# Growth and Development of *Rhyzopertha dominica* Fabricius (Coleoptera: Bostrichidae) on White, Red and Black Rice

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**Abstract**

*Rhyzopertha dominica* is a polyphagous stored pest to many grains including rice. *R. dominica* can easily spread from one place to another to infest stored products. The aim of this research was to know the influence of three grains types with different weight to *R. dominica* growth, development, net reproduction rate and gross reproduction rate on red, black and white rice. The research was conducted in Pest Laboratory, Department of Plant Pests and Diseases, Faculty of Agriculture, University of Brawijaya Malang. The research result showed that there was an interaction among three grains types with different weight to the number of *R. dominica* larval, pupal, and newly adult emerged, while the number of eggs, weight of newly adult emerged, the reduction percentage of grain and phase of the egg, larval, pupal and the life cycle period of *R. dominica* were affected by different grains types factor. The $R_0$ value showed that on the next generation, number of female was increase 1.25 times from the previous generation on white rice, while on red and black rice the population was increase up to 2.63 and 2.49 times from the previous generation.

**Keywords:** Growth and Development, Reproduction Rate, Rice*, Rhyzopertha dominica.*

## INTRODUCTION

There are many kinds of stored products that are stored in warehouse. Rice is one of the products that are stored in the warehouse. Based on the color of the rice, there were several types of rice are known in Indonesia as white, black, red and glutinous rice. Rice consist of various nutritional content such as carbohydrates, proteins, fats, vitamins, minerals and other components. Yield losses of stored rice in the warehouse are caused by the presence of pests [1]. Pests of stored grain such as Lesser Grain Borer (*Rhyzopertha dominica* F) is one of the pest which are classified as primary pests that can be invested on various types of seeds such as wheat, corn, rice and other cereal crops. The weight of rice grain is decrease due to the damage caused by larval and adult of *R. dominica* [2]. Based on previous study [3], using six varieties of rice milled (IR-64, Cibogo, Ciherang, Membrano, Sembada, and Intani-2) which showed that the number of eggs laid by imago *R. dominica* females, the number of new progeny (F1) and a decrease in weight loss on membrano rice variety was lower followed by the Ciherang rice variety, IR-64, Cibogo, Sembada and Intani-2. Based on the index of susceptibility, Membrano is the resistant, while Ciherang, IR-64, Sembada and Cibogo are the moderately resistant rice varieties, and Intani-2 is the highly susceptible. The aims of this research is to know the effect of three grains types with different weight to *R. dominica* growth, development, net reproduction rate and gross reproduction rate on red, black and white rice. Therefore, this study can provide information about the chance of *R. dominica* growth and development to invest on white, red and black rice as well as the net reproduction rate of *R. dominica* in the next generation.

## MATERIAL AND METHOD

The research was conducted in Pest Laboratory, Department of Plant Pest and Diseases, Faculty of Agriculture, University of Brawijaya, Malang from October 2017 to September 2018. The tools that used in this study were hand counters, scales, scissors, brush sizes 00 and 1, rubber band, trays, glass tubes d = 6.5 and t = 9, digital cameras, refrigerator, thermohygrometer, Petri dish d = 10 and t = 1.5, Olympus S2X7 + Camera DP 26 microscope. The materials that used in the study were white rice of Ciherang variety, red rice, black rice, white chiffon type fabric, paper label.

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**Research Preparation**

***Rearing of Insects***

*R. dominica* insects were obtained from Biotrop Entomology Laboratory, Bogor. Propagation of *R. dominica* was carried out by following the method [4]. About 100 pairs of *R. dominica* were infested on glass tubes t = 28cm d = 20cm containing 500 g of white rice of Pandanwangi variety. The glass tube was covered with white chiffon and labeled then stored in a room with a temperature of 27 ± 2°C and humidity of 65 ± 5%. Adult of *R. dominica* infested for one week. The infested rice was left until newly adult emerge. The first progeny (F1) *R. dominica* was used in this study.

***Preparation of the Research Medium***

The research was carried out using Ciherang variety of white, red and black rice which obtained from Kanigoro Village, Pagelaran, Malang, East Java, Indonesia. Sterilization of red, black and white rice was carried out following the method [4] using a refrigerator (freezer) at approximately -15°C for one week. The rice was transferred to the refrigerator at 5°C for one week to protect the rice from re-infestation of insects and mites. Rice was placed at 27 ± 2°C for two weeks before the research started.

