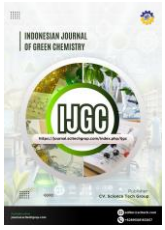

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Combination of Biological and Inorganic Fertilizer on Growth and Production of Rice (*Oryza Sativa*): Mini Review

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Abstract

Rice production in Indonesia fluctuates annually, often due to limited nutrient availability for optimal plant growth. A promising approach to enhance rice productivity and sustainability is the combination of biological and inorganic fertilizers. This review examines the effects of combined fertilization on lowland rice growth and yield, evaluating different fertilization strategies. Treatments included no fertilization, standard inorganic fertilization, and varied combinations of biological and inorganic fertilizers. Findings reveal that specific combinations improved rice growth parameters such as plant height, tiller number, and leaf color intensity, achieving similar or superior results compared to inorganic fertilizers alone. Moreover, this integrated approach demonstrated enhanced productive tiller counts and grain yield, indicating higher agronomic efficiency. These insights underscore the potential benefits of using combined fertilization strategies to optimize rice productivity while promoting sustainable agricultural practices.

Keywords: *Rice, fertilizers, productivity, sustainability, integration*

1. Introduction

Rice (Oryza sativa L.) is a staple food for millions of people in Indonesia, but the country's rice production faces challenges due to limited soil nutrient availability, which often requires substantial input from inorganic fertilizers to achieve optimal yields. However, the long-term reliance on chemical fertilizers has raised concerns about soil degradation, environmental pollution, and increased costs for farmers (Anisuzzaman et al., 2021). These impacts have driven researchers and farmers alike to seek alternative, sustainable fertilization practices that can support high productivity without compromising environmental health (Anisuzzaman et al., 2021).

One promising approach involves the combination of biological and inorganic fertilizers, which has been shown to enhance rice growth parameters such as plant height, productive tiller count, and yield components. Studies have indicated that integrating organic fertilizers, like chicken manure, with reduced doses of nitrogen, phosphorus, and potassium (NPK) can maintain or even improve rice yields while decreasing chemical dependency (Sunarpi et al., 2020). Such combinations allow for reduced use of synthetic fertilizers by up to 50%, aligning with sustainable agriculture goals and reducing potential negative impacts on soil and water quality (Sunarpi et al., 2020).

Beyond organic manure, other biological resources like brown algae extracts and straw compost have demonstrated beneficial effects when used alongside inorganic

fertilizers. For instance, combining algae-based fertilizers with half the usual inorganic dose has produced similar outcomes to full-dose treatments in terms of leaf chlorophyll content, nutrient absorption, and yield metrics (Turmuktini et al., 2012). Meanwhile, incorporating straw compost with water-saving irrigation practices not only enhances rice productivity but also conserves water resources and reduces chemical fertilizer requirements by up to 25% (Turmuktini et al., 2012).

In addition to organic matter and algae extracts, bio-fertilizers containing arbuscular mycorrhizal fungi (AMF) are gaining attention for their ability to improve rice yields, especially in nutrient-poor or dryland systems. Wangiyana et al. (2019) found that AMF application in red rice varieties intercropped with soybean significantly increased filled grain numbers and overall yield, underscoring the adaptability of bio-fertilizers in diverse soil conditions. The findings across these studies indicate that combining biological and inorganic fertilizers can enhance yield, reduce environmental strain, and improve soil health, making it a viable strategy for sustainable rice production in Indonesia (Wangiyana et al., 2019).

2. Literature Review: The Impact of Combined Biological and Inorganic Fertilizers on Lowland Rice Production

Combining biological and inorganic fertilizers has emerged as a sustainable solution to improve rice growth and yield in Indonesia while reducing environmental impact. The integration of organic manure, particularly chicken manure, with inorganic fertilizers has shown promising results. Anisuzzaman et al. (2021) found that applying this combination improved plant height, productive tiller numbers, and overall yield components, even when the chemical fertilizer dose was reduced by 50%. The study demonstrated that organic manure could effectively supplement inorganic nutrients, creating a synergistic effect that sustains yield while reducing the need for chemical inputs. This finding highlights the potential of organic-inorganic combinations to mitigate environmental degradation associated with heavy chemical use in rice farming (Anisuzzaman et al., 2021).

In addition to organic manure, the use of algae-based liquid fertilizers has been explored as a partial replacement for chemical fertilizers. Sunarpi et al. (2020) investigated the application of Lombok brown algae extract combined with 50% of the standard inorganic fertilizer dose, finding that the algae-based treatment resulted in similar nutrient uptake and yield as the full-dose chemical treatment. Specifically, the algae extract improved chlorophyll content and N, P, K levels in the leaves, which are essential for optimal plant growth. This approach not only supports rice productivity but also offers an environmentally friendly alternative to reduce dependency on chemical fertilizers, demonstrating the versatility of algae as a biological input that complements reduced inorganic doses (Sunarpi et al., 2020).

Furthermore, combining organic compost with advanced irrigation practices provides a holistic approach to sustainable rice production. Turmuktini et al. (2012) examined the integration of straw compost with a water-saving irrigation system, finding that it significantly boosted rice yields to 8–12 tons per hectare while reducing chemical fertilizer needs by 25% and water usage by 30–50%. This method not only enhanced productivity but also promoted resource conservation, aligning with sustainable agricultural practices aimed at reducing the environmental footprint of rice farming. Given the increasing scarcity of water resources, this strategy presents a viable option for achieving high productivity under resource-limited conditions (Turmuktini et al., 2012).

