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Application of organic farming system to conventional rice cultivation at Timpag rice seed farm, Tabanan, Bali

Iqbal Erdiansyah[1], Achmad Yayan Sokhibul Fattah[1], Siti Nurul Hidayah[1], Hidayatul Rahmawati[1], Ida Bagus Nyoman Ray Aditya[1]

[1] *Food Crop Production Technology, Department of Agricultural Production, State Polytechnic of Jember, Indonesia*

Correspondence should be addressed to:
Siti Nurul Hidayah
nurul160203@gmail.com

Abstract:
Organic farming is a cultivation system that prioritizes using natural and environmentally friendly inputs to create sustainable agriculture. This research/implementation aims to determine the use of liquid organic fertilizer (POC), Jakaba, tofu waste POC, and refugia plants in supporting organic rice cultivation in conventional rice cultivation. Activities were carried out from March to May 2025 at the Timpag Rice Seed Farm, Tabanan, Bali. Jakaba liquid organic fertilizer and tofu waste were applied periodically with the spray method starting at 14 days after planting (HST) with an interval of two weeks until entering the generative phase. Meanwhile, refugia plants such as zinnia, kenikir, and widelia were planted around the cultivation field to support pest biological control. Parameters observed included plant height, number of productive tillers, and insect diversity index. The results showed that the application of POC and refugia can support the growth of rice plants and create a balanced agricultural ecosystem. Thus, the application of organic inputs and ecological approaches like this has great potential in supporting a productive and sustainable organic farming system.

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INTRODUCTION

Rice is a major food commodity that has a strategic role in maintaining national food security, especially in Indonesia, where most of the population consumes rice as a staple food. The high consumption needs of the community can mean that the production of rice plants needs to be increased again to meet the food needs of the Indonesian people. In 2024, rice production is estimated at 52.66 million tons of MDG, a decrease of 1.32 million tons of MDG or 2.45 percent compared to rice production in 2023, which amounted to 53.98 million tons of MDG (BPS, 2024). The problem of declining production is that rice cultivation often relies on synthetic chemicals, such as inorganic fertilizers and pesticides. Excessive use of these materials in the long term can reduce soil fertility, pollute the environment, and disrupt the balance of agricultural ecosystems.

As a sustainable alternative, organic rice cultivation comes with an environmentally friendly approach that prioritizes the use of natural inputs and maintains ecosystem balance. Organic rice cultivation not only pays attention to yield productivity, but also prioritizes soil health, biodiversity, and environmental safety, both in terms of fertilization and pest control.

One of the main components in organic rice cultivation is the use of liquid organic fertilizer (POC). POC comes from organic materials such as industrial waste, household waste, and local

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microorganisms, which are fermented to produce nutrients in a form that is easily absorbed by plants (Fitriatin and Betty, 2019). The application of liquid organic fertilizer is not only able to provide macro and micronutrients, but also improve soil structure, increase soil microbial activity, and accelerate the growth and productivity of rice plants naturally (Hartatik et al., 2015).

In addition to fertilization, pest and disease control in organic farming systems is carried out with an ecological approach, one of which is through the application of refugia plants. Refugia plants are flowering plants that are deliberately planted around agricultural land to provide habitat and food sources for natural enemies of pests, such as parasitoids and predators (Mahanani et al., 2020). With refugia, ecosystem balance can be maintained, and pest populations can be suppressed naturally without the need to rely on chemical insecticides. Thus, the application of organic systems in rice cultivation is an important effort in creating a productive, safe, and sustainable agricultural system for farmers, consumers, and the environment.

METHOD

This activity was conducted from March to May in one place, namely at the Timpag Rice Seed Farm, Tabanan, Bali. Methods used include:

Plant Cultivation

Planting using caplakan is a technique of planting rice by walking forward. This technique makes it easier for farmers to plant rice because the view is wider. This technique is assisted by a traditional tool called a caplakan, as a tool for making planting distance lines, for the planting distance used is 27 cm x 27 cm, with a minimum number of clumps per hole of 5 clumps. The rice seed variety used is the Inpari 32 variety. The age of rice seedlings that are ready to be transplanted is ± 14 HSS.

