The Effect of Organomineral on pH, Nitrogen Content, Organic-C Content and Yield of Upland Rice (Oryza sativa L.) on Inceptisols, West Java Indonesia

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Abstract. Generally, Inceptisols has low to moderate fertility characteristics. This condition can make a problem on the development of upland rice production caused by poor soil quality. Upland rice is one of the cultivated plants that is cultivated on dry land. This research was aimed to find the perfect combination of organomineral including humic acid, zeolite, natural phosphate, and dolomite on soil and yield of upland rice in Inceptisols. This research was conducted at Ciparanje, Faculty of Agriculture, Universitas Padjadjaran from July 2017 to February 2018. This experiment applied a Randomize Block Design (RBD) consisted of 10 treatments and three repetitions with the combination of humic acid (6; 8; 10 kg/ha); zeolite (150; 200; 250 kg/ha); dolomite (100; 150; 200 kg/ha) and natural phosphate (250; 300; 350 kg/ha). The result of this experiment showed that there was a significant effect of the organomineral on pH, Organic-C and yield of upland rice but no for total N. However the combination of humic acid 10 kg / ha + zeolite 150 kg / ha + dolomite 100 kg / ha + raw phosphate 250 kg / ha is the best doses compared to other combinations.

1. Introduction

Paddy (Oryza sativa L.) is a very important cultivating plant for human, because more than half of the world's population depends on this plant as a main food. Furthermore, the rice production in Indonesia is expected to increase as population increases. In 2015, the demand of rice reached 30.92 million ton with assuming an average per capita consumption is 132.98 kg/capita/year. To meet the amount of production, various methods need to be done. One of them is to expand the area of rice cultivation to dry land. Moreover, this land has a big potential to develop, because around 5.1 million ha spread in various provinces in Indonesia [1]. On the other hand, the main problems in this land is low water content and nutrients. This conditions can lead to low productivity of rice and requires paddy rice plants that can survive in this condition, one of them is upland rice. This land in West Java reached 110.424 ha with average yield 2.85 t/ha and the highest yield is 3.1 t/ha. In 2006, this production can contribute on food security in West Java until 315.082 t/ha. Even so, the yield of upland rice is still lower than paddy rice in West Java [2].

One of the factor that can increasing upland rice production is application of material that can change characteristics of poor soil, such as ameliorant like zeolite. The application of this material in industry and agriculture is a lot, because zeolite has characteristics like high cation exchange capacity, high water holding capacity, and high adsorption capacity [3]. The other materials is dolomite, it is a mineral which contains nutrients of Magnesium (Mg) and Calcium (Ca) with the chemical formula CaMg (CO₃)₂. This type is commonly used for agricultural land, plantation land, industrial and fishery needs and applied to stabilize soil pH. Last material is natural phosphate, this fertilizer is important for plant growth as a source of P nutrients and has ability to slow release of P nutrient. Furthermore, to...
complete this role, we need to add organic fertilizer. This fertilizer can increase plant growth and production, because they are able to play a role in improving soil structure, increasing CEC, increasing water retention, increasing soil biological activity, and as a source of plant nutrition. Regarding [4,5], organic fertilizer is material made by composting process from waste (animals or plants) that contain 67-82 kg CO₂ from one ton food waste and garden waste. Furthermore, the active form from organic matter is humic substances that has chemically active compounds, with high CEC contains [6,7]. This material has benefits in improving soil properties because rich of carbon (41% - 47%) and nitrogen [8]. Moreover, humic acid has an important role in supporting the life of microorganisms that live in the soil, increasing membrane permeability, increase production of chlorophyll and photosynthesis. Based on the explanation above, it is expected that through application of the combination of organomineral can improve the efficiency of the use of inorganic fertilizers, it is also expected to increase the characteristics of soil on dry land.

2. Materials and Methods

The experiments were conducted at Experimental field, Soil Fertility and Soil Nutrition Laboratory Department Soil Science and Resource Management, Faculty of Agriculture, Universitas Padjadjaran. The organomineral combination consisting of humic acid, zeolite, dolomite, and natural phosphate from Yogyakarta, insecticide (sihalotrin 106 g/L, tiametoksam 141 g/L, profenofos 500 g/L, carbofuran) and fungicide also Situ Bagendit rice seed variety. The soil that used is Inceptisols from Ciparanje region.

