Natural Enemy of Spodoptera frugiperda (Lepidoptera: Noctuidae) in Palu Valley, Central Sulawesi

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Abstract-In order to identify Spodoptera frugiperda Smith & Abbot (Lepidoptera: Noctuidaenatural)'s enemies and quantify the prevalence and percentage of parasitism, all instars of this insect were collected in maize (corn) fields throughout six locales in the Palu Valley, Central Sulawesi, in 2021. Larvae were kept in controlled environments, fed an artificial diet, and monitored every day until the appearance of parasitoids, the advent of Beauveria bassiana, Verticillium lecanii, Metarrhizium sp., and Aspergillus sp., or until they reached adulthood. In total, 162 of the 371 larvae that were collected—or 43.66%—were attacked by parasitoids and entomopathogens. With parasitoids emerging from 129% of the larvae, the prevalence of parasitism by parasitoids was 2.98%. Archytas marmoratus (Diptera: Tachinidae) and Pristomerus sp. (Ichneumonidae) were the parasitoids discovered The two parasitoids that were most frequently found had an impact on 0.17% and 0.05% of the total larvae collected, respectively. Additionally, four types of entomopathogenic fungi were discovered: 0.13%, 0.27%, 0.23%, and 0.13% parasitism for Metarhizium sp., Beauveria bassiana, Verticillium lecanii, and Aspergillus sp., respectively.

Keywords - *Spodoptera frugiperda*, *parasitoid, entomopathogenic fungi.*

I. INTRODUCTION

Spodoptera frugiperda Smith & Abbot (Lepidoptera: Noctuidae), sometimes known as the Fall armyworm (FAW), is a major pest of maize (Zea maize) and various other crops that results in decreased yields and financial losses in nations throughout Asia and Africa. [1], [2], [3], [4] S. frugiperda is a member of the Noctuidae family and the Lepidoptera order. This species is regarded as a global pest because of its polyphagous behavior, high ability, voracity, ability to produce enormous populations, and high dispersal rates [5], [6]. Food security is being threatened by S. frugiperda. It can obliterate a nation's cereal crops [7], [8]. Grass, sorghum, potatoes, cotton, peanuts, beets, tomatoes, alfalfa, onions, and soybeans are among the more than 50 plant species that armyworms consume [9]–[11]. S. frugiperda initially originated in tropical and subtropical regions of the Americas, but throughout the summer, it migrates to temperate regions in North and South America[12]. S. frugiperda has been discovered to attack maize crops in Indonesia in the provinces of West Sumatra, Banten, West Java, Bali, and Sulawesi island [13]–[16]. S. frugiperda is the morphologically characterized plant-disturbing organism that affects maize in Central Sulawesi, particularly in Sigi Regency [17]. 8.3-20.6 million tons or 2.481-6.187 million US dollars per year are lost as a result of this insect attack on maize crops in 12 African countries [18]. If the affected plant population is between 55 and 100%, an infestation of S. frugiperda larvae in maize might result in a yield loss of 15–73% [19]. Chemical insecticides and plant growing methods have been used in control efforts.

The issues that were investigated included the fact that the most popular method for controlling the insect pest S. frugiperda is chemical control. The incorrect and indiscriminate use of this approach, however, renders it ineffective and leads to acute and chronic poisoning of agricultural workers as well as the development of resistance, the eradication of local natural enemies, and soil degradation [20]. Native natural enemies can be used to control these pests instead of insecticides [21], which has many benefits, including not having a negative impact on the environment or human health. Additionally, natural enemies may be easily handled and released in the wild, are frequently specialized, and some have advanced search capabilities.

Therefore, preliminary investigation involving surveys, collections, and identification of S. frugiperda's natural enemies on maize is required. Due to growing economic and environmental concerns, surveys of natural enemies in different regions of their distribution have been conducted across the majority of Asia and the Americas countries [22], [23]. According to this data, it is imperative to do study into the role of natural enemies in pest control. The first

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step should involve conducting field surveys to identify the species present and how their populations differ in relation to insect pest species.

This investigation aimed to discover S. frugiperda's parasitoids, predators, and diseases as natural enemies. The specific goal is to create a database and collection of S. frugiperda's natural enemies (parasites, predators, and diseases) in the ecology of corn plantations. S. frugiperda will be managed by farmers using natural enemies in the ecology of the corn crop. If natural enemies are recognized and can be identified, one of the contributions to science and technological development is plant protection. Biological control is a crucial part of integrated pest management since it is used to combat S. frugiperda pests on maize. These natural enemies include parasitoids, predators, and diseases.

