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Methods of Reducing Inorganic Fertilizers with Aspergillus Fungi on Oryza Sativa

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***Abstract*―** *This study was conducted to determine the optimum dosage of Aspergilus sp fungi originating from the rhizosphere of regular paddy rice in inorganic P fertilizer in binding to phosphate solubility, as well as growth and production in order to reduce the use of inorganic P fertilizer in rice paddy. and production of lowland rice. To determine the interaction of the administration of Aspergilus, sp and P inorganic phosphate solvents and increase phosphate availability and the growth and production of lowland rice. The results obtained after the application of inorganic P fertilizer to rice paddy plants that the application of phosphate solvent mushrooms can increase plant height, number of productive tillers, P uptake and 1000 grains of wet grain higher than without P solvent mushroom administration. plant height, number of productive tillers, P uptake, and 1000 grains of wet grain were higher than those without inorganic P fertilizer. The interaction of phosphate solvent fungus treatment with inorganic fertilizer (4 kg / plot of 100% inorganic P fertilizer) can increase plant height.*

***Keywords*―** *Solvent mushroom P. Padi, Fertilizer P, Paddy Field.*

I. INTRODUCTION

Rice is an important food crop in Indonesia. The Indonesian population makes rice as a staple food. Ninety-five percent of Indonesia's population consumes food sourced from rice. Indonesia's ability to meet rice needs

for its people is very important, where the country's ability to fulfill rice self-sufficiency has declined within three decades after the occurrence of rice self-sufficiency in 1984 due to declining land productivity. nutrients, especially nutrient Posfor (P) due to the continuous application of P fertilizer, especially inorganic P fertilizer, but the P nutrient cannot be used by plants because it is bound to soil minerals. To increase P uptake, both from the soil and from fertilizers can be done in various ways, one of which is biotechnology, namely utilizing P solvent mushrooms sourced from around the rhizosphere of the rice plant.

Most rice fields in Indonesia have saturated phosphate. The phosphate cannot be utilized as much as possible by plants, because phosphate in the form of P is bound in the soil, so farmers continue to fertilize P in paddy fields even though there is sufficient P content. In acid soils, phosphate will be compounded in the forms of Al-P, Fe-P, and occluded-P, whereas in alkaline soils, phosphate will be compounded with calcium (Ca) as Ca P forms complex compounds that are difficult to dissolve. Thebinding of phosphate causes the phosphate fertilizer given to be inefficient, so it needs to be given in high quantities. Giving phosphate fertilizer into the soil, only 15-20 % can be absorbed by plants. While the rest will be absorbed between colloidal soil and remain as residue in the soil This will cause phosphate deficiency for plant growth. To find out the optimum dosage of Aspergilus sp fungi originating from the rhizosphere area of paddy rice which is routine in inorganic P fertilizer in binding to phosphate solubility, as well as growth and production in order to reduce the use of inorganic P fertilizer of lowland rice.

2. To determine the optimum dosage of inorganic P fertilizer in increasing phosphate availability and growth and production of paddy rice.
3. To determine the interaction of the administration of Aspergilus, sp and P inorganic phosphate solvents and increase the availability of phosphate and the growth and production of lowland rice.

II. LITERATUR REVIEW

Traditional rice cultivation has been very successful in preserving land productivity. For thousands of years the rice paddy system has managed to maintain moderate but stable rice yields without causing environmental damage. This happens because flooding increases soil fertility and rice production by increasing the pH of the soil to near neutral, increasing nutrient availability, especially P, and increasing the overhaul of organic matter.

Fertilization is a very important tool for increasing rice production. Its use has increased rapidly after the launch of the intensification program which began in 1969. Where the current recommendations for fertilizing lowland rice are common to all regions of Indonesia without considering the nutrient status of the soil and the ability of plants to absorb nutrients. While it is known that P nutrient status in paddy fields varies greatly from low to high (Adiningsih et al., 1989, Moersidi et al., 1990).

The results of the research on intensification rice fields, most of the rice plants were not responsive to P. fertilization. As a result of continuous phosphate fertilization for a long time, it was suspected that in some locations intensification rice fields had accumulated P in the soil, because most of the P fertilizer given was bound on the ground. The results also show that the efficiency of phosphate fertilization in paddy fields is very low, only about 10-20% of the amount of fertilizer given (Adiningsih et al., 1989). To improve the efficiency of fertilizer use and keep the yield of rice paddy high, the recommendation for fertilizing rice in intensified paddy fields needs to be prepared based on soil nutrient status and also how to increase P uptake that has accumulated in the soil (Kasno et al., 2003).

Using chemical fertilizers that are excessive and continuous need to be reviewed specifically to overcome the saturation P, because besides being inefficient, it also has a negative impact on the environment. Maintenance of health and fertility of plants by paying attention to the effects of soil fertility and health are important in agricultural systems. Biological rules that support the recycling chain that occurs in nature between producer organisms, consumers and decomposers must be maintained. Utilization of biological fertilizers based on a positive response to an increase in fertilizer and rice production efficiency is expected to improve the welfare of farmers.

