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APPLICATION OF VERMICOMPOST TO INCREASE GROWTH AND YIELD OF UPLAND RICE ON MARGINAL LANDS

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ABSTRACT

Rice is the main food for almost all people in Indonesia, whose population is increasing. However, the increase in population was not followed by an increase in the area of paddy fields for rice cultivation, which is a producer of rice. Upland rice is one of the solutions to increase rice production because it can be grown on dry land even on marginal land but it must be done with the right cultivation techniques, including by applying vermicompost organic fertilizer. This study aims to determine the effect of vermicompost in increasing the growth and yield of upland rice on marginal land, especially ultisols. The study was conducted in the screen house of the UISU Faculty of Agriculture experimental field using a Non-Factoral Randomized Block Design of three replications with a dose of vermicompost as a treatment. The results showed that the dose of vermicompost significantly affected the growth and yield of upland rice. Plant height, flowering age and panicle length of upland rice showed a linear response with increasing doses of vermicompost given, while the number of productive tillers and milled dry weight of upland rice showed a quadratic response with various doses of vermicompost. The optimum dosage of vermicompost to increase the number of productive tillers and milled dry weight of upland rice to a maximum limit were 34.71 t/ha and 62.04 t/ha, respectively.

KEYWORDS: Upland rice, ultisols, vermicompost, organic fertilizer.

INTRODUCTION

The need for rice as one of the main sources of food for the Indonesian population continues to increase, because in addition to the population continuing to grow by an increase of around 2% per year, there is also a change in consumption patterns of the population from non-rice to rice and a decrease in fertile irrigated paddy fields due to land conversion for non-rice interests. agriculture, and the emergence of the phenomenon of degradation of soil fertility causes an increase in the productivity of irrigated lowland rice which tends to be sloping so that it is unable to keep up with the rate of increase in population.[1] As a result, in order to continue to be able to meet the needs of the Indonesian population for rice, the development of rice cultivation is carried out by utilizing marginal land through planting upland rice.

Upland rice is one of the food crops that has the potential to be developed on marginal land because upland rice does not require standing water in its early growth phase like paddy rice. Superior varieties of upland rice have the potential to produce 5-6 tons of dry milled grain per hectare. Until 2007, the harvested area of upland rice had only reached 1.1 million ha, with a production of 2.93 million tonnes and a productivity of 2.7 million tonnes/ha.[2]

Marginal or "suboptimal" soil is potential land for agriculture, both for food crops, plantations and forest plants. Naturally, marginal soil fertility is low. This is indicated by the acid soil reaction, low nutrient reserves, exchangeable bases and low base saturation, while high to very high aluminum saturation. Marginal land can be interpreted as land that has low quality because it has several limiting factors if it is used for a particular purpose. Actually, these limiting factors can be overcome with input, or costs that must be spent. Without meaningful input, agricultural cultivation on marginal land will not provide benefits.[3]

In Indonesia, marginal land is found in both wet and dry land. Wetlands are in the form of peatlands, acid sulphate lands and tidal swamps covering an area of 24 million ha, while dry lands are 47.5 million ha of Ultisols and 18 million ha of Oxisols. Indonesia has a long coastline reaching 106,000 km with a potential land area of 1,060,000 ha, generally including marginal land. Millions of hectares of marginal land spread over several islands, the prospects are good for agricultural development but currently not managed properly. These lands are in low fertility, so technological innovation is needed to improve their productivity.[4]

The main obstacle in cultivating upland rice on marginal land, especially on ultisols, is the low nutrient content and water availability. These soils usually have an acidic pH and high Al saturation. As a result, the availability of P and other basic cations (Ca, Mg, K and Na) is very low.[5] The characteristics of this ultisol soil were also found in the results of Arifin et al.'s research.[6] However, the low availability of nutrients and water in this marginal soil can be corrected by applying vermicompost organic fertilizer.

