

**EFFECT OF NPK BIO-ORGANOMINERAL DOSAGE ON GROWTH AND YIELD OF RICE PLANTS ON POLLUTED SOIL**

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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 poses a threat to rice cultivation, particularly in the Rancaekek paddy fields. This study aimed to investigate the effect of NPK Bio-Organomineral (NBO) fertilizer on the growth and yield of rice plants in industrially polluted land. The experiment was conducted 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<sup>-1</sup>, and NBO treatment with doses of 125; 250; 375; 500; 625; 750 kg.ha<sup>-1</sup>. The results showed that the application of NBO fertilizer increased the number of productive tillers, vegetative tillers, and grain dry weight. The optimal dose of NBO at a dose of 750 kg.ha<sup>-1</sup> showed the best results in increasing the number of vegetative tillers and productive tillers, while the dose of 375 kg.ha<sup>-1</sup> showed the best results economically in increasing grain dry weight.

**Keywords:** Crop Productivity, Fertilizer, Soil

**1. INTRODUCTION**

Rice is one of the cereal crops that produces grains of rice as a staple food and a major food source consumed by the majority of the population in Indonesia. With the development in the agricultural sector to meet these needs, the issues regarding food, especially rice, become increasingly complex. The biggest challenge of development 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.

In 2022, the per capita rice consumption in Indonesia was 82.87 kg per year, with production reaching 54.75 million tons and rice harvested area of 10.45 million hectares (Central Statistics Agency, 2023). 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 (Handayani *et al.*, 2022).

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, 2017). If these heavy metal elements are absorbed by plants, 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 be hazardous to human health (Agustine *et al.*, 2018).

Soil inherently has the ability to 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, 2014). Treatment is needed to improve soil fertility with environmentally friendly fertilizer application using biological agents, such as NPK Bio-Organomineral (NBO) 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). The NBO fertilizer is expected to be an effective solution to improve soil fertility contaminated by industrial waste in the paddy fields of Rancaekek Subdistrict.

The appropriate application of NBO 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 study aims to analyze the effect of applying NBO 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.

## **2. MATERIAL AND METHODS**

### **2.1 Location and Soil Samples**

This study was conducted in a Greenhouse located at Ciparanje Experimental Farm, Jatinangor, owned by the Faculty of Agriculture, Padjadjaran University, at an altitude of approximately  $\pm$  740 meters above sea level (masl). Soil analysis was carried out at the Soil Chemistry and Plant Nutrition Laboratory, Jatinangor, Sumedang Regency, West Java. The production of NBO fertilizer tablets was done in the Fertilizer Room of Cileles, Faculty of Agriculture, Padjadjaran University, Jatinangor, Sumedang Regency. In addition, inoculation of biological agents used in the formulation of NBO fertilizer, namely *Bacillus subtilis*, was carried out at the Soil Biology Laboratory, Faculty of Agriculture, Universitas Padjadjaran.

Soil samples were taken from rice fields in Jelegong Village, Rancaekek District, Bandung Regency and tested by taking a composite of 250 kg for 25 experimental buckets. The soil was brought to the experimental site to be homogenized by stirring well, then put into 20 cm diameter buckets of 10 kg per bucket, and fertilized for one week by giving water and stirring, then flooded with 3 cm of water. In this experiment, test plants were used, such as Inpari 32 rice varieties.

## 2.2 Process of NBO Fertilizer

The preparation of NBO fertilizer uses a formulation ratio of 60% NPK (N from urea fertilizer, P from guano derived from bat feces, K from empty palm bunches), 20% zeolite, 10% activated charcoal, and 10% compost from cow dung and roasted husks combined with biological agents (*Bacillus subtilis*). The ingredients are uniformed in size by filtering using a 40 mesh sieve, then stirred until homogeneous using a mixer. The homogenized mixture was then put into a tablet press to produce an NBO tablet formula with a weight of 0.8 g/tablet, a diameter of 15 mm, and a thickness of 10 mm.

## 2.3 Experiment Design

This study used was experimental method with Randomized Block Design (RBD). The treatments consisted of: control (no fertilization), NPK 250 kg/ha, and NBO treatment with doses of 125; 250; 375; 500; 625; 750 kg/ha (Table 1). The analysis design utilized 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, then the testing is continued with Duncan's multiple range test using Smartstat XL.

