Vol. 14, No. 3, pp. 760-768, August 2026 DOI: https://doi.org/10.23960/jat.v14i3.11851

Jurnal Agrotek Tropika

P-ISSN: 2337-4993
E-ISSN: 2620-3138

Journal homepage: https://jurnal.fp.unila.ac.id/index.php/JA

EFFICACY OF PUCUK IDAT, KEMUNTING, AND KEDEBIK LEAF POWDERS AGAINST SitophiluS oryzaeL. ON PADDY AND FIELD RICE

EFEKTIVITAS SERBUK DAUN PUCUK IDAT, KEMUNTING, DAN KEDEBIK TERHADAP MORTALITAS *SitophiluS oryzaeL.* PADA BERAS SAWAH DAN BERAS LADANG.

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ARTICLE HISTORY:

Received: 13 October 2025
Peer Review: 26 February 2026
Accepted: 14 August 2026

KEYWORDS:

Biological control, biopesticide, mortality, secondary metabolites, sustainable agricultre

ABSTRACT

*This study addresses the significant challenge of rice weevil (Sitophilus oryzae L.) infestation, which can cause yield losses of up to 70% in stored rice. This study aimed to assess the sustainability and environmental friendliness of botanical pesticides. The botanical pesticides used were wild shrubby vegetation such as pucuk idat (*Cratoxylum glaucum*), kemunting (*Rhodomyrtus tomentosa*), and kedebik (*Melastoma malabathricum*). These plants were selected for their natural resistance to pests, suggesting the presence of bioactive secondary metabolites. Using a factorial completely randomised design, this study examined the effect of plant species, rice types (paddy and field rice), and four doses of botanical pesticides (10, 15, 20, and 50 g) on rice weevil mortality. The results showed that the three types of botanical pesticides were significantly effective in controlling S. oryzae. The highest mortality rate of 83.3% was observed in the rice treatment with 20 g of pucuk idat leaf botanical pesticide. Mortality began to appear on the third day after treatment and peaked around the sixth day. This pattern indicates a delayed but potent toxic effect, likely due to bioactive compounds or secondary metabolites present in the plant leaves. Furthermore, interactions among plant species, rice varieties, and dosage strongly influenced the efficacy of this botanical pesticide. This research provides a foundation for the use of botanical pesticides as an effective, sustainable, and environmentally friendly alternative to rice weevil infestation. The application of botanical pesticides can support food security and sustainable agriculture by utilising the value of local plant biodiversity.*

KATA KUNCI:

Biopestisida, mortalitas, metabolit sekunder, pengendalian hayati, pertanian berkelanjutan

ABSTRAK

Penelitian ini mengatasi tantangan signifikan dari serangan kutu beras (*Sitophilus oryzae* L.), yang dapat menyebabkan kehilangan hasil hingga 70% pada beras yang disimpan. Penelitian ini bertujuan untuk mengkaji pengendalian berkelanjutan yang ramah lingkungan berbasis pestisida nabati. Pestisida nabati yang digunakan merupakan vegetasi perdu liar seperti pucuk idat (*Cratoxylum glaucum*), kemunting (*Rhodomyrtus tomentosa*), and kedebik (*Melastoma malabathricum*). Tumbuhan ini dipilih berdasarkan ketahanan alaminya terhadap hama, yang mengindikasikan keberadaan metabolit sekunder bioaktif. Dengan menggunakan rancangan acak lengkap faktorial, penelitian ini mengkaji pengaruh jenis tumbuhan, jenis beras (beras sawah dan beras ladang), dan empat dosis pestisida nabati (10, 15, 20, dan 50 g) terhadap mortalitas kutu beras. Hasil penelitian menunjukkan bahwa tiga jenis pestisida nabati tersebut secara signifikan efektif untuk pengendalian *S. oryzae*. Tingkat mortalitas tertinggi sebesar 83,3% pada perlakuan beras sawah dengan perlakuan pestisida nabati daun pucuk idat pada dosis 20 g. Mortalitas mulai terlihat pada hari ketiga pasca perlakuan dan mencapai puncaknya sekitar hari keenam. Hal ini mengindikasikan efek toksik yang tertunda namun kuat, yang diduga akibat senyawa atau kandungan metabolit sekunder tumbuhan. Selain itu, efikasi pestisida nabati ini sangat dipengaruhi oleh interaksi perbedaan jenis tumbuhan, jenis beras, dan dosis yang digunakan. Penelitian ini memberikan landasan awal dalam penggunaan pestisida nabati sebagai alternatif yang efektif, berkelanjutan, dan ramah lingkungan dalam mengatasi infestasi kutu beras. Aplikasi pestisida nabati dapat mendukung ketahanan pangan dan pertanian berkelanjutan melalui pemanfaatan nilai keanekaragaman hayati tumbuhan lokal.