**Physical and Chemical Analysis**

Physical and chemical analysis of the rice consists of hardness feed test, proximate and phenol test. The hardness test of rice was carried out using a food texture measuring tool, namely Universal Texture Analyzer. Hardness test was carried out to determine the hardness level of rice before the research used. The proximate test was carried out to determine the value of carbohydrate, protein, fat, water and ash content in each type of rice before being used in this study. The phenol test was carried out to know the phenol content in each type of rice which used on this research by Spectrophotometry analysis method. The result of physical and chemical analysis showed in Table 1.

**Laboratory Temperature and Humidity**

The temperature and humidity in the laboratory were daily observed using Thermohygrometer at 06.00 am, 12.00 pm and 06.00 pm.

**Table 1.** Physiscal and Chemical Parameter of Rice

| Type of Rice | Protein (%) | Fat (%) | Water (%) | Ash (%) | Carbohydrate (%) | Hardness of Rice (N) |
|---|---|---|---|---|---|---|
| Red | 7.61 | 2.18 | 11.68 | 1.21 | 77.32 | 35.98 |
| Black | 7.89 | 2.64 | 11.65 | 1.64 | 76.18 | 63.80 |
| White | 7.35 | 0.33 | 12.31 | 0.36 | 79.65 | 71.87 |

**Research Implementation**

***Growth and Development Research of R. dominica***

The study was conducted using no choice method on white, red and black rice. The study was arranged by Completely Randomized Design consisting of two factors and six replication. The first factor was the type of rice (white, red and black rice) and the second factor was the weight of the feed (20, 30 and 40 g). Infestation of *R. dominica* was done by infesting 15 pairs into each weight treatment, then the tube was covered by chiffon. Adult of *R. dominica* was infested for seven days. The observed variables were:

a. Mortality of *R. Dominica* adults. The observation was done by calculating the number of adults *R. dominica* that lived and died after seven days of early infestation.
b. The Number of eggs, Larval, pupal and F1 Progeny emerged *R. dominica*. The egg that produced by 15 pairs of adults *R. dominica* were observed on microscope. The calculated eggs are re-put into the rice to be observed for the number of larval, pupal, and F1 progeny. The F1 Progeny that appears was released every day until there is no new adult (F1) emerged, then calculated and observed the sex ratio.
c. Calculation of the percentage of weight reduction by using a formula [5] :

$$\text{Weight Loss } (\%) = \frac{(\mathbf{Wu\ x\ Nd}) - (\mathbf{Wd\ x\ Nu})}{\mathbf{Wu\ x\ (Nd + Nu)}} \times \mathbf{100\%}$$

**Description:**
Wu = weight of whole seeds
Wd = weight of damaged seeds
Nu = number of whole seeds
Nd = number of damaged seeds

d. The calculation of susceptibility index was followed Dobie index [6], where in the Dobie index was based on the number of the first progeny emerged (F1) *R. dominica* and the median development time:

$$IK = \frac{[\text{Loge}(\text{total F1 Progeny emerged})]}{\text{Median development time}} \times 100\%$$

The index of susceptibility (IK) consists of four categories:
IK 0 to 3 = Resistant
IK 4 to 7 = Moderately resistant
IK 8 to 10 = Susceptible
IK ≥ 11 = Highly susceptible

e. Calculation of the weight of new adult emerged *R. dominica* was carried out by sampling 10 individuals per treatment. So that the average weight of new *R. dominica* in each treatment was obtained [7].

The Observation of the egg longevity was done by taking a sample of 10 eggs placed on the same day on each type of feed. Eggs were observed daily until hatched into larval. The observation of the Larval longevity was carried out by taking samples of 10 Larval that released on the same day. These larvae were placed on bottles d = 3 t = 3 and infested on each feed treatment. Observations were made from the first time the Larvae released until the Larval turned into pupal. The observation of the pupal longevity was done by observing the holes in each grain treatment. Observations were carried out until the pupa changed to the F1 Progeny emerged. New male and female of *R. dominica* were mated to find out the time of first egg laid. The life cycle of *R. dominica* can be determined by calculating the required time of *R. dominica* in each treatment since the egg laid until the F1 progeny laid an egg for the first time. Observations were made using six replications.

