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INFLUENCE OF BIOFERTILIZER AND HUMIC ACID ON NPK CONTENT AND YIELD OF RICE (Oryza sativa L.)

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ABSTRACT

The objective of this study was to know the effect of biofertilizer and humic acid on NPK content and yield of riceIR-64 cultivar in Indramayu. Biofertilizer containing nitrogen fixing microbes (Azotobacter and Azospirillum) and phosphate solubilizing microbes (Pseudomonas mallei, Pseudomonas cepaceae, Penicillium sp. And Aspergillusniger) was used in this experiment. This research was conducted from April to July 2017 in paddy fields located at Gantar District, Indramayu. A Randomized Block Design (RBD) was used in this experiment with seven treatments and repeated four times. The treatments were biofertilizer(50 kg ha-1) and humic acid (20 L ha-1) with different recommendation doses of NPK fertilizer (0%, 25%, 50%, 75% and 100%). The result showed that biofertilizer and humic acid with different recommendation doses of NPK fertilizer significantly increase P content (0,73%) and yield of rice (8,93 t ha 1).

Keywords: biofertilizer, humic acid, NPK content, paddy, yield of rice.

INTRODUCTION

Rice (Oryza sativa L.) is the most important cereal crop in Indonesia. Advances in agronomic crop management such as NPK fertilization, pest control, weed control and water management can improve rice productivity especially in Indramayu. To maximize crop yield, the farmers often apply a higher amount of fertilizer than the minimum required for crop growth. However, long term use of chemical fertilizers also led to a decline in crop yields and soil fertility in the intensive cropping systems (Dadhichet al., 2011). Management nutrition is one of the keys to improving the productivity of agricultural land especially in wet tropics where the soil fertility rate is relatively low due to the high levels of weathering and nutrient leaching. Nitrogen, phosphorus, and potassium are the main limiting factors for wetland rice productivity. The response of rice to nitrogen, phosphorus, and potassium is influenced by several factors like level of organic matter. Organic matter is the key to improving soil productivity and fertilizer efficiency (Arafah and Sirappa, 2003).

The use of renewable resources and inputs is one the fundamental principles of sustainable agriculture that enables maximum crop productivity and minimal environmental risk (Kizilkaya, 2008).Phosphate solubilizing microbes (PSM) play an important role in influencing the growth of plants, in addition toa fixed Preleasecan also produce the enzyme phosphatise (Saparatka, 2003; Yadav and Tarafdar, 2003) and can produce phytohormones (Fitriatinet al. 2013). Phosphatase enzyme released by these microbes can make mineralization of organic P into P inorganic. (George, et al, 2002; Saparatka 2003, Fitriatin, et al, 2011).

Combination between biofertilizer and humic acid could reduce the use of NPK fertilizer. In line with Simanung kalitet al, (2006), the use of organic fertilizers and biofertilizers in long term periods could increase land productivity and prevent land degradation. Cereals Plant Research Institute (2013) reported that biological fertilizers can reduce the use of inorganic fertilizer up to 50% of the recommended dosage. Other studies show that humic acid can improve efficiency Inorganic fertilizers (Guar and Geeta, 1993), increased soil fertility and crop productivity (Van Lauweet al., 2002). The combination of humic acid and 50% dose recommendation of NP chemical fertilizers can improve cereal yield (Khan et al., 2010).

As discussed previously, the importance of balance fertilizing between biofertilizer, humic acid and inorganic fertilizer for rice crop in paddy field can affect nutrients absorption and yield of a crop. Therefore, combination of biofertilizer and humic acid with inorganic fertilizer (Urea, SP-36 and KCl) is very important input in order to improve land productivity in paddy field.

The objective of this research was to determine the balance dose between biofertilizer, humic acid and inorganic fertilizer which is capable to increase the content of NPK and production of rice crop in paddy field.

MATERIALS AND METHODS

A field experiment was conducted in paddy field located at Indramayu District, West Java, Indonesia using Randomized Block Design (RBD) with seven treatments and four replications. The treatments were biofertilizer (50 kg ha-1), humic acid (20 L ha-1) and five levels dose recommendation of NPK fertilizer (0%, 25%, 50%, 75% and 100%). The recommendation doses of NPK fertilizer for rice crop IR-64 cultivar were 300 kg ha-1 urea, 50 kg ha-1 SP-36 and 50 kg ha-1KCl.

