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Organic Fertilizer Application for the Cultivation of Sidenuk Rice Variety to Reduce Urea Usage

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ABSTRACT

(Sidenuk rice is a superior variety produced through a radiation mutation technique. The new varieties need to be supported by optimizing the rice production through fertilization technology. The purpose of this study was to determine if the organic fertilizer can increase growth, production and reduce the use of urea fertilizer in lowland rice. The study was conducted in a completely randomized design. Each treatment was repeated 4 times so that the total experimental unit was 32 rice pots. The treatments include (1) Control (without urea fertilizer), (2) Control (+) 100% urea, (3) 50% urea, (4) Local microorganisms (LOM), (5) Compost, (6) Biochar , (7) Azolla, (8) LOM + Compost + Biochar + Azola + SP 36 and KCl. The results showed that the highest grain weight was found on the treatment of 100% urea which was 43.97 g plant^{-1}. MKBA treatment (LOM fertilizer, compost, biochar, azolla) were not significantly different from 100% urea treatment. The result indicated that organic fertilizer formula (LOM fertilizer, compost, biochar, azolla) can reduce the use of urea fertilizer by 50%.

INTRODUCTION

Nitrogen is an important factor of nutrition in plant growth and development (Sisworo et al. 2006; Gu et al. 2018). Nitrogen chemical fertilizer in the form of urea has become a basic need of farmers, especially in Indonesia, so that waste in the use of urea cannot be avoided. The higher the availability of nitrogen in the soil and the provision of fertilizer N doses to a certain extent will reduce plant growth, plant biomass, grain yield (Triadiati et al. 2012). Excessive use of N fertilizer, can impacts to severe environment through leaching, evaporation, and N_2O emissions from agricultural land (Shi et al., 2019). To increase rice production, it is necessary to use methods such as: organic fertilizer technology, the use of biofertilizer, system of rice intensification.

One type of marginal soil used for rice growing media is soil of Latosol. Soil of Latosol is a soil developed from intermediate-base volcanic material, clay content > 40%, crumbs, loose and homogeneous color, deep soil profile, KB <50% in some parts of the B horizon, has a characteristic horizon A okrik, or umbrik, and B relic, do not have plintit and vertical nature. Soil of Latosol have further weathering with acidic pH characteristics, low organic matter and nutrient content, high clay content (> 60%), crumbs to lumps (Saptiningsih & Haryanti, 2015; Subardja et al., 2016).

Latosol soil shows that organic C is low, N is also low so that the soil still needs organic fertilizer for plants. The base saturation is very

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high at 98%. This shows that under the soil type Latosol has experienced further weathering, and its base cations are on the surface of all so easily washed, then the cations that are ready to be washed are bound by organic material and available to plants. So when organic matter is added to the soil, plants become very responsive to fertilization.

Cultivation system of rice intensification using microorganisms of local (LOM) is believed to be able to maintain soil fertility, increase soil microbe population, preserve the environment while at the same time maintaining and increasing soil productivity (Suhastyo et al. 2017). Microorganisms of local is a fermentation solution that contains micro and macro nutrients and also contains bacteria that have the potential to break down organic matter, and stimulate plant growth. Based on research(Paulus et al. 2018) that the application microorganisms of local (LOM) of gamal give the highest yield of rice grain weight of 9.50 kg $plot^{-1}$ equal to 7.92 tons ha^{-1}.

Biochar is a solid material that is the result of carbonization of biomass, which has the benefit of carbon sequester (Kookana et al., 2011). This material can be added to the soil with the aim of improving soil function and reducing emissions that produced by natural biomass. Based on research results (Noviani et al.2014)it can be concluded that the application of straw compost biochar and NPK fertilizer affects the increase of C-organic soil, BPF population, P availability and yield of rice plants. According to (Sun et al., 2017) application of biochar to coastal saline soils by reducing N washing, maintaining soil N retention. According to (Wu et al., 2019) application of biochar in lowland rice soils can effectively reduce methane gas (CH_4).

Azolla is a mini size water that has a high N nutrient content and is symbiotic with Cyanobacteria in binding free nitrogen in N fixation air (Rachman et al. 2006; Lestari dan Muryanto, 2018). Based on research (Hendrarti et al.1998) reported that the use of Azolla layer and 60 kg N ha^{-1}urea fertilizer was the best for increasing growth, production, uptake of N derived from fertilizer and efficient use of fertilizer in lowland rice. For this reason, this study was conducted to determine the effect of organic fertilizer which can increase growth, production and reduce the use of urea fertilizer in lowland rice optimally.

