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Effect of Combination of Plant Types on Attack of *Spodoptera Frugiperda* J. E Smith

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Abstract: *Spodoptera frugiperda J. E. Smith is a new pest in maize plantations originating from America and has spread to Sumatra in mid-2019. The aim of this study was to determine the combination of host plant species most favored by S. frugiperda larvae. The types of plants tested were sweet corn, hybrid corn, white corn, land rice, soybeans, green beans, and elephant grass. Each plot was combined with 3 types of plants so that there were 16 plots with 2 replications. The research was conducted using a descriptive method and each research plot was covered with mosquito nets. The larvae of S. frugiperda used were rearing 3 instar larvae and came from separate maize plantations. The results showed that S. frugiperda liked the combination of plants from the Gramineae family. The combination of plants favored by S. frugiperda was consecutively A (sweet corn, white corn and hybrid corn) with 33.8% attack intensity, E (sweet corn, soybean and land rice) 13% attack intensity, C (maize) white, soybean and elephant grass) attack intensity 12.8%, B (sweet corn, green beans and rice) attack intensity 12.3%, G (hybrid corn, soybean and rice) attack intensity 11.5%, D, F and treatment H. The number of pupae was also found in the combination treatment of corn, rice and elephant grass and not found in soybean and mung bean plants.*
Keywords: *combination; spodoptera frugiperda; intencsity; polyphagous pests*

I. Introduction

At the beginning of 2019, a type of armyworm was found on corn plants in Sumatra, this pest was called Spodoptera frugiperda JE Smith. It is an invasion that has become a new pest on maize (Zea mays) in Indonesia. This insect comes from America and has spread in various countries (Ministry of Agriculture, 2019).

According to research conducted by CABI in 2019, this pest attacks the growing points of plants which can result in failure to form shoots or young leaves of plants. Heavy attack occurs in the larval phase because it has a high feeding ability, the larvae will enter the plant and actively eat there. While the imago is a strong aviator and has a high cruising range(Sari et al., 2017; Silaban et al., 2022). In the field, the author planted various types of corn, tomatoes, soybeans and green beans and it turned out that sweet corn (Zea mays) was the most severely affected plant by S. frugiperda. In the vegetative phase, the symptoms of S. frugiperda attack began to appear which were marked by the presence of bite marks on the leaves until there was a severe attack, namely damaged leaves with wide holes. This makes the plants at the age of approximately 4 weeks after planting damaged by S. frugiperda larvae attack with an average attack intensity of 25%. The intensity of attacks until the 6th week reaches almost 50%.

Development is a change towards improvement (Shah et al, 2020). It is necessary to monitor the presence and development of S. frugiperda because some of its main hosts are food crops from the Graminae group such as corn, rice, wheat. Sorghum and sugarcane. This pest is polyphagous, causing heavy losses due to its attacks in African and European countries reaching 8.3 to 20.6 million tons per year with an economic loss value of between

US$ 2.5-6.2 billion per year (FAO & CABI 2019).

Damage to plants is usually indicated by larvae hoist marks, which are coarse powder resembling sawdust on the upper surface of the leaves, or around the shoots of corn plants. The initial symptoms of S. frugiperda attack are similar to those of other pests on maize. If the larvae damage the shoots, young leaves or growing points of the plant, it can kill the plant. In African countries, the loss of maize yields due to S. frugiperda attacks is between 4 and 8 million tons/year with a nominal loss of between US$ 1 - 4.6 million per year. Armyworm infestation on corn plants when the young leaves are still rolling causes yield loss of 15-73% if the plant population is attacked by 55-100%. In Nicaragua, insecticide application can save yields by about 33%. (FAO & CABI 2019).

The study of S. frugiperda used a combination of plants, with the object of various types of host plants being observed considering the lack of information about the combination of plants favored by this pest and its phenology in the field. It is necessary to know the combination of host plants for S. frugiperda by combining several types of plants such as sugarcane, corn, land rice, green beans, elephant grass and soybeans.(Azwana, 2021). That way it will be seen what combination of plants he likes the most and can be seen from the level of damage caused by this pest attack in the field(Agustiar et al., 2016; Fernando et al., 2020).

