

Effect of Application Timing and Concentration of Biosaka on the Growth and Yield of Organic Lowland Rice

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Abstract

To achieve sustainable and environmentally friendly agriculture, organic-based rice cultivation techniques utilising local resources are gaining popularity. Biosaka, a plant extract solution, functions as an elicitor with the potential to increase plant productivity. This study aimed to analyse: (1) the single effect of Biosaka application time on the growth and production of lowland rice; (2) the single effect of Biosaka concentration on the growth and production of lowland rice; and (3) the interaction between application time and concentration in influencing the growth and production of lowland rice. The study was conducted in Taratara Dua Village, West Tomohon District, Tomohon City, from April to October 2024. This field study used IR-64 rice varieties and a randomised block design with two factors: application time (5, 10, and 15 days) and concentration (0, 30, and 60 ml/15 L). The variables measured included plant height, number of productive tillers, panicle length, and grain yield. The results showed no interaction between the two factors. Although the application time factor did not significantly affect any variables, the Biosaka concentration significantly affected the number of productive tillers, panicle length, the number of filled and empty grains, and the dry grain yield per plot. Interestingly, this study achieved the highest yield in the control treatment (0 ml/L), with a dry grain yield of 6.19 kg per plot. This indicates that the Biosaka application, at the concentration tested, did not increase rice yield in this study.

Keywords: Application Time; Biosaka; Concentration; Lowland Rice; Organic Base

Introduction

Rice (*Oryza sativa* L.) is a major food crop that is crucial to Indonesia's national food security. Increasing rice production is a top priority to meet the growing food demand accompanying population growth. Inorganic fertilisers and synthetic pesticides have often driven intensive rice production. These chemicals have proven effective in significantly increasing crop yields in the short term. However, the continued and excessive use of chemical fertilisers and pesticides has resulted in various long-term negative impacts.

These impacts include agricultural land degradation, reduced soil microbial biodiversity, environmental pollution, and resistance to pests and plant diseases (Tilman et al., 2002; Cassman et al., 2003). One emerging breakthrough is using elicitors, compounds or substances that can trigger plant defence or metabolic responses without damaging cells (Mauch-Mani et al., 2011). These elicitors work by activating plants' natural mechanisms, such as producing bioactive compounds or increasing photosynthetic efficiency, which ultimately increases plant resistance to biotic and abiotic stresses and optimises growth (Tavernarakis et al., 2017).

Biosaka is a type of elicitor currently being discussed among organic farming practitioners in Indonesia. Biosaka is made from fermented natural materials, such as leaves and grasses from the surrounding environment, which are believed to contain natural elicitor compounds that can stimulate plant growth and defence (Rahardjo & Wibowo, 2022). However, because it is an innovation, scientific information regarding its effectiveness and application methods on rice plants is still minimal and has not been systematically tested.

Therefore, this study focuses on two treatment factors in the biosaka application: application timing and concentration. The correct application timing, such as during the vegetative or generative phase, can determine whether the elicitor works optimally to stimulate growth or improve yield quality (Mauch-Mani et al., 2011). Similarly, a concentration that is too low may not have a significant effect. At the same time, a concentration that is too high may cause phytotoxic effects or be cost-inefficient (Pang et al., 2019). This research is expected to provide valid scientific guidance for farmers to optimise the use of Biosaka elicitors, so that it can be an alternative solution to increase rice production sustainably and reduce dependence on chemical fertilisers.

This research aims to: (1) Analyse the single effect of Biosaka elicitor application timing on the growth and production of lowland rice; (2) Analyse the single effect of Biosaka elicitor concentration on the growth and production of lowland rice; and (3) Examine the interaction between Biosaka elicitor application timing and concentration in influencing lowland rice growth and production parameters.

The results of this research are expected to provide the following benefits: (1) Provide valid scientific information on the potential of Biosaka elicitors in agriculture, particularly for rice plants; (2) Provide clear and tested technical recommendations on the optimal application of Biosaka elicitors, thereby increasing crop yields and cost efficiency; and (3) Support environmentally friendly agricultural practices by reducing reliance on chemical fertilisers and pesticides.

