Akta Agrosia

Inventory and Potential of Yellow Rice Stem Borer (*Scirpophaga incertulas* Walker) as Parasitoid in Rice Field (*Oryza sativa* L) in Three Villages, Lima Puluh Regency, Batubara District, North Sumatra

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ARTICLE INFO

Keywords:
rice
Scirpophaga incertulas
parasitoid
parasitation Level
dominance
distribution pattern

Article history:
Received: June 07, 2020
Accepted: December 13, 2020
Published December 28, 2020

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ABSTRACT

Yellow rice stem borer (YRSB), Scirpophaga incertulas Walker, often causes decreased of rice production. One of the pest controlling of YRSB used based on the concept of IPC (integrated Pest Control) was biological control using egg parasitoids. The purpose of this research was to find out the inventory and potential of parasitoids of eggs in yellow rice stem borer (*S. incertulas*) on rice cultivation at 3 locations (Kuala Gunung Village, Cahaya Pardomuan Village, and Air Hitam Village) in Lima Puluh Sub-District, Batubara Regency, Northern Sumatra. The study used a survey method by taking samples of groups of eggs by purposive sampling on rice cultivation. Egg clusters are kept for several days until the parasitoids appear. Parasitoid that appeared was preserved in a bottle containing 70% alcohol, then identification was carried out at the Pest Laboratory of Departmemt of Agrotechnology, Faculty of Agriculture, University of Sumatera Utara. This research was conducted from March to September 2019. The results obtained by 3 Parasitoid families were identified, such as Eulophidae, Scelionidae, and Trichogrammatidae. Parasitoid level and parasitoid dominance index were higher in the non-insecticide treatment compared to the insecticide treatment. The highest parasitic rate recorded from the Eulophidae family and the lowest of the Trichogrammatidae family. The highest parasitoid dominance index was found in the Eulophidae family and lowest in the Trichogrammatidae family. The distribution pattern of the Eulophidae family was grouped, the Trichogrammatidae family was regular while the Scelionidae family was different for each village. Our prediction, the research will be useful for future.

INTRODUCTION

Rice is a primary source of food for most Indonesian people. This indicates that increasing rice production and productivity is necessity because the population continues to grow. The national average consumption of rice in Indonesia is about 139 kg/capita/year. Efforts to increase rice production are increasingly difficult due to various obstacles and problems, including climate change and pest attacks (Delly and Sunanjaya, 2016).

Until now, pests are still an obstacle for farmers. Almost every season there is an explosion of pests in rice cultivation. The main pests of rice such as rats, rice stem borer, and brown planthopper.

ISSN: 1410-3354 / e-ISSN:2615-7136

Cited this as: Siagian, S, A.Z. Siregar, and M.C. Tobing. 2020. Inventory and potential of Yellow Rice Stem Borer (*Scirpophaga incertulas* Walker) as parasitoid in rice field (*Oryza sativa* L) in three villages, Lima Puluh Regency, Batubara District, North Sumatra. Akta Agrosia 23(2):55–62.

Some other pests that have the potential to damage rice plantations are white back hopper, green leafhopper, rock jaundice, caterpillar, leaf folding, and stinky rice pest (Widiasara, 2017).

Rice stem borer is generally considered an important pest in rice plants around the world and attacks plants from the vegetative to generative phases. A total of 50 species in 3 families consist of Pyralidae and Noctuidae (Lepideptora order) and Diopsidae (Diptera order) which are known to attack rice plants. The species of Pyralidae is the species that attack the most and usually has a specific host plant. Rice stem borer is an endemic pest that can cause yield loss every year it reaches 10-30% (Damayangti *et al*., 2015; Lu et al., 2019).

In Indonesia, there are five species of rice stem borer which are an obstacle and can reduce rice production. These rice stem borers are yellow rice stem borer *Scirpophaga incertulas* (Walker) (Lepidoptera: Pyralidae), white rice stem borer *Scirpophaga innotata* (Walker), *Chilo suppressalis* Walker, *Chilo polychrysus* (Meyrick), and *Sesamia inferens* (walker) (Baehaki, 2012; Chatterjee and Dalash, 2014).

