JPPIPA 9(8) (2023)

Jurnal Penelitian Pendidikan IPA

*Journal of Research in Science Education*

http://jppipa.unram.ac.id/index.php/jppipa/index

# Population Number of Sitophilus *oryzae* L. Imago and Damage Intensity on Grains of Several Rice Varieties

Veronika Munde[1], Titik Sri Harini[1], Petronella S. Nenotek[1], Zainal Abidin[1], Yosep Seran Mau[1]*

[1]Agrotechnology Department, Faculty of Agriculture, Nusa Cendana University, Jl. Adisucipto-Penfui, Kupang NTT 85001, Indonesia

Received: January 19, 2023
Revised: June 30, 2023
Accepted: August 25, 2023
Published: August 31, 2023

Corresponding Author:
Yosep Seran Mau
yosepmau@staf.undana.ac.id

DOI: 10.29303/jppipa.v9i8.2956



**Abstract:** This study aimed to determine the *S. oryzae* imago number and the level of damage intensity it caused on grains of several rice varieties in Mauponggo District, Nagekeo Regency. The study was conducted at the Pest Laboratory of the Faculty of Agriculture, Nusa Cendana University. The study was laid out in a completely randomized design consisting of five rice varieties as treatments, each was four replicates. A rice grain of 100 grams was put into a plastic jar and infested with a uniform five pairs of *S. oryzae*. Observed variables included grain water content, number of *S. oryzae* imago and the percentage of grain weight loss as a measure of damage intensity. Data were subjected to analysis of variance, followed by an Honest Significant Post hoc test at a 0.05 % significance level. The study results showed significant differences among tested rice varieties in both imago populations as well as the level of grain weight loss. IR 64 variety showed the lowest number of imago of *S. oryzae* and also the lowest grain weight loss while local red and black rice were the highest in both the number of imago and grain weight loss at eight weeks after S. oryzae infestation.

**Keywords**: Damage intensity; Imago; Infestation; Rice grains; Sitophilus oryzae

## Introduction

Rice is a staple food for 90% of Indonesia's population (Yudansha et al., 2013). The rate of population growth that continues to increase has made Indonesia continue to spur rice production so that it can meet food needs and no longer import rice from other countries. Rice food self-sufficiency can be achieved through various technological innovation programs including the use of superior varieties and also developing an Integrated Crop Management (known with PTT) approach. However, there are still many obstacles encountered, one of which is improper postharvest handling. According to Herlina & Istiaji. (2016), storage is one of the most important postharvest links.

Different types/varieties of rice can cause differences in nutritional quality, and will also have different effects on the growth and development of insect pest populations (Hendrival & Melinda, 2017; Astuti, 2019; Hendrival et al., 2019). Mauponggo District is a rice production center in Nagekeo Regency, East Nusa Tenggara (known with NTT) Province, where many types of rice are consumed by the community, which are produced by local farmers themselves. Several types/varieties of rice that are cultivated and consumed are IR 64, IR 42, Ciherang, local brown rice, and local black rice. These types of rice have different physical qualities and nutritional content of rice which can lead to different levels of preference for these types of rice.

During storage, rice experiences a decrease in quality and quantity caused by physical, chemical and biological changes, as well as changes in the properties of rice flour due to storage, such as color, gas retention and particle size. The durability of food quality during storage is strongly influenced by the initial quality of stored raw materials and the introduction of preservatives during storage either by spraying insecticides, phosphine gas or carbon dioxide (Ratnawati et al., 2013).

Products in storage are inseparable from pest organisms, especially insects (Hendrival & Romadani, 2018; Manueke & Pelealu, 2015; Mehta et al., 2021). Pests on stored materials are generally pests that can cause direct damage where the damage occurs directly to the materials consumed (Wulandari et al., 2014). According

**How to Cite:**
Munde, V., Harini, T. S., Nenotek, P. S., Abidin, Z., & Mau, Y. S. (2023). Population Number of Sitophilus oryzae L. Imago and Damage Intensity on Grains of Several Rice Varieties. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6314–6320. https://doi.org/10.29303/jppipa.v9i8.2956

to(Herlina & Istiaji, 2016)Sitophilus oryzae populations can cause high damage and economic losses in the form of weight loss, quality loss, changes and decreased nutritional value. Therefore, it is necessary to take appropriate control measures.