Literature Review

Conventional rice cultivation relies heavily on synthetic inorganic fertilisers and chemical pesticides, posing significant environmental and ecological challenges. Long-term and excessive use of these chemicals leads to soil degradation, loss of soil microbial biodiversity, environmental pollution, and the development of pest and disease resistance (Tilman et al., 2002; Cassman et al., 2003).

To mitigate the impacts of conventional farming, a growing body of research is exploring environmentally friendly agricultural approaches, such as organic or organic-based farming. One approach farmers can take is the use of elicitors. Elicitors are compounds or substances that activate a plant's natural defences and metabolic responses without causing cell damage (Mauch-Mani et al., 2011). These substances trigger internal signalling pathways, produce bioactive compounds, increase photosynthesis and increase plant resistance to biotic and abiotic stress (Tavernarakis et al., 2017). Using elicitors can support sustainable agricultural strategies by harnessing the plant's biological mechanisms to enhance growth and yield, reducing dependence on synthetic inputs.

Among the various types of elicitors, a locally developed solution known as Biosaka is gaining attention, particularly within the organic farming community in Indonesia. Biosaka is a fermented solution from natural plant materials such as leaves and grass sourced locally (Rahardjo & Wibowo, 2022). These materials contain natural elicitor compounds stimulating plant growth and strengthening defence mechanisms. The concept behind Biosaka aligns with circular economy

principles and utilises local resources at a low cost. However, research on the efficacy and optimal application methods of Biosaka, particularly in lowland rice, remains limited. This lack of systematic, evidence-based research creates a significant knowledge gap for farmers and researchers, hampering its widespread and effective adoption (Tavernarakis et al., 2017).

The effectiveness of an elicitor is highly dependent on its application parameters. Specifically, application time and solution concentration are two critical factors that can determine the success or failure of a treatment. The application timing can influence whether an elicitor primarily promotes vegetative growth or improves reproductive development and grain quality (Mauch-Mani et al., 2011). For example, applying an elicitor during the vegetative stage can stimulate root and tiller development, while applying it during the generative stage can positively impact panicle formation and grain filling. Similarly, elicitor concentration is a dose-dependent factor. Inadequate concentrations may not induce significant physiological responses in plants, rendering the application ineffective (Pang et al., 2019). Conversely, excessively high concentrations can cause phytotoxicity, leading to stress or damage to plants. This delicate balance underscores the need for precise, scientifically determined application doses to ensure biological efficacy and economic viability. Previous studies of various elicitors have highlighted the importance of these factors in optimising plant responses (Pang et al., 2019; Tavernarakis et al., 2017).

Although Biosaka has the potential to be a sustainable alternative to synthetic fertilisers and pesticides, current knowledge is insufficient to provide reliable guidance to farmers. The existing literature lacks systematic studies examining the combined effects of Biosaka application timing and concentration on rice growth and yield. There is a clear research gap in understanding how these two important factors interact and influence key parameters, such as plant height, tiller number, and grain yield.

Research Method

Research Location and Time

Field research was conducted in Taratara Dua Village, West Tomohon District, Tomohon City, for 6 (six) months, from April 2024 to October 2024.

Materials and Tools

The materials and equipment used were: IR-64 rice seeds, Biosaka solution, straw compost, Organic Fertilizer (POC), inorganic fertilizer (Phonska 15:15:15), botanical pesticide, sprayer, and analytical balance.

Experimental Design

Treatments were assigned according to a factorial pattern in a Randomized Block Design (RBD). The treatments consisted of two: the first factor (T) was the Biosaka application time, consisting of: 5 days (T1); 10 days (T2); and 15 days (T3). The second factor (K) was the Biosaka concentration, consisting of: 0 ml/15 liters of water (K0); 30 ml/ 15 liters of water (K1); and 60 ml/15 L (K2). The treatment was repeated 3 times so that there were $4 \times 3 \times 3 = 36$ experimental plots.

Work Procedure

1. Plough the soil to a depth of 25-30 cm while incorporating plant debris and grass. After ploughing, apply straw compost evenly to the rice field at a rate of 2 tons per hectare.
2. Establish 18 experimental plots measuring 3m x 4m.