Observation of the life table is to know the rate of net reproduction and the gross reproduction rate of *R. dominica* on white, red and black rice. Observations were made by taking 100 eggs placed on the same day by adults *R. dominica* in each treatment. Observations were made by recording the number of eggs that had succeeded in hatching into Larval, then the Larval that succeeded to pupal, and the pupal that had successfully became new F1 Progeny *R. dominica* (lx). Observations were made using six replications. The observation of the mean number of eggs laid on each treatment is done to determine the number of offspring produced (mx).

**Data Analysis**

The data were analyzed using analysis of variance (ANOVA) at the 95% confidence level, and followed by LSD's test at 95%. Data of life table was analyzed and arranged in cohort. Based on data that compiled in the life table, the gross reproduction rate (GRR) is calculated from data on the average number of eggs laid in each treatment (mx) or with the formula ∑mx and the net reproduction rate or Net Reproductive Rate ($R_0$) derived from the total number of female adults or with the ∑lxmx formula [8,9].

## RESULTS

**Mortality of Imago *R. dominica* After Seven Days of Early Infestation**

Based on analysis result, the interaction among three types of rice with different weights did not significantly affect mortality of adult *R. dominica* after seven days of early infestation. The means mortality of *R. dominica* after seven days of early infestation on three types of rice with different weights showed in Table 2.

**Table 2.** The Means Mortality of *R. dominica* After Seven Days of Early Infestation in Three Types of Rice with Different Weights

| Interaction (Rice and Weight) | Mortality of adults *R. dominica* After Seven Days of Early Infestation (%) (x̄ ± SD) |
|---|---|
| Red Rice 20 g | 7.78± 7.20 |
| Red Rice 30 g | 6.67± 7.30 |
| Red Rice 40 g | 5.56 ±5.02 |
| Black Rice 20 g | 3.33± 2.98 |
| Black Rice 30 g | 3.89± 3.28 |
| Black Rice 40 g | 7.22± 6.47 |
| White Rice 20 g | 2.78± 1.36 |
| White Rice 30 g | 6.11± 5.74 |
| White Rice 40 g | 5.56± 5.44 |
| LSD's 5% | ns |

**Notes:** Data is transformed by the formula √ (x + 0.5) for analysis purposes; SD is a Standard Deviation; the sign (tn) shows there is not significant.

**Number of Eggs Laid by *R. dominica* After Seven Days of Early Infestation**

Based on analysis result showed, there was no interaction among the three types of rice with different weights for the mean number of eggs laid by *R. dominica* after seven days of early infestation, but there was an influence on each factor on the mean number of eggs laid by *R. dominica* adults. The mean number of *R. dominica* eggs with the influence of different types of rice was presented in Table 3.


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**Table 3.** The Mean Number of Eggs of *R. dominica* With The Effect of Different Types of Rice

| Type of Rice | Eggs of *R. dominica*(x̄ ± SD) |
|---|---|
| Red | 262.94 ± 80.02 b |
| Black | 249.00 ± 43.81 ab |
| White | 224.00 ± 87.00 a |
| LSD's 5% | * |

**Notes:** A number which followed by the same letter showed the results did not differ markedly on the advanced test using the Tukey's test on 5% faults levels; SD is a Standard Deviation; the sign (*) shown there is a significant.

**Table 4.** The Means Number of Eggs of *R. dominica* With Effect of Different Feed Weights

| Weight of Rice | Eggs of*R. dominica*(x̄ ± SD) |
|---|---|
| 20 gram | 173.11 ± 42.54 a |
| 30 gram | 251.72 ± 12.54 b |
| 40 gram | 311.11 ± 26.77 c |
| LSD's 5% | * |

**Notes:** A number which followed by different letters showed significantly different results on the advanced test using the Tukey's test on 5% fault levels; SD is a Standard Deviation; The sign (*) shownthat there is a significant.

