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Research Paper

THE EFFECT OF BALANCE FERTILIZATION COMPOSING OF RICE STRAW ORGANIC FERTILIZER AND NPK FERTILIZER ON GROWTH AND YIELD OF PADDY FIELD RICE (*ORYZA SATIVA L.*)

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The objective of this research was to study the effect of balance fertilization consisting of rice straw organic fertilizer and NPK inorganic fertilizers on the growth and yield of paddy field rice as well as to utilize rice straw available in abundant quantity at paddy feld area as nutrients and organic matter sources. This research was done at Lebak Kajang Village, Belitang Madang Raya Subdistrict, OKU Timur District from December 2013 to April 2014. Split Plot Design with 3 replications was used in this research. The main plot was rice straw addition with four levels consisting of J0: without rice straw addition (control), J1: rice straw at dose of 5 ton.ha^{-1}, J2: rice straw at dose of 10 ton.ha^{-1} and J3: rice straw compost at dose of 5 ton.ha^{-1}. The subplot was N, P, and K fertilizers dose with three levels consisting of P1: NPK 100% (N-P_2O_5-K_2O: 135-27-30 kg.ha^{-1}); P2: NPK 75% (N-P_2O_5-K_2O: 101.25-20.25-22.5 kg. ha^{-1}) and P3: NPK 50% (N-P_2O_5-K_2O: 67.5-13.5-15 kg.ha^{-1}). The subplot was NPK fertilizer addition with three levels consisting of P1: NPK 100% (N-P_2O_5-K_2O: 135-27-30 kg.ha^{-1}); P2: NPK 75% (N-P_2O_5-K_2O: 101.25-20.25-22.5 kg. ha^{-1}) and P3: NPK 50% (N-P_2O_5-K_2O: 67.5-13.5-15 kg.ha^{-1}). The observed parameters were tiller numbers per clump, leaf numbers per clump, Leaf Area Index (LAI), Crop Growth Rate (CGR), panicle numbers per clump, panicle weight per clump, unhulled rice weight per panicle, weight of 1000 grains, unhulled rice yield per plot and estimation of unhulled rice yield per hectare. The results showed that addition of rice straw compost combined with 100% NPK dose had increased rice crop growth than treatments of without rice straw addition, rice straw addition at dose of 5 ton.ha^{-1} and rice straw addition at dose of 10 ton.ha^{-1}, whereas 100% NPK dose and 75% NPK dose as well as rice straw compost addition had showed no differences in term of rice crop yield.

Keywords: Balance fertilizer, Organic fertilizer, Inorganic fertilizer, Rice crop

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INRODUCTION

Rice is the main food crop which has important role in agricultural development in Indonesia because it is the staple food source for Indonesia people. Rice crop cultivation is nowadays highly depend on inorganic fertilizer usage, whereas availability of this fertilizer is more scare and expensive so that proper technology which capable to decrease the use of inorganic fertilizer is required, for instance by using organic fertilizer. Raw material source for organic fertilizer which is available in abundant quantity in surrounding of the paddy feld is rice straw. Farmers in area of rice production center usually burned rice straw after harvesting period which results in environmental problem and community health disorder because smoke in high quantity can create respiratory disease (Hardjowigeno, 1987).

The condition of agricultural land, especially paddy field soil in Indonesia was in low fertility in addition to the problem mentioned above. This is due to the fact that rice intensification with high quantity of inorganic fertilizer input in long period and lack of attention in relation to the use of organic matter for rice production system results in the decrease of paddy field soil quality (Pramono, 2004). Indicator for the decrease of paddy field soil quality is low C-organic content of soil. Karama *et al*. (1990) had reported that from 30 locations of paddy field soil taken randomly in Indonesia, about 68% had C-organic content less than 1.5% and only 9% had C-organic content higher than 2%. Similar condition was also found in soil at rice production center of OKU Timur District, South Sumatra which had average C-organic content less than 1.5% (Budianta dan Tambas, 2004).

The effort to increase agricultural soil quality and crop production can be done by addition of organic fertilizer. Organic fertilizer addition can improve physical, chemical and biological properties of soil (Melati *et. al.,* 2008). Moreover, Riley *et al.* (2008) explained that organic fertilizer addition can improve soil physical property because organic matter is cementing agent for loosen soil grains or as aggregate stabilizer agent which help roots of crop in penetrating deeper into soil that results in higher absorbtion of nutrients and water. In addition, organic fertilizer can also improve rhizosphere which maintain nutrients cycle, improve exudation by roots of crop which in turn can increase degradation of soil organic matter and N mineralization (Morgan *et al.,* 2005). The biological property of soil is also improved due to organic matter availability because organic matter is source of energy for most of soil organisms (Saviozzi *et al.,* 2006).