Bio-fertilizers, especially those containing arbuscular mycorrhizal fungi (AMF), also play an important role in enhancing rice yields under challenging soil conditions. Wangiyana et al. (2019) studied the impact of AMF on red rice varieties intercropped with soybean, showing that AMF application significantly increased filled grain counts and overall yield. This is particularly relevant for dryland farming systems, where nutrient availability and soil fertility are often limited. The intercropping of soybean with rice also introduces additional nitrogen through natural fixation, further supporting the growth of rice in nutrient-poor soils. This approach highlights how bio-fertilizers can be tailored to specific cropping systems to optimize nutrient availability and yield (Wangiyana et al., 2019).

Moreover, the combination of chemical fertilizer with poultry manure has proven effective in maintaining yield levels while reducing chemical usage. In a study by Moe et al. (2019), rice varieties Manawthukha and Genkitsukushi achieved comparable growth and yield outcomes under a regime of 50% chemical fertilizer and 50% poultry manure as when full chemical fertilizer was applied. This integration demonstrated that poultry manure could partially replace chemical inputs without compromising productivity, offering a cost-effective and sustainable fertilization strategy. This approach not only addresses environmental concerns but also lowers production costs for farmers, suggesting that balanced organic-inorganic fertilization is a practical step towards achieving high productivity with reduced chemical dependency (Moe et al., 2019).

In summary, the combined use of biological and inorganic fertilizers shows promising results for sustainable rice cultivation in Indonesia. These approaches provide effective ways to maintain or increase yields while reducing reliance on chemical fertilizers, enhancing soil health, and conserving water. The findings underscore the importance of tailored fertilization strategies that incorporate local resources and environmental conditions to foster sustainable agricultural practices.

Table 1. Effectiveness of various fertilization methods on agricultural yield improvement

Method	Summary of Findings	References
Combination of inorganic fertilizers with organic manure such as chicken manure and N, P, K fertilizers	This combination improves plant height, productive tiller numbers, and other yield components, while reducing chemical fertilizer use by up to 50%.	(Anisuzzaman et al., 2021)
Use of Lombok brown algae extract as a liquid fertilizer	Applying algae extract with 50% inorganic fertilizer increases leaf chlorophyll content, N, P, K levels, and yield, comparable to 100% inorganic fertilizer dose.	(Sunarpi et al., 2020)
Combination of organic compost straw with water-saving irrigation technology	Increases rice yield to 8-12 tons/ha on average while reducing inorganic fertilizer use by 25% and irrigation water by 30-50%.	(Turmuktini et al., 2012)
Application of arbuscular mycorrhizal fungi (AMF) bio-fertilizer and	AMF bio-fertilizer increases filled grain count and rice yield, especially for specific red rice varieties grown	(Wangiyana et al., 2019)

intercropping with soybean	in dryland systems.	
50% chemical fertilizer combined with 50% poultry manure in Manawthukha and Genkitsukushi varieties	This combination enhances plant height, tiller count, and yield comparable to full chemical fertilizer (NPK) application.	(Moe et al., 2019)

Conclusions

The integration of biological and inorganic fertilizers offers a promising pathway for sustainable rice production in Indonesia, balancing the need for high yields with environmental stewardship. Studies indicate that combinations of organic manure, algae-based fertilizers, composted straw, bio-fertilizers like arbuscular mycorrhizal fungi (AMF), and poultry manure, when combined with reduced levels of chemical fertilizers, can enhance rice growth, increase yield components, and sustain productivity. These integrated approaches not only reduce dependency on chemical inputs, thus mitigating their environmental impact, but also improve soil health, optimize nutrient use efficiency, and promote water conservation. This body of research underscores the potential of balanced fertilization strategies to support sustainable agriculture, suggesting that tailored applications of biological and inorganic inputs can help address the challenges of modern rice farming. Future research should focus on fine-tuning these combinations across various soil types and environmental conditions to further enhance productivity and sustainability in rice cultivation.

References

Anisuzzaman, M., Rafii, M. Y., Jaafar, N., Ramlee, S. I., Ikbal, M., & Haque, M. A. (2021). Effect of Organic and Inorganic Fertilizer on the Growth and Yield Components of Traditional and Improved Rice (Oryza sativa L.) Genotypes in Malaysia. *Agronomy*.

Moe, K., Win, K., Mg, K. W., & Yamakawa, T. (2019). Effects of Integrated Organic and Inorganic Fertilizers on Yield and Growth Parameters of Rice Varieties. *Rice Science*.

Sunarpi, H., Nikmatullah, A., Sunarwidhi, A., Sapitri, I., Ilhami, B. K., & Widyastuti, S. (2020). Growth and yield of rice plants (Oryza sativa) grown in soil media containing several doses of inorganic fertilizers and sprayed with Lombok brown algae extracts. *IOP Conference Series: Earth and Environmental Science*, 594.

Turmuktini, T., Simarmata, T., Joy, B., & Resmini, A. C. (2012). Management of Water Saving and Organic based Fertilizers Technology for Remediation and Maintaining the Health of Paddy Soils and To Increase the Sustainability of Rice Productivity in Indonesia. *Asian Journal of Agriculture and Rural Development*, 2, 536–551.

Wangiyana, W., Aryana, I., & Dulur, N. W. D. (2019). Increasing Yield Components of Several Promising Lines of Red Rice through Application of Mycorrhiza Bio-Fertilizer and Additive Intercropping with Soybean in Aerobic Irrigation System. *International Journal of Environment, Agriculture and Biotechnology*.