MATERIALS AND METHOD

This experiment was carried out in the Agriculture Greenhouse, Isotope and Radiation Application Center (PAIR), National Nuclear Energy Agency (BATAN). This experiment was conducted from January to April 2019. Materials used in this study included: Sidenuk Varieties from BATAN, organic MOL fertilizer, commercial compost, rice husk which was burned to charcoal, *Azolla pinata*. Chemical fertilizers that used are urea, SP-36, and KCl as basic fertilizers. The chemicals used for the analysis of N are H_2SO_4 acid, selenium mixture, HCl, and NaOH. Tools used for laboratory analysis include Precisa 220 brand digital balance, measuring flask, Kjeldhal flask, burette, pH meter, and digestion block tube.

Experimental design

The study was conducted using a completely randomized design. Each was repeated 4 times so that the total experimental unit (pot) was 32 rice pots. The treatments include: (1) Control (without urea fertilizer), (2) Control (+) 100% urea, (3) 50% urea, (4) Microorganisms of Local (MOL), (5) Compost, (6) Biochar, (7) Azolla, (8) MOL + Compost + Biochar + Azola .

Processing microorganisms of local (MOL) fertilizer

The making of liquid organic fertilizer microorganisms of local (MOL) was done by utilizing local microorganisms that exist in the material. The ingredients used are glyceridic, banana weevil, banana peel, pineapple, brown sugar, rice flour. Solid materials that are still large are cut up to 2 cm in size. Next, each material is put in a bucket with a lid, then was given as much as 10 liters of water. Materials that have been added are then stirred evenly. Furthermore, it was allowed to undergo a fermentation process for 14 days until it is ready for use.

Planting Media Preparation

The land used in this research is Latosol Pasar Jumat Lebak Bulus, South Jakarta. The soil was taken from the topsoil at a height of 0 -20 cm. The soil was then put into a pot as much as 10 kg absolute dry weight per pot. Soil samples for the analysis of the initial soil chemical properties were taken in combination before the soil was used in the experiment. The results of the Latosol soil analysis at BATAN Pasar Jumat Lebak Bulus in the first experiment stated that this soil contains 3% sand, 57% dust, 40% clay, low organic C (1.1%), medium Ca (6.91cmolc kg-1), Low N-total (0.16%), low C/N ratio (7), very high base saturation (KB) (82%), slightly acidic soil pH (5.6), very high total P_2O_5 (610 ppm), moderate available P_2O_5 (29 ppm), low total K_2O (11 ppm), low CEC (10.95 $cmol_c\,kg^{-1}$)

Fertilization

In this study the fertilizers used were urea fertilizer (45.18% N), KCl fertilizer (61.09% K_2O), SP 36 fertilizer (36.38% P_2O_5), MOL organic fertilizer, commercial compost, biochar, azolla. The dose of 100% urea fertilizer is 124 ppm N (2,7 g urea/plant) divided by 2 times fertilization, which was 7 HST and at 45 HST. The dose of 50% urea fertilizer is 62 ppm N(1.35 g urea/plant) divided by 2 times the fertilization, which is 7 days after planting and at 45 days after planting. The dosage of SP-36 fertilizer and KCl fertilizer is 32 ppm P_2O_5 (0,9 gr SP-36/plant) 54 ppm K_2O (0,9 gr KCl/ plant) and given at planting time. Doses of LOM, compost, azolla are 5 t ha^{-1} (50 ml / plant), 30 t ha^{-1} (270 gr/plant), 200gr/m^2 (18 gr/ plant), respectively.

Harvesting

Harvesting of rice plants was harvested in the generative phase at the age of 120 days after planting (HST). Plant samples were taken by harvesting all parts of the plant using sickles. After that, the grain and the straw are separated. Then store in the oven. Furthermore, the dry weight of grain and straw was weighed, then analyzed for N uptake by the Kjedahl method.

Observation

Observations in this study were preliminary soil analysis, chemical analysis of biochar, MOL fertilizer, compost, observation of plant height and number of leaves aged 35 and 77 HST, stover weight, seed weight aged 120 HST with water content 14-18%, analysis of total N stover and seeds with Kjedahl method.

Statistical analysis

Plant analysis data were analyzed statistically using analysis of variance (ANOVA) with a confidence interval of 95% and was tested to see the effect of real differences Duncan's multiple range test (DMRT = Duncan multiple range test) at 5% level.

RESULTS AND DISCUSSION

Chemical analysis of biochar, microorganisms of local (MOL), compost

Based on the results of chemical analysis Table 1 showed that the nutrient content in biochar, compass, MOL, in general has a low value. This is due to the low nitrogen content in the source of organic matter materials. In this study, biochar derived from rice husks, has a low nitrogen element content of 0.47%. This is in accordance with research (Nurida, 2014; Sismiyanti & Yulnafatmawita, 2018) that biochar derived from rice husk has a small nitrogen value, is 0.05% and 0.84%.

