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The Combination Effect of Applying Liming Levels and Bat Dung on Increasing Soil pH in Ultisol Soil

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Abstract. Providing organic matter can increase soil pH and increase soil fertility. Through liming plus organic fertilizer such as bat droppings, it is hoped that it can increase the soil pH. This research aims to study the combined effect of applying lime and bat droppings on increasing soil pH in ultisol soil. This research was carried out in a plastic house in Ouw Village, Central Maluku Regency, from August 2023 to January 2024. Analysis of soil properties was carried out at the Soil Laboratory, Faculty of Agriculture, Pattimura University. The experimental design used in this research was a Randomized Step Design (CRD) with a 4 x 4 x 4 factorial pattern, where the parameter studied was soil pH in ultisol soil. The results of the research showed that the application of liming levels and bat droppings had an effect on increasing soil pH in ultisol soil.

Keywords: Liming Levels, Bat Dung, Increasing Soil pH, Ultisol

INTRODUCTION

The extent of ultisol soil has high potential for the development of dry land agriculture. However, the use of this land faces problems with soil characteristics that can inhibit plant growth, especially food crops, if not managed properly . However, Ultisol has various obstacles when used for agricultural purposes, namely: low base saturation (< 35%), and very low levels of weathered minerals, low C-Organic (0.78 - 2.24%) and is often accompanied by solubility. High Al and Mn. High Al saturation (>50%) can cause poisoning for plants in general, especially food plants. Apart from having problems with soil acidity (low pH) and low cation exchange capacity (KPK<24 me/100 g soil), Ultisol also contains nitrogen (N). the low one is total N of 0.12 - 0.27% and available P is very low, namely 1.43 - 2.51 ppm. Low pH in ultisol soil affects the growth rate of various types of plants, plants experience deficiencies in a number of soil nutrients. Soil that is too acidic contains toxic elements such as Al which binds phosphorus, so that phosphorus cannot be absorbed by plants.

Soil with a neutral pH is 6.5 to 7.8. This acid-base level is the ideal pH with the content of organic compounds, microorganisms, nutrients and minerals in optimal conditions. In plant growth, a good soil reaction is neutral because in this condition most nutrients dissolve easily in water so that plants can easily absorb nutrients. Soil pH is very important because the soil solution contains nutrients such as Nitrogen (N), Potassium (K), and Phosphorus (P) which plants need in certain amounts to grow, develop, and defend against disease. If the soil pH increases to above 5.5 then Nitrogen (in the form of nitrate) becomes available to plants. Phosphorus will be available to plants at a pH between 6.0 to 7.0. If the soil is too acidic, plants cannot utilize the N, P, K and other nutrients they need. In acidic soil, plants have a high probability of being poisoned by heavy metals and can ultimately die due to the poisoning (Nurmansyah , 2022) .

Efforts made to overcome problems with acidic ultisol soils are through liming and fertilization. Through liming the soil pH will increase and this will be followed by an increase in the availability of the elements P, K, Ca and Hg and a decrease in the availability of Fe and

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Hn . Liming is one way that can be done to overcome the problem of high acidity and Al saturation. By adding lime to the soil, it can change soil that is very acidic or acidic to near neutral pH. A good type of lime is magnesium or dolomite lime which can simultaneously supply Ca and Mg. According to Afandi *et al* ., (2015), applying organic material can increase soil pH and increase fertility land, among others; mineralization of organic materials will release plant nutrients complete (N, P, K, Ca, Mg, S and nutrients other micro) (Purnomo And Purnamawati , 2007).

One of the good organic materials to use is bat droppings (guano fertilizer). Guano is an organic material in the form of piles of solid feces and urine from bats or sea birds which can be found in caves which are natural habitats or nests for these animals. This guano can be used as organic fertilizer because it has a high content of ingredients that are effective in fertilizing the soil, namely phosphorus and nitrogen (Azai *et al* ., 2018). It is felt that bat droppings as an organic material are still lacking, especially since research on liming combined with organic materials in the form of bat droppings is still rarely carried out on acidic soils such as ultisol. Therefore , liming combined with wild animal droppings needs to be investigated in the cultivation of acidic soils such as ultisol to increase peanut yields. This research aims to study the combined effect of giving lime and bat droppings on the increase Soil pH in ultisol soil.