1. INTRODUCTION

The Bangka Belitung Islands are among Indonesia's rice-producing regions, with a productivity of 42.57 (ku/ha) (Central Bureau of Statistics, 2024). After the harvest season, farmers in Bangka generally mill the rice into fine grains and store it indoors in plastic sacks (Patiung, 2015). However, one of the challenges in home storage is the infestation of rice weevils. Rice weevils (*Sitophilus oryzae* L.) can reduce rice quality and quantity by up to 70% at room temperature (27-30 ^{o}C) (Gurjar, 2025). Damage caused by *S. oryzae* results in slight, hollow, and easily broken rice grains, resembling flour, with a musty odor and a degraded flavor (Mastuti *et al.,* 2020). One way to control *S. oryzae* is through the use of botanical pesticides.

Botanical pesticides are derived from natural ingredients such as plant leaves and offer several advantages, including being environmentally friendly, harmless, and containing essential substances and secondary metabolites that can inhibit the development and even kill insect pests (Hidayah *et al*., 2024); (Ginting *et al*., 2024); (Hadiyanti *et al*., 2021). Based on previous research, pesticides from local plants in powder formulations, applied at concentrations of 10-50 grams, have an insect mortality rate of 50-90%. In addition, the plants used contain phytochemicals that are highly effective in controlling *S. Oryzae* (Kusumawati and Istiqomah, 2022). This strengthens the evidence that plant botanical pesticides can control *S. oryzae*. However, several previous studies have used common plants already found in many places. Based on field studies, several shrub vegetation, such as pucuk idat (*Cratoxylum glaucum*), kemunting (*Rhodomyrtus tomentosa*), and kedebik (*Melastoma malabathricum* L.), are not attacked by pests (Regional Office of the Directorate General of Treasury, Babel Province, 2016).

The pucuk idat has the character of a shrubs plant with reddish green and greenish yellow leaves, rounded oval leaf shape with a smooth texture, kedebik plant has the character of a shrubs plant with light to dark green leaves, and a rough and slightly hairy leaf texture, and Kemunting has the character of a shrubs plant with the leaves are light to dark green with an oval shape, and the texture of the leaves is slightly rough. This presents great potential for utilizing these local plants as botanical pesticides. In addition to the absence of pest attacks, the populations of pucuk idat, kemunting, and kedebik are quite large in Bangka Belitung and can be used as cooking ingredients. Pucuk idat leaves, for example, are used in Bangka as a typical vegetable, and kemunting and kedebik fruits can be consumed by humans. Kusumawati and Istiqomah (2022) explain that several key principles or criteria for selecting materials for use as botanical pesticides include: being toxic to plant pests but safe for humans and the environment; being easy to propagate; being resistant to suboptimal conditions; and being easy to use.

Based on this, this research can serve as a basis for controlling rice weevils using natural, environmentally friendly materials. The use of natural materials from shrub vegetation is a novelty studied in this research. This presents great potential for utilizing these local plants as botanical pesticides.

2. MATERIALS AND METHOD

This research method used maceration extraction of local plant leaves. Local Bangka plants such as pucuk idat, kemunting, and kedebik are shrubs commonly found in residential areas and serve as the primary raw materials for preparing botanical pesticides. The rice weevils (*Sitophilus oryzae* L.) used in this study were obtained from previously infested rice and maintained under laboratory conditions. This maintenance activity was carried out in the Bioscience Laboratory of the Bangka Belitung State Manufacturing Polytechnic. The insects were reared by providing rice as a food source, and approximately 20 rice weevils were placed in a porous jar to allow air circulation. The insects were maintained for one week to allow population growth and ensure sufficient test insects for the experiment.

2.1 Preparation of biopesticides from shrub vegetation

Leaves from each local plant were collected, neither too old nor too young (Dewi, 2017). The harvested leaves were placed in plastic sample bags and transported to the laboratory. Upon arrival, the leaves were air-dried. The sufficiently dry leaves were then placed in an oven at 105°C temperature for approximately 24 hours for complete drying (Mayasari, 2016); Dewi, 2017; Nazilah & Suharjono, 2021). After being removed from the oven, they were left to cool in the open air for 1 hour. The completely dried leaves were mashed and then sieved through a 200-mesh sieve to achieve a fine flour texture (Mayasari, 2016).

