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Species Investigation of Rice Stem Borers and Its Parasitoids on Fallowing Rice Fields at Karawang, Indonesia

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ABSTRACT

Rice stem borers (RSB) cause the same damage symptoms and occur through the season and time. During the off-season for rice, these stem borers are not well-known. The research aims to determine the effect of fallowing rice on the presence of rice stem borers and their parasitoids, the potential for RSB infestation, and their parasitoid on subsequent rice seedlings in nurseries at Karawang Regency, West Java. Several variables are observed, including the number of rice stem borer larvae on stubbles, egg masses, the percentage of parasitized eggs, and the number of adults of rice stem borer in nurseries. The results show that species of rice stem borer on the fallow rice are *Scirpophaga incertulas* and *Sesamia inferens*. The population of *S. incertulas* is significantly higher on long rice fallow. The height of the paddy stubble at the two locations is not very different. However, the infested stubble in the short fallow period is higher than those in the long fallow. Eggs of *S. incertulas* whose high percentage hatched and parasitized, are primarily found in nurseries of areas with long fallow. There are three species of parasitoids identified.

INTRODUCTION

Rice stem borers (RSB) are considered one of the most predominant pests in rice cultivation, which can reduce both the quantity and quality of paddy production. The damage caused by the rice stem borer is commonly known as deadhearts (*sundep*) and whiteheads (*beluk*). Dead tillers characterize deadhearts, while whiteheads are characterized by empty or unfilled white grains (Baehaki, 2013). In Indonesia, there are six species of rice stem borers, namely the yellow rice stem borer (YRSB), *Scirphopaga incertulas* Walker, the white rice stem borer (WRSB), *S. innotata* Walker, the pink rice stem borer (PRSB) *Sesamia inferens* Walker, the striped rice stem borer (SRSB), *Chilo suppressalis* Walker, the dark-headed striped rice stem borer (DHSRSB) *C. polychrysus* Meyrick, and the gold-fringed rice stem borer (GFRSB) *C. auricilius* Dudgeon (Hattori & Siwi, 1986). The YRSB, *S. incertulas*, is one of the most destructive paddy pests in Indonesia and several countries in Asia (Hadi et al., 2015; Hamsein et al., 2020). These pests can infest paddy starting from the seedling phase to the panicle formation phase (Cahyoko et al., 2018). The YRSB and the PRSB belong to different family levels but are mostly found simultaneously in Indonesia's various rice field systems (Wilyus et al., 2013).

The YRSB spreads widely in Java, Sumatra, Kalimantan, Sulawesi, Bali, and Lombok (Baehaki, 2013). Suharto & Usyati (2005) expressed that YRSB has become a significant pest in the West Java province. In 2003, YRSB infested nine varieties of rice commonly grown in the Pantura area of Java, causing 37.9% pest attacks in the first growing season and increasing by 65% in the second season. In 2011, YRSB attacks on Pantura reached 146,315 ha. Pest attacks mainly occur in West Java, reaching an intensity of 26.9% or around 15,000 ha attacked by rice fields in Karawang (Directorate Food of Crop Protection, 2012).

According to Baehaki (2013), farmers mainly depend on insecticides to control YRSB. Nurindah (2006) added that intensive use of insecticides can form negative impacts, such as resistance, resurgence, the emergence of secondary insects,

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and pollution. On the other hand, an alternative, more environmentally friendly control method is to utilize natural enemies. Naturally, the rice field's natural enemies, such as parasitoids, will suppress the RSB population. As Rauf (2000) reports, there are three parasitoids of RSB eggs in Karawang Regency. The primary parasitoids are *Telenomus rowani* Gahan (Hymenoptera: Scelionidae), followed by *Trichogramma japonicum* Ashmed (Hymenoptera: Trichogrammatidae) and *Tetratichus schoenobii* Ferriere (Hymenoptera: Eulophidae). Samsi (2014) mentions those parasitoids are also found to parasitize *S. incertulas* in Ngawi Regency, respectively in dominant order being *T. japonicum, T. rowani*, and *T. Schoenobii*. Usyati et al. (2003) report that *Trichogramma* spp. and egg parasitoids from the Trichogrammatidae insects have been commonly used as biological agents in controlling various Lepidoptera insect pests.

