The Performance of Natural Enemy of Rice Pest in the Rice Field of Farmers Field School of Integrated Pest Control in South Borneo

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Abstract: ***Research was conducted by considering about the performance of natural enemy of rice pest in the rice field of alumni and non-alumni Farmers Field School of Integrated Pest Control (SLPHT – Sekolah Lapangan Pengendalian Hama Terpadu) in South Borneo. It starts from January to September 2013. Some research locations are included such as Pasar Kamis Village in Banjar District, Guntung Payung Village in Banjarbaru District, and Sungai Rangas in Banjar District. The performance of natural enemy of rice pest is understood using four kinds of trap, such as insect net (sweep net), light trap, yellow trap and pitfall trap. The examined parasitoid includes Telenomus rowani and Rogas narangae, which both are the parasitoid against rice stalk borer egg. The predator observed includes Agriope bruennnichi, Conocephalus longipennis, Clubiona sp, Verania discolor, Ophionea indica, Oxyopes spp, Paederus spp and Tetragnatha maxillosa. The pest used as prey is brown rice pest (Nilaparvata lugens Stall.) in either nymph or adult stadia. Result of research indicates that the parasitoid which parasite the egg of rice stalk borer is compared between PHT and non-PHT fields. The ability of parasitoid is more extensive in PHT field. The ability of predator to consume the prey is also compared between PHT and non-PHT fields and the result is varied. Only Conocephalus longipennis, Clubiona sp, and Tetragnatha maxillosa have higher ability of predating in PHT field.***

Keywords: natural enemy, parasitoid, predator rice pests, SLPHT, South Borneo

1. Introduction

Integrated Pest Management (PHT- Pengelolaan Hama Terpadu) is a national program of Indonesia after the explosion of brown rice pest population in 1970s. It is made official by the Instruction of President of Republic of Indonesia No. 3 of 1986 about The Improvement of Brown Rice Pest Control in Rice Plant, and this Instruction is used as legal base. Act No.12 of 1992 about Cultivation System, precisely Article 20, has mentioned that plant protection is realized by the presence of PHT system. McClelland (2002) asserts that PHT is implemented in Indonesia for rice production.

According to Price (2001), SLPHT is about environmental education for farmers, and this education is insisting to produce the better behavior of OPT management (OPT – Organisme Pengganggu Tanaman). Price and Gurung (2006) also say that SLPHT program contributes the knowledge about the insect in the OPT management. In SLPHT, farmers recognize various OPT and make their own decision to do the control based on PHT concept.

In South Borneo Province in 2009, SLPHT is assisted by the funding from Local Budget. The improvement and the assurance of national food production are indirect goals of this funding. Consistent to government program for SLPHT, PHT concept is applied to manage the ecosystem to improve environmental stability. The impact of SLPHT on the performance of natural enemy in the rice management in South Kalimantan has not yet observed such that further research is needed. Therefore, a research is conducted to understand the impact of SLPHT of rice on the performance of natural enemy.

The objective of this research is to analyze the performance of natural enemy of rice pest in the rice field of alumni and non-alumni farmers of SLPHT. The understanding about the performance of natural enemy of rice pest in the rice ecosystem will help one to acknowledge the benefit of SLPHT for the improvement of ecosystem, especially that relates to the natural enemy of rice pest in South Borneo.

2. Methodology

Research was conducted in rice field in South Borneo. Three locations are selected. One is Guntung Payung Village in Banjarbaru City, and two locations remain in Banjar District (Pasar Kamis Village in Kertak Hanyar Sub district and Sungai Rangas Village in Sungai Tabuk Sub district) in South Borneo Province. Research is implemented in one season of planting in 2013, either from May to September 2013.

2.1 Material and Equipment

2.2.1. Material

Siam local rice; chemical fertilizers such as Urea, SP36 and KCl; organic liquid fertilizer, Trichoderma; chemical pesticide and botanical pesticide.

2.2.2. Equipment

Light trap, insect net, yellow trap, pitfall trap, collecting bottle, knapsack sprayer brand Solo, aspirator, plastic bucket at diameter 20 cm, killing bottle and reaction tube.

2.2 The Implementation of Research and Data Analysis

2.3.1. The Determination of The Performance of Natural Enemy. The performance of natural enemy of the pest is understood by firstly observing and collecting the arthropod

as the natural enemy of rice insect pest. Some species of arthropod are collected either insect (parasitoid and predator) or non-insect (spider) from the observation plot determined in the rice field owned by alumni and non-alumni farmers of SLPHT. The captured arthropod is also examined and it is facilitated by constructing insect garden. The performance of natural enemy in predator type is determined by examining the predating ability of the predator by locking up a predator in the glass tube with some nymphs of brown planthopper (Nilaparvata lugens). It is observed everyday with three replications. For The performance of natural enemy in parasite type can be also measured by collecting the eggs of rice borer into the reaction tube which is closed with cotton. Each reaction tube is filled with a group of egg and observed in laboratory. The fields of alumni and non-alumni farmers of SLPHT are then called as PHT and non-PHT fields.

