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The Effect Of Biochar Applications Of Rice Husk And Coffee Skin On P And Zn Nutritions And The Growth Of Rice (Oryza Sativa L.) Plants In Satisfied Rice Land

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Abstract

This study aims to evaluate the effect of rice husk and coffee husk biochar, evaluate difference effect of rice and coffee husk biochar and to know the effect of difference of dose of rice and coffee husk biochar phosphate and zinc, and rice growth in the paddys soil with high total P . The research was conducted on the greenhouse, Faculty of Agriculture, University of North Sumatra, Medan. The soil which used from the paddys soil in Lubuk Dendang, Perbaungan, Serdang Bedagai which has the high total P. The experiment was carried out using completely randomized design with 7 treatment : control ; 10 tons/ha, 20 tons/ha, and 30 tons/ha rice husk biochar ; 10 tons/ha, 20 tons/ha, and 30 tons/ha coffee husk biochar. The Analysis of data used the analysis of variance and contrast orthogonal test.

Keywords: biochar, paddy soil, P, Zn, rice growth

1. Introduction

The need for rice as the main food commodity is increasing day by day, but the problem of its availability is a matter of great urgency to be overcome. For this reason, various efforts have been made, both extensification by opening new land and intensification efforts. Where intensification aims to increase the yield of each unit area of an area through the application of new technologies, including the provision of nutrient inputs to the soil and appropriate management methods through various programs launched (Sumaryanto et al, 2001).

Continuous application of P fertilizer in paddy fields every growing season with high doses causes the accumulation of P nutrients in the soil, so that fertilization efficiency decreases considering that P fertilizer is not easily evaporated, washed or carried away by water and this suppresses the availability of micro nutrients, especially Zn nutrients in the soil so that the productivity of lowland rice decreases due to an imbalance of nutrients in the soil. The Directorate General of Food Crops Agriculture (2000) reports that there is P saturation in several intensification areas which is estimated for Indonesia to reach 2.5 million ha, due to continuous P fertilization every growing season. This P accumulation will become a residue in the soil and will result in rice plants being unresponsive to P fertilization in the next growing season.

All organic matter added to soil significantly improves soil function, including the retention of some essential plant nutrients. Biochar is much more effective in nutrient retention and availability to plants than other organic materials such as compost or manure. This also applies to P nutrients that are not retained by ordinary organic matter. Carbon in biochar is stable and can be stored longer in the soil than other organic materials. Therefore, all the benefits associated with nutrient retention and soil fertility can last longer than other forms of organic matter that are commonly administered (Gani, 2009).

The addition of biochar to the soil increased the CEC and pH, up to 40% of the initial CEC and up to one pH unit, respectively. The high availability of nutrients for plants is the result of increased nutrition directly from biochar and increased nutrient retention. With pot research using rice (Oryza sativa L.) it was concluded that the addition of biochar significantly increased plant growth and nutrition. Although the leaf N concentration decreased, the uptake of P, K, Ca, Zn, and Cu by plants increased with the higher addition of biochar. The leaching of the applied N fertilizer was significantly reduced by the application of biochar, while the leaching of Ca and Mg was slowed (Lehmann and Joseph, 2009).

2. Materials and Methods

The research was carried out at the Greenhouse of the Faculty of Agriculture, University of North Sumatra, Medan with an altitude of ± 25 meters above sea level. This research was conducted from June to October 2016.

The materials used in this experiment were rice seeds of Ciherang variety, saturated P soil (high total P content) taken from Lubuk Dendang Village, Kec. Perbaungan, Kab. Serdang Bedagai, rice husks as biochar material, coffee bean husks as raw material for biochar, Urea (46% N) and KCl (60% K2O) fertilizers as basic fertilizers, water to flood rice fields, chemicals for analysis in the laboratory, and other materials that support this research.The tools used are a hoe to take and homogenize the soil, a bucket as a soil container, a biochar maker (pyrolyzer), a scale to weigh soil and biochar, laboratory tools for analysis, and other tools that support this research.

This study used a completely randomized design (CRD) with 7 treatments and 5 replications so that 35 experimental units were obtained. The results of the treatment used the F test at the 5% level and if it was real then the Orthogonal Contrast test was carried out.