III. Research Method

The research was carried out at the Experimental Field of the Faculty of Agriculture, University of Medan Area on Jalan PBSI Number 1, Percut Sei Tuan District, Medan Estate, with an altitude of ± 22 meters above sea level (m asl). The research was conducted in November 2020 - February 2021.

The materials used in this study were sweet corn seeds, white corn and hybrids, soybean seeds (Glycine max L), mung bean seeds (Vigna radiate), upland rice seeds (Oryza sativa L), and elephant grass seeds (Pennisetum purpureum), larvae of S frugiperda instar 3, cow manure, compound NPK fertilizer, and water.

The tools used are hoe, gembor, bamboo pole, white insect net, sewing thread, white lever, tape measure and complete stationery.

The method used in this study is a descriptive method that describes problems that occur in the present or ongoing, aiming to describe what happened as it should when the research was conducted.

Mosquito net or cage *(screen)* using white mosquito nets collectively/plots, with a roof area of 1 x 1.5 m ; width around 5.5 m ; and 2 m high. Types of plants used: Sweet corn (Zea mays L saccharata) (T1), white corn (Zea mays var. amylacea) (T2), hybrid corn (Zea mays var. indurata) (T3), soybean (Glycine max L) (T4), green beans (Vigna radiate) (T5), elephant grass (Pennisetum purpureum) (T6), upland/land rice (Oryza sativa L) (T7).

Determine the combination of plants randomly, and the following combinations are determined as many as 16 combinations:

A(T1T2T3)	E(T1T4T7)	I(T1T4T6)	M(T1T5T6)
B(T1T5T7)	F(T2T4T7)	J(T2T5T6)	N(T2T5T7)
C(T2T4T6)	G(T3T4T7)	K(T3T4T6)	O(T3T5T6)
D(T3T5T7)	H(T4T6T7)	L(T4T5T7)	P(T4T5T6)

III. Results and Discussion

3.1 Attack Symptoms

Symptoms of a severe attack are found in corn plants, according to (Nonci et al. 2019) the symptoms of S. frugiperda attack can be seen on the young leaves that are still curled with bite holes and dirt. Based on observations made in this study, the results showed that corn, rice, and elephant grass were the main choices as food sources for S. frugiperda larvae, plants belonging to the grass family support the breeding of these larvae.

The larvae of Spodoptera frugiperda were in instar 3 and were allocated to each plant sample of 2 tails.

Note: the number of replications was 2 replications, consisting of 32 plots with a plot size of 1 x 1.5 m each, consisting of 3 types of plants with a total of 9 plants per plot. The spacing is 40 x 50 cm, the distance between plots is 40 cm with a total of 288 plants.

Parameter observations consisted of attack symptoms, pest attack intensity, larval mortality, and the percentage of larvae that became pupae.

half of the plant in the vegetative phase. Based on observations from larval sources, namely hybrid maize cultivation, it was seen that the greatest damage to growth and production of maize was caused by S. frugiperda larvae.

Figure 1. *Symptoms of S. frugiperda attack on various plants, a. white corn, b. sweet corn, c. hybrid corn, d. elephant grass, e. rice, f. green beans, g. soy*
(source: Personal Documentation, 2021)

*S. frugiperda*can attack all test plants, symptoms of attack on 3 types of family corn plants are characterized by the destruction of the shoots of young plants accompanied by a large amount of larval droppings. Likewise, the symptoms of S. frugiperda attack on elephant grass are not much different from the symptoms of attack on corn plants, and on rice the symptoms of attack are marked by the breaking of the leaf midrib accompanied by some attached larval droppings. In contrast to green beans and soybeans, the symptoms of attack

were only seen on the first day after the investment was marked by the presence of larvae bite marks on the edges of the young leaves.

*S. frugiperda*attack each type of plant test with different percentage power and intensity of attack. The highest attack was only seen in the combination of corn plants with an intensity of almost 50% or the Percentage and Intensity of Spodoptera frugiperda attack.

