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Effect of Combination of Poultry Manure and Rice Husk Biochar on Soil Fertility and Rice Plants

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ABSTRACT
Rice plants occupy a strategic position as a staple food producer for the people of Indonesia. Faced with limited suboptimal soil fertility, especially low levels of nutrients and soil pH, the use of organic fertilizers combined with local ameliorants is one solution to increase soil fertility. The purpose of this study was to obtain a combination of chicken or quail manure with rice husk biochar, which can reduce the use of inorganic fertilizers (urea, SP-36, and KCl). This study used a completely randomized design (CRD) consisting of 7 treatments (A, B, C, D, E, F, and G) which was a combination of 100% to 25% inorganic fertilizer of the recommendations, chicken manure or bird manure quail 5 tons/ha, and rice husk biochar 5 tons/ha. The parameters observed were plant height, total chlorophyll, seed dry weight, soil pH, soil NPK content, and Al-dd content. Observational data were analyzed with the F test at the 5% level then further tests were carried out using the Honest Significant Difference (HSD) test. The results showed that the treatments had a very significant effect, namely C, D, and E treatments resulted in a decrease in Al-dd, and an increase in K and had a significant effect on rice plant height. It was concluded that a combination of 5 tons/ha of chicken manure or quail manure with 5 tons/ha of biochar could increase soil fertility and rice plant height during the vegetative period and could substitute inorganic fertilizers up to 50% of the recommended dose.

INTRODUCTION

Rice (*Oryza sativa* L.) is the main crop that produces staple food for the Indonesian population, which currently accounts for around 275.36 million people (Dirjen Dukcapil Kemendagri, 2022). Indonesia has a suboptimal land area of 157.2 million hectares (ha). The area of suboptimal land in Indonesia that is suitable for agriculture reaches 91.9 million hectares (ha), of which about 21.5 million ha (23.5%) is a suboptimal wetland (Haryono, 2013). Wet suboptimal land includes tidal swampland, lowland swamp, and peat. Tidal swamp land is a swamp area that is affected by tides, located near the seashore, mostly in the form of mineral soil and partly in the form of peat (Mulyani & Sarwani, 2013).

Suboptimal land naturally has low productivity, so the usual approach to optimal land cannot be applied to suboptimal land. Suboptimal land consists of two typologies, namely suboptimal wetland and dry suboptimal land. The problems faced in cultivating plants in the suboptimal wetland are low soil pH, low soil fertility, fluctuations in the water regime, various physicochemical conditions of the soil, the presence of toxic substances, and saltwater intrusion. The low fertility is exacerbated by the continuous use of chemical fertilizers which causes the soil to dry quickly, cracks when there is not enough water is sticky when processed, the tillage layer is shallow and production is difficult to increase and even tends to decrease (Kurniawan et al, 2017). Efforts that have been made to overcome these obstacles are with minimum tillage or no tillage, fertilization, liming/amelioration, the introduction of site-specific varieties of rice, water regulation (micro water management) and improvement of cultivation techniques (Masulili, 2015). The results of the preliminary research that the research team has carried out are that the application of 5 tons/ha of oil palm empty fruit bunch compost with 10 tons/ha of Chromolaena odorata biomass on acid sulphate soil can increase the pH from 5.26 to 6.22 (Hayat et al., 2014). Further research on suboptimal wet soil with the use of 5 tons of poultry manure (chicken/quail) combined with 5 tons of rice husk biochar per hectare on corn can reduce the use of inorganic fertilizers (urea, SP-36, and KCl) by about 25%- 75% of the recommended dose (Hayat et al., 2021).

