Microorganisms In Ex-Coal Mining Land After The Application Of Organic Fertilizers In Saliki Village Samarinda, East Kalimantan

Samsurianto, Wawan Kustiawan, Marjenah, Djumali Mardji

Abstract: This study was intended to determine whether organic fertilizers affect the presence of soil microorganisms after coal mining. The study location was the ex-coal mining area of PT Graha Benua Etam, in Saliki Village, Samarinda, East Kalimantan. This study used 4 kinds of organic fertilizer on the soil planted with Jabon seedlings, namely market waste vegetable fertilizer (WV), chicken manure (CM), cow dung (CD) and goat manure (GM). The results of this study indicated that before fertilizing 2 fungal genera were found in soil samples, namely Aspergillus and Trichoderma. At 3 months after fertilizing the soil with WV, 3 fungal genera were found, namely Aspergillus, Penicillium, and Trichoderma. At 3 months after fertilizing the soil with CM, CD, and GM found 3 genera of fungi the same with WV. At 6 months after fertilizing the soil with WV 3 genera of fungi were found that were same with 3 months, plus two other genera, namely Mucor and Rhizopus. At 6 months after fertilizing the soil with CM, CD, and GM the same 3 fungal genera as WV were found. Before fertilizing there was found 3 families of bacteria, namely Azotobacteraceae, Bacillaceae, and Micrococcaceae. At 3 and 6 months after fertilizing the soil with the four organic fertilizers, the same 3 families as before fertilizing were found. Nematodes were not found in soil samples before fertilizing, but 3 months after fertilizing with the four organic fertilizers there was found 3 genera, namely Dorylaimus, Rhabditis and Rotylenchullus. At 6 months after fertilizing, 5 genera of nematodes were found in the soil fertilized with WV and CM, namely Aphelenchus, Dorylaimus, Rhabditis, Rotylenchullus, and Hoplolaimus. In the soil fertilized with CD, only 3 genera of nematodes were found, namely Dorylaimus, Rhabditis, and Rotylenchullus. In the soil fertilized with GM, 4 genera of nematodes were found, namely Dorylaimus, Rhabditis, Rotylenchullus, and Hoplolaimus. It can be concluded that the number of genera of microorganisms increases with improved ex-mining soil conditions resulting from the application of organic fertilizers.

Index Terms: bacteria, ex-coal mining, fertilizer, fungi, microorganism, nematode

1 INTRODUCTION

COAL mining techniques commonly used in East Kalimantan are open pit mining with back-filling methods. Mining like this causes an increase in critical land, due to the loss of top soil, sub soil, land cover vegetation, heavy pressure from raindrops, greater soil erosion, direct touch of sunlight, soil compaction occurs due to heavy vehicle and soil parent material will appear on the surface of the soil [1]. The open coal mining system results in changes in landscape [2] and leaves environmental damage if it is not reclaimed [3], although landfill has been carried out with top soil, because fertile topsoil has mixed with the infertile soil at the bottom [4]. Topsoil is a micro- and macro-fauna habitat which plays an important role in supporting plant growth. These roles include helping to provide nutrients for plants, regulating nutrient cycles in the soil, synthesizing and breaking down soil organic matter, improving ground water availability and affecting plant health [5]. The loss of top soil is the main cause of declining population and soil micro-fauna activities which play an important role in the supply of nutrients [6]. The characteristics of ex-coal mining land include open soil, high temperature, low soil pH, non-vegetation and micro-fauna degradation [7], [8]. To reduce the decrease in soil quality due to mining, the addition of compost or organic fertilizer is a need on the soil. Compost can be made by utilizing organic waste from a very large number of markets in the city of Samarinda, where 815.04 tons/day of waste production is left out and has not been maximally processed. In 1 year, organic waste collected in the landfill (waste disposal site) is 382,957 m^3 per year. Organic waste that can be transported is 62% (237,210 m^3), un-transported organic waste 32% (122,546 m^3) and processed by the community for 6% (22,977 m^3) [9]. These activities can cause environmental pollution and as a source of various infectious diseases in the community, even though organic market waste if processed into organic fertilizer or compost can improve environmental health and biological properties of land damaged by coal mining. Market organic waste still contains a lot of completely unraveled ingredients such as carbohydrates, fats and proteins [10] and water that can be used for to support plant growth [11]. Organic fertilizers have an essential function to bulge the surface of soil (top soil), increase the population of microorganisms, enhance absorption and save water which can increase soil fertility [12]. In this study, the plants used were Anthocephalus cadamba Miq. (jabon) seedlings, but what was reported in this article was microorganisms present in the soil before and after fertilization..