**Table 1: The Dosage of NBO Fertilizer**

Symbol	Treatment	Dosage (kg.ha <sup>-1</sup> )
A	Control	0
B	NPK Phonska Fertilizer	250
C	NBO Fertilizer	125
D	NBO Fertilizer	250
E	NBO Fertilizer	375
F	NBO Fertilizer	500
G	NBO Fertilizer	625
H	NBO Fertilizer	750

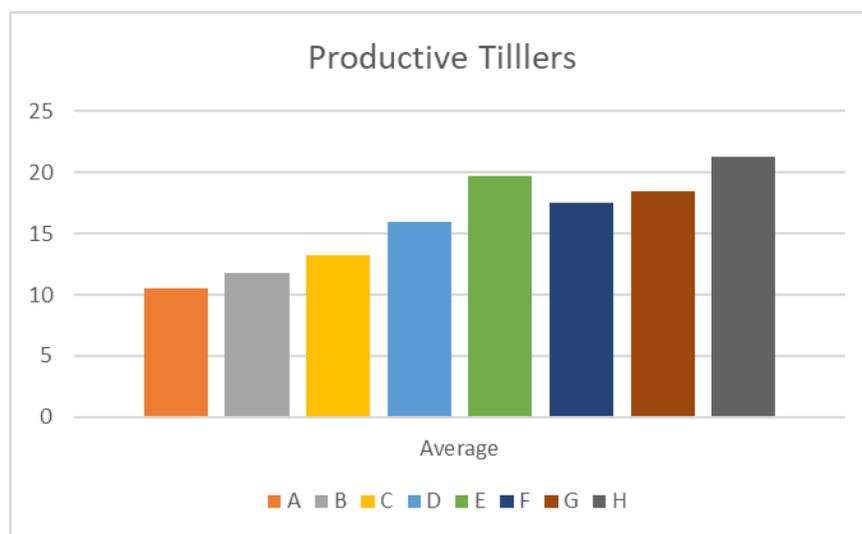
Note : The treatment (A) or control is the treatment without fertilizer application.

Treatment B is a treatment recommendation with the application of NPK Phonska (15:10:12) at a dose of 250 kg/ha based on the recommended dose for Rancaekek location-specific paddy rice plants listed in the Minister of Agriculture Regulation No. 13 of 2022.

## 3. RESULT AND DISCUSSION

### 3.1 Productive Tillers

The application of various doses of NBO 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 1.



**Figure 1.** Effect of NBO on Productive Tillers

**Note:** Treatment A (Control), B (NPK 100% 250 kg.ha<sup>-1</sup>), C (NPK 125 kg.ha<sup>-1</sup>), D (NPK 250 kg.ha<sup>-1</sup>), E (NPK 375 kg.ha<sup>-1</sup>), F (NPK 500 kg.ha<sup>-1</sup>), G (NPK 625 kg.ha<sup>-1</sup>), H (NPK 750 kg.ha<sup>-1</sup>)

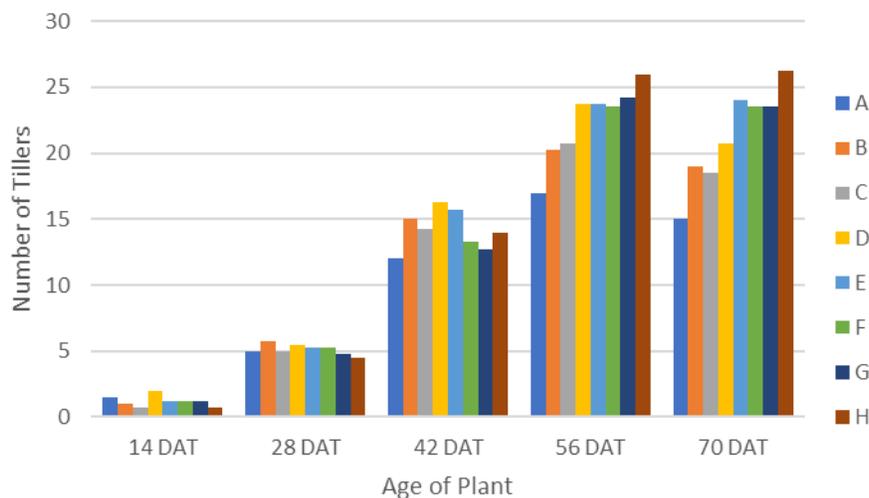
Based on Figure 1, the highest number of productive tillers is NBO fertilizer in treatment H (750 kg.ha<sup>-1</sup>) with an average of 21 tillers. Treatment A (control) is the treatment that has the least number of productive tillers, which is 11 tillers. The application of NBO fertilizer in tablet form has a significant effect on increasing the number of productive tillers when compared to the treatment without fertilization and the treatment with 100% NPK fertilizer (recommendation).

