Utilization ameliorant for improvement productivity of "Raja Uncak" local rice in Kapuas Hulu Regency West Kalimantan

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Abstract. Raja Uncak local rice in the Kapuas Hulu Regency, West Kalimantan Province. is very popular to neighboring country (Malaysia). Rice Raja Uncak is usually planted by farmers once a year in the traditional way and does not use inorganic fertilizers but uses litter from the Kapuas River. The purpose of this study was to increase the productivity of Raja Uncak local rice by giving several ameliorants. The research method used was in the form of a field experiment with a randomized block design. The treatments applied were T1 (Compost of organic litter from Kapuas River application 5 t ha^{-1}), T2 (Biochar application 5 t ha^{-1}), T3 (lime application 2 t ha^{-1}), and (T0) (without ameliorant). The results showed that the treatment with 5 t ha^{-1} of compost delivers the best results and was significantly different from other treatments. Providing 5 t ha^{-1} of compost can increase the productivity of Raja Uncak local rice from 0.72 t ha^{-1} (Without ameliorant) to 3.14 t ha^{-1}. Thus, the effort to provide ameliorant in the form of 5 t ha^{-1} of compost is recommended for the Raja Uncak local rice cultivation in Kapuas Hulu Regency.

1 Introduction

The Government of Republic of Indonesia has issued Presidential Regulation of the Republic of Indonesia (-Perpres) No. 31 of 2015 concerning the spatial plan for national border areas in Kalimantan [1]. The Perpres mentioned five regencies that are included in the state border area, including; Kapuas Hulu Regency, Sintang Regency, Sanggau Regency, Bengkayang Regency and Sambas Regency.

The food barn program in the border area was also launched by the Indonesian government a few years ago. West Kalimantan Province is one of the provinces that has 5 national border areas, including in Sambas, Sanggau, Sintang, Bengkayang and Kapuas Hulu Regencies. It is hoped that the agricultural development program in the border areas of the country will increase people's income, which in turn will improve the economy in the border areas. One of the key factors of this program is an increase in production which is supported by agricultural innovation by taking into account the potential of local wisdom of the local

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community. Support for innovation in the form of technological innovation is important in developing border areas as food barns.

The border area in Kapuas Hulu Regency which borders the State of Malaysia and Brunei Darussalam has the potential for the development of local rice whose taste is very much preferred by the Malaysian people, namely Raja Uncak rice. Raja Uncak rice is a local rice in the Kapuas Hulu district with the name of the area being Saloang rice whose rice prices are quite promising. Most of the farming communities in Putussibau Selatan Subdistrict, Kapuas Hulu Regency, cultivate local rice of the Raja Uncak rice type, and other local types such as Anik, Rana Halus, and Balik. This local rice is about 5 – 6 months old and is cultivated with an organic system in rainfed rice fields once a year (October - March) in the low season with an area of 4,823 ha.

The problem faced by farmers in Raja Uncak rice cultivation is still low. This is because the paddy fields have degraded organic matter content which is used every season for organic rice cultivation without returning organic matter back to the paddy fields. Soil degradation problems are very common lately, including the loss of the organic layer of paddy soil which can affect the productivity of paddy fields. In eroded soils, loss of topsoil results in greater loss of soil organic matter. The average annual reduction rate of soil organic matter in China is 0.5%, while the average annual reduction rate of soil organic matter in heavily eroded soils in China is 1.35% [2].

To meet the nutrient needs of rice plants in an organic farming system, proper nutrient management is needed through the provision of organic fertilizers and the management of organic matter found around the rice fields (in situ). Changes in soil chemical properties in organic farming systems need to be evaluated to determine the increase in productivity of paddy fields and at the same time increase rice productivity. Organic matter serves as a soil enhancer and can help plants absorb nutrients [3]. Examples of organic materials that can be used are manure from livestock and green manure such as rice straw compost, azolla, and other organic litters.

Organic materials contain from Kapuas River litter are elements needed by plants. Litter from river can increase the phosphorus content available in the soil that can be utilized by plants. Litter from river also increases the availability of nitrogen in the soil so that nitrogen can be available to plants [4]. In addition to litter, there are many types of organic materials that can be reused into the soil, such as waste products and products from agricultural companies, food processing, municipal waste, and industry. Generally, organic materials available and utilized include: agricultural waste, municipal waste, organic waste from food processing, organic waste from industrial paper and wood factories, and consumer food waste [5], crop residues, green manure, municipal waste, industrial waste, compost [6], and plant residues or forage materials [7].

