

Effect of NPK Bio-Organomineral Dosage on Growth and Yield of Rice Plants on Industrial Waste Polluted Land

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Abstract

Rice is a staple food in Indonesia and its production is crucial to meet the increasing demand. However, industrial pollution threatens rice cultivation, particularly in the Rancaekek paddy fields. This study aimed to investigate NPK Bio-Organomineral fertilizer on rice plants' growth and yield in industrially polluted land. The experiment was conducted in September 2023-February 2024 in a greenhouse using Inpari 32 rice varieties. The research was set up in a randomized block design with eight treatments and four replications. The treatments consisted of: control (no fertilization), NPK 250 kg/ha, and NPK Bio-Organomineral treatment with doses of 125, 250, 375, 500, 625, 750 kg/ha. The results showed that applying NPK Bio-Organomineral fertilizer increased the number of productive tillers, vegetative tillers, and grain dry weight. The optimal dose of NPK Bio-Organomineral fertilizer at a dose of 750 kg/ha showed the best results in increasing the number of vegetative and productive tillers. The dose of 375 kg/ha showed the best economic results in increasing the grain dry weight. This study shows that Bio-Organomineral NPK fertilizer can effectively improve soil fertility and increase rice yields on industrial waste-polluted land.

Key words : *Crop Productivity, Fertilizer, Soil*

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INTRODUCTION

Rice is one of the cereal crops that produces rice grains as a staple food and a major food source consumed by most of the population in Indonesia. With the development in the agricultural sector to meet these needs, the issues regarding food, especially rice, have become increasingly complex. The most significant development challenge is providing food production for the population, which is projected to reach 9 billion worldwide by 2030. The increasing demand for food due to

Indonesia's growing population contrasts with the current agricultural productivity. Various efforts are needed to increase yields optimally to meet these food needs.

According to data from the Central Statistics Agency (2023), in 2022, Indonesia's per capita rice consumption was 82.87 kg per year, with production reaching 54.75 million tons and rice harvested area of 10.45 million hectares. High rice consumption must be balanced with sufficient rice production to meet national needs, one of which

is by giving full attention to this issue to ensure food needs are met.

The development of the industrial sector has negative impacts on agriculture and food security. One of them is the damage to the rice ecosystem due to industrial waste pollution from textile factories dumping their waste into rivers used for irrigation, resulting in significant losses for farming efforts and agricultural production. Textile waste pollution contains heavy metals in paddy fields, which is extremely dangerous if it exceeds the threshold. These heavy metals include Pb, Cr, and Cu, which affect the quality of plants grown on them, requiring control efforts to reduce heavy metal solubility.

For example, the Rancaekek paddy fields show contamination from pollutants. Heavy metal waste originates from textile dye substances, including arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), copper (Cu), and zinc (Zn) (Komarawidjaja, 2016). If plants absorb these heavy metal elements, it can hinder plant growth and even lead to crop failure. Furthermore, heavy metals absorbed by food crops and consumed by humans, such as rice, can harm human health (Agustine et al., 2018).

Soil inherently can self-purify from harmful substances, but if the amount of contaminated harmful substances in the soil exceeds the standard quality, the soil's self-purification is insufficient (Novandi et al., 2014). Therefore, treatment is needed to improve soil fertility with environmentally friendly fertilizer application using biological agents, namely NPK Bio-Organomineral fertilizer.

NPK Bio-organomineral fertilizer is a mixture of N fertilizer based on urea, zeolite, activated charcoal, and compost with biological agents (*Bacillus subtilis*). Microorganisms play a

role in reducing heavy metal levels in the soil and improving environmental quality (Sudirja et al., 2016). NPK Bio-Organomineral fertilizer is expected to be an effective solution to enhance soil fertility contaminated by industrial waste in the paddy fields of Rancaekek Subdistrict.

The appropriate application of NPK BioOrganomineral can affect the increase in growth and yield of rice plants, supported by the

modification of fertilizer form and size. The form and size of fertilizer affect nutrient solubility, application speed, ease, and availability, which can be adjusted to the plant's needs. This improves fertilization efficiency, minimizing nutrient losses due to volatilization or leaching, thus reducing environmental pollution (Yerizam et al., 2017).

This research aims to analyze the effect of applying Bio-Organomineral NPK fertilizer on industrially polluted paddy fields planted with rice, focusing on vegetative tillers, productive tillers, and milled dry grain. The goal is to determine the optimal fertilizer dosage.

MATERIALS AND METHODS

This experiment was conducted in a Greenhouse in the Experimental Garden of Ciparanje, Jatinangor, owned by the Faculty of Agriculture, Padjadjaran University, at approximately $\pm$ 740 meters above sea level (masl). Soil analysis, on the other hand, was carried out at the Soil Chemistry and Plant Nutrition Laboratory, Jatinangor, Sumedang Regency, West Java. NPK Bio-organomineral fertilizer tablets were produced in the Fertilizer Room of Cileles, Faculty of Agriculture, Padjadjaran University, Jatinangor, Sumedang Regency. The experiment was conducted from September 2023 to February 2024.

