Original Paper

Effectiveness Test of Parasitization by Parasitoid Tricogramma japonicum in Controlling White Rice Stem Borer (*Scirphopaga innotata*)

Susilawati Astrodjojo[1), Suratman Sudjud[2], Sri Soenarsih DAS[2]*
1) *Postgraduate Student Master of Agriculture, Khairun University, Ternate, Indonesia*
2) *Department of Agriculture, Khairun University, Ternate, Indonesia*
*) *Corresponding Author:* astrodjojos@yahoo.com

Abstract— **Rice is an essential food crop besides corn and soybeans. The need for rice each year increases along with population growth. One of the pests affecting rice is the white rice stem borer. The present research aimed to test the effectiveness and to examine the interaction between plant age and the number of Tricogramma japonicum parasitoid. The research was carried out at the Agrotechnology Laboratory of the Faculty of Agriculture, Khairun University, Ternate, and the rice fields of Bumi Restu village SP I, East Wasile district. The research design operative was a randomized block design where factor A (A1 = 21 DAS, A2 = 42 DAS, A3 = 56 DAS) was the age of the plant, and factor B (B0 = 0, B1 = 50, B2 = 100, B3 = 150) was the number of eggs of Corcyra cephalonica. Biological control using different amounts of Trichogramma japonicum parasitoid led to different interactions and results for each tested parameter. For the number of egg groups, there was no interaction with plant age, but the treatments which were found effective in suppressing stem borer populations were B2 and B3 (100 and 150). The most effective pias as indicated by damage intensity parameter was B3 (150), which was applied to plants aged 21 DAP. Furthermore, for plant height, different number of parasitoids poses significantly effective results. Percentage unhulled grain of pias B3 (150) causes insignificant damage. For production there is no interaction with plant age, but pias B2 (100) shows high yield. The conclusion is that pias B3 (150) applied to 21 days of plants is very effective in controlling white rice stem borer.**

Keywords— *parasitoid parasites, Tricogramma japonicum, white rice stem borer*

I. INTRODUCTION

Rice is one of the food crops with substantial importance, besides corn and soybeans. The need for rich each year increases in line with population growth and the development of industries that use rice as raw material. To meet these needs, a strategy for achieving food crop production target has been established through 1) increasing productivity, 2) expansion of plantation areas, 3) production security and 4) empowerment of agricultural institutions and support for farm financing [5]. Rice is included in the category of seasonal crops, which are characterized by a very rapidly changing ecosystem due to frequent changes resulting from soil cultivation, plant growth, pest attacks, harvests and delayed cultivation that occur in a short time [16]. In connection with production, in 2018 national rice production reached 56.54 million tons of (henceforth MDG) (BPS, 2018). When converted into rice, it is equivalent to 34.42 million tons of rice. Meanwhile, rice production for North Maluku province in 2020 was 35.36 thousand tons of MDGs (BPS, 2019).

In the framework of securing rice production in Indonesia, especially in North Maluku, there are many obstacles or factors affecting rice production. These factors include the problem of plant variety, irrigation, production inputs, impacts of climate change, plant pests, pesticides, and the reduced coverage of paddy fields. Pests are risks that have to be addressed and taken into account in every plant cultivation business. Pests are animals or plants, including those with both micro and macro size, which disturb, inhibit, and even kill cultivated plants. Based on the types of attack, these threats are divided into 3 groups, namely pests, disease vectors, and weeds.

Pests are animals that directly damage plants. There are several types of pests, including insects, mollusks (e.g. snails), rats, mammals (pigs), and nematodes [9]. Pest attacks are highly visible and can lead to huge losses if they occur massively. However, pests generally do not have an infectious effect, unless the pest manifests a vector of a disease. Disease vectors or commonly referred to as disease-carrying factors are organisms that trigger the symptoms of illness, reduce immunity, or interfere with plant metabolism, which causes abnormal symptoms to occur in plant's metabolic system. Some diseases can still be overcome and

do not have serious effects if the plant immunity can be increased. In other words, the variety is tolerant to the diseases affecting plants. However, there are also diseases that have serious effects on plants and even cause death. Some of the vectors of plant diseases are viruses, bacteria, and fungi. Generally, symptoms of disease have rapid infectious effect and are difficult to detect [7].

Biological control is motivated by various basic knowledge of ecology, especially the theory of population regulation by means of integrating natural controllers and ensuring ecosystem balance. Natural enemies consisting of predators, parasitoids and pathogens are the main natural controllers of pests that work in response to population density so that these biological agents cannot be separated from the life and proliferation of pests. The existence of an increasing pest population can result in economic losses for farmers due to environmental conditions that do not provide opportunities for natural enemies to perform their natural functions [13].

