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# Resistance of Local Rice Varieties from South Pesisir Regency to Brown Planthopper, *Nilaparvata lugens* Stal

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## Abstract

The use of resistant rice varieties remains a key component in managing the brown planthopper (BPH), *Nilaparvata lugens* Stål (Hemiptera: Delphacidae). However, information on the resistance of indigenous rice varieties from South Pesisir Regency, West Sumatra Province, Indonesia, is still limited. This study aimed to evaluate the resistance levels of several local rice varieties from South Pesisir Regency to BPH. The experiment was conducted under laboratory conditions using a completely randomized design with seven treatments and four replications. The treatments consisted of five local rice varieties (Sarai Sarumpun, Kutu, Bakwan, Banang Salai, and Bujang Marantau), with TN1 and IR74 used as susceptible and resistant controls, respectively. Seven-day-old rice seedlings were infested with second–third instar BPH nymphs. Variables observed included BPH attack symptoms, mortality, attack percentage, and attack intensity. The results showed significant variation in resistance among the tested varieties. Banang Salai exhibited the highest resistance, with 83.13% BPH mortality, 68.75% attack percentage, and 50.34% attack intensity, indicating a resistant response. In contrast, Sarai Sarumpun showed the lowest resistance, with only 25.94% BPH mortality and the highest attack intensity (90.52%), and was classified as highly susceptible. These findings demonstrate that Banang Salai is a promising local genetic resource for BPH resistance, highlighting the potential of indigenous rice varieties to support sustainable pest management.

Keywords: Attack, banang salai, indigenous, mortality, sarai sarumpun

## Introduction

The brown planthopper (*Nilaparvata lugens* Stål; Hemiptera: Delphacidae), commonly known as BPH, is one of the most destructive pests of rice in Asia, including Indonesia (Syahrawati et al., 2019). This monophagous pest poses a persistent threat to rice production and food security. BPH causes direct damage by sucking phloem sap and indirect damage by transmitting plant viruses, such as rice ragged stunt virus (RRSV) and rice grassy stunt virus (RGSV) (Horgan et al., 2018). Infested rice plants typically exhibit "hopperburn" symptoms, which may result in yield losses exceeding 70% under severe infestation conditions (Listihani et al., 2023). Outbreaks of BPH populations are frequently associated with the widespread cultivation of genetically uniform rice varieties and the excessive or improper use of chemical insecticides, which disrupt the ecological balance of rice agroecosystems (Sulistyawati et al., 2022).

Chemical-based control of BPH has proven to be unsustainable due to pest resurgence, the development of resistance, and adverse ecological impacts. Consequently, host plant resistance is widely recognized as the most effective and environmentally friendly strategy for managing BPH populations. Resistance of rice plants to *N. lugens* is generally governed by three main mechanisms: antibiosis, antixenosis, and tolerance (Horgan et al., 2018). Since the identification of the first resistance gene (*Bph1*) in the IR26 variety, more than 40 BPH resistance genes have been identified and mapped in the rice genome, including *Bph9*, *Bph14*, and *Bph32* (Mishra et al., 2022; Li et al., 2024). However, the effectiveness of these resistance genes often declines over time due to the rapid evolution of new BPH biotypes that can overcome host plant defenses (Hu et al., 2016). This situation revealed the urgent need to identify new and diverse sources of resistance, particularly from genetically heterogeneous local varieties or landraces that have undergone long-term natural selection.

Local rice varieties in Indonesia, including those originating from South Pesisir Regency, West Sumatra, Indonesia, have evolved through prolonged adaptation to specific agroecosystems. These traditional cultivars are known to exhibit tolerance to various environmental stresses and may harbor unique resistance traits against major pests such as *N. lugens* (Ezward et al., 2022). Previous studies have reported that several local rice varieties from Sumatra and Java display varying levels of resistance to BPH, reflecting their genetic distinctiveness as well as differences in local BPH biotypes (Iswanto et al., 2020; Puspito et al., 2023; Sari et al., 2023; Rinaldi et al., 2023). Despite these findings, the resistance status of local rice varieties originating from South Pesisir Regency has not been systematically investigated. The absence of region-specific resistance limits the utilization of local varieties as potential sources of resistance traits.