Based on the reports mentioned above, it is thought that the cultivation of rice from the soil preparation until harvest needs further evaluation. The presence of rice stem borer larvae throughout the production process, from nursery until post-harvest, must also be evaluated. Soil maintenance and different planting dates are thought to have influenced the presence of *S. incertulas* larvae and other rice stem borers in Karawang. In addition, the ineffective harvesting technique that still leaves paddy stubbles on the field has also contributed to the increase in the pest population.

Indonesia has three common paddy harvesting methods: traditional, manual, and mechanical (Sulistiaji, 2007). In West Java, paddy is harvested manually using a sickle, and the grains are removed from the stalk using a thresher machine. This harvesting technique usually leaves the lower stem of the rice, called stubble. The stubbles, which can be short or tall, remain after the cutting of the paddy. Paddy stubble can harbour and provide RSB larvae and pupae after the harvest period and potentially become the source of the infestation in the following season. The condition of the growth phase of paddy in a wide area may have different planting times according to the availability of water for cultivation. The cultivation timing differences cause various periods for fallowing rice fields. A long period of fallow contributes to the newly growing rice emerging from stubble, known as turiang. Information on the presence of RSB in rice fields during that period is still limited.

In the following rice season, some land ready for planting will create a nursery earlier than the rest of the land in that wide rice field area. The initial infestation of RSB is mostly through nurseries on seedbed sites. The adults lay their eggs on paddy in the nursery (Adiartayasa & Wijaya, 2016). The occurrence of RSB larvae on paddy stubbles during post-harvest and adult RSB on nurseries and her eggs, including parasitation on egg masses, need to be observed. This research aims to determine the effect of fallowing rice fields on the presence of rice stem borers and their parasitoids and the potential for RSB infestation on subsequent rice seedlings at Karawang Regency, West Java.

MATERIALS AND METHODS

Research Site

This study was conducted from July to August 2020 in Karawang Regency, including Rawamerta and Kutawaluya District. The insect samples were identified at the Insect Biosystematics Laboratory, Department of Plant Protection, IPB University in Bogor.

RSB larvae were sampled in Rawamerta District, Gombongsari Village (6°13'31"S; 107°23'11"E), and Kutawaluya District, Sindangmukti Village (6°11'36"S; 107°21'48"E). The long rice fallow fields in Rawamerta District are represented in Fig. 1a, showing rice plants harvested for several weeks and left paddy stubbles overgrown with new tillers called *turiang*. The short rice fallow fields occur in Kutawaluya District; the rice plants have just been harvested, and the left stubbles do not have *turiang* yet.

RSB egg masses and their parasitoids were sampled in 4 nurseries in two different rice fallow areas. Two nurseries were lying in the long rice fallow area, located in Rawamerta District, i.e, Gombongsari Village, including Gombong Sub-village (6°13'56"S; 107°22'37"E) and Kosambi Subur Sub-village (6°13'27"S; 107°23'06"E) and two other seedbeds were lying in the short rice fallow area in Kutawaluya district, i.e: Sindangsari Village, including Ciligur Sub-village (6°11'39"S; 107°22'23"E) and Krajan Sub-village (6°11'50"S; 107°22'25"E). Fig. 1b shows the rice seed bed.

Sampling of RSB Larvae on Paddy Stubble

Larvae sampling was determined by a *purposive sampling* method, which selected as many as 25 rice plots per location that still had paddy stubbles. A total of 30 samples of paddy stubbles per plot were collected diagonally and brought to the laboratory. All stems from each stubble, both from sites that have grown new tillers and from locations with stubble that have not yet grown *turiang* are dissected to identify larvae up to species level and to count the RSB larvae number. Identifying the larvae refers to the key insect identification (Hattori & Siwi, 1986). The data presented as larvae species name, average population density per 30 stubble samples, and borer-infested level rates on stubble. Then, the data from those two different fallow periods are compared.

