Jurnal Pertanian Tropik ISSN NO: 2356- 4725/p- ISSN : 2655-7576
Vol.8.No.3. 2021 (24) 169-174 DOI: 10.32734/jpt.v8i3, Dec.7543

Analysis of Soil Biological Conditions in Organic and Inorganic Agriculture Areas in Tanah Datar Regency

Analisis Kondisi Biologi Tanah pada Kawasan Pertanian Organik dan Anorganik di Kabupaten Tanah Datar

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ABSTRACT

Soil is a medium for plant growth and supplies nutrients to plants. In general, soil supplies 13 of the 16 essential nutrients needed for plant growth, especially food crops. These essential nutrients must be continuously available in balanced doses. Microorganisms in the soil have an important role in maintaining soil quality and ecosystem balance, and has the potential as a sensitive biological indicator in environmental changes. Organic matter in the soil is stabilized by various complex processes that prevent decomposition due to the biological conditions of microorganisms that affect the condition of soil quality and organic compounds. The role of soil microbes in the cycle of various nutrients in the soil is very important, so that if one type of microbe does not function, there will be an imbalance in the nutrient cycle in the soil. Every organic and mineral matter in the soil can affect the activity of enzymes in particular. Enzymes that can be obtained from soil consist of groups of enzymes oxidoreductase, transferase, hydrolase, lyase, isomerase and ligase. Most of the enzymes obtained from soil come from bacteria and fungi. Only a small part is produced by plants and animals. . This research is a survey method and soil sampling (purposive sampling) followed by soil testing in the laboratory with the following stages: (a) analysis of experimental soil samples at the Soil Biology Laboratory, Soil Research Institute, Bogor, (b) interview. Analysis of organic and organic soil nitrogenase activity in Jorong Carano Batirai and Jorong Aie Angek, Tanah Datar Regency obtained a total of 4 samples. Indicates the presence of nitrogenase activity, namely NOI, NAI, NOII and NAII (Nitrogenase Organik Carano Batirai (I), Nitrogenase Anorganik Carano Batirai (I), Nitrogenase Organik Aie Angek (II), Nitrogenase Anorganik Aie Angek(II)). The highest nitrogenase activity based on Acetylene Reduction Assays (ARA) was in the NOII sample and the lowest was in the NAI sample. Land management affects urease activity, urease is an enzyme that is sensitive to various levels of land management. Higher urease activity with organic use, because the level of land management is less intensive and receives little inorganic fertilizer or pesticide.

Keywords : soil enzyme activity, soil biological fertility

INTRODUCTION

Soil is a medium for plant growth and supplies nutrients to plants. In general, soil supplies 13 of the 16 essential nutrients needed for plant growth, especially food crops. These essential nutrients must be continuously available in balanced doses. Therefore, Soil fertility is an aspect of the soil-plant relationship, that is plant growth in relation to available nutrients in the soil (Handayanto *et al*., 2017).

Furthermore Handayanto *et al.* (2017) states that the dependence of plants on soil is not only a place to rest, but also as a supplier of nutrients needed for physiological processes and the formation of plant structures, except for carbon obtained

from the air through stomata. Hydrogen and oxygen are obtained from water through plant roots. Other nutrients, nitrogen, phosphorus, potassium, calcium, sulfur and micronutrients are obtained directly from the soil. Therefore, plants depend on the soil for nutrients.

Soil is also a complex, dynamic and living habitat for a large number of organisms, including representatives of all groups of microorganisms, algae and almost all animal phyla. Microorganisms in the soil have an important role in maintaining soil quality and ecosystem balance, and potentially as sensitive biological indicators in environmental changes (Zhang *et al*., 2006). Soil microorganisms provide a biological link with the physical and chemical environment of the soil, affects the environment and in turn is affected by the environment itself (Rai, *et al*., 2010).

Although the organic matter content of most soils is only around 2-10%, very important role. Organic matter in the soil is stabilized by various complex processes that prevent decomposition due to the biological conditions of microorganisms that affect soil quality conditions and organic compounds. The properties of the compound include recalcitrant of organic molecules which are resistant to degradation by microorganisms and enzymes, chemical stabilization due to various interactions of organic molecules, surface condensation or adsorption thereby reducing the availability of organic molecular substrates and physical protection of organic substrates from decomposers due to substrate occlusion in the aggregate. In terms of biology, this includes biotic processes, namely the production of exo-enzymes, mechanical destruction of organic matter, bioturbation of soil mass, fixation of C into living cells. In addition, ecological processes including the energy requirements of cells control decomposition, lost due to diffusion inhibiting growth and preventing the formation of new colonies which are ultimately hindered or can be appropriate for mineralization of soil organic matter (Bot dan Benites, 2005)

Reduced soil fertility due to uncontrolled use of chemical fertilizers and pesticides. Agricultural systems based on high input energy such as chemical fertilizers and pesticides can damage the soil which in turn can reduce soil productivity. Organic farming has actually been known for a long time, since the science of farming is known to man, everything is done traditionally and using natural ingredients (Mayrowani, H., 2012).