2.2 Preparation of the experimental medium

In the preparation phase, rice is a crucial food source for insect pests. Two hundred grams of rice was used, clean, unbroken, wrinkled, and free from a musty odor. This experiment was conducted in a closed, porous container.

2.3 Experimental Design

The factorial experiment used a Completely Randomized Design with three types of local plant pesticides (pucuk idat, kemunting, and kedebik), two types of local rice (sawah dan ladang), and four doses of pesticide (10, 15, 20, and 50 grams) (Indriyani *et al*., 2019); (Mahardika *et al*., 2020); Nazilah & Suharjo, 2021; (Habibi & Wahyudi, 2022)). Each treatment was performed in triplicate, yielding 72 experimental units, with each unit housing 20 insect pests. The rice weevil pests were maintained for 2 months to determine the population, and the one used in the study was the imago phase. The plant-based pesticide leaf meal was applied after three weeks of insect infestation in the jars or in the treatment containers where the rice was being fed. The pesticide powder is directly applied to the container containing rice and rice weevil pests at the specified dosage. The jars were placed in the Biosciences laboratory at a controlled temperature of ±27°C (Dewi, 2017).

2.4 Observations and Parameters

The parameters observed in this study included the moisture content of rice before and after treatment (clean and pest-infested) (Dewi, 2017), the percentage of insect pest mortality (Junaedi *et al.,* 2024), the efficacy or number of pests killed (Setiawan & Supriadi, 2014), the time it takes for insects to die (Setiawan & Supriadi, 2014), the effectiveness level of botanical pesticides (Junaedi *et al.,* 2024), and the weight of rice and pests before and after treatment (Mulyo, 1987 *in* Booroto *et al*., 2017). Insect pest mortality was observed by counting dead pests 3 times every 3 days for 2 weeks. The data were entered into Excel for subsequent ANOVA analysis, with means and standard errors at the 95% confidence level.

3. RESULT AND DISCUSSION

3.1 Leaf Powdersas Botanical Pesticides

Some of the Leaf Powders used in the research include pucuk idat, kedebik, and kemunting. The pucuk idat has the character of a shrubby plant, a dark brown and semi-woody stem that grows upwards and branches (Figure 1a). The kedebik plant is characterized by dark brown and semi-woody stems that grow upwards and branch (Figure 1b). Kemunting is a shrubby plant that has semi-woody stems similar to idat shoots, grows upwards and is branched and the stems are brownish gray (Figure 1c).

Figure 1. Shrub vegetations: Pucuk idat (a), Kedebik (b), and Kemunting (c).

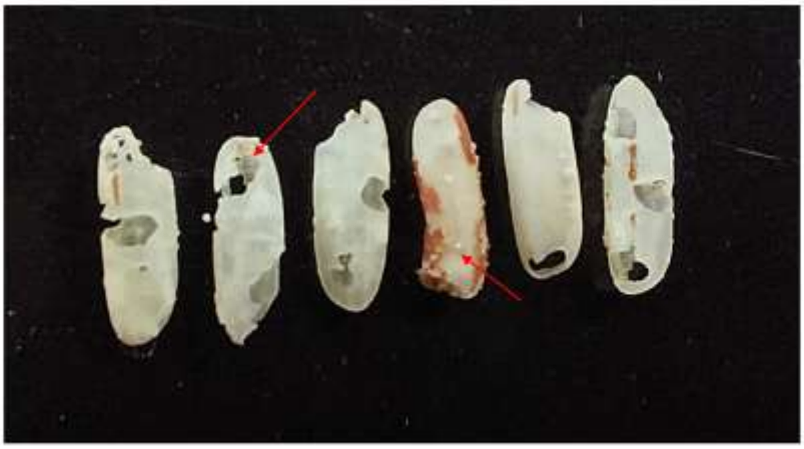

Figure 2. Symptoms of attack by the pest *Sitophilus oryzae* L.