Recent research emphasizes the importance of integrating phenotypic screening with molecular characterization to identify and validate resistance traits in rice (Li et al., 2024). Such integrated approaches have facilitated the discovery of new resistance genes derived from landraces, which can subsequently be incorporated into modern breeding programs through the use of marker-assisted selection. Nevertheless, most studies have focused on landraces from East and South Asia, whereas information on Indonesian local rice varieties remains scarce (Wijayanti et al., 2018). This research gap reflects the limited availability of regional data on the resistance of local rice varieties to BPH biotypes that evolve under specific local environmental conditions. Additionally, environmental factors and traditional cultivation practices are recognized as influencing BPH dynamics and plant responses to infestation (Sulistyawati et al., 2022).

South Pesisir Regency has wide diversity of local rice varieities that are still actively cultivated by traditional farmers. The region's agroecosystem ranges from coastal lowlands to upland, creating a unique environment for genetic differentiation and local adaptation. Exploring and evaluating the resistance of these regional varieties to *N. lugens* infestation is therefore a crucial step toward identifying potential resistant genotypes. As emphasized by Puspito et al. (2023), utilizing local rice varieties as donor sources of resistance genes is essential for addressing the rapid evolution of BPH biotypes in rice production systems.

This study aimed to evaluate the resistance levels of local rice varieties originating from South Pesisir against BPH. The results are expected to provide valuable insights for selecting resistant rice varieties suitable for sustainable rice production in West Sumatra and to serve as a genetic resource for national rice breeding programs.

## Methods

The study was conducted from June to September 2024 at the Insect Bioecology Laboratory and the Integrated Pest Management Laboratory, Department of Plant Protection, Faculty of Agriculture, Universitas Andalas, Padang, Indonesia.

**Research Design**

A Completely Randomized Design (CRD) was used. This experimental study began with several varieties, seven treatments (TN 1 (Sarai Sarumpun, Bakwan, Banang Salai, Kutu, Bujang Marantau, IR 74) in four replications. Each replication was infested with 160 second and third-instar BPH nymphs.

**Planting Medium Preparation**

The planting medium consisted of a mixture of paddy soil and cow manure at a ratio of 5:1 (w/w), equivalent to 5 kg of paddy soil and 1 kg of cow manure. The soil and manure were thoroughly mixed in a plastic container, and water was added gradually while stirring until a homogeneous mixture was obtained. The prepared medium was then incubated for seven days to allow partial decomposition of the organic matter and to improve the physical properties of the soil.

**Preparation of Rice Seedlings for BPH Rearing**

Rice seeds of the IR42 variety were used as the food source for BPH. The seeds were obtained from local farmers in Padang, West Sumatra. The seeds were evenly distributed in 250 mL plastic cups and soaked in water for 24 h until fully submerged to stimulate germination. After soaking, the seeds were air-dried for approximately 2 h and then sown in plastic trays measuring 30 × 21 × 5 cm. Each tray was filled with approximately 3 cm of the prepared planting medium. The seedlings were maintained for seven days before being transferred to BPH rearing cages.

**BPH Rearing and Propagation**

The BPH population used in this study originated from the 20th laboratory generation maintained at the Integrated Pest Management (IPM) Laboratory and reared continuously on the IR42 rice variety. When the rice seedlings reached seven days after sowing (DAS), ten pairs of adult BPH were introduced into plastic trays containing IR42 seedlings and placed inside BPH rearing cages. To obtain uniform developmental stages, the insects were allowed to oviposit for approximately three days. After this period, all adult BPH were removed from the cages. The infested seedlings were then maintained to allow BPH populations to develop until the required number was achieved. Nymphs of the second and third instars from the third generation were used for the resistance bioassay.