To suppress the paddy rice stem borer, one needs to utilize the parasitoid biological control. Parasitoids are part of natural enemies that are extensively researched and have shown good results in controlling insect pests than predatory insects (Maramis et al., 2011).

A parasitoid is generally an insect of the order Hymenoptera, and one of the families whose members play a large role in biological control is Trichogrammatidae. Trichogrammatidae is a family that is well-known as a biological control agent of various pest insects classified as egg parasitoids. Research on the development and release of the parasitoid family Trichogrammatidae has been widely carried out in several countries and is reported to be able to suppress pest populations, especially from the order Lepidoptera (Samsi, 2014; Sharma et al., 2015).

Egg parasitoids most developed to control insects of the order Lepidoptera. This is due to the egg parasitoid to control pests before damage crops. Egg parasitoid of Yellow Rice Stem Borer which is found in the field and has an important role is Trichogrammatidae family, relatives, and family Eulophidae Scelionidae have the potential and effective in reducing the population of the rice stem borer. The ability of these three parasitoids to paralyze rice stem borer eggs varies greatly depending on the place and environment that supports them to develop (Tang *et al*., 2017). The objectives of the study to inventory and determined the potential of egg parasitoids of yellow rice stem borer *(Scirpopaga incertularis*) at rice plantations in three villages in Lima Puluh District, Batubara Regency, North Sumatra.

MATERIALS AND METHODS

This research was conducted in the field and laboratory from March to September 2019. Field research was conducted out on farmers' rice plantations in three villages in Limapuluh District, Batubara District: Kuala Gunung Village, Cahaya Pardomuan Village, Air Hitam Village with a height of ± 28 meters above the sea level. The identification process of the biological stage was carried out at the Pest Laboratory, Agrotechnology Study Program, Faculty of Agriculture, University of North Sumatra. This study used a survey method by taking samples of groups of rice stem borer eggs by purposive sampling in rice cultivation. Egg sampling aims to determine the pattern of spread, parasitic rate, diversity, and dominance of parasitoids of yellow rice stem borer (*Scirpophaga interculas* Walker). Egg samples were taken from three different villages. Retrieval of data using the quadratic method. The area of sampling land in each village was 300m x 100m, divided into 5 diagonal plots and 1 plot outside the quadrant as a control (without insecticide) measuring 10m x 10m and then divided into 4 subplots, so the total was 24 sampling plots in each village. Sampling was done in groups of rice aged 3-10 weeks after planting so that 8 observations were made. Furthermore, the identification of preserved parasitoid specimens was carried out, calculating paraitic level of parasitoid (P = 3 (A+B)/3 (A+B) + (C+D) + 0.5 (E+F) + (H+M) *100%), dominance of the parasitoids (C= ni/N) of the yellow rice stem borer eggs, the distribution pattern of the parasitoid (Id= ni (ni-1) N/ n (ni-1), and the physical-chemical factors in the field.

RESULTS AND DISCUSSION

Parasitoid identification

The results showed that parasitoid eggs that parasitized yellow rice stem borer eggs consisting of 1 order, and 3 families, such as described below.

Hymenoptera : Eulophidae

The body size was 1-2.5 mm, overall bluish-black (metallic). It had an elbow-shaped antenna (angled) consisting of 7 segments, antenna-like a comb with fine hairs in each segment. 4-5 flagellum, 2-4 funicular segments, sculettum there are 2 pairs with longitudinal lines, bluish-black. The Mesosoma and metasoma families were separated (Gibson et al., 1997; Goulet and Huber, 1993), such as descibed into Figure 1 below.