RESEARCH METHODS

1. Place and time of research

This research was conducted in plastic houses in Ouw Village , Central Maluku Regency . Analysis of soil properties was carried out at the Soil Laboratory, Faculty of Agriculture, Pattimura University. This research will take place from August 2023 to January 2024.

2. Materials and tools

The materials used in this research consisted of :

a. Ouw Village Ultisol Soil .
b. Dolomite Lime CaHg (C03)2
c. Bat droppings from Liano Cave, Ouw Village
d. Materials for soil analysis are adjusted to the analysis needs.

The tools used are :

a. Soil map from Anthonius (1989).
b. 3 gallon plastic bucket.
c. Sieve the soil 2 mm in size.
d. (4) Paralon pipe measuring 0.5 cm in diameter.
e. Hand sprayer.
f. Thermometer.
g. Tools for soil analysis.

3. Experimental design

The treatment tried consisted of 2 factors, namely the level of lime administration based on Al dd (k) and the level of bat droppings (b).

The level of lime administration based on Al dd consists of 4 levels, namely :

k0 = 0.0 x Al $_{dd}$ or 0 gram/pot
k1 = 0.5 x Al $_{dd}$ or 1.84 grams/pot
k2 = 1.0 x Al $_{dd}$ or 3.68 grams/pot
k3 = 1.5 x Al $_{dd}$ or 5.52 grams/pot

The level of treatment for bat droppings consists of 4 levels, namely :

b0 = 0 grams/pot
b1 = 48 grams/pot

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b2 = 96 grams/pot
b3 = 192 grams/pot

The total treatment combinations in this study were sixteen, each of which was :

k0b0	k0b1	k0b2	k0b3
k1b0	k1b1	k1b2	k1b3
k2b0	k2b1	k2b2	k2b3
k3b0	k3b1	k3b2	k3b3

The treatments tried above were each repeated four times, so that the total experimental units were sixty- four units .

The design model used is a completely random design (RAL) with a 4 x 4 x 4 factorial pattern, with a mathematical model :

$$Y_{ijk} = u + k_i + b_j + kb_{(ij)} + E_{ijk}$$

Where :

I	=	1, 2, 3, 4
J	=	1, 2, 3, 4
Y_{ijk}	=	Response
U	=	Average age of trial
k_i	=	Effect of level i lime treatment
b_j	=	Effect of j-level bat feces treatment
$kb_{(ij)}$	=	The interaction effect of the i-level lime treatment with the j-level bat droppings
E_{ijk}	=	Experimental error

If the F test is real, continue with the honest significant difference test (BNJ). To obtain the relationship between treatment and the observed response variable, it is determined using a regression equation, while correlation is to test the closeness of the relationship.

4. Response variable : Soil pH ($H_2$0 1 : 2.5)
5. Research Implementation

Soil was taken at a depth of 0 - 30 cm, then air-dried. After drying, the soil was sieved with a 2 mm sieve to remove coarse materials.

8 kg of soil was mixed with lime and bat droppings until evenly distributed according to the treatment plan and put into each plastic bucket and incubated for two weeks.

6. Analysis of Observation Results

Observation of the response variable to the soil, namely soil pH

RESULTS AND DISCUSSION

1. Effect of liming level and bat droppings level on soil pH

The effect of liming level and bat droppings level on soil pH is presented briefly in the form of diversity analysis data and can be seen in table 1.

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Table 1. Analysis of the diversity of effects of liming level (k) and bat droppings level (b) on soil pH.

Response Variable	Level k	Level b	kxb interactions
Soil pH	**	**	*

Information: * = Real
**= Very real
tn= Not real

2. Soil pH

The diversity analysis in Table 1 shows that Changes in soil pH are significantly influenced by the interaction of liming levels with bat droppings.

Table 2. Mean difference test for the interaction of lime treatment and bat droppings on soil p

Treatment	b0	b1	b2	b3
k0	4,961 a (A)	5,329 a (B)	5,467 a (B)	5,467 a (B)
k1	5,542 b (A)	5,579 b (A)	5,545 a (A)	5,664 b (A)
k2	5,499 b (A)	5,592 b (A)	5,677 a (A)	5,642 b (A)
k3	5,509 b (A)	5,772 a (B)	5,639 a (B)	5,805 a (B)

H.