3. Results and Discussion

Soil PH

The data for observing soil pH at 4 WAP from each treatment and the results of the analysis of variance are presented in Appendix 1. The results of the analysis of variance are not significant.

Table 1. Soil pH in Various Biochar Treatments

Treatment	pH	Criteria

Control	6.93	Neutral
Rice husk biochar 10 tons/ha	6.73	Neutral
Rice husk biochar 20 tons/ha	6.67	Neutral
Rice husk biochar 30 tons/ha	7.03	Neutral
Coffee bean husk biochar 10 tons/ha	6.77	Neutral
Coffee bean husk biochar 20 tons/ha	7.00	Neutral

Note * : Criteria based on LPT. 1983

Based on the results obtained (Table 1.) it is known that the average soil pH ranges from 6.67 to 7.1. All pH in each treatment were in the neutral criteria.

PeP - Land Available

Observation data P Available soil from each treatment and the results of the analysis of variance are presented in Appendix 2. The results of the analysis of variance are not significant.

Table 2. P – Available Soil in Various Biochar Treatments

Treatment	P Available (ppm)	Criteria*
Control	111.22	Very high
Rice husk biochar 10 tons/ha	224.87	Very high
Rice husk biochar 20 tons/ha	182.19	Very high
Rice husk biochar 30 tons/ha	268.38	Very high
Coffee bean husk biochar 10 tons/ha	251.72	Very high

Note * : Criteria based on LPT. 1983

From the results obtained (Table 2.) it is known that the available P content of the soil in all treatments was at a very high criterion. Based on the results of the variance, there were no treatments that were significantly different between treatments. However, it can be seen from the figures that the best treatment is with rice husk biochar at a dose of 30 tons/ha.

Zn HCl 25%

Total Zn observation data (HCl 25%) from each treatment and the results of the analysis of variance are presented in Appendix 3. The results of the analysis of variance are not significant.

Table 3. Zn HCl 25% Soil in Various Biochar Treatments

Treatment	Zn - HCl 25% (ppm)	Criteria
Control	60.31	Tall
Rice husk biochar 10 tons/ha	69.46	Tall
Rice husk biochar 20 tons/ha	59.54	Tall
Rice husk biochar 30 tons/ha	57.52	Tall
Coffee bean husk biochar 10 tons/ha	60.25	Tall

Note * : Criteria based on Dobermann and Fairhust, 2000.

From the results obtained (Table 3.) it is known that the soil Zn content (HCl 25%) in all treatments was in high criteria. Based on the results of the variance, there was no significant difference between the treatments.

Plant height

Data on plant height observations from 5 WAP to 9 WAP from each treatment and the results of analysis of variance were presented. The results of the analysis of variance are not significant.

Table 4. Plant Height in Various Biochar Treatments

Treatment	Plant Height (cm)				
	5 MST	6 MST	7 MST	8 MST	9 MST
Control	74.76	83.26	91.20	92.66	94.22
Rice husk biochar 10 tons/ha	76,70	83.92	92.04	94.26	96.22
Rice husk biochar 20 tons/ha	74.78	82.74	90.68	93.14	95.28
Rice husk biochar 30 tons/ha	78.26	87,80	94.20	96.24	97.58
Coffee bean husk biochar 10 tons/ha	75.54	86.98	93.48	94.84	96.30
Coffee bean husk biochar 20 tons/ha	74.36	84.84	93.56	96.06	98.72
Coffee bean husk biochar 30 tons/ha	76.22	83.58	91.20	92.16	93.60

From the data obtained (Table 4.) it is known that the average plant height at 5 WAP was between 74.36 – 78.26 cm, at 6 WAP between 82.74 – 87.7 cm, at 7 WAP between 90.68 – 94, 20 cm, at 8 MST between 92.16 – 96.24 cm and at 9 MST between 93.60 – 98.72 cm.

Number of tillers

The observation data on the number of tillers from 5 WAP to 9 WAP from each treatment and the results of the analysis of variance are presented in Appendix 5. The results of the analysis of variance were not significant.

