ISSN 2808-3229
Journal of Biodiversity and Biotechnology. 5(2), 65–70,
2025 URL: https://jurnal.uns.ac.id/jbb/article/view/113966
doi: http://dx.doi.org/10.20961/jbb.v5i2.113966

Effects of Rice Varieties on Attractiveness, Population Development, and Weight Loss Caused by *Sitophilus oryzae* During Storage

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Abstract
Sitophilus oryzae is one of the main pests that attack rice and cause quantitative and qualitative losses during storage. This study aims to analyze the effect of several rice varieties on attractiveness, population development, and weight loss of rice due to S. oryzae infestation. The study was conducted using a free choice test to measure attractiveness, population development observation, and weight loss measurement on four rice varieties, namely red rice, white rice, black rice, and brown rice. The results showed that brown rice had the highest palatability and the highest population growth rate, black rice was the second best, followed by husked rice. In contrast, white rice had the lowest palatability, population growth rate, and weight loss. The pattern of rice weight loss was consistent with the pest population level, where varieties with higher *S. oryzae* populations experienced a greater percentage of weight loss. The differences in *S. oryzae* response between rice varieties are thought to be related to the physical and chemical characteristics of the rice varieties, including nutrient content and grain structure, which affect pest preference and development success. This study shows that rice varieties have the potential to be used as an essential component in post-harvest pest management strategies, particularly in efforts to reduce losses during storage through the selection of varieties that are relatively more resistant to *S. oryzae* infestation and the use of rice varieties to develop attractants for trapping *S. oryzae*.

Keywords: pest attractiveness; pest population; rice varieties; *Sitophilus oryzae*; weight loss.

Cite this as: Marsadi, D., Yuliadhi, K. (2025). Effects of Rice Varieties on Attractiveness, Population Development, and Weight Loss Caused by Sitophilus oryzae During Storage. 5(2), 65–70. doi: http://dx.doi.org/10.20961/jbb.v5i2.113966

Introduction

Rice plants (*Oryza sativa* L.) are the primary source of rice, which is a staple food for more than half of the world's population. Rice also plays a vital role in supporting food security, social and economic stability, and agricultural sustainability in developing countries, especially in Indonesia (1). Rice, as the main product of rice plants, not only serves as a source of energy but also as an essential source of nutrition for the community. Currently, more and more people are realizing the importance of healthy food, so public interest in functional rice such as brown rice, brown rice, and black rice is increasing. This is because these types of rice come from rice varieties that have special nutritional content, such as fiber, vitamins, minerals, and bioactive compounds that are higher than those of regular white rice.

Rice production continues to be increased by improving seed types and farming methods, but the problem of post-harvest losses remains a significant threat to ensuring the availability and quality of rice. One of the leading causes of post-harvest yield loss is rice weevil (*Sitophilus oryzae* L.) infestation. *S. oryzae* is a cosmopolitan pest with a high infestation rate and significant destructive capabilities. *S. oryzae* is capable of attacking whole rice grains and completing its entire life cycle inside the grain, causing structural damage to the endosperm, increased weight loss, and a noticeable decline in the physical and nutritional quality of rice (2). Attacks by *S. oryzae* on rice are greatly influenced by the characteristics of the rice variety and type, such as nutritional content, endosperm hardness, grain size and shape, and the thickness of the aleurone layer and bran, which are known to affect oviposition preference, larval

development success, and pest population growth rate. Doherti et al. (3) reported significant differences in attractiveness, number of offspring, and damage levels between rice types and varieties. The results of a study by Syahrullah et al. (4) also showed that the population density of *S. oryzae* was positively correlated with an increase in weight loss and physical damage in various local rice varieties.

Damage caused by warehouse pests such as *S. oryzae* not only results in quantitative losses in the form of weight loss but also reduces the physical quality and commercial value of rice through contamination with powder, frass, and potential biological contamination that poses a risk to food safety (5). Until now, warehouse pest control has generally used synthetic insecticides that have the potential to leave harmful residues and accelerate the development of pest resistance, thereby posing risks to human health and the sustainability of storage systems. To overcome these problems, a sustainable control approach is needed through the selection of rice types and varieties that produce rice that is relatively resistant to storage as a safer and more environmentally friendly alternative. To date, research that simultaneously examines the attractiveness, population dynamics, and weight loss rate of *S. oryzae* in four commercial rice types (white rice, red rice, brown rice, and black rice) under uniform storage conditions is still minimal. However, these four rice types have different morphological characteristics and nutritional compositions that have the potential to affect their susceptibility to storage pests. Based on this description, this study was conducted to analyze the differences in attractiveness, population development dynamics, and weight loss rates of *S. oryzae* in white rice, brown rice, brown rice, and black rice during storage. The results of this study are expected to provide a scientific basis for determining the type of rice that is more resistant to storage and to support the development of a safe, effective, and sustainable rice storage system.