Information : Numbers followed by the same letter are not significantly different in BNJ. 05 (O, 18), uppercase for rows and lowercase for columns.

k0, k1, k2, k3: liming level 0 x Al_{dd} , 0.5 x Al_{dd} , 1 x Al_{dd} and 1.5 x Al_{dd} .
bo, b1, b2, b3 : levels of bat droppings 0 g, 48 g, 96 g, and 192 g per plant.

The mean difference test for the interaction of lime and bat dung treatments (Table 2) shows that at b 0 , b1, b3 shows that the soil pH significantly increases at the liming level k1. Meanwhile, in b2 all lime treatments were applied not significantly different. At k 0 and k3, the treatment of BL bat droppings significantly increased soil pH. At k1 and k2 all treatments bat droppings were not significantly different. Overall It appears that the combination k 1 b 0 has the best effect on soil pH. This shows that liming in moderate doses can raise the soil pH to a limit that is favorable for plant growth, namely pH 5.54. According to Nurhayati *et al* . (2014) that lime contains the elements Ca and Mg, through a hydrolysis reaction it will release OH^- ions which have an impact on increasing soil pH . Added Amelia *et al* . (2018), liming can Increasing soil pH can then reduce the solubility of micro elements that are poisonous to plants. The lime reaction in neutralizing H^+ and releasing Ca^{2+} or Mg^{2+} increases soil pH in Ultisol soil types (Maulana *et al* ., 2020). Soil pH is the main variable that can influence every process that occurs in the soil. The mobility of nutrients in the soil is highly dependent on soil pH (Kamble *et al* ., 2013).

The reaction of lime material in soil is basically an exchange reaction between Ca and Mg ions with Al and H ions . Ca and Mg ions will occupy the adsorption complex while the source of soil acidity, namely Al, precipitates as $Al(OH)_3$ difficult to dissolve. Increases in Ca and Mg and deposition of Al thus reduce the concentration of H^+ in the soil so that the pH increases. According to Bahtiar (2008) *in* Rizki *et al* ., (2021) , lime is a group of carbonates commonly used in an effort to increase soil pH because it dissociates into Ca^{2+} , Mg^{2+} and $CO3^{2-}$ ions in the soil.

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Apart from lime, applying bat droppings also has the effect of increasing soil pH. Utami (2014) *in* Kartana and Akiun (2019), explained that the application of bat dung compost is an organic material that plays a role in increasing soil respiration and biomass of soil microorganisms, where the more bat dung compost that is added, the higher the population and activity of soil microorganisms. This fact is in accordance with what was stated by Barchia (2008) that acid mineral dry land requires a lot of organic matter because the average organic matter content in the soil is still very low, namely 3.64% . The organic matter content in soil that is good for cultivating plants is 5%. Bat droppings include organic fertilizer, where according to Sudirja *et al* ., (2006) that the greater the dose of organic fertilizer treatment given, the more the soil pH increases .

Apart from being given a level of liming, there is an element of lime in bat droppings. This happened because the natural pile of solid feces and urine from bats was mixed with the lime found in the cave where it was located, which after research had the best nutritional and mineral content. Bat droppings contain a number of complex micro and macro mineral contents, have high natural nitrogen and phosphorus content (Nining, 2018 *in* Kasmawati *et al* ., 2022). This content is due to a mixture of bat droppings and lime found in the cave. This was confirmed by Rahma (2023) that phosphate deposits came from bat droppings deposited in limestone caves. Bat droppings containing phosphoric acid react with rocks limestone and calcium carbonate rocks. The reaction that occurs will form calcium phosphate as a result of stone replacement metasomatic limestone. Calcium phosphate composition is found in surface deposits, cave deposits and bottom deposits. In general, the formation process for all three is the same, namely the result of a reaction between limestone and bat droppings containing phosphoric acid due to the influence of rainwater or groundwater.

The coefficient of determination for liming in this study contributed 55 percent to 99 percent and the remaining 45 percent. According to Ghozali (2016), the Coefficient of Determination Test (R^2) essentially measures how far the model's ability is to apply variations in the dependent variable. The coefficient of determination functions to determine the percentage of influence of the independent variable on the dependent variable . This research shows that liming and bat droppings are closely related and have the most important role in increasing soil pH.

CONCLUSION

Providing a level of liming and bat droppings has the effect of increasing the soil pH in ultisol soil

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