

## Research Article

# Combination of NPK fertilizer with bokashi rice straw on growth and yield of Cisantana rice varieties

## *Kombinasi pupuk NPK dengan bokashi jerami padi terhadap pertumbuhan dan hasil tanaman padi sawah varietas Cisantana*

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**Abstract:** One of the cultivation technologies that need to be considered in increasing rice production is the proper use of fertilizer. This study is to find out the substitution of NPK fertilizer with rice straw bokashi to the growth and yield of rice paddy plants cisantana varieties. This research was conducted from August to November 2020 in Samaku Village, Bualemo District, Banggai Regency. The method used is a Randomized Design Group (RAK) factorial pattern consisting of 2 factors, namely factor A (NPK fertilizer) and factor B (Straw Bokashi). The combination of NPK fertilizer and rice straw bokashi has no natural effect on rice paddy plants of Cisantana varieties. Still, it has a natural impact on grain dry weight per plot. The treatment of rice straw bokashi independently has a noticeable effect on the height of the plant, the number of saples, the number of productive saples and the length of the panic. The bokashi straw rice dose of 75% (3.75 tons/ha) is the best dose for high plant growth, number of saples, number of productive saples and malai length. While the dose of 75% NPK (187.5 kg/ha) + 75% bokashi rice straw (3.75 tons/ha) is the best combination dose for varied dry weight of grain per plot.

**Keywords:** Straw bokashi, NPK fertilizer, Cisantana rice variety

**Abstrak:** Salah satu teknologi budidaya yang perlu diperhatikan dalam meningkatkan produksi tanaman padi adalah dengan penggunaan pupuk secara tepat. Penelitian ini untuk mengetahui substitusi pupuk NPK dengan bokashi jerami padi terhadap pertumbuhan dan hasil tanaman padi sawah varietas Cisantana. Penelitian ini dilaksanakan pada bulan Agustus sampai November 2020 di Desa Samaku Kecamatan Bualemo Kabupaten Banggai. Metode yang digunakan adalah Rancangan Acak Kelompok (RAK) pola faktorial yang terdiri dari 2 faktor yaitu faktor A (pupuk NPK) dan faktor B (Bokashi Jerami). Kombinasi pupuk NPK dan bokashi jerami padi tidak berpengaruh nyata terhadap pertumbuhan tanaman padi sawah varietas Cisantana, namun berpengaruh nyata terhadap berat kering gabah per petak. Perlakuan bokashi jerami padi secara mandiri berpengaruh nyata terhadap tinggi tanaman, jumlah anakan, jumlah anakan produktif dan panjang malai. Dosis bokashi jerami padi 75% bokashi jerami padi (3,75 ton/ha) merupakan dosis terbaik untuk pertumbuhan tinggi tanaman, jumlah anakan, jumlah anakan produktif dan panjang malai. Sedangkan dosis 75% NPK (187,5 kg/ha) + 75% bokashi jerami padi (3,75 ton/ha) merupakan dosis kombinasi terbaik untuk variabel berat kering gabah per petak.

**Kata kunci:** Bokashi jerami, pupuk NPK, padi sawah varietas cisantana

## INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food for more than 95% of Indonesia's population and is widely cultivated by farmers in the Banggai district. In 2018, rice productivity in the Banggai district was 4.31 tons/ha but decreased in 2019 to 4.28 tons/ha ([BPS Central Sulawesi, 2020](#)).

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One of the factors causing the decline in rice productivity is the insufficient supply of fertilizer on rice fields due to the reduction in fertilizer subsidies by the government. Inorganic fertilizer is required to produce >10 tons of GKG/ha with a minimum dose of 200 kg/ha of urea and 300 kg/ha of Phonska NPK ([Agricultural Research and Development Agency, 2016](#)).

Fulfilment of nutrient needs in rice plants can also be obtained by giving organic fertilizers. The addition of organic fertilizer that decomposers have decomposed effectively increases rice growth and production ([Sitepu et al. 2017](#)). The content of rice straw bokashi fertilizer is: N= 1.83%, P<sub>2</sub>O<sub>5</sub>= 4.38%, K<sub>2</sub>O= 0.97% and Si= 12.82% ([Birmadi et al. 2019](#)). According to [Raskun \(2018\)](#), giving bokashi to rice plants has a significant effect on rice production, and the optimal dose is 0.8 kg/10 kg of soil.