For this reason, technological innovation is needed in the use of organic fertilizer derived from poultry waste as a biochar additive which is believed to be able to increase the supply of macronutrient main nutrients (NPK), but faced with suboptimal soil that reacts to acid, manure needs to be enriched with rice husk biochar to overcome the problem. soil acidity. Wet suboptimal land includes tidal swampland, lowland swamp, and peatland. Tidal swamp land is swamp land that is affected by tides, located near the coast, mostly in the form of mineral soil and partly in the form of peat (Mulyani & Sarwani, 2013). Tidal swamp land is characterized by aquik conditions (saturated water) and has sulfidic material (iron sulfide) which is better known as pyrite, generally reacts with extreme acid ($pH<4$) so it is often called acid sulfate (Subagyo, 2006). Lebak swamp land is swamp land that is not affected by tides but is influenced by a very dominant river, namely in the form of large floods that periodically inundate the area during the rainy season (Subagyo, 2006). Peatlands are formed due to the addition of fresh organic matter faster than its breakdown. Peat chemical properties that are prominent and related to agriculture include soil acidity, carbon stock, nutrient availability, CEC, ash content, organic acid and pyrite (Szajak et al., 2007; Fahmi et al., 2014). The availability of macro elements in peat soil is very varied. The basic elements in peat are found in a low category, but elsewhere in a high category, while N and P are in the moderate to a very high category, but are not immediately available to plants (Mulyani & Sarwani, 2013; Subagyo, 2006; Wiratmoko et al., 2008).

Land characteristics that are a problem in agricultural development in tidal land include fluctuations in water regimes, various physicochemical soil conditions, high soil acidity and organic acids in peatlands, the presence of toxic substances, saltwater intrusion, and low natural soil fertility. The provision of ameliorant or soil improvement materials and fertilizers is an important factor to improve soil conditions and increase land productivity. The soil improvement material can be in the form of lime (calcite and dolomite) or ash (rice husk ash and sawdust ash). The exact dose of ameliorant material depends on soil conditions, especially soil pH (Nazemi et al., 2012). Rice production in suboptimal tidal land is still relatively low. The average rice production has only reached 2.5 tons/ha, even though the potential yield can reach 4.0-5.0 tons/ha (Sabran et al, 2003). The low productivity is due to constraints including low soil fertility, low pH, the presence of toxic substances Fe and Al, as well as water fluctuations that depend on the tides of river water. Based on the description above, it is necessary to research the combination of manure and rice husk biochar which aims to get the best combination of chicken or quail manure combined with rice husk biochar to reduce the use of inorganic fertilizers in rice cultivation.

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METHOD

The research was carried out in Sungai Rengas Village, Sungai Kakap District, Kubu Raya Regency, West Kalimantan Province, Indonesia, starting from March 2021 to July 2021. The rice used was the Ciherang variety with an average production of 10 tons per hectare and a harvest age of around 100-105 days. The research was carried out in polybags using soil originating from tidal land which was one of the suboptimal wetlands, with Alluvial soil type and soil weight per polybag is 10 kg. The study began with taking soil samples using a sample ring to calculate the bulk weight of the soil which became the basis for calculating fertilizer doses.

The method used in this study was experimental in the form of a Completely Randomized Design (CRD). The treatment that will be applied consists of 7 treatment combinations, namely:
A = 100% inorganic fertilizer + rice husk biochar 5 tons/ha,
B = 75% inorganic fertilizer + 5 tons/ha chicken manure + 5 tons/ha rice husk biochar,
C = 75% inorganic fertilizer + 5 tons/ha quail manure + 5 tons/ha rice husk biochar,
D = 50% inorganic fertilizer + 5 tons/ha chicken manure + 5 tons/ha rice husk biochar,
E= 50% inorganic fertilizer + 5 tons/ha quail manure + 5 tons/ha rice husk biochar,
F= 25% inorganic fertilizer + 5 tons/ha chicken manure + 5 tons/ha rice husk biochar,
G = 25% inorganic fertilizer + 5 tons/ha of quail manure + 5 tons/ha of rice husk biochar.

Each treatment will be repeated four times with two sample plants so that 56 experimental plant samples will be produced. The recommended dose of inorganic fertilizer was 200 kg urea/ha, SP-36 = 100 kg/ha and KCl = 100 kg/ha. Parameters observed in this study were rice plant height (cm), total leaf chlorophyll (unit), seed dry weight (grams), soil pH, soil N content (%), available P (ppm), soil K content (cmol (+)/kg), Al-exchangeable funds (cmol(+)/kg). The control variable in this study was the factor of uniform initial soil media, namely using soil weighing 10 kg per polybag, the rice variety used was Ciherang with uniform seed age conditions, and polybags were placed in relatively uniform environmental conditions.

