INVENTORY OF PESTS IN FOOD WAREHOUSES

PULIHASIH, A. Y.

Faculty of Health, Univercity of Nahdlatul Ulama Surabaya, East Java, Indonesia.
e-mail: akasyekti2009[at]yahoo.com

(Received 04th June 2024; revised 02nd September 2024; accepted 12th September 2024)

Abstract. Rice as the most important staple food controls the livelihood of many people and is a parameter of the country's economic and social stability which is used as a source of energy and carbohydrates. Insect's pest infestation on rice product cause a serious damage either in quantitative or qualitative aspect. Therefore, a study was conducted to determine the insects associated with rice in storage. This study aims to find out the various types of pests that exist in private contractor warehouses, the percentage of rice damage with the duration of storage, and the appropriate time limit for storing rice temporarily in the warehouse. This research is a descriptive study, using direst survey method, andand identified population was all insects found on rice sacks. The results of the inventory can be found from 90 samples of each of the 250 grams of rice with a storage period of 1.5 months found several types of warehousing pests, namely Cryptolestes pusillus S, Acarus siro L., Sitophilus oryzae L, Tribolium castaneum, Rhizopartha dominica F and Corcyra cephalonica Strint.
Keywords: *food warehouse, rice, pest, identification, imago*

Introduction

The rice storage process is an important activity in the post-harvest stage, which is done because rice is harvested seasonally, while rice is needed every day. Rice storage is also important as food availability to overcome difficult times such as drought and floods resulting in crop failure. During the storage process, rice decreased in quality and quantity. Decrease in the quantity and quality of food can occur during storage in the warehouse caused by pest insect attacks, because the pest insects of the warehouse have the ability to multiply quickly, spread easily, and can invite the growth of mold and mildew (Nuraini et al., 2022). Insects infesting stored foods are one of the most destructive and common problems which turn out to be very serious if leave untreated. Insects in storage are potentially harmful because they damage directly or indirectly to stored materials. Direct damage occurs because insects eat stored materials, cause physical and chemical contamination, and damage to packaging, equipment and storage structures. Damage can be even greater because it causes indirect damage such as the growth of fungi and moulds. Ilato et al. (2012) said that agricultural products were destroyed 10-20% annually and even worse in the improper management or warehouse to keep this product. Insects infesting stored foods are one of the most destructive and common problems which turn out to be very serious if leave untreated.

Food damage that occurs during storage is physical, chemical, mechanical, biological and microbiological damage that will reduce the quality of stored food qualitatively and quantitatively, especially rice. The number of rice lice is due to quality of the rice itself, in addition to being provoked storage length and pile of rice, especially with regard to ambient temperature and humidity (Hong et al., 2018). The longer and the thicker the rice pile, the more raises a large number of pest populations rice lice and affect the quality of rice itself. Most causes of post-harvest damage occur due to post-harvest pest attacks (Mastuti et al., 2020). Insect pests can cause damage or loss, either directly or indirectly to rice. Direct damage in the form of reduction in the weight of the product,

reduction of shelf life, decrease in nutritional value and nutritional content. Indirect damage such as fungal growth, as well as contamination of stored food. Initial quality, storage time span or storage period, storage techniques or methods, and storage warehouse conditions affect the natural process. Losses due to post-harvest pest insects may be affected by storage periods associated with post-harvest pest insects (Hamel et al., 2020). Storage periods affect pest development and increase the percentage of damaged food products (Ilmi and Putra, 2023; Ilato, et al 2012). The level of insect infestation is an important quality factor of food grains and represents a serious and continuing problem for the grain and milling industries (Nuraini et al., 2022). The population of some pests is increasing with the increasing length of the rice storage period. However, information on the relationship between the food storage period and the intensity of post-harvest pest insects and the weight loss characteristics of food products, in particular rice damage, remains small. Therefore, a study was conducted to determine the insects associated with rice in storage (Hagstrum, 2016; Hendrival and Muetia, 2016).

Materials and Methods

This research is a descriptive study, using survey method with cross sectional approach. The research was conducted at BULOG Warehouse 103 Demak. The study population was all insects found on rice sacks. This research was conducted using a direct survey method by handpicking by taking insect pests attached to the staple in the storage warehouse. Samples were taken from 30 sacks in a pile of rice from 1.5 months of shelf life then from each sack of rice 3 working samples were taken, each sample consisting of 250 grams of rice obtained from each part of the pile (top, middle and bottom). Sampling was carried out by purposive sampling, namely by taking samples of rice suspected of being infested with pests. The criteria for pest infested samples were characterised by the presence of insects in the sample and or the presence of symptoms of insect pest attack on the sample, namely the presence of powdered residue of grubs on the rice. Insect pests found were sorted/separated according to type and location of collection. Pest samples were collected in 70% alcohol for identification. Insect pest identification was conducted at the Plant Pests and Diseases Laboratory, Faculty of Agriculture, Veteran National Development University, Surabaya. Identification of insect pests using relevant literature materials, i.e. Hagstrum (2016).