Giving straw compost together with NPK fertilizer can increase nitrogen uptake (N) in plants, but if it is not combined with NPK, straw compost can increase soil N, as well as plant growth (plant height and number of tillers/clumps) ([Kaya, 2013](#)). According to [Nangge et al. \(2020\)](#), applying NPK fertilizer and straw compost to IPB 3S rice varieties can reduce the use of NPK fertilizer by 75%. Based on this, this study was conducted to determine the substitution of NPK fertilizer with rice straw bokashi on the growth and yield of Cisantana rice varieties.

## MATERIALS AND METHODS

This research was conducted from August to November 2020 in Samaku Village, Bualemo District, Banggai Regency. The tools used in this study include hand tractors, hoes, buckets, sickles, harvesting machines, digital scales, cameras and stationery. The materials needed in the research include lowland rice seeds of Cisantana variety, bokashi rice straw and NPK fertilizer.

This study used a factorial randomized block design (RAK) consisting of 2 factors and each factor consisting of 3 levels, namely:

Factor I: application of NPK fertilizer (A) which consists of 3 levels, namely:

A1 = 25% NPK (62.5 kg/ha)

A2 = 50% NPK (125 kg/ha)

A3 = 75% NPK (187.5 kg/ha)

Factor II: giving rice straw bokashi (B) which consists of 3 levels, namely:

B1 = 25% bokashi Rice straw (1.25 tons/ha)

B2 = 50% bokashi Rice straw (2.5 tons/ha)

B3 = 75% bokashi Rice straw (3.75 tons/ha)

The observed variables are; plant height (cm) was measured every week at 2-6 weeks after planting (WAP); the number of tillers per clump was counted every week since the plants were 2 WAP to 6 WAP; panicle length (cm); number of productive tillers per clump; and weight/weight of dry grain per plot.

The data obtained were analyzed for variance according to the design used, namely a factorial randomized block design (RAK) using Minitab 16 software. The Tukey test was carried out if the p-value < 0.05 or p-value < 0.01 to determine the difference between treatments.

## RESULTS AND DISCUSSION

### Plant height

Observation of the height of rice plants that were given a combination of NPK fertilizer and rice straw bokashi was carried out 5 times from 2 weeks to 6 weeks. The analysis of

variance showed that the combination of NPK fertilizer with rice straw bokashi did not affect plant height growth. Still, the independent rice straw bokashi treatment significantly impacted plant height at the age of 2 and 5 WAP ([Table 1](#)) and had a very significant effect on the age of 6 WAP ([Table 2](#)).

**Table 1.** Plant height at 2 WAP and 5 WAP

Plant age	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	<i>p-value</i>
2 WAP	29,44ab	31,33a	28,04b	0,015
5 WAP	53,26b	56,33a	55,00ab	0,023

**Note:** The numbers followed by different letters mean significantly different based on the Tukey test (*p-value* < 0.05).

Based on the Tukey test, the highest rice plant height was in treatment B<sub>2</sub> with an average of 31.33 (2 WAP) and 56.33 (5 WAP). At the age of 2 weeks, treatment B<sub>2</sub> (rice straw bokashi 2.5 tons/ha) was significantly different from B<sub>3</sub> (rice straw bokashi 3.75 tons/ha), but not significantly different from B<sub>1</sub> (rice straw bokashi 1.25 ton/ha). At 5 WAP, treatment B<sub>2</sub> was significantly different from B<sub>1</sub> and not significantly different from B<sub>3</sub>. This is by the results of [Kaya \(2013\)](#), that the application of straw compost and NPK fertilizer independently has a significant effect, while the interaction of the two does not affect rice plant height.

**Table 2.** Plant height 6 weeks after planting

Treatments	Average		<i>p-value</i>
B <sub>1</sub>	75,96	b	0,002
B <sub>2</sub>	81,70	a	
B <sub>3</sub>	82,33	a	

**Note:** The numbers followed by different letters mean that they are very significantly different based on the Tukey test (*p-value* < 0.01).