3. Seed preparation and sowing are carried out by placing the rice seeds to be tested in a bucket of salt solution, stirring them, and separating the floating seeds from the sinking ones. The sinking seeds are considered the best quality or full seeds. The seeds are then washed with water until clean. The seeds are soaked for 24-48 hours, then removed and placed in a porous sack to allow air to enter the rice seeds. They are then stored in a humid, air-conditioned area for 24 hours.
4. Sowing is carried out in the rice field plots. These aerated seeds are sown in rice fields until they are 15 days old, before being transplanted into the rice fields.
5. Three seedlings are planted per hole, using a 2:1 spacing system. This system aims to provide optimal growing space for sunlight and facilitate weeding and pest control.
6. Biosaka production and application to plants are carried out in accordance with SOPs (Kementerian Pertanian, 2022). Application of inorganic NPK-Phonska fertiliser (50% of the recommended dose) is carried out at planting time and at 30 days after planting.
7. Plant maintenance, including pest and disease control, weeding, and water management. Pest and disease control is carried out using integrated pest management (IPM) and botanical pesticides.
8. Harvesting is carried out when the plants are mature, indicated by uniform yellowing of the grains or a grain moisture content of around 23-25%.

How to Make Biosaka

Materials and Tools:

- One handful of grass or leaves from 5-7 different types, choose ones that are fertile, healthy, and free from pests and diseases.
- 10-20 liters of clean water.
- Container or bucket
- Sieve
- Stirring tool

Method:

1. Material preparation: Collect one handful of grass and leaves from various types found around you. Make sure the leaves or grass you choose are healthy and fresh. Examples include elephant grass, papaya leaves, cassava leaves, or other types of grass.
2. Kneading and mixing: Place the collected grass and leaves into a bucket filled with 10-20 litres of water. Gently knead and stir continuously for 15-20 minutes. This kneading process is important so that the starch from the leaves and grass can completely dissolve into the water.
3. Observe changes: While kneading, observe changes in the solution; it will turn cloudy, like rice water, and feel sticky to your hands. Once it reaches this consistency, the kneading process is complete.
4. Filtering: Filter the Biosaka solution to separate the leaves and grass residue. You will only use the liquid.
5. Storage and application: The finished Biosaka solution must be used immediately, within 24

hours of preparation. If stored for too long, its quality will decline.

6. Application method: Apply Biosaka by spraying it on plants at a very low concentration, namely 15-40 ml per spray tank (15-20 litres). Spraying is sufficient to be done thinly, like a mist, until it covers the entire leaf surface (Kementerian Pertanian, 2022)

Observation Variables

The observed response variables included:

- (1) Plant height, measured when the plant ends its vegetative period and at harvest
- (2) Number of productive tillers, measured at harvest
- (3) Panicle length, measured after harvest
- (4) Number of pithy grains per panicle, measured at harvest
- (5) Number of empty grains per panicle
- (6) Yield of dry grain harvested per plot, measured after harvest

Data Analysis

Data from all observation variables were tested using analysis of variance, and if significant, continued with the Least Significant Difference (LSD) test at the 5% level.

Results and Discussion

The statistical analysis showed no interaction between the timing of Biosaka application and the Biosaka concentration. The timing of Biosaka application also did not significantly impact the growth and yield of organically grown lowland rice. Biosaka concentration treatments significantly impacted the number of productive tillers, panicle length, the number of pithy grains per panicle, the number of empty grains per panicle, and the dry grain yield (GKP) per plot. The Least Significant Difference (LSD) test further confirmed that the 0 ml/15L (K0) concentration treatment was the most effective, producing the highest values for all observed variables, followed by the 30 ml/15L concentration, and generally the lowest at the 60 ml/15L concentration (Table 1).

Table 1. Effect of Biosaka Concentration on Plant Height, Number of Productive Tillers, Panicle Length, Number of Pithy Grains per Panicle, Number of Empty Grains per Panicle, and GKP Yield per Plot

Treatment	Plant Height (cm)	Number of Productive Tillers	Panicle Length (cm)	Number of Pithy Grains per Panicle	Number of Empty Grains per Panicle	GKP Yield per Plot (kg)
0 ml/15 L	63,18	26,82 a	25,69 a	121,20 a	18,24 a	6,19 a
30 ml/15 L	62,78	25,31 b	25,44 a	110,64 b	25,02 b	5,63 b
60 ml/15 L	62,27	24,29 c	24,93 b	105,33 c	25,60 b	5,25 c
BNT 5%	ns	0,58	0,68	2,38	2,67	0,23

Note: Numbers followed by the same letter are not significantly different at the 5% level.