Vermicompost is a source of organic fertilizer used in the cultivation of various types of plants. Vermicompost is obtained from the decomposition of organic matter by earthworms (detrivores) to reduce the amount of organic waste. Earthworms use organic waste for metabolism and make vermicompost which contains various nutrients such as N, P and K and others.[7] Vermicompost is more effective in its use compared to other organic fertilizers because it has a faster effect and a lower application rate, so that the use of inorganic fertilizers can be saved.[8] This has been proven by Regista et al.[9] on the growth of *Chlorella sp*.; Astari et al.[10] on edamame cultivar soybeans; Setiawan et al.[11] on pakcoy (*Brassica rapa* L.); Sihaloho et al.[12] on soybean varieties Detam 1; Suparno et al.[13] on sweet potato (*Ipomoea batatas* L.). However, the use of vermicompost has never been reported in upland rice cultivation on marginal land, especially on ultisols, so this study aims to determine the effect of vermicompost in increasing the growth and yield of upland rice on marginal lands, especially ultisols.

MATERIALS AND METHODS

The study was carried out in the experimental field screen house of the Faculty of Agriculture, Islamic University of North Sumatra, Medan, North Sumatra at an altitude of ± 25 masl with a flat topography.

The study used a non-factorial randomized block design with three replications with doses of vermicompost as treatment, namely 0 t/ha (V0), 5 t/ha (V1), 10 t/ha (V2), and 15 t/ha (V3). The research was carried out in 10 kg polybags. Ultisols were taken from the Tambunan Plantation, Salapian District, Langkat Regency. Before the soil is put into the polybag, it is first crushed and sieved so that there are no lumps of soil.

Upland rice seeds before planting in polybags are first sown. Nursery is done by soaking the seeds in water for 24 hours and then draining them for 12 hours. with the aim of accelerating the germination process. After that the seeds are sown in fertile soil media with high organic matter content. Furthermore, after 21 days the rice seedlings can be transferred to polybags. Application of Vermicompost is carried out 5 days before planting the rice seedlings with the dose according to the treatment by mixing Vermicompost with ultisol which has been prepared in a polybag.

The variables observed were plant height, flowering age, number of productive tillers, panicle length, and dry grain weight of milled.

RESULTS

The results of statistical analysis showed that vermicompost had a significant effect on upland rice plant height 6 weeks after planting (WAP), flowering age, number of productive tillers, panicle length, and weight of milled dry grain of upland rice.

Table 1: Plant height (cm), flowering age (days), number of productive tillers (saplings), panicle length (cm), and weight of milled dry grain (g) of upland rice with various doses of vermicompost.

Treatments	Plant height	Flowering age	Number of productive tillers	Panicle length	Weight of milled dry grain
V0	45.02cd	53.42a	2.62c	26.62b	7.98c
V1	54.61c	52.83a	5.88b	26.69b	17.58b
V2	69.63b	52.58a	10.44a	26.93ab	28.64a
V3	79.91a	51.42b	10.76a	27.25a	34.40a

Note: Numbers in the same column followed by different letters show significantly different at the 5% level based on Duncan's test

V0: 0 t/ha; V1: 5 t/ha; V2: 10 t/ha; V3: 15 t/ha

Application of vermicompost significantly affected the height of upland rice plants at 6 WAP. The highest upland rice plants were obtained at the vermicompost dose treatment of 15 t/ha (V3), which was 79.91 cm which was significantly different from the treatment with vermicompost doses of 10 t/ha (V2), 5 t/ha (V1) and without vermicompost (V0), namely respectively 69.63 cm, 54.61 cm, and 45.02 cm (Table 1).

