Effect of NPK Fertilizer and Biochar Applications on Growth and Yield of Irrigation Rice

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ABSTRACT

The objective of experiment was to investigate the effect of NPK and Biochar applications on paddy rice growth and its production. The research was conducted at Empetrieng village, Aceh Besar district, Aceh Province, Indonesia. The experimental was arranged in a randomized complete block design with two factors and four replicates. First factor was NPK at ratio of 15:15:15 as fertilizer application (0; 60; and 120 kg ha^{-1}, respectively) and second factor was Biochar application at 0 and and 10 ton ha^{-1}). The results showed that the application of Biochar affected significanly on plant height at 28 and 90 DAP (day after planting), percentage of unfilled grain per peanicle; whereas aplication of NPK affected significanly on plant height at 45 and 90 DAP, number of tiller 45 DAP, number of peanicle per clump, number of total grain per peanicle, number of filled grain per peanicle, and yield ton per ha, respectively.

Keywords : NPK fertilizer, Biochar, paddy rice

Introduction

Rice is the main food of Indonesian people. The rice field has dominant contribution in yield of paddy rice because generally rice paddy is planted in wet land. Irrigation is very important for the rice field paddy because this influences the yield of paddy rice productivity (Adiratma, 2004). Biochar or charcoal represents one option to soil management. Biochar had been applied traditionally by some farmers at many places. Several reports showed that biochar has the role in improving fertility soil. Biochar has a lot of pores because it has large surface, so it has high water holding capacity. Although biochar is not fertilizer, it can be used as mixed fertilizers (Gani, 2009).

Materials and Methods

The field experiment was established at Empetring Village, Darul Kamal Subdistrict, Aceh Besar District, Aceh Province, Indonesia on December 2009 to May 2010.

This research was designed as experiment field continued in laboratory with the the following step: (a) field trial was done by planting Ciherang varietas paddy rice. NPK fertilizer and biochar treatment were applied as according to each plot combination treatment; (b) observation was done by looking at the plant growth i.e. plant height, and number of tiller; (c) paddy rice growth was measured by determining the plant height at 28, 35, 45 and 90 day after planting (DAP) and number of tiller 28, 35, and 45 day after planting (DAP). Measurement of final plant height and number of tiller were done, at 1-2 days before harvest paddy rice; and (d) estimation to yield component of paddy rice was done by determining the number of panicle per clump, number of total

grain per panicle, percentage of unfilled grain per panicle, number of filled grain per panicle, weight of 1.000 grain at water content 14%, and yield ton per hectare at water content 14%.

The experiment was arranged in a randomized complete block design with two factors and four replicates. First factor was NPK at 15:15:15 fertilizer application. F0 was without fertilizer; F1was 60 kg ha^{-1} NPK which was equal to 150 g $plot^{-1}$; and F2 was 120 kg ha^{-1} NPK which was equal to 300 g $plot^{-1}$. Second factor was Biochar application; B0 was without biochar; and B1 was 10 ton ha^{-1} which was equal to 25 kg $plot^{-1}$.

Results and Discussion

Plant Height and Number of Tiller of Paddy Rice Plant

Vegetative growth with parameter of plant height and tiller number were not significantly affected by biochar and NPK treatments (Tables 1 and 2), eventhough, plant height and tiller number tend to increase with biochar 10 ton ha^{-1} and NPK 120 kg ha^{-1} treatments. Biochar and NPK applications can improve soil fertility by repairing soil chemical properties in the form of content improvement and in the N, P, K nutrient availibility. Improvement of N, P, K nutrient availibility would affect the nutrient availibility, so that can this would improve the growth of plant height and tiller number.