In this study the compost that used has C-organic is 30% , N-total is 2% , C / N ratio is 2%, this condition indicates the C / N ratio is ready to use. Based on research (Irfan et al., 2017)that bokashi from livestock manure contains carbon values of 17.2 -21.83%, N values of 0.83-1.31%, C / N ratio of 13.57-25.41. According to research (Masganti dan Nurhayati, 2017)that rice straw compost has livestock containing carbon value of 35.11%, N value of 1.86%, C / N ratio of 18.88. This condition is generally in accordance with the standards that determined by SNI 19-7030-2004.

Table 1. Chemical analysis of biochar compost, MOL, azolla pinnata

Parameter	Biochar	Compost	LOM	Azolla Pinnata
pH H2O	9.16	6.77	.	
pH KCl	8.55			
Humic acid (%)	0.99			
Fulvat acid (%)	1.05			
SiO_2 Rough silicate (%)	18.46			
Dust (%)	42.73			
H_2O (%)	31.48			
C-organic (%)	14.96	30	8.76	39.57
N-total (%)	0.47	2	0.44	2.82
C/N ratio	31.82	15	19.90	14.03
P_2O_5 (%)	0.37	3.52	1.23	0.25
K2O (%)	1.03	1.23	0.80	
CaO (%)	0.28			
MgO (%)	0.17			
S (%)	0.08			
Ca (ppm)			147.19	
Mn (ppm)			4.42	
Fe (ppm)			2.60	
Cu (ppm)			0.053	
Zn (ppm)			0.891	

In this study MOL fertilizer used had C-organic was 8.76 %, N-total was 0.44%, C / N ratio was 19.90%, this condition showed that the C / N ratio was ready to use. Based on research (Budiyani et al.,2016)microorganism of local from banana weevil contain value C-organic of 2.9%, N-total of 0.019%. Meanwhile according to research (Batara et al., 2016) states that the nutrient content in the solution from microorganisms local derived from banana weevil, contains a low nutrient content such as element N of 0.02%, P of 0.01%, K of 0.15%.

N-total uptake in grain, straw and plant

The data in Table 2 showed the effect of fertilization on the percentage of total N content in grain and rice straw. The data in table 2 showed the effect of fertilization on the percentage of total N content in grain and rice straw. From the data in the table, it can be seen that the response of N-uptake in straw and plant caused by all fertilizer treatments are not significantly different. In the control treatment where no fertilizer added to the soil, the plant shown the same response of N-uptake compare to other treatment. This is probably due to the readily available form of nitrogen in the soil, as indicating by the high saturation base in the soil (82%). High saturation base (KB) in the soil is indicating the number of available bases in the soil. As the CEC (KTK) of the soil is classified as low, it can be concluded that the cation base is in the free form which can be easily leached from the soil solution. The existence of cultivated plant in the soil has given a strong bonding to the free cation bases and decreasing its risk from being leached. And the plant gained the benefit from its existence in the free form by easily absorp the NH4+ as the source of nitrogen. This is the reason why, the N-uptake shown the same response upon all the treatment given. The soil pH tends to acidic, this is also indicating the form of available N as NH^{4+}.

From the data in table 2 it can be seen that

Table 2. N-uptake of grain rice and straw that was affected by fertilization (g plant^{-1})

Treatment	N-Uptake of grain	N-Uptake of straw	N-uptake of plant
Control	0.134 ab	0.302 a	0.436 a
50% Urea	0.229 abc	0.718 a	0.948 a
100 % Urea	0.256 abc	0.716 a	0.973 a
MOL	0.382 c	0.525 a	0.906 a
Compost	0.072 a	0.343 a	0.416 a
Biochar	0.292 bc	0.679 a	0.972 a
Azolla	0.296 bc	0.511 a	0.807 a
MKBA	0.441 c	0.720 a	1.161 a

Note: Numbers followed by the same letters in the same column show results that are not significantly different based on the DMRT test at the error level of 5%

MKBA treatment can increase N uptake in grain by 229.10% compared to control without urea fertilizer, amount to 92.57% compared with 50% urea, 72.26% compared with 100% urea. Based on statistic the treatment MKBA not significant difference with 50% Urea 100 % Urea, MOL, Biochar and Azolla uptake. This is because each organic fertilizer has its own advantages. MOL have functions to activate microorganisms. Compost as an energy source for microbe growth. Biochar has functions to improve soil structure, adding micro pores formed after combustion that function as microhabitat for microbes. According to (Sun et al., 2017) application of biochar to coastal saline soils by reducing N leaching, maintaining soil N retention. Azolla has functions to take N from the air. So that when all these organic fertilizers were combined, it can increase the availability of nutrients for increase plant production.