In Table 3 showed a significantdifference in the type of rice to the average number of eggs placed by *R. dominica* after seven days of early infestation. The average number of eggs placed by *R. dominica* after seven days of early infestation on red rice was higher at 262.94 grains compared to black rice (249.00 grains) and white rice (224.00 grains). The means number of eggs *R. dominica* with the influence of different feed weights is presented in Table 4. Table 4 shows that there is a significant difference in different weight of rice to average number of eggs laid by imago *R. dominica* after seven days early infestations.

**Amount of Larval, Pupal and F1 Progeny Emerged of *R. dominica***

Based on analysis result showed that average range of the number of Larval, pupal and F1 progeny emerged of *R. dominica* pointed out that there were an interactions among the three types of rice with different weight. The mean number of Larval, pupal and F1 progeny emerged of *R. dominica* with the influence of three types of rice with different weight was presented in Table 5.

Table 5 showed the number of Larval, pupal and F1 progeny emerged of *R. dominica* on white rice were significantly different red and black rice. Based on the correlation test showed that there was a positive correlation in the fat content in rice by the number of Larval (r = 0.806; p = 0.009), pupa (r = 0.836; p = 0.005) and adult (F1) *R. dominica* (r = 0.805; p = 0.009). This was suggested that the higher the fat content in rice, the higher the number of Larval, pupal and F1 progeny emerged of *R. dominica*. Conversely, the lower the fat content in rice, the lower number of Larval, pupal and adults emerged.

**Table 5.** The Mean number of Larval, Pupal and F1 Progeny Emerged of *R. dominica*with The Influence of Three Types of Rice with Different Weight

| Interaction (Rice and Weight) | Larval (x̄ ± SD) | Pupal[1] (x̄ ± SD) | F1 progeny *R. dominica* (x̄ ± SD) |
|---|---|---|---|
| Red Rice 20 g | 156.50 ± 19.18 bc | 135.67 ± 22.85 b | 122.83 ± 22.19 b |
| Red Rice 30 g | 200.83 ± 55.73 cd | 174.83 ± 55.96 bc | 162.17 ± 54.82 bc |
| Red Rice 40 g | 308.33 ± 42.57 e | 289.83 ± 45.41 d | 276.83 ± 43.96 d |
| Black Rice 20 g | 162.67 ± 35.32 bc | 147.00 ± 33.23 bc | 107.17 ± 50.08 b |
| Black Rice 30 g | 206.00 ± 37.27 cd | 173.00 ± 20.66 bc | 164.17 ± 13.89 bc |
| Black Rice 40 g | 264.17 ± 25.92 de | 222.67 ± 42.99 c | 210.83 ± 39.46 c |
| White Rice 20 g | 57.00 ± 25.28 a | 26.33 ± 2.58 a | 11.50 ± 2.95 a |
| White Rice 30 g | 88.83 ± 57.66 ab | 29.33 ± 3.88 a | 18.33 ± 5.32 a |
| White Rice 40 g | 77.17 ± 16.63 a | 38.83 ± 5.98 a | 27.33 ± 6.41 a |
| LSD's 5% | * | * | * |

**Notes:** A number which followed by the same letter in the same column shows the results did not differ markedly on the advanced test using the Tukey's test on 5% fault levels. 1) Data is transformed by the formula √ (x + 0.5) for analysis purposes; SD is the Standard Deviation; The sign (*) shows that there is a significant.

**Sex Ratio *R. dominica***

Based on analysis result, it showed that the sex ratio of the female are more compared to the sex ratio of male adults. The sex ratio of *R. dominica* was presented in Table 6.

**Table 6.** The Sex Ratio of *R. dominica*

| Interaction (Rice and Weight) | Male Adults (x̄ ± SD) | Female Adults (x̄ ± SD) | Sex Ratio (Male : Female) |
|---|---|---|---|
| Red Rice 20 g | 54.00 ± 10.86 | 70.50 ± 13.10 | 1:1.31 |
| Red Rice 30 g | 75.00 ± 25.87 | 87.17 ± 29.78 | 1:1.16 |
| Red Rice 40 g | 127.00 ± 14.63 | 149.83 ± 33.77 | 1:1.18 |
| Black Rice 20 g | 45.17 ± 29.46 | 53.17 ± 33.72 | 1:1.18 |
| Black Rice 30 g | 77.50 ± 12.58 | 86.67 ± 6.15 | 1:1.12 |
| Black Rice 40 g | 99.83 ± 18.35 | 111.00 ± 21.93 | 1:1.11 |
| White Rice 20 g | 5.50 ± 1.38 | 6.00 ± 2.45 | 1:1.09 |
| White Rice 30 g | 7.83 ± 2.48 | 10.50 ± 3.39 | 1:1.34 |
| White Rice 40 g | 12.00 ± 2.97 | 15.33 ± 3.98 | 1:1.28 |