According to Hsu *et al.* (2009), organic matter will increase biological activity of soil as well as increase soil water availability. Availability of soil water will produce higher absorption and transportation of nutrients which results in higher photosynthesis rate and increase of food supply for plant growth (Muhakka *et al.,* 2006).

The study results from Darwin *et al.* (2012) showed that addition of bokashi or organic fertilizer from chicken dunk combined with half dose of recommended inorganic fertilizer could increase crop production and decrease inorganic fertilizer usage. Moreover, study results from Pangaribuan *et al.* (2011) also showed that organic fertilizer (bokashi) from crop residues could also decrease inorganic fertilizer usage. Furthermore, Sudiarso (2004) stated that organic fertilizer addition in combination with inorganic

fertilizer at half of recommended dose could increase the growth and production of rice crop. The study results from Marlina *et al*. (2014) showed that combination of organic fertilizer at dose of 300 kg.ha^{-1} (rice straw compost enriched with N_2 fixation bacteria, phosphate dissolving bacteria and growth stimulator bacteria) and inorganic fertilizer at 75% of recommended dose was the best combination to increase NPK nutrients absorption and rice crop production at lowland swamp area.

The objective of this research was to study the effect of balance fertilization consisting of rice straw organic fertilizer and NPK inorganic fertilizers on the growth and yield of paddy field rice as well as to utilize rice straw available in abundant quantity at paddy feld area as nutrients and organic matter sources.

MATERIALS AND METHODS

This research was done at Lebak Kajang Village, Belitang Madang Raya Subdistrict, OKU Timr District from December 2013 to April 2014. Split Plot Design with 3 replications was used in this research. The main plot was rice straw addition with four levels consisting of J_0: without rice straw addition (control), J_1: rice straw at dose of 5 ton.ha^{-1}, J_2 : rice straw at dose of 10 ton.ha^{-1} and J_3: rice straw compost at dose of 5 ton.ha^{-1}. The subplot was NPK fertilizer addition with three levels consisting of P_1: NPK 100% (N-P_2O_5-K_2O: 135-27-30 kg.ha^{-1}); P_2: NPK 75% (N-P_2O_5-K_2O: 101.25-20.25-22.5 kg. ha^{-1}) and P_3: NPK 50% (N-P_2O_5-K_2O: 67.5-13.5-15 kg.ha^{-1}).

Land preparation was conducted by cleaning the land from weeds and previous crop residues left in the field (Figure 1). Soil was flooded, plowed and harrowed in order to achieve loosen and level soil condition. Subsequently, plot with dimension 3 m x 2 m was developed having 30 cm distance between treatments and 1 m distance between replications. Rice seeds of Ciherang variety which were previously germinated for 21 days were planted with planting distance of 20 cm x 20 cm consisting of 2-3 seeds per planting hole. The J_1 and J_2 treatments were done by submerging rice straw at dose of 5 and 10 ton.ha^{-1}. J_3 treatment

Figure 1: Land Preparation

was conducted by distributing rice straw compost at dose of 5 ton ha^{-}. J_1, J_2 and J_3 treatments were carried out at the same time with initial soil tillage, i.e., 2 weeks before planting. N fertilizer was given two times, i.e., half dose at 7 days after planting (DAP) and the rest was at 42 days after planting (DAP). P and K fertilizers in accordance to the recommended dose were given at 7 days after planting (DAP). Irrigation was done since initial planting where crop height was about 5 cm until 10 days after planting (Figures 2 and 3). Irrigation subsequently can be regulated according to crop growth stages. Weeds control was done manually at crop age period of 15 days after planting (DAP) and subsequent weed control was done according to weeds condition in the field. Pest and disease control was done preventively by using biopesticide of specific formula. Harvesting was done at crop age period of 90 days after planting.