2 MATERIAL AND METHODS

This study used 4 organic fertilizers, namely market waste vegetable fertilizer (WV), chicken manure (CM), cow dung (CD) and goat manure (GM) which were given to ex-coal mining land with A. cadamba as experimental seedlings. The ingredients for the fertilizer are first processed into compost for 3 months. The land consisted of 3 blocks as replications, each block was divided into 5 plots, the distance between planting holes was 3x3 m. Each plot consisted of 24 seeds and in 1 block there were 120 planting holes, so the number of seedlings in the 3 research blocks were 360 plants. Planting holes were made with a size of width, length and depth of 30 x 30 x 30cm. A total of 1.5kg of organic fertilizer was included in each planting hole, then after 3 months it was fertilized again with the same weight. At 3 and 6 months after fertilizing, soil samples were taken from the planting holes to investigate the presence of microorganisms.

- *Samsurianto, Wawan Kustiawan, Marjenah, Djumali Mardji*
- *Faculty of Forestry, Mulawarman University*
- *Email: sam.fmipa1@gmail.com, wawan.kusti51@gmail.com, djumalmardji@gmail.com*

3. RESULTS AND DISCUSSION

TABLE 1. *MICROORGANISMS ON EX-COAL MINING SOIL BEFORE FERTILIZING*

Soil sample	Fungi	Bacteria
1	Aspergillus Trichoderma	Azotobacteraceae
2	Aspergillus Trichoderma	Azotobacteraceae
3	Aspergillus	Bacillaceae Micrococcaceae

TABLE 2. *MICROORGANISMS ON EX-COAL MINING SOIL AT 3 AND 6 MONTHS AFTER FERTILIZING WITH ORGANIC FERTILIZER*

Fertilizer	Fungi		Bacteria		Nematodes	
	3 months after fertilizing	6 months after fertilizing	3 months after fertilizing	6 months after fertilizing	3 months after fertilizing	6 months after fertilizing
WV1	Aspergillus Penicillium Trichoderma	Aspergillus Trichoderma	Azotobacteraceae	Azotobacteraceae	Dorylaimus Rotylenchullus	Aphelenchus Dorylaimus Rhabditis Rotylenchullus
WV2	Aspergillus Penicillium Trichoderma	Aspergillus Rhizopus Trichoderma	Azotobacteraceae	Azotobacteraceae	Rhabditis Rotylenchullus	Aphelenchus Hoplolaimus Rhabditis
WV3	Aspergillus Trichoderma	Aspergillus Trichoderma Penicillium Mucor	Bacillaceae Micrococcaceae	Azotobacteraceae	Rhabditis Rotylenchullus	Rhabditis Rotylenchullus
CM1	Aspergillus Penicillium Trichoderma	Aspergillus Trichoderma Penicillium	Azotobacteraceae	Azotobacteraceae	Dorylaimus Rotylenchullus	Rhabditis Rotylenchullus
CM2	Aspergillus Penicillium Trichoderma	Aspergillus Trichoderma	Azotobacteraceae	Azotobacteraceae	Rhabditis Rotylenchullus	Aphelenchus Dorylaimus Rhabditis Rotylenchullus
CM3	Aspergillus Trichoderma	Aspergillus Rhizopus Trichoderma	Bacillaceae Micrococcaceae	Micrococcaceae Bacillaceae	Rhabditis Rotylenchullus	Hoplolaimus Rhabditis Rotylenchullus
CD1	Aspergillus Penicillium Trichoderma	Aspergillus Penicillium Trichoderma	Azotobacteraceae	Azotobacteraceae	Dorylaimus Rotylenchullus	Dorylaimus Rotylenchullus
CD2	Aspergillus Penicillium Trichoderma	Aspergillus Penicillium Trichoderma	Azotobacteraceae	Azotobacteraceae	Rhabditis Rotylenchullus	Rhabditis Rotylenchullus
CD3	Aspergillus Trichoderma	Aspergillus Trichoderma	Bacillaceae Micrococcaceae	Micrococcaceae Bacillaceae	Rhabditis Rotylenchullus	Rhabditis Rotylenchullus
GM1	Aspergillus Penicillium Trichoderma	Aspergillus Penicillium	Azotobacteraceae	Azotobacteraceae	Dorylaimus Rotylenchullus	Dorylaimus Rhabditis Rotylenchullus
GM2	Aspergillus Penicillium Trichoderma	Aspergillus Trichoderma Penicillium	Azotobacteraceae	Azotobacteraceae	Rhabditis Rotylenchullus	Dorylaimus Rhabditis
GM3	Aspergillus Trichoderma	Aspergillus Penicillium Trichoderma	Bacillaceae Micrococcaceae	Bacillaceae	Rhabditis Rotylenchullus	Hoplolaimus Rhabditis Rotylenchullus

