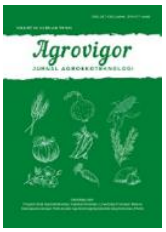
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Article

Growth and NPK Level of Two Rice Varieties (Oryza sativa L.) Due to Differences in the Combination of Inorganic and Biological Fertilization

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ABSTRACT

The increase on rice plant growth can be done through the application of organic and inorganic fertilizers, as well as the use of appropriate varieties. This research aimed to examine the effect of a combination of organic and inorganic fertilizer doses and the use of varieties on improving rice plant growth and nutrient level. The research was conducted from June to August 2025 located in Sudimoro Village, Megaluh Subdistrict, Jombang Regency. This research used a factorial randomized block design (RBD) with two factors and three replications. Factor 1 is a combination of biological and inorganic fertilizer doses consisting of 9 levels of treatment, namely: 100% inorganic fertilizer + no biological fertilizer (P1), 75% inorganic fertilizer + no biological fertilizer (P2), 50% inorganic fertilizer + no biological fertilizer (P3), 100% inorganic fertilizer + 5 ml biological fertilizer (P4), 75% inorganic fertilizer + 5 ml biological fertilizer (P5), 50% inorganic fertilizer + 5 ml biological fertilizer (P6), 100% inorganic fertilizer + 10 ml biological fertilizer (P7), 75% inorganic fertilizer + 10 ml biological fertilizer (P8), and 50% inorganic fertilizer + 10 ml biological fertilizer (P9). Factor 2 is the rice plant varieties, namely: Inpari 32 (V1) and Ciherang (V2). The observations conducted included growth observations, namely plant height, number of leaves, number of tillers and dry weight of plants observed at 15, 30, 45, and 60 days after planting and NPK level of plants observed at 60 days after planting. The results showed that the combination of 100% inorganic fertilization + 10 ml of organic fertilizer generally increased plant height, number of leaves and dry weight of rice plants. The use of the Ciherang variety resulted in better plant height, number of leaves and dry weight of rice plants compared to the Inpari 32 variety. The use of a combination of inorganic and

organic fertilizer had a significant effect on increasing the number of tillers of rice plants of the Inpari 32 variety compared to the Ciherang variety. The nitrogen content of rice plants (1.17 to 1.99%) is included in the deficiency category, while the phosphorus content (0.14 to 0.31%) and potassium (1.45 to 2.22%) are included in the excess category, where the addition of biofertilizer has an effect on increasing the nitrogen, phosphorus and potassium content of rice plants compared to without biofertilizer.

INTRODUCTION

Rice (*Oryza sativa* L) is a major food crop in Indonesia due to its high demand as a staple food source. Jombang Regency is one of the rice production centers in East Java. It was recorded that rice productivity in Jombang Regency in 2024 was 344,349 tons of dry grain (GKG), lower than the 2023 rice productivity of 346,879 tons. Furthermore, the area of rice production in Jombang Regency had decreased, reaching 56,763 hectares in 2023, while in 2024 the harvested area decreased to 55,623 hectares, representing a decrease of 1,140 hectares or 2.01% (Statistics Indonesia of Jombang Regency, 2024).

Crop productivity is significantly influenced by land condition. Plants cannot produce optimally if there are limiting factors such as low soil fertility(Mahbub et al., 2023). To increase soil fertility, farmers generally use high doses of inorganic fertilizers to maintain stable crop yields. While this practice can meet plant nutrient needs in the short term, in the long term it can reduce soil pH and cation exchange capacity (CEC), making the added inorganic fertilizers less effective in providing nutrients to rice plants (Murnita & Taher, 2021).

Dependence on inorganic fertilizers inevitably increases crop production cost, given the high price of inorganic fertilizer due to increasingly difficult-to-obtain subsidies. This leads to a decline in farmers' profits. One approach to addressing land productivity issues is to substitute or complement the use of inorganic fertilizers with biofertilizers. Nutrient provision can occur through increased plant access to nutrients, for example through dissolution by phosphate-solubilizing microbes, or through decomposition by actinomycete fungi or earthworms (Herdiyantoro & Setiawan, 2015).

The use of biological fertilizers in the form of phosphate-solubilizing bacterial inoculants *Pseudomonas mallei* and *Pseudomonas cepaceae* and phosphate-solubilizing fungi *Penicillium sp*. and *Aspergillus sp*. can increase the available phosphorus content of the soil, the growth and yield of rice plants (Fitriatin et al., 2017). The application of indigenous phosphate-solubilizing microbes increases the nutrient content of peat soil (Istina et al., 2020). The application of NPK fertilizer at a dose of 50% and the application of biofertilizer with a volume of 20 mL/plant as well as a combination of 20 mL biofertilizer + 50% NPK affected the growth and productivity of tomato plants (Faizah, 2014). The treatment of 0.75 doses of NPK + 1.00 doses of biofertilizer was the most effective and profitable treatment agronomically with an RAE value of 100%, and economically with an R/C value of 1.83 (Hazra & Santosa, 2022).