Weight of grain and rice straw

Based on statistic results, the highest weight of grain value is found in the 100% urea treatment, which is 43.97 g plant^{-1}. MKBA treatment can increase grain weight by 142.71% compared to control without urea fertilizer, by 8.53% compared to 50% urea, by 63.04% compared to compost fertilizer. Statistically the MKBA treatment (LOM fertilizer, compost, biochar, azolla) showed values that were not significantly different from the treatment of 100% urea (Table 3). This is probably because in MOL fertilizer, compost, there are microbes that are useful to help release nutrients so that they can be absorbed by plants, and the LOM content used comes from banana weevil that functions as a growth regulator cytokinin that can stimulate plant growth (Kurniati et al. 2017).

According to the study (Batara et al. 2016) the highest total number of microbe

Figure 1. Application of various types of Organic Fertilizers in Rice Paddy Plants

Table 3. Effect of organic fertilization on dry weights of grain, straw and rice paddy plants (g plant^{-1})

Treatment	Weight of grain	Weight of straw
Control	15.45 a	84.20 a
50% Urea	34.55 bc	126.72 ab
100 % Urea	43.97 c	164.00 b
MOL	32.55 bc	146.15 b
Compost	23.00 ab	115.72 ab
Biochar	32.22 bc	150.32 b
Azolla	33.02 bc	125.07 ab
MKBA	37.50 c	157.75 b

Note: Numbers followed by the same letters in the same column show results that are not significantly different based on the DMRT test at the error level of 5%

populations was found in purslane LOM, the highest N_2 inhibiting bacteria on krokot and gamal LOM, solvent P bacteria and cellulolytic microbial on rice LOM. In addition, the microbes that will interact with each other in degrading and mineralizing complex compounds of organic matter into simple compounds and a number of essential nutrients such as N, P and K. The availability of nutrients is also an important factor in microbe growth (Gunawan et al. 2010). In addition, compost treatment showed the second smallest grain weight after control. This is likely because compost is derived from leaves, and has not been fully decomposed, so occur immobilization of N. Nitrogen will be used by microbes, so there is a possibility that N was absorbed by microbes. Therefore, the amount of N organic becomes more than N inorganic. Thus, the amount of inorganic N absorbed by plants becomes less, so plant growth is inhibited.

Based on statistic results, table 3 data showed that the highest weight of straw value is found in the 100% urea treatment, and lowest weight of straw was found in the control treatment without urea fertilizer. This is because urea fertilizer is a chemical fertilizer which is more quickly available to be absorbed by plants, so that the plant's weight is higher, when compared to control plants without urea fertilizer. Although the N uptake in straw and grain was not significantly different, the control treatment resulted in the lowest weight of grain and straw. In this case, it is suspected that because the supply of N nutrients for plants only comes from the soil, there is no addition of other N elements during the plant growth period. In other treatments, there was the addition of the element N so that the weight of straw and grain was higher than the control treatment.

Provision of biochar derived from burning husks that have a high pH value, high organic C and high surface area. The nature of biochar causes biochar to have high nutrient retention power so as to reduce nutrient expenditure. Based on research (Herman & Resigia, 2018) that the treatment of 75% biochar rice husk + 25% rice straw compost affects the growth and production of rice plants. Furthermore the addition of azola, has a high nitrogen content and symbiosis with Cyanobacteria in binding free nitrogen in the air of N fixation (Lestari dan Muryanto, 2018). So thus, this combination can make the nutrients available in the soil can be utilized by rice plants so that rice production can increase. Based on research (Nurmayulis et al.2011) showed that the application of 50% nitrogen fertilizer (100 kg ha^{-1}) and 1.13 tons ha^{-1} Azolla michrophylla gave good results on plant height parameters 2-6 MST, Number of tillers 2-7 MST. Application of gliricidia LOM have an effect on the number of productive tillers, the number of filled grain/ panicle, the number of empty grain/panicle, and the dry grain yield (GKP) / plot, but not affect the plant height (Paulus et al. 2018).

CONCLUSION

The treatment of MKBA (MOL fertilizer, compost, biochar, azolla) shows a value that is not much different from the treatment of 100% urea. Organic fertilizer formula (LOM fertilizer, compost, biochar, azolla) can reduce the use of urea fertilizer by 50%

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