WV = waste vegetable. CM = chicken manure. CD = cow dung. GM = goat manure

3.1 Fungi

Before fertilizing, 2 fungal genera were found in soil samples, namely Aspergillus and Trichoderma (Table 1). At 3 months after fertilizing the soil with WV (WV1, WV2 and WV3) 3 fungal genera were found, namely Aspergillus, Penicillium, and Trichoderma. At 3 months after fertilizing the soil with CM (CM1, CM2 and CM3), CD (CD1, CD2 and CD3), and GM (GM1, GM2 and GM3) were found 3 genera of fungi, the same with WV1, WV2 and WV3 (Table 2). At 6 months after fertilizing the soil with WV, 3 fungal genera were found which were same with 3 months, plus two other fungal genera, namely Mucor and Rhizopus. At 6 months after fertilizing the soil with CM (CM1, CM2 and CM3), CM (CM1, CM2 and CM3), and GM (GM1, GM2 and GM3) were found in 3 genera of fungi same with WV1, WV2 and WV3. So the number of fungi found before fertilizing were 2 genera, at 3 months after were 3 genera and 6 months after became 5 genera. This shows that organic fertilizers can enrich the genera of soil fungi. It was a possibility that the fungi were carried away from the fertilizer, so that they developed in the soil. This indicated that the fungi were resistant to extreme habitat conditions. It is well known, that the condition of ex-coal mining land is very extreme, the land is open, so that the air and soil temperatures are high, the air and soil moisture is low, the soil pH is low. But in the presence of organic fertilizers, some species of microorganisms can still survive as observed in this study. According to Sajadah Co. [13], vegetable waste contains a lot of mineral nitrogen (N), phosphorus (P), potassium (K), and vitamin B12; cow manure has a high level of N, P, and K, so that it can supply the nutrients needed by the soil maximally. Fertile soil is favored by microorganisms and vegetation, so they can grow and develop well.

3.2 Bacteria

Before fertilizing, 3 families of bacteria were found, namely Azotobacteraceae, Bacillaceae, and Microccaceae (Table 1). At 3 and 6 months after fertilizing the soil with WV, CM, CD, and GM was found 3 families of bacteria that were same with their families before fertilizing (Table 2). This indicated that the three families of bacteria were resistant to the extreme habitat conditions, while other bacteria were dead. The number of families of bacteria in the ex-mining soil is possible to increase with the development of vegetation on it, especially vegetation that is resistant to extreme environmental conditions, especially species of herbs. The results of study conducted by Suryani et al. [14], bacteria found in chicken manure were Lactobacillus achidophilus, Lactobacillus reuteri, Leuconostoc mensenteroide and Streptococcus thermophilus, a small portion of which were Actinomycetes and molds. The other researcher noted that bacteria in cow dung were Bacillus sp., Vigna sinensis, Corynebacterium sp., and Lactobacillus sp., fungi Aspergillus and Trichoderma, protozoa, yeast Saccharomyces and Candida [15]. These species of microorganisms are likely to be found directly in the fertilizer, so they are not affected by extreme environmental conditions such in at ex-coal mining area.

3.3 Nematode

Before fertilizing there was no nematodes were found in soil samples. At 3 months after fertilizing with WV, 3 genera were found, namely Dorylaimus, Rhabditis and Rotylenchullus. Likewise, the soil fertilized with CM, CD, and GM was found in the same genera as the soil fertilized with WV. At 6 months after fertilizing, 5 genera of nematodes were found on soil fertilized with WV and CM, namely Aphelenchus, Dorylaimus, Rhabditis, Rotylenchullus, and Hoplolaimus. In soil fertilized with CD, only 3 genera were found, namely Dorylaimus, Rhabditis, and Rotylenchullus. In the soil fertilized with GM found 4 genera, namely Dorylaimus, Rhabditis, Rotylenchullus, and Hoplolaimus. There was no nematode found before soil fertilizing, but after the soil is fertilized with the organic fertilizers, there were nematodes whose the number of genera differed according to the organic material used, where the soil fertilized with WV had the same number of nematode genera with CM, whereas in the soil fertilized with CD and GM there were fewer genera of nematodes. It means that soil fertilized with WV and CM was preferred by nematodes rather than soil fertilized with two other organic fertilizers. The application of organic fertilizer can increase the abundance of soil nematodes and make the soil environment tend to be healthy [16]. The results of the study by Liu et al. [17] showed that organic fertilizers differed in effect on soil nematodes, fertilizers that have carbon C-rich plant residues support a population of free-living nematodes, whereas manure containing lots of nitrogen is more effective in controlling plant-eating nematodes. Application of fertilizers from plant waste is most effective way to increase soil biodiversity in intensively managed agroecosystems.

4. Conclusion

The use of organic fertilizers on ex-coal mining soil can increase in the number of species of fungi, bacteria and nematodes. The number of species of microorganisms is dependent on the type of organic fertilizer used. Soil fertilized with organic fertilizers derived from market waste (vegetable scraps) and chicken manure is more microorganisms found than in soil fertilized with cow and goat manure, although there are only small differences in the number of species.

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