The absence of an interaction between application time and Biosaka concentration indicates that

the effect of Biosaka on lowland rice plants remained unchanged even when applied at different times. The main effect of application time was also insignificant, indicating that the frequency of Biosaka spraying did not significantly impact rice growth and yield.

Conversely, Biosaka concentration was the primary determinant, significantly influencing most of the observed parameters, namely the number of productive tillers, panicle length, number of full grains, number of empty grains, and dry grain yield (GKP) per plot. The results table shows a consistent pattern: the treatment without Biosaka (0 ml/15 L) produced the best results for almost all observed variables. The 30 ml/15 L treatment produced lower yields than the control, and the 60 ml/15 L treatment produced the lowest results.

Biosaka is not classified as a fertiliser, but rather acts as an elicitor or "signalling agent." Elicitors stimulate plants to activate their own defence and metabolic systems, increasing growth and stress resistance (Suryadi, 2023). Optimal concentration is crucial because biosaka contains various organic compounds, hormones, enzymes, and living microbes (PGPR) that interact with plants.

Based on the results of this study, it was obtained that the treatment without Biosakade (0 ml/15L) gave the best results in all observation variables, compared to the Biosakade treatment (30 ml/15L and 60 ml/15L). This is supported by the results of the study by Kartika et al. (2023) on the Effect of Biosaka and Inorganic Fertiliser Application on the Growth and Uptake of N, P, and K Nutrients in Upland Rice Variety Inpago 13 Fortiz, which found that higher plant growth was found in the treatment without Biosakade than with Biosakade. The treatment without Biosakade (B0) can increase the absorption of N, P, and K and can reduce the dose of inorganic fertiliser. The treatment without Biosakade (B0) the most efficient absorption of N, P, and K is found in inorganic fertilizers of 25-75% of the recommended dose, while the treatment using Biosakade (B1) the most efficient absorption of N, P, and K is found in inorganic fertilizers of 0-50% of the recommended dose.

Most research findings contradict claims from other studies that generally demonstrate the positive benefits of Biosaka. Research by Harahap and Nasution (2021) found that Biosaka application at specific frequencies and doses significantly increased dry grain weight per plot and 1,000-grain weight.

There are several scientific explanations for these results, namely: (1) Dose-Response Effect, which states that a substance, such as a biostimulant or hormone, can be beneficial at low doses, but actually becomes phytotoxic (toxic to plants) or inhibits plant growth at high doses (Maesano et al., 2020). Symptoms of phytotoxicity can include stunted growth, as seen in a decrease in the number of productive tillers and panicle length at a concentration of 60 ml/15L; (2) Nutritional Imbalance, although Biosaka is not classified as a fertiliser, its nutrient and hormone content can disrupt the natural balance of plants if applied in excessive amounts. High concentrations can cause hormonal imbalances that actually inhibit grain filling (the number of full grains) and even increase the number of empty grains; (3) Product Variability, where the quality and composition of Biosaka are highly dependent on the raw materials/plant types and the manufacturing process. Biosaka made from certain types of weeds or under less than ideal conditions can have contents that are less beneficial for plants.

The finding that the timing of Biosaka application did not have a significant effect also differs from several other studies. For example, research by Purnomo and Budi (2022) found that Biosaka application during the plant's generative phase (i.e., during panicle formation and grain filling) provided the most optimal results. This difference in results could be due to various factors, such as the rice variety used, climatic conditions, and the specific cultivation practices employed in the study.

Overall, this study indicates that Biosaka concentration is a critical factor in determining success or failure. Concentrations higher than 0 ml/15L, particularly 60 ml/15L, actually had negative effects. These findings suggest that Biosaka use should be carried out with great caution and may require very low doses, or even be unnecessary under the conditions of this study.

