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Effect of NPK fertilizer and biochar residue on paddy growth and yield of second planting

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Abstract. The objective of experiment was to study effects of NPK fertilizer and Biochar residue on paddy growth and yield of second planting. The research was conducted at Empetrieng village, Aceh Besar district, Aceh Province. The experimental arranged in a randomized complate block design with two factors and four replications. Biochar consisted of two levels, i.e. without biochar residue and with biochar residue 10 ton ha^{-1}. NPK fertilizer consisted of three levels, i.e. without NPK, NPK 60 kg ha^{-1}, and NPK 120 kg ha^{-1}. The result showed that application of NPK significantly affected, plant height 35, 45 and 90 day after planting (DAP), number of tiller 35 and 45 DAP, number of panicle per clump, number of total grain per panicle, percentage of unfilled grain, percentage of filled grain per panicle, 1.000 grain weight, and potential yield per ha. Biochar Residue significantly affected potential yield per ha.
Keywords : NPK fertilizer, biochar, paddy yield

Introduction

Recomendation of fertilization for paddy until now still impersonal, so fertilization still not rational and not balance. Some farmers use fertilizer exessive and other farmers use fertilizer less than plant needed, so paddy production not optimal because of there is not nutrient balance in soil. In another case, chemical fertilizer availability more and more difficult and its price more expensive, because subsidy reduction by goverment, so its use has to more effecient. Balance fertilization is one of key factor to fix and incrrease agricultural land productivity. Fertilizer application to soil will add one or more soil nutrient and will change other nutrient balance (Silalahi *et al.*, 2006). Until now the nutrients that still have problemme are nitrogen, phosphor and potassium because they were needed in a lot of quantities and they called primer macro nutrients. They often deficiency in soil (Hasibuan, 2006).

Biochar is made from incomplete combustion, so leaves nutrients that make soil fertile and can use as one of soil tillage (Gani, 2009). Biochar used as ameliorant and not as fertilizer. Biochar has high CEC (*Cation Exchange Capacity*) so can binding soil cations and used by plant.

Materials and Methods

The field experiment was established at Empetring Village, Darul Kamal Subdistrict, Aceh Besar District, Aceh Province, Indonesia on November 2010 to March 2011. This experiment was continue from the experiment before (first planting). First planting was done on December 2009 to May 2010. The treatment of first planting consist of two factors : NPK fertilizer factor (without NPK fertilizer, NPK 60 kg ha^{-1}, dan NPK 120 kg ha^{-1}), and biochar factor (without biochar and biochar 10 ton ha^{-1}). Biochar treatment on first planting as biochar residue treatment on second planting. Paddy planting on first and second planting was done on rainy season and at same plots.

This research has been experiment field is continued with research in laboratory with the the following step : (a) field trial by planting Ciherang varietas paddy rice, NPK fertilize and biochar residue treatment; (b) paddy rice growth perceived is plant height at 28, 35, 45 and 90 day after planting (DAP) and number of tiller done at 28, 35, and 45 day after planting (DAP); and (c) perception to yield component of paddy rice that is 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 experimental arranged in a randomized complate block design with two factor and four replication. First factor was NPK 15:15:15 fertilizer application. F0 = without fertilizer;

F1 = 60 kg ha^{-1} NPK (N = 9 kg ha$^{-1,}$ P_2O_5 = 9 kg ha^{-1}, dan K_2O = 9 kg ha^{-1}); and F2 = 120 kg ha^{-1} NPK (N = 18 kg ha$^{-1,}$ P_2O_5 = 18 kg ha^{-1}, dan K_2O = 18 kg ha^{-1}). Second factor was Biochar residue application. B0 = without biochar; and B1 = 10 ton ha^{-1} (from first planting).

Results and Discussion

Plant Height

Table 1 and 2 showed that NPK fertilizer treatment did not significantly to plant height on 28 DAP, but significantly on 35, 45 and 90 DAP. Biochar residue treatment did not significantly to plant height on 28, 35, 45 and 90 DAP. Interaction on data analyze showed that NPK fertilizer and biochar residue did not significantly to plant height on 28, 35, 45 and 90 DAP.

Table 1. Average of plant height on 28 DAP effect of NPK fertilizer and biochar residue treatment

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	(cm)	.....
0	52,06	53,09	50,72
10	52,88	53,43	53,98

Table 2. Average of plant height on 35, 45 and 90 DAP effect of NPK fertilizer and biochar residue treatment

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	35 DAP cm	.....
0	55,71	58,98	59,00
10	57,04	60,38	60,79
Average BNT $_{(0,05)}$ = 2,34	56,38 a	59,68 b	59,90 b
	.....	45 DAP cm	.....
0	61,21	68,67	70,03
10	61,10	70,66	74,04
Average BNT $_{(0,05)}$ = 3,29	61,16 a	69,67 b	72,04 b
	.....	90 DAP cm	.....
0	85,25	89,48	89,99
10	84,96	91,09	92,99
Average BNT $_{(0,05)}$ = 2,32	85,11 a	90,29 b	91,49 b

Pirngadi dan Abdulrachman (2005) said that NPK fertilizer treatment increase paddy plant height. NPK fertilizer can increase soil fertility though soil chemistry properties repair like increasing N, P and K and their available. With increasing the available of N, P and K, so plant will have enough nutrient and then the plant height will increase. Paddy plant responsive on single NPK fertilizer and compound NPK fertilizer. Fertilization of compound NPK signifigantly increase plant height until primordial phase. The increasing growth cause of repairing soil chemistry propreties as increasing of N and P in soil (Purnomo, 2009).