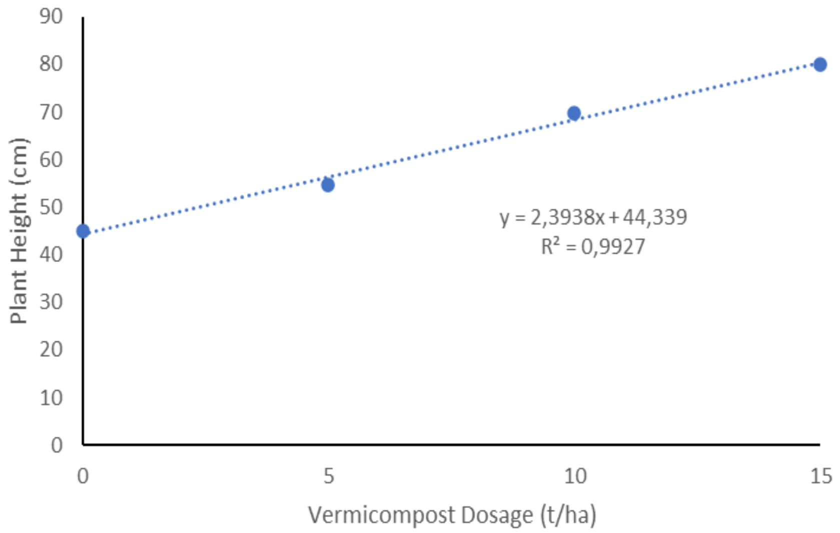

Figure 1: The shape of the relationship between the height of the upland rice plant and the dose of vermicompost given.

Figure 1 shows that the increasing dose of vermicompost given, the rice plant height will increase. This means that the form of the relationship between the two is linear with the regression equation Y = 2.3938x + 44.339 with a coefficient of determination (R^2) 0.9927 which means that 99.27% of the height of upland rice plants is affected by the dose of vermicompost given.

Application of vermicompost also significantly affected the flowering age of upland rice. The fastest flowering age of upland rice was obtained at the dose of vermicompost 15 t/ha (V3), which was 51.42 days, which was significantly different from the dose of vermicompost 10 t/ha (V2), 5 t/ha (V1) and without vermicompost (V0). namely 52.58 days, 52.83 days, and 53.42 days respectively (Table 1).

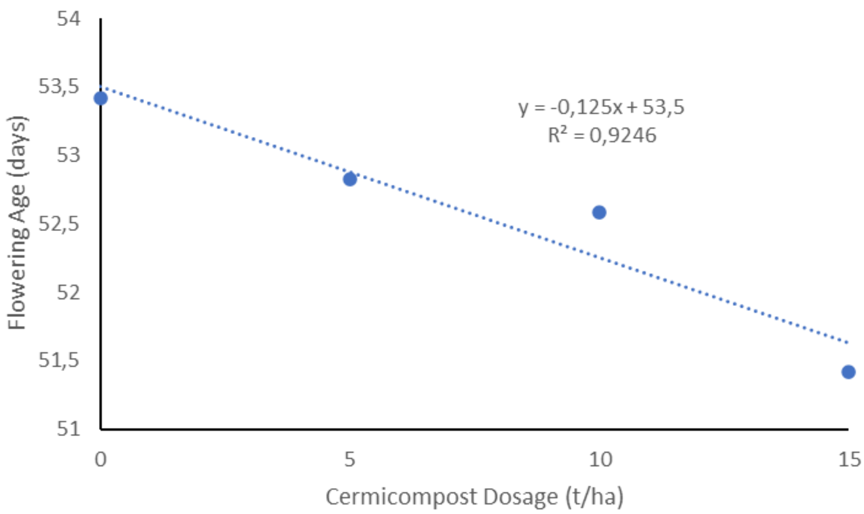

Figure 2: The shape of the relationship between the flowering age of upland rice and the dose of vermicompost given.

Figure 2 shows that the relationship between the age of flowering of upland rice and the dose of vermicompost is minimum linear, that is, increasing the dose of vermicompost given will accelerate the flowering period of rice plants. The regression equation between dois vermicompost and flowering time of upland rice is Y = -0.125x + 53.5 with a coefficient of determination (R^2) 0.9246 which means that 92.46% of the flowering period of upland rice is influenced by the dose of vermicompost given.