Material and Methods

Time and Place of Research

This research was conducted at the Integrated Pest Management Laboratory, Faculty of Agriculture, Udayana University, Bali, Indonesia, from October to December 2025.

Materials and Equipment

The materials used included white rice, brown rice, red rice, black rice, and test insects (*S. oryzae*). The equipment used included analytical scales, plastic jars, gauze, and statistical software.

Experimental Design

The study used a completely randomized design (CRD) because it was conducted in a homogeneous environment (6). There were four treatments (white rice, brown rice, brown rice, black rice) with five replicates, resulting in a total of 20 experimental units.

Media Preparation

Each jar was filled with approximately 75 g of rice and inoculated with 5 pairs of *S. oryzae* imagoes, then covered with gauze for air circulation.

Attractiveness Test (Preference)

The preference test was conducted using the free choice test method, where the four rice types were placed together in one test arena, and 20 *S. oryzae* imagoes were released in the center of the test area. The number of insects that chose each type was recorded after 24 hours as an indicator of attractiveness (7).

Population Development Observation

The first generation (F1) population was counted after 45 days of incubation to reflect the reproduction rate and population development of *S. oryzae* in each rice type. The population development rate was calculated using the formula from Zhang (5):

Population growth rate (%):

$$\frac{Final\ population - Initial\ population}{Initial\ population} x100$$

Weight Loss Measurement

Weight loss observation of rice was conducted after all *S. oryzae* imagoes emerged. Rice weight loss is defined as the decrease in rice mass during the storage period caused by pest attacks. The percentage of rice weight loss was calculated using the formula according to Susanti (8):

Weight loss (%):

$$\frac{\text{initial rice weight} - \text{final rice weight}}{\text{initial rice weight}} x100$$

Data Analysis

The data on the attractiveness of *S. oryzae* were analyzed using analysis of variance (ANOVA) at a significance level of 5%

(α = 0.05) to determine the effect of rice varieties on the number of insects attracted. If the ANOVA results showed significant differences between treatments, the analysis was continued with Duncan's Multiple Range Test (DMRT) at a significance level of 5% to compare the mean values and identify statistically different treatment groups. Data on population development and rice weight loss were presented descriptively in tabular form to illustrate trends and differences between rice varieties during the observation period.

Results and Discussion

Attractiveness (Preference) Test

The *S. oryzae* preference test showed that rice varieties had a significant effect on the number of S. oryzae individuals attracted to each treatment (Table 1). The results of the analysis of variance showed significant differences between rice varieties, as indicated by a p-value < 0.05, which was further tested using Duncan's 5% test. Duncan's multiple range test showed that brown rice had the highest average number of individuals attracted, namely 9.2 individuals, and was significantly different from all other varieties. Black rice showed a medium level of attractiveness with an average of 6.4 individuals. White rice and brown rice had an average of 3.0 and 1.4 individuals, respectively, and were not significantly different from each other, indicating a relatively low level of attractiveness to *S. oryzae*.

Overall, there was a gradation in the level of attraction of *S. oryzae* to rice varieties, with the order of preference being red rice > black rice > white rice ≈ brown rice, as reflected in the separation of groups in Duncan's test.

Table 1. Mean number of *S. oryzae* individuals attracted to different rice varieties.

Treatment (Rice Variety)	Experimental Replicates					Mean
	U1	U2	U3	U4	U5	
Red rice	11	8	10	9	8	9,2[a]
White rice	1	4	3	4	3	3[c]
Black rice	6	7	6	6	7	6,4[b]
Brown rice	2	1	1	1	2	1,4[c]

Note: Different letters indicate significant differences at $p < 0.05$.

The high level of attractiveness of *S. oryzae* to red rice indicates that this variety possesses characteristics that are more attractive to stored product pests compared to other rice varieties. This preference is presumably associated with differences in the physical and chemical properties of the grains, particularly the composition of volatile compounds and nutrient content, which function as olfactory and gustatory stimuli for insects. Cao reported that *S. oryzae* exhibits significant attractive responses to specific volatile compounds, such as nonanal, hexanal, and 1-octen-3-ol, which are commonly found in rice varieties with intact aleurone layers and bran (9). These compounds play a crucial role in guiding pest orientation during host and food source searching.

In addition to volatile compounds, grain nutritional characteristics also contribute to host preference by *S. oryzae*. Salman stated that carbohydrate and protein contents, as well as grain moisture levels, influence feeding behavior and oviposition decisions of the pest (10). Rice varieties with relatively higher nutritional content tend to be more preferred because they can better support the energy requirements and reproductive success of insects. This is consistent with the results of the present study, in which red rice and black rice, which are generally recognized as having higher nutritional value than white rice, exhibited higher levels of attractiveness.