2.2.1 Observation Plot

The fields owned by alumni and non-alumni farmers of SLPHT are observed. The observation is made on 500 m2 of each field, and this spot is then called as observation plot. This plot is divided into five sub-plots by diagonal dimension 1m x 5 m. In this each plot, insects are captured by insect net, yellow trap, pitfall trap and light trap. Light trap involves lantern as light source. Light trap and pitfall trap are installed from 18.30 pm – 7 am. Insect net and yellow trap are installed from 7 am – 10 am. Insect net is used by swaying the net for 10 double swings. Different quantity of traps is put in each plot. Two yellow traps, five pitfall traps, and one light trap are installed.

Capture period is once a week when the plant age is one month old to generative phase of milk-mature grain. The capturing result is collected and then identified based on family. The identification is made based on the book of the introduction of insect and natural enemy of rice pest written by Borror et al (1991) and also on similar book for the morpho-species written by Reissig, Heinrich, Litsinger, Moody, Fieder, Meww and Barrion (1986). Result of this identification is still doubted, and re-identification is made at Laboratory of Entomology and Laboratory of Biology LIPI in Cibinong.

2.2.2 Data Analysis

The performance of natural enemy is determined by analyzing the ability of predator to consume the pest insect and analyzing the ability of parasite to parasite the pest insect in insect garden. The ability of natural enemy is measured by counting the percentage of how much prey is consumed and how much host is infected. Species abundance rate, diversity index, distribution rate and species equality rate also help the author to understand the ability of natural enemy. These percentages are counted with the following equation:

$$P = \frac{a}{b} \times 100\ \% \quad (1)$$

Where:
P = percentage of predatory or parasitism;
a = the number of prey or host attacked;
b = the number of prey or host observed.

3. Result and Discussion

3.1 Arthropod Abundance

The arthropod captured is then identified and grouped into several categories such as pest, natural enemy (parasitoid and predator) and others (pollinator, decomposer, vector and other). All of them are captured from the field in three research locations. It is indicated that the total species quantity and the abundance of arthropod in PHT field in three locations are relatively higher than those captured in non-PHT field. In PHT field, the species quantity is between 88-118 species and the abundance ranges between 8,577–12,231 individuals, while in non-PHT field, the species remains between 72 – 108 species and the abundance ranges between 7,417 – 7,990 individuals. Rizali, Buchori and Triwidodo (2002) have found that insect diversity in the field nearby the forest is counted to 14,352 individuals comprising to 16 orders, 110 families and 435 species. The biggest insect abundance is Order Hymenoptera (45.4%). Of 435 species identified, the highest species quantity is shown by Order Diptera (37.9%). The quantity of species, including pest, parasitoid and predator in three locations, which are Pasar Kamis, Guntung Payung and Sungai Rangas Villages, is relatively higher in PHT field than in non-PHT field.

3.2 Species and Abundance of Natural Enemy

3.2.1. Parasitoid

Parasitoid in PHT field and non-PHT field in three locations involves 4 orders and 17 families. The orders and families of the captured parasitoid are Hymenoptera (Bethylidae, Braconidae, Chalcididae, Diapriidae, Eulophidae, Evanioidea, Formicidae, lchneumonidae, Mymaridae, Platygastridae, Pteromalidae, and Scelionidae), Diptera (Anisopodidae, Lauxaniidae, and Pipunculidae), Strepsiptera (Stylopidae) and Eucolinae (Figitidae).

The abundance of parasitoid in each location, either in PHT field and non-PHT field, is explained as following. Pasar Kamis Village has 4,172 individuals (PHT) and 3,375 individuals (Non-PHT). Guntung Payung Village has 3,623 individuals (PHT) and 2,498 individuals (Non-PHT). Sungai Rangas Village has 1,298 individuals (PHT) and 643 individuals (Non-PHT)

Telenomus rowani (Hymenoptera: Scelionidae) has the highest quantity from each location. Sylvicola punctatus (Diptera: Anisopodidae) has the lowest quantity. According to Ressig et al. (1986), Telenomus rowani is the important parasitoid for rice pest, especially against the egg of rice stalk borer.