The rice flea (Sitophilus oryzae) is one of the insects of the order Coleoptera which attacks rice yields the most (Mehta et al., 2021; Rita Devi et al., 2017). *S. oryzae* makes small holes in the rice grains as a result of which the rice is easily broken and crushed like flour, so the quality becomes low (Annisa et al., 2021; Fajarwati et al., 2015). Besides attacking rice, *S. oryzae* also attacks other crops such as corn, red beans, wheat and sorghum (Ria et al., 2014; Yudansha et al., 2013; Zunjare et al., 2016). The level of damage caused by *S. oryzae* shows a linear relationship between the population size and the level of damage (Herlina & Istiaji, 2016; Khan et al., 2014).

Factors that determine the degree of damage to rice by warehouse insect pests during the storage period include the number of population, rice moisture content, humidity, physical condition of the warehouse, temperature, variety of rice origin, and rice storage time.(Hendrival et al., 2018). Various types of rice consumed by the people in Mauponggo District, Nagekeo Regency, NTT are often damaged by *S. oryzae* rice lice. However, so far it is not known which types of rice are most liked/disliked by this pest and the consequences of experiencing damage or weight loss it causes.

Study of preferences or preferences of *S. oryzae* for the types of rice consumed by people in Mauponggu District and the level of damage caused by *S. oryzae* provide information that can be used as a recommendation for farmers to choose rice that is resistant to S. *oryzae* attack in storage.

This study aims to determine the number of imago populations and the level of damage caused by *S. oryza*e on several types of rice in Mauponggo District, Nagekeo Regency, NTT Province, and also found out which rice had the highest and lowest levels of damage and population numbers of *S. oryzae* imago.

## Method

*Methods and place of research*

This study used a survey method for sampling the test rice in Mauponggo District, Nagekeo Regency, and then the test rice samples were brought to the Laboratory of Plant Pests, Faculty of Agriculture, University of Nusa Cendana, for testing. The research took place in July - October 2022.

*Research design*

Experiments in the laboratory used a completely randomized design (CRD) with 5 treatments of rice types/varieties namely IR 64, IR 42, Ciherang, Local Red Rice and Local Black Rice, each consisting of 4 replications so that a total of 20 experimental units were obtained.

*Research procedure*

1. Preparation of test insects

A total of 20 pairs of imago *S. oryzae*reared on 100 grams of rice in a plastic jar measuring 15 cm high and 6 cm in diameter, and allowed to mate for 5 days. After 5 days, the 20 pairs of imago were removed from the jar, and the resulting eggs were allowed to hatch and subsequently produced new imago (uniform F1 *S. oryzae* offspring), which were then used as test insects. Furthermore, as many as 5 pairs of *S. oryzae* imago were used as test insects for each treatment in this study.

2. Morphological characterization of test material rice

Before being infested with test insects, the rice samples were first characterized The morphology of rice shape, rice size, rice texture and rice color.

3. Test insect infestation on test rice

Each type of rice was weighed as much as 100 g using an analytical balance (Brand: Citizen) and put into a plastic jar, then infested with 5 pairs of imago (5 male and 5 female) *S. oryzae*. Five days after infestation, 5 pairs of test insect imago were removed from the plastic jar containing the test rice. The eggs produced in the test rice were allowed to develop for further observation.

*Observational variables*

1. Water content

Observation of rice water content was carried out using a moisture meter, namely (Grain Moisture Meter).

2. Damage symptom

Damage symptoms were observed at 4 weeks after infestation (MSI). The observed symptoms were the rice grains with holes and the presence of flour remnants resulting from the grinding of *S. oryzae* larvae.

3. Number of new imago on 4 and 8 MSI

The number of new imago was observed at week 4 MSI by removing the rice from the plastic jar and counting the number of newly emerged imago. Then, put the rice back into the plastic jar. The number of imago was observed next at 8 MSI.