**Notes:** the SD is the Standard Deviation.

**The Weight of F1 Progeny Emerged of *R. dominica***

The interaction among these three types of rice with different weight has no effect against the weight of F1 progeny emerged of *R. dominica*. The mean weight of F1 progeny emerged of *R. dominica* with an influence of different rice types was presented in Table 7.

**Table 7.** The Mean Weight of F1 Progeny Emerged of *R. dominica* with an Influence of Different Types of Rice

| Type of Rice | Weight of F1 Progeny *R. dominica* (x̄ ± SD) |
|---|---|
| Red | 0.0013 ± 0.0001 a |
| Black | 0.0018 ± 0.0003 b |
| White | 0.0011 ± 0.0000 a |
| LSD's 5% | * |

**Notes:** a number which followed by the same letter showed the results did not differ markedly on the advanced test using the Tukey's test on 5% faul levels; SD is the Standard Deviation; sign (*) shows that there is a significant.

In Table 7, it can be seen that the mean weight of F1 progeny emerged of *R. dominica* was influenced by different types of rice. The mean weight of adult on black rice was higher i.e. 0.0018 mg compared to the mean weight of the adults on the red and white rice (0.0013 mg and 0.0011 mg). Based on the correlation test showed a positive correlation (r = 0.763; p = 0.017) on fat content Rice to the weight of the new adults *R. dominica*. This was suggested that the higher the fat content in rice, the new adults *R. dominica* will get heavier. Conversely, the lower the fat content in rice, the new adults *R. dominica* will get lighter.

**Egg, Larval, Pupal Longevity and Life Cycle Period of *R. dominica***

The research was conducted on the conditions of the laboratory with a mean temperature of 27°C and humidity 61%. The results of the analysis of variance showed that the interaction among the three types of rice with different weight has no effect against egg, larval, pupal longevity and the life cycle of *R. dominica*. The mean longevity of egg, Larval, pupal and the life cycle of *R. dominica* with an influence of different types of rice are presented in Table 8.

Table 8 showed that longevity of egg, larval, pupal and the life cycle of *R. dominica* was influenced by different types of rice. Average longevity of egg, Larval, pupa and the life cycle of *R. dominica* on white rice are longer, i.e. 4.48 days; 29.27 days; 10.06 days; and 52.04 days compared to black and red rice. Physical and chemical characters of feed were suspected to be the factors that cause the differences of the longevity of Larval, pupa and life cycle of *R. dominica*. It is supported by the correlation test which shows that there is a positive correlation between the hardness of feed, the moisture content and the content of carbohydrates in rice to the longevity of eggs (r = 0.773; p = 0.015; r = 0.884; p = 0.002), Larval (r = 0.944; p = 0.000; r = 0.902 ; p = 0.001), pupal (r = 0.969; p = 0.000; r = 0.997; p = 0.000) and the life cycle of *R. dominica* (r = 0.993; p = 0.000; r = 0.973; p = 0.000).

**Weight Loss and Sensitivity Index Feed**

The results of the analysis of variance showed that the interaction among the three types of rice with different weight has no effect to a weight loss of feed due to the infestation of *R. dominica*. The results of the analysis of the calculation method according to the index of susceptibility of Dobbie showed that different type of rice will affect the category ofindex of susceptibility. The mean of weight loss and categories of index susceptibility of feed were presented in Table 9.

