

Study of some Chemical Properties of Ultisols Soils Based on the Existence of Earth Worms

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Abstract—*The purpose of the study was to determine some of the chemical properties of the soil on Ultisols inhabited and uninhabited by earthworm populations.*

The research was carried out from April to June 2019, taking soil samples on mixed garden land in the Bukit Pinang Urban Village, Samarinda and soil analysis at the Soil Science Laboratory, Faculty of Agriculture, Mulawarman University, Samarinda, East Kalimantan Province.

The research activities are: field observations, determining the location of soil sampling, soil sampling, collection and calculation of earthworms, and analysis of soil chemical properties in the laboratory.

The data collected were: population density of earthworms, and some soil chemical properties: soil pH C-organic, N-total, P-available, and K-available.

The results showed that Ultisols inhabited by worm populations had several soil chemical properties (soil pH, C-organic, N-total, P-available and K-available) which were higher than Ultisols soils that were not inhabited by earthworms.

Keywords—*Soil Chemical Properties, Earthworms, Ultisols.*

I. INTRODUCTION

Soil is part of the natural body that covers the earth with a thin layer, is synthesized in the form of a profile from weathered rocks and minerals, and decomposes organic matter which then provides water and nutrients that are useful for plant growth. According to [1] that soil fertility provides an overview not only of the types of nutrients but also the amount of nutrients available in the soil. Earthworms are organisms that are indicators of soil fertility that play an important role in improving soil productivity.

Earthworms play a very important role in maintaining soil fertility physically, chemically and biologically. Physically, earthworms play a role in mixing coarse or fine organic matter between the top and bottom layers so that their distribution is more even. This activity also causes the formation of a stable and loose soil structure, better aeration, smoother water infiltration thereby reducing erosion [2].

Earthworms are a group of macrofauna that play an important role in various physical, chemical or biological processes of soil [3]. Earthworms are one of the most important organisms in the soil because they can mix various layers of the soil and introduce carbon in the form of organic matter into the soil. It is in this mixing process that organic matter spreads throughout the soil and provides the nutrients that plants need. In addition, earthworms also spread microorganisms in their intestines which increase the biological population in the soil. These worms will improve the physical, chemical and biological properties of the soil which acts as a soil conditioner [4].

The presence of earthworms is an indicator of the health of a soil, because through the activities of these earthworms it can improve the physical and chemical properties of the soil [5]. Earthworm droppings contain nitrogen, phosphorus, potassium, magnesium and calcium which are essential for plant growth [6].

II. RESEARCH METHOD

2.1 Time and place

The research was carried out from April to June 2019, taking soil samples on mixed garden land in Bukit Pinang Urban Village, Samarinda and soil analysis at the Soil Science Laboratory, Faculty of Agriculture, Mulawarman University, Samarinda, East Kalimantan Province.

2.2 Materials and tools

The materials used are: soil samples and materials for soil analysis. The tools used are: hoes, machetes, shovels, sieves, tape measure, glass bottles, buckets, sacks, gloves, tweezers, cameras, laboratory equipment, and stationery.

2.3 Approach Method

The method used in this research is descriptive and comprehensive.

2.4 Research Implementation

The research implementation activities were as follows: (1) conducting field observations, (2) determining the location of soil sampling, namely 3 plots not found earthworms (a1, a2 and a3) and 3 plots found earthworms (b1, b2, and b3), (3) soil sampling (including plot making, sampling) (4) collection and calculation of earthworms, analysis of soil chemical properties in the laboratory.

2.5 Data retrieval

The data collected are: (1) population density of earthworms, (2) several chemical properties of the soil: soil pH C-organic, N-total, P-available, and K-available.

III. RESULTS AND DISCUSSION

3.1 General Condition of Research Site

The research location is a mixed garden area consisting of fruit trees such as lai, durian, banana, orange, salak, rambutan, manga, rambai, breadfruit, coconut, guava and manga; Some of the land is also planted with corn, taro, bamboo, rubber, cassava and part of the land is overgrown with weeds.

3.2 Earthworm Population

The results of observations of earthworm populations in predetermined sample plots are presented in detail in Table 1.

TABLE 1
EARTHWORM POPULATION STATUS

No	Soil Sample Location	Amount (earthworm)	Population Density (earthworm/cm ²)
1	There are no earthworms (a1)	0	0,00
2	There are no earthworms (a2)	0	0,00
3	There are no earthworms (a3)	0	0,00
4	There are earthworms (b1)	6	0,00192
5	There are earthworms (b2)	3	0,00120
6	There are earthworms (b3)	5	0,00160

Source : Primary Data Processed

The results of the study in Table 1 show that at the location of soil sampling (b1, b2, and b3) earthworms were found in a row, namely 6, 3, and tail or with a population density of consecutive 0,00192 earthworms cm⁻²; 0,00120 earthworms cm⁻²; and 0,00160 earthworms cm⁻².

3.3 Soil Chemical Properties

The results of the analysis of several soil properties in plots without and with earthworm populations in detail are presented in Table 2.