Another important consideration in the proper use of fertilizers is the selection of appropriate rice varieties, which plays a crucial role in the cultivation process. The use of superior varieties with high yield potential and resistance to major diseases is essential to achieve optimal productivity. This study employed the Inpari 32 and Ciherang varieties, both of which have been recognized for their high yield potential, tolerance to lodging, and resistance to pests and diseases. These varieties possess several agronomic advantages, including resistance to blast and bacterial leaf blight (HDB), relatively short growth duration, large grain size, low moisture content, and high yield potential that meets market standards (Akbar & Lizmah, 2022). Despite numerous studies investigating the effects of either biological or inorganic fertilizers independently, limited research has focused on their synergistic effects when combined with different rice varieties, particularly in relation to growth and yield performance. Therefore, this study aims to analyze the impact of combined biological and inorganic fertilization on enhancing rice production across different varieties. The optimization of fertilization strategies through such combinations is expected to provide a sustainable approach to improving rice productivity.

MATERIALS AND METHODS

The research was conducted from June to August 2025, in Sudimoro Village, Megaluh Subdistrict, Jombang Regency with vertisol soil type at an altitude of 40 m above sea level. The materials used were Inpari 32 and Ciherang rice seeds, NPK fertilizer (16:16:16), urea fertilizer, biofertilizer that's containing *Azospirillum sp, Rhizobium sp, Aspergillus niger, Trichoderma harzianum, and Pseudomonas fluorescens,* plenum and confidor pesticides, and novlect herbicide.

The method used was a Factorial Randomized Block Design (RBD) with 2 factors repeated 3 times. Factor 1 is a combination of doses of biological fertilizer and inorganic fertilizer consisting of 9 levels of treatment, namely: 100% inorganic fertilizer + no biological fertilizer (P1), 75% inorganic fertilizer + no biological fertilizer (P2), 50% inorganic fertilizer + no biological fertilizer (P3), 100% inorganic fertilizer + 5 ml biological fertilizer (P4), 75% inorganic fertilizer + 5 ml biological fertilizer (P5), 50% inorganic fertilizer + 5 ml biological fertilizer (P6), 100% inorganic fertilizer + 10 ml biological fertilizer (P7), 75% inorganic fertilizer + 10 ml biological fertilizer (P8), and 50% inorganic fertilizer + 10 ml biological fertilizer (P9). Factor 2 is the rice plant varieties, namely: Inpari 32 (V1) and Ciherang (V2). Each experimental plot measured 2 m × 2 m (4 m²) and was planted with 36 rice seedlings at a spacing of 25 cm × 25 cm between plants.

The observations conducted included growth measurements of plant height, namely plant height, number of leaves, number of tillers and dry weight at 15, 30, 45, and 60 days after planting, as well as plant NPK level at 60 days after planting. The data obtained from these observations were then analyzed using analysis of variance (F Test) at a 5% level. If significant differences were found, a Fisher's Least Significant Difference (LSD) test was conducted at a 5% level.

RESULTS AND DISCUSSION

Plamt Height

Plant height is a growth parameter that can be observed with the naked eye. The results of the study showed that there was no significant interaction between the combination of biofertilizer and inorganic fertilizer doses and plant variety. Separately, the combination of biological and inorganic fertilizer doses significantly affected rice plant height at 15, 30, 45, and 60 days after planting. The variety significantly affected rice plant height at 60 days after planting (Table 1).

The table 1 showed that the use of inorganic fertilizer combined with biological fertilizer significantly increased the height of rice plant. The application of 100% inorganic fertilizer combined with 10 ml of biological fertilizer (P7) was able to increase the height of rice plant, while reducing the dose of inorganic fertilizer by 50%, either without or with the addition of 5 ml of biological fertilizer, tended to result in shorter rice plant height, although this results was not significantly different from the height of rice plant due to the application of single inorganic fertilizers at a dose of 100%. The result indicated that the application of biological fertilizer was quite significant in increasing the growth of rice plants, in this case the height of rice plants. Biofertilizers containing inoculants *Rhizobium sp., Azospirillum sp., Azotobacter sp., Bacillus sp., Aspergillus sp., Streptomyces sp*., Phosphate-solubilizing bacteria, *Pseudomonas sp., and Trichoderma sp*. were able to increase the availability of macronutrients for plants, which had implications for improving plant height. This is in line with research result (Hazra & Santosa, 2022) which showed that the application of biofertilizer to rice plants was able to increase plant height. The presence of beneficial microorganisms generally acts as an agent that can increase nutrient availability for plants (Gofar et al., 2025).

Differences in rice plant varieties significantly affected the height of rice plants at 60 days after planting, where the Ciherang variety produced taller plants than the Inpari 32 variety. This is because differences in varieties will affect the appearance of the plants. This result is in line with a research (Alavan et al., 2015) where differences in genetic traits of each superior variety, both in terms of plant adaptation to the environment, resulted in varying responses.

Number of Leaves

The number of leaves is a parameter that needs to be observed in plant growth because leaves are the places where photosynthesis occurs, so the more leaves there are, the better the plant growth can proceed. The results of the study showed that in the number of leaves parameter there was no significant interaction between

the combination of doses of biofertilizer and inorganic fertilizer with plant variety factors. Separately, the combination of doses of biological fertilizer + inorganic fertilizer significantly affected the number of leaves of rice plants at the ages of 30, 45, and 60 days after planting. Meanwhile, the variety factor significantly affected the number of leaves of rice plants at the ages of 15 and 30 days after planting (Table 3). Each rice variety has distinct characteristics that responds differently to various growing environments. The table 3 showed that the Ciherang variety generally had a higher number of leaves than the Inpari 32 variety. The Ciherang variety had relatively high vigor, allowing it to produce a large number of leaves (Rahmatika & Sari, 2020). The greater the number of leaves that absorb sunlight, the faster the photosynthesis process will occur (Sumardi et al., 2024).