**Preparation of Test Rice Plants**

Seeds from seven rice varieties used as test plants were soaked in water for 24 h and subsequently air-dried for 2 h. A total of 30 seeds from each variety were sown in plastic containers filled with the planting medium. Five days after sowing, seedlings were thinned to 20 plants per container by removing excess seedlings. The remaining seedlings were maintained until seven days after sowing and used for BPH infestation, following the method described by Effendi and Munawar (2013).

**BPH Infestation**

BPH infestation was conducted when the rice seedlings were seven days after sowing (DAS). Each treatment consisted of 20 rice plants, and each plant was infested with eight second– to third–instar BPH nymphs, evenly distributed among the plants, resulting in a total of 160 nymphs per treatment. After infestation, the rice plants were covered with cylindrical mylar plastic cages (18 cm in diameter and 50 cm in height), with the upper opening secured with gauze to prevent insect escape while allowing for air circulation.

**Variables Observed**

**BPH mortality**

BPH mortality was observed one day after BPH infestation, every day for eight days. Observations stopped after 90% of the TN 1 variety showed death symptoms on day eight. Mortality was calculated by determining the BPH mortality percentage in second and 3rd-instar nymphs. BPH mortality was determined by counting the number of dead BPHs, which was calculated using the following formula:

$$\mathrm{M}(\%) = \frac{\mathrm{Nd}}{\mathrm{Nt}} \mathrm{x}\ 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Description: M = Mortality, Nd = number of dead BPH nymphs, Nt = total number of BPH nymphs infested

BPH mortality data correction was performed using the Abbott formula:

$$\text{Corrected Mortality } = \frac{\mathrm{Mt-Mc}}{100-\mathrm{Mc}} \mathrm{x}\ 100 \ \ldots\ldots \text{(2)}$$

Description: Mt = treatment mortality (%), Mc = Control mortality

**Attack percentage (%)**

The attack percentage on test plants was observed one day after infestation. Observations were conducted daily and concluded after the TN 1 variety showed 90% death symptoms or was completely dead on day 8 (IRRI, 2002). To calculate the infestation percentage, use the following formula:

$$P = \frac{n}{N}\ x\ 100 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

Description: P = Attack percentage (%), n = Number of rice plants attacked, N = Number of rice plants observed

**Attack intensity (%)**

The intensity of BPH infestation on test plants was observed 1 day after infestation. Observations were conducted daily and concluded after the TN 1 variety showed 90% or complete death symptoms on day 8 (IRRI, 2002). Infestation intensity was calculated using the formula:

$$I = \frac{\Sigma(\mathrm{nixvi})}{\mathrm{ZxN}} \mathrm{x}\ 100\% \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

Description: I = Attack Intensity, ni = Number of rice plants attacked at score i, vi = Scale value for each observed plant at score i, Z = Total number of observed plants, N = Highest scale value

The scoring is presented in Table 1.

Table 1. Scoring of rice resistance to BPH attacks (IRRI,2022)

| Scoring | Symptom | Criteria |
|---|---|---|
| 0 | No damage | Very resistant |
| 1 | Very little damage, with less than 1% damage to the tips of the first and second leaves of the test plants. | Resistant |
| 3 | Most of the first and second leaves of the plants turned yellow. | Moderate resistant |
| 5 | Some plants turned yellow and stunted, or 10-25% wilted. | Moderate susceptible |
| 7 | Over half of the plants wilted or died, and the remaining plants were severely stunted or dried out. | Susceptible |
| 9 | All plants died | Very susceptible |

The final classification of rice variety resistance to BPH was based on the modal value obtained from four replications. Plant damage scores were first assessed for each replication. The resistance level of each variety was then determined according to the mode of these scores (Effendi and Munawar, 2013).

### Data Analysis

Data were analyzed using analysis of variance followed by a Least Significant Difference (LSD) test at a 5% significance level using Statistix 8.