The preference pattern observed in this study is also consistent with the findings of Sharma et al., who reported that *S. oryzae* is capable of distinguishing and selecting hosts based on differences in the physical and chemical characteristics of the substrate (11). Therefore, the variation in attractiveness among rice varieties observed in this study confirms that the phytochemical profile and physical properties of rice grains are key factors influencing host selection by *S. oryzae*. From a practical perspective, this information is essential for postharvest pest management, as rice varieties with lower attractiveness may present a reduced risk of infestation and can be prioritized in sustainable storage systems.

Observation of Population Development

The population development of *S. oryzae* differed significantly among rice varieties during the observation period (Table 2). All treatments were initiated with the same initial population (10 adult individuals). Population growth rate (%) was calculated based on the increase in the total number of

insects per replicate at the end of the observation period relative to the initial population. The final population size included all emerged individuals, regardless of life stage, and was expressed as the mean number of insects per replicate.

The highest population growth rate was recorded on red rice (2.954%), followed by black rice (2.720%), brown rice (1.968%), and white rice (676%), indicating marked differences in the suitability of rice varieties for population development of *S. oryzae*.

Table 2. Percentage of population growth of *S. oryzae* on different rice varieties

Treatment	Population *S. oryzae*		Population growth rate (%)
	Initial	Final	
Red rice	10	305.4	2.954
White rice	10	77.6	676
Black rice	10	282	2.720
Brown rice	10	206.8	1.968

The differences in population growth rates indicate that rice varietal characteristics play an essential role in supporting the reproductive success and development of *S. oryzae*. Abedi et al. (12) reported that starch content and macronutrient levels in cereal grains are positively correlated with the population growth rate of stored product insects, as these nutrients serve as the primary energy sources for larval development and egg production. Rice varieties with higher nutritional content tend to provide more favorable conditions for the population development of *S. oryzae*.

Zhang et al. (5) also demonstrated that different rice varieties offer varying levels of physiological support for *S. oryzae* development, including differences in developmental duration and metabolic efficiency. More digestible varieties allow the insect to complete its life cycle more rapidly, resulting in higher population growth rates. In the present study, the high population growth observed on red and black rice is likely associated with the preservation of nutrients in the bran and aleurone layers, which support oviposition, larval development, and adult emergence.

In contrast, the low population growth rate observed in white rice can be attributed to the removal of most bran layers during polishing, leading to a reduction in essential nutrients required by the insect. Meanwhile, the more moderate population growth on brown rice may be influenced by its more complex grain structure and relatively thicker outer layers, which can restrict larval penetration and slow individual development. Abedi et al. (12) reported that grain physical structure may act as a mechanical barrier to oviposition and nutrient utilization by stored-product insects.

Overall, the variation in *S. oryzae* population development among rice varieties suggests that varietal susceptibility to stored-product insect infestation can serve as an essential indicator in the design of postharvest pest management strategies. Rice varieties with lower population growth rates have the potential to reduce infestation risk and minimize losses during storage.

Weight Loss Assessment

The results of the weight loss assessment revealed significant differences among rice varieties after the storage period under *S. oryzae* infestation (Table 3). The highest percentage of weight loss was recorded in red rice (7.68%), followed by black rice (6.61%), brown rice (5.04%), and white rice (4.57%). This pattern indicates that each rice variety exhibits a different level of susceptibility to quantitative damage caused by feeding activity and population development of *S. oryzae* during storage.

Table 3. Percentage of Rice Grain Weight Loss Caused by *S. oryzae* Infestation During Storage

Treatment	Initial rice weight	Final rice weight	Weight loss (%)
Red rice	75.04	69.28	7.68
White rice	75.03	71.60	4.57
Black rice	75.04	70.08	6,61
Brown rice	75.04	71.26	5.04

Weight loss is an essential parameter for describing the level of physical damage and mass loss in rice caused by *S. oryzae* infestation during storage. High weight loss values reflect the intensity of grain consumption by *S. oryzae*, the formation of feeding tunnels, and the accumulation of powdery debris resulting from larval feeding and development. Hendrival and Rika (13) reported a robust positive correlation between S. oryzae population density and the percentage of rice weight loss during storage ($r = 0.996$; $p < 0.01$), indicating that an increase in pest population directly causes greater quantitative losses.

The differences in weight loss among the rice varieties observed in this study can be explained by variations in the physical and chemical properties of rice grains, such as starch and protein content, moisture level, and husk hardness. Das et al. (14) showed that these

parameters were significantly positively correlated with the amount of rice weight loss due to *S. oryzae* infestation. Rice varieties with higher nutritional content and a more permeable grain structure tended to experience greater weight loss.