4. Percentage of weight loss (%)

The percentage of weight loss is calculated at 8 MSI. The initial weight of rice before infestation and the final weight of rice at 8 MSI are used to calculate the percentage reduction in weight loss of rice (Wulandari et al., 2014):

$$Percentage\ of\ Weight\ Loss = \frac{Initial\ Weight - Final\ Weight}{Final\ Weight} x100 \quad (1)$$

*Data analysis*

The data obtained was analyzed by Variety (ANOVA) and if there was a treatment effect, then it was continued with a further test of Honest Significant Difference (0.05% BNJ) to see differences between treatment means.

## Result and Discussion

*Rice water content*

The initial water content of the test rice ranged from 10.98% to 12.50%, while the water content at 8 MSI ranged from 9.98% to 10.30% (Table 1). At first, the lowest water content was found in IR 64, and the highest in local brown rice and black rice. During the 8 weeks of testing, the test rice experienced a decrease in water content, with a decrease in moisture content of 0.7% (IR 64) to 2.52% (local black rice), and at the end of the observation (8 MSI), all types of rice had water is almost the same, namely about 10%.

The water content affects the texture of the rice; High water content will make the rice softer making it easier for imago *S. oryzae* to grind the rice(Susanti et al., 2022). Physiologically, during storage there will be an increase in the water content of rice after *S. oryzae* infestation, which is due to the presence of respiration by insects. During storage, rice produces moisture due to the high population of *S. oryzae*. However, the data in Table 1 shows the opposite, namely a decrease in water content in all types of rice tested. This is presumably because there are not so many imago populations, or also because the process of evaporation of water from inside the seeds is higher into the container environment compared to water produced by the respiration process of insects.

**Table 1.** Average moisture content of 5 types of rice at the beginning and end of the experiment (8 MSI)

| Treatment/Type of Rice | The start of the experiment | End of trial (8 MSI) | Percentage of Reduction in Water Content |
|---|---|---|---|
| IR 64 | 10.98 | 10.28 | 0.7 |
| IR 42 | 11.68 | 10.30 | 1.38 |
| Ciherang | 11.45 | 10.20 | 1.25 |
| Local Red Rice | 12.38 | 10.03 | 2.35 |
| Local Black Rice | 12.50 | 9.98 | 2.52 |

The Indonesian National Standards Agency (2015) reports that the maximum water content standard for rice in storage is 14%, damage will be faster with a moisture content of more than 14%. The results for measuring the water content (Table 1) are lower than this standard, both at the beginning and at the end of the test, thus causing damage to the fish due to the water content.

*Symptoms of rice damage by*S. oryzae

Symptoms of rice damage by*S. oryzae*observed at 4 MSI. The results of observations showed that there were differences in symptoms of damage between the five types/varieties tested, among others, in terms of grain shape and rice color (Figure 1).