The intensity of S. fruiperda attack was different for each combination of plants used. Observations were made for 7 days after the infestation was carried out. Observations were stopped when there was no longer any larval activity on the plant or there was a change in the larval phase to pupa. Figure 4 is a graph of observation data for combination A to combination H. Each combination is distinguished by the color of the line. Based on the data in the graphic image, it shows that the highest average attack intensity was in combination A (sweet corn, white corn and hybrid corn). The highest attack on day 4 reached 33.8%. while combination B (sweet corn, green beans, and land rice) the highest average attack intensity on day 2 only reached 12.3%. In combination C (white corn, soybean, and elephant grass) the highest average attack intensity was on day 3 only reaching 12.8%. Combination D (hybrid maize, green beans, and land rice) the highest attack intensity on day 5 reached 11.1%. Combination E (sweet corn, soybean, and land rice), the highest average attack intensity was on day 4 reaching 13%.

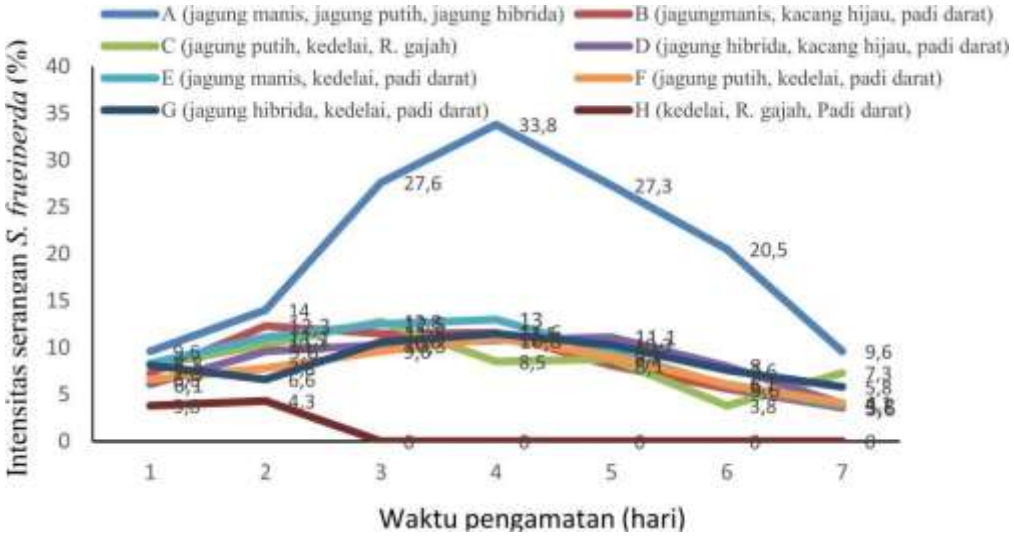

Figure 2. *Graph of the average intensity of S. frugiperda attacks on the combination of AH*

Combination F, the highest attack intensity reached 11% on day 4 (white corn, soybean, and land rice). Combination G (hybrid corn, soybean and land rice) the highest attack intensity was on day 4 reaching 11.5%. combination H (soybean, elephant grass, and land rice) the highest average attack intensity only reached 4.3% on day 2.