Observation of Infested Stubbles on Rice Fallow Area by RSB

Observation of infested stubbles consists of measuring the height of the remaining harvested paddy, infested stubbles, and the intensity of infested tillers. The location sites of this observation were done on the same sampling site of RSB larvae on paddy stubbles, i.e., on 25 plots and 30 stubbles of each plot. Each location was done for the area with two different fallow periods. The height of stubbles from the base of the stem to the end of the cut stem was measured using a ruler. The measurement was carried out before the stubbles were dissected to observe the presence of RSB larvae inside.

Infested stubbles were counted using the formula 1:

$$\text{Percentage of infested stubbles} = \frac{Total\ numbers\ of\ infested\ stubbles}{Total\ numbers\ of\ stubbles\ observed} \times 100\% \quad ..1)$$

The intensity of infested tillers in this observation on the area of the long rice fallow period including new tillers, whereas stubbles on short fallow period only stubble with existing tillers, using the formula 2:

$$\text{Percentage of intensity infested tillers} = \frac{Total\ numbers\ of\ infested\ tillers\ on\ one\ stubble}{Total\ numbers\ of\ tiller\ observed\ on\ one\ stubble} \times 100\% \quad ..2)$$

A Sampling of RSB and Their Parasitoids in the Nursery on Rice Fallow Area

Sampling of egg masses and RSB adults was carried out on 15 rice seedbeds per observation location, namely in 4 predetermined sub-villages, and carried out two samples at intervals of 15 days. The egg mass and RSB adults are taken from each seedbed and counted. Egg masses are put into separate glass tubes and kept for 3-5 days to determine the number of eggs that hatch, fail to hatch, or parasitize. Hatching larvae of RSB eggs or emerging adult parasitoids were identified and counted. Parasitoid species are determined based on the key identification of Barrion & Litsinger (1994).

Data Analysis

Data on the population density and percentage of two species of RSB larvae in paddy stubble and the height of paddy stubble and RSB infestation level were tested using the Man Whitney test at 5% and t-Test at 5%. The density of adults and egg masses of RSB in nurseries, the hatching of RSB larvae, and the emergence of parasitoids from egg masses in nurseries were tested using the Duncan test at a level of 5%. The data were analyzed using *IBM SPSS Statistics version 25* software. The data on infested stubble and intensity-infested tillers by RSB and the parasitization of RSB eggs in seedbeds were analyzed using *Microsoft Excel 2013*.

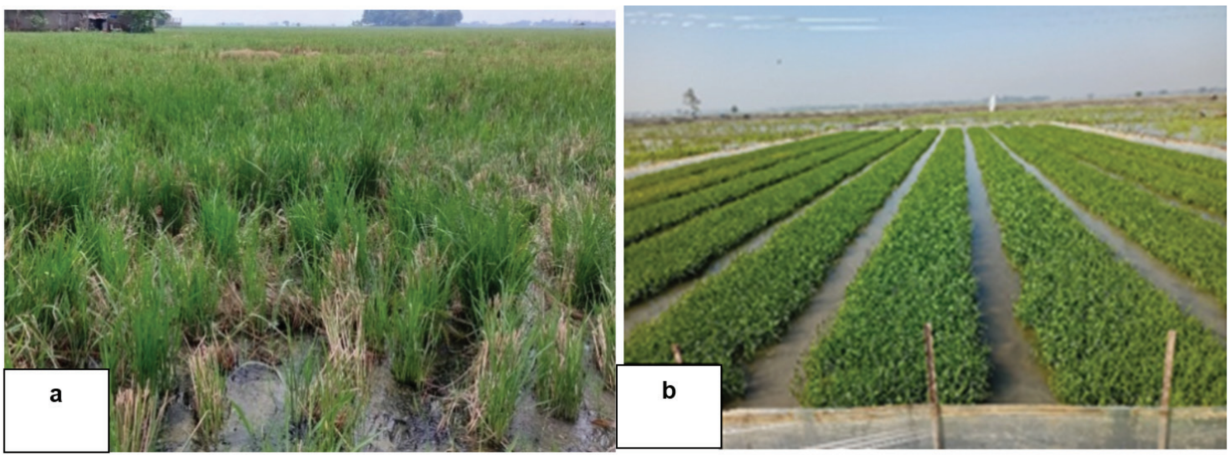

Fig. 1. Sampling location: (a) location of paddy stubble that has been overgrown with *turiang* to observe RSB larvae in Rawamerta District, (b) rice nursery location to observe clusters of RSB adult and egg masses in Kutawaluya District