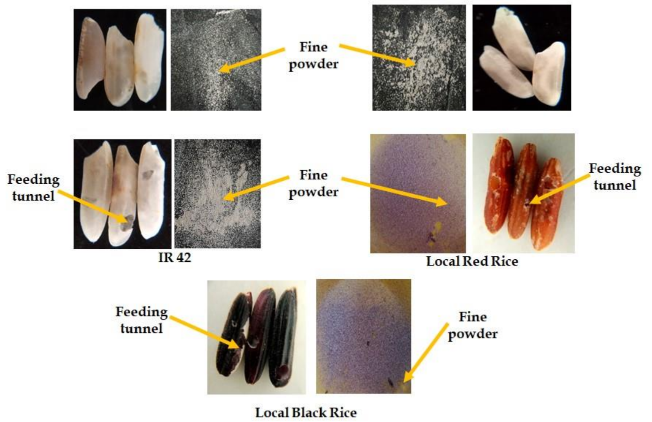


**Figure 1.** Symptoms of Damage by Sitophilus oryzae on the five types/varieties of rice tested.

Visually, there were differences in the symptoms of damage between the types of rice tested. At 4 MSI rice varieties IR 64 and Ciherang had not shown any signs of damage in the form of grinding holes, but there was fine powder such as flour, which was thought to be the result of larvae dragging. The absence of clearly visible drill holes means that the feeding activity of *S. oryzae* on these two types of rice is still limited, which may indicate that these two types of rice are not preferred. This is in accordance with the opinion(Herlina & Istiaji, 2016)that the appetite of *S. oryzae* insects can cause damage to various types of rice. Smaller grains with a hard and dense structure are more resistant to attack by S. oryzae, while large grain structures and smooth surfaces are easily attacked by *S. oryzae* (Temesgen & Waktole, 2013).

*S. oryzae*showed the same symptoms of damage to rice variety IR 42, local red rice, and local black rice, namely the symptoms that appeared began with the formation of several irregular holes, scrap marks on the surface of the rice grains (Herlina & Istiaji, 2016)explained that a small hole in the rice grain was made by the female insect with her mouthparts before oviposition of the eggs on the rice grain. When opened, the infected rice grains will show signs of attack in the form of the presence of *S. oryzae* in the larval and pupal stages. According to (Gvozdenac et al., 2020; Herlina & Istiaji, 2016; Ria et al., 2014), the damage caused by S. oryzae attack causes small holes in the rice grains so that they break easily and crumble like flour.

Further attacks will cause the inside of the rice grain to turn into powder and leave the pericarp.(Mehta et al., 2021)explained that S. oryzae attack can cause damage to the grain and will leave the ear pericarp. Damage to rice from the inside of the grain is caused by the eating activity of the larvae inside the affected rice grains. According to the phase of development, the larval and pupal phases occur in the rice grain. The results of the study (Figure 1) showed the presence of fine powder symptoms in all treatments of the five types of rice, which was thought to be the result of larvae feeding activity on the tested rice.

*Number of imago Sitophilus oryzae*

The results of the analysis of variance (ANOVA) showed that the type of rice had a very significant effect on the imago population*S. oryzae,* both at 4 and 8 MSI, which means that there are differences in the number of imago between the five types of rice tested. The mean number of new imago S. oryzae at 4 and 8 MSI in Table 2.

**Table 2.** Average Total Population of Imago 4 and 8 MSI

| Treatment/Type of Rice | Number of Imago (tails) | |
|---|---|---|
| | 4 msi | 8MSI |
| IR 64 | 3.50 a | 15.50 a.m |
| IR 42 | 14.75 b | 17.50 a.m |
| Ciherang | 7.75 ab | 19.25 a.m |
| Local Red Rice | 43.50 c | 103.00b |
| Local Black Rice | 35.50 c | 162.50c |

Information: The numbers in the column followed by the same letter are not significantly different on the 0.05% BNJ test.

Table 2 shows that the average number of imago was significantly different between the five rice variety treatments, both at 4 and 8 MSI. At 4 MSI, the lowest imago population was rice IR 64 (3.50 individuals) which was not significantly different from Ciherang (7.5 individuals) but significantly different from other treatments. The largest number of imago populations at 4 MSI was observed in local brown rice (43.5 individuals) which was not significantly different from local black rice (35.5 individuals). The data in Table 2 shows a trend of increasing the number of imago populations*S. oryzae*with increasing test time. At 8 MSI, the number of *S. oryzae* imago population increased significantly with a range of 15.5 individuals (IR 64) to 162.5 individuals (local black rice). Local black rice has the highest number of imago, followed by local red rice (103.0 individuals) in second place. IR 64 rice had the lowest imago population, which was significantly different from IR 42 and Ciherang rice.