Different fertilization treatments also impact the number of leaves in rice plants. Table 3 also showed that the combination of 100% inorganic fertilizer and 10 ml of biological fertilizer significantly increased the number of leaves in rice plants (P7). Reducing the dose of inorganic fertilizer without adding biofertilizer resulted in the lowest number of leaves. This indicates that rice plants must meet their nutrient needs to prevent a decrease in metabolism, which can inhibit plant growth. This is in line with finding (Setyorini et al., 2020) which stated that plants receiving insufficient fertilizer doses tended to experience delays in growth of leaves and photosynthesis. Biological fertilizer can be used as an alternative source of additional nutrients for plants, as evidenced by treatment P5, P7, and P8, where reducing the dose of inorganic fertilizer accompanied by the addition of biological fertilizer resulted in a number of leaves that was not significantly different from the 100% inorganic fertilizer treatment (P1). The combination of biological and inorganic fertilizers can increase the efficiency of nutrient absorption by plant roots, which then accelerates vegetative growth, including leaf development (Bashan et al., 2014).

Table 1. Rice plant height due to combination treatment of biological fertilizer + inorganic fertilizer doses and variety types on the 15th, 30th, 45th and 60th observation days

Treatment	Height of rice plant (cm) at various plant ages							
	15		30		45		60	
Combination of doses of biological fertilizer + inorganic fertilizer								
100% inorganic fertilizer + no biological fertilizer (P1)	42.67	bcd	77.95	cd	85.67	b	100.00	bcd
75% inorganic fertilizer + no organic fertilizer (P2)	36.33	a	60.20	a	77.67	a	91.83	a
50% inorganic fertilizer + no biological fertilizer (P3)	36.00	a	59.60	a	76.00	a	89.50	a
100% inorganic fertilizer + 5 ml of biological fertilizer (P4)	43.33	cd	78.82	cd	86.50	bc	96.17	abc
75% inorganic fertilizer + 5 ml of biological fertilizer (P5)	37.63	ab	62.90	ab	79.83	ab	91.17	a
50% inorganic fertilizer + 5 ml of biological fertilizer (P6)	36.67	a	59.17	a	76.67	a	90.67	a
100% inorganic fertilizer + 10 ml of biological fertilizer (P7)	44.33	d	80.02	d	93.00	c	103.00	d
75% inorganic fertilizer + 10 ml of biological fertilizer (P8)	41.00	abcd	74.93	bcd	86.33	bc	101.67	cd
50% inorganic fertilizer + 10 ml of biological fertilizer (P9)	38.50	abc	69.47	abc	85.00	b	92.33	ab
LSD 5%	5.57		12.30		7.05		8.12	
Variety								
Inpari 32 (V1)	38.59		67.59		82.63		92.44	a
Ciherang (V2)	40.62		70.87		83.30		97.85	b
LSD 5%	ns		ns		ns		3.83	

Description: Number accompanied by the same letter indicates no significant difference based on the 5% LSD test

(p = 0.05), ns = no significant difference.

Table 3. Number of leaves of rice plants due to combination treatment of organic fertilizer + inorganic fertilizer doses and type of variety on the 15th, 30th, 45th and 60th observation days

Tratment	Number of rice plant leaves at various plant ages (hst)							
	15		30		45		60	
Combination of biological fertilizer + inorganic fertilizer doses								
100% inorganic fertilizer + no biological fertilizer (P1)	56.33		68.00	bcd	77.50	cd	78.00	bcd
75% inorganic fertilizer + no biological fertilizer (P2)	45.83		53.50	a	62.50	ab	68.00	ab
50% inorganic fertilizer + no biological fertilizer (P3)	45.00		51.00	a	56.50	a	59.50	a
100% inorganic fertilizer + 5 ml of biological fertilizer (P4)	58.00		65.83	bc	78.33	cd	83.17	cd
75% inorganic fertilizer + 5 ml of biological fertilizer (P5)	48.33		58.50	ab	74.00	bc	78.33	bcd
50% inorganic fertilizer + 5 ml of biological fertilizer (P6)	43.50		54.00	a	68.67	abc	72.33	bc
100% inorganic fertilizer + 10 ml of biological fertilizer (P7)	62.67		76.33	d	92.33	e	87.50	d
75% inorganic fertilizer + 10 ml of biological fertilizer (P8)	56.17		75.83	d	90.17	de	87.50	d
50% inorganic fertilizer + 10 ml of biological fertilizer (P9)	50.67		70.50	cd	75.00	bc	84.50	d
LSD 5%	ns		9.61		12.80		11.46	
Variety								
Inpari 32	44.78	a	61.41	a	74.11		77.26	
Ciherang	58.89	b	66.04	b	75.89		78.04	
LSD 5%	6.21		4.53		ns		ns	

Description: Number accompanied by the same letter indicates no significant difference based on the 5% LSD test (p = 0.05), ns = no significant difference.

Increasing the number of beneficial microorganisms such as N2-binding bacteria and phosphate-solubilizing bacteria through the application of biofertilizers is very important for plants as a potential alternative to reducing the use of chemical fertilizers (Wickramasinghe et al., 2021).

