

Parasitoid of fall armyworm larvae, *spodoptera frugiperda*

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Parasitoid of fall armyworm larvae, *spodoptera frugiperda* (Lepidoptera: Noctuidae) on mize at Lombok Island

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Abstract. Fall armyworm (FAW) is a new pest in Indonesia that has spread throughout Indonesia, including the island of Lombok. Since entering Indonesia until now, there are still no effective techniques for controlling it. For this reason, it is necessary to explore natural enemies, especially the parasitoids associated with larvae. The research method used is exploratory with survey techniques in the field. Exploration of *spodoptera* larvae parasitoid was carried out in four districts and one city. Thirty (30) research locations were determined by strative random sampling according to the maize planted area. Insect sampling was carried out diagonally with each plot measuring 5 x 5 m. The results of the study are as follows: (1). Three species of larvae of *Spodoptera frugiperda* parasitoid were found, namely *Apanteles* spp. (Hymenoptera: Braconidae), *Eriborus* spp. (Hymenoptera: Ichneumonidae) and *Exorista* spp. (Diptera: Tachinidae). (2). The level of parasitization shows very small, namely 2.16% on average. (3) The levels of parasitoid dominance obtained were the families of Tachinidae (67%), Braconidae (22%) and Ichneumonidae (11%).

Keywords: Parasitoid; FAW; Larvae; Mize; Lombok-Island

1. Introduction

Corn (*Zea mays*) is the primary food of Indonesia people after rice, so its availability is really needed for food security in Indonesia. Corn was the second biggest contributor after rice in food crops sub-sector [1]. Its contribution for gross domestic product (GDP) keeps increasing every year, even when economy crisis occurred. In Indonesia, for fulfilling the domestic consumption's need, they are still importing corn from another country. In order to increase food crops and food self-sufficiency, the government has been doing PAJALE program for the last three years. This program has succeeded, and NTB is one of central national production. The corn's production in west Nusa Tenggara is 63,88 tons of dry shellfish in 2018 [2]. The corn's production and self-sufficiency food are almost failed caused by the new pest's invasion which is corn fall armyworm.

The corn fall armyworm, *Spodoptera frugiperda* J.E. Smith, is a new invasive insect in Indonesia. This pest comes from middle America then it spread to the Africa in 2016, India in 2017, and

Indonesia in 2019 [3]. It attacks corn plant at vegetative phase leading into plant's failure. Spodoptera frugiperda larvae has a very high eating ability and cannibalism to keep its food, so there is no food seizure competition. The imago of this pest is moth with a very strong fly roaming ability, and it even can fly up to 100 km by following wind's direction, so it can spread really quick to every place [4].

In Indonesia, this pest's attack appeared for the first time at corn plant season on April-May 2019 at several central corn productions in Sumatra island. This pest had made corn farmer in Lampung, West Sumatra, Aceh, Riau, Jambi, Bengkulu, South Sumatra, Java island like Banten, Bandung, Sumedang, Garut, Central Java, East Java and also NTB worried. Spodoptera frugiperda pest had entered to NTB's region with several regions that have been attacked, such as: Dompu district, Sumbawa, West Lombok, East Lombok, and North Lombok [2]. In Lombok island, this Spodoptera frugiperda pest's existence was already existed on August 2019 and spread in four districts and one city. If this condition is not taken care wisely, it will threat the corn self-sufficiency food especially in NTB that is become one of the national corn barns.

This pest spreads really quick, and in no time, it is reported in the entire Indonesia's region. The loss that was reported caused harvest failure, so the corn plant was turned into animal's feed. In order to control the pest's spreading, many institutes were doing chemical eradication and it didn't give a satisfied result. The pest's control that relies on using pesticide is giving a negative impact on environment, so a friendlier control's technique is needed. One of that control's technique is by using corn Fall armyworm's natural enemy. The information and data about this natural enemy have already done especially in the origin region of this new pest. Lombok island is located at Wallace line that has different flora and fauna compared to west region of Indonesia. At this condition, it becomes possible for Lombok island to have a local natural enemy as biological control's agent of corn Fall armyworm. This information surely doesn't have any report yet, so an exploration research about local natural enemy is needed to prevent this new pest's invasion.

