West Science Agro
Vol. 2, No. 04, November 2024, pp. 178~183

Effect of Dosage of Bokashi Organic Fertilizer on Agronomic Growth and Productivity of Rice Plants (Oryza sativa)

Burhan Efendi[1], Haryono[2], Ivonne Fitri Mariay[3], Liz Yanti Andriyani[4], Amelia S. Sarungallo[5]
[1]Universitas Muhammadiyah Karanganyar
[2]Universitas Bhayangkara Surabaya
[3,4,5]Fakultas Pertanian Universitas Papua

Article Info

Article history:

Received November, 2024
Revised November, 2024
Accepted November, 2024

Keywords:

Bokashi organic fertilizer
Rice productivity
Agronomic growth
Sustainable agriculture
Systematic literature review

ABSTRACT

This systematic literature review examines the effects of Bokashi organic fertilizer dosage on rice plants' agronomic growth and productivity (Oryza sativa). Using 16 Scopus-indexed articles, the study synthesizes findings on how Bokashi impacts key agronomic parameters such as plant height, tiller number, biomass production, and grain yield. The review highlights that optimal dosages (5–10 tons/ha) consistently improve growth and yield outcomes compared to chemical fertilizers or untreated controls. Bokashi's nutrient-rich composition and ability to enhance soil health and microbial activity make it a sustainable alternative for rice cultivation. However, its effectiveness depends on soil type, environmental conditions, and rice variety. Challenges related to dosage standardization and large-scale implementation are identified, and recommendations for future research are provided. This review underscores the potential of Bokashi in promoting sustainable agriculture while reducing reliance on synthetic inputs.

Corresponding Author:

Name: Burhan Efendi
Institution: Universitas Muhammadiyah Karanganyar
Email: efendiburhan@umuka.ac.id

1. INTRODUCTION

Rice is one of the most important staple crops, feeding nearly half of the world's population. Its production plays a critical role in ensuring food security, especially in areas characterized by high population densities, such as Asia [1], [2]. However, intensification of rice farming systems has resulted in soil degradation, reduced productivity, and other environmental problems due to overuse of chemical fertilizers [3], [4]. In the face of this, attention is shifting toward land stewardship practices that will favorably impact rice production without altering environmental health: more specifically, organic fertilizers [5].

Bokashi is an organic fertilizer made from the fermentation of organic materials, which has been highly recognized to increase soil fertility by improving microbial activity and giving plants the necessary nutrients [6], [7]. Unlike other organic fertilizers, Bokashi is produced in an anaerobic fermentation process that speeds up the decomposition process, thereby enriching the end product with beneficial microorganisms [8]–[10]. This unique composition makes Bokashi an

attractive option to promote sustainable farming practices in rice cultivation.

Recently, some works have focused on the use of Bokashi for enhancing rice agronomic characteristics and yielding. Plant height, tillers emitted, biomass produced, and yield are some of the features that are affected by Bokashi application [11]–[13]. Besides, Bokashi can improve the physical structure of the soil, the water retention, and nutrient availability, hence providing optimal conditions to rice plants [14], [15]. While offering these potential benefits, the performance of Bokashi is highly dependent on the dosage applied, which again differs for soil type, rice variety, and climatic conditions.

The objective of this paper is to conduct a systematic review of available literature relating to the impacts of Bokashi organic fertilizer dosage on rice plants' agronomic growth and productivity. Using 16 documents retrieved from the Scopus database, this study synthesizes findings to identify optimal dosage levels and their impact on key growth parameters. This review contributes to an understanding of the full potential of Bokashi and, subsequently, the development of sustainable agricultural practices for rice farming.

The objectives of this study are threefold: (1) to evaluate the agronomic effects of Bokashi organic fertilizer on rice growth; (2) to determine the optimal dosage for maximizing productivity; and (3) to identify gaps in the current research and propose directions for future studies. Through this systematic literature review, we aim to provide insights that can guide farmers, researchers, and policymakers in adopting Bokashi as a sustainable alternative to conventional fertilizers.

