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Adaptation of Yellow Rice Stem Borer Egg Parasitoid to Exposure to Several Active Insecticide Ingredients in Jembrana Regency, Bali

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ABSTRACT: Rice (*Oryza sativa* L.) is the main carbohydrate source in Indonesia, but its productivity is often threatened by stem borer infestations. Control with chemical insecticides is still predominantly carried out by farmers, even though it has the potential to suppress the population of natural enemies such as parasitoids. This study aims to evaluate the morphological characteristics of rice stem borer egg parasitoids, evaluate the effect of several insecticide active ingredients on community structure and parasitization levels of rice stem borer egg parasitoids in Jembrana Regency. The study used a randomized block design with four treatments, namely control, chlorantraniliprole 50 g/L, dimehipo 525 g/L, and monosultap 400 g/L, each with seven replications. The results showed that morphologically three species of rice stem borer egg parasitoids were successfully identified, namely *T. japonicum* , *T. dignus* , and *T. schoenobii* . Several active insecticide ingredients directly affect the structure of the parasitoid community, characterized by an abundance index (R1 = 0.225 - 0.235) and low diversity (H` = 0.308 - 0.347) , as well as a moderate dominance index (D = 518) to high (D = 0.762). The level of parasitization of rice stem borer eggs (22.08% - 24.80%) with the dominant species *T. schoenobii* .

KEYWORDS: Rice (Oryza sativa L) , Rice Stem Borer, Egg Parasitoid, Insecticide

INTRODUCTION

Rice (*Oryza sativa* L.) is a major commodity that serves as a staple carbohydrate requirement for the majority of the Indonesian population (Maulana *et al* ., 2024). However, in the process of cultivating rice plants, farmers face various obstacles, one of which is attacks by plant pests (OPT). Rice stem borers are a major pest in rice plants that often cause losses for farmers. In Bali, four species of rice stem borers have been found to attack rice plants, namely the yellow rice stem borer (*S. incertulas*) *,* pink rice stem borer (*S. inferens*) *,* striped rice stem borer (*C. suppressalis*) *,* and the black-headed rice stem borer (*C. polychrysus*) (Wijaya *et al* ., 2021) . Among the rice stem borer pest species, *S . i ncertulate* is the most dominant type and causes the most severe damage in the field (Hadi *et al* ., 2015) .

Until now, control efforts carried out by farmers still rely on chemical insecticides because farmers assume that the use of chemical insecticides is more effective and efficient, but improper handling can cause target pests to become resistant, natural enemies are killed and poisoned, and can cause environmental pollution (Hasibuan, 2015). To avoid negative effects due to the use of insecticides in controlling pest attacks, an integrated pest management (IPM) method must be used. The use of parasitoids in controlling rice stem borers is a fairly effective and efficient control (Maulina *et al* ., 2020). Egg parasitoids found in Bali are *Trichogramma japonicum* , *Telenomus rowani* , and *Tetrastichus schoenobii* . (Adiartayasa and Wijaya, 2016).

Pesticide use can directly or indirectly affect the killing of natural enemies. This is due to farmers not using pesticides wisely (Junaedi *et al.* , 2016) . Studying the adaptability of the three types of yellow rice stem borer egg parasitoids from a genetic perspective has not been widely discussed to date. Therefore, research is needed on how adaptation occurs. Rice stem borer egg parasitoids due to exposure to several active insecticide ingredients in Jembrana Regency, Bali **.**

RESEARCH METHODS

Study This implemented in roomy And laboratory. Study roomy done in the Subak Sawe Dauh Tukad, Jembrana District, Jembrana Regency, Bali . The research was conducted from March to August 2025 . Study the laboratory covering maintenance rice stem borer eggs, and morphological identification were carried out at the Plant Pest Laboratory , Faculty of Agriculture, Udayana University. Tools Which used in study This is microscope stereo binoculars, camera, transparent plastic tube, cotton, petri dish, collection bottles, stationery, transparent plastic bags, brushes, labels, dissection needle. The materials used in this study were insecticides with active ingredients Chlorantraniliprole 50 g/l, Dimehipo 525 g/l, and Monosultap 400 g/l, rice stem borer eggs, and 70% alcohol. The study used a randomized block design (RAK) based on standard methods consisting of 4 treatments and 7 replications consisting of control, insecticide with the active ingredient Chlorantraniliprole 50 g/l, Dimehipo 525 g/l, and Monosultap 400 g/l. The concept of this research was carried out in 2 stages, namely field research and laboratory research. The plot unit was a plot measuring 10 mx 15 m, with a distance between plots of 50 cm. Insecticide application was carried out from the age of rice 7 after planting (dap), which was repeated every week for 10 applications, with an application dose of 0.75 ml/l and a spray volume of 500 l/ha using a sprayer with a capacity of 16 liters (sprayer). Observation of egg parasitoids was carried out by collecting yellow rice stem borer eggs in each replication in the treatment plot of ± 10 egg groups each week and was taken 10 times. Egg samples found at the research location were then maintained in the Laboratory. Maintenance of eggs that had been collected in the field to observe the emergence of rice stem borer parasitoids and observed the emergence of the parasitoids every day and recorded in the observation book. then the morphological characteristics were identified under a binocular microscope by observing the type of parasitoid that appeared and identifying its morphology such as color, antennae, wing shape, using the guide according to Barrion and Litsinger , (1994).