IR 64 rice has a population of imago *S. oryzae*the lowest because this rice has a grain shape that tends to be round and short, the texture is hard and the surface of the rice is smooth and slippery so it is not suitable for the development of rice bugs. As a result, the number of *S. oryzae* imago in the IR 64 rice treatment was less than the other treatments, where in rice with this shape and texture, *S. oryzae* imago could not lay eggs in large numbers so that the number of S. oryzae produced was also small. The hard texture of rice and its smooth surface are not favored by female S. oryzae imago for laying eggs (Akhter et al., 2018; Kiran et al., 2020; Rizal et al., 2019). Therefore, S. oryzae cannot reproduce on hard rice texture, smooth and slippery rice surface. This is reinforced by the fact that in practice at the farm level, IR 64 rice has gone through an intensive process of grinding or peeling the epidermis layer so that the surface of the rice is smooth and slippery so that S. oryzae cannot reproduce rapidly, and the resulting imago are small in number.

Average population of imago *S. oryzae* the highest at 4 MSI was found in local brown rice (43.50 individuals) which was not significantly different from the treatment of local black rice (35.5 individuals). The higher imago population in local red rice and local black rice is because these two rices have the characteristics of a rough, long and slender grain shape and still have an aleurone layer, where such rough surface conditions are preferred by rice lice so that it is possible for them to produce more eggs. In addition, the initial moisture content of local red rice and local black rice was higher than the other types of rice treatment, which is thought to have contributed to the higher number of S. oryzae imago populations (Herlina & Istiaji, 2016) stated that the *S. oryzae* rice bug was able to reproduce well on rice with a moisture content ranging from 13-15%, and the damage would be higher with a high level of moisture content.

At 8 MSI the highest number of imago populations was found in the treatment of local black rice (162.50 individuals) followed by local brown rice (103 individuals) in second place. These results indicate that black rice is the most vulnerable type of rice to attack*S. oryzae*of the five types of rice tested. The high number of *S. oryzae* imago is caused by the black/dark color of the rice which makes it easier for *S. oryzae* to oviposition on the rice grains. Black rice has a rough grain shape and still has an aleurone layer, so female imago *S. oryzae* likes it to be able to lay eggs in large numbers. Herlina & Istiaji (2013) stated that the female *S. oryzae* ovipositioned on coarse grains of rice, and laid more than one egg in a grain of rice faster, compared to small and fine grains.

The data in Table 2 shows an increase in the number of imago *S. oryzae* from 4MSI to 8MSI. This happened because the imago S. oryzae at the beginning of storage experienced reproduction, so that the average population of *S. oryzae* increased. This is in accordance with the opinion(Hendrival & Melinda, 2017)that the population of *S. oryzae* infested on rice will increase from one time to another as long as the rice is stored. Long storage periods can provide time for *S. oryzae* to reproduce widely, so that the pest population can increase.

*Percentage of Weight Loss of Rice*

Attack damage intensity *S. Oryzae* measured as a percentage of rice weight loss during the test period (8 weeks). The results of the analysis of variance showed that the type of rice had a very significant effect on the percentage of weight loss of rice, which meant that the percentage of weight loss of rice was significantly different between the five types of rice tested at 8 MSI. The average percentage of rice weight loss is presented in Table 3.

**Table 3.** Percentage of Weight Loss of Rice for Five Types of Rice during 8 weeks of testing (8 MSI)

| Treatment/Type of Rice | Percentage of Rice Weight Loss (%) at 8 MSI | |
|---|---|---|
| IR 64 | 4.73 | a |
| IR 42 | 6.45 | a |
| Ciherang | 5.08 | a |
| Local Red Rice | 12.10 | b |
| Local Black Rice | 17.28 | b |

Note: The numbers in the column followed by the same letter are not significantly different in the 0.05% BNJ test

Table 3 shows that the average percentage of rice weight loss was significantly different between treatments. The decrease in the weight of rice in the treatment of the variety IR 64 (4.73%). IR 42 (6.45%) and Ciherang (5.08) were not significantly different from each other but significantly different from local brown rice (12.10%) local black rice (17.28%).

The highest weight loss was found in the local black rice treatment, namely 17.28%, but it was not significantly different from the local brown rice treatment. The higher percentage of weight loss of brown rice and black rice is closely related to the higher number of imago populations *S. oryzae* on these two types of rice (Table 2). According to Hendrival & Melinda, (2017) an increase in the number of insect populations will cause damage or decrease in the quality and quantity of rice.