Number of Tiller of Paddy Rice Plant

Table 3 and 4 showed that NPK fertilizer treatment did not significantly to number of tiller of paddy rice plant on 28 DAP, but significantly on 35, and 45 DAP. Biochar residue treatment did not significantly to number of tiller of paddy rice plant on 28, 35, and 45 DAP. Interaction on data analyze showed that NPK fertilizer and biochar residue did not significantly to number of tiller of paddy rice plant on 28, 35, and 45 DAP.

NPK fertilizer can increase soil fertility through soil chemistry properties repair like increasing N, P and K and their available. Purnomo (2009) said that paddy plant responsive on single NPK fertilizer and compound NPK fertilizer. Tiller number of paddy increase significantly with N, P, and K fertilizer application. The experiment result of Kaderi (2004) showed that tiller number per clump on compound NPK fertilizer application more than control plant. This condition showed that compound NPK fertilizer can give more nutrient to plant.

Growth of productive tiller number connected with nitrogen available and successful of primordial formation.

Table 3. Average of tiller number on 28 DAP effect of NPK fertilizer and biochar residue treatment.

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	Bar per clump	.....
0	9,52	10,46	10,69
10	10,23	10,44	11,48

Table 4. Average of tiller number on 35 and 45 DAP effect of NPK fertilizer and biochar residue treatment.

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	35 DAP	.....
		Bar per clump	
			14,83
0	10,92	13,02	
10	11,29	13,42	15,75
Average BNT $_{(0,05)}$ = 1,39	11,11 a	13,22 b	15,29 c
	.....	45 DAP	.....
		Bar per clump	
0	11,21	13,50	16,06
10	10,85	13,67	17,25
Average BNT $_{(0,05)}$ = 1,18	11,03 a	13,59 b	16,66 c

Yield Component of Paddy Rice Plant
Number of Panicle per Clump

Table 5. Average of number of panicle per clump effect of NPK fertilizer and biochar residue treatment.

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	Malai	.....
0	8,23	9,85	11,77
10	8,19	9,63	11,71
Average BNT $_{(0,05)}$ = 1,10	8,21 a	9,74 b	11,74 c

Number of Total Grain per Panicle,

Table 6. Average of number of total grain per panicle effect of NPK fertilizer and biochar residue treatment.

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	Butir	.....
0	94,0	116,0	98,0
10	100,0	109,0	110,0
Average BNT $_{(0,05)}$ = 11,68	97,0 a	112,0 b	104,0 ab

Percentage of Unfilled Grain per Panicle,

Table 7. Average of percentage of unfilled grain per panicle effect of NPK fertilizer and biochar residue treatment.

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	(%)	.....
0	16,27	13,91	12,28
10	15,31	10,39	13,62
Average BNT $_{(0,05)}$ = 2,95	15,79 b	12,15 a	12,95 ab

Percentage of Filled Grain per Panicle,

Table 8. Average of percentage of filled grain per panicle effect of NPK fertilizer and biochar residue treatment.

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	(%)	.....
0	83,73	86,09	87,72
10	84,69	89,61	86,38
Average	84,21 a	87,85 b	87,05 ab
BNT $_{(0,05)}$ = 2,95			

Weight of 1.000 Grain at Water Content 14% ,

Table 9. Average of weight of 1000 grain at water content 14% effect of NPK fertilizer and biochar residue treatment.

Biochar Residue (ton ha^{-1})	NPK Fertilizer (kg ha^{-1})		
	0	60	120
	.....	Gram	.....
0	25,56	26,54	26,54
10	25,86	26,53	26,42
Average	25,71 a	26,54 b	26,48 b
BNT $_{(0,05)}$ = 0,47			

Yield Ton per Hectare at Water Content 14%.

Table 10. Average of yield ton per hectare at water content 14% effect of NPK fertilizer and biochar residue treatment.

Biochar Residue	NPK Fertilizer (kg ha^{-1})			Average
(ton ha^{-1})	0	60	120	BNT $_{(0,05)}$ = 0,27
	.....	ton ha^{-1}	.....	
0	4,04	5,19	6,10	5,11 a
10	4,74	6,07	6,59	5,80 b
Average	4,39 a	5,63 b	6,35 c	
BNT $_{(0,05)}$ = 0,33				

Table 10 showed that yield potention grain per hectare on second planting at water content 14% increase with increasing NPK fertilizer dose on every biochar treatment. Yield potention on without NPK fertilizer treatment increase with biochar residue 10 ton ha^{-1} treatment. Pirngadi and Abdulrachman (2005) explained that NPK fertilizer application can increase plant hight, number of panicle per clump, number of productive panicle per clump, and dry grain yield. Chan *et al.* (2007) said that various experiment that have done showed biochar application have real agronomy benefit, but the results are not universal because other experiment showed different result or give negative effect. This is because biochar has some properties depend on its raw materials and various interaction between biochar and soil type.

Conclusions

Treatment of NPK fertilizer affected significantly to plant height 35, 45 and 90 day after planting (DAP), number of tiller 35 and 45 DAP, number of panicle per clump, number of total grain per panicle, percentage of unfilled grain per panicle, percentage of filled grain per panicle, Wight of 1.000 grain and yield ton per ha on second planting. Treatment combination of biochar residue 10 ton ha^{-1} and 120 kg ha^{-1} NPK fertilizer.

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