In tropical acid soils, P is mainly bound to Ca-P, Fe-P and Al P. bonds. This bond between Ca, Fe and Al and P can be released through chelating or bonding organol metal from the functional groups of secreted organic acids. by phosphate solvent fungi. This functional group is also able to neutralize the positive colloidal charge of the soil so that the reactivity of cations and colloids to phosphate decreases so that the availability of phosphate increases (Premono, 1992; Tan, 1998). Apart from the neglect of the phosphate dissolution mechanism from materials which are difficult to dissolve by fungal activity associated with phosphatase and phytase enzymes (Alexander, 1977). In tropical acid soils P which is mainly bound to Ca-P, Fe-P and Al P. bonds This Ca, Fe and Al with P can be released through darkening or bonding of organol metal from functional groups of organic acids secreted by the fungus phosphate solvent. This functional group is also able to neutralize the positive colloidal charge of the soil so that the reactivity of cations and colloids to phosphate decreases so that the availability of phosphate increases (Premono, 1992; Tan, 1998). Apart from the neglect of the phosphate dissolution mechanism from materials which are difficult to dissolve by fungal activity associated with phosphatase and phytase enzymes (Alexander, 1977).

A. *Phosphate Dissolution Mechanism*

In the soil, phosphate can be in the form of organic and inorganic which is an important source of phosphate for plants. Organic phosphate comes from organic matter, while inorganic phosphate comes from phosphate-containing minerals. The dissolution of phosphate compounds by phosphate solvent microorganisms takes place chemically and biologically for both organic and inorganic phosphate forms. Phosphate solvent microorganisms require the presence of phosphate in the form available in the soil for growth. Changes in pH play an important role in increasing phosphate solubility (Thomas, 1985; Asea et al., 1988). Furthermore, these organic acids will react with phosphate binders such as Al3 +, Fe3 +, Ca2 +, or Mg to form stable organic chelates so that they can free bound phosphate ions and can therefore be absorbed by plants.

The mechanism of chemical phosphate dissolution is the main phosphate dissolution mechanism carried out by microorganisms. These microorganisms excrete a number of low molecular weight organic acids such as oxalate, succinate, tartrate, citrate, lactate, α-ketoglutarate, acetate, formate, propionate, glycolate, glutamate, glyoxylate, malate, fumarate (Illmer and Schinner, 1992; Banik and Dey, 1982 ; Alexander, 1977; Beauchampdan Hume, 1997). The increase in organic acids is followed by a decrease in pH. The decrease in pH can also be caused by the release of sulfuric and nitric acids in the chemoautotrophic oxidation of sulfur and ammonium, respectively by the bacteria Thiobacillus and Nitrosomonas (Alexander, 1977).

The role and function of soil fungi greatly determine the success of the sustainability of agricultural production systems. Soil mushrooms are responsible for various nutrient transformations in the soil that are related to soil fertility and health. Mushroom fertilizers live in association with plant roots, increase nutrient availability, stimulate growth and protect plants against pathogens through phytohormone compounds, toxins and enzymes produced. The use of mushroom fertilizers in helping plant growth and protection is done directly or indirectly. The direct role of dissolving the bound P becomes available through organic acids and the enzymes it produces. While the indirect role is done by producing antifungal compounds that can suppress the growth of pathogenic fungi (Kennedy and Papendick, 1995).

B. *Utilization of Phosphate Solvent Microorganisms for Eeficiency of Phosphate Fertilization*

The use of phosphate solvent microorganisms as biofertilizers is done by inoculating the soil directly on seed plants or given to seeds (Paul and Clark, 1989). Inoculation is usually carried out at the time of planting together with P. fertilization. In soils with high P content due to accumulation or residue of P fertilizer application that accumulates, these microorganisms can be used as phosphate miners from these soils. By providing phosphate solvent microorganisms, it is expected to increase the solubility of P from the given P fertilizer and P compounds derived from previous fertilization residues in the soil.

The ability of various types of phosphate solvent microorganisms to provide P elements is widely reported. The P. putida bacteria, Citrobacteri intermedium and Serratia mesenteroides are able to increase P which dissolves in AlPO4 medium from phosphate rocks by 6 to 19 times, which is around 0.57-22.0 ppm, but is unable to dissolve FePO4 (Premono etal. , 1991). Bacterial isolates used by Sundara Rao and Sinha (1963). Able to dissolve Ca3 (PO4) 2 to 172 ppm. Goenadi et al. (1993). Isolating phosphate solvent bacteria from Andisol soil, Ultisol and from manure and found that the phosphate solvent bacteria can dissolve phosphate 10 to 184 times more than the control.