POC (Liquid Organic Fertilizer) Application

There are 2 applications used, namely POC Jakaba and POC tofu water waste. The application is by spraying. The concentration used for jakaba is 60ml/liter, and for tofu water waste, 160ml/liter. POC is applied at the age of 14 HST with an interval time of 2 weeks until the plants enter the generative period or age 60 HST.

Application of Refugia

The planting of refugia starts from seeds which are then sown on a 10m² field, then, after growing into new seedlings, they are moved to the edge of the rice cultivation area. The plant distance used is 50-60 cm between plant to plants. Plants used as refugia plants in the Timpag Rice Seed Farm are ornamental flowers such as zianna paper flowers, kenikir flowers, and widelia flowers. Planting refugia should be made at the time before the main crop is planted so that it can be used as a shelter and breeding ground for natural enemies. Observations include biological indices consisting of diversity index (H'), species richness index (R), evenness index, similarity index, and dominance.

Observation Parameters

Parameters observed in this activity include plant height, number of tillers, and diversity index. Plant height was observed using a meter starting from the soil surface to the highest leaf when the plant was 60 HST, the number of tillers was observed at the age of 60 HST by counting the number of productive tillers in each sample of rice clumps, for diversity index observations were made when the plants were 6 MST and 10 MST, the identification data were compiled in an excel program based on the type and population of insects. Total species and populations are displayed in tabular form.

RESULT

Application of Refugia Plants

The results of observations that have been made, as many as 2 observations (1 time in the vegetative phase and 1 time in the generative phase) on refugia land and land without refugia, obtained the composition of insects caught and identified as presented in Table 1.

Table 1. Composition and Number of Insects Captured in Refugia and Non-Refugia Fields

Ordo	Family	Spesies	Observation Plots		Role
			Refugia	Without Refugia	
Diptera	*Muscidae*	*Musca autumnalis*	8	16	Predator
Hemiptera	*Reduviideae*	*Zelus tetracanthus*	2	7	Predator
Coleoptera	*Staphynlinoidae*	*Neobisnius ganglbauer*	8	10	Predator
Coleoptera	*Elateridae*	*Agriotes insanus*	1	3	Predator
Orthoptera	*Acrididae*	*Melanoplus bivittatus*	6	4	Pests
Odonata	*Libelluide*	*Pachdiplax longipennis*	3	5	Predator
Diptera	*Cocidomyidae*	*Orseolia oryzae*	38	20	Pests
Lepidoptera	*Nymphalidae*	*Lethe anthedon*	0	5	Predator
Orthoptera	*Terigidae*	*Tetrix subulata*	10	7	Pests
Hemiptera	*Alydidae*	*Leptocorisa oratorius*	12	8	Pests
Coleoptera	*Coccinelidae*	*Exochomus children*	8	8	Predator
Hemiptera	*Pentatomidae*	*Nezara viridula*	8	5	Pests
Araneae	*Tetragnathidae*	*Opdometa fastigata*	5	5	Predator
Diptera	*Tipulidae*	*Tipula oleracea*	3	5	Dektivor
		Total	101	108	

Notes: A0= No Refugia, A1= Refugia

From the observations made, biological indices were obtained consisting of diversity index (H'), species richness index (R), evenness index, similarity index, and dominance as in Table 2.

Table 2. Arthropod diversity index

Index	Land	
	Refugia	Without Refugia
Diveristas Shanon Winner (H’)	2.44	2.16
Simpson’s Dominance (C)	0.1	0.2
Type Wealth Margalef (R)	2.8	2.6
Evenness of Evenness (E)	0.92	0.84
Sorensen Type Similarity (ISS)	0.60	0.60

Application of Liquid Organic Fertilizer (POC) of Tofu Water Waste

From the results of observations of plant height and the number of tillers made once at the age of 60 HST rice. Observations were made on land applied POC Wastewater tofu and on land without the application of POC wastewater tofu, as in Tables 3 and 4.