The data obtained from the results of the study were analyzed using the F test. If the results of the F test showed that the calculated F is less than or equal to the F table of 5%, then the treatment has no significant effect, if the calculated F results are greater than the F table of 5% or the same with F table 1% then the treatment has a significant effect, and if the calculated F is greater than the F table 1% then the treatment has a very significant effect. If the effect of the treatment is real or very real, then the analysis is continued with the honest significant difference test (HSD) at the 5% level of confidence, to determine differences in treatment levels.

RESULTS AND DISCUSSION

The results of the study using organic fertilizer derived from poultry (chicken and quail) waste combined with rice husk biochar generally showed a significant effect on plant height, available K, and decreased soil Al-dd. The other variables showed no significant effect but showed a tendency that the treatment had the potential to increase the amount of chlorophyll, dry weight of rice, soil pH, total N, and available P (see Table 1).

The effect of treatment on rice plant height showed that the application of inorganic fertilizer application of 75% of the recommended dose followed by the use of quail manure and rice husk biochar could produce the highest plant height of 81.13 cm. Plant height is a growth process that occurs mainly in the vegetative stage. Plant height growth is the result of increasing the number and size of stem cells due to cell division. The process of cell division requires an energy supply that comes from ATP. Cell division requires nutrients that function to build cell mass. Sources of cell energy and nutrients to build these cells are supplied from nutrients in the good soil that comes from natural nutrients, also from the addition of organic fertilizers given, remembering in this quail manure.

The application of N, P and K elements can increase plant height and yield of Inpari 30 rice (Budiono et al., 2019). The use of chemical fertilizer compost t is useful for increasing rice plant height, where at 100% flowering it is recorded in the treatment of half a dose of compost fertilizer. given at the same time as a half dose of chemical fertilizer (85.92) followed by a full dose of chemical fertilizer (85.80), and control plots (82.70) (Anas et al., 2016).

Table 1
Effect of Application of Organic Fertilizer from Poultry and Rice Husk Biochar on Rice Plants and Soil Fertility

Treatment	Observation Variable							
	Plant Height (Cm)	**Amount Of Chlorophyll (Units)**	**Dry Grain Weight (Gr)**	**pH**	**N (%)**	**P (ppm)**	**K (cmol(+) /Kg)**	**Al-dd (cmol(+) /Kg**
A	71.53 a	39.49	16.13	4.23	0.72	17.93	0.17 a	0.59 a
B	76.63 ab	40.44	17.38	4.43	0.75	32.63	0.20 ab	0.22 b
C	81.13 b	39.51	12.63	4.54	0.71	37.61	0.28 abc	0.11 b
D	75.31 ab	38.96	14.25	4.49	0.71	40.08	0.21 abc	0.11 b
E	77.31 ab	38.14	12.13	4.64	0.72	41.25	0.31 c	0.11 b
F	74.44 ab	37.96	15.5	4.64	0.76	38.91	0.22 abc	0.14 b
G	75.21 ab	39.95	9.75	4.60	0.75	33.63	0.30 bc	0.14 b
Influence	*	ns	ns	ns	ns	ns	*	*

*Note : * = Significantly influential, ns = not significant*
Values in the same column followed by the same letter indicate that the treatment is not significantly different at the 5% HSD test level.

The effect of the treatment applied to the increase in the amount of chlorophyll showed that there was no significant effect of all treatment combinations, but the average results obtained showed that a 25% reduction in inorganic fertilizer followed by the addition of chicken manure and rice husk biochar resulted in the highest average amount of chlorophyll, namely 40.44 units. This result was followed by a 75% reduction in inorganic fertilizer treatment followed by the addition of quail manure and rice husk biochar to produce a total chlorophyll of 39.95%. The results of Efeendi et al. (2020) that the dose of biochar rice husks of 12.5 tons ha-1 resulted in higher chlorophyll content of rice leaves, namely 25.65 units. The formation of the amount of chlorophyll is influenced by the amount of N nutrients that can be absorbed by plants and includes the element Magnesium. The contribution of N elements from manure and Mg from rice husk biochar is thought to increase the amount of chlorophyll.