2. Research Method

This research used descriptive method with field survey technique. This technique was used for determining the location of observation and collecting sample.

2.1. Date and Place of research

This research was held at four districts and one city that were located on Lombok island. Those locations were west Lombok district, central Lombok, east Lombok, north Lombok, and Mataram city. The total of locations was based on purposive random sampling, so around thirty locations were obtained like in Figure 1. The research was held on May until August 2020. The next step was to maintain the collected Spodoptera frugiperda larvae at Plant Protection Laboratory, and an identification of found parasitoid was done.



Figure 1. The location of sample collecting of corn Fall armyworm

2.2. Research Implementation

The determination of corn planted field in every district and city had been done with transects method along 1 km minimum line between one location to another (L1-Ln). Every chosen location was done with plotting diagonally, so five plots sample were obtained. The collecting of plant's sample had been done to the corn plant that planted in 5 x 5 m plot each. The sample plant was determined around 20% from the total of plant that planted in one sample plot. The determination of sample plant had been done by systematically random sampling which the quantity was depend from planting distance that was used by the farmer.

The collecting of sample larvae had been done directly to corn plant that showed a damage symptom with using scissors or tweezer. Larvae's sample that had been obtained was put into the plastic bag with given an information label, plot number, date and place. Sample larvae that had been collected was brought to the laboratory for maintained until parasitoid that associated came out. Location's label was noted according to the GPS when collecting sample had been done.

2.3. Research variable

The variables that were observed in this research were *Spodoptera frugiperda* larvae's species variety, parasitoid species, the total of parasitoid per individual and parasitization level.

The observation was implemented every day with noted the total of larvae that became pupa, the total of pupa that became its imago, and also larvae and pupa that were attacked by parasitoid. The level of parasitization from *Spodoptera frugiperda* larvae that was being parasitized calculated with formula:

$$P = n/N \times 100\%$$

where:

P = parasitization level

n = the total of larvae or pupa that was being parasitized

N = the total of larvae or pupa that was maintained and the collection result from field

Parasitoid identification that came from larvae or pupa was observed for its morphology characteristic with help from stereo microscope and it was matched with identification books that were written by Nonci *et al.* 2019 [5], Molina-Ochoa *et al.*, 2003[6], Sharanabasappa *et al.*, 2020[7],

Agboyi *et al.*, 2019 [8], Ruiz-Najera *et al.*, 2007 [9], Nguyen Ngoc Bao Chau and Nguyen BaoQuoc. 2015[10], Crosskey, R.W. 1970[11].

The diversity and abundance of the insect can be measured with Shannon-Wiener diversity index. Shannon-Wiener index formula [12]:

$$H' = -\sum (pi)(\log e. pi)$$

$$Pi = \Sigma ni/N$$

H : Shannon-Wiener diversity index

Pi :species individual proportion

ni : the total of species individual

N :the total of all species individual

According to Krebs 1985 (13), there are three diversity index criteria. Where:

$H < 1.00$ = low diversity

$H > 1.00 \leq 3.0$ = medium diversity

$H > 3.00$ = high diversity

3. Result and Discussion

From the collection result and maintenance, 835 *Spodoptera frugiperda* larvae were obtained. Three species of larvae parasitoid were found from the samples that were collected from the field and maintenance in the laboratory. They were Tachinidae family, Braconidae, and Ichneumonidae (Figure 2). Those three parasitoid were included in Hymenoptera and Dipetra ordo, as stated by Ruiz-Najera RE., et al. 2007[9] that the three family were frequently found attacked *Spodoptera frugiperda* in Chiapas, Mexico [14; 16].