Table 5. Number of tillers in various treatments of biochar

Treatment	Number of tillers				
	5 MST	6 MST	7 MST	8 MST	9 MST
Control	17.60	25,80	27.40	27.60	31.00
Rice husk biochar 10 tons/ha	19.80	27,20	28,40	29,00	31,20
Rice husk biochar 20 tons/ha	21.40	26.00	26,80	28.00	30,20
Rice husk biochar 30 tons/ha	19,20	26.00	27.60	28,80	29.40
Coffee bean husk biochar 10 tons/ha	20.00	29.20	30,20	29.40	32.00
Coffee bean husk biochar 20 tons/ha	18,20	29,00	28,80	29.40	31.40
Coffee bean husk biochar 30 tons/ha	22.60	30,20	30,20	32.40	34.00

From the data obtained (Table 5.) it was known that the average number of tillers at 5 WAP was between 17.60 – 22.60 tillers, at 6 MST between 25.80 – 30.20 tillers, at 7 MST between 26.80 – 30, 20 tillers, at 8 WAP between 27.60 – 32.40 tillers and at 9 WAT between 29.40 – 34.00 tillers.

Head Dry Weight

Observation data on shoot dry weight (g) from each treatment and the results of the analysis of variance are presented in Appendix 6. The results of the analysis of variance were not significant.

Table 6. Head Dry Weight on Various Biochar Treatments

Treatment	Head Dry Weight (g)
Control	32.94
Rice husk biochar 10 tons/ha	49.58
Rice husk biochar 20 tons/ha	37,10
Rice husk biochar 30 tons/ha	42.26
Coffee bean husk biochar 10 tons/ha	54.07
Coffee bean husk biochar 20 tons/ha	31.86
Coffee bean husk biochar 30 tons/ha	51.55

From the data obtained (Table 6.) it is known that the average dry weight of the canopy ranged from 31.86 to 54.07g. Based on the results of the variance, there was no significant difference from each treatment.

Root Dry Weight

The observation data on root dry weight of each treatment and the results of the analysis of variance are presented in Appendix 7. The results of the analysis of variance are not significant.

Table 7. Root Dry Weight on Various Biochar Treatments

Treatment	Root Dry Weight (g)
Control	39.60
Rice husk biochar 10 tons/ha	50,14
Rice husk biochar 20 tons/ha	50.79
Rice husk biochar 30 tons/ha	35.67
Coffee bean husk biochar 10 tons/ha	45.14
Coffee bean husk biochar 20 tons/ha	41.56
Coffee bean husk biochar 30 tons/ha	66.32

From the data obtained (Table 7.) it is known that the average dry weight of the roots ranged from 35.67 to 66.31g. Based on the results of the variance, there was no significant difference from each treatment.

Number of productive tillers

Data on the number of productive tillers from each treatment and the results of the analysis of variance are presented in Appendix 8. The results of the analysis of variance are not significant.

Table 8. Number of productive tillers in various biochar treatments

Treatment	Number of productive

	tillers
Control	15.00
Rice husk biochar 10 tons/ha	19,00
Rice husk biochar 20 tons/ha	19.50
Rice husk biochar 30 tons/ha	19,00
Coffee bean husk biochar 10 tons/ha	23.50
Coffee bean husk biochar 20 tons/ha	23.50
Coffee bean husk biochar 30 tons/ha	22.00

From the data obtained (Table 8.) it is known that the average weight of productive tillers ranged from 15.00 – 23.50.

Plant P Level

The observational data on plant P levels from each treatment and the results of the analysis of variance are presented in Appendix 9. The results of the analysis of variance were not significant.

Table 9. Plant P Levels in Various Biochar Treatments

Treatment	Plant P Content (%)	Criteria*
Control	0.39	Tall
Rice husk biochar 10 tons/ha	0.38	Tall
Rice husk biochar 20 tons/ha	0.35	Tall
Rice husk biochar 30 tons/ha	0.30	Tall
Coffee bean husk biochar 10 tons/ha	0.34	Tall
Coffee bean husk biochar 20 tons/ha	0.35	Tall
Coffee bean husk biochar 30 tons/ha	0.36	Tall

Note *: Criteria based on Jones, Wolf and Mills. 1991

From the data obtained (Table 9.) it is known that the average plant P content is in the high criteria in all treatments.

Plant Zn Content

The observational data on plant Zn levels from each treatment and the results of the analysis of variance are presented in Appendix 10. The results of the analysis of variance are significant.