Observed Variables

a. Structure of Rice Stem Borer Parasitoid Community

- **Index abundance species**

Index abundance measured with use index Magalef (Magurran, 2021)

$$\mathbf{R1} = \frac{\boldsymbol{S} - \mathbf{1}}{\mathbf{ln}\,\boldsymbol{N}}$$

Notes:

R1 = Index Abundance
S = Number of species found
Ln = Logarithm nature
N = Amount Total Individual

Mark:

R1 < 3.5 = Low abundance index
3.5 < R1 < 5.0 = Index moderate abundance
R1 < 5.0 = Index abundance tall

- **Index diversity**

Index diversity counted use formula index diversity species Which indeveloped by Shannon and Wiener (1949) as follows:

$$\boldsymbol{H'} = \sum_{i=1}^{s} \mathbf{pi\ Ln\ Ni}$$

Notes:

H' = Index Diversity Shannon – Vienna
Pi = proportion of the i-th species in the community
Ln = logarithm nature
Ni = abundance individual species i-th
N = total number of individuals of all species.

Mark:

H'<1.0 = index diversity low
1 < H' < 3 = Index moderate diversity
H' > 3.0 = Index high diversity.

- **Index dominance species**

  Index dominance (D) counted with use index Menheinick (Magurran, 2021)

$$D = \sum \left(\frac{ni\,(ni-1)}{N\,(N-1)} \right)$$

Notes:

D = Index Dominance

N = Amount total individual

Ni = Amount individual type to –i

Mark:

0.00 < D < 0.30 = Low dominance index

0.30 < D < 0.60 = Index dominance currently

>0.60 = High dominance index

b. Parasitization Level of Rice Stem Borer Parasitoids

The parasitoid parasitization rate was calculated using the formula (Kim and Heinrich, 1985):

P (*T. japonicum*) $= \frac{0{,}5\ x\ Tj}{Pb+0{,}5xTj} \times 100\%$

P (*T. rowani*) $= \frac{Tr}{PbxTr} \times 100\%$

P (*T. schoenobii*) $= \frac{3\ x\ Ts}{Pb+3xTs} \times 100\%$

Notes:

P = Parasitization Level

Pb = Number of borer larvae that appear

Tj = Number of *Trichogramma japonicum imago* that appear

Tr = Number of *Telenomus rowani imago* that appear

Ts = Number of *Tetrastichus schoenobii imago* that appear

RESULTS

Morphological characteristics of rice stem borer egg parasitoids in Jembrana Regency

Based on the results of morphological identification conducted in the Laboratory from three different egg collection locations in Jembrana Regency, three types of yellow rice stem borer egg parasitoids (*S. incertulas*) were found, namely *T. japonicum* , *T. dignus* , and *T. schoenobii*

The effect of several active insecticide ingredients on the community structure of rice stem borer egg parasitoids

The results of the study showed that the community structure of the yellow rice stem borer egg parasitoid with the treatment of several active insecticide ingredients contained three main parasitoid species, namely *T. japonicum* , *T. dignus* , and *T. schoenobii* which can be seen in (Table 1).

Table 1. Community Structure of Rice Stem Borer Egg Parasitoids in Subak Sawe Dauh Tukad, Jembrana District

Species	Active ingredient of insecticide			
	Control	Dimehipo 525 g/l	Monosultap 400 g/l	Chlorantraniliprole 50 g/l
T. schoenobii	687	737	511	486
T. dignus	134	67	145	57
T. japonicum	32	45	93	32
N parasitoid	853	849	749	575
N *S. incertulas*	7020	7229	6464	4967
N egg mass of YRB	96	99	89	68
S parasitoid	3	3	3	3
S incertulas (YRB)	1	1	1	1
R1	0.226	0.225	0.228	0.235
H'	0.328	0.308	0.347	0.311
D	0.674	0.762	0.518	0.727

Description: N = Total individuals, S = Species abundance, R1 = Abundance index, H' = Diversity index, D = Dominance index, YRB = Yellow Rice Stemborer

The effect of several active insecticide ingredients on the parasitization level of rice stem borer egg parasitoids

The calculation of the parasitization rate of rice stem borer egg parasitoids in Subak Sawe Dauh Tukad, Jembrana District, showed differences between treatments. The results of the calculation showed that the control treatment had a total parasitization rate of 24.80% (Figure 2).