The effect of treatment on increasing dry grain yields showed that there was no significant effect of all treatment combinations. However, on average, it showed that the treatment of reducing inorganic fertilizer by 25%, followed by the addition of chicken manure and rice husk biochar, resulted in an average number of grains weighing 17.38 grams per clump. The results of Efeendi et al. (2020) showed that composting of 8.9 tons per hectare produced a maximum of 7.63 tons/ha of rice. The yield of the rice grain is a pile of biomass in the form of carbohydrates present in rice seeds. Rice seed filling is highly dependent on the supply of macro and micronutrients.

The effect of treatment on increasing soil pH showed no significant effect, but in general, the average pH value showed that the combination of organic fertilizer from poultry combined with rice husk biochar. The poultry manure used contains bases such as K, Mg, Ca, and Na as well as rice husk biochar. These bases can dominate around the root area so that they can help neutralize pH conditions, and can increase the availability of nutrients for plants. The results of the study (Sa'adah et al., 2018), the application of soil amendments increased soil pH from 3.7 to 6.2. Significant ($p < 0.05$) changes in high soil pH were observed after 57 DAP.

e-ISSN: 2615-1707. Page: 53-59

The effect of treatment on soil N, P, and K levels showed that the combination of poultry manure treatment had a significant effect on soil K levels. From the results of the honest real difference test in Table 1, it can be seen that the application of 50% inorganic fertilizer from the recommended dose combined with 5 tons/ha of quail manure and 5 tons/ha of rice husk biochar resulted in the highest increase in K levels of 0.31 cmol(+)/kg and followed by an inorganic fertilizer application treatment of 25% of the recommended dose combined with 5 tons/ha of quail manure and 5 tons/ha of rice husk biochar which resulted in a K value of 0.31 cmol(+)/kg. Here it shows that the 50-75% reduction in inorganic fertilizers can be replaced by the addition of a combination of 5 tons of quail manure and 5 tons of rice husk biochar. From the results of the analysis of nutrient levels carried out on quail manure combined with rice husk biochar, N = 1.16%; P = 4.09%, K = 1.01%. Here it can be seen that the fertilizer has the potential to supply nutrients for plants, besides that this organic fertilizer can improve the life of soil microorganisms.

The addition of rice husk biochar also greatly improved the physical and chemical conditions of the suboptimal soil used. The results of soil analysis at the research site showed that the soil texture was dominated by dust by as much as 78.37% and clay by as much as 21.63%. With the addition of this biochar, the soil will be more porous, so the macro pore conditions will increase so that the distribution and circulation of soil oxygen are getting better. Other uses of biochar are related to the mechanical processing that occurs in the soil, namely: increasing water holding capacity (Santi & Goenadi, 2010; Sutono & Nurida, 2012; Sukartono & Utomo, 2012; Yu et al., 2013) and decreasing nutrient leaching (Novak et al., 2009; Yao et al., 2012).

The effect of treatment on the reduction of soil Al-dd was seen to have a significant effect, where the treatment of reducing inorganic fertilizers by 25-50% accompanied by the application of chicken or quail manure of 5 tons/ha combined with rice husk biochar as much as 5 tons/hectare resulted in a decrease in Al-dd up to 0.11 cmol(+)/kg. Meanwhile, the application treatment of 100% inorganic fertilizer added with biochar husk as much as 5 tons/hectare has not been able to reduce the Al-dd of the soil, where in this treatment the condition of the Al-dd of the soil has a high value of 0.59 cmol(+)/kg. The results of research by Wahjudin (2006), provision of compost from rice, corn, soybeans or peanuts into the Vertic soil Hapludult reduces Al-dd content inside different land.

CONCLUSIONS

The results showed that a 25% reduction in inorganic fertilizer combined with 5 tons of quail manure and 5 tons of rice husk biochar had a significant effect on producing the highest rice plant height of 81.13 cm. Reduction of inorganic fertilizers by 50% combined with 5 tons of quail manure and 5 tons of rice husk biochar had a significant effect on increasing soil K levels of 0.31 cmol(+)/kg. Reduction of 25-50% inorganic fertilizer combined with 5 tons of quail manure or chicken manure and 5 tons of rice husk biochar had a significant effect on reducing soil Al-dd to 0.11 cmol(+)/kg.

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