Based on the Tukey test analysis results, the highest mean for rice plant height at the age of 6 WAP was in treatment rice straw bokashi 3.75 tons/ha (82.33). The treatment of rice straw bokashi 3.75 tons/ha was significantly different from that of bokashi rice straw 1.25 tons/ha but not significantly different from that of rice straw bokashi 2.5 tons/ha. This is due to an increase in the nutrient uptake of rice plants with an increase in the dose of bokashi fertilizer due to relatively better soil conditions. The N element contained in bokashi fertilizer can increase the height growth of rice plants because it plays a role in the photosynthesis process and helps the formation of protein. According to [Abu et al. \(2017\)](#), the function of the nutrient N is to stimulate root growth, photosynthesis, and protein formation to stimulate vegetative growth (plant height).

### Number of tillers per clump

The analysis of variance showed that the combination of NPK fertilizer with rice straw bokashi did not affect the number of tillers. Still, the independent rice straw bokashi treatment significantly affected tillers aged 2 and 3 WAP ([Table 3](#)). At the age of 2 weeks after planting, the highest number of tillers was in the rice straw bokashi treatment of 3.75 tons/ha with an average of 2.67, while at the age of 3 WAP, the highest number of tillers was in the rice straw bokashi treatment of 3.75 tons/ha, with an average of 6.26. Giving bokashi rice straw can increase the vegetative growth of rice plants (plant height and number of tillers) because it can improve soil structure and increase nitrogen availability in the soil and nitrogen uptake by plants ([Kaya, 2013](#)).

**Table 3.** Number of paddy rice tillers per clump.

Plant age	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	<i>p-value</i>
2 WAP	2,07b	2,22ab	2,67a	0,047
3 WAP	4,63b	4,63b	5,26a	0,026

**Note:** The numbers followed by different letters mean that they are very significantly different based on the Tukey test (*p-value* < 0.05).

The results of laboratory tests of rice straw bokashi samples in addition to containing nitrogen also contain elements of P (0.28%), K (0.46%), Ca (0.29%), Mg (0.10%), Na (0.69 %) and Fe (8,632 ppm). The availability of these nutrients is essential for the vegetative growth of rice plants, which can produce the optimal number of tillers per clump. According to [Hadisuwito \(2007\)](#) that the function of the nutrient N is to form protein and chlorophyll, the function of element P as an energy source that helps plants in the development of the vegetative phase, the function of Ca to activate the formation of root hairs and strengthen stems, element K functions in the formation of proteins and carbohydrate.

### Number of productive tillers

The analysis of variance showed that the combination of NPK fertilizer with rice straw bokashi did not affect the number of productive tillers. Still, the independent rice straw bokashi treatment significantly affected the number of productive tillers ([Table 4](#)).

**Table 4.** Number of productive tillers

Treatments	Average		<i>p-value</i>
B <sub>1</sub>	19,00	b	0,048
B <sub>2</sub>	20,59	ab	
B <sub>3</sub>	22,22	a	

**Note:** The numbers followed by different letters mean that they are very significantly different based on the Tukey test (*p-value* < 0.05).

Tukey test analysis showed that the highest number of productive tillers was in treatment rice straw bokashi 3.75 tons/ha with an average of 22.22, and the lowest was in treatment rice straw bokashi 1.25 tons/ha with an average of 19.00. This shows that the higher the dose of bokashi fertilizer, the higher the number of productive tillers of rice plants. This research by [Zahrah \(2011\)](#), showing that increasing the dose of bokashi from 0 to 30 tons/ha at various doses of organic NPK and increasing the dose of organic NPK from 0 to 600 kg/ha at different doses of bokashi, was able to increase the amount of organic NPK. Productive tillers at the dose of bokashi 30 tons/ha and organic NPK 600 kg/ha were 19.0 stems/clump. [Tufaila et al. \(2014\)](#) stated that giving bokashi can affect productive tillers of lowland rice plants. Biologically, bokashi fertilizer can increase the activity of soil microorganisms which can increase the availability of nutrients and stimulate root growth. Plant roots function in absorbing water and nutrients to promote plant growth, such as the number of productive tillers ([Sahardi et al. 2014](#)).