## Results

### BPH Mortality

BPH mortality among local rice varieties from South Pesisir Regency revealed significant differences among treatments. Overall, BPH mortality on the local rice varieties was relatively high. The highest mortality was recorded on the eighth day after infestation in the Banang Salai variety, reaching 83.13%, whereas the lowest mortality was observed in the Sarai Sarumpun variety, with only 25.94% mortality (Table 2)

Table 2. BPH mortality in several local rice varieties from Pesisir Selatan Regency, on the eighth day after BPH infestation

| Variety | BPH Mortality (%) ± SD | | |
|---|---|---|---|
| IR 74 | 87.19 | ± 2.60 | a |
| Banang Salai | 83.13 | ± 3.83 | a |
| Bujang Marantau | 49.32 | ± 3.08 | b |
| Bakwan | 48.88 | ± 3.77 | b |
| Kutu | 46.50 | ± 3.76 | b |
| Sarai Sarumpun | 25.94 | ± 0.62 | c |
| TN 1 | 00.00 | ± 0.00 | d |

Notes: Numbers followed by the same lowercase letter in the same column are not significantly different based on LSD test at the 5% level

The progression of BPH mortality in local rice varieties from South Pesisir Regency was observed from the first day to the eighth day after infestation. Overall, BPH mortality increased in all tested rice varieties throughout the 8 days after infestation (DAI).

The highest BPH mortality was observed in the IR74 variety (control), increasing from 54.05% on the fifth day to 87.19% on the eighth day after infestation. This mortality level was not significantly different from that recorded in the Banang Salai variety. The lowest mortality was consistently recorded in the Sarai Sarumpun variety, which ranged from 7.84% to 25.94% during the same observation period (Figure 1).

### Attack Percentage (%)

Observations of the percentage of BPH infestation on several local rice varieties in South Pesisir Regency showed significantly different results. Based on observations, the lowest rate of plants infected with BPH was found in the Banang Salai variety, at 68.75%. The attack percentage differed significantly from that of the Sarai Sarumpun, Bakwan, Kutu, and Bujang Marantau varieties, which had high percentages (Table 3). Banang Salai also exhibited a relatively low attack incidence compared to the others. The attack percentage increased from the first to the eighth day after infestation in each observation. The most pronounced increase occurred between the fourth and sixth days after infestation (Figure 2).

### Attack Intensity

Observations of the attack intensity of BPH in several local rice varieties from South Pesisir Regency showed significant differences. The lowest attack intensity of BPH was found in Banang Salai (50.34%) and the highest was found in the Sarai Sarumpun variety at 90.52%, a non-significant difference from the Bakwan and Kutu varieties (Table 3).

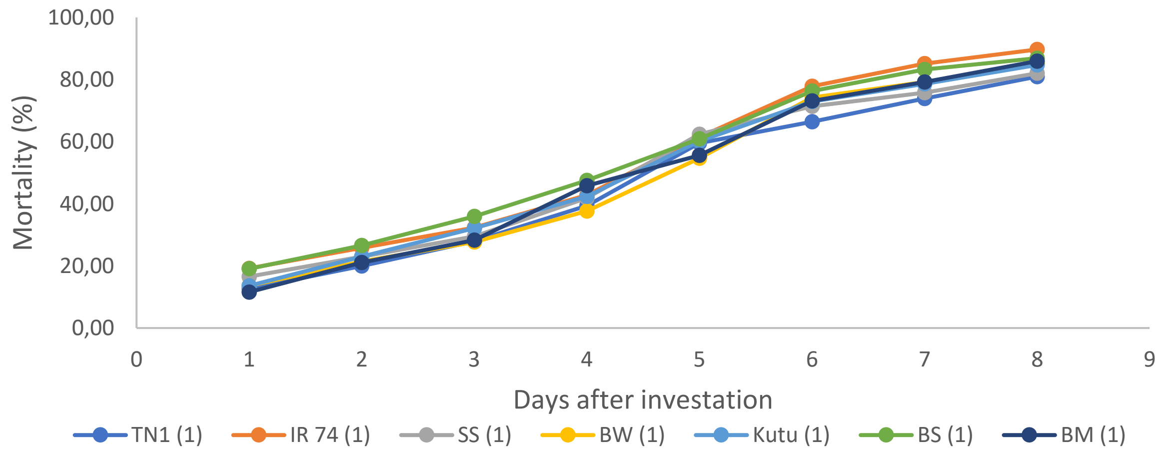


Figure 1. Development of BPH mortality from the first to the eighth day after brown planthopper infestation.