TABLE 2
SOME SOIL PROPERTIES IN PLOTS WITHOUT AND WITH EARTHWORM POPULATION

No	Soil Sampling Location	Soil pH	C-Organic (%)	N-Total (%)	P Available (ppm)	K Available (ppm)
1	There are no earthworms (a1)	5,20 (M)	0,45 (SR)	0,21 (S)	15,25 (R)	97,22 (ST)
2	There are no earthworms (a2)	5,50 (M)	0,51 (SR)	0,13 (R)	9,82 (SR)	77,78 (ST)
3	There are no earthworms (a3)	5,30 (M)	0,66 (SR)	0,23 (S)	1,64 (SR)	72,22 (ST)
4	There are earthworms (b1)	6,12 (AM)	4,98 (T)	0,38 (S)	23,45 (S)	116,67 (ST)
5	There are earthworms (b2)	5,92 (AM)	3,77 (T)	0,36 (S)	13,45 (R)	108,33 (ST)
6	There are earthworms (b3)	6,70 (N)	3,41 (T)	0,41 (S)	19,82 (S)	80,56 (ST)

Source: Primary Data Processed

Note: M = acid; AM = slightly acid; N = neutral; SR = very low; R = low; S = medium; T = high; dan ST = very high.

3.3.1 Soil pH

The results of the study in Table 2 show that the soil pH in the soil without earthworms (a1, a2, and a3) was 5.20; 5.50; and 5.30 (status classified as sour), while the plots containing earthworms (b1, b2, and b3) were 6.12; 5.92; and 6.70 (status classified as slightly sour to neutral). This situation indicates that the soil found in earthworms has a higher soil pH value than the soil that is not inhabited by earthworms. It was explained by [7] that earthworms play a role in mixing coarse or fine organic matter between the top and bottom layers so that their distribution is more even. Furthermore, it is stated by [8] that when organic matter is decomposed it will produce ions OH⁻ which can neutralize the ionic activity H⁺. Organic acids will also bind Al⁺⁺⁺ and Fe⁺⁺ which can form complex compounds (chelates), so that Al⁺⁺⁺ and Fe⁺⁺ not hydrolyzed again.

3.3.2 Content of C-Organic

The results in Table 2 show that the C-Organic content of the soil in the soil without earthworms (a1, a2, and a3) was 0.45%, respectively; 0.51%; and 0.66% (very low status), while in plots with earthworms (b1, b2, and b3) 4.98% respectively; 3.77%; and 3.41% (high status). The increased C-organic content was caused by earthworms being able to decompose and mix organic matter into the soil from plant remains that fell on the soil surface. It was stated by [9] that earthworms and other soil organisms play a major role in the destruction of organic matter. Added by [10] that the distribution of organic matter in influencing the earthworm population, because it is related to the source of nutrition, so that in soils that have low organic matter content, there is little or no earthworm population found.

3.3.3 Content of N-Total, P-Available and K-Available

The results in Table 2 show that the soil N-Total content in the soil without earthworms (a1, a2, and a3) was 0.21%, respectively; 0.13%; and 0.23% (low to moderate status), while in the soil that contained earthworms (b1, b2, and b3) that was 0.38%, respectively; 0.36%; and 0.41% (medium status).

The results in Table 2 show that the P-Available soil content in the soil without earthworms (a1, a2, and a3) is 15.25 ppm, respectively; 9.82 ppm; and 1.64 ppm (status classified as very low to low), while in the soil that contained earthworms (b1, b2, and b3), they were 23.45 ppm, respectively; 13.45 ppm and 19.82 ppm (low to moderate status).

The results in Table 2 show that the K-Available soil content in the soil without earthworms (a1, a2, and a3) is 97.22 ppm, respectively; 77.78 ppm; and 72.22 ppm (very high status), while the plots containing earthworms (b1, b2, and b3) were 116.67 ppm, respectively; 108.33 ppm and 80.56 ppm (status is very high). The results showed that the content of N-total, available P and available K in the soil that was inhabited by earthworms was higher than the content of N, P and K in the soil without an earthworm population. This is because earthworms can change the physical and chemical properties of the soil, facilitate the process of mineralization of organic matter, and stabilize the nutrient cycle. As stated by [1] that the activity of earthworms can increase inorganic N in the soil. [11] stated that the presence of earthworms causes accelerated mineralization of organic matter which causes C-organic and total N to increase, C/N ratio decreases, P-available and K-available content increases. Furthermore, it was stated [12] that the activity of earthworms increased the availability of soil

nutrients and increased the rate of nutrient cycling. All of these contribute to changes in the form of bound organic N, P and K to forms available to plants and shortening the nutrient supply period.

IV. CONCLUSIONS AND SUGGESTIONS

4.1 Conclusion

Based on the results of research and discussion, it can be concluded that Ultisols inhabited by worm populations have several soil chemical properties (soil pH, C-organic, N-total, P-available and K-available) which are higher than Ultisols soils that are not inhabited by earthworms.

4.2 Suggestion

It is necessary to carry out similar research on soils with different vegetation accompanied by observations of more complete physical and chemical properties as well as the number and types of earthworms.

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