Figure 1. Eulophidae family parasitoids (Microscopic photo, 2020)

Hymenoptera : Scelionidae

It had a black body length of 0.5-2 mm, 11-12 segment antenna, and 9-10 segment flagellum. Sub-marginal veins of the rear wing reach hamuli. On the front wing, the submarginal vein usually reaches the anterior end of the wing (Jonshon, 1984). There was a stigma vein and has a post marginal vein. The chest was slightly convex toward the posterior part. Tarsus consists of 5 segments and there were fine spines (Gibson et al., 1997; Goulet and Huber, 1993) are shown into Figure 2.

Figure 2. Scelionidae family parasitoids (Microscopic photo, 2020)

Hymenoptera: *Trichogrammatidae*

It had small body measuring 0.2-1 mm yellowish-brown, abdomen, and thorax 6 together, with transparent clear wings surrounded by many long feathers (tufts) at the tips of the wings, each wing forming a line. It had an arista antenna form, shorter than the head and metasoma,has 2-3 flagellum consisting of funiculuc and clavus, tarsus consists of 3 segments (Gibson et al, 1997;Gibson and Huber, 1993) (Figure 3)

Figure 3. Trichogrammatidae family parasitoids (Microscopic photo, 2020)

Parasitic Level of Parasitoid

The parasitic level of parasitoids in the insecticide treatment field showed that the highest level of parasitization (41.78%) was found in the Eulophidae family in Air Hitam Village and the lowest (0.05%) was found in the Trichogrammatidae family in Kuala Gunung Village. Furthermore, while the level of parasitoid parasitic on land without treatment while the level of parasitoid parasitization on land without insecticide treatment showed that the highest average

Table 1. Identification of three eggs parasitoid families

Families	Morfologi Serangga		
	Antenna	Wings	Limb
Eulophidae	Consists of 6-7 segments	The front wings are long and curved submarginal parts	The end of the limb (tarsus) has 4 segments
Scelionidae	Consists of 11-12 segments and elbow-shaped	The rear wing is smaller than the front wing and has one small hook	The end of the limb (tarsus) has 5 segments
Trichogrammatidae	Consisting of 6 segments, there are fine hairs	The edge of the feathered wing is longer than other types	The end of the limb (tarsus) have 3 segments

observation (38.53%) of the Eulophidae family was found in Air Hitam Village, and lowest (0.00%) found in the Trichogrammatidae family in Kuala Gunung Village.

Table 2 showed the recorded data on parasitoids of parasitoid eggs in yellow rice stem borer in 3 three villages in fifty sub-district, Batubara Regency, Northern Sumatra.

The high level parasitic of parasitoid Eulophidae was suspected because the parasitoid ability to parasitize was higher compared to other parasitoids. One individual parasitoid family Eulophidae could paralyze 2-3 eggs yellow rice stem borer or called parasitoid gregarius. As stated by Junaedi et al. (2016) that the parasitoid power of the Eulophidae family was higher than that of other parasitoid parasites and can parasitize 2-3 eggs per individual parasitoid. Ganeshwari and Kumar (2019) also stated that the parasitoid family Eulophidae had a higher ability to spawn than the parasitoid family Scelionidae and Trichogrammatidae

Table 2 showed that the level of parasitation was different for each village. The highest parasitic levels were found in Air Hitam Village with the average parasitic levels of Eulophidae (41.78%), Scelionidae (13.04%), and Trichogrammatidae (0.08%). While the lowest parasitic rate was found in Kuala Gunung Village with an average parasitoid level of the family Eulophidae (28.06%), Scelionidae (4.36%), and Trichogrammatidae (0.03%). This was thought to be caused by differences in the way of cultivation including the frequency of fertilizer application and type of fertilizer, frequency of application of insecticides, and active ingredients used, as well as differences in rice varieties cultivated at each study location. In Air Hitam and Kuala Gunung villages, insecticide applications were carried out once a week starting from 2 weeks after plant, in contrast to Desa Cahaya Pardomuan, the application of insecticides was done once in 10 days, starting from 2 weeks after plant.. Cahyoko et al. (2018) stated that the intensity of the application of pesticides can reduce the abundance of yellow rice stem borer in the field, thereby reducing the level of parasitic egg parasitoid in the field.