The experiment was arranged in Randomize Block Design (RBD), consisted of 10 combination treatments with 3 replications, there are humic acid (6; 8; 10 kg/ha); zeolite (150; 200; 250 kg/ha); dolomite (100; 150; 200 kg/ha); and natural phosphate (250; 300; 350 kg/ha). Data analysis was performed with SPSS 16.0 application. If F test shows significant result (sig <0.05), then do advanced test by using Duncan test 5%. The observations consisted of Percentage of organic C using the Walkley and Black method; pH-content using electrode glass (pH meter); N contain using Kjeldahl method; and yield of upland rice

3. Results and Discussion

3.1 Organic C

Based on the data in Table 1, the organomineral treatments had significant effect on soil organic C content, for all treatments.

| Treatments | Organic C (%) |
|-------------|---------------|
| A = Control | 1.37 a        |
| B = Combination of HA 6 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 1.48 ab |
| C = Combination of HA 6 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 1.49 ab |
| D = Combination of HA 6 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 1.61 bc |
| E = Combination of HA 8 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 1.70 bc |
| F = Combination of HA 8 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 1.86 c |
| G = Combination of HA 8 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 1.66 bc |
| H = Combination of HA 10 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 0.52 |
| I = Combination of HA 10 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 0.52 |
| J = Combination of HA 10 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 0.55 |

Note: HA : Humic Acids ; Z : Zeolite ; D : Dolomite ; NF : Natural Fosfat
For general, we can see that all the treatments gives high organic C contain than control. In Table.1 above, the dose of humic acid treatment 10 kg/ha + dolomite 200 kg/ha + natural phosphate 350 kg/ha + zeolite 250 kg/ha give the best result (7%-40%) compared to control and other treatments. This condition can happen because organic material such as humic acid, contain high C organic and other nutrients for plants. Although the percentage of organic matter is no more than 5% in every type of mineral soil, but humic acid is usually rich in carbon (more than 40%), high oxygen content, nitrogen and low hydrogen content [8]. Organic materials can also improve soil structure, aeration and the soil ability to bind water. Furthermore, this is happen because all material that we add in treatments can increase the organic C contain.

3.2 Total N
Based on the data in Table.2, the organomineral treatments had no significant effect on total N content, for all treatments. When we see in Table. 2 above, the N contain for all the treatments gives high nitrogen contain than control. On the other hand, this is not gives significant effect on statistics value. This is caused by sorption of nitrogen as nitrate ions (NO₃⁻) and ammonium ions (NH₄⁺) by plant at vegetative stage is used for increasing the height and number of tillers of plant. The absorption of N by plants is influenced by several factors, such as physiological conditions of the plant, type of plant, and needs of plants in certain nutrients. Moreover, external or environmental factors that affect the absorption of N by plants are light, air, water, and soil pH [9]. According to [8], humic acid also give a source of nitrogen from 2%-5% but on the other side, zeolite application can reduce N contain this is due to the coating by zeolite or activated charcoal that can make a nitrogen not dissolved immediately.

| Treatments                              | Total N (%) |
|-----------------------------------------|-------------|
| A = Control                             |             |
| B = Combination of HA 6 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 0.41        |
| C = Combination of HA 6 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 0.47        |
| D = Combination of HA 6 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 0.45        |
| E = Combination of HA 8 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 0.49        |
| F = Combination of HA 8 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 0.46        |
| G = Combination of HA 8 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 0.52        |
| H = Combination of HA 10 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 0.52        |
| I = Combination of HA 10 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 0.52        |
| J = Combination of HA 10 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 0.55        |