Observation was conducted during rice growth through destructive method by taking 2 crop samples for each treatment combination at rice age period of 30, 45, 60, and 70 days after planting as well as during harvest (90 days after planting) (Figure 4). Observation of rice growth and yield was consisted of tiller numbers per clump, leaf numbers per clump, Leaf Area Index

Figure 2: Seedling

Figure 3: Planting Activities

Figure 4: Rearing Activities

(LAI), Crop Growth Rate (CGR), panicle numbers per clump, panicle weight per clump, unhulled rice weight per panicle, weight of 1000 grains, unhulled rice yield per harvested plot and estimation of unhulled rice yield per hectare. Data was analyzed by using analysis of variance (F test) at α = 5%. The test for differences amongst treatments was done by using Least Significance Different (LSD) at α = 5%.

RESULTS AND DISCUSSION

Tiller Numbers per Clump

Treatment combination of rice straw addition and NPK fertilizers dose had significant effect on rice tiller numbers per clump at period of 30 days after planting (DAP) such as shown in Table 1.

Rice tiller numbers was not significantly different for treatments of NPK 100% dose and NPK 75% dose with several methods of rice straw addition as well as NPK 50% dose with rice straw addition at dose of 5 ton.ha^{-1} and dose of 10 ton.ha^{-1} and rice straw compost. Tiller numbers per clump was decreased for treatment of NPK 50% dose without rice straw or rice straw at 5 ton.ha^{-1} dose. These results showed that the use of NPK 100% fertilizer can be decreased up to dose of NPK 75% if it was followed by rice straw

Table 1: Tiller Numbers Per Clump At 30 Days After Planting (DAP) Due To Combination Of NPK Fertilizer Dose And Rice Straw Addition

NPK Treatments	Tiller numbers per clump			
	Without rice straw	Rice straw at dose of 5 ton ha^{-1}	Rice straw at dose of 10 ton ha^{-1}	Rice straw compost at dose of 5 ton ha^{-1}
100%	16.33ab	16.22ab	16.41a	16.42a
75%	16.19ab	16.17ab	16.20ab	16.28ab
50%	15.94b	15.91b	16.8ab	16.18ab

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α = 5%

addition, but tiller numbers would be decreased if NPK fertilizer dose was decreased up to 50%. Data in Table 2 showed that treatment of NPK fertilizer dose had no significant effect on numbers of tiller per clump at age of 45 and 60 Days After Planting (DAP). The numbers of tiller at NPK 100% dose was not significantly different than that of NPK 75% dose in 75 days after planting observation, but it was significantly different than that of NPK 50% dose. The numbers of tiller in rice straw compost treatment (J_3) generally was significantly higher, although it was not significantly different than that of rice straw treatment at dose 10 ton.ha^{-1} (J_2). Analysis results of organic matter conducted at Soil Chemical Laboratory, Faculty of Agriculture, Sriwijaya University showed that organic matter content of rice straw compost was 15.8%, whereas organic matter content of fresh rice straw was 10.6%. These results showed that rice straw compost and fresh rice straw can be used as organic matter source within soil.

Leaf Numbers per Clump

Treatment combination of rice straw addition and NPK fertilizer dose had significant effect on leaf numbers at observation of 30 days after planting (Table 3).

The addition of NPK fertilizer at 100% dose in general was not different than NPK fertilizer at 75% dose, except at rice straw compost. Leaf numbers of rice crop for NPK fertilizer at 100% dose in general was not different than NPK fertilizer at 75% dose at observation of 45, 60 and 75 days after planting, but leaf numbers would be lower if NPK fertilizer dose was decreased to 50% (Table 4). Rice straw treatments showed that rice straw compost addition (J_3) had produced higher leaf numbers than that of without rice straw addition (J_0), rice straw addition at dose

Table 2: Tiller Numbers Per Clump At Several Crop Ages at NPK Fertilizer Dose and Rice Straw Addition

Treatments	Crop Ages (DAP)		
	45	60	75
NPK Fertilizer			
100%	21.01	29.05	18.96a
75%	20.2	28.42	18.50ab
50%	19.93	28.1	18.36b
Rice straw addition			
-Without rice straw	19.43b	27.30b	17.59c
-Rice straw at dose of 5 ton ha^{-1}	19.07b	26.88b	16.33d
-Rice straw at dose of 10 ton.ha^{-1}	21.20a	29.67a	19.67b
-Rice straw compost at dose of 5 ton ha^{-1}	21.81a	30.15a	20.84a

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α= 5%

Table 3: Leaf Numbers Per Clump At 30 Days After Planting (DAP) Due To Combination Of NPK Fertilizer Dose and Rice Straw Addition