The selected microbial of biofertilizer containing the isolate of Azotobactersp, Azospirillumsp, Pseudomonas mallei, Pseudomonas cepaceae, Penicillium sp. And Aspergillusniger were obtained from the collection of soil Microbiology Laboratory, Agriculture Faculty, UniversitasPadjadjaran, Indonesia. Biofertilizer was made by mixing seven kg sterile compost with bacterial biomass which is extracted from 100 ml isolate of Azotobacter, 100 ml isolate of Azospirillum, and 100 ml isolate of phosphate solvent bacteria respectively having density of 108 CFU.mL-1. Bacterial biomass was obtained by centrifuging the liquid propagation of these bacteria at velocity of 15000 rpm for five minutes. Biofertilizer distributed on the paddy plots after transplanting. Single seedling (14 days) was planted with plant spacing about 25 cm x 25 cm in line. The solution of humic acid (1 : 100) was applied on paddy plots twice (1 WAT and 3 WAT) with dose 20 L ha-1.Urea fertilization was given twice the first-half at 3WAT and the second-half of the dosage when the plant was five WAT whereas KCl fertilization and SP36 was given at the time of five WAT (Table 1).

Crop maintenance consisted of: 1) Watering, 2) Cultivating conducted manually by uprooting the existing weeds, 4) Pest and disease control conducted manually. Harvesting was done when the rice grains was more than 75% mature at each tiller, which was shown by yellow flag leaves.

The observed parameters were chemical soil properties before experiment, analysis of NPK content of crop tissue at primordial phase and yield of rice. Data was statistically processed with analysis of variance for Randomized Block Design (RBD). When the variance analysis results showed significant difference, then it was followed by Duncan Multiple Range Test (DMRT) test at 5% level.

Table 1.The Given Dosage of Biofertilizer, Humic Acid (HA) and NPK Fertilizer.

Treatments	Biofertilizer (g plot^{-1})	Humic acid (ml plot^{-1})	NPK fertilizer (g plot^{-1})		
			Urea	SP-36	KCl
Control	0	0	0	0	0
100% NPK fertilizer	0	0	120	20	20
Bio+HA	20	8	0	0	0
Bio+HA + 25% NPK fertilizer	20	8	30	5	5
Bio+HA + 50% NPK fertilizer	20	8	60	10	10
Bio+HA + 75% NPK fertilizer	20	8	90	15	15
Bio+HA + 100% NPK fertilizer	20	8	120	20	20

RESULTS AND DISCUSSION

Soil Characteristics

Based on analysis results of soil chemical properties conducted before experiment, soil used in this experiment was classified as acid soil (pH H2O=6,19) with high value of cation exchange capacity (28,73 cmol kg-1), low C-organic content (1,6%), low value of N-total (0,18%), high available P (124,02 ppm P) and medium value of available K (38,82 mg 100g-1) with soil texture of siltyclay consisting of 3% sand, 49% silt and48% clay. The soil used as growth media in this research generally having low soil fertility level with pH (H2O) of soil is classified as acid having low values of C-organic content and N-total. In addition, soil in this research should be added with biofertilizer containing nitrogen fixing microbes and phosphate solubilizing microbes and humic acid in order to increase N, P and K nutrients so that better growth and production of rice crop can be achieved.

Nitrogen content of plant

There was no significant effect between biofertilizer and humic acid with NPK fertilizer on N content. Therefore, the treatment was increase the percentage N content higher than control. This increase was due to conjoint use of chemical and organic fertilizers. Biofertilizer and humic acid with 50% dose recommendation of NPK fertilizer gave higher value than 75% and 100% dose recommendation of NPK fertilizer. This result is in agreement with that of Negassaet al. (2002), positive and significant response of the Azotobacterwas observed with lower doses of inorganic fertilizers than the higher doses. Karthikeyan and Sakthivel (2011), bacteria of Azospirillumand Azotobacter could increase crop biomass, crop productivity, which contributed N nutrient through N2 fixation at crop rhizosphere environment as well as phytohormone in direct manner.