Fungi are better able to dissolve P in the form of AlPO4 (in acid soils), while bacteria are more effective in dissolving phosphate in the form of PO4 Ca3 in alkaline soils (Banik and Dey, 1982). Some researchers have proven that certain types of fungi have a higher ability than bacteria (Beever and Burns, 1980; Banik and Dey, 1982; Kucey, 1983; Illmer and Schinner, 1992; Goenadi and Saraswati, 1993). According to Goenadi and Saraswati (1993), the ability of phosphate dissolving fungi ranged from 12 to 162 ppm in the Pikovskaya medium which contained a relatively more difficult source of PAPOPO4 from other P sources. Lestari and Saraswati (1997) reported that the solvent fungi P increased dissolved phosphate levels by 27-47% in acid soils. This different growth environment provides a good opportunity to develop fungi in the tropics because fungi prefer acid soils.

A number of plants that have been inoculated with phosphate solvent microorganisms include wheat, sugar beet, cabbage, barley, soybeans, corn, rice, long beans, peanuts, tomatoes, potatoes, cotton, cucumber, and can increase yields 10 to 15% . Utilization of Pseudomonas and Citrobacter intermedium can increase plant wet weight by 30% (Premono et al., 1991).

III. ANALIZE AND RESULT.

This shows that the administration of phosphate solvent mushrooms can increase P uptake through the phosphatase enzyme it produces and can break phosphate which is bound by organic compounds so as to increase the absorption of plant p. From the results of P absorption analysis it can be seen that by giving phosphate solvent fungi, it can increase P uptake by 40.46% to 44.93% when compared to without phosphate solvent fungus administration, so that P plant needs are met. Fitriatin et al. (2009) stated that phosphate solvent fungi can substitute part or all of the plant's need for fertilizer P. Phosphate solvent fungi are very effective at releasing fixed P in soil minerals so that P uptake in the soil can increase (El-Azouni, 2008).

TABLE 1. Average Plant Height Due to Phosphate Solvent and Inorganic P Fertilizers and their Interactions

Treatment	HEIGHT PLANT (cm) AGES 10 MST
Jamur Pelarut P (A)	
A0	95,84 c C
A1	102,64 ab AB
A2	104,16 a A
A3	100,86 b B
Pupuk P Anorganik (F)	
F0	97,58 c C
F1	100,98 b B
F2	103,55 a A
Interaksi (A x F)	
A0F0	94,33 e C
A0F1	97,47 cd C
A0F2	95,73 de CD
A1F0	97,93 c C
A1F1	102,07 b B
A1F2	107,93 a A
A2F0	101,40 b B
A2F1	102,33 b B
A2F2	108,73 a A
A3F0	96,67 cd CD
A3F1	102,07 b B
A3F2	101,80 b B

In figure 1, it can be seen that, the relationship between the height of the farm and the phosphate solvent fungus is quadratic positive. The highest plant height was obtained in treatment A2 (4 kg / plot) which was 104.16 cm.

Relationship between Plant Height and Phosphate Solvent Mushroom can be seen in figure 1.

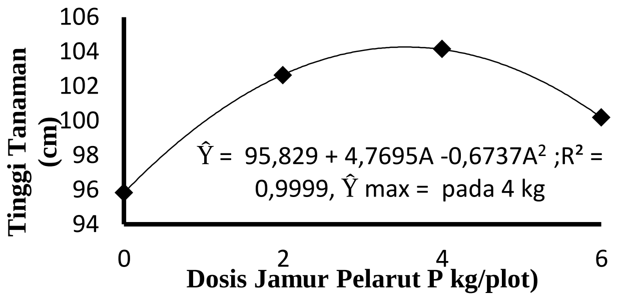

Fig. 1. Relationship between Plant Height and Phosphate Solvent Mushrooms

The treatment of inorganic P fertilizer F2 at the age of 10 MST showed the highest plant height and was very significantly different from the treatments of F1 and F0.

Giving inorganic P fertilizer according to recommended doses from ages 4 to 10 MST consistently produced the highest plants compared to controls. This is consistent with the ability of inorganic P fertilizer to increase the availability of plant nutrients. This result is in line with the research of Fitriatin et al (2009) showing that the administration of P fertilizer and increasing the dose of P to the optimum level will continue to increase p uptake in the soil so that plant growth will be better.

IV. CONCLUSIONS

From the results of the study it can be concluded that:
1. Provision of phosphate solvent mushrooms can increase plant height, number of productive tillers, P uptake and 1000 grains of wet grain higher than without phosphate solvent.
2. Giving inorganic P fertilizer can increase plant height, number of productive tillers, P uptake and 1000 grains of wet grain higher than without inorganic P fertilizer.
3. The interaction of phosphate solvent fungus treatment with inorganic P fertilizer (40 ml phosphate 100% solvent P inorganic fertilizer) can increase plant height, number of productive tillers, P uptake and 1000 grains of wet grain higher than without phosphate solvents and fertilizer P inorganic. The best combination treatment on a combination of A2F2.

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