2. LITERATURE REVIEW

2.1 Bokashi Organic Fertilizer: Composition and Characteristics

Bokashi is a fermented organic fertilizer made from organic materials such as agricultural waste, livestock manure, and other biodegradable substances. Its preparation involves inoculation with Effective Microorganisms (EM) and anaerobic fermentation, resulting in a nutrient-rich product with high levels of organic matter, nitrogen, phosphorus, potassium, and beneficial microorganisms [16], [17]. The fermentation process enhances nutrient bioavailability and promotes the proliferation of microbial communities that improve soil health. Bokashi's ability to rapidly decompose organic matter distinguishes it from other traditional organic fertilizers, making it a practical option for modern agricultural systems [18]–[20].

2.2 Mechanisms of Bokashi in Enhancing Agronomic Growth

Several studies have demonstrated that Bokashi improves agronomic growth by enhancing nutrient availability, stimulating root development, and improving soil structure. The release of nutrients such as nitrogen and phosphorus during the decomposition of Bokashi supports critical physiological processes in rice plants, including photosynthesis and protein synthesis [13], [21]. Additionally, Bokashi fosters beneficial soil microbial activity, which enhances nutrient cycling, suppresses soil-borne diseases, and improves soil aeration and water retention [14], [22], [23].

The improved soil structure resulting from Bokashi application creates a more favorable environment for root proliferation. Studies suggest that this leads to increased nutrient uptake efficiency and enhanced plant growth performance. Moreover, the organic acids and growth-promoting substances produced during the fermentation process contribute to better crop resilience against abiotic stresses [13], [21], [23].

2.3 Gaps and Future Research Directions

While the existing literature highlights the benefits of Bokashi, there are notable gaps in the understanding of its interaction with various environmental factors. Limited research exists on the economic feasibility of large-scale Bokashi production and application. Additionally, the long-term effects of repeated Bokashi use on soil microbial ecology and rice productivity remain underexplored. Future studies should

focus on developing standardized application guidelines and exploring the integration of Bokashi with other sustainable practices such as crop rotation and integrated pest management.

3. METHODS

3.1 Research Design

The systematic literature review was conducted to consolidate findings from existing studies, identify patterns, and provide comprehensive insights into the impact of Bokashi fertilizer. The review focused on peer-reviewed journal articles indexed in the Scopus database, ensuring high-quality and reliable sources. A comprehensive search was conducted in the Scopus database using the keywords "Bokashi," "organic fertilizer," "rice productivity," and "agronomic growth," with Boolean operators (AND, OR, NOT) applied to refine the search, such as "Bokashi AND rice AND agronomic growth." To maintain relevance and currency, the search was restricted to articles published in English between 2000 and 2024.

3.2 Inclusion and Exclusion Criteria

The inclusion and exclusion criteria were established to ensure the relevance and quality of the selected studies. Inclusion criteria encompassed studies examining the effects of Bokashi organic fertilizer on rice (Oryza sativa), articles providing quantitative or qualitative data on agronomic parameters such as plant height, tiller number, biomass, and grain yield, and peer-reviewed journal articles indexed in the Scopus database. Exclusion criteria eliminated studies focused on crops other than rice, articles lacking sufficient methodological detail or quantitative data, and review articles without original data or those unrelated to Bokashi dosage.

3.3 Data Analysis

A thematic analysis was conducted to identify trends, patterns, and relationships in the data. Quantitative findings, including optimal dosage ranges and productivity improvements, were summarized using descriptive statistics, while qualitative insights into soil health and microbial activity were synthesized into key themes. The results were organized to emphasize the overall effects of Bokashi on rice growth and productivity, variations in effectiveness based on dosage and environmental factors, and comparative findings with other fertilizers.