The number of productive tillers of upland rice was also affected by the dose of vermicompost, where the highest number of productive tillers was found in the 15 t/ha (V3) vermicompost dose treatment which was not significantly different from the 10 t/ha vermicompost dose (V2), but significantly different to treatment doses of vermicompost 5 t/ha (V1) and without vermicompost (V0), namely 10.76 tillers, 10.44 tillers, 5.88 tillers, and 2.62 tillers (Table 1). This shows that the higher the dose of vermicompost, the more productive tillers it will produce.

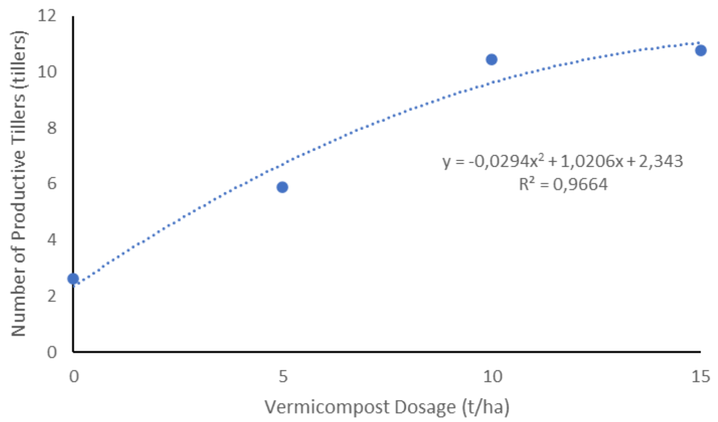

Figure 3: The shape of the relationship between the number of productive tillers of upland rice and the dose of vermicompost given.

Figure 3 shows that the relationship between the number of productive tillers of upland rice and the dose of vermicompost is quadratic, which means that increasing the dose of vermicompost to the optimum dose will increase the number of productive tillers of upland rice, but if the dose of vermicompost given is above the optimum dose, the number of productive tillers will be upland rice will decrease. The regression equation between the dois of vermicompost and the number of productive tillers of upland rice is Y = -0.0294x2 + 1.0206x + 2.343 with a coefficient of determination (R^2) 0.9664 which means that 96.64% of the number of productive tillers of upland rice is affected by the dose of vermicompost given.

Table 1 also shows that the vermicompost dose had a significant effect on the panicle length of upland rice, where the longest panicles were found in the 15 t/ha (V3) vermicompost dose treatment which was not significantly different from the 10 t/ha vermicompost dose (V2), but significantly different against vermicompost dose treatment of 5 t/ha (V1) and without vermicompost (V0), namely 27.52 cm, 26.93 cm, 26.69 cm and 26.62 cm respectively.

The relationship between panicle length and dose of vermicompost is linear, that is, if the dose of vermicompost is increased, the panicle length of upland rice will also increase (Figure 4). The regression equation between dois of vermicompost and panicle length of upland rice is Y = 0.0426x + 26.553 with a coefficient of determination (R^2) of 0.934 which means that 93.4% of the panicle length of upland rice is influenced by the dose of vermicompost given.