Some parasitoid types are found in all locations. These types are Goniozus triangulifer (Hymenoptera: Bethylidae), Elasmus sp (Hymenoptera: Eulophidae), Trichomma cnaphalocrosis (Hymenoptera: Ichneumonidae), Platygaster oryzae (Hymenoptera: Platygastridae), Telenomus rowani (Hymenoptera: Scelionidae), Tomosvaryella oryzaetora (Diptera: Pipunculidae), and Pipunculus javanensis (Diptera: Pipunculidae). According to Quicke (1997), parasitoid species from Order Hymenoptera (12 families) are general species which is abundant in all land ecosystems, and it represents the most population of parasitoid.

3.2.2 Predator

Predator in PHT field and non-PHT field consists of 9 orders and 31 families. The captured orders and families are Araneae (Araneidae, Lycosidae, Oxyopidae, Tetragnathidae, and Salticidae), Coleoptera (Carabidae, Clubionidae, Coccinellida, Desidae, Hydrophilidae, Malachiidae, Melyridae and Staphyl inidae), Dermaptera (Carcinophoridae), Hemiptera (Coreidae, Gerridae, Miridae, Nabidae, Belostomatidae, Lauxaniidae, Reduviidae, and Pentatomidae), Diptera (Sciaridae, Taeniapterinae, and Asilidae), Heteroptera (Microphysidae), Hymenoptera (Formicidae), Odonata (Coenagrionidae, and Libellulidae) and Orthoptera (Gryllidae and Tettigoniidae).

The abundance of predator in PHT field and non-PHT field is explained as following. Pasar Kamis Village has 4,676 individuals (PHT) and 2,557 individuals (Non-PHT). Guntung Payung Village has 1,076 individuals (PHT) and 1,244 individuals (Non-PHT). Sungai Rangas Village has 2,828 individuals (PHT) and 2,064 individuals (Non-PHT).

The abundance of predator is varying in PHT field and non-PHT field in three locations. Certain predator may only present in certain location. The abundance of predator in PHT field tends to be higher than in non-PHT field in Pasar Kamis and Sungai Rangas Villages, but not in Guntung Payung Village.

Predator species with the highest abundance is Tetragnatha maxillosa either in PHT field and non-PHT field in all locations with the individuals ranging from 219-3,074 individuals. Some predator species are not found in PHT field or non-PHT field. The abundance of predator from Tretragnathidae family is always higher than other predator, and this finding is consistent to Herlinda (2000) and Suana (2004).

Other predator species found in all locations are Pardosa pseudoannulata (Araneae: Lycosidae), Oxyopes javanus (Araneae: Oxyopidae), Oxyopes salticus (Araneae: Oxyopidae), Tetragnatha maxillosa (Araneae: Tetragnathidae), Maripissa magister (Araneae: Salticidae), Ophionea indica (Coleoptera: Carabidae), Verania discolor (Coleoptera: Coccinellida), Axinotarsus marginalis (Coleoptera: Malachiidae), Paederus spp Curtus (Coleioptera: Staphylinidae), Microvelia douglasi douglas (Hemiptera: Coreidae), Limnogonus fossarum (Hemiptera: Gerridae), Nabis sternoferus (Hemiptera: Nabidae), Polytoxus fuscovittatus (Hemiptera: Reduviidae), Agriocnemis fermina femina (Odonata: Coenagrionidae), Acisoma panorpoides (Odonata: Libellulidae), and Metioche vittaticollis (Orthoptera: Gryllidae) and Conocephalus longipennis (Orthoptera: Tettigonidae).

Pursuant to Shepard et al. (1995), at least there are 8 predator spiders found in the rice ecosystem, such as Araneidae (2 species), Lycosidae (1 species), Lynipidae (1 species), Oxyopidae (2 species), Salticidae (1 species) and Tetragnathidae (1 species). Predator has higher ability than parasitoid to spread themselves and also has more extensive host to be infected (Hidaka, 1993).

3.3. The Ability of Natural Enemy

3.3.1 Parasitoid

Result of the observation onto the egg of rice stalk borer indicates that two parasitoids are occupying the egg, which are Telenomus rowani (Hymenoptera: Scelionidae) and Rogas narangae Rohwer (Hymenoptera: Baraconidae). The eggs collected from each location are assigned into 50 groups. Some eggs with parasitoid are not grouped. Hence, PHT field provides 15-17 egg groups, while non-PHT field supplies 18-27 egg groups (Table 1.).

Table 1: The Number of Egg Group with Parasitoid from PHT field and Non-PHT field in Pasar Kamis, Guntung Payung and Sungai Rangas Villages

Pasar Kamis		*Guntung Payung*		*Sungai Rangas*	
The Number of Egg Group in Field					
PHT	Non-PHT	PHT	Non-PHT	PHT	Non-PHT
17	18	16	20	15	27

Parasite rate of the egg groups from three villages is relatively higher in PHT field than non-PHT field (Table 2.).