All of them have the potential to be processed into organic materials that are useful for increasing soil fertility naturally as organic fertilizers, because they contain high nutrients. Organic materials that are widely available around the rice fields are rice straw and rice husks. Leftover rice straw can be used as organic compost and rice husks can be used as husk charcoal (biochar). Biochar is a porous wood charcoal substance, often also called charcoal or agro-char. Utilization of organic matter in the form of biochar is known to improve chemical, physical and biological fertility of the soil. Biochar is able to improve soil through its ability to increase pH, retain nutrients, and make nutrients more available to plants [8-9], does not disturb the carbon-nitrogen balance and retains water [9], provides a good habitat for soil microbes, increases the activity of biota in the soil and reduces pollution [8-9]. There are also various organic materials that can be used as raw materials for biochar, and have been put forward in many studies. Among them are rice straw [8], oil palm shells [9], corn straw and oil palm empty fruit bunches [8], sawdust [10], and rice husks [8-11].

On the banks of the Kapuas River in the Putussibau Selatan District, Kapuas Hulu Regency, there is a lot of organic litter mixed with river mud. The organic litter material can be used as organic compost to be used as organic fertilizer in situ. In addition, there is also a lot of rice husk that has not been utilized; the rice husk can be used as husk charcoal (biochar) as an ameliorant material for the cultivation of local rice plants of Raja Uncak.

The purpose of this study was to determine the effect of the use of several types of abundant organic materials around the study site such as organic litter compost from the banks of the Kapuas River and husk charcoal and lime on the production of local rice plants in Raja Uncak using an organic farming system. The results of this study are expected to increase the productivity of Raja Uncak rice in the border areas, especially in Kapuas Hulu Regency, West Kalimantan Province, Indonesia.

2 Materials and methods

The research was conducted in rice fields during the rainy season (September 2018 – February 2019) in Melapi Village, Putussibau Selatan District, Kapuas Hulu Regency, West Kalimantan Province, Indonesia. The materials used include rice seeds of the local Raja Uncak variety, agricultural production facilities in the form of organic materials in the form of organic litter compost, husk charcoal and other auxiliary materials.

This research is a field experiment in rainfed rice field with organic rice cultivation system. The research was conducted in paddy fields with the size of each plot of 100 m^2 (5m x 20m). The environmental design used was a Randomized Block Design (RBD) with 4 treatments, and repeated 6 times. These treatments include:

T0: Without the addition of organic matter and other ameliorant ingredients (control),

T1: Provision of organic material in the form of organic litter compost from the Kapuas River at a rate of 5 t ha^{-1}.

T2: Provision of husk charcoal (biochar) at a rate of 5 t ha^{-1}.

T3: Application of dolomite at a rate of 2 t ha^{-1}.

Raja Uncak local rice cultivation is done by not giving chemical fertilizers (inorganic). Firstly, organic litter from the banks of the Kapuas River that is used is composted using a decomposer for one month. Before sowing, rice seeds were given seed treatment, namely by soaking in a solution of Bacillus sp. is a Plant Growth Promotion Rhizobacteria (PGPR) that can increase plant growth and production. Bacillus is able to fixation of nitrogen, dissolve phosphate and synthesize phytohormones IAA (Indole 3- Acetic Acid). The ability of Bacillus sp. as PGPR can increase the availability of low nitrogen and phosphate nutrients in rice fields [12]. Meanwhile, mycorrhizae fungi can infect plant roots by forming hyphae that can help roots to absorb water and nutrients [13]. The data from the experimental results of several treatments were analyzed using the Analysis of Variance (Anova) method, and continued with the further test of significant difference with the Duncan's Multiple Distance Test [14]. Observations were made on the yield of rice converted per hectare. To determine the value of profit and economic feasibility of each treatment, financial analysis and R/C Ratio were carried out.

3 Results and discussion

3.1 Rice production

Treatment with organic litter compost at a dose of 5 t ha^{-1} showed the highest dry milled grain yield was 3.14 t ha^{-1} and was significantly different from other treatments. While the treatment of giving biochar from husk charcoal can produced 2 t ha^{-1} of grain, then lime

treatment can produce 1.02 t ha^{-1} of grain and the control produces 0.72 t ha^{-1} of dry milled grain.

Table 1. The results of Duncan's Multiple Distance Test in the experiment of administering several ameliorants to local rice yields of Raja Uncak in Kapuas Hulu Regency, West Kalimantan Province, Indonesia.

Treatments	Milled Dry Grain Yield (water content, 14%) t/ha	
T1 (Organic litter compost)	3,14	A
T2 (Biochar)	2,00	B
T3 (Lime)	1,02	C
T0 (Control)	0.72	D

The application of organic compost from the Kapuas River as organic fertilizer at a dose of 5 t ha^{-1} gave the highest dry milled grain yield of 3.14 t ha^{-1}. This showed that nutrients have an important role in the growth and production of rice plants such as nitrogen (N), phosphorus (P) and potassium (K). The N content in organic compost can be directly utilized by rice plants, but generally in the soil it will be converted into ammonium and nitrate through the process of ammonification and nitrification by soil bacteria [15-16]. The application of 5 t ha^{-1} of organic compost can save the use of Urea, TSP and KCl fertilizers by 100 kg ha^{-1} and the use of organic compost as much as 5 t ha^{-1} for 4 growing seasons can contribute to 170 kg K, 160 kg Mg, and 200 kg Si [17]. All organic matter added to the soil significantly improves various soil functions, including the retention of various essential nutrients for plant growth [18].