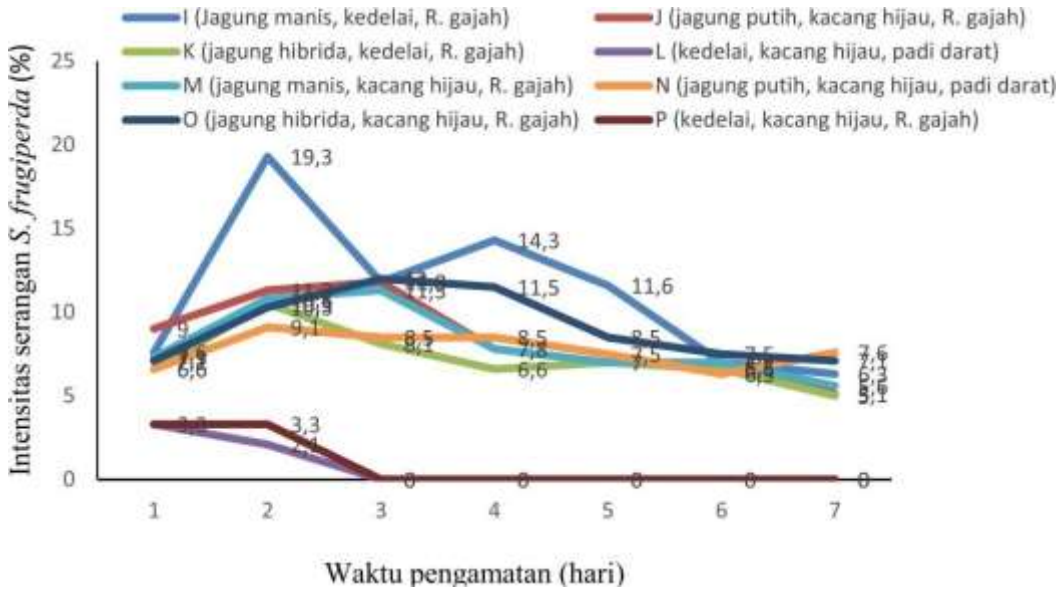

Figure 3. *Graph of the average attack intensity of S. frugiperda on the IP . combination*

Next is the observation of combination I to combination P in Figure 2. Each combination is distinguished by the color of the line. Based on the data in the figure, the highest average attack intensity was in combination I (sweet corn, soybean, and elephant grass). The highest attack on day 4 reached 14.3%. While combination J (white corn, green beans, and elephant grass) the highest average attack intensity on day 3 only reached 11.8%. In combination K (hybrid maize, soybean, and elephant grass) the highest average attack intensity was on day 2, which only reached 10.5%. The combination of L (soybean, mung bean, and land rice) the highest attack intensity on day 1 reached 3.3%. Combination M (sweet corn, green beans, and elephant grass), the highest average attack intensity was on day 3 reaching 11.3%. Combination of N (white corn, green beans, and land rice) the highest attack intensity reached 9.1% on day 2. The combination (hybrid corn, green beans and elephant grass) had the highest attack intensity on day 3 reaching 12%. combination of P (soybean, mung bean and elephant grass) the highest average attack intensity only reached 3.3% on day 2.

Observation of the intensity of the attack showed that the highest attack was in the combination A of sweet corn, white corn, and hybrid corn, which means that S. frugiperda really liked these plants. This is in line with previous research by Subiono (2019) regarding the preference of S. frugiperda to the feed test, stating that these larvae prefer grass (C4) plants such as corn and rice, this was observed through the larval growth period with this feed faster and the pupa is heavier. When compared with legume-type feeds (C3) such as soybeans and peanuts, it can be seen from the longer growth period to the imago phase and lighter pupa weight.

Subiono (2019) also stated that the content of C4-type plants has more complete nutritional content for the growth and development of S. frugiperda, the grass family is known to have Dimboa compounds which are thought to play an important role as feeding attraction and egg laying that supports the development of these larvae. Compared to C3 plants, it is known to have phytoalexin compounds (flavonoids), which are secondary metabolites that act as plant resistance to disease, this is a definite cause of slowing growth of S. frugiperda fed legumes.

3.2 Larval Mortality

Several factors can affect the decline in the activity of S. frugiperga larvae until they die, one of which is climatic conditions and environmental conditions in the research area. Based on BMKG data on the condition of the research land, the standard average temperature reached 26.6℃ in November 2020. In December 2020 it reached 26.4℃, in January 2021 it reached 26.3℃ and February it reached 26.4℃. Besides that, rainfall is also an important factor, where the highest rainfall occurred in December 2020 reaching 286 mm and in January 2021 reaching 292 mm. High rainfall will affect the level of humidity, where on the land this research shows the highest humidity data occurred in December 2020, an average of 88%.