The highest weight loss in rice was observed in red rice, indicating that this variety is not only more attractive to *S. oryzae* but also provides more favorable conditions for pest population development, resulting in greater damage intensity. In contrast, white rice showed the lowest weight loss. The low weight loss of rice is due to *S. oryzae* being less attracted to white rice compared to other rice varieties. *S. oryzae* low interest in white rice is thought to be due to white rice's relatively higher resistance or lower nutritional content to support the development of *S. oryzae* pests.

The evaluation of weight loss among rice varieties provides an essential scientific basis for selecting more storage-resistant varieties and developing effective post-harvest pest control strategies to minimize losses during storage.

Conclusion

The results of the study indicate that rice varieties have a significant effect on attractiveness, population development, and the level of damage to rice caused by S. oryzae infestation during storage. Red rice showed the highest levels of attractiveness, population growth rate, and weight loss, while white rice showed the lowest values for all parameters observed. The differences in S. oryzae's response to each rice variety indicate that the physical characteristics and nutritional composition of the grains play an important role in determining S. oryzae's preference and development success.

Acknowledgments

The author would like to express his deepest gratitude to the institution for the facilities provided, as well as to all those who took the time to discuss, provide valuable feedback, and offer suggestions so that this research could be carried out correctly.

Conflict of Interest

The authors declare that there are no conflicts of interest, either financial or non-financial, that could have influenced the conduct of the research, the data analysis, or the preparation of this manuscript.

References

[1] Marsadi D, Dirgayana IW, Dewi KACJ. Keanekaragaman dan persentase serangan hama yang menyerang tanaman padi (*Oryza sativa* L.) pada fase vegetatif di Subak Kenderan. BIOMA J Biol Makassar. 2021;6(2):55–63.

[2] Djaya AA, Desrahmat Z, Padriyani, Melhana, Lilies S. Efektivitas beberapa jenis insektisida nabati terhadap hama kutu beras (*Sitophilus oryzae* L.) pada beras Siam. J Penelit UPR Kaharati. 2024;4(1):16–26.

[3] Doherty E, Sun Q, Wilson B. Stored rice varietal resistance towards *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). Crop Prot. 2023;165:106162.

[4] Syahrullah, Lyswina A, Mariana. Kerusakan beras oleh *Sitophilus oryzae* L. dari beberapa varietas padi. J Proteksi Tanaman Tropika. 2019;2(3):136–142.

[5] Zhang L, Wang H, Liu G. The rice cultivar affects the population growth and physiological enzyme activity of *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) reared on rice grains. J Stored Prod Res. 2023;104:102163.

[6] Annisa M, Hendrival H, Khaidir K. Evaluasi ketahanan beras lokal Provinsi Sumatera Barat terhadap hama *Sitophilus oryzae* (L.). J Agrotek Tropika. 2021;9(3):543–552.

[7] Astuti LP. Feeding preference and development of *Sitophilus oryzae* L. on organic and inorganic rice cultivation. J Agric Sci. 2019;41(3):561–568.

[8] Susanti S, Hendrival H, Usnawiyah, Hafifah, Muhammad N. Kerentanan relatif jenis beras terhadap *Sitophilus oryzae* L. (Coleoptera: Curculionidae) pada keadaan kadar air rendah. J Ilm Mhs Agroekoteknologi. 2022;1(1):10–17.

[9] Cao Y, Hu Q, Huang L, Anthanassiou CG, Maggi F, Di Ilaria D, et al. Attraction of *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) to the semiochemical volatiles of stored rice materials. J Pest Sci. 2024;97:73–85.

[10] Salman AMA, Fouad HA, Mahmoud DO. Host preference of *Sitophilus oryzae* and *Tribolium castaneum* to different stored cereals. J Sohag Agriscience. 2024;9(1):132–136.

[11] Sharma YV, Yadav U, Yadav A. Host preference and damage potential of rice weevil, *Sitophilus oryzae* L., on different stored millets. J Exp Agric Int. 2024;46(8):26–31.
[12] Abedi Z, Razmjou J, Dastjerdi HR, Ebadollahi A. Physical and biochemical characteristics of cereal grains affect population growth parameters of *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). J Stored Prod Res. 2024;109:102459.
[13] Hendrival H, Rika M. Pengaruh periode penyimpanan beras terhadap pertumbuhan populasi *Sitophilus oryzae* (L.) dan kerusakan beras. Biogenesis. 2016;4(2):95–101.
[14] Das P, Kalita S, Patgiri P, Sarmah B, Saikia H. Physico-chemical basis of insect-resistance of traditional rice varieties against *Sitophilus oryzae* (L.). Indian J Tradit Knowl. 2024.