Number of rice plant tillers

The number of rice plant tillers indicates the potential yield of harvested grain, because healthy tillers will develop into panicles (rice flower stalks) that produce rice grains. The results of this research showed that in the parameter of tiller number at the age of 15 hst there was no significant interaction between the combination of biological and inorganic fertilizer doses with plant variety factors. Separately, the treatment factor of the combination of biological fertilizer + inorganic fertilizer doses significantly affected the number of tillers at the age of 15 hst. The variety factor also significantly affected the number of leaves of rice plants at the age of 15 hst. (Table 3). The table 3 showed the results of rice tiller number measurements at 15 days after planting, which were influenced by the combination of biological fertilizer and inorganic fertilizer doses and the type of rice variety. The application of biological fertilizer at doses of 5 ml and 10 ml was able to reduce the use of inorganic fertilizer on rice plants. This was evidenced by the P5, P8, and P9 treatments, which produced tiller numbers that were not significantly different from those of the P1 treatment. These results are appropriate with a research (Riyanti & Purnamawati, 2015) where the application of straw burial and biofertilizer, as well as organic fertilizer with a half-reduction in the NPK fertilizer dose, was able to increase plant growth, especially tiller number.

Table 3. Number of rice plant tillers due to the combination of biological fertilizer + inorganic fertilizer doses and variety types on the 15th observation day

Treatment	Number of rice plant tillers at 15 days after planting	
Combination of biological fertilizer + inorganic fertilizer doses		
100% inorganic fertilizer + no biological fertilizer (P1)	17.83	bc
75% inorganic fertilizer + no biological fertilizer (P2)	15.33	ab
50% inorganic fertilizer + no biological fertilizer (P3)	14.00	a
100% inorganic fertilizer + 5 ml of biological fertilizer (P4)	18.50	bc
75% inorganic fertilizer + 5 ml of biological fertilizer (P5)	15.17	ab
50% inorganic fertilizer + 5 ml of biological fertilizer (P6)	13.83	a
100% inorganic fertilizer + 10 ml of biological fertilizer (P7)	18.83	c
75% inorganic fertilizer + 10 ml of biological fertilizer (P8)	17.17	abc
50% inorganic fertilizer + 10 ml of biological fertilizer (P9)	15.50	abc
LSD 5%	3.44	
Variety		
Inpari 32	14.07	a
Ciherang	18.40	b
LSD 5%	1.62	

Description: Number accompanied by the same letter indicates no significant difference based on the 5% LSD test (p = 0.05).

Biological fertilizer containing *Azospirillum* sp. and *Azotobacter sp*. will form a symbiosis with roots and, through its specific mechanism providing nutrients, especially available nitrogen that can be absorbed by plants to support growth, including tiller number (Mulyaningsih et al., 2015). The number of tillers is also influenced by differences in rice plant varieties. The table 3 showed that the Ciherang variety produced more tillers than the Inpari 32 variety at 15 days after planting. The number of tillers is closely related to plant height, as a research result (Akbar & Lizmah, 2022) which showed that the Ciherang variety was able to adapt to its surrounding environment, so that increasing plant height in rice fields could increase the number of tillers. The number of tillers was also significantly and positively correlated with production, where increased grain yield was closely related to an increase in the number of productive tillers and the weight of 1,000 productive grains (Chairuman et al., 2021). The interaction between the combination of biological fertilizer and inorganic fertilizer doses with plant variety factors significantly affected the number of rice plant tillers at 30, 45, and 60 days after planting (Table 4). At 30 days after planting, the application of 75% inorganic fertilizer + 10 ml of biological fertilizer (P8) to both varieties resulted in a higher number of rice plant tillers compared to other fertilizer combinations on both rice varieties, but this result was not significantly different from the treatment of 100% inorganic fertilizer + 5 ml of biological fertilizer (P4) on the Inpari 32 variety (V1) or 100% inorganic fertilizer + 10 ml organic fertilizer (P7) on both rice plant varieties. At the age of 45 days after planting, the treatment of 100% inorganic fertilizer + 10 ml of biological fertilizer (P7) on the Inpari 32 (V1) variety produced a higher number of tillers compared to other treatments, but was not significantly different from the number of tillers due to the treatment of 100% inorganic fertilizer + 5 ml of biological fertilizer (P4) on the Inpari 32 (V1) variety or the treatment of 100% inorganic fertilizer + 10 ml of biological fertilizer (P7) on the Ciherang variety. Meanwhile, at the age of 60 days after planting, the application of 100% inorganic fertilizer + 5 ml of biological fertilizer (P4) on the Inpari 32 (V1) variety produced a higher number of tillers compared to other treatments, but was not significantly different from the number of tillers due to the treatment of 100% inorganic fertilizer + 10 ml of biological fertilizer (P7) and 75%

inorganic fertilizer + 10 ml of biological fertilizer (P8) on the same variety.

Table 4. Number of rice plant tillers due to the interaction of the combination treatment of biological fertilizer +inorganic fertilizer doses and variety types at various observation ages.