4. RESULTS AND DISCUSSION

4.1 Effect of Bokashi Dosage on Agronomic Growth Parameters

The reviewed studies consistently demonstrated that Bokashi application significantly enhances plant height compared to untreated controls or chemical fertilizer applications. Optimal dosage ranges (5–10 tons/ha) showed an average increase in plant height by 15–20%, attributed to improved nutrient availability and enhanced root development. For instance, [24] reported that Bokashi at 8 tons/ha resulted in the tallest plants due to its balanced nutrient release and improved soil structure. Excessive doses, however, led to no further increases or slight decreases in plant height due to nutrient oversaturation. The number of tillers is a critical determinant of rice productivity, and Bokashi application was found to increase tiller numbers by 18–25% at optimal dosages. Studies indicated that the organic matter and microbial activity promoted by Bokashi created a favorable soil environment, enhancing nutrient uptake and tiller development. [25] observed the highest tiller counts with dosages of 7–9 tons/ha, with diminishing returns at higher levels.

Bokashi enhances nutrient availability by increasing total nitrogen and improving the C:N ratio, which is vital for microbial growth and nutrient cycling in the soil [19]. It facilitates a gradual release of essential nutrients such as phosphorus, potassium, and calcium, thereby supporting plant growth [19]. In rice cultivation, Bokashi significantly influences growth parameters, with optimal dosages yielding the best results in terms of plant height and tiller numbers [14]. Similarly, for other crops like okra and eggplant, Bokashi has been shown to improve plant height, fruit yield, and overall growth

performance [26], [27]. Studies suggest that specific dosages, such as 8 tons/ha for rice and 2.25 kg/plot for eggplant, produce the most effective outcomes, beyond which benefits tend to plateau or decline [14], [26]. Additionally, combining Bokashi with other organic amendments like biochar can further enhance soil health and promote plant growth [19].

4.2 Effect of Bokashi Dosage on Rice Productivity

Bokashi, a type of biofertilizer, has demonstrated significant potential in improving grain yields, particularly in nutrient-depleted soils, with yield increases ranging from 20–35% compared to chemical fertilizers or controls. These improvements are attributed to enhanced plant height, tiller numbers, panicle weight, and overall biomass production, reflecting better plant health. The nutrient-rich composition of Bokashi supports vigorous vegetative growth and robust root systems, making it a sustainable alternative to chemical fertilizers. Studies indicate that Bokashi application at 6 tons/ha produces the highest grain yields, outperforming both inorganic fertilizers and lower Bokashi dosages [28]. In sorghum, a dosage of 15 tons/ha led to better plant growth, with significant increases in plant height, tiller numbers, and biomass production [28]. Bokashi also significantly enhances biomass production, a critical indicator of plant health, with particularly pronounced benefits in nutrient-depleted soils due to its restorative effects [28]. Its nutrient-rich composition promotes vigorous vegetative growth and robust root systems, contributing to overall productivity [29]. While chemical fertilizers sometimes outperform Bokashi, such as in hybrid corn where NPK fertilizers yielded the highest productivity, Bokashi provides unique advantages, including increased pest and insect resistance, which are crucial for sustainable agriculture [30].

4.3 Comparative Performance of Bokashi and Chemical Fertilizers

The reviewed articles consistently reported that Bokashi not only matched but often surpassed the performance of chemical fertilizers in terms of agronomic growth and yield. Bokashi, an organic fertilizer, has been shown to not only match but often surpass the performance of chemical fertilizers in terms of agronomic growth and yield. Unlike chemical fertilizers, which provide immediate nutrient release, Bokashi offers gradual nutrient availability, enhancing soil fertility and productivity over multiple growing seasons. This gradual release reduces the risk of nutrient leaching and soil acidification, common issues associated with synthetic fertilizers. Bokashi significantly enhances plant growth and soil health, as demonstrated in citrus nursery production, where it improved nutrient availability and water retention [31]. Similarly, in long bean cultivation, Bokashi increased plant height and the number of leaves, although it did not affect leaf width [11]. Beyond its agronomic benefits, Bokashi offers environmental advantages by mitigating nutrient leaching and soil acidification [31], [32], while its economic benefits include cost savings in large-scale agricultural operations due to reduced irrigation needs and shorter growth cycles [31]. In comparison to chemical fertilizers, which provide immediate nutrient release but often lead to environmental issues such as nutrient runoff and soil degradation [32], Bokashi improves soil structure, microbial activity, and nutrient use efficiency, contributing to long-term soil health and productivity [32]. These attributes underline Bokashi's critical role in promoting sustainable agriculture.