Table 3. Plant height observation data

Sampel	Application of tofu waste POC (gr)	Without tofu waste POC (gr)
1	87.4	87.1
2	87.1	87.1
3	87.3	87.2

Table 4. Observation data number of tillers

Sampel	Application of tofu waste POC (gr)	Without tofu waste POC (gr)
1	26.7	23.4
2	25.9	23
3	26.2	22.8

Application of Liquid Organic Fertilizer (POC) JAKABA

From the results of observations of plant height and the number of tillers made once at the age of 60 HST rice. Observations were made on land that was applied with POC JAKABA and on land without the application of POC JAKABA, as in Tables 5 and 6.

Table 5. Plant height observation data

Sampel	Application of POC JAKABA (gr)	Without tofu waste POC (gr)
1	87.4	87.7
2	87.3	87.5
3	85.9	87.1

Table 6. Observation data on the number of tillers

Sampel	POC JAKABA Application	Without POC JAKABA
1	22.9	23.3
2	24.4	23.2
3	23.4	23.6

DISCUSSION

The application of refugia plants in conventional organic rice cultivation has proven to have a favorable effect on arthropod community structure, which is reflected in the difference in diversity indices between refugia and non-refugia fields. Refugia plants such as Zinnia, Kenikir, and Widelia play an important role in providing habitat and food sources (such as nectar) for beneficial insects, especially natural enemies of pests. Based on Table 1, the total number of arthropod individuals found in the refugia plot (A0) was 101 individuals, while in the plot without refugia (A1) was 108 individuals. Although the number of individuals was slightly higher in the plot without refugia, the composition of arthropod species in the refugia plot was more balanced between pests and natural enemies (Erdiansyah et al, 2023). Predator species such as Musca autumnalis, Zelus tetracanthus, Neobisnius ganglbauer, and Exochomus children were found more in the refugia plots than without refugia. This shows that refugia plants can attract and support the presence of natural enemies around rice fields (Wardana, 2017).

In addition to making identification observations, data analysis of the arthropod diversity index was also conducted. Based on Table 2, the value of the diversity index (H') in the refugia land is

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2.44, higher than the land without refugia of 2.16. This indicates that the application of refugia creates a more diverse and stable arthropod community (Siregar and Lesnida, 2021). This indicates that the application of refugia creates a more diverse and stable arthropod community (Siregar and Lesnida, 2021). High diversity is closely related to the stability of agricultural ecosystems and the natural ability to suppress pest populations through the presence of natural enemies. The dominance value in the refugia field was 0.1, lower than the field without refugia (0.2). This indicates that on refugia land, no one species dominates the community excessively, so competition between arthropod populations is more balanced. In contrast, the higher dominance in the no-refugia field indicates the possibility that pest species such as Orseolia oryzae (the main pest) dominate the arthropod community (Erdiansyah et al, 2021). The species richness index in the refugia site was 2.8, slightly higher than that in the no-refugia site (2.6). This indicates that the number of arthropod species is higher in the refugia fields. Refugia plants that flower throughout the plant growth cycle serve to increase the attractiveness of various types of stalking insects, thus enriching species diversity. The evenness index in the refugia field was 0.92, higher than the field without refugia, which was 0.84. The high value of evenness indicates that the population among species in the refugia land is more evenly distributed, indicating that there is no significant population imbalance. Land without refugia tends to experience inequality due to the dominance of certain pest species. The similarity index value between the two plots (refugia and no refugia) was 0.60, indicating a moderate level of similarity. This indicates that although there are several types of insects that are the same in both fields, the community structure is ecologically different. The cause of the not much different diversity index in rice fields with refugia and without refugia is that the distance between the two fields is not too far away, which allows arthropod mobility in both (Siregar and Lesnida, 2021).