Combination of biological fertilizer and inorganic fertilizer doses	Number of rice plant tillers due to the interaction of the combination treatment of biological fertilizer + inorganic fertilizer doses and variety types at various observation ages											
	30				45				60			
	Variety				Variety				Variety			
	Inpari 32 (V1)		Ciherang (V2)		Inpari 32 (V1)		Ciherang (V2)		Inpari 32 (V1)		Ciherang (V2)	
100% inorganic fertilizer + no biological fertilizer (P1)	20.00	ef	20.00	ef	23.00	cde	25.00	def	23.33	cde	26.00	def
75% inorganic fertilizer + no biological fertilizer (P2)	1200	a	22.00	fg	15.33	a	22.33	bcde	17.00	ab	22.33	cde
50% inorganic fertilizer + no biological fertilizer (P3)	13.00	ab	17.00	cde	14.67	a	19.00	abc	14.67	a	19.00	abc
100% inorganic fertilizer + 5 ml of biological fertilizer (P4)	28.00	h	19.00	def	33.00	hi	21.00	bcd	36.33	i	24.67	de
75% inorganic fertilizer + 5 ml of biological fertilizer (P5)	16.00	bcd	19.00	def	25.33	def	20.00	abcd	25.33	def	21.67	bcd
50% inorganic fertilizer + 5 ml of biological fertilizer (P6)	17.00	cde	15.00	abc	26.67	efg	18.00	abc	26.67	efg	18.67	abc
100% inorganic fertilizer + 10 ml of biological fertilizer (P7)	25.00	gh	25.00	gh	34.00	i	29.33	fghi	34.33	hi	31.00	gh
75% inorganic fertilizer + 10 ml of biological fertilizer (P8)	26.33	h	27.00	h	32.00	ghi	27.67	efgh	32.67	hi	30.00	fgh
50% inorganic fertilizer + 10 ml of biological fertilizer (P9)	17.00	cde	21.00	f	17.00	ab	25.00	def	17.00	ab	27.00	efg
LSD 5%	3.33				5.36				4.97			

Description: Number accompanied by the same letter indicates no significant difference based on the 5% LSD test (p = 0.05).

These results indicated that the provision of appropriate nutrients through a combination of inorganic and biological fertilizer could increase the potential for increasing the number of tillers in several rice varieties. Biological fertilizer not only support initial growth but also accelerate plant development as they enter a more intensive vegetative phase. These results align with a research (Elita et al., 2020) that found the application of biological fertilizer containing *Azotobacter sp.* and *P. fluorescens* resulted in a higher number of tillers in rice plants compared to the addition of compost alone, where the number and variety of

microbes play a significant role in the provision of nutrients that can influence plant growth.

On the other hand, reducing the dose of inorganic fertilizer on the Inpari 32 (V1) variety without the addition of biological fertilizer tended to produce the lowest number of tillers in all observation periods, while the Ciherang (V2) variety was relatively more tolerant to the stress of reducing the dose of inorganic fertilizer where the number of tillers of the Ciherang variety due to the application of 75% inorganic fertilizer + no biological fertilizer (P2) was not significantly different from the treatment of 100% inorganic fertilizer + no biological fertilizer (P1). These results are in accordance with the result of a research (Permana et al., 2024) which stated that the Ciherang variety tended to have slightly better adaptation compared to the Mekongga and Inpari 32 varieties.

Dry weight of plants

The dry weight of rice plants indicates the amount of biomass absorbed by plants as a result of photosynthesis and metabolic rates within the plant. The results of this research showed that in the dry weight parameter, there was no significant interaction between the combination of biological fertilizer and inorganic fertilizer doses and plant variety factors across all observation periods. Separately, the combination of biological fertilizer and inorganic fertilizer doses significantly affected the dry weight of rice plants at 30, 45, and 60 days after planting. The variety factor significantly affected the dry weight of rice plants at 15 days after planting (Table 5).

The table 5 showed that at 30 days after planting, 50% reduction in inorganic fertilizer dosage was shown to reduce the dry weight of rice plants even though it was accompanied by the addition of biofertilizers, as shown by treatment P3, P6, and P9. Nutrients in the soil and plants which were below critical limits were nutrients that could be limiting factors for plant growth and yield (Kasno et al., 2020). At the observation ages of 45 and 60 days after planting, a reduction in inorganic fertilizer dosage accompanied by the addition of biological fertilizers was shown to increase the dry weight of rice plants. In line with a research (Dewi & Setiawati, 2018) where the application of biological fertilizers increased the number of endophytic bacteria that could increase plant biomass because they could produce the phytohormone IAA, a growth-promoting hormone in plants.

Table 5. Dry weight of rice plants (g) due to the interaction of the combination treatment of biological fertilizer + inorganic fertilizer doses and variety types at various observation ages.

Treatment	Dry weight of rice plants at various plant ages						
	15	30		45		60	
Combination of biological fertilizer + inorganic fertilizer doses							
100% inorganic fertilizer + no biological fertilizer (P1)	4.83	45.00	bc	96.67	cde	110.97	bcd
75% inorganic fertilizer + no biological fertilizer (P2)	4.67	43.83	b	82.33	ab	98.03	abc
50% inorganic fertilizer + no biological fertilizer (P3)	4.33	37.50	a	75.00	a	68.97	a
100% inorganic fertilizer + 5 ml of biological fertilizer (P4)	6.17	46.17	bc	95.33	cde	118.50	cd
75% inorganic fertilizer + 5 ml of biological fertilizer (P5)	5.00	45.00	bc	92.00	bcd	95.20	abc
50% inorganic fertilizer + 5 ml of biological fertilizer (P6)	4.83	38.83	a	90.50	bc	80.83	ab
100% inorganic fertilizer + 10 ml of biological fertilizer (P7)	8.00	48.00	c	107.17	e	137.27	d
75% inorganic fertilizer + 10 ml of biological fertilizer (P8)	7.00	45.33	bc	104.00	de	119.93	cd
50% inorganic fertilizer + 10 ml of biological fertilizer (P9)	4.33	40.00	a	99.83	cde	100.10	abc
LSD 5%	ns	3.74		12.56		31.56	
Variety							
Inpari 32	5.26	43.14		90.19	a	100.40	
Ciherang	5.67	43.44		97.11	b	106.22	
LSD 5%	ns	ns		5.92		ns	

Description: Number accompanied by the same letter indicates no significant difference based on the 5% LSD test (p

= 0.05).