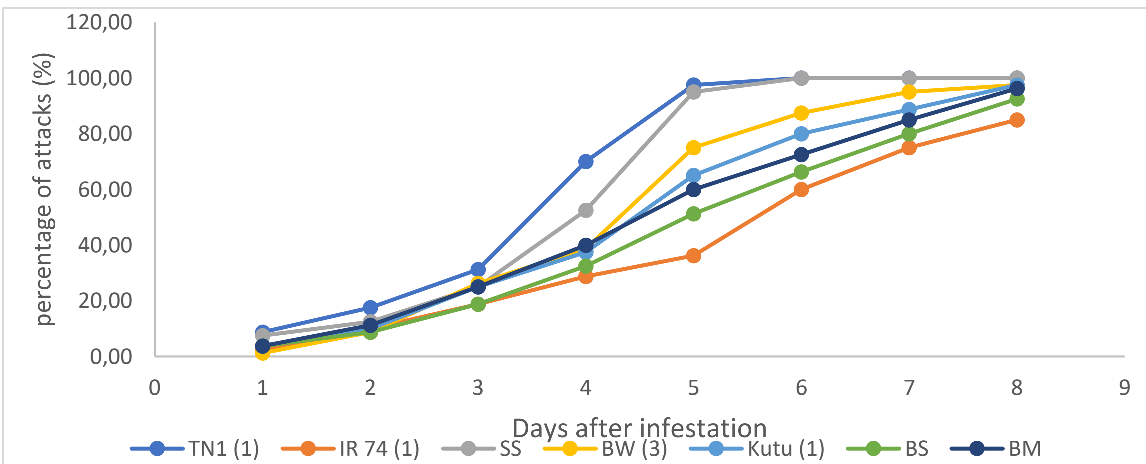


Figure 2. Development of BPH attack percentage during eighth day after infestation

Table 3. Brown planthopper percentage infestation on several local rice varieties from South Pesisir Regency, 8 days after BPH infestation.

| Variety | Percentage (%) ± SD | | |
|---|---|---|---|
| TN1 | 100 | ± 0,00 | a |
| Sarai Sarumpun | 100 | ± 0,00 | a |
| Bakwan | 97.5 | ± 2.89 | a |
| Kutu | 97.5 | ± 5.00 | a |
| Bujang Marantau | 96.26 | ± 2.50 | a |
| Banang Salai | 68.75 | ± 6.29 | b |
| IR 74 | 58.75 | ± 10.31 | c |

Numbers followed by the same letter in the same column are not significantly different according to the LSD at the 5% level.

**Attack Intensity**

Observations of BPH attack intensity among local rice varieties from South Pesisir Regency revealed significant differences among treatments. The lowest attack intensity was recorded in the Banang Salai variety (50.34%), whereas the highest attack intensity was observed in the Sarai Sarumpun variety (90.52%), which was not significantly different from the Bakwan and Kutu varieties.

Based on the damage scoring values of the five tested local rice varieties, Banang Salai was classified as moderately resistant, while Bakwan, Kutu, and Bujang Marantau were categorized as susceptible. In contrast, the Sarai Sarumpun variety was classified as highly susceptible (Table 4).

Table 4. Attack Intensity of brown planthopper on several local rice varieties from South Pesisir Regency on the eighth day after infestation

| Variety | Attack Intensity (%) ± SD | | | Scale | Criteria |
|---|---|---|---|---|---|
| TN 1 | 92.21 | ± 4.96 | a | 9 | Highly susceptible |
| Sarai Sarumpun | 90.52 | ± 5.39 | a | 9 | Highly susceptible |
| Bakwan | 76.50 | ± 16.97 | ab | 7 | Susceptible |
| Kutu | 76.40 | ± 6.08 | ab | 7 | Susceptible |
| Bujang Marantau | 66.52 | ± 11.75 | bc | 5 | Moderately susceptible |
| Banang Salai | 50.34 | ± 14.50 | cd | 3 | Moderately resistant |
| IR 74 | 23.81 | ± 19.46 | d | 1 | Resistant |