The treatment of rice type IR 64 experienced the lowest percentage of weight loss (4.73%) and was not significantly different from the treatment of IR 42 and Ciherang. IR 64. IR 42 and Ciherang are white rice varieties. According Astuti, (2019); Herlina & Istiaji, (2016) the low weight loss occurs because white rice contains certain chemicals that affect consumption preferences which can interfere with egg laying. and also the surface is smoother (because the rice is polished more intensively). so that the female imago does not like to lay eggs on its surface. The difference in the percentage of weight loss in the treatment of the test rice could be caused by differences in the fineness of the rice surface. which determines the level of liking/dislike of insects towards rice. For example. on grains of rice that are too hard. The larvae will damage the rice grains by eating carbohydrates in the grain resulting in a decrease in weight loss (Temesgen & Waktole, 2013). Food suitability is closely related to the dynamics of insects choosing suitable food sources for their population growth or in their breeding process (Costa et al., 2016; Hendrival & Romadani, 2018).

The results of this study also indicate that the longer the storage time. the higher the number of imago population *S. Oryzae* and the consequences. there was a decrease in the weight of the test rice due to consumption by *S. oryzae*. whose population increases with increasing storage time. This is in line with Booroto et al., (2017) which explains that the longer it is stored. the percentage of weight loss will increase due to an increase in the number of imago populations and feeding activity of *S. oryzae*. Furthermore (Rizal et al., 2019)stated that the density of pest populations has a close relationship with the rate of weight loss of rice caused. Local black rice and local red rice had a higher population of *S. oryzae* imago than other types of rice. therefore. then the percentage weight loss of black rice and brown rice is higher than IR 64, IR 42 and Ciherang rice.

## Conclusion

There were differences in the number of *S. oryzae* imago in the five types of rice tested both at 4 MSI (4 – 44 individuals) and at 8 MSI (16 – 163 individuals). IR 64 rice had the lowest number of imago populations at both 4 and 8 MSI while the highest number of imago populations was observed in local brown rice (at 4 MSI) and local black rice (at 8 MSI). The level of damage to rice/the percentage of rice weight loss was significantly different between the types of rice treatment. with a range of 0.7% (IR 64) to 17.28% local black rice). In general. The weight loss of white rice (IR 64, IR42 and Ciherang) was not significantly different from each other but significantly lower than colored rice (black rice and local red rice).

**Acknowledgment**
The authors would like to thank all parties involved in assisting the research implementation in the field.

**Author Contributions**
The authors of this article consist of five people. This article was completed cooperatively and together in each stage.

**funding**
This research receives no external funding

**Conflict of Interests**
The authors declare no conflict of interest.

## References

Akhter, M., Sultana, S., Sultana, S., Akter, T., Akter, T., Begum, S., & Begum, S. (2018). Oviposition preference and development of rice weevil, *Sitophilus oryzae* (Lin.) (Coleoptera: Curculionidae) in different stored grains. *Bangladesh Journal of Zoology*, *45*(2), 131–138. https://doi.org/10.3329/bjz.v45i2.35708

Annisa, M., Hendrival, H., & Khaidir, K. (2021). Evaluasi Ketahanan Beras Lokal Provinsi Sumatera Barat Terhadap Hama *Sitophilus oryzae* (L.). *Jurnal Agrotek Tropika*, *9*(3), 543. https://doi.org/10.23960/jat.v9i3.4939

Astuti, L. P. (2019). Feeding preference and development of *Sitophilus oryzae* L. On organic and inorganic rice cultivation. *Agrivita*, *41*(3), 561–568. https://doi.org/10.17503/agrivita.v41i3.2362

Badan Standar Nasional Indonesia. (2015). *Beras*. Badan Standarisasi Nasional. Jakarta,

Booroto, L. A., Goo, N., & Noya, S. H. (2017). Populasi Imago *Sitophilus oryzae* L. (Coleoptera: Curculionidae) Pada Beberapa Jenis Beras Asal Desa Waimital Kecamatan Kairatu. *Jurnal Budidaya Pertanian*, *13*(1), 36. https://doi.org/10.30598/jbdp.2017.13.1.36