Most of the causes of nutrient deficiency in the soil are due to the amount of nutrients (macro) in little or in unavailable form, which is bound by clay minerals or ions dissolved in the soil. To increase the quantity of macro nutrients, especially N, it can be done by increasing the role of symbiotic and non-symbiotic N-fixing microbes. P availability can be increased by utilizing P solubilizing microbes, because the first problem with P is that most of the P in the soil is in a form that cannot be taken up by plants or in the form of insoluble inorganic minerals such as C32HPO4. Mycorrhizal fungi can also increase the absorption of most macro and micro nutrients especially immobilized nutrients namely P and Cu (Sharma, 2002).

Soil microbes also produce metabolites that have effects as growth regulators. Azotobacter bacteria besides being able to fix N also produce thiamin, riboflavin, nicotin indole acetic acid and gibberellins which can accelerate germination when applied to seeds and stimulate the regeneration of root hairs so that nutrient absorption through the roots is optimal. Microbial metabolites that are antagonistic to other microbes such as antibiotics can also be used to suppress soil-borne pathogenic microbes around plant roots. To meet the needs of soil microbes immobilize various nutrients so as to reduce the loss of nutrients through washing. The immobilized nutrients are converted as microbial cell mass and will again be available to plants after mineralization occurs when the microbes die (Nasahi, 2010).

Furthermore, Nasahi, (2010) argues that, the role of soil microbes in the cycle of various nutrients in the soil is very important, so that if one type of microbe does not

function, there will be an imbalance in the nutrient cycle in the soil. The availability of nutrients is closely related to the microbial activity involved in it.

The activity of microorganisms in the soil is strongly influenced by land use systems, both natural and agricultural (Melero *et al*., 2005). Good soil management such as manipulation of microbial habitats, soil treatment system, can affect the microbial community in the soil. Continuous planting of the same plants will reduce soil microbial diversity and have a negative effect on the development of bacteria, especially phosphorus bacteria as well as on the qualitative and quantitative composition of fungi (Styla dan Sawicka, 2010).

Every organic and mineral matter in the soil can affect the activity of enzymes in particular. Enzymes that can be obtained from soil consist of groups of enzymes oxidoreductase, transferase, hydrolase, lyase, isomerase and ligase. Most of the enzymes obtained from soil come from bacteria and fungi. Only a small part is produced by plants and animals. Enzymes have several important functions, They are involved in the nutritional cycle, affect fertility efficiently, stimulates the activity of degrading organic matter and acts as an indicator of soil change (Dick *et al*., 2000).

Tanah Datar Regency has an area of 133,600 ha spread over hilly and mountainous areas or at an altitude of 600 - 2,500 m dml. Soil in this area develops towards andisols or belongs to the *great group hapludand*.

The value of soil fertility in Tanah Datar Regency is very diverse. The area on the slopes of Mount Merapi is a fertile area, while areas in hilly areas have various fertility.

Soil biological properties, especially enzyme activity in soil, are important parameters to estimate the productivity of a land because soil enzyme activity is a primary breaker, So it is necessary to know the differences in soil biological properties which are approached by measuring nitrogenase and urease in several types of land use.

Based on the description above, the authors are interested in carrying out research with the title Analysis of Soil Biological Conditions in Organic and Inorganic Agriculture Areas in Tanah Datar Regency.

MATERIALS AND METHODS

This research was conducted in Jorong Carano Batirai, Sungai Tarab and Jorong Aie Angek Districts, Sepuhuh Koto District, Tanah Datar Regency with an altitude of ± 600 - 2.500 meters above sea level (mdpl). This research was conducted from August to September 2021.

The materials used in this study were incomplete soil samples. While the tool used is a knife, shovel, hoe, meter, bag, plastic, label, camera, stationery and laptop.

This research is a survey method and soil sampling (Purposive sampling) which is followed by soil testing in the laboratory with the following stages: (a) analysis of experimental soil samples at the Soil Biology Laboratory, Soil Research Institute, Bogor, (b) Interview.

Tabel 1. Analysis of soil biological properties

No.	Soil Enzyme Activity	Method
1.	Nitrogenase	Acetylene Reduction Assays (Turner & Gibson, 1980)
2.	Urease	FIA-Star – NH_4^+ (Kandeler, 1995)

RESULTS AND DISCUSSION

Enzyme Activity

Results of Qualitative and Quantitative Analysis of Nitrogenase Activity

Soil samples as much as 4 samples were purified and rejuvenated on solid NFB media. Of the 4 samples that can grow on solid NFB media, The samples were then analyzed qualitatively for their nitrogenase activity on semi-solid NFB media. Based on

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the research conducted, 4 samples were selected which could show the presence of nitrogenase activity in the media, i.e. sample with code NOI, NAI, NOII, NAII (Nitrogenase Organik Carano Batirai (I), Nitrogenase Anorganik Carano Batirai (I), Nitrogenase Organik Aie Angek (II), Nitrogenase Anorganik Aie Angek(II)). Nitrogenase activity in the sample was indicated by the formation of white pellicle on the media (Figure 1).