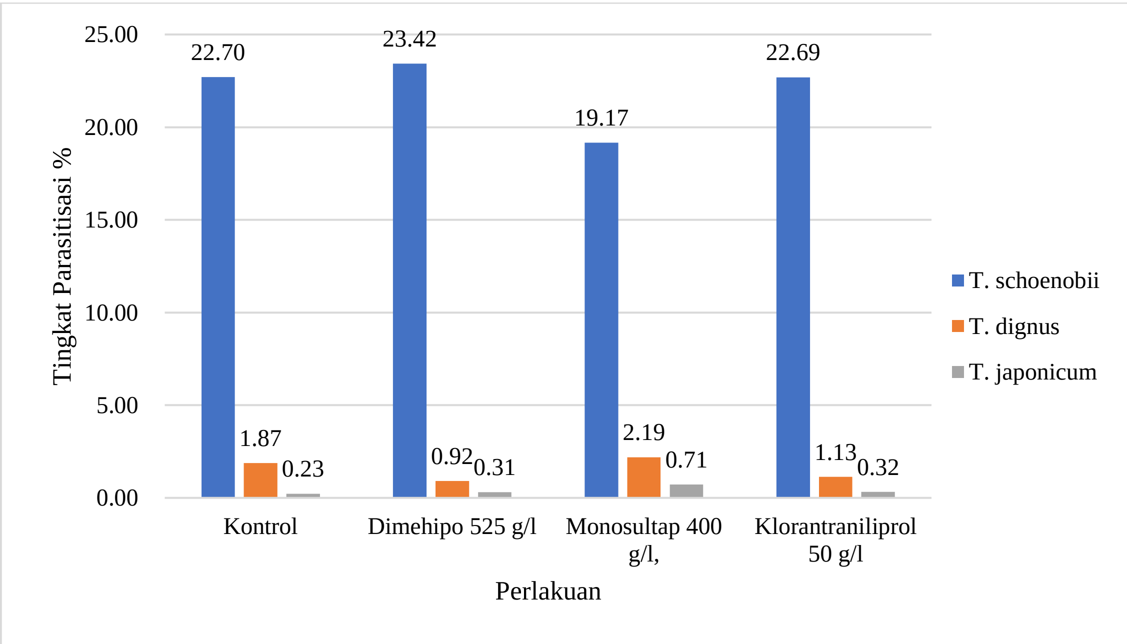

Figure 2. Parasitization level in Subak Sawe Dauh Tukad, Jembrana District

DISCUSSION

Morphological characteristics of rice stem borer egg parasitoids in Jembrana Regency

Based on the results of morphological identification conducted in the Laboratory from three different egg collection locations in Jembrana Regency, three types of yellow rice stem borer egg parasitoids (*S. incertulas*) were found, namely *T. japonicum* , *T. dignus* , and *T. schoenobii* . (Figure 1)

Figure 1. (a) *T. japonicum* , (b) *T. dignus* , (c) *T. schoenobii*

Research conducted by Wijaya *et al* . (2021) found three types of parasitoids , namely *T. japonicum* , *T. rowani* , and *T. schoenobii,* at different altitudes in Bali. According to Pratiwi (2016), The parasitoid species found in Sumberagung and Sumengko Villages, Jatirejo District, Mojokerto are *T. rowani, T. dignus,* and *T. schoenobi.* These three parasitoid species share similar morphological characteristics: thin wings consisting of two pairs of membranes, with the forewings larger than the hindwings, and fine hooks (hamuli). The head bears compound eyes, three ocelli, and a pair of medium- to long-sized antennae (Armando *et al* ., 2020).