The high level of parasitoid parasitization in the 3-5 weeks after plant observation in each village was thought to be caused by the high population of the host egg group in the vegetative phase because in this phase a new sapling formation occurs. The population of the host egg group was directly proportional to the high level of parasitoid parasitation. This was consistent with Rama et al. (2013) report finding that the level of parasitoid egg parasitization would increase with an increasing population of the host egg group, as well as Rahaman et al. (2014) which states that the highest S. *incertulas* population is in the puppies stage, but yield losses due to S. *incertulas* attacks could still be compensated because of the ongoing formation of tillers.

Dominance index

The highest dominance index (0.67%) was found in the treatment without insecticide in Cahaya Pardomuan Village by the parasitoid family Eulophidae in the category of moderate dominance, while the lowest dominance (0.00%) was found in the Trichogrammatidae family in each village and including the low dominance category (Table 3). Meanwhile, the

Table 2. Parasitic level of parasitoid Noted: Dap=day after plantation

Location	Dap	Treatment of land with insecticide			Treatment of land without insecticide		
		Eulophidae	Scelionidae	Trichogrammatidae	Eulophidae	Scelionidae	Trichogrammatidae
	3	33.9	6.6	0.4	39.4	0	0
	4	36.6	5.6	0	30.9	4.2	0
	5	29.7	5.1	0	33.8	1.8	0
	6	33.9	4.8	0	28.7	2.2	0
	7	26.2	2.8	0	26.9	8.3	0
	8	21.7	2.1	0	47.8	0	0
	9	30	4.6	0	28	5.3	0
	10	12.5	3.3	0	17.8	5	0
Average		28.06	4.36	0.05	31.66	3.82	0
	3	32.9	29.8	0	71.4	6.6	0.6
	4	39.4	5.4	0	48	5.3	0
	5	32.5	8.3	0	23.1	5.6	0
	6	32.5	7.1	0	39.4	4.4	0
	7	27.9	1.2	0.5	41.6	11.6	0
	8	25.5	5.1	0	31.1	2.1	0
	9	22.9	6.3	0	17.3	7.6	0
	10	15.9	3.3	0	12.5	3.3	0
Average		28.68	8.31	0.06	35.55	5.81	0.07
	3	43.42	30.16	0.63	53.74	6.13	0.63
	4	67.88	16.78	0	38.57	3.57	0.12
	5	46.82	21.34	0	0	11.63	0
	6	46.45	10.44	0	56.45	11.29	0
	7	37.5	12.46	0	46.45	4.52	0
	8	33	8	0	38.89	18.52	0
	9	31.23	7.3	0	36.04	5.52	0
	10	27.97	0.77	0	38.1	30.16	0
Average		41.78	13.4	0.08	38.53	11.41	0.09

highest dominance index (0.62) was found in the Eulophidae family in the village of Cahaya Pardomuan, while the lowest (0) was found in the Trichogrammatidae family in three research locations.

The dominance of the family Eulophidae was higher compared to other parasitoids (Table 3). This was presumably because the parasitoid family Eulophidae had a higher parasitic power (Gibson et al., 1997; Goulet and Huber, 1993). The Eulophidae family parasitoids did not depend on the shape and structure of the egg group, in contrast to the 2 other parasitoids where the Scelionidae and Trichogrammatidae family parasitoids would decrease if the size of the egg group gets bigger.

Trichogrammatidae parasitoids had a dominance index of 0 (zero) with the lowest category in the insecticide and non-insecticide treatment fields in 3 study sites. This was thought to be caused by the parasitoid character of Trichogrammatidae which was very selective in choosing a host for laying eggs. Another factor influencing the dominance of the Trichogrammatidae parasitoid was its short life cycle of only 1-2 days resulting in very low population dominance. Following Yunus's research (2017) reporting that the parasitoid family Trichogrammatidae tended to be more selective in choosing a host as a place for laying eggs to breed new individuals.