NPK Treatments	Tiller numbers per clump			
	Without rice straw	Rice straw at dose of 5 ton ha^{-1}	Rice straw at dose of 10 ton ha^{-1}	Rice straw compost at dose of 5 ton ha^{-1}
100%	35.06d	34.40ef	36.32b	36.85a
75%	35.02d	34.23fg	36.01bc	36.36b
50%	34.66e	33.93g	35.3d	35.93c

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α = 5%

of 5 ton.ha^{-1} (J_1) or rice straw addition at dose of 10 ton.ha^{-1} (J_2). These results showed that rice straw compost addition could improve soil condition and soil aeration so that roots capable to absorb nutrients already available within soil.

Leaf Area Index (LAI)

Treatment combination of rice straw addition and NPK fertilizer doses had significant effect on LAI of crop at 30 days after planting (Table 5).

Leaf area indexes were significantly higher for treatments of rice straw compost and rice straw addition at doses of 5 ton.ha^{-1} and 10 ton.ha^{-1} respectively at NPK fertilizer 100% dose, but was not significantly different than rice straw compost treatment at NPK fertilizer 75% dose. Table 6 showed that rice straw addition ad NPK doses separately had significant effect on crop's LAI at ages of 45, 60 and 75 DAP. Crops that were

Table 4: Tiller Numbers Per Clump at Several Crop Ages at NPK Fertilizer Dose And Rice Straw Addition

Treatments	Crop Ages (DAP)		
	45	60	75
NPK Fertilizer			
100%	54.75a	68.10a	56.05a
75%	54.34ab	67.85ab	55.83b
50%	53.89b	67.36b	55.78b
Rice straw addition			
-Without rice straw	53.54c	67.67b	55.29c
-Rice straw at dose of 5 ton ha^{-1}	52.95d	66.7c	55.10d
-Rice straw at dose of 10 ton ha^{-1}	54.72b	68.27a	56.31b
-Rice straw compost at dose of 5 ton ha^{-1}	56.10a	68.34a	56.86a

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α= 5%

Table 5: Average Value of Leaf Area Index (LAI) at 30 Days After Planting (DAP) Due to Combination of NPK Fertilizer doses and rice straw addition

NPK Treatments	Leaf Area Index (LAI)			
	Without rice straw	Rice straw at dose of 5 ton ha^{-1}	Rice straw at dose of 10 ton ha^{-1}	Rice straw compost at dose of 5 ton ha^{-1}
100%	1.29de	1.26fg	1.38ab	1.39a
75%	1.29de	1.26g	1.36bc	1.39a
50%	1.28ef	1.22h	1.31d	1.34c

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α = 5%

Table 6: Average Value Of Leaf Area Index (LAI) At Several Crop Ages Due To Combination Of NPK Fertilizer Dose And Rice Straw Addition

Treatments	Crop Ages (DAP)		
	45	60	75
NPK Fertilizer			
100%	2.48a	3.74a	1.92a
75%	2.39b	3.69b	1.84b
50%	2.25c	3.63c	1.79c
Rice straw addition			
- Without rice straw	2.29c	3.58c	1.71c
- Rice straw at dose of 5 ton ha^{-1}	2.25d	3.53d	1.67d
- Rice straw at dose of 10 ton ha^{-1}	2.44b	3.77b	1.96b
-Rice straw compost at dose of 5 ton ha^{-1}	2.50a	3.86a	2.06a

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α= 5%

fertilized by using NPK 100% dose had produced significantly higher LAI value than that of NPK 75% and 50% doses at ages of 45 to 75 DAP. The addition of rice straw compost had produced significantly higher LAI values of rice crop than that of without rice straw addition and rice straw addition at doses of 5 ton.ha^{-1} and 10 ton.ha^{-1}, respectively. These results showed that rice straw compost additions were significantly better than that of rice straw additions at doses of 5 ton.ha^{-1} and 10 ton.ha^{-1}, respectively.

Crop Growth Rate (CGR)

The addition of rice straw and NPK fertilizer doses had significant effect on CGR at observation period of 30, 45, 60 and 75 DAP (Table 7).