The NBO fertilizer contains NPK nutrients that affect the number of tillers of rice plants. Provision of compound fertilizer in the form of NPK in rice plants tends to produce a greater number of productive tillers compared to a single N fertilizer (Siska, 2020). This is because the nutrients that are fulfilled are more complete and in accordance with the needs of rice plants.

The zeolite contained in NBO fertilizer also plays a role in adsorbing N elements in the form of ammonium and then releasing them when the availability of these elements in the soil is low (Sumniarti, 2019), so that it can produce more productive tillers compared to no fertilization and NPK Phonska fertilizer.

### 3.2 Vegetative Tillers

The application of various doses of NBO 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 NBO on Vegetative Tillers

**Note:** Treatment A (Control), B (NPK 100% 250 kg.ha<sup>-1</sup>), C (NPK 125 kg.ha<sup>-1</sup>), D (NPK 250 kg.ha<sup>-1</sup>), E (NPK 375 kg.ha<sup>-1</sup>), F (NPK 500 kg.ha<sup>-1</sup>), G (NPK 625 kg.ha<sup>-1</sup>), H (NPK 750 kg.ha<sup>-1</sup>)

Based on Figure 2, the application of NBO fertilizer with treatment H (750 kg.ha<sup>-1</sup>) 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, increasing the number of tillers and increasing the number of clumps in rice plants. The NBO tablet fertilizer can release ammonium (N-NH<sup>+</sup>) 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 NBO 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, 2019).

### 3.3 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, 2015). If the

moisture content is too high, more than 14%, the rice will be too soft or mushy, resulting in broken grains.

The quality of paddy in Indonesia is significantly influenced by factors such as moisture content, empty grain content, and paddy varieties (Setiawati, 2020). The higher the quality of dried milled paddy with low empty grain and dirt content, the higher the milling yield. The treatment of NBO 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 below.

**Table 2. Effect of NBO on Grain Dry Weight**

Symbol	Treatment	Grain Dry Weight (g)
A	Control	21,28 a
B	NPK Phonska 250 kg.ha <sup>-1</sup>	24,88 a
C	NBO 125 kg.ha <sup>-1</sup>	34,25 b
D	NBO 250 kg.ha <sup>-1</sup>	37,55 b
E	NBO 375 kg.ha <sup>-1</sup>	48,93 cd
F	NBO 500 kg.ha <sup>-1</sup>	42,18 bc
G	NBO 625 kg.ha <sup>-1</sup>	50,03 cd
H	NBO 750 kg.ha <sup>-1</sup>	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)

Based on Table 2, the application of NBO 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<sup>-1</sup>), which weighed 48.93 g, was the best dose economically because the weight increased against treatment A and treatment B (NPK Phonska). This proves that the use of NBO 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). 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, 2018).

The application of NBO 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). Zeolites given as ameliorants can prevent the leaching of sodium and potassium nutrients out of the root zone (Sudirja *et al.*, 2023).

#### 4. CONCLUSION

Fertilizer of NBO can increase the growth and yield of paddy rice on land polluted by industrial waste. The application of NBO fertilizer at a dose of 750 kg.ha<sup>-1</sup> showed the best results in increasing the number of vegetative tillers and productive tillers, while the dose of 375 kg.ha<sup>-1</sup> showed the best results economically in increasing the grain dry weight.

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