The dominance of the Eulophidae family in the vegetative phase was higher than that of the generative phase due to the high dispersal power of the parasitoids in invading new crops. This parasitoid was more likely to look for a new place with a higher host egg population. As stated by Wilyus et al. (2012) showed that the dominance of the family Eulophidae was higher compared to other parasitoids. This was presumably because the parasitoid family Eulophidae had a higher parasitic power. The Eulophidae family parasitoids did not depend

Table 3. Score of dominance index

Location	Treatment	Dominance index		
		Eulophidae	Scelionidae	Trichogrammatidae
Kuala	Control	0.60	0.39	0
Gunung	Insecticide	0.52	0.09	0
Cahaya	Control	0.67	0.25	0
Pardomuan	Insecticide	0.62	0.30	0
Air	Control	0.51	0.47	0
Hitam	Insecticide	0.41	0.20	0

on the shape and structure of the egg group, in contrast to the 2 other parasitoids where the Scelionidae and Trichogrammatidae family parasitoids would decrease if the size of the egg group gets bigger.

The low level of dominance of the Trichogrammatidae family was influenced by its pyrogenic character, which during its lifetime produces only one egg when it first appears as an imago. As stated by Jhonson (2000) that the Trichogrammatidae family belongs to the provigenic group, which was an insect that only produces eggs at the time of its first appearance as an imago and did not produce again during its lifetime.

Distribution Pattern

The distribution patterns of the Eulophidae, and Trichogrammatidae families in each village were grouped and organized, while the Scelionidae families in Kuala Gunung and Cahaya Pardomuan villages were organized and in Air Hitam Village were grouped (Table 4).

It was found that in one group of eggs that were parasitized by the family Trichogrammatidae would always be found other parasitoids. This results in the presence of the Trichogrammatidae family in parasitizing the *S. incertulas* eggs, which did not affect other parasitoids.

Wilyus *et al.* (2012) stated that the dependence of the parasitoid Eulophidae which could only breed on S. incertulas eggs so that it was suspected that individuals tend to gather and look for environmental conditions that suited their needs. Following Riyangto's research (2014) stating that generally found in the pattern of the distribution of groups, this was caused by the nature of individuals who tend to gather in looking for environmental conditions that suit their needs. The distribution pattern of Eulophidae parasitoid clustering could help control yellow rice stem borer pests because the parasitoids tend to cluster so that they could paralyze the groups of eggs.

The distribution pattern of the Eulophidae parasitoid in the three study sites was clustered. Under the study of Rama *et al.,* (2013) which states that the spread of the parasitoid Eulophidae is wider than other parasitoids. so that it can maximalize the group of eggs. Yunus (2005) stated that the flying distance of the Trichogrammatidae family was so short that it caused this parasitoid unable to parasitize the egg group optimally. This was a factor in the occurrence of regular patterns of spread in the Trichogrammatidae family. Sofiah et al. (2013) also stated that the pattern of random distribution was strongly influenced by environmental conditions and also competition between organisms in their habitat, besides that the host population was also the source of food affects the distribution of a population.

CONCLUSION

The parasites of yellow rice stem borer pests in the villages of Kuala Gunung, Cahaya Pardomuan, and Air Hitam had three families, namely Eulophidae, Scelionidae, and Trichogrammatidae. The highest parasitic level was the Eulophidae family and the lowest was the Trichogrammatidae family. Parasitoid level and parasitoid dominance index were higher in the control treatment compared to the insecticide treatment. The highest parasitoid dominance index was found in the Eulophidae family and the lowest in the Trichogrammatidae family.

Table 4. Distribution pattern

Sampling location	Morista Index		
	Eulophidae	Scelionidae	Trichogrammatidae
Kuala Gunung	2.43 (group)	0.80 (regular)	0.006 (regular)
Cahaya Pardomuan	2.45 (group)	0.71 (regular)	0.013 (regular)
Air Hitam	1.81 (group)	1.14 (group)	0.001 (regular)

The pattern of parasitoid distribution in the three study locations of the Eulophidae family was grouped, the Trichogrammatidae family was regular (uniform) and the Scelionidae family differed in each village.

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