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Interaction of Biochar and Water Hyacinth Compost Plus Arakan: A Solution for Increasing Marginal Land Fertility with Sweet Corn Test Plants

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Abstract

Indonesia has quite extensive reed fields, which have great potential to be developed in the agricultural extensification program. Therefore, efforts are needed to increase the fertility of reed land by adding organic matter in the form of compost. Water hyacinth and arakan are water weeds that are found in Lake Tondano, Minahasa Regency, North Sulawesi Province. Water hyacinth and arakan are good sources of organic matter because they contain C-organic, nitrogen, phosphorus, and potassium, which are important elements for plant growth. The use of biochar is one of the innovations that can be applied to overcome problems in agriculture. The purpose of this research is to find out the influence of the interaction between biochar and hyacinth+arakan compost on the growth and yield of sweet corn, as well as to determine the optimal dose of biochar at various doses of hyacinth+arakan compost to achieve the best corn yield. The experiment was conducted using a factorial cluster randomized design with two factors. The first factor is the dose of biochar (A), which consists of three levels: A0 (without biochar), A1 (10 tons/hectare biochar), and A2 (20 tons/hectare biochar). The second factor is the dose of hyacinth compost+arakan (B), which also consists of three levels: B0 (without hyacinth compost+Arakan), B1 (20 tons/hectare hyacinth compost+Arakan), and B2 (40 tons/hectare water hyacinth compost+Arakan). The combination of these two factors produced 9 treatments, each of which was repeated 3 times so that there were a total of 27 experimental units. The data obtained was analyzed using Analysis of Variance (ANOVA). If a significant effect of the treatment is found, the analysis is continued with the Least Significant Difference (LSD) test at a significance level of 5%. The results of the research show that the interaction between the dose of biochar and the dose of hyacinth+arakan compost has no significant effect on plant height, the number of leaves, and the weight of sweet corn cobs. However, the single influence of water hyacinth compost+Arakan proved to be significant on the three variables. A dosage of 20 tons/hectare of water hyacinth compost+Arakan gives the best growth and yield of sweet corn.

Keywords: *Reed Soil; Compost; Soil Fertility*

Introduction

Imperata cylindrica Beauv is a very potential land to be developed in the agricultural land extensification and intensification program to realize food security and independence. This is because *Imperata cylindrica* Beauv is the most detrimental type of weed. After all, it absorbs a lot of nutrients, especially N, P, K, and Ca. In addition, former *Imperata cylindrica* land also has poor physical properties, namely dense soil structure, high soil density, low soil permeability, and poor soil aeration because it is relatively quickly saturated with water and easily flooded so that it can experience severe erosion (Sanchez, 1992).

Imperata sedge fields generally have low soil fertility levels characterized by acidic to slightly acidic soil reactions, low nutrient content, especially P and K, low organic matter, low Cation Exchange Capacity (CEC) and base saturation, moderate to high Al saturation (Kesumaningwati, 2014). Therefore, efforts need to be made to support increased land productivity, one of which is through proper soil processing.

Water hyacinth and Arakan as aquatic weeds greatly disrupt the activity of Lake Tondano and are difficult to eradicate, so a way is needed to reduce their productivity by managing water hyacinth and Arakan as compost materials. Water hyacinth is good to use as an organic material because it contains C-organic, N, P, and K elements needed by plants, as is the case with Arakan. The addition of biochar is one of the innovations that can be applied to overcome problems in the agricultural sector, such as reducing the acidity level of soil such as reed land, and increasing chemical fertility so that it can increase the productivity of food crops. Biochar in the soil cannot replace the role of fertilizers, so the addition of other nutrients is needed to increase crop yields. Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) and Arakan (*Hydrilla verticillata*) are aquatic weeds that are often found and become a problem in Lake Tondano, Minahasa Regency because of their high population which disrupts lake activity.

Rehabilitation of reed land using biochar is expected to improve soil quality so that fertilization can be more efficient and effective. Biochar is a product derived from biomass waste that is heated without air or with air but only a little. Reed land is poor in physical, chemical, and biological fertility. Chemical fertility is important because plants require macronutrients such as N, P, and K, and micronutrients for their growth. Indonesia has around 30 million hectares of reed land (*Imperata cylindrica*) but it can increase with a forest fire (Monica et al., 2023; Juarsah, 2015). Reed land is a very potential land to be developed in an agricultural extensification program that can increase the area of productive agricultural land.

Water hyacinth contains 78.47% organic matter, 21.23% C-organic, 0.28% total N, 0.0011% total P, and 0.016% total K. The results of the study showed that water hyacinth plants contain 78.47% organic matter, 21.23% C-organic, 0.28% total N, 0.0011% total P, and 0.016% total K (Mindari et al., 2023; Ali et al., 2019). According to Lensari et al., (2022), after composting for 30 days, the content of Hydrilla compost consists of 15.95% C-organic, 0.73% N, and 0.40% P. The C/N content is 21.85, the N content is 0.73%, and the P content is 0.40%, these results are by the Indonesian National Standard for compost. Organic fertilizer's soil fertility has several effects on several chemical properties of the soil, including increasing soil pH so that nutrients are more easily absorbed by plants (Rahman et al., 2021). The formulation of organic fertilizer *Hydrilla verticillata*+cow dung+chicken manure at a dose of 20 tons/hectare can reduce the dose of NPK Phonska by half the recommended dose (Sondakh et al., 2019).