Costa, D. C. D. S., Almeida, A. C. D. S., Araújo, M. D. S., Heinrichs, E. A., Lacerda, M. C., Barrigossi, J. A. F., & Jesus, F. G. De. (2016). Resistance of Rice Varieties to *Sitophilus oryzae* (Coleoptera: Curculionidae). *Florida Entomologist*, *99*(4), 769–773. https://doi.org/10.1653/024.099.0432

Fajarwati, D., Himawan, T., & Astuti, L. P. (2015). Uji repelensi dari ekstrak daun jeruk purut (*Cytrus hystrix*) terhadap hama beras *Sitophilus oryzae* Linnaeus (Coleoptera: Curculionidae). *Jurnal HTP*, *3*(1), 102–108. https://jurnalhpt. ub.ac.id/ index.php/jhpt /article/view/171

Gvozdenac, S., Tanasković, S., Vukajlović, F., Prvulović, D., Ovuka, J., Višacki, V., & Sedlar, A. (2020). Host and ovipositional preference of rice weevil (*Sitophilus oryzae*) depending on feeding experience. *Applied Ecology and Environmental Research*, *18*(5), 6663–6673. https://doi.org/10.15666/aeer/1805_66636673

Hendrival, H., Khaidir, K., Afzal, A., & Rahmaniah, R. (2018). Kerentanan Beras Asal Padi Lokal Dataran Tinggi Aceh Terhadap Hama Pascapanen. *Jurnal Agroteknologi*, *8*(2), 21–30. http://dx.doi.org /10. 24014/ja.v8i2.3357

Hendrival, H., & Romadani, F. P. (2018). Kajian Kerentanan Dan Kerusakan Beras Lokal Provinsi Sumatera Selatan Terhadap Hama Pascapanen *Sitophilus oryzae* L. (Coleoptera: Curculionidae). *Jurnal Biota*, *4*(2), 90–97. https://doi.org/10.19109/biota.v4i2.2104

Hendrival, & Melinda, L. (2017). Pengaruh Kepadatan Populasi *Sitophilus oryzae (L.)* terhadap Pertumbuhan Populasi dan Kerusakan Beras Effect Population Density *Sitophilus oryzae (L.)* against Population Growth and Damage Rice. 10(1), 17–24. https://doi.org/10. 22437/biospecies.v10i1.3484

Herlina, L., & Istiaji, B. (2016). Respon Ketahanan Beberapa Varietas Gandum terhadap Hama Gudang *Sitophilus zeamais* (Coleoptera: Dryophthoridae). *Buletin Plasma Nutfah*, *19*(2), 89. https://doi.org/10.21082/blpn.v19n2.2013.p89-101

Khan, K., Khan, G. D., Din, S., & Khan, S. A. (2014). Evaluation of Different Wheat Genotypes Against Rice Weevil ( *Sitophilus oryzae* ( L .) (Coleopteran : Curculionidae ). *Journal of Biology, Agriculture and Healthcare*, *4*(8), 85–90. https://www.researchgate.net/profile/ Subhan-Din/publication/268630915

Kiran, S. A., Padmasri, A., Kumar, B. A., & Madhavi, M. (2020). *Varietal preference of different rice genotypes by rice weevil Sitophilus oryzae* ( L .). *8*(4), 1954–1961. https://www.entomol journal. com/archives/2020/vol8issue4/ PartAE/ 8-4-315-344.pdf

Kumar, R. (2017). *Insect pests of stored grain: biology, behavior, and management strategies*. Apple Academic Press Inc. Oakville. CRC Press. Taylor and Francis Group. Retrieved from https://books.google.co.id/books?hl=id&lr =&id=dj4PEAAAQBAJ&oi=fnd&pg=PP1&dq=Insect+pests+of+stored+grain:+biology,+behavior,+and+management+strategies.+Apple+Academic+Press+Inc.+Oakville