IAA phytohormone, which was a result of endophytic bacterial secretion, had a positive impact on plant growth by increasing root density, length, and surface area. This root development caused an expansion of nutrient absorption, thereby increasing shoot and root biomass. The results of this research indicated that the use of biological fertilizer as part of a fertilization strategy could improve the growth and dry weight of rice plants. Appropriate application of biological fertilizer and inorganic fertilizer could significantly contribute to increasing rice productivity on agricultural land.

Differences in plant varieties also significantly affected the dry weight of rice plants at 45 days after planting. The table 6 also shows that the Ciherang variety had a higher dry weight than the Inpari 32 variety. Optimal physiological characteristics can be achieved if the plants have good genetic traits and are grown in an environment suitable for plant growth and development (Gusmiatun & Marlina, 2019).

Nitrogen, phosphorus and potassium level in rice plant

Testing for nitrogen, phosphorus, and potassium nutrient levels is performed when rice plants reach their maximum vegetative phase. Nutrient levels in plant tissue indicate the actual nutrient levels absorbed by the plant. Nutrient level testing is intended to determine rice plant nutrient uptake under various fertilizer treatments and plant varieties. Nitrogen, phosphorus, and potassium are macronutrients that often limit plant growth.

The results of the research showed differences in nitrogen nutrient levels in rice plants across various combinations of biological fertilizer and inorganic fertilizer doses and variety types. Figure 1 showed that rice plant nitrogen levels ranged from 1.17 to 1.99%. This figure was classified as a deficiency because it is below the critical limit of nitrogen content in rice plant tissue, which was 2.0% (Tahir et al., 2019). Nitrogen is an essential nutrient that forms amino acids, nucleic acids, nucleotides, and chlorophyll, which is crucial for rice plant growth and production (Dobermann & Fairhust, 2000).

Reducing the dose of nitrogen fertilizer without the addition of biological fertilizer in the Inpari 32 and Ciherang varieties tended to produce low nitrogen levels where the lowest nitrogen level was found in the treatment of 50% inorganic fertilizer + without biological fertilizer (P3) in the Inpari 32 variety (V1) which is 1.17% followed by the same fertilization treatment in the Ciherang variety (V2) which was 1.26%.

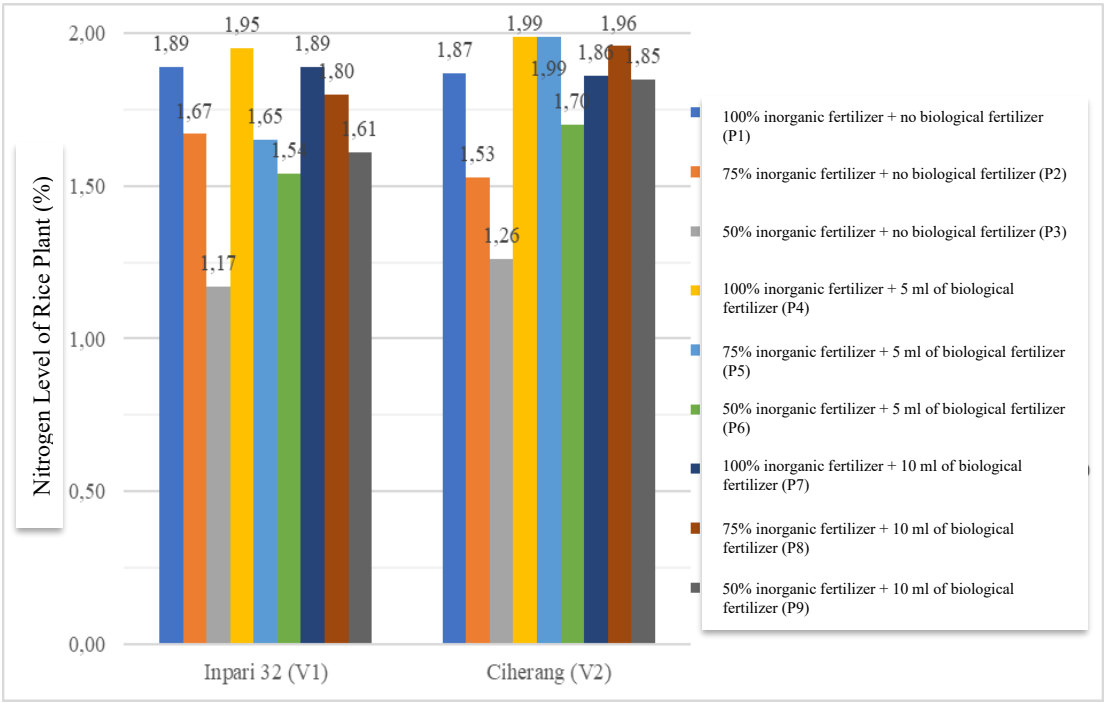


Figure 1. Nitrogen level of rice plants due to combination treatment of biological fertilizer + inorganic fertilizer doses and variety types