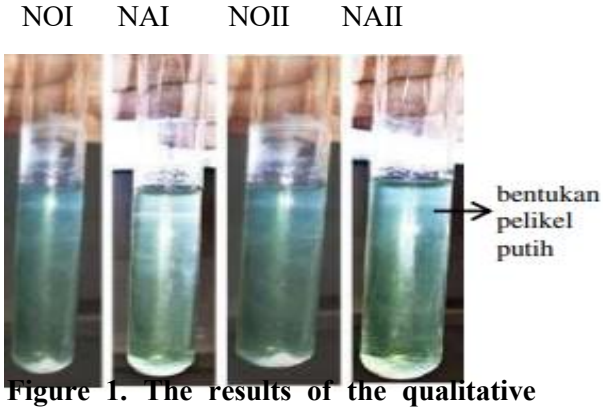
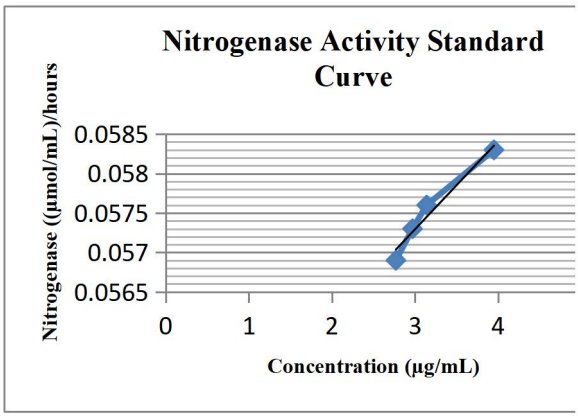


Figure 1. The results of the qualitative test of sample nitrogenase activity on semi-solid NFB media

Based on the research conducted, the results of the linear regression value for the standard curve are 0.095.



From the standard curve it can be seen the concentration value of ethylene gas in each sample, namely NOI of 3.1426 µg/mL, NAI of 2.7759 µg/mL, NOII of 3.9585 µg/mL and NAII of 2.9726µg/mL. The amount of nitrogenase activity in the sample within 1 hour of the first incubation based on calculations obtained the following results: NOI of 0.0576 µmol/mL/jam, NAI of 0.0569 µmol/mL/jam, NOII of 0,0583 µmol/mL/jam and NAII of 0,0573 µmol/mL/jam. Based on these data, it is known that the highest nitrogenase activity is found in the NOII sample, while the lowest nitrogenase activity was NAI. This is in accordance with the thickness of the pellicle formed on the NFB medium when the sample will be tested for Acetylene Reduction Assays (ARA), Is reduction of acetylene (C2H2) by the enzyme nitrogenase produced by nitrogen-fixing bacteria (Turner & Gibson 1980)

Table 2. Nitrogenase activity

No	Sample Code	Concentration of Ethylene Gas Formed (µg/mL)	Nitrogenase ((µmol/mL)/Jam
1.	NOI	3,1426	0,0576
2.	NAI	2,7759	0,0569
3.	NOII	3,9585	0,0583
4.	NAII	2,9726	0,0573

Urease

Table 3. Urease activity

No	Sample Code	Urease (mg NH_4^+-N . kg^{-1} . 2 jam^{-1})
1.	UOI	98,57
2.	UAI	89,85
3.	UOII	126,85
4.	UAII	119,95

Urease Activities in Different Types of Land Management

Urease activity on andosol soil types and different land cultivation is presented in Table 3. Soil urease activity was determined by measuring the product of urea hydrolysis by urease, namely [NH_4^+-N] as measured on FIAstar with ë 590-720 nm. Based on the results of this study, it is known that the land with land use can be categorized into two, namely organic and inorganic land, Soil

urease with inorganic land use is higher than organic land use. This can be influenced by several factors, including land use at both levels of land management, fertilizing inorganic fertilizers and applying pesticides more intensively so as to create soil conditions (especially the rhizosphere) have poor soil aggregate structure, the microclimate suitable for enzyme-producing microbes is disturbed (Tisdale et al., 1985; Gianfreda dan Bollag, 1996; Schutler dan Dick, 2002)

CONCLUSIONS AND SUGGESTIONS

Conclusions

Analysis of organic and organic soil nitrogenase activity in Jorong Carano Batirai and Jorong Aie Angek, Tanah Datar Regency, obtained 4 samples. Indicates the presence of nitrogenase activity, that is NOI, NAI, NOII and NAII. The highest nitrogenase activity based on ARA was in the NOII sample and the lowest was in the NAI . sample. Land management affects urease activity, urease is an enzyme that is sensitive to various levels of land management. Higher urease activity with organic use, because the level of land management is less intensive and receives less inorganic fertilizers and pesticides.

Suggestions

Further research is needed on the more complete physical and chemical properties of the soil, as well as further research on the microbial population of organic and organic agricultural land so that the fertility status of agricultural soils can be more complete as an effort to support the Government in general and the community in particular in increasing agricultural production.

ACKNOWLEDGEMENTS

This research was supported by a grant from DRPM Kemenristek/BRIN anggaran tahun 2021. also don't forget to say many thanks to LPPM UGN for their support this research can be carried out.

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