II. RESEARCH METHODS

A. Survey of natural enemies

An investigation of natural enemies in the corn-planting ecosystem in Sigi Regency, which is divided into 7 subdistricts: Dolo, West Dolo, South Dolo, Gumbasa, Marawola, West Marawola, and Palolo. Each sub-district had three villages chosen as the primary locations for growing maize. Each production center has three sample plots (each with a plot size of one hectare), with five sample units per plot. Each sampling location has 10 maize plants, making up the three sampling sites that make up each sampling unit.

B. Insect Sampling on Corn Plants

In order to cover all seven places in the Sigi district's corn planting ecosystem, the survey was conducted in two stages in 2021. April to June 2021 is the first stage, while July to October 2021 is the second.

At the observation sample points in each sample unit, insects are observed and sampled under a loupe. Each sample unit has three locations for sampling. S. frugiperda eggs, larvae, pupae, and imago were collected from the field, identified morphologically, and deposited one at a time in 8.5 x 10 x 5 cm transparent rectangular rearing containers.

A black net is placed over the breeding container to stop the imago or larvae from escaping. To absorb the moisture produced by the feed, tissue paper is placed at the bottom of the container (corn leaves). While the imago was given a 10% honey solution, the larvae were fed corn leaves. Under room conditions (24 4 °C, 82 8% RH, and a 12:12 h photoperiod [L:D]), larvae and adults were grown in a lab. Every 24 hours, parasitoids released from eggs, larvae, and pupae were counted and put in 70% ethanol. In accordance with the guidelines provided by Ochoa et al. [24], natural enemies were determined.

At each area, pitfall traps and nets were used to keep an eye out for predators in corn plantations. Use Sharanabasappa et alidentification 's of predatory insects [25]. Collecting S. frugiperda eggs, larvae, and pupae, and placing each one in a petri dish with tissue paper on top to absorb moisture from the feed, was done in order to conduct observations for insect diseases (corn leaves). We feed corn leaves to the larvae. Using a solar power meter, eggs, larvae, and pupae were raised in a laboratory setting at 24 4 °C, 82 8% RH, and 12 12 hours of illumination (L: D). Observed and put into the agar medium in a petri dish were eggs, larvae, and pupae that had died because of the disease. The pathogen growing in PDA (potato dextrose agar) media was isolated and further developed for purification. Identification of pathogens was done using Stereo Digital Microscope.

C. Identification of Natural Enemies

Entomopathogenic fungi were collected by modifying the used bait method [26], [27]. The bait method uses Tenebrio molitor larvae as insect bait fed to soil samples containing conidial fungi. Soil sampling was done by digging the soil using a Soil Sampling Drill (Ø 20 mm) to a depth of 10-15 cm around the plant rhizosphere and taking 5 points to collect 1 kg of soil. Then the soil sample is put into a plastic bag and given an information label based on the location of the sample and the date of sampling. Soil samples were cleaned of plant roots and sieved with a size of 10 mesh. Then it was put into plastic trays (30 x 20 x 10 cm3) containing 1 kg of soil. Then moistened with sterile distilled water with soil moisture exceeding 30%. After that, 30 newly molted larvae of third instar T. molitor were placed on the bottom of the tray, and the bodies of the larvae were sprinkled with a layer of sample soil which was 20-30 mm thick. Then the tray containing the soil samples was covered with a black cloth and sprayed with sterile water to keep the soil moist. The larvae were infested in the soil sample for seven days to allow the conidia of the entomopathogenic fungus to infect T. molitor, after which dead larvae infected with the entomopathogenic fungus were grown in PDA medium. Isolation and identification of entomopathogenic fungi. The infected Tenebrio bait is then isolated and purified. Surfaces of larvae infected with entomopathogenic fungi were sterilized by modifying the method of Sharma et al. [26] by rinsing with 1% NaOCl for 1 minute, then rinsing with 100 mL of distilled water three times. Surface larval sterilization is carried out to get the fungus that has penetrated the larval cuticle and prevents the emergence of airborne mould. Sterilized larvae were grown in PDA media

and incubated for two days. Then the fungi that grow are purified on PDA media to get pure isolates. Types of entomopathogenic fungi isolated from T. molitor larvae were identified based on morphological characteristics, such as colony colour and culture form on PDA, shape and colour of conidia using Humber's taxonomy book [28]. Conidial density was calculated, and viability was observed by growing 10 µL of fungal conidia suspension (1 x 106 conidia mL-1) in a 2% water-agar medium containing 2 g of agar which was given 100 mL of distilled water (w/v), then cultured incubated for 2 x 24 hours.