### Panicle length

The analysis of variance showed that the combination of NPK fertilizer with rice straw bokashi did not affect panicle length. Still, the independent rice straw bokashi treatment significantly impacts panicle length ([Table 5](#)). The highest panicle length was in treatment rice straw bokashi 3.75 tons/ha with an average of 20.81, and the lowest was in treatment rice straw bokashi 1.25 tons/ha with an average of 19.37. The research by [Zahrah \(2011\)](#), rice plants that

were given bokashi fertilizer and organic NPK produced a longer panicle length (27.8 cm) compared to plants that were not given fertilizer (26.7 cm).

**Table 5.** Panicle length

Treatments	Average	p-value
B <sub>1</sub>	19,37 b	0,034
B <sub>2</sub>	20,00 ab	
B <sub>3</sub>	20,81 a	

**Note:** The numbers followed by different letters mean that they are very significantly different based on the Tukey test ( $p$ -value < 0.05).

The results showed that the higher the dose of fertilizer applied to the soil, the higher the average panicle length of rice plants. According to [Muharam & Purnomo \(2013\)](#), increasing the dose of inorganic fertilizer on land that has been given bokashi will increase the ability of plants to produce maximum panicle length. Lack of nutrients in the panicle initiation period can cause panicle formation to be not optimal. This is because rice plants require sufficient water and N elements so that plant cells actively divide during panicle formation ([Azalika et al. 2018](#)).

### Weight of Dry Grain Per Plot

The analysis of variance showed that the combination of NPK fertilizer with rice straw bokashi had a significant effect on the weight of dry grain per plot ([Table 6](#)). The highest dry grain weight per plot was in the A<sub>3</sub>B<sub>3</sub> treatment with an average of 4.56 and the lowest in the A<sub>1</sub>B<sub>1</sub> treatment with 1.40.

**Table 6.** Weight of dry grain per plot

Treatments	Average	p-value
A <sub>1</sub> B <sub>1</sub>	1,40 f	0,034
A <sub>1</sub> B <sub>2</sub>	2,00 e	
A <sub>1</sub> B <sub>3</sub>	2,63 d	
A <sub>2</sub> B <sub>1</sub>	2,40 de	
A <sub>2</sub> B <sub>2</sub>	2,78 cd	
A <sub>2</sub> B <sub>3</sub>	2,79 cd	
A <sub>3</sub> B <sub>1</sub>	3,10 c	
A <sub>3</sub> B <sub>2</sub>	3,60 b	
A <sub>3</sub> B <sub>3</sub>	4,56 a	

**Note:** The numbers followed by different letters mean that they are very significantly different based on the Tukey test ( $p$ -value < 0.05).

The combination of organic and inorganic fertilizers produces optimal grain yields compared to the application of inorganic fertilizers according to the recommended dose without the addition of organic matter ([Muharam & Purnomo, 2013](#)). [Thamrin \(2000\)](#) reported that the use of straw compost significantly increased the yield of harvested dry rice grains. The provision of straw compost significantly increased the grain yield of 12.25 tons/ha in dry rice. The results of research conducted by [Paulus & Senduk \(2016\)](#) that the highest yield of the dry grain harvest (GKP) was achieved by the treatment of organic straw fertilizer and organic fertilizer for legumes combined with 40% NPK, which were 9.03 tons/ha and 8.62 tons/ha, respectively.

The application of NPK fertilizer and bokashi straw can meet the nitrogen needs of plants. Nitrogen plays a role in the photosynthesis process during the grain filling phase and



increases the protein in the grain ([Abu et al. 2017](#)). The number of pithy grain and seed weight formed in one panicle is very dependent on the photosynthesis process ([Donggulo et al. 2017](#)).

## CONCLUSIONS

Based on the study results, it can be concluded that the combination of NPK fertilizer and rice straw bokashi had no significant effect on the growth of Cisantana rice varieties but had a significant effect on the dry weight of grain per plot. Rice straw bokashi treatment significantly affected plant height, number of tillers, number of productive tillers, and panicle length. The dose of rice straw bokashi 75% rice straw bokashi (3.75 tons/ha) was the best dose for plant height growth, number of tillers, number of productive tillers and panicle length. The dose of 75% NPK (187.5 kg/ha) + 75% rice straw bokashi (3.75 tons/ha) was the best combination dose for the dry weight variable of grain per plot.

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