Numbers followed by the same letter in the same column are not significantly different according to the LSD at the 5% level

The attack intensity of BPH increased progressively from the first to the eighth day after infestation across all tested rice varieties. The most pronounced increase in attack intensity occurred between the fifth and eighth days of observation. Among the varieties, Banang Salai exhibited the slowest increase in attack intensity, whereas Sarai Sarumpun showed a rapid increase in attack intensity during the same observation period (Figure 4).

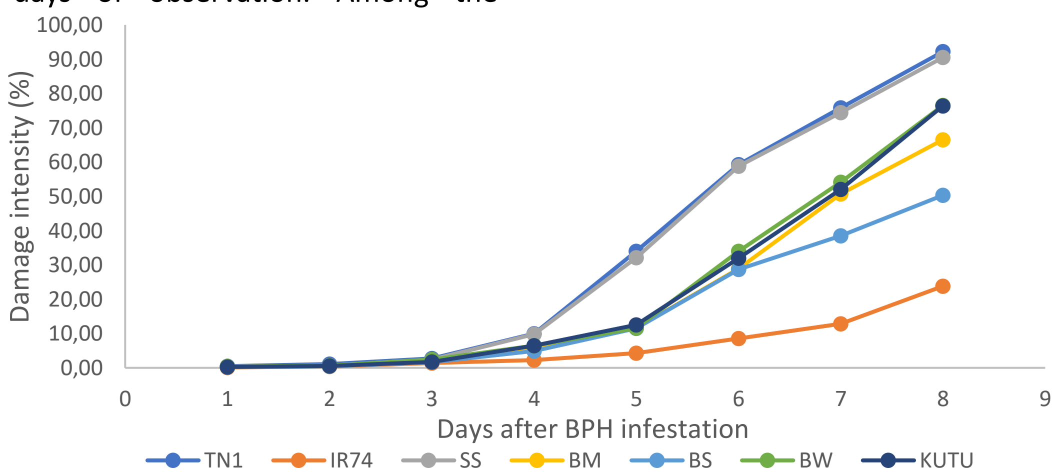


Figure 4. Development of BPH attack intensity from the first day to the eighth day after infestation. Notes: SS = Sarai Sarumpun, BM = Bujang Marantau, BS = Banang Salai, BW = Bakwan, Kutu = Kutu

## Discussion

The occurrence of hopperburn and plant mortality under high infestation pressure in the present study confirms the severe physiological disruption caused by BPH feeding. BPH mortality varied significantly among the tested rice varieties (Table 2; Figure 2), indicating differences in varietal resistance to BPH. The highest mortality was recorded in Banang Salai (83.13%), whereas the Sarai Sarumpun variety showed the lowest mortality (25.94%). High mortality levels in Banang Salai suggest the presence of effective resistance mechanisms that negatively affect BPH survival. Resistant rice cultivars are known to suppress the feeding efficiency, prolong the developmental duration, and reduce the reproductive success of BPH, ultimately leading to increased insect mortality (Yang et al., 2018). In contrast, susceptible cultivars provide favorable nutritional and physiological conditions that support insect development and population growth, as reflected by the low mortality and severe damage observed in Sarai Sarumpun.

Morphological characteristics of rice plants are among the primary factors influencing resistance to BPH. Field observations in this study revealed that Banang Salai possesses relatively rough leaf surfaces and stiff stems, traits that likely hinder stylet penetration and sap uptake. Such physical barriers can reduce feeding efficiency and increase insect mortality, as previously reported by Qomaroodin (2006) and Yang et al. (2018). Li et al. (2024) further demonstrated that rice varieties with thicker cell walls and higher lignin content reduced BPH feeding efficiency by up to 40% compared to varieties with softer tissues. Additionally, higher trichome density on leaf surfaces has been shown to negatively affect BPH feeding and oviposition preferences (Khetnon et al., 2022). These findings support the observed high mortality and low infestation intensity in Banang Salai, suggesting that morphological resistance plays a vital role in limiting BPH damage.