Method

The research was conducted in Kakaskasen two Districts of East Tomohon City, North Sulawesi Province, Indonesia from May to September 2024. The factorial experiment in a Randomized Block

Design consisted of 2 factors. Factor I Biochar dose (A): A0= Without Biochar, A1= 10 tons/hectare Biochar, A2= 20 tons/hectare Biochar. Factor II is the dose of water hyacinth+Arakan compost (B) consisting of: B0= without water hyacinth+Arakan compost, B1= 20 tons of water hyacinth+Arakan compost/ha, B2= 40 tons of water hyacinth+Arakan compost/ha. 9 experiments were obtained which were repeated 3 times so that 27 experimental units were obtained. The observed response variables, including plant height, number of leaves, and cob weight (without husks), were measured at harvest. Data were analyzed using analysis of variance and if there was an effect of treatment, it was continued using the Least Significant Difference (LSD) test at the 5% test level.

Results and Discussion

The results of the statistical analysis showed that the interaction between the dose of biochar and the dose of water hyacinth+Arakan compost had no significant effect on plant height, number of leaves, and weight of sweet corn cobs. The single effect of water hyacinth+Arakan compost was significant on all observed variables. The results of the 5% LSD test are presented in Table 1.

Table 1. Effect of water hyacinth+arakan compost dose on plant height, number of leaves, and weight of sweet corn cobs

Treatment	Plant Height (cm)	Number of Leaves	Cobs Weight (grams)
B0 (Without compost water hyacinth+Arakan)	84.22 a	9.56 a	149.44 a
B1 (20 tons/hectare compost water hyacinth+Arakan)	118.11 b	10.11 ab	173.79 ab
B2 (40 tons/hectare compost water hyacinth+Arakan)	129.56 b	11.11 b	193.89 b
LSD 5%	31.84	0.92	26.58

Note: Numbers followed by the same letter are not significantly different based on the 5% LSD test

Table 2 shows that the pH of the reed land soil is acidic so the addition of compost increases the pH of the reed land soil because organic fertilizer has several advantages, one of which is that it can neutralize the pH. Marsono & Sigit, (2004), that organic fertilizer has several advantages, one of which is that it can neutralize the pH. Wardani & Rosa, (2017); and Wardhani et al., (2019), one step to restore soil fertility is by adding organic fertilizer to the soil.

Table 2. pH, C-organic, nitrogen, phosphor, potassium

	pH H_2O	pH KCl	C-Organic (%)	N (%)	P (ppm)	K (%)
Reed land compost	5.51	4.78	4.27	0.48	169	0.10
Water hyacinth+Arakan	7.95	-	31.27	3.25	2.74	0.61

Note: Palm plant instrument standard testing center testing laboratory, 2024 (International Organization of Standardization 17025 Accreditation)

Discussion

Corn plant growth increased compared to without giving water hyacinth+Arakan compost. Plant height and number of leaves were lowest without giving water hyacinth+Arakan compost. A dose of 20 tons/hectare of water hyacinth+Arakan compost gave the best growth. Water hyacinth + Arakan compost contains high Nitrogen (Table 1). Nitrogen is very much needed by sweet corn plants for plant growth. Nitrogen as a component of amino acids is very important in the process of photosynthesis. In addition, compost as organic material undergoes humification to form humus, the next process, namely the mineralization of humus, will produce base cations that increase pH, as stated by Hardjowigeno, (2007), that organic fertilizers about soil fertility have several influences on several chemical properties of the soil, including increasing soil pH so that nutrients are more easily absorbed by plants.

The best sweet corn cob weight in B1 (20 tons/ha of water hyacinth + Arakan compost) and B2 (40 tons/hectare of water hyacinth+Arakan compost). Compost contains elements N, P, and K. The higher the availability of nutrients, especially macronutrients N, P, and K in the soil, the better the plant growth, especially when given to reed land soil. According to Sutejo (2002), the function of N for vegetable plants is as a protein component, for the growth of plant shoots and to fertilize vegetative growth. The function of P as one of the protein components is needed for the formation of flowers, fruits, and seeds, stimulating root growth to become longer and stronger so that plants will be resistant to drought. The element K plays a role in metabolic processes such as photosynthesis and respiration which are important in growth. Likewise, Sumarmo, (1993); and Kriswanto et al., (2016) stated that phosphorus is very much needed by plants during the formation of cobs, activating the filling of cobs and accelerating the ripening of seeds. The element potassium is very much needed by plants when the panicle comes out.

Conclusion

The interaction between the dose of biochar and the dose of water hyacinth+Arakan compost had no significant effect on plant height, number of leaves, and weight of sweet corn cobs. The single effect of water hyacinth+Arakan compost was significant on plant height, number of leaves, and weight of sweet corn cobs. The dose of 20 tons/hectare of water hyacinth+Arakan compost provided the best growth and results. The application of organic compost can be a solution to increase land fertility on sweet corn productivity to utilize marginal land such as reed land.

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