**Table 8.** The Means Longevity of Egg, Larval, Pupa and The Life Cycle of *R. dominica* with An Influence of Different Types of Rice

| Type of Rice | Egg (days) (x̄ ± SD) | Larval (days) (x̄ ± SD) | Pupal (days) (x̄ ± SD) | Life Cycle (days) (x̄ ± SD) |
|---|---|---|---|---|
| Red | 3.23 ± 0.28 a | 27.14 ± 0.57 a | 7.75 ± 0.10 a | 46.15 ± 0.42 b |
| Black | 3.56 ± 0.38 a | 26.04 ± 0.81 a | 7.51 ± 0.03 a | 44.09 ± 0.42 a |
| White | 4.48 ± 0.05 b | 29.27 ± 0.07 b | 10.06 ± 0.10 b | 52.04 ± 0.19 c |
| LSD's 5% | * | * | * | * |

**Notes:** A number that is followed by the same letter in the same column shows the results did not differ markedly based on Tukey's test on 5% fault levels; SD is the Standard Deviation; sign (*) shows that there is a real difference.

Table 9 showed that the different types of rice affected on the feed weight loss due to the infestation of *R. dominica*. Feed weight loss on white rice is lower compared to red and black rice. This was allegedly because the number of Larval and first progeny emerged (F1) on white rice is lower compared to the red and black rice, so the feeding activity of *R. Dominica* in Larval and adults phase on white rice lower than on red and black rice. Based on the correlation test showed that there was a positive correlation between the weight loss to the number of Larval ($r = 0.819$, $p = 0.007$) and imago *R. dominica* ($r = 0.813$; $p = 0.008$). This was showed that the higher number of Larval and new adult *R. dominica,* the higher weight loss. Conversely, the lower number of Larval and new adult *R. dominica*, the lower weight loss. Table 8 showed that the red and black rice belong to the same susceptibility category that was 'Moderately Resistant', while white rice was belong to 'resistant'.

**Table 9.** The Means Weight Loss and Categories of Index Susceptibility of Feed

| Type of Rice | Weight Loss (x̄ ± SD) | Index Susceptibility | Category Index Susceptibility |
|---|---|---|---|
| Red | 4.23 ± 0.63 b | 3.60 | Moderately Resistant |
| Black | 5.24 ± 0.52 b | 3.63 | Moderately Resistant |
| White | 0.74 ± 0.06 a | 1.54 | Resistant |
| LSD's 5% | * | | |

**Notes:** A number which followed by the same letter showed the results did not significantly different based on Tukey's test on 5% fault levels: SD is the Standard Deviation; sign (*) indicates the presence of a real difference; Provision of Index Susceptibility value consist of four categories; where resistant (0 to 3), moderately resistant (4 to 7), susceptible (8 to 10), and highly susceptible (more than 11).

**The Life Table of *R. dominica***

Based on the life table, it was showed that the highest percentage of the die individuals (dx) occured on the eggs and larval phase. Based on the method of Price [10] gross reproduction rate (GRR) and net reproduction rate *R. dominica* can be calculated based on the amount of the value of mx and lxmx on cohort table. The value of gross reproduction rate and net reproductive rate *R. dominica* in three types of rice are presented in Table 10.

The value of the GRR in Table 10 indicates that *R. dominica* was able to produce offspring of 8.15 individuals per parent per generation on red rice, 8.12 individuals per parent per generation on black rice, and 8.53 individuals parent per generation on white rice. In Table 10, it can be seen that the value of $R_0$ produced by female *R. dominica* in white, red and black rice were: 1.25; 2.63; and 2.49 per individual/adult/generation. It showed that the population could rise up to 1.25 times more from previous generation on white rice, up to 2.63 and 2.49 times more on red and black rice.

**Table 10.** The Value of Gross Reproduction Rate and Net Reproductive Rate of *R. dominica* on White, Red and Black Rice

| Type of Rice | GRR | $R_0$ |
|---|---|---|
| Red | 8.15 ± 2.96 | 2.63 ± 0.80 |
| Black | 8.12 ± 1.25 | 2.49 ± 0.44 |
| White | 8.53 ± 0.39 | 1.25 ± 0.15 |

**Notes:** GRR (*Gross Reproduction Rate*); $R_0$ (*Net Reproductive Rate*).

## DISCUSSION

Based on research results for eggs, Larval, pupal, new imago in first progeny (F1) and first progeny's (F1) weight, R. *dominica,* for different type of rice in several weight showed that the different type of rice is more influential for first progeny (F1) and first progeny's (F1) weight *R. dominica.* Based on correlation test, there was a relationship between physical and chemical in feed matters. There are factors that influence insect's


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growth and its development, such as feeding (nutrition, texture, water content), climatic condition (temperature, humidity, illumination), natural enemies' condition (predator, parasitoid, pathogen), and human activities [11].