3.2 Symptoms Attack of *Sitophilus oryzae* L.

Rice weevils (*Sitophilus oryzae* L.) are a significant pest in rice storage. According to Febrianti and Suharto (2019), rice weevils cause physical, chemical, and microbiological damage to rice, thereby reducing its quality. Habiba *et al*. (2024) also added that rice weevils can reduce rice quality during storage, which is associated with the rice's moisture content. Based on this study's results, the moisture content of rice was 19.68%, and that of rice with insects was 14.68%.The national regulation under Presidential Instruction Number 3 of 2012 and the National Standardization Agency (SNI) through SNI 612:2008, stated that the maximum moisture content for rice storage is 14%. This is done to prevent and avoid *Sitophilus* pest attacks. Putri *et al.* (2019) noted that a moisture content of 14% increases the rice weevil population. Damage caused by rice weevils includes irregularly hollow rice, rice powder, and empty, easily brittle rice, as shown in Figure 2. This is in accordance with Habiba *et al.* (2024), that one of the consequences of rice weevil attacks is that the rice becomes perforated and turns into powder.

3.3 Characteristics of Dead *Sitophilus oryzae* L.

The study found that several single applications of botanical pesticides achieved quite high effectiveness in controlling rice weevil pests. The presence of dead rice weevils was considered an indicator of the effectiveness of the botanical pesticides. This is because the pesticide powder is found throughout the rice weevil's body, which is thought to interfere with its respiratory system. This finding is consistent with the study by Bayu *et al*. (2022), which reported that plant-based pesticide powders contain phytochemical compounds capable of disrupting the digestive and respiratory systems of rice weevils. Dead rice weevils observed in this study exhibit distinctive physical characteristics, including legs and snouts that bend inward and bodies that are slightly shrunken, which is consistent with findings by Djaya *et al*. (2024). Furthermore, Aisyah *et al*. (2024) reported that the shrinkage of the rice weevil body is associated with the inhibitory effects of phytochemicals present in botanical pesticides, which interfere with ATP formation during respiration. The characteristics of dead rice weevils are shown in Figure 3.

3.4 Effectiveness of Botanical Pesticides from Shrub Vegetations

The results of mortality observations on rice husks (Table 1) show that different types of rice, different botanical pesticide sources, and different doses yield different mortality values. Botanical pesticides at single doses offer varying levels of effectiveness, as evidenced by the mortality rates observed in recent observations. The highest mortality was observed in the treatment with paddy rice, pucuk idat leaves at a dose of 20 g, namely 83.3%. In upland rice, the highest mortality was observed in kemunting leaves at doses of 10 and 50g, namely 63.3%. According to Sari and Aisyah (2025), the effectiveness of botanical pesticides in reducing mortality is 63.3-83.3%, which is considered adequate to very effective.

Differences in mortality among treatments using different rice types, botanical pesticides, and dosages are influenced by the bioactive compounds present in the botanical pesticides. According to Yuliani and Jadmiko (2023), the presence of botanical pesticide particles in the jar of *S. oryzae* will deprive rice weevils of oxygen, leading to their death. Nopiani *et al.* (2025) also added that the presence of respiratory toxic compounds in botanical pesticides causes the death of rice weevils, as shown in Figure 3. Although some effectiveness values were quite high, differences in dosage, rice type, botanical pesticide ingredients, and repetitions did not affect them. This is shown in Table 2 below.

Figure 3. The death characterization of *Sitophilus oryzae* L.

Table 1. Mortality value (%) of *Sitophilus oryzae* L.

Treatment			Mortality (%)		
Rice	Leaf	Doses (g)			
Field	Pucuk idat	10	3.3	33.3	33.3
		15	16.7	33.3	36.7
		20	0	16.7	20
		50	46.7	53.3	**60**
	Kedebik	10	0	10	23.3
		15	6.7	16.7	23.3
		20	30	30	30
		50	23	20	56.7
	Kemunting	10	36.7	40	**63.3**
		15	10	20	46.7
		20	6.7	46.7	50
		50	20	30	**63.3**
Ricefield	Pucuk idat	10	10	16.7	**63.3**
		15	60	53.3	**70**
		20	0	20	**83.3**
		50	10	10	10
	Kedebik	10	6.7	13.3	26.7
		15	40	30	33.3
		20	10	26.7	43.3
		50	3.3	50	50
	Kemunting	10	3.3	20	23.3
		15	10	16.7	23.3
		20	0	0	20
		50	46.7	40	46.7

Table 2. The effect of botanical pesticides on the rice weevil mortality

Treatment	*P-Value*	Standard Deviation
Botanical pesticides	0.825382	0.095358705
Dosages	0.289098	0.069648238
Rices type	0.452164	0.155979089
Replications	0.824159	0.095358705