Table 2.Effect of biofertilizer and humic acid on N content of plant at the end of vegetative period.

Treatments	N content (%)
control	1.85 a
100% NPK fertilizer	1.98 a
Bio + HA	1.93 a
Bio + HA + 25% NPK fertilizer	2.09 a
Bio + HA + 50% NPK fertilizer	2.12 a
Bio + HA + 75% NPK fertilizer	1.94 a
Bio + HA + 100% NPK fertilizer	2.02 a

**Means not followed by the same letter are significantly different at the 5% level of Probability as determined by DMRT.*

P content of plant

Data in Table 3 show that application of biofertilizer and humic acid with different doses recommendation of NPK fertilizer significantly increased P content of plant in comparison with control. This may be due to the activity of phosphate solubilizing microbes which slightly produced organic acids and phosphatase enzymes which are affected the solubility and

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availability of P. So the available P can be absorbed increasingly. These beneficial effects were also reported by El-Kouny (2007). In addition, humic acid is able to stimulate root growth of rice plants so that rice plants can absorb nutrients well.

Table 3.Effect of biofertilizer and humic acid on P content of plant at the end of vegetative period

Treatments	P content(%)
Control	0.58 a
100% NPK fertilizer	0.61 ab
Bio + HA	0.62 ab
Bio + HA + 25% NPK fertilizer	0.68 bc
Bio + HA + 50% NPK fertilizer	0.73 c
Bio + HA + 75% NPK fertilizer	0.60 ab
Bio + HA + 100% NPK fertilizer	0.64 ab

**Means not followed by the same letter are significantly different at the 5% level of Probability as determined by DMRT*

The results illustrated in Table 3 show that increasing the rate of applied NPK fertilizer gradually until 50% increased the amount of P concentration.The highest amounts of P concentration were recorded by application of biofertilizer and humic acid with 50% dose recommendation of NPK fertilizer. The use of biofertilizers containing P-solubilizing microbial is one of the ways to increase the availability of phosphorus. Turanet al. (2007)danFitriatinet al. (2014) reported a greater increase in plant root and shoot weight as well as phosphorous uptake in treatments with phosphate solubilizing bacteria than without phosphate solubilizing bacteria.

K content of plant

There was no significant effect between biofertilizer and humic acid with NPK fertilizer on K content of plant. Therefore, the treatment was increase the percentage K concentration higher than control. This increase due to the role of biofertilizer and humic acid that can stimulate roots growth.

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Table 4.Effect of biofertilizer and humic acid on P content of plant atthe end of vegetative period.

Treatments	K concentration (%)
Control	1.43 a
100% NPK fertilizer	1.57 a
Bio + HA	1.61 a
Bio + HA + 25% NPK fertilizer	1.63 a
Bio + HA + 50% NPK fertilizer	1.54 a
Bio + HA + 75% NPK fertilizer	1.44 a
Bio + HA + 100% NPK fertilizer	1.58 a

**Means not followed by the same letter are significantly different at the 5% level of Probability as determined by DMRT*

Yield of rice

Application of biofertilizer and humic acid with different dose recommendation of NPK fertilizer recorded highly significant increases yield of rice. These results may be due to the improvement of soil fertility status (availability of nitrogen, phosphorus and potassium). Study from Simanungkalit (2001) implies that application of biofertilizer and inorganic fertilizer was integrated approach in improving the growth and the production of crop

Table 5.Effect of biofertilizer and humic acid on yield of rice

Treatment	Yield (t ha^{-1})
control	5.77 a
100% NPK fertilizer	7.22 c

Bio + HA	6.64 b
Bio + HA + 25% NPK fertilizer	7.98 d
Bio + HA + 50% NPK fertilizer	8.93 f
Bio + HA + 75% NPK fertilizer	8.51 ef
Bio + HA + 100% NPK fertilizer	8.29 de

**Means not followed by the same letter are significantly different at the 5% level of Probability as determined by DMRT.*

CONCLUSION

Application of biofertilizer and humic acid increased growth of rice. Biofertilizer and humic acid combined with inorganic fertilizer at 50 % of crop requirement dose was the best combination in increasing nitrogen and phosphate concentration of rice crop and yield of rice.

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