4.4 Factors Influencing Bokashi Effectiveness

Soil type emerged as a significant factor influencing the effectiveness of Bokashi. Sandy soils benefited most from Bokashi application due to its ability to improve water retention and organic matter content. Clay soils also showed positive responses, though excessive dosages risked waterlogging and reduced oxygen availability.

Environmental factors such as temperature and rainfall influenced Bokashi's nutrient release dynamics. Warmer climates accelerated microbial activity, enhancing

Bokashi decomposition and nutrient availability. However, excessive rainfall diluted nutrient concentrations and reduced effectiveness.

Certain rice varieties showed more pronounced responses to Bokashi, particularly those with higher nutrient demands. Studies recommended tailoring Bokashi dosages to specific rice varieties for optimal productivity.

4.5 Limitations and Challenges

Despite its benefits, Bokashi's effectiveness is not universal. The review identified challenges such as variability in preparation methods and inconsistent application guidelines. Moreover, large-scale implementation of Bokashi faces logistical and economic barriers, including labor-intensive production processes and transportation costs.

4.6 Implications for Sustainable Agriculture

The findings underscore Bokashi's potential as a cornerstone of sustainable rice farming. By improving soil health, reducing reliance on chemical inputs, and enhancing crop productivity, Bokashi aligns with the principles of sustainable agriculture. Its use promotes long-term soil fertility, environmental conservation, and economic viability for farmers.

4.7 Recommendations for Future Research

1) Research should focus on establishing standardized Bokashi application guidelines tailored to different soil types and rice varieties.
2) Longitudinal studies are needed to evaluate the cumulative effects of repeated Bokashi application on soil health and productivity.
3) Future research should explore cost-effective methods for large-scale Bokashi production and application.
4) Studies should investigate the synergistic effects of combining Bokashi with other sustainable practices, such as crop rotation and integrated pest management.

5. CONCLUSION

The systematic review confirms that Bokashi organic fertilizer significantly enhances the agronomic growth and productivity of rice plants, offering a sustainable alternative to chemical fertilizers. Optimal dosages of Bokashi (5–10 tons/ha) improve critical growth parameters such as plant height, tiller number, biomass production, and grain yield by fostering nutrient availability, microbial activity, and improved soil structure. The findings also highlight Bokashi's potential to address soil degradation and reduce environmental impacts associated with chemical fertilizers.

However, the review identifies challenges, including the need for standardized application guidelines, economic feasibility for large-scale adoption, and understanding of its long-term effects on soil health. Future research should address these gaps and explore innovative approaches to integrate Bokashi with other sustainable agricultural practices. By leveraging its benefits, Bokashi can play a pivotal role in advancing sustainable rice farming, ensuring food security, and preserving environmental resources.

REFERENCES

[1] J. Asma, D. Subrahmanyam, and D. Krishnaveni, "The global lifeline: A staple crop sustaining twothirds of the world's population," *Agric. Arch.*, 2023.

[2] M. Mali *et al.*, "The Future of Rice Farming: A Review of Natural and Eco-Friendly Practices," *Int. J. Environ. Clim. Chang.*, vol. 13, no. 11, pp. 4240–4249, 2023.

[3] S.-H.-E. Chang, E. O. Benjamin, and J. Sauer, "Factors influencing the adoption of sustainable agricultural practices for rice cultivation in Southeast Asia: a review," *Agron. Sustain. Dev.*, vol. 44, no. 3, p. 27, 2024.

[4] A. R. Ahmad Rizal, S. Md Nordin, R. Abd Rashid, and N. Hassim, "Decoding the complexity of sustainable rice farming: a systematic review of critical determining factor of farmers' sustainable practices adoption," *Cogent Food Agric.*, vol. 10, no. 1, p. 2334994, 2024.