The results of the identification of the morphological characteristics of each parasitoid found were that *T. japonicum* has a very small size of 0.6 mm with an oval-shaped imago body and is black (Figure 5.1 (a)). The caput is black (Figure 5.1 (a)). The antennae are club-shaped (*clavate*) and consist of 5 segments covered with fine hairs. The wings are transparent and covered with fine hairs on the entire wing and on the edge of the wing have longer hairs. According to Junaedi *et al.* (2016) the body of this parasitoid is black and the smallest compared to other types. The antennae consist of six segments with tips equipped with short hairs. The edges of the wings have relatively longer feathers, while the legs on the tarsus are composed of three segments. *T. japonicum* has a very small body size, namely 0.4 mm, with a dominant black color. The female antennae are club-shaped with very short and sparse hairs, while the male antennae are straight and covered with thicker hairs. The antennae are composed of seven segments, the eyes are reddish, the thorax is black, and the wings are equipped with fine feathers and long tassels on the edges. (Awaluddin, 2019). The wings are transparent and covered with long, fine hairs along the edges. The antennae consist of 5-8 segments and include one ring segment (Armando *et al* ., 2020).

T. dignus has a body size of 0.7 mm with a shiny black body. The caput is wider than the thorax and has a pair of large eyes. The caput is black. The antennae are blackish yellow and begin to turn dark black at the tip of the antennae. *The T. dignus antennae* consist of 10 segments and are arranged tightly with almost uniform segment sizes, filiform type. The wings of *T. digus* are almost the same as those of *T. japonicum* , which have a transparent color covered with fine hairs and on the edges of the wings have longer hairs, but the wings of *T. dignus* are larger, namely 0.74 mm (Figure 5.1 (b)). The legs of *T. dignus* are yellow. According to Borror *et al* . (1996) *Telenomus* sp. is classified as belonging to the order Hymenoptera, suborder Apocrita, and family *Scelionidae* . This insect has morphological characteristics in the form of a relatively slender body with a length of around 0.5–1 mm, shiny black in color, and a thorax that appears slightly convex towards the posterior. The metasoma consists of elongated segments and is divided into one sclerite, so that the lateral part of the metasoma appears rounded. According to Pratiwi (2016) Description of the morphological characteristics of *T. dignus* , namely having filiform antennae with 8 segments with segments 5, 6, and 7 getting thicker, the male antennae are yellow with half of the scapus pale and the tips of segments 3-4 are brown, body length 0.7-0.8 mm, the length of the thorax and abdomen is almost the same.

Imago *T. schoenobii* has a metallic bluish black color with a body measuring 1.4 mm, larger than *T. japonicum* , and *T. dignus.* It has brownish yellow legs. The caput is round and shiny, dark blackish in color and there is a pair of compound eyes. The elbowed antenna consists of 6 segments, each segment has an almost uniform size, cylindrical to oval in shape, so this antenna can be classified as a moniliform type. The color of the antenna is brownish yellow to black. The wings have a transparent color and are covered with feathers (Figure 5.1 (c).

According to Barrion and Litsinger (1994), *T. schoenobii* has morphological characteristics in the form of an elongated abdomen with a tapered tip, yellow legs, and a tarsus on each leg composed of 4 segments **.** The antennae are angled with eight segments, while the tarsus consists of four segments. The forewings have a long and curved submarginal section so that the blood vessels are not clearly visible. The body length reaches about 1.4 mm (Baehaki, 2013). According to Awaluddin (2019) *T. schoenobii* has a shiny green or bluish body. The antennae consist of seven segments with a combination of brown and yellow. The wings are covered with irregularly arranged feathers, the thorax looks smooth, and the tarsus at the end of the legs is composed of four segments. This parasitoid is 1–3 mm long and has a metallic bluish-green color (brilliant metallic). The antennae consist of 5 or no more than 13 segments. The wings are covered with irregular hairs (Armando *et al.,* 2020).

The effect of several active insecticide ingredients on the community structure of rice stem borer egg parasitoids

The results of the study showed that the community structure of the yellow rice stem borer egg parasitoid with the treatment of several active insecticide ingredients contained three main parasitoid species, namely *T. japonicum* , *T. dignus* , and *T. schoenobii* which can be seen in (Table 3.1). The results of the abundance index of rice stem borer egg parasitoid species in Subak Sawe Dauh Tukad, Jembrana District showed a low species abundance index value, namely (R1 = 0.225 - 0.235). The highest abundance index value was in the chlorantraniliprole 50 g / l treatment, namely with a value of R1 = 0.235 and the lowest was in the dimehipo 525 g / l treatment, namely R1 = 0.225. The diversity index in Subak Sawe Dauh Tukad, Jembrana District was (H` = 0.308 - 0.347) with a low diversity index category. For the highest value in the monosultap 400 g / l treatment with a value of H` = 347 while the dimehipo 525 g / l treatment has the lowest value of H` = 0.308. The dominance of the species *T. japonicum* , *T. dignusi* , and. *T. schoenobii* , in Subak Sawe Dauh Tukad, Jembrana District with a moderate index to a high dominance index, where the highest index value is in the dimehipo 525 g / l treatment with a value of D = 0.762 (> 0.60), while the moderate dominance index in the monosultap 400 g / l treatment is D = 518 (D = 0.30 < D < 0.60) which is dominated by the *T. schoenobii species* in all treatments. (Table 1)