Results and Discussion

Identifying rice pest insects is done based on their morphological characters (colour, body shape, antenna, wing shape size, and number of legs). Based on the results of sampling rice commodities, then identification of rice pest insects is carried out. From the identification of post-harvest pests, the insects found were Cryptolestes pusillus S. (796 heads), Acarus siru L. (695 individuals), Sitophilus oryzae L. (539 individual), Tribolium castaneum (442 individuals), Rhizopertha dominica F. (191 individuals), and Corcyra cephalonica Staint. (170 individuals). The morphological identification of each bealahras pest found is as follows.

Flat grain beetle (Cryptolestes spp.)

Flat grain beetles are small reddish brown insects about 1.5mm long with long antennae and a flattened body. Eggs are laid throughout the stored grain and develop into tiny larvae with characteristic tail horns, biting mouth parts and three pairs of legs. They feed on damaged grain and wheat embryos. Pupation takes place in a cocoon. A complete life cycle takes from 4-5 weeks and adults may survive up to one year. This is one of the most common pests of stored grains, thought to be originally native to warmer areas of Europe it is now most prevalent in tropical and subtropical regions but regularly occurs in all temperate areas through the worldwide trade in foodstuffs and may occasionally become established in artificially heated food production premises. It is a secondary pest of grains, attacking only seeds that have been damaged by physical handling or by infestations of other pest species e.g. it often occurs among large populations of the rice weevil. Adults fly well and may quickly find suitable host material but they are attracted to volatiles produced by damaged grains and so under suitable conditions of temperature and humidity such material is quickly infested. Adults of both sexes feed on or within grains etc. they mate among the host material and females live for up to a year, laying eggs over most of this time (*Figure 1*).

Figure 1. *Flat grain beetle.*

Acarus siro L.

Grain mites are not really insects, but closely related to the insects. They are microscopic (1/50”), pale grayish white, smooth, wingless, and soft bodied. Populations can increase to such large numbers that grain appears to be covered with a moving layer of dust. Adults have 8 legs, while larvae only have 6 legs. Each leg has one claw on the end along with a sucker. These mites are unable to penetrate the seed coat, so they can only attack seeds that have been damaged by mechanical damage or pathogen attack. A. siro mites can only feed on the endosperm when the seeds are damaged and mouldy. A. siro mites feed on the embryo, leading to reduced germination rates and seed nutrient content. Dead skin residues and excretions left by A. siro mites cause an unpleasant, musty odour in the stored material. The presence of mites on stored material causes rejection by consumers, and stored material becomes unfit for consumption by livestock or humans (*Figure 2*).

Figure 2. *Acarus siro L.*

Sitophilus oryzae L.

Figure 3 shows that the imago of Sitophilus oryzae is bright black or brownish-black, has four ovoid (oval) features of reddish-brown-yellow colour on the elytra, sometimes four reddish spots on the elytra, and reddish-brown legs. This beetle has a long snout, blackish brown in colour. Rice aphid is the common name for a small insect of the genus Sitophilus that lives on stored grains. It attacks and eats grain or rice stored in storage. The rice weevil (Sitophilus oryzae L.), is one type of insect pest that damages rice supplies in storage, both in quantity and quality. Rice bugs cause the rice grains to become perforated and easily broken and crumbled like flour, resulting in low quality because of the bad taste and musty smell. Rice grains are crushed and dusty, in a fairly short period of time. The attack of this rice aphid pest can result in the development of fungi, resulting in damaged rice production, a musty odour that is unpleasant and cannot be consumed. Sitophilus oryzae L. or commonly called the rice bug is known as the rice powder weevil, this pest is cosmopolite or widespread in various places in the world. The damage caused by this rice bug is heavy, and is often considered the most detrimental pest to food products.

Figure 3. *Sitophilus oryzae L.*

Rhyzopertha dominica

The lesser grain borer is the most serious pest of stored grain in Western Australia. It is a dark brown cylindrical beetle about 3 mm long. The head is hidden by the thorax when viewed from above. Females lay up to 500 eggs scattered loosely through the grain. The eggs hatch to produce curved white larvae with brown heads and three pairs of legs. The larvae burrow into slightly damaged grains and eat out the starchy interior. After pupating the adults emerge from the grain, leaving large irregular exit holes.The life cycle takes about one month under summer conditions and adults may survive for a further eight months The adult lesser grain borers chews grain voraciously causing damage which may facilitate infestation by a secondary pest. It is a strong flyer and may rapidly migrate from infested grain to begin new infestations elsewhere. The rice weevil has four orange-brown areas on the wing cases, and is about 3mm long with a characteristic rostrum (snout) protruding from its head. It has biting mouth parts at the front of the rostrum and two club-like antennae (*Figure 4*).