Soil samples were taken from Jelegong Village, Rancaekek District, Bandung Regency rice fields. Then, the soil samples were placed into an 8-liter bucket, filled three-quarters full, and thoroughly mixed, ensuring even distribution, with approximately 4 liters of water added. In this experiment, test plants were used, namely Inpari 32 rice varieties, which had been sown for 14 days and then transplanted into planting media in the bucket filled with soil and water in a muddy condition, with 2 plants per bucket. After 14 days, rice plants were thinned, leaving only 1 plant.

The production of NPK Bio-Organomineral fertilizer used a formulation ratio of 60% NPK, 20% zeolite, 10% activated charcoal, and 10% compost with biological agents (*Bacillus subtilis*), thoroughly mixed until homogeneous using a mixer. The resulting homogeneous mixture

was then fed into a tablet pressing machine to produce NPK Bio-Organomineral tablet formula with a density of 0.8 g/tablet, diameter of 15 mm, and thickness of 10 mm.

The experimental design used was a Randomized Block Design (RBD). The treatments consisted of: control (no fertilization), NPK 250 kg/ha, and NPK BioOrganomineral treatment with doses of 125, 250, 375, 500, 625, 750 kg/ha (Table 1). The analysis design utilized an ANOVA test, while testing the difference in treatment means was conducted using the F test at the 5% significance level. If there are significant differences among treatment means, the testing is continued with Duncan's multiple range test using Smartstat XL.

Table 1. The dosage of NPK Bio-Organomineral fertilizer

Symbol	Treatment	Dosage (kg/ha)
A	Control (no fertilizer)	0
B	NPK 100% (recommendation)	250
C	NBO	125
D	NBO	250
E	NBO	375
F	NBO	500
G	NBO	625
H	NBO	750

Note:

NBO = NPK Bio-Organomineral

In the experiment, the measured parameters were the growth of rice plants, namely productive tillers, vegetative tillers, and grain dry weight. Observations of vegetative tillers were conducted before entering the generative stage, specifically at 14, 28, 42, 56, and 70 days after sowing. Measurement of grain dry weight was carried out after obtaining the value of dry harvested grain by sun-drying for 3-4 days to achieve a moisture content of approximately 1214%, then weighing to get the value of grain dry weight.

RESULTS AND DISCUSSION

Productive Tillers

The application of various doses of NPK Bio-Organomineral fertilizer showed a diverse response to the number of productive tillers of rice plants. The average number of productive tillers of rice plants can be seen in Figure 6.

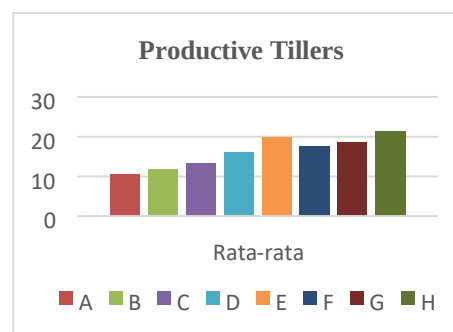


Figure 1. Effect of NPK Bio-Organomineral on Productive Tillers

Note: Treatment A (Kontrol), B (NPK 100% 250 kg/ha), C (NPK 125 kg/ha), D (NPK 250 kg/ha), E (NPK 375 kg/ha), F (NPK 500 kg/ha), G (NPK 625 kg/ha), H (NPK 750 kg/ha)

Based on Figure 6, the highest number of productive tillers is NPK Bio-Organomineral fertilizer in treatment H (750 kg.ha⁻¹) with an average of 21 tillers. Treatment A (control) is the treatment that has the least number of productive tillers, which is 11 tillers. The application of NPK Bio-Organomineral fertilizer in tablet form significantly increases the number of productive tillers compared to the treatment without fertilization and the treatment with 100% NPK fertilizer (recommendation). Bio-Organomineral NPK fertilizer contains NPK nutrients that affect the number of tillers of rice plants. Siska, et al. (2019) stated that the provision of compound fertilizer in the form of NPK in rice plants tends to produce more productive tillers than a single N fertilizer. This is because the fulfilled nutrients are more complete and meet the needs of rice plants.

Bio-Organomineral NPK fertilizer also contains zeolite which plays a role in adsorbing N elements in the form of ammonium and then releasing it when the availability of these elements in the soil is low (Suminarti, 2019), so that it can provide more productive tillers compared to no fertilization and 100% NPK fertilizer.

Vegetative Tillers

The application of various doses of NPK Bio-Organomineral fertilizer showed a diverse response to the number of vegetative tillers of rice plants. The average number of tillers of rice plants can be seen in Figure 2.