The low abundance and diversity index in Subak Sawe Dauh Tukad is indirectly influenced by ecological and environmental factors. One of them is the application of pesticides carried out by farmers which can indirectly affect parasitoid biology. According to Maulana *et al* . (2024) The effect of insecticides during spraying can reduce pest population levels which causes there to be insufficient hosts for parasitoids. The diversity and population of parasitoids are not only influenced by environmental conditions and the intensity of pesticide use, but also depend heavily on the availability of host populations (Junaedi *et al.* , 2016). The abundance and diversity of insect populations in the field are influenced by intrinsic and extrinsic factors (Supartha *et al.,* 2020).

The dominance index in this study showed index values from moderate to high. Subak Sawe Dauh Tukad, Jembrana District, had a moderate to high dominance index, where the highest index value was in the 525 g/l dimehipo treatment with a D value = 0.762 (> 0.60), while the moderate dominance index was in the 400 g/l monosultap treatment, namely D = 518 (D = 0.30 < D < 0.60). For the dominant species, namely *T. schoenobii* . (Table 3.1). According to Wijaya *et al* . (2021). *T. schoenobii* is the most dominant species at different altitudes. *T. schoenobii* is a parasitoid that also has predatory properties. Each larva is able to parasitize 2–3 eggs and its competition is stronger than other parasitoids (Awaluddin. 2019) . The parasitoid frequency of *T. schoenobii* is twofold higher than that of *T. japonicum* and *T. rowani* (Rauf, 2000).

The effect of several active insecticide ingredients on the parasitization level of rice stem borer egg parasitoids

The calculation of the parasitization rate of rice stem borer egg parasitoids in Subak Sawe Dauh Tukad, Jembrana District, showed differences between treatments. The results of the calculation showed that the control treatment had a total parasitization rate of 24.80% with each parasitization of *T. schoenobii* reaching 22.70%, while *T. dignus* was 1.87% and *T. japonicum* was only 0.23%. For the 400 g/l Monosultap treatment, the lowest total result was 22.08% with parasitization of *T. schoenobii* at 19.17%, *T. dignus* at 2.19% and *T. japonicum at* 0.71%. The most dominant parasitoid species in all treatments in Subak Sawe Dauh Tukad, Jembrana District, was *T. schoenobii* (Figure 2).

The results of the parasitization rate calculation show that the role of the environment and the use of pesticides also indirectly affect the parasitization rate of rice stem borer egg parasitoids. According to Junaedi *et al.* (2016), environmental factors greatly influence the low level of parasitoid parasitization. Insecticide application shows a significant influence on the dynamics of parasitoid communities in the field, which is reflected in changes in diversity, abundance, dominance, and egg parasitization (Supartha, *et al* ., 2024). In Subak Sawe Dauh Tukad, the *T. schoenobii species* shows the highest parasitization ability followed by *T. rowani* and *T. japonicum.* According to Supartha (2001), *T. schoenobii* has a high dispersal ability so that it can quickly colonize new planting areas, making it present earlier in the rice ecosystem than other parasitoids . According to Suharto and Usyati, (2005), the parasitoid species *T. schoenobii* also acts as a predator for other parasitoids so that no other parasitoids were found, apart from the parasitoids *of T. schoenobii.*

CONCLUSION

Based on the research results and discussion above, it can be concluded that: (1) The results of morphological identification found three species of rice stem borer egg parasitoids, namely; *Tricogramma japonicum, Telenomus dignus,* and *Tetrasticus schoenobii.* (2) Several insecticide active ingredients directly affected the community structure of rice stem borer egg parasitoids. The results showed low abundance and diversity indices in all treatments, while the dominance index was in the medium to high category, with the highest index value being in the 525 g/l dimehipo treatment with a D value of 0.762 (> 0.60), dominated by the *T. schoenobii species.* (3) The level of parasitization of rice stem borer eggs in Subak Sawe Dauh Tukad, due to exposure to several active pesticide ingredients, showed the highest in the control treatment, namely 24.80% with the dominant species being *Tetrastichus schoenobii* .

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