Figure 4. *Rhyzopertha dominica.*

Tribolium castaneum

Imago is slightly flattened and red-brown in colour with a body length of approximately 3-4 mm. The elytra are blackish brown in colour and there are longitudinal stripes on the elytra. The surface of the elytra is slightly wavy. The antennae consist of 11 segments and three segments at the end are enlarged so that they resemble a mace and widen towards the tip in a regular manner. Imago is slightly flattened and red-brown in colour with a body length of approximately 3-4 mm. The elytra are blackish brown in colour and there are longitudinal stripes on the elytra. The surface of the elytra is slightly wavy. The antennae consist of 11 segments and three segments at the end are enlarged so that they resemble a mace and widen towards the tip in a regular manner. T. castaneum is an external feeder because T. castaneum does not attack whole grains, but eats cracked or broken grains, without entering the inside of the grain (Friamsa et al., 2018). The rust-red flour beetle is frequently found on farms,. it is a reddish brown beetle about 3mm long. The final three segments of its antennae are greatly enlarged to form a club shape. Young adults are pale brown in colour becoming darker with age. Females lay up to 1000 eggs loosely scattered throughout infested grain. Cream-coloured larvae with biting mouth parts and three pairs of legs hatch and remain free from the grain, feeding on cereal dust and damaged grains. A generation

takes about one month to complete under summer conditions, but longer in cold weather. Adults may live up to a year, is winged and may fly (*Figure 5*).

Figure 5. *Tribolium castaneum.*

Corcyra cephalonica Strint

The imago is grey in colour with the wing veins darker than the membrane. Antennae are filiform with a straight labial palpus. The larval false limbs are conical. Male imago have a smaller body shape compared to female imago. Corcyra cephalonica is one of the insect pests that attack food commodities in storage, this species is a serious problem in milled rice, especially in sacks. This pest insect is a cosmopolitan insect, which can be found throughout the world, especially in the tropics. C. cephalonica can develop quickly, with a short life cycle and the ability to produce high eggs so that it can damage materials quickly, ranging from 9.6%-20.2% (Hendrival and Muetia, 2016). In each research inventory of warehouse pests, it is always found that the type of insect pest Tribolum spp.; Sitophilus-oryzae L.; Rhizopertha dominica F.; Corcyra cephalonica S. and others, because this pest is indeed an important pest that is very economically detrimental to the storage material in the warehouse (Ilato et al., 2012). This is in accordance with the research of Isbatullah et al. (2023), in 10 BULOG warehouses in East Java, pests were also found Sitophilus oryzae L.; Tribolium spp.; Corcyra Sp. The condition of the rice is also very important in preventing pest infestation. The moisture content of stored rice is the most dominant trait affecting the durability of rice to be stored without being damaged, rotten and attacked by warehouse pests. Rice with a moisture content of less than 14% will be safer to store, while rice with a moisture content of more than 14% will cause microbial metabolism and insect breeding to run fast. Storage at low temperatures will be safer than at high temperatures. Milled rice will experience changes in flavour and aroma if stored at 15 0C for 3-4 months. Rice wrapped in a plastic bag and stored at 8.5-13 0C still has a good aroma and flavour after being stored for more than 7 months (Isbatullah et al., 2023) (*Figure 6*).

Figure 6. *Corcyra cephalonica Strint.*

Moisture content of ingredients plays an important role in the development of insect pests and postharvest food damage. According to Mastuti et al. (2020), the air humidity factor is very influential on the life of insect pests post-harvest. Air humidity has a positive relationship with the condition of the storage material. If the relative air humidity in the storage area increases, it will be followed by an increase in the moisture content of the storage material. An increase in the moisture content of the storage material can also affect the increase in the population of insect pests. The developmental period, survival and egg production of postharvest insect pests depend on the suitability of the environment and food. Insect population rates may increase as a result of a shortened developmental period, increased survival or more egg production. Under normal conditions, the warehouse is the source where food is available so the main issues for insects are temperature and moisture content. However, most postharvest insect pests can survive on a large variety of storage materials and there are variations in the abundance of insects on each storage material. Ambient temperature and moisture content of the storage material are the main factors that influence the developmental period of insects. The moisture content of the storage material/humidity of the air can affect the length of the larval stage. Low moisture content of the rice to be stored lengthens the larval stage, but the egg stage is not affected, thus changing the age structure balance in an already stable population. Ambient temperature and humidity in storage can be either a cause or a consequence of the presence of pests (Rianti and Astuti, 2023; Nuraini et al., 2022; Mastuti et al., 2020; Friamsa et al., 2018). In addition, there are several important factors that must be applied to rice that will be stored in a warehouse, namely (Setyaningrum et al., 2016): (1) Broken grain rate is when rice grains are broken into less than a quarter of the size of the original grain. The broken surface is very susceptible to attack by storage pests, both microorganisms and insects. So the number of broken grains will increase the possibility of attack by warehouse pests. In general, the limit of broken kernels is less than 25% of the rice; and (2) Broken Grain Content Broken grain is when the colour is different from the actual colour. The normal rice seed colour is clear white. This colour is found in rice grains that are ripe or have been harvested.