In line with the result of a research (Arrasyid et al., 2020) where the reduction in the dose of nitrogen fertilizer had implications for reducing the nitrogen level of rice plants. Efforts to increase the efficiency of inorganic fertilization through the addition of biological fertilizers also increased the nitrogen level of rice plants as shown in the P4 treatment in the Inpari 32 and Ciherang varieties, as well as the P5 and P8 treatments in the Ciherang variety. One way to increase nitrogen availability in the soil and absorption in lowland rice plants could be done by utilizing Azotobacter bacterial isolates as biological fertilizers to reduce the decline in soil health due to the input of synthetic chemicals (Tando, 2019).

The research result also showed that the phosphorus level of rice plants varied due to differences in the combination of biological fertilizer and inorganic fertilizer doses and the type of variety. The figure 2 showed that the phosphorus level of rice plants ranged from 0.14 to 0.31%. This figure was categorized as excessive because it exceeded the critical limit of phosphorus levels for rice plants, which was 0.1%, but it was still within safe limits. It was less than the critical limit of phosphorus toxicity, which was 1% (Tahir et al., 2019). n rice plants, phosphorus plays a role in encouraging growth and panicle formation, triggering flowering and fruit ripening, especially in cold climate conditions, encouraging more clump/tiller formation that allows for faster recovery and adaptation when rice plants experience stress, and supporting the formation of better grain grains and having better nutritional content in relation to phosphorus levels in seeds (Maulidan & Putra, 2024).

The application of biological fertilizer resulted in increased phosphorus level in rice plants. This was proven in the P4 and P7 treatments, which produced plants with higher phosphorus level compared to the P1 treatment for each variety. This is in line with a research (Bertham et al., 2020), which found that the application of biological fertilizer increased soil microbial populations, which resulted in increased nutrient uptake by plants. Biological fertilizer containing phosphate-solubilizing bacterial inoculants would increase phosphorus availability in the soil, as these bacteria are able to convert fixed phosphorus into available phosphorus for rice plants (Supriyo et al., 2014).

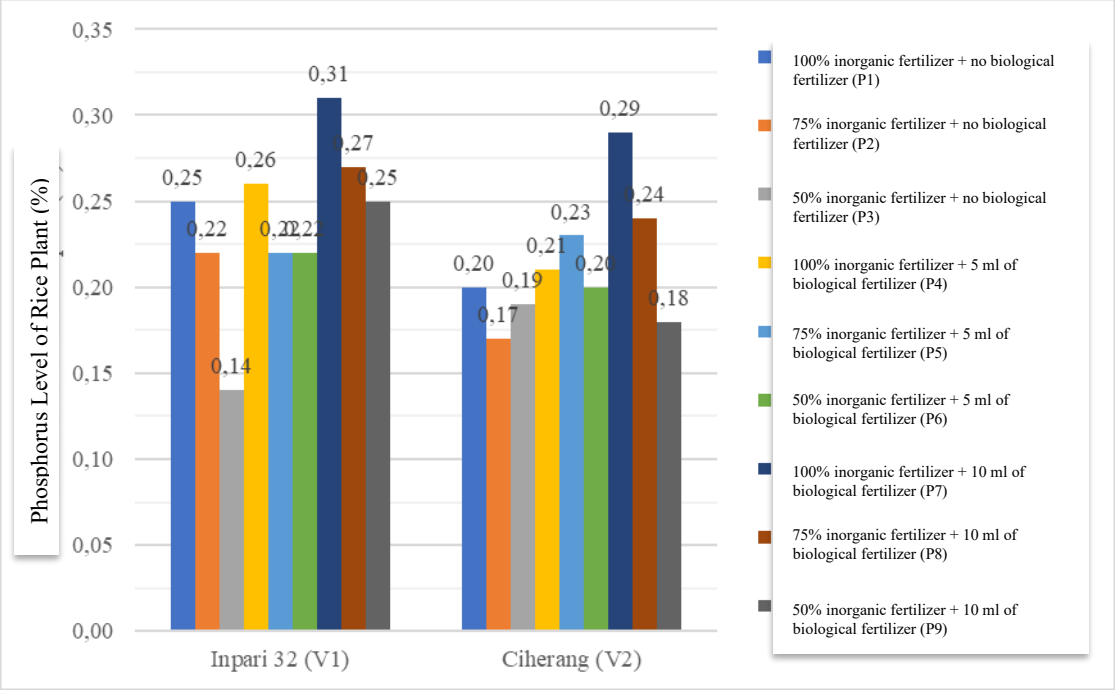


Figure 2. Phosphorus level in rice plants due to combination treatment of biological fertilizer + inorganic fertilizer