At present, in Indonesia there are 6 types of rice stem borer, consisting of 5 types of family Pyralidae and 1 type of family Noctuidae. Different types of stem borer have different characteristics in distribution and bio-ecology, but are similar in the way they attack or bore plant stems and the damage they cause. The white rice stem borer is known locally as attack. This pest has the scientific name Scirpophaga innotata. These insects are highly attracted to light. At the beginning of the rainy season, these insects emerge just as the population of prepupae sinks [2].

The handling of plant pathogens is an important aspect in securing rice production. Pests can cause damage from the nursery to harvesting with the level of resultant damage which varies considerably depending on the type of pest, variety and environment. In the rice agro-ecosystem, the producer is the rice itself. It is estimated that there are 100 species of insect that play a role as primary consumers, including 20 species that can cause significant damage and pose a major effect on decreasing production. Types of pests known to attack rice plants include rats, stink bugs, stem borer, fake white pests, and armyworms. In addition, diseases that are often encountered in plants are blast, brown leaf spot, midrib blight, and many more. One of the pests that are currently growing rapidly in North Maluku is the white rice stem borer (Scirpophaga innotata) (Villaverde et al, 2016). Scirpophaga innotata attacks rice from nurseries to panicle initiation period during vegetative or attack period. This period is characterized by the breaks of rice stalks because they are bored and dried like straw. In the generative phase, panicles appear dry and hollow, called outs [8].

In the last few decades, the mainstay of rice pest control for farmers is dominated by the use of pesticides. Integrated Pest Management (IPM) is the basis of government policies in plant protection programs which are officially outlined in Presidential Instruction No.3/ 1986, Law no. 12 1992 concerning crop cultivation systems and Government Regulation No.6/1995 concerning plant protection. The IPM policy began to develop as a correction to conventional pest control efforts that prioritize inappropriate and excessive use of pesticides [1]. In addition to increasing production costs, this method also results in adverse environmental side effects such as resistance, resurgence and the emergence of secondary pests as well as causing residual problems.

Integrated pest control is a pest control strategy which is based on an ecological concept that emphasizes the activities of natural mortality factors and uses control tactics with low disturbance to the existing natural factors. One of the main components of IPM is the utilization of natural enemies consisting of predators, parasitoids, and insect pathogens. Potential natural enemies for rice stem borer are such parasitoids as Tetrastichus schenobii, Telenomus rowani and Tricogramma japonicum. Predators and parasitoids are able to reduce pest population density. Likewise, pathogenic fungi can bring down pest development, reduce reproductive capacity, and reduce pest resistance to predators, parasitoids and other pathogens. The edifice of these initiatives is what is called biological control [15].

Based on the abovementioned issues, the present study aims at delving into the attack intensity of white rice stem borer, Shircopaga innotata, in rice cultivation areas in North Maluku and the resultant magnitude of production loss. By implication, the findings are projected to shed lights on how to apply potential natural parasitoid enemies in controlling white rice stem borer. The purpose of this study is to test the effectiveness and to examine the effect of the interaction between plant age and the number of Tricogramma japonicum parasitoids.

II. MATERIALS AND METHOD

A. Research Site and Setting

The study was conducted at Khairun Ternate University and the rice fields of Bumi Restu SP I village, East Wasile district. The research took place from November to January 2020. In addition, the laboratory analysis of the research was conducted at the Agrotechnology Laboratory, Faculty of Agriculture.

B. Materials and Equipment

The materials used in this study were Corcyra cephalonica eggs, rice plants, and Tricogramma Japonicum sp. The equipment operationalized included trays, plastic boxes, plastic jars, black cotton cloth, duplex paper, scissors, cutter, glue, plastic buckets, small brushes, small filter, magnifying glass, microscope, sterilization box, 15 watt UV lamp, frying pan, stove, plastic bucket, and shading net.

C. Research Procedure

This research was carried out in several stages, starting with the multiplication of Corcyra cephalonica eggs and the

breeding of Trichogramma japonicum eggs in the laboratory. Afterward, the next stage was field research where Trichogramma japonicum parasitoids were released on rice plants.

D. Research Method

This research applied experimental method. The experimental design employed a factorial randomized block design (RBD) consisting of 2 factors, namely Factor A concerning plant age and Factor B which related to the number of eggs of Corcyra cephalonica. Factor A consisted of:

A1 = 21 DAP
A2 = 42 DAP
A3 = 56 DAP

Factor B consisted of:

B0= control
B1=50 eggs of Corcyra cephalonica parasitized by T. Japonicum
B2=100 eggs of Corcyra cephalonica parasitized by T. Japonicum
B3=150 eggs of Corcyra cephalonica parasitized by T. Japonicum

The treatment was repeated three times which resulted in a total of thirty-six units of treatment.