RESULTS AND DISCUSSION

Diversity and Population Density of RSB on Paddy Stubble on Rice Fallow

Two species of RSB are found on paddy stubbles at two observation sites: S. *incertulas* (YRSB) and *S. inferens* (PRSB). The number of YRSB in Rawamerta District is 15.84 larvae per 30 stubbles, and PRSB is 5.08 larvae per 30 stubbles. On the other hand, in Kutawaluya District, the average population of YRSB is 3.48 per 30 stubbles, and PRSB is 47.88 larvae per 30 stubbles (Table 1). The results show that in the long rice fallow district, the population of YRSB is higher than that of PRSB, while conversely, in the short rice fallow district. The average of each RSB larvae population per 30 stubbles from 25 plot samples in both districts is significantly different.

The population of PRSB in the short rice fallow district is much higher than the population of YRSB. This is thought to be influenced by several factors, one is the biological activity of adult female PRSB, which is believed to lay eggs in rice plants in the early generative phase until one month after harvest. Singh & Kular (2015) explain that *S. inferens* infestation peaks when rice plants have entered the generative phase. This statement is also supported by Pallavi et al. (2018), who stated that the highest population of *S. inferens* occurs in the maturation phase. Meanwhile, population PRSB is known to decline as paddy plants age. A study by Damayanti et al. (2015) showed that the population and intensity of PRSB attacks gradually decrease as plants age. This is thought to affect the low population of larvae YRSB in short rice fallow districts, where paddy plants have entered the generative phase and have just been harvested and may be less preferred adult female YRSB to lay eggs, adult female PRSB is the opposite.

RSB Infested Stubbles in Rice Fallow

The height of the paddy stubbles at the two observation sites is not significantly different (Table 2). However, infested tillers' infestation levels and intensity in the two fallow rice periods differ significantly. The infestation rate of stubble by RSB in the short rice fallow district is highest due to the RSB, which infests the generative phase of paddy still in the larvae stage and lives at the base of paddy stubbles. The average intensity infested tillers in short rice fallow reached 7.42%.

RSB larvae that tend to feed on the below side of the plant are usually left on the stubble when the rice is harvested. The average RSB larvae tend to be in the base of the rice stem to the base of the rice stem. According to Soomro et al. (2014), RSB populations are in stumps up to 15 cm above ground level. Therefore, it is advisable to cut as low as possible so that the remaining RSB from the generative phase will be discarded along with other post-harvest residues. This is in line with the research of Soomro et al. (2014), who found that harvesting at a height of 15 to 20 cm above the ground is recommended because it can reduce the population density of RSB larvae and pupae. Beuzelin et al. (2012) also explained that lowering the cutting height of rice plants from 40 cm to 20 cm reduced rice stem borer attack on stubble by 70% to 81% in Mexico. Meanwhile, in the Karawang case, the cutting height of the paddy is too high, which could cause a change in RSB larvae to be pupated. The adult emerging from the pupae stage could threaten the following season.

Table 1. The larvae density and percentage of two RSB species in long and short fallow at Karawang Regency

Rice fallow period	Average number of larvae per 30 stubbles	
	***Scirpophaga incertulas* (YRSB)**	***Sesamia inferens* (PRSB)**
Long	15.84±12.35 aA* (71.32%)	5.08±4.28 bB (28.68%)
Short	3.48±2.92 bB (8.9%)	47.88±26.85 aA (91.1%)

Remarks: * Numbers in the same column followed by the same lowercase letters are significantly different. The numbers in the same row followed by the same uppercase letters are not significantly different (Mann Whitney test and t-Test, α = 5%).