Figure 2. Three parasitoid species that were successfully collected from worm maintenance in laboratory

Morphology characteristics of Braconidae family were around 3 mm for the length of its body, black in color with yellow abdomen. The antenna had filiform shaped with seventeen segment. This parasitoid had a pair of membrane wings that indicated this insect came from Hymenoptera ordo. The front wing was consisted of pterostigma, 3R1, 2Rs, 2nd discal cell, 2nd sub-discal cell, 1st sub-discal cell, plical cell, sub-basal cell, basal cell, 1st discal cell, 1st sub-marginal cell. The unique characteristic of this parasitoid was 2m-cu venation that did not exist at its front wing, and there was 1/Rs+M venation at its front wing. 1r-m Venation at the back wing was usually separated into R1 and Rs. That characteristic was closer with Braconidae family's characteristic that was described by Hordzi and Botchey [14]. The pupa was located in white cocoon and outside of the host. This parasitoid attacked

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larvae at instar 2-3 that was found on the field and it never attacked big Instar stadium 4-6. This condition was also reported by another researcher that said Braconidae family usually attacked the first Instar until the third instar [7;10].

The characteristic morphology of Ichneumonidae family had around 6 mm body length, black body and filiform shaped antenna that consisted of seventeen segments. This parasitoid was categorized as soliter parasitoid because only one parasitoid that appeared at one host. This parasitoid had black body and brown limbs. It had a slim waist and an abdomen that was pointy at the start and become wider at the end. Its back limbs were longer than other limbs. Its slim abdomen with the first metasoma segments could be seen at dorsal. The front wing didn't have kosta cell. It had 2m-cu wing Venation and there was no Rs + M Venation. The back wing had a clearly curved M+Cu Venation. The front wing had 4 mm length which was longer than the back wing that had 3 mm length. Various references stated that Parasitoid from this family attacked large larvae around Instar 4-6 at Spodoptera. Agboyi LK. et al. 2020 [8] reported that Ichneumonidae attacked Spodoptera frugiperda at stadium five to sixth

Tachinidae appeared around 1-4 per host. Tachinidae fly had these characteristics, such as: 4 white line at thorax at its abdomen, the thorax and head filled with thick hair, and white line at its eyes [15]. This parasitoid parasitized when the host was still in larvae stadium, but the host would be dead when it entered pupa stadium. Pupa from this insect had dark brown with 8 mm pupa size. Pupa finished its cycle in 7 days then it came out as an imago. The imago came out from pupa with breaking the tip of its pupa. Agboyi et al. 2020 reported that Tachinidae parasitoid from Diptera order put its egg externally at stadium 5-6 larvae from Spodoptera frugiperda and continued until the larvae turned into pupa. This condition was also reported by the previous researcher Molina-Ochoa et al. 2002 that parasitoid was found on the field at pupa phase [6]. Hordzi and Botchey stated that the Tachinidae that was found at Ghana was classified as larvae-pupa parasitoid [14].

3.1. Parasitization level

Parasitization level from three larvae parasitoid species that was found at Spodoptera frugiperda worm was presented in Table 1.

Table 1. Parasitoid species of Spodoptera frugiperda larvae and its parasitization

Healthy larvae (collected)	835
Parasitization level (%)	2.16
Dominant parasitoid level:	
1. Tachinidae (%)	67
2. Braconidae (%)	22
3. Ichneumonidae (%)	11

At table 1, it showed that the total of parasitoid that was collected was very little, so the parasitization level became very low only reached 2.16%. This very little total of parasitoid that was found on the field most likely caused by pesticide use that was too intensive by the farmer, and it caused non-target organism killed. On the other hand, Lombok local parasitoid was still not able to decrease the corn Fall armyworm as the newcomer in Indonesia. This fact was possible because the local natural enemy was not very effective compared to the natural enemy from the origin place of the

pest just like the previous new comer pests handling experience such as flea (*Heteropsylla cubana*) that was came into Indonesia at 1986.

4. Conclusion

(1). Three species of larvae of *Spodoptera frugiperda* parasitoid were found, namely *Apanteles* spp. (Hymenoptera: Braconidae), *Eriborus* spp. (Hymenoptera: Ichneumonidae) and *Exorista* spp. (Diptera: Tachinidae). (2). The level of parasitization was very small, namely 2.16% on average. (3) The levels of dominant parasitization obtained were the families of Tachinidae (67%), Braconidae (22%) and Ichneumonidae (11%).

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