Note : HA : Humic Acids ; Z : Zeolite ; D : Dolomite ; NF : Natural Fosfat

3.3 Soil Acidity (pH)
Based on the data in Table.3, the organomineral treatments had significant effect on pH content, for some treatments. Regarding Table.3 above, we can see that the pH value is increasing for all treatments than control. The pH value of this soil is obtained from active (actual) acidity and potential acidity. Furthermore, actual acidity is caused by the presence of H⁺ ions in the soil solution. This ions can be produced when cations reactions, humification process of organic matter or root activities.
Table 3. Effect of Organomineral Combination (Humic Acid, Dolomite, Natural Phosphate and Zeolite) on pH

| Treatments | pH   |
|------------|------|
| A = Control | 1.37 a |
| B = Combination of HA 6 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 1.48 ab |
| C = Combination of HA 6 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 1.49 ab |
| D = Combination of HA 6 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 1.61 bc |
| E = Combination of HA 8 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 1.70 bc |
| F = Combination of HA 8 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 1.86 c |
| G = Combination of HA 8 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 1.66 bc |
| H = Combination of HA 10 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 0.52 |
| I = Combination of HA 10 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 0.52 |
| J = Combination of HA 10 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 0.55 |

Note: HA : Humic Acids ; Z : Zeolite ; D : Dolomite ; NF : Natural Fosfat

The treatment of Humic Acid 10 kg/ha + Dolomite 100 kg/ha + Natural Phosphate 250 kg/ha + Zeolite 150 kg/ha give the high pH value compared to control and other treatments. It can be seen that the application of ameliorant with a maximum dose of humic acid can increase the value of soil pH, because humic acid can reduce the solubility of Al and Fe soils by make complex compounds that are difficult to dissolve. Also application of dolomite with contains elements of Ca and Mg, can shift the position of H+ in reaction and increase soil acidity. Furthermore, dolomite is provides H supply to the soil which reacts with H+ to water and causes H+ levels is decrease and soil pH is increases [10].

3.4 Yield of Upland Rice

Based on the data in Table 4 that the organomineral treatments had significant effect for some treatments than control. As general, yield of upland rice parameter gives increasing pattern than control.

Table 4. Effect of Organomineral Combination (Humic Acid, Dolomite, Natural Phosphate and Zeolite) on Yield

| Treatments | Yield of Upland rice (g) |
|------------|--------------------------|
| A = Control | 1.37 a                   |
| B = Combination of HA 6 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 1.48 ab |
| C = Combination of HA 6 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 1.49 ab |
| D = Combination of HA 6 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 1.61 bc |
| E = Combination of HA 8 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 1.70 bc |
| F = Combination of HA 8 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 1.86 c |
| G = Combination of HA 8 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 1.66 bc |
| H = Combination of HA 10 kg/ha + Z 150 kg/ha + D 100 kg/ha + NF 250 kg/ha | 0.52 |
| I = Combination of HA 10 kg/ha + Z 200 kg/ha + D 150 kg/ha + NF 300 kg/ha | 0.52 |
| J = Combination of HA 10 kg/ha + Z 250 kg/ha + D 200 kg/ha + NF 350 kg/ha | 0.55 |

Note: HA : Humic Acids ; Z : Zeolite ; D : Dolomite ; NF : Natural Fosfat

The dosage of Humic Acid formulation Humic Acid 10 kg/ha + Dolomite 100 kg/ha + Natural Phosphate 250 kg/ha + Zeolite 150 kg/ha give the highest yield of upland rice (23.05 g). According to [9], supply of N in the generative phase is very important in postpone leaf aging process and maintaining photosynthesis during the grain filling phase and increasing protein. This adequacy during
the generative phase is very important to achieve high rice yield. Furthermore, increased yield of dry milled grain also caused by the application of humic acid because this material has growth hormones such as auxins, cytokines, and gibberellins. This hormones can serves to stimulate the process of seed germination and push ahead the process of roots formation, stimulate cell, increase flowering, percentage of flowers and fruit, and reduce the loss of flowers and fruit [12].

4. Conclusion

The combination of organomineral (humic acid, zeolite, dolomite, and natural phosphate) give significantly affect on organic C, soil pH and yield of upland rice plants, but not significantly affect on the percentage of N-total content. The combination dose of humic acid 10 kg / ha + zeolite 150 kg / ha + dolomite 100 kg /ha + natural phosphate 250 kg / ha is the best dose for this experiment.

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