doses and variety types

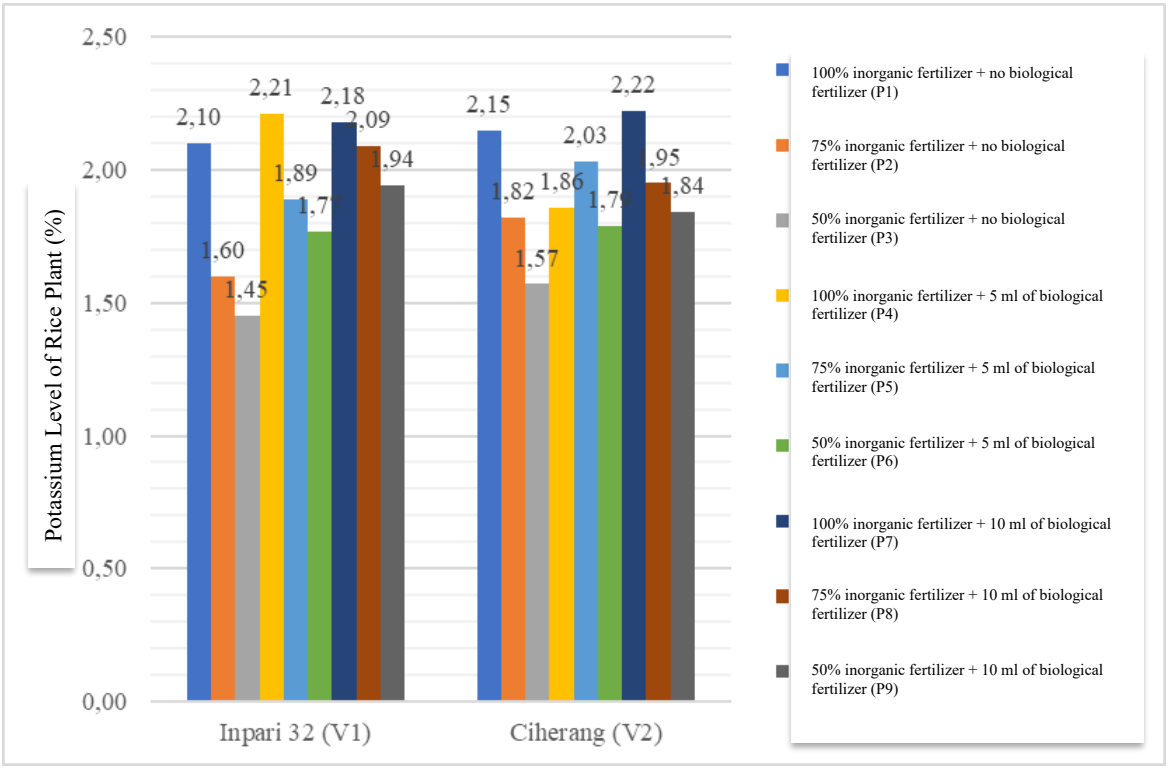


Figure 3. Potassium level in rice plants due to combination treatment of biological fertilizer + inorganic fertilizer doses and variety types

Potassium levels in rice plants also varied due to differences in the combination of biological fertilizer and inorganic fertilizer doses and variety types, ranging from 1.45 to 2.22% (Figure 3). This figure was considered excessive because it exceeded the critical limit of 1% potassium content for rice plants (Tahir et al., 2019). Potassium influenced various plant physiological processes, including cell division, nitrate reduction, and the conversion of synthesized products into protein. It played a role in enzyme activity, and regulates stomatal movement, thus facilitating the movement of nutrients into and out of the plant (Kaya, 2014).

The addition of biological fertilizer also had an impact on increasing the potassium level of rice plants. It can be seen that the P7 treatment produced rice plants with higher potassium level compared to P1 in each rice variety, while the P4 treatment also produced rice plants with higher potassium level compared to P1 in the Inpari 32 variety. Biological fertilizer containing Bacillus sp. inoculant applied to rice paddies could increase the absorption of phosphate and potassium nutrients from straw by 26.36% and 23.57% (Husna, 2019).

CONCLUSION

The application of 100% inorganic fertilizer + 10 ml biological fertilizer (P7) generally produced better rice plant growth among other treatments in terms of plant height, number of leaves, and dry weight. The Ciherang variety showed superior performance compared to the Inpari 32 variety in plant height, number of leaves, and dry weight. However, the combination of inorganic and biological fertilizers had a more pronounced effect on increasing the number of tillers in the Inpari 32 variety compared to Ciherang. Interestingly, the treatment with 75% inorganic fertilizer + 10 ml biological fertilizer (P8) resulted in a higher number of tillers than the treatment with 100% inorganic fertilizer in both varieties. This indicates that P8 is the most efficient treatment because it produced growth performance comparable to 100% inorganic fertilizer (P1) while reducing the inorganic fertilizer input by 25%, demonstrating partial substitution of

chemical fertilizer through the use of biological fertilizer. The addition of biological fertilizer contributed to increasing the N, P, and K content of rice plants, suggesting that microbial activity in the biofertilizer enhanced nutrient availability and uptake efficiency in the rhizosphere. The nitrogen content of rice plants in various combinations of biological and inorganic fertilizer doses and across both varieties ranged from 1.17% to 1.99%, indicating nitrogen deficiency. Meanwhile, phosphorus and potassium contents ranged from 0.14% to 0.31% for phosphorus and 1.45% to 2.22% for potassium, both of which were in the excessive range.

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AUTHORS CONTRIBUTIONS

MF and MN considered and planned the experiment. MF and MN collected data and also performed analysis data. MN interpreting the data. MF prepared the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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