E. The Observation Parameters

1) The Percentage of parasitized stem borer eggs (%)

The percentage of parasitized stem borer eggs was observed by calculating the parasitation starting ± six days after application. The number of eggs parasitized was calculated using the following formula:

$$P = \frac{A}{B} x\ 100\%$$

where:
P = Percentage of parasitized eggs
A = The number of parasitized eggs
B = The total number of eggs [11].

2) The Number of Egg Groups

The group of eggs was obtained from the experiment beds, and these eggs were counted to find out the population.

3) The Percentage of Damage Intensity of Rice Affected by Stem Rice White Borer

$$I = \frac{a}{a + b}\ x\ 100\%$$

where:
I = Intensity of attacks (%)
a = The number of samples (affected plant parts)
b = The number of unaffected plant parts
(Department of Agriculture, 2018)
Scale of Damage Severity
R = rate of attacks $\leq$ 25 %

S =   rate of attacks $> 25 \leq 50$ %
B = rate of attacks $> 50 \leq$ 85 %
P =   rate of attacks > 85 %

4) Plant Height

Plant height was measured at the end of the study. This was measured from the base of the stem to the flag leaf.

5) Percentage of Empty Grains

The percentage of empty grains was determined by employing the following formula:

$$GH = \frac{\sum Empty\ grain}{\sum Total\ grains}\ x\ 100\%$$

(Ministry of Agriculture, 2019)

6) Production

The final production is calculated by counting plots at the end of the planting period (harvest).

E. Data Analysis

The data analysis used factorial randomized block design, which employed the SAS program with the following mathematical model.

$$Yijk = \mu + \alpha i + \beta j + (\alpha + \beta)ij + Fk + \sum ijk$$

If there is a different effect from each treatment, then Duncan's test will be carried out.

III. RESULTS AND DISCUSSION

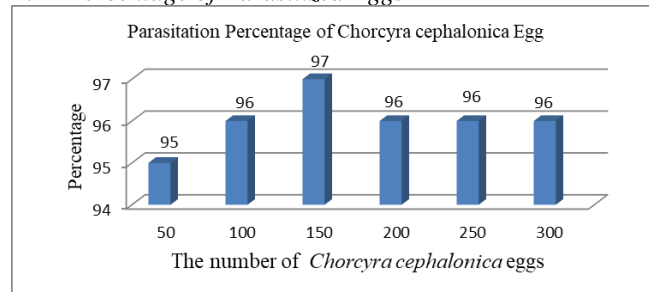### A. Percentage of Parasitized Eggs

Figure 1. The Percentage of Parasitized Eggs

Figure 1 shows that of all the treatments tested do not show any significant difference. This means that 95% eggs are parasitized at room temperature, regardless of the number of Trichograma japonicum parasites. Parasitation rate is expressed as the percentage of egg group parasites and the percentage of eggs parasitized. The determination of the parasite level for each egg collectively takes into account the parasitoid behavior [14].

B. The Number of Egg Groups

The results of analysis of variance for the number of egg groups did not show any interaction with plant age. However, the number of egg groups was influenced by the number of filter papers released in the experimental plots.

Table 1.The Average of Egg Groups under Treatment Variables of Plant Age and Number of *Chorcyra cephalonica* Parasitized Eggs

Treatment	Number of Egg Groups
B0	2,00 a
B1	1,88 ab
B2	1,44 b
B3	1,44 b
Duncan	0,429

The numbers followed by the same letter are not significantly different in the Duncan test with α 0.05

Treatment B0 (control) is not significantly different from B1 (50 items), but significantly different from B2 (100 items) and B3 (150 items). There is no correlation with plant age because rice stem borer moths usually lay the egg groups after being spread in the nursery. It is also possible for the moths to lay eggs after the plants are transplanted or even after the plants have entered the generative phase.

C. Damage Intensity

The results of the analysis of variance for damage intensity showed that the treatment of plant age and the number of parasitized eggs held a very significant interaction in the A3B0 treatment, as evinced by a value of 98.667. This treatment was significantly different from all treatments, but insignificantly different from A3B3 treatment. Meanwhile, the treatment A3B3 did not significantly differ from the treatment of A3B1 and treatment of A3B2.

