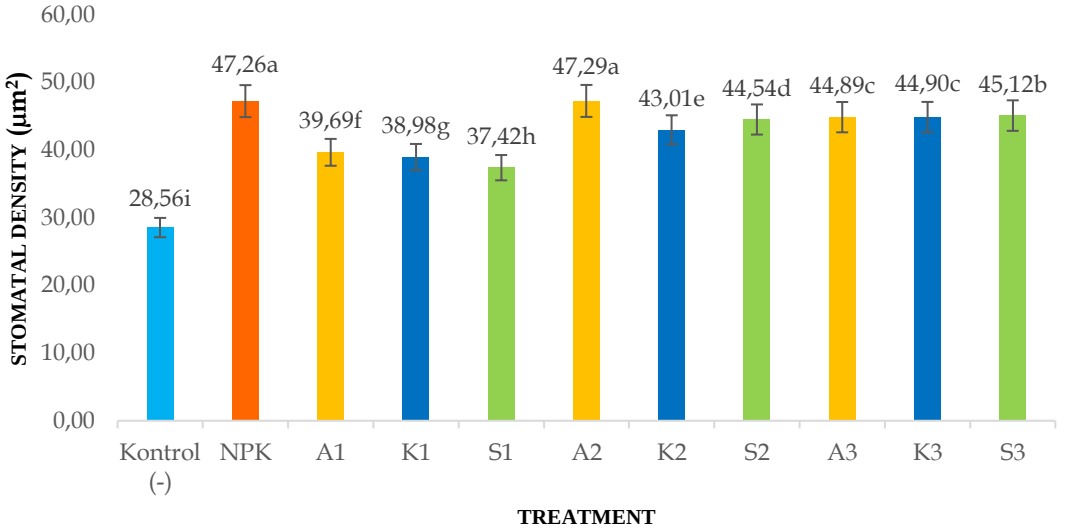

Figure 5. Stomatal Density (µm²) of Black Potato 90 HST

Figure 5 shows that the application of three types of fermented manure in A2 treatment (10 kg/plot chicken manure) gave better results on black potato stomatal density compared to the application of NPK cow and goat manure.

DISCUSSION

Fermented chicken manure gave the best effect on the number of leaves and the number of branches compared to the fermented cow and goat manure treatments. Meanwhile, NPK fertilizer gave the best results on the plant height among three fertilizer fermentations. In addition to contain the complete nutrients, manure also improves the physical properties of the soil. The addition of organic substance from manure to the soil will automatically increase the population of decomposer microbes and the rapidly process of decomposing organic matter into nutrients needed by plants. The moist soil due to the use of organic materials also creates an ideal condition for the development of various microbes in the soil. The manure and cocopeat in this treatment can improve soil chemical properties such as pH, C-organic, P_2O_5, K-dd, and Nitrogen (N) which is needed by plants has increased for the plant roots can grow well and can absorb more nutrients. The N element absorbed by the roots is used for plant growth, especially the stem, branches and leaves. The application of organic fertilizers containing N elements will encourage the plant growth and increase in plant height (Jumadi and Suhaili, 2020).

Plant growth will occur in vegetative phase. The vegetative phase in plants is related to three important physiological processes, including cell division, cell length increase, and the beginning of cell differentiation process. All of three physiological processes require carbohydrates, because it combine with nitrogen compounds to form protoplasm in plant buds that will affect the increase in plant height. Meanwhile, the availability of carbohydrates formed in plants is influenced by the availability of nutrients for the plants itself (Isabella, 2016).

Chicken manure and goat manure have higher nutrient content than cow manure. K nutrient content in goat manure is relatively higher than other manures, and N and P levels are almost same as other manures. The high N nutrient content in chicken manure encourages the growth of plant height (Thin, Radian and Sasli, 2021). The application of chicken manure and goat manure still has the best results compared to cow manure. The availability of nutrients in higher amounts in chicken manure and goat manure treatments is determined by the amount of nutrients contained in it. The available nutrients in sufficient quantities will have a positive impact on the vegetative growth of shallot plants.

Chicken manure contains three times higher nitrogen than other manures, which can increase the growth of the number of leaves (Roidah, 2013). The nutrients are absorbed for the growth of stem diameter as the vegetative phase of a plant nears its completion, while nutrients are concentrated on the growth of plant height at the beginning of a plant's life cycle. Plants absorb a large amount of macronutrients, particularly in the

vegetative phase, such as nutrients N, P, and K. N, P, and K that are necessary for plant growth, especially in stimulating the formation of plant height and stem diameter enlargement (Puspadewi, Sutari and Kusumiyati, 2016).

Walida (2020) said that the application of chicken manure fertilizer can improve soil chemical properties, including soil pH, C-organic, N-total, C/N, P-available, and cation exchange capacity. These improvements make the soil become more air-shafted, and becomes looser and increases the microorganisms activity. Chicken manure contains Corganik up to 26.15% which lead to more effective tuber growth (Harti and Anugrah, 2018). Kasele (2002), stated that the application of fertilizer can reduce the leaf wide and increase the density of stomata 7% to 19% in maize leaves. The increase in the number of stomata on the leaves can be influenced by the environment, such as CO_2 levels, water and other emulsion gases. The anatomical character of the leaves concerning number, width and length of stomata can change due to the influence of environmental factors (temperature, moisture content, CO_2, light and others) (Ermayanti and Andry, 2004). The development of the photosynthetic yield per unit leaf area may be influenced by variations in stomatal density, which may increase the level of gas exchange. The increased photosynthetic yields will be accompanied with the development of plant productivity (Azmat *et al.*, 2009).

CONCLUSION

Based on the aforementioned investigation, it can be stated that chicken manure, as opposed to goat manure and cow manure, had a more favorable impact on the growth and anatomy of black potato plants. The nutritional value of goat and chicken manures is higher than that of cow excrement. Compared to other manures, chicken manure has a nitrogen content that is three times higher, which can promote leaf growth.

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