Further observations to separate YRSB and PRSB from the RSB data in Table 2 are presented in Table 3, that the paddy stubbles are infested by both species of RSB, which are found in one stubble in long rice fallow, Rawamerta District up to 5.73% and in short fallow of Kutawaluya District up to 6.27%. The paddy stubbles in long rice fallow are more infested by YRSB than PRSB. The average infestation of YRSB in long rice fallow reached 24.67%, while PRSB is 6.27% (Table 3). The presence of *turiang* is thought to support the existence of YRSB at the observation site, which then infested paddy stubbles. Hamsein et al. (2020) state that the morphology of rice plants influences the egg-laying behavior of adult female YRSB, which are more attracted to an upper region of plants to lay the eggs. In addition, this species is known to be monophage and feeds on young and healthy paddy.

The paddy stubbles harvested in the short rice fallow district are more infested by PRSB, with an infested rate of up to 54.00%, while YRSB is 3.20% (Table 3). The increased population of PRSB, when paddy enters the generative phase and still lays eggs after the plants are harvested, is thought to affect the high infestation of paddy stubbles. In addition, adult females are known to lay eggs on paddy stem and leaf bases that are usually not cut off during harvest (Baladhiya et al., 2018). PRSB is also known to be polyphagous with more than one host plant (Jeevanandham et al., 2020; Hussain et al., 2019).

The data in Table 3 reinforces the data contained in Table 1, where the high RSB infested on rice stubbles is influenced by its high population. Cahyoko et al. (2018) state that the level of RSB infestation is indeed correlated with the population. The contradiction of the RSB population will give different results on infested paddy stubble. These results also show that adult female RSB can lay eggs in fallow conditions that leave stubbles after harvest and after the ricefield has been left for a long time. Larvae can live and thrive by infesting left paddy stubble in the field. This fallow field can be a source of infestation for RSB infests on paddy in the next season.

Population of RSB Moths and Their Egg Masses in the Nursery

Numbers of RSB moth and their egg masses were observed in two nurseries within the long rice fallow area and two within the short rice fallow area. The seeding process was carried out on both fallow periods for approximately three weeks. This study shows that the number of RSB moths and their egg masses in nurseries in long rice fields and one nursery in short fields are not significantly different (Table 4).

Table 2. The average of the height of paddy stubble, infested stubble by RSB, and intensity infested tillers on the stubble of RSB level in rice fallow

Rice fallow period	Stubble length (cm)	Infested stubbles (%)	Intensity/tillers on paddy (%)
Long	53.08±3.80 a	48.13±28.06 b	3.38±2.25 b
Short	53.54±3.90 a	76.00±19.58 a	7.42±4.06 a

Remarks: * Numbers in the same column followed by the same letters are not significantly different (t-Test and Mann Whitney Test, α = 5%)

Table 3. The average percentage of infested rice stubbles by RSB on rice fallow

Rice fallow period	Average stubbles infested by (%)			Average of uninfested stubbles (%)
	Scirpophaga incertulas (YRSB)	*Sesamia inferens* (PRSB)	*S. incertulas* and *S. inferens* (RSB)	
Long	24.67±4.54	6.27±1.83	5.73±1.88	63.33±13.65
Short	3.20±1.17	54.00±5.37	6.27±1.67	36.53±4.68

Table 1, Table 2, and Table 3 show that the RSB larvae could live on the paddy stubbles. These larvae stage will become pupae and emerge as adults. Then, the RSB moth will fly from stubbles, find the nurseries in their surroundings, and lay her eggs. Ratih et al. (2014) stated that the distance between rice fields influences the RSB moth population so that it can move from one rice field to another. Sun et al. (1993) also suggested that RSB moths are potent fliers, the cumulative flight distance of adult female of RSB can fly to be over 32 km. In this case, the paddy stubbles on both fallow rice fields could be an infestation source of RSB for the nurseries. In addition, abiotic factors, such as temperature, relative humidity, and wind velocity influenced on the RSB population (Sharmitha et al., 2021).The YRSB is the only RSB species found in the nurseries in this study. This is thought to be influenced by the character of an adult female of YRSB who likes young plants to lay eggs. Pathak & Kahn (1994) mention that YRSB is found in nurseries. Based on observations, RSB infests as early as ten days after seeding. Ahmad et al. (2016) reported that YRSB is the major pest in paddy nurseries. Thus, YRSB population control through monitoring during seeding and egg mass retrieval is highly recommended. Singh & Tiwari (2019) stated that *S. incertulas* is an RSB species whose population is always abundant at all stages of paddy development. Controlling YRSB during seedling is one solution that can be done to suppress the RSB population at the next phase of paddy development.