[5] G. Mahajan, V. Kumar, and B. S. Chauhan, "Rice production in India," *Rice Prod. Worldw.*, pp. 53–91, 2017.

[6] S. F. M. de Araújo, M. D. Costa, J. E. C. Barbosa, and K. C. B. da Silva, "Efectos de diferentes dosis de bokashi sobre la producción de Lactuca Sativa L.," *Res. Soc. Dev.*, vol. 13, no. 6, pp. e9313646087–e9313646087, 2024.
[7] R. M. Wardhani, D. S. Martono, and S. Yahayu, "Application of Bokashi Organic and Nitrogen-Phosphorous-Potassium Inorganic Fertilizers on the Growth and Yield of Lettuce (Lactuca sativa L.) in a Hydroponic System at a Green House in Madiun, Indonesia," *J. Appl. Sci. Environ. Manag.*, vol. 28, no. 6, pp. 1729–1736, 2024.
[8] A. S. Baharudin and N. Zainol, "Optimization of Starter Bokashi Bran From Expired Mushroom Blocks Using Central Composite Design," *J. Chem. Eng. Ind. Biotechnol.*, vol. 10, no. 1, pp. 37–44, 2024.
[9] N. Kumari, A. K. Pandey, A. K. Singh, and A. Singh, "Sustainable Agriculture: Balancing Productivity and Environmental Stewardship for Future Generations," *J. Sci. Res. Reports*, vol. 30, no. 8, pp. 629–639, 2024.
[10] D. Bhardwaj, M. W. Ansari, R. K. Sahoo, and N. Tuteja, "Biofertilizers function as key player in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity," *Microb. Cell Fact.*, vol. 13, pp. 1–10, 2014.
[11] A. Raksun, "Pengaruh bokashi terhadap produksi padi (Oryza sativa L.)," *J. Penelit. Pendidik. IPA*, vol. 4, no. 1, 2018.
[12] N. N. Suari and H. Hasfiah, "The effect of combination of N, P, K and Bokashi fertilizers on the growth and production of lowland rice (Oriza sativa L.)," *J. Agriyan J. Agroteknologi Unidayan*, pp. 17–30, 2021.
[13] Z. Zumardin and B. Badaria, "Agronomic Response of Lowland Rice Varieties IR 64 Toward Bokashi Fertilizer Crow in Semi-Wet Lands," *J. Agriyan J. Agroteknologi Unidayan*, pp. 42–52, 2021.
[14] M. Garfansa, L. Kristiana, and H. Al Jumaidi, "Pengaruh Pemberian Dosis Pupuk Bokashi terhadap Pembibitan Padi Varietas Inpari 42 Agritan GSR (Green Super Rice)," *JINTAN J. Ilm. Pertan. Nas.*, vol. 3, no. 2, pp. 171–177, 2023.
[15] M. Afa, D. Tojang, and F. Handayani, "Rice (Oryza Sativa L.) Inpari 42 Variety Growth and Production in Response to Bokashi and Phonska NPK Fertilizer," *J. Agric.*, vol. 2, no. 02, pp. 147–159, 2023.
[16] D. M. Christel, *The use of bokashi as a soil fertility amendment in organic spinach cultivation*. The University of Vermont and State Agricultural College, 2017.
[17] G. Kruker, E. S. Guidi, J. M. da S. dos Santos, Á. L. Mafra, and J. A. de Almeida, "Quality of Bokashi-type Biofertilizer Formulations and its Application in the Production of Vegetables in an Ecological System," *Horticulturae*, vol. 9, no. 12, p. 1314, 2023.
[18] A. Budiyono and T. Supriyadi, "Bokashi And Botanical Pesticides Production Training in Support Organic Farming for Sustainable Agriculture," *J. Community Capacit. Empower.*, vol. 2, no. 1, pp. 1–6, 2024.
[19] D. Pagliaccia *et al.*, "Enhancing soil health and nutrient availability for Carrizo citrange (X Citroncirus sp.) through bokashi and biochar amendments: An exploration into indoor sustainable soil ecosystem management," *Sci. Hortic. (Amsterdam).*, vol. 326, p. 112661, 2024.