Rice storage must be done properly to protect the rice from the effects of weather, prevent pests, and inhibit changes in the quality and nutritional value of rice. Long

storage of rice in poor conditions will cause damage to the smell and taste of rice. This damage is mainly due to rancidity that occurs in the fat content of rice, resulting in a musty odour. The musty odour of long-stored milled rice is caused by rancid carbonyl compounds, which are compounds resulting from the oxidation of fat with oxygen from the air (Ilato et al., 2012).

Conclusion

The results of the inventory on rice that has been packed in sacks and stacked in the BULOG rice warehouse, deliberately taken rice that has shown to have pest infestation disorders can be found 7 species of warehouse pests with the most pests of the type Cryptolestes pusillus S. The entire pest species found were Cryptolestes pusillus S (776 heads), Acarus siro L., (675 individual), Sitophilus oryzae L. (539 individual), Tribolium castaneum (442 individual), Rhizopartha dominica F. (191 individual), and Corcyra cephalonica Strint (170 individual).

Acknowledgement

This research is self-funded.

Conflict of interest

The authors confirm that there is no conflict of interest involve with any parties in this research study.

REFERENCES

[1] Friamsa, N., Witjaksono, W., Wijonarko, A. (2018): Diversity of Feed Storage Pest Beetle in Banten Province. – Jurnal Perlindungan Tanaman Indonesia 22(1): 20-26.
[2] Hagstrum, D. (2016): Atlas of stored-product insects and mites. – Elsevier 876p.
[3] Hamel, D., Rozman, V., Liška, A. (2020): Storage of cereals in warehouses with or without pesticides. – Insects 11(12): 21p.
[4] Hendrival, H., Muetia, R. (2016): Pengaruh periode penyimpanan beras terhadap pertumbuhan populasi Sitophilus oryzae (L.) dan kerusakan beras. – Biogenesis: Jurnal Ilmiah Biologi 4(2): 95-101.
[5] Hong, K.J., Lee, W., Park, Y.J., Yang, J.O. (2018): First confirmation of the distribution of rice weevil, Sitophilus oryzae, in South Korea. – Journal of Asia-Pacific Biodiversity 11(1): 69-75.
[6] Ilato, J., Dien, M.F., Rante, C.S. (2012): Jenis dan Populasi Serangga Hama Pada Beras di Gudang Tradisional dan Modern di Provinsi Gorontalo. – Eugenia, 18(2): 102-110.
[7] Ilmi, N., Putra, M.I. (2023): Kajian Awal Keberadaan Hama Gudang Pada Unit Pengelolaan Gabah Beras (Studi Kasus Gudang Gabah Beras UD. BZK dan UD. Pirwan Di Kabupaten Pinrang). – Jurnal Agrotan 9(1): 16-20.
[8] Isbatullah, M., Amrullah, S.H., Harnita, R. (2023): Inventory of Warehouse Pests on Grain Samples at the Plant Quarantine Laboratory of the Makassar Agricultural Quarantine Center. – Journal Of Biology Education 6(1): 23-39.
[9] Mastuti, R.D., Subagiya, S., Wijayanti, R. (2020): Serangan Sitophilus oryzae Pada Beras Dari Beberapa Varietas Padi dan Suhu Penyimpanan. – Agrosains: Jurnal Penelitian Agronomi 22(1): 16-20.

[10] Nuraini, I.V., Prakoso, B., Suroto, A. (2022): Survei dan identifikasi hama gudang pada komoditas padi, jagung, dan kedelai di Kecamatan Batuwarno, Wonogiri. – Biofarm: Jurnal Ilmiah Pertanian 18(2): 87-95.
[11] Rianti, P.S., Astuti, L.P. (2023): KEANEKARAGAMAN DAN KELIMPAHAN HAMA PASCAPANEN DI GUDANG BERAS PERUM BULOG KANTOR CABANG CIANJUR: DIVERSITY AND ABUNDANCE OF STORED PRODUCT PESTS IN THE RICE STORAGE OF PERUM BULOG CIANJUR BRANCH OFFICE. – Jurnal HPT (Hama Penyakit Tumbuhan) 11(1): 11-19.
[12] Setyaningrum, H., Himawan, T., Astuti, L.P. (2016): Identifikasi serangga yang berasosiasi dengan beras dalam simpanan. – Jurnal HPT (Hama Penyakit Tumbuhan) 4(1): 39-44.