Egg Parasitization in the Nursery on Rice Fallow Area

Most of the reared eggs fail to hatch. Hatching eggs is influenced by egg viability, parasitation, and other abiotic factors. The number of hatched eggs and the unhatched were almost equivalent in value. In this study, the cause of the unhatched eggs was unknown. Hasanah et al. (2018) explained that the failure of Lepidoptera eggs to hatch could be caused by abiotic factors unsuitable for the eggs' embryonic development. This is because every insect has different temperature tolerances for their survival. It is thought that taking egg masses from the observation sites to the laboratory can change the abiotic conditions, affecting egg development. The highest average number of hatched eggs, followed by the emergence of larvae, is found in the long rice fallow nursery at 41.38% in the first observation (Table 5). On the other hand, the highest percentage of unhatched egg masses is from short rice fallow areas, 60.72% and 60.19% (Table 5).

The parasitized egg masses are found in nurseries from rice fallow areas, with the highest percentage reaching 35.29% from long rice fallow nurseries (Table 5). Nickel (1964) and Suneel et al. (2008) explain that egg parasitoids are essential in controlling RSB populations when pest abundance is high. Meanwhile, the egg masses that hatched into the larvae and appeared as parasitoids are only found in long rice fallow nurseries. This study finds the most parasitized egg masses in nurseries in long fallow areas. The higher population of YRSB in long fallow areas (Table 1) is thought to influence the number of parasitoids that appear. The abundance of egg parasitoids is higher when the level of RSB attack on the paddy field is higher, and this is supported by a high egg mass density, making it easier for parasitoids to find egg mass of RSB to parasitize (Maramis et al., 2011). However, the high average percentage of parasitization of egg masses does not guarantee that the plant is free from RSB infestation. However, the presence of parasitoids can prevent the pest population from exploding.

Table 4. Adult and egg mass of rice stem borer per seedbed found in the paddy nursery at Karawang on rice fallow area

Nursery on rice fallow area	Nursery in sub-village	Seeding date	Avarage number per seedbed			
			Moths		Egg masses	
			O1	O2	O1	O2
Long	Gombong	19-07-2020	0.51 ab*	0.22 a	0.69 b	0.71 b
	Kosambi Subur	03-08-2020	0.36 ab	0.13 a	0.46 b	0.16 b
Short	Ciligur	15-07-2020	2.20 a	0.62 a	3.80 a	3.35 a
	Krajan	06-08-2020	0 b	0.08 a	0 b	0.06 b

Remarks: *Numbers in the same column followed by the same letters are not significantly different (Duncan test, α = 5%). O1 is the first observation, ten days after seeding (DAS). O2 is the second observation, 15 days after seeding (DAS).

Table 5. The condition of yellow rice stem borer eggs found in the seedling nursery at Karawang in the rice fallow area

Nursery on rice fallow area	Nursery in Sub-village	Number of Egg mass (%)							
		Hatched		Unhatched		Parasitized		Hatched and parasitization	
		O1	O2	O1	O2	O1	O2	O1	O2
Long	Gombong	41.38±3.29	31.82±3.13	44.83±5.39	49.09±4.87	12.07±1.48	13.64±1.46	1.72±0.34	5.45±0.71
	Kosambi Subur	30.77±2.21	23.53±0.44	55.77±4.25	35.29±0.61	13.46±1.26	35.29±0.80	0.00	5.88±0.35
Short	Ciligur	35.51±46.21	36.77±27.03	60.72±52.35	60.19±35.35	3.77±2.47	3.04±1.54	0.00	0.00
	Krajan	0.00	25.00±0.56	0.00	62.50±1.22	0.00	12.50±0.33	0.00	0.00

Remarks: The O1 is the first observation, ten days after seeding (DAS). The O2 is the second observation, 15 days after seeding (DAS).