The application of Jakaba liquid organic fertilizer in conventional organic rice cultivation aims to increase plant growth through the provision of natural nutrients derived from fermented local microorganisms. Based on the observation of each rice plant sample in Tables 1 and 2, the results show that the application of JAKABA liquid organic fertilizer or without the application of JAKABA is relatively equivalent to the parameters of plant height and number of tillers. This can be caused by several factors, such as uniform environmental conditions, the age of the plants at the time of observation, or the effectiveness of nutrient uptake from POC, which takes longer to show a real effect. In the sense that there is an overlap where only some elements can be absorbed by plants. Optimal nutrient availability will affect and increase the vegetative growth of rice leaves and the number of tillers. This happens because fertilizer application is closely related to the availability of essential nutrients needed by plants, which have a role in plant growth (Ramadita et al., 2024). Overall, the observation results show that the application of Jakaba liquid organic fertilizer has the potential to support the growth of organic rice, although the increase has not been significant in a limited observation time. The use of organic fertilizers in a sustainable and scheduled manner will likely provide more visible results in the long run, especially in improving soil fertility and stimulating vegetative and generative growth of plants.

Liquid organic fertilizer (POC) based on tofu wastewater is an alternative biofertilizer that is environmentally friendly and has high potential in supporting conventional organic rice cultivation. Tofu wastewater contains essential nutrients such as nitrogen, phosphorus, and potassium. Based on observations in Table 3 and Table 4, liquid organic fertilizer does not significantly affect the growth of rice plant height, but has a positive effect on the number of tillers. This is due to the availability of sufficient nutrients for rice plants. The number of tillers in rice is determined during the vegetative period of the plant because during the vegetative period, the plant experiences a growth period that includes the formation of tillers. Nutrients that have a role in plant growth are the nutrients Nitrogen, Phosphorus, and Potassium. Nitrogen nutrients play a role in stimulating the formation of plant tillers because plant absorption of tofu waste POC is faster than plant absorption of solid fertilizers. Phosphorus nutrients also have an important role in growth, namely supporting cell division at the point of growth of new tillers (Rahayu et al., 2023). The processing of tofu waste POC and the fermentation process also affect the quality and effectiveness of tofu waste liquid organic fertilizer in providing nutrients that are easily absorbed by plants (Mahadi et al., 2023). Microorganisms contained in tofu waste POC that have the role of decomposing organic matter will release nutrients gradually. If the process of decomposing and releasing nutrients is not optimal, the nutrients absorbed by rice plants will be slow so as not to affect plant height. In addition, environmental conditions also affect the availability of nutrients from POC tofu waste, such as soil pH and climate (Nurman et al., 2017).

Overall, the application of POC from various sources and refugia in conventional organic farming systems was shown to improve rice growth and support ecological-based pest control. These observations reinforce the role of organic and locally based cultivation technologies in creating a productive and sustainable agricultural system. In addition to increasing production yields, this approach also supports environmental conservation efforts and reduces dependence on synthetic inputs that have a negative impact on the ecosystem.

CONCLUSION

The application of Jakaba POC, tofu waste POC, and refugia plants in conventional organic rice cultivation can improve plant growth and support ecosystem balance. POC provides the nutrients needed by plants, while refugia increases the diversity of natural enemies, helping with biological pest control. This approach is effective in supporting environmentally friendly and sustainable organic farming.

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CONFLICTS THAT MAY OCCUR

Conflicts of interest that may occur in the application of Jakaba POC, tofu waste POC, and refugia plants in conventional organic rice cultivation can arise from differences in interests between agricultural actors, agricultural input providers, and policymakers. Farmers who start switching to organic fertilizers may face pressure from chemical fertilizer distributors who feel threatened by the market. In addition, the use of tofu waste as raw material for POC can lead to competition with other industries that also utilize the waste. On the other hand, the application of refugia, which requires additional space on cultivated land, can lead to differences in views between farmers who prioritize land for main production and those who encourage ecologically based pest control. Conflicts can also arise if there is no regulatory alignment or policy support for the use of local organic inputs in the organic farming certification scheme.

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