Table 1. Average of plant height effect biochar and NPK treatment

Treatment Combination	Plant height (cm)			
	28 DAP	35 DAP	45 DAP	90 DAP
B0 F0	42,70 a A	52,40 a A	66,45 a A	69,88 a A
B0 F1	44,45 a A	55,09 a A	71,30 a A	71,18 a A
B0 F2	43,68 a A	54,85 a A	71,73 a A	74,80 a A
B1 F0	45,23 a A	45,27 a A	65,63 a A	71,05 a A
B1 F1	46,28 a A	48,35 a A	72,80 a A	76,93 a A
B1 F2	46,75 a A	48,74 a A	76,88 a A	78,23 a A
BNT 0,05	3,206	15,341	4,627	5,700

Tabel 2. Average of tiller number effect biochar and NPK treatment

Treatment Combination	Number of tiller (bar)		
	28 DAP	35 DAP	45 DAP
B0 F0	14,08 a A	12,70 a A	11,98 a A
B0 F1	12,50 a A	13,05 a A	13,68 a A
B0 F2	14,35 a A	14,53 a A	16,23 a A
B1 F0	13,05 a A	13,05 a A	11,65 a A
B1 F1	13,70 a A	15,03 a A	14,83 a A
B1 F2	14,15 a A	14,83 a A	17,18 a A
BNT 0,05	1,802	2,269	1,937

Mori and Marjenah (1993) reported that biochar or husk chrocoal can be used as soil material repairing with increasing air permeability as well as the water percolation. Purnomo (2009) stated that paddy rice plant responded to single NPK and compound NPK. Compound NPK fertization significantly improves paddy rice plant height at the primordial stage. Improvement of this growth is caused of by soil chemical properties may increase the rate of N and P in soil.

Kaderi (2004) stated that number of tiller per clump was higher after the addition of NPK compared to control plant. This showed that compound of NPK added the nutrient element for plant. Growth of tiller number is related to N sufficiency and efficacy to primordial forming.

Yield of Paddy Rice Plant

Yield component of paddy rice plant did not significantly effected either by Biochar or NPK treatments (Table 3), eventhough the yield component of paddy rice plant tend to increase with the application of Biochar at 10 ton ha^{-1} and NPK at 120 kg ha^{-1} compared to the control treatmentwithout Biochar and without NPK.

Tabel 3. Average of yield component effect biochar and NPK treatment

Variable	Treatment combination						BNT 0,05
	B0 F0	B0 F1	B0 F2	B1 F0	B1 F1	B1 F2	
Number of panicle per clump (panicle)	9,67 Aa	11,04 aA	12,54 aA	9,56 aA	10,96 aA	11,75 aA	1,249
Number of total grain per panicle (grain)	146,72 aA	130,75 aA	117,09 aA	145,14 aA	126,61 aA	122,65 aA	20,425
Percentage of unfilled grain per panicle (%)	20,37 aA	22,84 aA	23,14 aA	16,68 aA	19,11 aA	17,86 aA	4,569
Number of filled grain per panicle (grain)	116,29 aA	100,81 aA	89,78 aA	120,61 aA	102,44 aA	100,63 aA	14,190
Weight of 1.000 grain at water content 14% (gram)	24,78 aA	24,93 aA	24,74 aA	25,02 aA	25,28 aA	24,21 aA	1,576
Yield ton per hectare at water content 14% (ton ha^{-1})	4,32 aA	5,88 aA	6,20 aA	4,33 aA	5,89 aA	6,79 aA	0,748

Biochar at 10 ton ha^{-1} tend to increase the yield component of paddy rice plant as is compared to without Biochar treatment. This is because Biochar at 10 ton ha^{-1} gave the growth media of soil microorganism. Consequently this may improve the amount of soil microorganism but this was not followed with the increase of nutrient availibility in soil. Therefore, soil microorganism exploit the nutrient source to energy that give in the emulation between soil microorganism with the root plant in fulfilling nutrient. This may cause competition between soil microorganism and the root plant.

Increase of NPK dose tend to to improve the yield component of paddy rice plant compared to that without NPK treatment. This is caused by NPK fertilize that can directly gave the nutrient element required by plant. So that with the existence of nutrient element provided by NPK can fulfill the nutrient required by the plant growth. This may also repaire soil chemical properties with sufficiency of nutrient element so that this affected the increase of yield component of paddy rice plant.

Conclusions

Treatment of biochar affected significantly onthe plant height at 28 and 90 day after planting (DAP), percentage of unfilled grain per panicle. Meanwhile, treatment of NPK affected significantly on the plant height at 45 and 90 DAP, number of tiller 45 DAP, number of panicle per clump, number of total grain per panicle, number of filled grain per panicle, and yield ton per ha.

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