Table 6. The number of RSB larvae and parasitoids emerged from egg masses in paddy nurseries in the rice fallow area at Karawang

Nursery on rice fallow area	Nursery in Sub-village	Average number of stemborer larvae and parasitoids appeared							
		YRSB larvae		*T. schoenobii*		*T. rowani*		*T. japonicum*	
		O1	O2	O1	T2	O1	O2	O1	O2
Long	Gombong	15.25 a	5.69 a	3.01 a	0.48 ab	1.52 a	3.01 a	1.94 a	1.50 a
	Kosambi Subur	6.41 ab	8.71 a	2.91 a	4.93 a	3.00 a	5.33 a	0.00 a	0.00 b
Short	Ciligur	5.42 b	3.78 a	3.31 a	1.69 ab	3.13 a	2.05 a	0.14 a	0.07 b
	Krajan	0.00 b	5.33 a	0.00 a	0.00 b	0.00 a	1.07 a	0.00 a	0.00 b

Remarks: The O1 is the first observation, ten days after seeding (DAS). The O2 is the second observation, 15 days after seeding (DAS).

Three species of parasitoids appeared from the YRSB egg masses collected from rice nurseries in both rice fallow areas. Among them, are *Tetrastichus schoenobii, Telenomus rowani,* and *Trichogramma japonicum*. Similar parasitoids were reported from YRSB in Jambi (Wilyus et al., 2013), and the last observation was in Karawang by Rauf (2000). The number of *T. schoenobii* is not significantly different in nurseries from both rice fallow areas (Table 6). Rauf (2000) explains that the larvae of the late instar *T. schenobii* will eat at least three egg hosts. Therefore, *T. schoenobii* needs many eggs to develop into adults. The numbers of *T. rowani* are not significantly different in both fallow rice areas (Table 6). This parasitoid most appeared from the egg masses in long rice fallow nursery at the second observation and reached 5.33 parasitoids (Table 6). However, this parasitoid appeared in all locations, including the fewest egg masses found. This incident is due to *T. rowani's* ability to exploit hosts efficiently; they only need one host egg to live (Resiani & Sunanjaya 2016). This ability supports *T. rowani* in parasitizing YRSB eggs in the nursery, becoming the highest parasitoid discovered in the observation site. Meanwhile, the number of *T. japonicum* was the lowest among others. The most increased occurrence appeared at the nursery in the long rice fallow area at the first observation of 1.94 (Table 6). According to Rauf (2000), this parasitoid does not like the texture of YRSB eggs covered with scales. In addition, its small size also makes it challenging to penetrate egg masses, so the parasitization rate is lowest compared to other parasitoids (Baehaki, 2013).

Variations in the size of egg masses at each location are thought to cause differences in the number of larvae that hatch and parasitoids that appear. Samsi (2014) reveal that the number of hatched larvae is related to the high variation of egg masses. In addition, the difference in seeding time in each sub-village can also be a driver. Farmers who do late seeding direct adult YRSBs to fly to newly planted rice fields that provide more food. Several factors influence the appearance of adult parasitoids from egg masses. Overlapping RSB eggs makes it difficult for parasitoids to choose in the lower egg masses, resulting in fewer parasitized eggs (Jannah, 2010). Other factors include the size of the female parasitoid, the size and quality of the egg host, and the egg-laying ability of the female parasitoid (Nurafiatin, 2000). Yunus et al. (2004) report that egg production tends to increase with increasing size of female parasitoids. The high number of eggs produced indicates more parasitoids' offspring.

CONCLUSION

RSB species found at the study site are *S. incertulas* (YRSB) and *S. inferens* (PRSB) in long rice fallow. The most dominant population is YRSB, while in short, rice fallow is PRSB. The moth RSB population and the most egg masses occur in short rice fallow nurseries. Meanwhile, the percentage of parasitized eggs occurs in long rice fallow nurseries. The RSB parasitoids identified in this study are *Tetratichus schoenobii, Telonomus rowani,* and *Trichogramma japonicum.*

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