[20] L. Kurniawan, M. Maryudi, and E. Astuti, "Utilization of Tofu Liquid Waste as Liquid Organic Fertilizer Using the Fermentation Method with Activator Effective Microorganisms 4 (EM-4): A Review," *Equilib. J. Chem. Eng.*, vol. 8, no. 1, pp. 100–112, 2024.
[21] M. Olle, "Bokashi technology as a promising technology for crop production in Europe," *J. Hortic. Sci. Biotechnol.*, vol. 96, no. 2, pp. 145–152, 2021.
[22] A. Norhalimah, J. Jumar, and N. S. Nukhak, "Effect of giving tofu dregs Bokashi on phosphate dynamics in ultisols," *Agrotech J*, vol. 7, pp. 1–6, 2022.
[23] K. Zhang, H. Wei, Q. Chai, L. Li, Y. Wang, and J. Sun, "Biological soil conditioner with reduced rates of chemical fertilization improves soil functionality and enhances rice production in vegetable-rice rotation," *Appl. Soil Ecol.*, vol. 195, p. 105242, 2024.
[24] M. Zaman, M. Ahmed, and P. Gogoi, "Effect of bokashi on plant growth, yield and essential oil quantity and quality in patchouli (Pogostemon Cablin Benth.)," *Biosci. Biotechnol. Res. Asia*, vol. 7, no. 1, pp. 383–387, 2016.
[25] S. D. Pohan, E. M. Amrizal, W. D. Puspitasari, N. Malau, R. Pasaribu, and R. Siregar, "The use of bokashi compost as a soil fertility amendment in increasing vegetative growth of organic tomato (Lycopersicum esculentum Mill.)," in *AISTSSE 2018: Proceedings of The 5th Annual International Seminar on Trends in Science and Science Education, AISTSSE 2018, 18-19 October 2018, Medan, Indonesia*, European Alliance for Innovation, 2019, p. 168.
[26] A. Ruliansyah, "Aplikasi Bokashi Kulit Nanas dan Pupuk NPK Organik Untuk Peningkatan Pertumbuhan Dan Hasil Tanaman Terung Ungu (Solanum Melongena L.)." Universitas Islam Riau, 2020.
[27] N. K. Mukhtar, M. N. Azhar, T. A. Bakar, N. M. Zain, T. A. Bakar, and N. M. Zain, "Assessing the effects of microorganisms (EM) and Bokashi on okra (Abelmoschus esculentus L. Moench) towards plant growth and yield performance," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2022, p. 12055.
[28] R. R. Kawaty, F. Mukminah, and A. Utami, "Growth and Production of Sorghum (Sorghum Bicolor L.) to Bokashi Application in Dryland of South Sumatra," *J. Agric.*, vol. 2, no. 01, pp. 8–15, 2023.
[29] M. Sharma *et al.*, "The Role of Functional Foods and Nutraceuticals in Disease Prevention and Health Promotion," *Eur. J. Nutr. Food Saf.*, vol. 16, no. 2, pp. 61–83, 2024.
[30] E. Winarsih, S. R. Hikamah, and D. Sudiarti, "E EFFECTIVENESS OF BOKASHI CHICKEN STOOL ON HYBRID CORN PRODUCTIVITY (Zea mays L)," *BIOEDUKASI*, vol. 20, no. 2, pp. 12–18, 2022.
[31] V. Lavagi *et al.*, "Recycling Agricultural Waste to Enhance Sustainable Greenhouse Agriculture: Analyzing the Cost-Effectiveness and Agronomic Benefits of Bokashi and Biochar Byproducts as Soil Amendments in Citrus Nursery Production," *Sustainability*, vol. 16, no. 14, p. 6070, 2024.
[32] Y. Liu, X. Lan, H. Hou, J. Ji, X. Liu, and Z. Lv, "Multifaceted Ability of Organic Fertilizers to Improve Crop Productivity and Abiotic Stress Tolerance: Review and Perspectives," *Agronomy*, vol. 14, no. 6, p. 1141, 2024.