Manueke, J., & Pelealu, J. (2015). Ketertarikan Hama *Sitophilus oryzae* Pada Beras, Jagung Pipilan Kacang Tanah, Kacang Kedelai, Dan Kopra. *Eugenia*, *21*(2), 70–79. https://doi.org/10.35791/eug.21.2.2015.9706

Mehta, V., Kumar, S., & Jayaram, C. S. (2021). Damage Potential, Effect on Germination, and Development of *Sitophilus oryzae* (Coleoptera: Curculionidae) on Wheat Grains in Northwestern Himalayas. *Journal of Insect Science*, *21*(3). https://doi.org/10.1093/jisesa/ieab034

Ratnawati, Djaeni, M., & Hartono, D. (2013). Perubahan Kualitas Beras Selama Penyimpanan Change of Rice Quality During Storage. *Pangan*, *22*(3), 199–207. https://www.jurnalpangan.com/ index.php/pangan/article/view/89/76

Ria, S., Antika, V., Astuti, L. P., & Rachmawati, R. (2014). Perkembangan *Sitophilus oryzae* L. (Coleoptera: Curculionidae) pada berbagai jenis pakan. Jurnal HPT, 2(4): 77-84. https://jurnalhpt.ub.ac.id/index.php/jhpt/article /view/154*Sitophilus oryzae*. *2*(4), 77–84.

Rita Devi, S., Thomas, A., Rebijith, K. B., & Ramamurthy, V. V. (2017). Biology, morphology and molecular characterization of *Sitophilus oryzae* and *S. zeamais* (Coleoptera: Curculionidae). *Journal of Stored Products Research*, *73*(September), 135–141. https://doi.org/10.1016/j.jspr.2017.08.004

Rizal, S., Mutiara, D., & Agustina, D. (2019). Preferensi Konsumsi Kumbang Beras (*Sitophilus oryzae* L) Pada Beberapa Varietas Beras. *Sainmatika: Jurnal Ilmiah Matematika Dan Ilmu Pengetahuan Alam*, *16*(2), 157. https://doi.org/10.31851/sainmatika.v16i2.3287

Susanti, S., Hendrival, H., Usnawiyah, U., Hafifah, H., & Nazaruddin, M. (2022). Kerentanan Relatif Jenis Beras Terhadap *Sitophilus oryzae* L. (Coleoptera: Curculionidae) Pada Keadaan Kadar Air Rendah. *Jurnal Ilmiah Mahasiswa Agroekoteknologi*, *1*(1), 10. https://doi.org/10.29103/jimatek.v1i1.8458

Temesgen, K., & Waktole, S. (2013). Differential Resistance of Maize to Maize Weevil (*Sitophilus zeamais* Motschulsky) (Coleoptera: Curculionidae) under Laboratory Conditions. In *Journal of Entomology* (Vol. 10, Issue 1, pp. 1–12). https://scialert.net/abstract/ ?doi=je. 2013.1.12

Wulandari, SS. Oemry, dan Pangestiningsih Y. (2014). Pengaruh tekstur butiran pada beberapa komoditas terhadap jumlah imago hama *Sitophilus oryzae* L. (Coleoptera: Curculionidae) Di Laboratorium. *Jurnal Online Agroekoteknologi*, 2, 1189-1195. https://dx.doi.org/10.32734/jaet.v2i3.7510

Yudansha, A., Himawan, T., & Astuti, L. P. (2013). Perkembangan dan Pertumbuhan *Sitophilus oryzae* L. (Coleoptera: Curculionidae) pada Beberapa Jenis Beras dengan Tingkat Kelembaban Lingkungan yang Berbeda. *Jurnal HPT*, *1*(4), 1–8. https://jurnalhpt.ub.ac.id/index.php/jhpt/article /view/48

Zunjare, R., Hossain, F., Muthusamy, V., Jha, S. K., Kumar, P., Sekhar, J. C., Thirunavukkarasu, N., & Gupta, H. S. (2016). Genetic variability among exotic and indigenous maize inbreds for resistance to stored grain weevil (*Sitophilus oryzae* L.) infestation. *Cogent Food and Agriculture*, *2*(1). https://doi.org/10.1080/23311932.2015.1137156