Table 2: The Parasite Rate in the Egg of Rice Stalk Borer from PHT field and Non-PHT field in Pasar Kamis, Guntung Payung and Sungai Rangas Villages

Field Type	*Parasite Rate (%)*		
	Pasar Kamis	*Guntung Payung*	*Sungai Rangas*
PHT	60.63	55.16	46.99
Non-PHT	56.71	51.82	40.26

Note: Egg group in PHT field in Sungai Rangas Village shows two species, which are Telenomus rowani and Rogas narange, while in other two villages, only species Telenomus rowani is found

In Pasar Kamis and Guntung Payung Villages, the borer egg is collected from the rice only, while in Sungai Rangas Village, the egg is collected from rice and also water weed, purun tikus. It is because the rice field in Sungai Rangas Village is widely occupied with this weed. Asikin and Thamrin (2001) admit that this weed is the popular site for rice stalk borer to lay their egg.

Parasitoid from the gene Telenomus (Hymenoptera: Scelionidae) is egg parasite which is aggressively attacking the egg laid on the leaf (Shepard et al., 1995), and Telenomus rowani is known as the parasitoid of streaky rice stalk borer (Chilo suppressalis, C. polychrysus, C. auricillus), yellow rice stalk borer (Scipophaga incertulas), white rice stalk borer (Scirpophaga innotata) and rose red rice stalk borer (Sesamia inferens). Parasitoid Rogas narangae attacks the egg of leaf roller pest (Cnaphalocrosis medinales).

3.3.2. Predator

Based on the collection in insect garden, the ability of predator in preying is examined. Eight species of predator are observed such as Argiope bruennichi, Conocephalus longipennis, Clubiona sp, Verania discolor, Ophionea indica, Oxyopes spp., Paederus spp., and Tetragnatha maxillosa. Each predator species is put into glass tube. This tube is already filled with mineral water, 3-weeks old rice, and

nymph of brown rice pest as the prey. The tube is only accommodating one predator. This process is replicated for three times and observed for a week. The pest used as the prey is the nymph of brown rice pest (Nilaparvata lugens).

Result of examination indicates that the predator with the greatest consumption of nymph is Conocephalus longipennis with predating rate ranging from 3.63 – 6.23 individuals per day, while the lowest predating rate is shown by Ophionea indica ranging from 0,29 - 0,90 individuals per day. The ability of predator in preying the pest is mostly below one percent, but it is the true ability of predator per individual. According to Sembel (2010), it does not mean so low because the ability of predator in field is representing the obvious (significant) rate of the ability of predator in pressing off the pest population. The result of this examination is shown in Table 3.

Table 3: The Ability of Predator in Preying Brown Planthopper (Nilaparvata lugens) in PHT field and Non-PHT field in Greenhouse

Predator Names	*Pasar Kamis*		*Guntung Payung*		*Sungai Rangas*	
	PHT	Non-PHT	PHT	Non-PHT	PHT	Non-PHT
Argiope bruennichi	0.48	0.52	0.62	0.43	0.95	0.90
Conocephalus longipennis	6.23	3.63	5.10	4.43	5.31	4.34
Clubiona sp	2.74	2.54	2.06	1.89	3.09	2.54
Verania discolor	0.62	0.52	0.48	0.43	0.48	1.48
Ophionea indica	0.33	0.43	0.90	0.81	0.81	0.86
Oxyopes spp.	0.38	0.38	2.14	2.09	1.95	2.10
Paederus spp.	0.67	0.38	1.95	1.29	0.67	1.48
Tetragnatha maxillosa	0.62	0.38	0.62	0.57	0.48	0.43

Note: Result of observation for a week with three replications

4. Conclusion

The performance of natural enemy is shown by the quantity of species, the abundance, and the ability to parasite the egg of rice stalk borer for parasitoid, ad the ability to prey on brown rice pest for predator. The species quantity, the abundance and the ability of parasitoid to parasite the egg of rice stalk borer are relatively higher in PHT field than in non-PHT field. The ability of predator in preying on brown rice pest is varying. Parasitoid species is examined to understand the ability to parasite the egg of rice stalk borer. By comparing PHT field and non-PHT field, the ability of parasitoid in PHT field is higher. The ability of predator in preying is varying between PHT field and non-PHT field. Only Conocephalus longipennis, Clubiona sp, and Tetragnatha maxillosa with higher ability of predating in PHT field.

5. Future Scope

The ability of parasitoid and predator species is still not comprehensively understood. Therefore, complete information may only be obtained through further research on both these natural enemy groups.

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