Table 2. Average of Damage Intensities (%) under Treatment of Plant Age and Number of Chorcyra cephalonica (Pias) Parasitized Eggs

Treatment	Damage Intensity
A3B0	98,66 a
A3B3	89,33 ab
A3B1	86,66 b
A2B0	85,33 b
A3B2	84,00 bc
A1B0	74,66 cd
A2B3	65,33 de
A2B1	64,00 e
A2B2	62,66 e
A1B1	33,33 f
A1B2	24,00 f
A1B3	10,67 g
Duncan	5,05

The numbers followed by the same letter are not significantly different in the Duncan test with α 0.05

Overall, the treatment of plant age (56 DAT) with variations in the number of eggs per bag showed a significant

intensity of damage where the plant did not experience optimal growth (attack symptom). Damage to plants is characterized by the destruction of the tissue on the rice stalks so that the supply of water and nutrients is cut off, plants become stunted, plant shoots are damaged and easily uprooted. Furthermore, the A1B3 treatment showed very little damage with an attack intensity of 10.667%.

D. Plant Height

The results of observations and analysis of varied plant heights are presented in Table 3. The table shows that the plant heights in treatments A1B1, A1B2, A1B3, A2B1, A2B2, A2B3, A3B1, A3B2 and A3B3 are not significantly different, but these are significantly different from treatments A1B0, A2B0 and A3B0. Meanwhile, A2B0 is significantly different from A3B0, and significantly different from A1B0. This correlation can be interpreted that at the age of 21, 42 and 56 DAP without treatment (control setting). The plant height was very low and indicated by the presence of attack.

Table 3. Average Plant Heights under Treatments of Plant Age and Number of Chorcyra cephalonica Parasitized Eggs

Treatment	Plant Height
A3B3	93,45 a
A3B2	93,33 a
A1B3	93,30 a
A1B2	93,20 a
A1B1	93,10 a
A2B3	93,04 a
A3B1	93,01 a
A2B1	92,98 a
A2B2	91,86 a
A2B0	65,33 b
A1B0	63,61 cb
A3B0	62,58 c
Duncan	0,989

The numbers followed by the same letter are not significantly different in the Duncan test with α 0.05

Table 3 shows that the plant heights in treatments A1B1, A1B2, A1B3, A2B1, A2B2, A2B3, A3B1, A3B2 and A3B3 treatments are not significantly different, but these are significantly different from treatments A1B0, A2B0 and A3B0. A2B0 is significantly different from A3B0 and significantly different from A1B0. This correlation can be interpreted that at the age of 21, 42 and 56 DAP without treatment (control setting). The plant height was also found very low, and the presence of attack was identified.

E. Percentage of Empty Grain

Analysis of variance showed that the treatment of plant age and the number of Chorcyra cephalonica parasitized eggs (pias) posed different effects on several treatments. The following table presents the analysis results.

Table 4. Average Percentage of Empty Grains under Treatment of Plant Age and Number of Chorcyra cephalonica Parasitized Eggs

Treatment	Empty Grain
A2B0	59,82 a
A1B0	59,81 a
A3B0	57,27 a
A1B1	18,23 b
A1B2	16.73 b
A3B1	15.12 b
A3B2	14,73 b
A2B3	14,78 b
A3B3	14,59 b
A2B1	14,19 b
A2B2	13,99 b
A1B3	13,84 b
Duncan	6,295

The numbers followed by the same letter are not significantly different in the Duncan test with α 0.05

The highest percentage of empty grain was found in treatment A2B0, followed by A1B0 and A3B0. These treatments were significantly different from all the treatments. The use of pias was characterized with a varying number of parasitized Chorcyra cephalonica eggs, namely 50 (B1), 100 (B2) and 150 (B3). These treatments showed a low percentage of empty unhulled rice below 19%.

F. Production

Analysis of variance showed that the treatments involving varying plant ages and the number of Chorcyra cephalonica parasitized eggs did not demonstrate any interaction between greens and plant age. By contrast, the amount of gutter affects the value of production. Table 5 shows that the treatment without dressing (B0) was very significantly different with all treatments. Furthermore, B1 is not significantly different from B2 and B3.

Table 5. Average Productions in Treatment of Plant Age and Number of Chorcyra cephalonica Parasitized Eggs

Treatment	Production
B2(100)	3,56 a
B1 (50)	3,54 ab
B3(150)	3,48 b
B3(150)	3,48 b
Duncan	0,079

The numbers followed by the same letter are not significantly different in the Duncan test with α 0.05

IV. CONCLUSION

The parasitoid Trichogramma japonicum has been found effective in suppressing the development of white rice stem borer. Of all treatments under analysis, the research findings corroborate that treatment B3 (150 eggs) is the most effective one in controlling white rice stem borer, which is applied at 21 days after planting

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