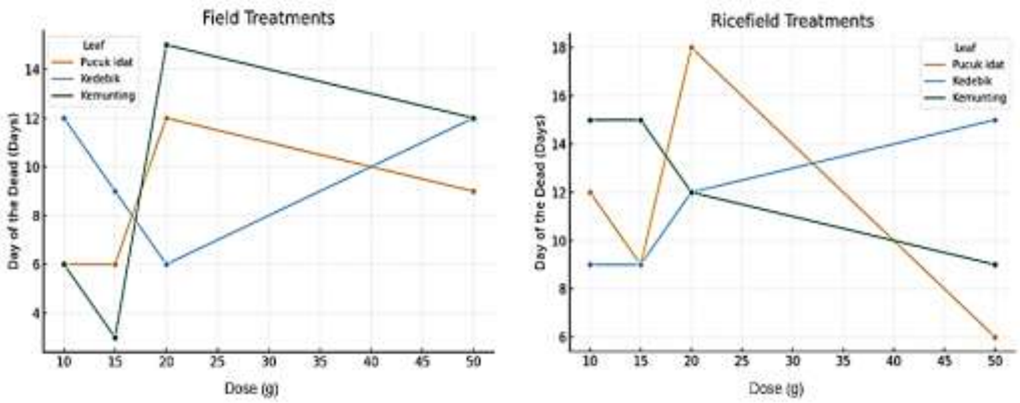

Figure 4. Graph of the rate of death of *Sitophilus oryzae* L. due to plant pesticides.

Based on the ANOVA results in Table 2, the dosage, rice type, botanical pesticide ingredients, and replications did not significantly affect the effectiveness value. One possible reason this botanical pesticide did not affect rice weevil control was its relatively narrow dosage range and the amounts used. Furthermore, based on the mortality values, there appears to be a correlation between the day of death and the rate of insect death. In the given treatment, *S. oryzae* L. began to die on the third day after application, although the numbers were not high.

The highest number of deaths occurred on the sixth day after application. Based on the LT50 calculation, which transforms mortality data into probit values and the observation time, the analysis results show that the death rate is below LT50. This is because the fastest death rate occurs on the third day, with a death population of approximately 30%, which is still below 50% of the total test population (20 individuals). The following graph shows the day of insect mortality (Figure 4).

The ineffectiveness of botanical pesticides and LT50 pest treatments is likely due to several factors, namely the dosage used and the morphological characteristics of the insect pests. According to Aisyah *et al*. (2024), the dosage used is positively correlated with the amount of bioactive ingredient in the botanical pesticide powder. The higher the dosage of botanical pesticides, the higher the bioactive concentration, and the faster these active compounds accumulate in rice weevil pests (Syahwal *et al*., 2024). In addition, rice weevils have a fairly hard exoskeleton, so it takes a long time and a high dose to penetrate it and disrupt their respiratory or nervous systems (Djaya *et al*., 2024). Rani *et al*. (2019) added that the head of the rice weevil pest is quite hard and sturdy, which can act as a physical barrier to the entry of botanical pesticides into the body. These factors may explain why botanical pesticides sometimes show lower effectiveness in controlling rice weevils.

The speed at which insects die due to botanical pesticide treatment is influenced by the active compounds in plant leaf extracts (Sari & Aisyah, 2025). Some active compounds contained in plants that can be used as botanical pesticides include alkaloids, flavonoids, saponins, tannins, essential oils, antimicrobials, etc., which are specific to the plant or plants used (Yuliartati *et al.,* 2024; Cindowarni & setyawati, 2025; Pramono *et al*., 2023; Ayuningtias *et al.,* 2025).

4. CONCLUSIONS

Based on this research, it can be concluded that shrub vegetation, namely pucuk idat, kedebik, and kemunting, at a single dose, can control rice weevil (*Sitophilus oryzae* L.). The highest mortality rate of 83.3% was achieved in the rice paddy treatment with pucuk idat leaf pesticide at a dose of 20 g. Its effectiveness varies depending on the combination of plant species, rice type, and dosage, with pest mortality generally appearing on the third day and peaking on the sixth day after application, thought to be caused by toxic active compounds in the plants. However, overall, shrub vegetation control has not been effective. Future research is expected to increase the dosage, include phytochemical analysis, and determine the amount of pesticides present.

5. ACKNOWLEDGMENTS

The Bangka Belitung State Manufacturing Polytechnic supported the author's research through the Internal Grant program. In addition, the author thanks to Directorate General of Research and Development, Ministry of Higher Education, Science, and Technology, regarding Publication Support for Reputable Journals in 2025, Number 0488/C/DT.06.01/2025.

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