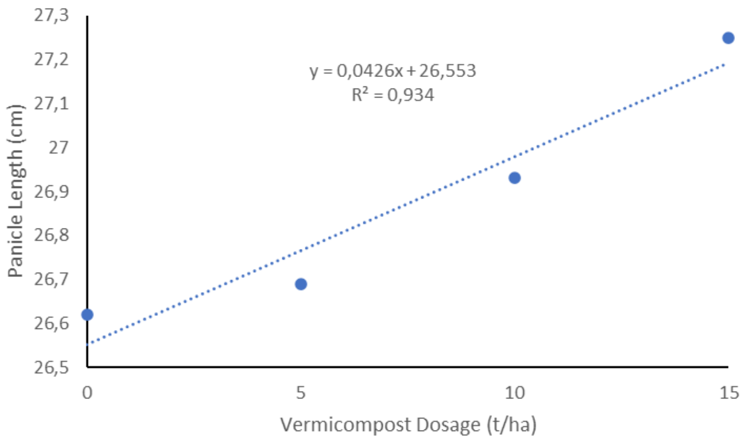

Figure 4: The shape of the relationship between the panicle length of upland rice and the dose of vermicompost given.

The dry grain weight of milled upland rice was also influenced by the dose of vermicompost given. The heaviest milled dry grain of upland rice was obtained at the vermicompost dose treatment of 15 t/ha (V3) which was not significantly different from the vermicompost dose treatment at 10 t/ha (V2), but significantly different from the vermicompost dose treatment at 5 t/ha (V1) and without vermicompost (V0), namely 34.40 g, 28.64 g, 17.58 g, and 7.98 g (Table 1).

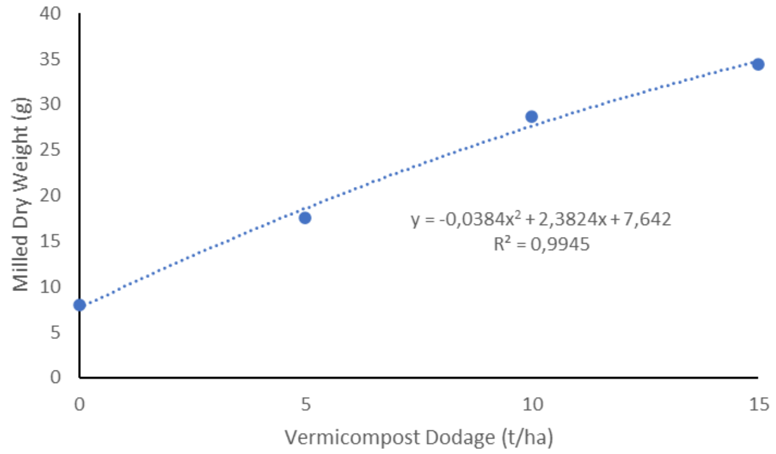

Figure 5: The shape of the relationship between the dry grain weight of milled of upland rice and the dose of vermicompost given.

The shape of the relationship between the dry weight of milled upland rice and the dose of vermicompost is quadratic, that is, the higher the dose of vermicompost given to the optimum limit, the milled dry weight of upland rice will also increase. However, if the dose of vermicompost given is increased above the optimum dose, the dry weight of milled upland rice will decrease (Figure 5). The regression equation between the dois of vermicompost and the dry weight of milled upland rice is Y = -0.0384x2 + 2.3824x + 7.642 with a coefficient of determination (R^2) 0.9945 which means that 99.45% of the dry weight of milled upland rice is affected by the dose of vermicompost given.

DISCUSSION

The results of this study showed that the vermicompost fertilizer applied had a significant effect on the growth and yield variables of upland rice. The effects include plant height, flowering time, number of productive tillers, panicle length, and milled dry weight of upland rice.

In this study vermicompost was used at a dose of 0 t/ha, 5 t/ha, 10 t/ha and 15 t/ha. Upland rice plants showed a linear response to increasing doses of vermicompost fertilizer on the variables of plant height, flowering age and panicle length of upland rice, while the number of productive tillers and milled dry weight showed a quadratic response.