Table 1 shows that the treatment with biochar at a dose of 5 t ha^{-1} gave a dry milled grain yield of 2 t ha^{-1} and was significantly different when compared to lime and controls. It is suspected that biochar will have a positive effect on soil fertility so that it affects the growth and production of rice plants. Soil treated with 10 t ha^{-1} biochar can increase the pH value of the soil from the initial condition of 6.78 to 7.40 or an increase of 9.14% [19]. The application of biochar 22.4 t ha^{-1} increased total soil organic carbon 1.4 times and increased soil available Mn 1.5 times compared to control [20]. Biochar can change the physico-chemical properties of the soil, so it can affect soil fertility [21].

The application of lime to rice plants gave the dry milled grain yield of 1.02 t ha^{-1} which was lower than the application of compost and biochar but higher than the control which only produced 0.72 t ha^{-1}. The application of lime has not been optimal in providing rice grain yields, presumably because the application of lime which is only 2 t ha^{-1} still cannot raise the soil pH at the research site, before being limed the pH was 4.07 and after being limed it became 5.51. pH 5.51 is still quite acidic, so that soil nutrients are still bound by soil colloids. Soil acidity is very influential on the availability of plant nutrients, where soil acidity below pH 5.6 lacks base cations that can be exchanged at low pH.

The application of lime which is only 2 t ha^{-1} is still not enough to add alkaline cations in the soil. Low soil pH affects plant productivity, plants will grow well in soil pH conditions ranging from 6-7 [22]. Such soil conditions will provide sufficient Ca, Mg and P elements for growth [23].

3.2 Profit value

The results of the analysis of Raja Uncak organic rice farming in Kapuas Hulu Regency showed that Raja uncak organic rice farming with compost treatment had higher revenues, profits and R/C Ratio than those treated with Biochar, Lime or Control (Table 2).

Table 2. Results of analysis of local organic rice farming Raja Uncak in Kapuas Hulu District, West Kalimantan Province, Indonesia.

Treatments	Production cost IDR	Revenue IDR	Profit IDR	R/C Ratio
T1 (Compost)	9.221.250	25.120.000	15.898.750	2.73
T2 (Biochar)	11.865.000	16.000.000	4.135.000	1.35
T3 (Lime)	9.961.500	8.160.000	(-)1.801.500	0.82
T0 (Control)	6.577.500	5.760.000	(-) 817.500	0.88

This condition is due to the addition of compost that is able to provide higher production yields and is significantly different from other treatments. In addition, the farming costs required for the cultivation of organic Raja Uncak rice with the application of compost are lower than the application of biochar and lime. Raja Uncak organic rice farming with compost only costs 77.72% of the production cost of Raja Uncak organic rice farming using biochar and 92.59% of the production cost of Raja Uncak organic rice farming using lime. This shows that the production cost of Raja Uncak organic rice farming using compost can save production costs of 22.28% from the production cost of Raja Uncak organic rice farming using biochar and can save production costs of 7.43% of the production costs of organic rice farming who uses lime.

The acceptance of Raja Uncak organic rice farming that was treated with compost was greater than the rest three treatments. This happened because the yield of milled dry grain yields produced from Raja Uncak organic rice farming that was given compost treatment was greater than that given biochar, lime or control treatment. The difference in acceptance between each treatment ranged from Rp. 9,120,000 to Rp. 19,360,000.

Another analysis result is the R/C ratio. The R/C ratio describes the value of the comparison between total revenue and total costs. The results of the analysis of the R/C ratio of the organic rice farming of Raja Uncak which were treated with compost were higher than those treated with biochar, lime or control. The value of the R/C ratio for Raja Uncak organic rice farming which was treated with compost was 2.73. This means that each cost incurred is Rp. 1,000 will generate revenue of Rp. 2,730.

4 Conclusion and suggestion

Farmers in Kapuas Hulu Regency are accustomed to use organic litter compost from the banks of the Kapuas River for the organic cultivation of Raja Uncak rice. However, the dose of compost is still below 2 t ha^{-1}, thus the production of grain yields is less than 2 t ha^{-1}. The results of this study recommend farmers to use organic compost litter from the banks of the Kapuas River with a dose of 5 t ha^{-1}, because by increasing the dose to 5 t/ha it can add more organic materials in the soil so that nutrients in the soil are more available to plants, proven to be able to increase the productivity of local rice Raja Uncak by 336% from 0.72 t ha^{-1} to 3.14 t ha^{-1} of grain. It also allows and increase in profit to IDR 15,898,750.

In the next growing season, it is recommended to combine the treatment of organic compost with biochar which is thought to have a positive effect on land productivity and increasing the productivity of local rice Raja Uncak.

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