Table 10. Plant Zn Levels in Various Treatments

Treatment	Plant Zn Content (ppm)	Criteria*
Control	27,00	Optimum
Rice husk biochar 10 tons/ha	29.33	Optimum
Rice husk biochar 20 tons/ha	28.67	Optimum
Rice husk biochar 30 tons/ha	25.67	Optimum
Coffee bean husk biochar 10 tons/ha	28.00	Optimum
Coffee bean husk biochar 20 tons/ha	30.33	Optimum
Coffee bean husk biochar 30 tons/ha	35.00	Optimum

Note *: Criteria based on Jones, Wolf and Mills. 1991

From the data obtained (Table 10.) it is known that the average plant Zn content is in the high criteria in all treatments. Based on the results of the variance, it is known to be significant at the 5% level. The results of the Orthogonal Contrast follow-up test are presented in Table 11.

Table 11. Contrast Test of Plant Zn Levels in Various Biochar Treatments

SK	db	JK	KT	Fhit	F 0.05	Note:	F 0.01
Treatment	6	161.90	26.98	3.13	2.85	*	4.46
B0 vs B1,B2,B3,B4,B5,B6	1	16.07	16.07	1.86	4.6	mr	8.86
B1,B2,B3 vs B4,B5,B6	1	46.72	46.72	5.42	4.6	*	8.86
B1 vs B2 vs B3	2	9.39	4.69	0.54	3.74	mr	6.51
B4 vs B5 vs B6	2	43.56	21.78	2.53	3.74	mr	6.51
Error	14	120.67	8.62				
Total	20	282.57					

Description : * = Real ; tn = Unreal

Based on the results of the Orthogonal Contrast further test, it was found that the administration of rice husk biochar was significantly different from the administration of coffee bean husk biochar on plant Zn levels. The highest plant Zn content was found in the coffee bean skin treatment, with an average of B4, B5 and B6 of 31.11 ppm.

Discussion

Soil Chemical Properties

The application of rice husk biochar and coffee bean husk had no significant effect on the pH of the paddy field soil. This can be seen from the pH criteria of all treatments which are the same, namely neutral. In paddy fields, the pH will tend to be neutral due to inundation. In general, this neutral pH value in acidic soils is caused by the addition of OH- ions from the reduction of Fe3+ to Fe2+. Whereas in alkaline-reacting soils, the decrease in soil pH by flooding occurs due to the presence of OH- ions produced by the reduction reaction of CO2 gas with H2O. Setyorini and Abdulrachman (2009) stated that the pH of paddy fields (flooded soil) is caused by several factors such as changes in ferrous to ferrous, sulfate to sulfide, carbon dioxide to methane and accumulation of ammonium.

Plant Growth

For plant height and number of tillers, the application of rice husk biochar and coffee bean husk biochar did not have a significant effect. This can be caused by the seed gene factor, where the seeds used are superior seeds so that the vegetative growth of plants is relatively the same. In addition, the nature of biochar itself is not much different from the nature of organic matter, which releases nutrients slowly, so that the effect is less visible on plant growth in the first growing season. However, it can be seen in Table 5. and Table 6. with the addition of biochar, the value was higher than the control although not significantly different.

For Plant P, the application of biochar rice husk and coffee bean husk also gave an effect that was not significantly different. All plants showed very high plant P content both in the control treatment and with the application of rice husk and coffee bean husk biochar with various doses given. However, for plant Zn, it showed a significant effect between the control and the administration of biochar. The administration of coffee bean husk biochar was significantly higher than that of rice husk biochar. However, all treatments showed plant Zn levels in optimum conditions. When viewed from the overall P and Zn levels of the plant, the best treatment was with rice husk biochar treatment of 30 tons/ha. Because in this treatment, the P of the plant was closer to the optimum level while the Zn of the plant was at the optimum level.

4. Conclusion

The application of rice husk biochar and coffee bean husks in P saturated lowland soils had a significant effect on plant Zn levels, but had no significant effect on soil available P, soil Zn HCl, and plant P levels. Coffee bean husk biochar has more potential to increase plant Zn levels compared to rice husk biochar. The difference in biochar dosage did not significantly affect P and Zn nutrients and rice plants in P saturated lowland soils.

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