In addition to physical barriers, biochemical defenses play a substantial role in rice resistance against BPH. Secondary metabolites such as oxalic acid, phenolics, flavonoids, and saponins have been widely reported to exhibit toxic or antifeedant effects on phloem-feeding insects (Dwipa et al., 2018; Iswanto et al., 2016). These compounds interfere with insect digestion and metabolism, leading to reduced growth, reproductive inhibition, and increased mortality (Shi et al., 2023). The high BPH mortality observed in Banang Salai and IR74 (Table 2) is likely associated with elevated levels of such defensive compounds. Darmadi and Alawiyah (2018) reported that high oxalic acid concentrations in rice stems effectively deter BPH oviposition, thereby suppressing population development in resistant varieties. Although biochemical analyses were not conducted in the present study, the mortality patterns strongly suggest the involvement of antibiosis mechanisms.

The percentage of infested plants and the intensity of infestation further reflected varietal resistance levels (Figures 3 and 4). Banang Salai consistently exhibited the lowest infestation percentage (68.75%) and attack intensity (50.34%), corresponding with its high BPH mortality. This inverse relationship between infestation intensity and insect mortality indicates that BPH was unable to complete its life cycle efficiently on resistant varieties. Similar patterns were reported by Sari (2024), who found that Batang Piaman exhibited significantly lower infestation rates (50% and 55%, respectively) than other tested varieties. These results reinforce the role of host-plant resistance in suppressing pest populations by simultaneously reducing survival and feeding success.

The nutrient composition, particularly the nitrogen and carbohydrate content, also influences the dynamics of BPH infestation. High nitrogen levels in rice plants increase palatability and provide essential nutrients that enhance BPH growth and reproduction (Hao et al., 2018; Wang et al., 2024). Conversely, rice varieties with lower nitrogen content and higher concentrations of secondary metabolites tend to be less susceptible, as these compounds disrupt feeding behavior and act as repellents. Horgan et al. (2021) revealed that rice varieties with higher flavonoid content reduced BPH feeding activity by up to 55% compared to low-flavonoid varieties. This suggests that morphological and biochemical traits act synergistically to confer resistance, a mechanism that likely underlies the strong resistance observed in Banang Salai.

Overall, the present study demonstrates that Banang Salai possess high resistance to *N. lugens*, characterized by elevated pest mortality (Table 2), reduced infestation incidence (Figure 3), and lower attack intensity (Figure 4). In contrast, Sarai Sarumpun exhibited high infestation levels and low mortality, indicating susceptibility to the disease. These findings confirm that resistance to BPH in rice is polygenic and complex, involving interactions among morphological, physiological, and biochemical mechanisms (Shi et al., 2023). Notably, the identification of Banang Salai as a resistant local variety highlights the potential of indigenous rice germplasm as a valuable genetic resource for breeding programs. It supports the integration of host-plant resistance into sustainable Integrated Pest Management (IPM) strategies in South Pesisir Regency and similar agroecological regions.

## Conclusion

The results showed significant variation in resistance among the tested varieties. Banang Salai exhibited the highest resistance, with 83.13% BPH mortality, 68.75% attack percentage, and 50.34% attack intensity, indicating a resistant response. In contrast, Sarai Sarumpun showed the lowest resistance, with only 25.94% BPH mortality and the highest attack intensity (90.52%), and was classified as highly susceptible. These findings demonstrate that Banang Salai is a promising local genetic resource for BPH resistance, highlighting the potential of indigenous rice varieties to support sustainable pest management

## Declaration

### Author Contributions

Dea Safitri contributed to the preparation of the manuscript. Novri Nelly served as corresponding author, while Arneti was a co-author. All authors have read and approved the final version of the manuscript.

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### Conflict of Interest

The authors declare that there are no financial or personal relationships that could have influenced the work reported in this article.

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