Table 7 showed that CGR at NPK 100% dose was not different than that of NPK 75% dose, but

Table 7: Crop Growth Rate (CGR) (10^{-4} g day-1) at Several Crop Ages due to Combination of NPK Fertilizer Dose and Rice Straw Addition

Treatments	Crop Ages (DAP)			
	0-30	30-45	45-60	60-75
NPK Fertilizer				
100%	10.06a	10.48a	11.92a	9.76a
75%	10.04ab	10.46ab	11.89ab	9.75ab
50%	10.02b	10.44b	11.86b	9.74b
Rice straw addition				
- Without rice straw	10.02c	10.43c	11.85c	9.73c
- Rice straw at dose of 5 ton ha^{-1}	10.00c	10.41c	11.81d	9.72c
- Rice straw at dose of 10 ton ha^{-1}	10.05b	10.47b	11.91b	9.75b
-Rice straw compost at dose of 5 ton ha^{-1}	10.09a	10.52a	12.00a	9.79a

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α= 5%

it was significantly higher than that of NPK 50% dose. In addition, CGR value for rice straw compost addition was significantly higher than that of rice straw addition treatments at doses of 5 ton.ha^{-1} and 10 ton.ha^{-1} as well as without rice straw, respectively.

Table 8: Average Number Of Panicle Per Clump and Unhulled Rice Weight Per Panicle Due to Combination Of NPK Fertilizer Dose And Rice Straw Addition

Treatments	Panicle numbers per clump	Panicle weight per clump (g)	Unhulled rice weight per panicle (g)
NPK Fertilizer			
100%	17.35a	60.59a	3.50a
75%	17.31a	60.50a	3.44a
50%	17.18b	58.34b	3.37b
Rice straw addition			
- Without rice straw	17.25	59.53	3.44
- Rice straw at dose of 5 ton ha^{-1}	17.2	58.54	3.39
- Rice straw at dose of 10 ton.ha^{-}	17.27	60.04	3.47
- Rice straw compost at dose of 5 ton ha^{-1}	17.34	61.13	3.54

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α= 5%

Table 9: Average Value Of 1000 Grains and Unhulled Rice Yield Per Plot and Unhulled Rice Yield Per Ha Due To Combination Of Npk Fertilizer Dose And Rice Straw Addition

Treatment	Weight of 1,000 grains (g)	Unhulled rice yield per plot (kg)	Unhulled rice yield per ha (ton.ha^{-1})
NPK Fertilizer			
100%	26.30a	1.50a	6.28a
75%	26.24a	1.50a	6.24a
50%	26.04b	1.45b	6.05b
Rice straw addition			
- Without rice straw	26.27	1.48	6.16
- Rice straw at dose of 5 ton ha^{-1}26.19	1.45	6.06	
- Rice straw at dose of 10 ton.ha^{-1}26.31	1.49	6.19	
- Rice straw compost at dose of 5 ton ha^{-1}	26.38	1.52	6.3

Remarks: Numbers followed by the same letters at the same column showed not significantly different based on Least Significance Different test at α= 5%

Numbers and Weight of Panicle per Clump, Unhulled Rice Weight per Panicle, 1,000 Grains Weight and Unhulled Rice Yield per Plot and per Hectare.

The addition of NPK fertilizer doses had significant effect on panicle numbers and weight per clump, unhulled rice weight per panicle, 1,000 grains weight and unhulled rice yield per plot and per hectare, whereas rice straw addition treatments had no significant effect (Table 8 and 9). Tables 8 and 9 showed that addition of NPK fertilizer 100% dose was not different than NPK fertilizer 75% dose, but it was significantly different than NPK fertilizer 50% dose in term of panicle numbers and weight per clump, unhulled rice weight per panicle, 1,000 grains weight and unhulled rice yield per plot and per hectare. Moreover, unhulled rice yield tend to be higher for treatments of rice straw addition at doses of 10 ton.ha^{-1} and rice straw compost than that of without rice straw addition and rice straw addition at doses of 5 ton.ha^{-1}, respectively. These results showed that organic matter in rice straw had significant effect on the increase of soil fertility. The study from Padmini (2009) showed that mixture of organic fertilizer and NPK at optimum dose had increase numbers of tiller, panicle length and panicle numbers of rice crop.

CONCLUSION

The addition of rice straw compost and NPK fertilizer at 100% dose had increase rice crop growth than that of without rice straw addition as well as rice straw at doses of 5 ton.ha^{-1} and 10 ton.ha^{-1}. Treatments of NPK 100% dose and NPK 75% dose as well as rice straw compost addition had showed no different results in term of rice crop yield.

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