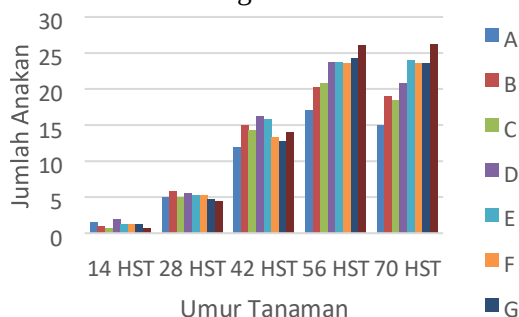


Figure 2. Effect of NPK Bio-Organomineral on Vegetative Tillers

Note: Treatment A (Kontrol), B (NPK 100% 250 kg/ha), C (NPK 125 kg/ha), D (NPK 250 kg/ha), E (NPK 375 kg/ha), F (NPK 500 kg/ha), G (NPK 625 kg/ha), H (NPK 750 kg/ha)

Based on Fig. 5, the application of NPK Bio-Organomineral fertilizer with treatment H (750 kg.ha⁻¹) has the best number of vegetative tillers compared to other treatments. Meanwhile, the control treatment has the least number of tillers at all observation times. This is in line with the plant height due to the effect of the slow-release tablet fertilizer form that gives a response in the late vegetative period.

The provision of urea as a source of N nutrients greatly affects the growth of rice plant tillers to grow optimally (Abu, et al., 2017). N nutrients play an important role in vegetative growth (Mastur, et al., 2015), such as increasing stem and leaf growth, the number of tillers and the number of clumps in rice plants. NPK Bio-Organomineral tablet fertilizer can release ammonium (N-NH₄⁺) from urea when nitrogen

levels in the soil are low, thus maintaining its availability until the maximum vegetative phase (Sudirja, et al., 2016).

Different doses of NPK Bio-Organomineral tablet fertilizer cause variations in its solubility, so there are differences in the number of vegetative tillers produced. In addition to different volume sizes, nutrient solubility can also be influenced by different soil pH in each experimental bucket. Nutrients N, K, Ca, Mg, and S tend to decrease in availability if the soil pH also decreases (Siswanto, 2018).

Grain Dry Weight

Grain dry weight of paddy can be done after determining the quantity of grains from direct threshing and weighing to obtain the value of harvested dried paddy. Subsequently, the value of dried milled paddy with a moisture content of <14% is obtained. The quality of the rice produced during milling is influenced by the moisture content of the paddy (Iswanto et al., 2018). If the moisture content is too high, more than 14%, the rice will be too soft or mushy, resulting in broken grains.

Table 2. Effect of NPK Bio-Organomineral on Grain Dry Weight

Symbol	Treatments	Grain Dry Weight
A	Control	21,28 a
B	NPK 250 kg/ha	24,88 a
C	NBO 125 kg/ha	34,25 b
D	NBO 250 kg/ha	37,55 b
E	NBO 375 kg/ha	48,93 cd
F	NBO 500 kg/ha	42,18 bc
G	NBO 625 kg/ha	50,03 cd
H	NBO 750 kg/ha	55,75 d

Note: The same letter behind the number indicates that it is not significantly different according to Duncan's Multiple Range Test ($p < 0,05$)

According to Setiawati (2020), the quality of paddy in Indonesia is significantly influenced by

factors such as moisture content, empty grain content, and paddy varieties. The higher the quality of dried milled paddy with low empty grain and dirt content, the higher the milling yield. The treatment of NPK BioOrganomineral fertilizer produces different effects on the components of milled dry grain yield. The yield components of rice plants in each treatment can be seen in Table 2 above.

Based on Table 2, the application of NPK Bio-Organomineral tablet fertilizer on the lowest grain dry weight was produced in treatment A (control), which weighed 21.28g. The milled dry grain weight in treatment E (375 kg.ha⁻¹), which weighed 48.93 g, was the best dose economically because the weight increased against treatment A and treatment B (100% NPK). This proves that the use of NPK Bio-Organomineral fertilizer is effective in increasing the grain dry weight.

Treatment A has the lowest weight due to the absence of fertilizer application. Adding fertilizer to the soil can increase the availability of nutrients that can support plant growth and production (Aziz, 2023). However, these nutrients easily become unavailable due to leaching and evaporation. The loss of nutrients during the grain filling phase can cause the grain to be incompletely filled and affect the weight of the rice grain (Syafriyani et al., 2018).

The application of NPK Bio - organomineral grain dry weight due to the addition of ameliorant materials in the form of zeolite, activated charcoal and compost which can provide nutrients continuously and maintain the availability of nutrients in the roots according to plant needs (Sudirja et al., 2023). In addition, it has NPK content which is a nutrient element needed by plants in their growth so that it can affect the increase in the production component of paddy rice plants (Simanjuntak, et al., 2015).

Balanced fertilization with nutrient management from organic fertilizers or ameliorants and balanced inorganic fertilizers can increase the availability of nutrients for rice plants, thus supporting the process of fertilization and filling of rice grains (Jaenuristy et al., 2022). The presence of activated charcoal can also hold the availability

of potassium nutrients for plants (Mariana et al., 2021). In addition, zeolites given as ameliorants can prevent the leaching of sodium and potassium nutrients out of the root zone (Sudirja et al., 2023).

CONCLUSION

NPK Bio-Organomineral fertilizer can increase the growth and yield of paddy rice on land polluted by industrial waste. The application of NPK Bio-Organomineral fertilizer at a dose of 750 kg/ha showed the best results in increasing the number of vegetative tillers and productive tillers, while the dose of 375 kg/ha showed the best results economically in increasing the grain dry weight.

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