III. RESULTS AND DISCUSSION

In total, 371 FAW larvae were collected from 6 sites, with two collections per site. The sample found 162 parasitized larvae but no emergence of 209 larvae. Only pathogens were observed. This parasitoid is a species of the Order Diptera (Tachinidae) and Ichneumonidae (Hymenoptera) (Table 1 and Table 2). Molina-Ochoa et al [29] found that specimens parasitized FAW larvae from the families Braconidae (Aleoides, Chelonus, Cotesia, Glyptapanteles, Homolobus, and the genus Meteorus), Ichneumonidae (Campoletis, Eiphosoma, Ophion, and Pristomerus genera), and Eulophidae (Aprostocetus, Euplectrus, and Horismenus) in Michoacán, Jalisco, Sinaloa, Nayarit, Veracruz, and Colima, Mexico, in various plants. In this study, it was not found, as found by Ochoa et al. [29]. The parasitoid species in this study were from the Order Diptera, Tachinidae and the Order Hymenoptera, Ichneumonidae. These results are similar to those reported by Delfin-González et al. [30], who found Lespesia archippivora (Riley), A. marmoratus, and E. platyhypenae in the Mexican state of Yucatán.

The data obtained indicate a large diversity of parasitoid species and the degree of parasitism, depending on the geographic area, although all sites share many of the same species. Regional differences in parasitoid species and levels of parasitism may be largely due to environmental differences, other than weather, adjacent plants, and alternative hosts. In addition, sampling rate, host population density, natural enemy adaptation rate, and host and parasitoid population growth, among others, will influence natural enemy determination. The tachinid fly found in this study has yet to be able to calculate the level of parasitism. However, the incidence of parasitism was 2.98% by Tachinidae and Ichneumonidae species. The results of research from several experts that are relevant to this study are: thirty-four specimens of predatory P. maculiventris were found eating FAW larvae in cornfields. The high incidence of fungal infections in 6 locations (Table 2) may be due to the significant rainfall and weather in Palu Valley. Fungal growth and germination are strongly influenced by environmental conditions, especially temperature and relative humidity.

Table 1. Natural enemies *S.frugiperda* emerged from Zea mays in Palu Valley

Natural Enemies	LOCATION							
	Marawola	Marawola Barat	Dolo	Dolo Barat	Palolo	Gumbasa	Total	Parasitized (%)
Entomopathogen								
Beauveria sp.	8	4	4	2	2	6	26	0,27
Metarrhizium sp.	6	5	0	0	4	4	19	0,13
Verticillium sp.	6	5	3	6	5	3	28	0,23
Aspergillus sp.	2	4	0	8	2	0	16	0,13
Predator								
Coccinellidae	2	4	2	5	3	4	20	-
Cocopet	4	2	0	0	0	2	8	-
Parasitoid								
Tachinidae	6	6	0	0	0	2	14	0,17
Iccneumonidae	5	0	0	2	0	0	7	0,05

Table 2. Incidence of Natural Enemies of *S.frugiperda* at Palu valley

Location	Total larvae	Parasitized larvae	Parasitoid Emerged parasitoids	Parasitized %	Entomopathogen *B.bassiana*	*V.lecanii*	*Aspergillus sp.*	*Metarrhizium sp.*
Marawola	75	20	19	0,266	6	6	3	5
Marawola Barat	80	23	17	0,287	5	8	2	4
Dolo	20	13	10	0,65	4	3	2	4
Dolo Selatan	88	45	36	0,511	13	9	12	11
Palolo	83	42	33	0,506	11	10	13	8
Gumbasa	25	19	14	0,760	6	6	3	4

VI. CONCLUSION

In this study, out of 371 collected larvae, 162 larvae were attacked by natural enemies (parasitoids and entomopathogens), representing a total incidence of 43.66 %. The incidence of parasitism by parasitoids was 2.98%, and parasitoids emerged from 129% of the larvae. The parasitoids found were: Archytas marmoratus (Diptera : Tachinidae) and Pristomerus sp. (Ichneumonidae). Four species of entomopathogenic fungi were also found: Metarhizium sp., Beauveria bassiana, Verticillium lecanii, and Aspergillus sp.

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