Conclusion

1. The concentration of Biosaka affected the number of productive tillers, panicle length, the number of pithy grains per panicle, the number of empty grains per panicle, and the GKP yield per plot. The best concentration was obtained with the 0 ml/L (control) treatment, with a GKP yield of 6.19 kg per plot. The timing of Biosaka application did not affect plant height, the number of productive tillers, panicle length, the number of pithy grains per panicle, the number of empty grains per panicle, and the dry grain yield (GKP) per plot
2. There was no interaction between the timing of biosacca application and Biosaka concentration on the growth and yield of organic-based lowland rice.
3. Further studies are needed to explore alternative application methods, different plant types, or other environmental conditions where Biosaka might be effective. This research should focus on understanding the mechanisms of Biosaka and identifying specific contexts where it provides a measurable benefit, as its use in this study did not show positive effects on the measured variables.

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References

- Ansar, M., Manurung, R., Barki, H., Suwandi, P., Pambudy, R., Fahmid, I. M., & Sugiharto, U. (2023). *Elisitor Nuswantara Biosaka: Terobosan Pertanian Berkelanjutan Menuju Tanah Nusantara Land of Harmony*. IPB Press.
- Badan Pusat Statistik. (2023). *Statistik Tanaman Padi dan Palawija 2022*. BPS-Statistics Indonesia.
- Cassman, K. G., Dobermann, A., & Walters, D. T. (2003). Agroecosystems, nitrogen, and sustainability. *Ambio*, 32(3), 132–140.
- Dinas Pertanian dan Pangan Kabupaten Demak. (2023). *Standar Operasional Pembuatan Biosaka*. Dipertanpangan.demakkab.go.id. Retrieved from <https://dipertanpangan.demakkab.go.id/?p=5637>
- FAO. (2023). *The State of Food Security and Nutrition in the World*. Food and Agriculture Organization of the United Nations.
- Harahap, R., & Nasution, A. (2021). Pengaruh frekuensi aplikasi biosaka terhadap pertumbuhan dan produksi padi sawah (*Oryza sativa* L.). *Jurnal Agroteknologi*, 15(3), 150–160.
- Kartika, M. A., Nurhidayati, N., & Basit, A. (2024). Pengaruh aplikasi biosaka dan pupuk anorganik terhadap pertumbuhan dan serapan hara N, P, dan K pada padi gogo varietas Inpago 13 Fortiz. *AGRONISMA*, 11(2), 391–406.
- Kementerian Pertanian Republik Indonesia. (2022). *Pedoman Teknis Pembuatan Biosaka dan Aplikasinya pada Tanaman Pangan*. Jakarta: Ditjen Tanaman Pangan, Kementan.

- Maesano, J., Kurniawan, E., & Putra, D. (2020). Potensi fitotoksik pupuk organik cair dari limbah rumah tangga pada tanaman sawi. *Jurnal Ilmu Pertanian*, 23(1), 1–8.
- Mauch-Mani, B., Baccelli, I., Luna, E., & Métraux, J. P. (2011). Elicitors, defenders, and resistance in plants. *The New Phytologist*, 190(4), 842–853.
- Pang, J., Chen, Z., Ma, Q., Zhu, T., Tang, Z., & Chen, G. (2019). The effects of different concentrations of elicitors on plant growth and resistance. *Plant Physiology and Biochemistry*, 137, 1–8.
- Purnomo, S., & Budi, A. (2022). Efektivitas aplikasi biosaka pada fase pertumbuhan vegetatif dan generatif tanaman padi. *Jurnal Agronomi*, 18(2), 45–55.
- Rahardjo, B., & Wibowo, S. (2022). *Inovasi Pertanian Berkelanjutan: Pemanfaatan Biosaka*. Lembaga Penelitian dan Pengembangan Pertanian.
- Suryadi, S. (2023). Aplikasi biosaka pada budidaya padi organik untuk peningkatan produktivitas. *Prosiding Seminar Nasional Pertanian Organik*.
- Tavernarakis, E., Koutsi, V., & Spyridakis, E. (2017). Elicitors in plant defense and development. *Journal of Plant Growth Regulation*, 36(4), 1104–1116.
- Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature*, 418(6898), 671–677.