For the variables of plant height and panicle length, the application of vermicompost up to a dose of 15 t/ha (V3) increased the plant height and panicle length of upland rice, but for the variable age of flowering, an increase in the dose of vermicompost given could accelerate the flowering period of upland rice. Meanwhile, for the variable number of productive tillers and milled dry weight of upland rice, giving vermicompost to the optimum dose can increase the number of productive tillers and milled dry weight of upland rice, but if the dose of vermicompost is increased beyond its optimum dose, there will be a decrease in the number of productive tillers and the weight of upland rice. dry milled upland rice. The optimum dose of vermicompost to increase the number of productive tillers to a maximum limit was 34.71 t/ha, while the optimum dose of vermicompost to increase the dry weight of milled upland rice to a maximum limit was 62.04 t/ha.

Vermicompost fertilizer contains 1.45-2.18% N, 0.89-1.49% P, 0.70-1.49% K, and 10.0-30.0% C-organic. Marsono and Sigit.[14] stated that the nutrients in vermicompost can increase the growth and production of soybean plants. Giving organic matter can also increase the availability of water in the soil so that it can increase the production of upland rice, especially when filling the seeds. Water plays a role in the translocation of organic compounds from the leaves to the seeds.

According to Sutedjo and Kartasapoetra.[15] nutrients N, P and K are very important elements in the growth and production of upland rice, namely increasing the number of tillers, harvest dry weight, panicle length and milled dry weight. These elements have different roles in preparing organic compounds in growth and production. Nitrogen is a component of the building blocks of amino acids and proteins. Nitrogen functions in the most important part of amino acids, nucleic acids, and chlorophyll, increasing plant protein levels and accelerating vegetative growth, thus making seeds and growing multiply. The effect of vermicompost on plants is due not only to the quality of the mineral nutrients provided but also to other growth regulating components such as plant growth hormones and humic acids. In addition, the application of vermicompost in the field improves soil quality by increasing microbial activity and microbial biomass which are key components in nutrient cycling and production of growth regulators. Phosphate plays a role in enzymatic reactions in the growth of the vegetative parts of soybean plants. Element P is very important in plant growth because it is a component of energy sources. Meanwhile, K plays a role in the translocation of organic compounds from the leaves to the branches/meristem parts of the rice grains.

The influence of vermicompost fertilizer on production is also suspected due to the growth response of the formation of rice grains due to the addition of elements contained in vermicompost, especially K elements. K elements play a role in seed growth. Potassium is an element that plays a role in the translocation of organic compounds from leaves to seeds.[14]

Dosing of vermicompost up to 15 t/ha markedly increased all observed variables. This is because vermicompost contains about 10.0-30.0% organic C so that it is thought to be able to improve the physical and biological properties of the soil. Biologically, organic matter is food for soil microorganisms. This increase in organic matter will increase the number and activity of soil microorganisms, thereby indirectly improving soil physical properties including soil friability and aeration. Yadaf et al.[16] states that organic matter is food for microorganisms in the soil. An increase in organic matter in the soil will increase the activity of soil microorganisms so that the soil becomes loose and increases soil aeration. Good aeration will support root development and absorption of plant nutrients.

CONCLUSION

The vermicompost given gave a positive response to the growth and yield of upland rice grown on marginal land. The dose of vermicompost significantly affected plant height, flowering time, number of productive tillers, panicle length, and milled dry weight of upland rice.

The response of plant height and panicle length of upland rice to the application of vermicompost in various doses was positive linear, which means that an increase in the dose of vermicompost given will increase the plant height and panicle length of upland rice, while the response of flowering age of upland rice to the application of vermicompost in various doses is linear negative which means that increasing the dose of vermicompost given will decrease or accelerate the flowering age of upland rice.

The response of the number of productive tillers and milled dry weight of upland rice to the application of vermicompost in various doses was quadratic, which means that increasing the dose of vermicompost to the optimum limit will increase the number of productive tillers and milled dry weight of upland rice, but if the dose of vermicompost given exceeds the optimum dose, then number of productive tillers and milled dry weight of upland rice will decrease. The optimum dosage of vermicompost to increase the number of productive tillers and milled dry weight of upland rice to a maximum limit were 34.71 t/ha and 62.04 t/ha, respectively.

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