Insects used protein and glycogen as energy. Protein affects reproductive performance of insect directly. Stored protein of insect affects to the number of eggs, new adults emerged and size of adults. Insect with high-protein feed requirement will utilize the availability of these compounds for tissue formation, so that the Larval can reach the final instar stage more quickly. Protein provides basic substances for the formation of Larval body tissues that are used to pass the instar stage during its development, while carbohydrates tend to act more as energy sources. The nutrients received by *R. dominica* Larval not only affect the growth, development and survival of Larval, but also the ability to survive pupal to become imago *R. dominica* [12].

Based on research on the phase of the egg, Larval, pupal and the life cycle period of *R. dominica* in white rice was longer than the other treatments. The nutrient content in feed, especially carbohydrates, affects the life span of insects [13-15]. Nutrition is one of the important factors that affect the life of insects such as the process of growth, breeding, reproduction and fitness of the immune system. The growth and reproduction of insects is strongly influenced by nutrients, which is obtained during the Larval and adult insects. Larval requires balanced amounts of protein, carbohydrates, fats, vitamins, minerals, and water for optimal growth and development [16].

Based on research results, it found that the number of sex ratio of a population composition is not consistent though insect sex ratio generally balanced [17]. Activities during the Larval phase and imago *R. dominica* which feeding from the seed until the remaining outer layer, only causes the feed to become severely decreased. A female adult of *R. dominica* laid eggs outside the seeds or in the bottom of the treatment bottle. The incubation period that has been completed, causes the Larval to come out of the egg by making a circular hole on the egg surface. The newly hatched Larval is whitish with a brownish head. After some time, the Larval enter the grain through the soft part of the feed [18].

The Larval feed the inside of the seeds throughout their lives to complete the phase and turn into pupal in the seeds. Pupa will be inside the seeds until they turn into the new *R. dominica* image. The new adult *R. dominica* will eat the inside of the seeds until it can get out of the seeds. Larval and adult *R. dominica* when feeding will produce large amounts of excreta with impurities that resemble pellet granules. Larval emit pellet-like granules when infesting feed, causing odors that make it easy to detect *R. dominica* infestations [19].

Based on the index of susceptibility value for the treatment of three different types of rice with different weights, showed that white rice was catagorized as resistant, while black rice and brown rice were rather resistant category. A higher diversity index indicates higher susceptible varieties. Varieties with a higher susceptibility index produce maximum progenies and vice versa, varieties with a lower susceptibility index produce a minimum number of progenies [20].

Population growth is very dependent on the female adults that are able to survive as well as the number of eggs that were successfully laid. Based on these factors, it can be done on population size predictions for the next generation of a population insect that had previously been known. The calculation of the reproduction rate is required to infer the population growth of an organism [10]. The gross reproduction rate is the average number of offspring per female carriers produced by the individual whose life reaches a maximum age. Meanwhile, the net reproduction rate is the value of the average abundance of offspring produced by individual females every generation after taking into account death or life chance (lx) [21].

This study showed that the GRR value of white rice is higher compared to GRR in red and black rice. But the value of $R_0$ for white rice is lower compared to brown rice and black rice. The high mortality rate occured in the egg phase and the Larval of the first instar *R. dominica* recorded during the wet season (November-December 2014), were caused by several factors: 1) the appearance of parasitoid *R. dominica* Larval, such as: *Anisopteromalus calandrae* (Howard) and *Theocolax elegans* (Westwood) (Hymenoptera: Pteromalidae), 2) predatory mite infestation of Newport *Ventricosus pyemotes* (Acari: Pyemotidae) in eggs and Larval, 3) low temperature conditions when the study was conducted. The low temperature causes the eggs laid by *R. dominica* slightly and cannot hatch due to inappropriate conditions, so that the number of Larval needed is not sufficient for further biological studies of *R. dominica* during winter [22].

**CONCLUSION**

Growth and development of *R. dominica* was not influenced by interactions between the types of rice and different weight, but an influential factor was the different types of rice. The reproduction rate of *R. dominica* on red, black and white rice showed the population will tend to increase in the next generation.

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