S. frugiperda larvae will survive at normal temperature and humidity or room temperature. If seen from the observations every day the larvae that migrate on average are in green bean and soybean plants on the second day after investment. Some larvae migrate to plant combinations with corn or elephant grass. Close range of hosts can sometimes encourage the spread or transfer of these insects between plants (CABI, 2019). This has been successfully documented as field evidence at the time of observation, it can be seen in Figure 4.

Figure 4. *Documentation of S. frugiperda moving from rice to elephant grass. (source; Personal Documentation, 2021).*

Table 1. Mortality of S. Frugiperda larvae on various test plants

No	Combination	Plant	Number of Larvae Reduced		N mortality	
			I	II	I	II
1	A	Sweet corn	0	1	0	16.6
		White Corn	1	2	16.6	33.3
		Hybrid Corn	2	2	33.3	33.3
2	B	Sweet corn	1	1	16.6	16.6
		Mung beans	6	6	100	100
		Land Rice	3	2	50	33.3
3	C	White Corn	0	1	0	16.6
		Soya bean	6	6	100	100
		elephant grass	2	4	33.3	66.6
4	D	Hybrid Corn	2	1	33.3	16.6
		Mung beans	6	6	100	100

		Land Rice	2	5	33.3	83.3
5	E	Sweet corn	1	1	16.6	16.6
		Soya bean	6	6	100	100
		Land Rice	2	4	33.3	33.3
6	F	White Corn	0	1	0	16.6
		Soya bean	6	6	100	100
		Land Rice	2	2	33.3	33.3
7	G	Hybrid Corn	1	1	16.6	16.6
		Soya bean	6	6	100	100
		Land Rice	1	2	16.6	33.3
8	H	Soya bean	6	6	100	100
		Elephant Grass	0	4	0	66.6
		Land Rice	3	4	50	66.6
9	I	Sweet corn	1	1	16.6	33.3
		Soya bean	6	6	100	100
		Elephant Grass	3	3	50	66.6
10	J	White Corn	2	1	33.3	16.6
		Mung beans	6	6	100	100
		Elephant Grass	2	3	33.3	50
11	K	Hybrid Corn	2	1	33.3	16.6
		Soya bean	6	6	100	100
		Elephant Grass	3	4	50	66.6
12	L	Soya bean	6	6	100	100
		Mung beans	6	6	100	100
		Land Rice	3	6	50	100
13	M	Sweet corn	0	1	0	50
		Mung beans	6	6	100	100
		Elephant Grass	2	4	33.3	66.6
14	N	White Corn	2	2	33.3	33.3
		Mung beans	6	5	100	83.3
		Land Rice	2	3	33.3	50
15	O	Hybrid Corn	1	3	16.6	50
		Mung beans	6	6	100	100
		Elephant Grass	2	4	33.3	66.6
16	P	Soya bean	6	6	100	100
		Mung beans	6	6	100	100
		Elephant Grass	2	3	33.3	50

Symptom S. frugiperda attack was only slightly on mung bean and soybean compared to maize, rice, and elephant grass.

The highest larval mortality was in soybean and mung bean plants reaching 100%, compared to maize, land rice and elephant grass. Observations of the study showed that the mortality of S. frugiperda larvae depended on the combination of plant species. Several morphological forms of grasses such as corn, rice, and elephant grass support the safety of larvae laying eggs and survival. Usually the larvae hide at the end of the plant that is still not fully opened. This is in line with the general information submitted by the Center for Forecasting Plant Pest Organisms (2016) in a journal entitled Introduction to invasive pests S. frugiperda.

3.3 Natural Enemy Diversity

The diversity of natural enemies is the biggest factor causing the death of S. frugiperda larvae. This is in line with previous studies by Nadrawati, et al (2019) regarding the identification of new pests and their natural enemies on maize, which contained the same groups of parasitoids and predators as my findings in this research area. Such as black ants and a group of larvae and imago of Coleomagilla maculate. The same thing that I found in the field became an important fact in knowing the natural enemy of S. frugiperda.

Shylesha (2018) reportfound natural enemy complexes of S. For larvae in special combinations such as legumes, they only lasted 1 to 2 days. While the larvae that survive on the elephant grass frugiperda plant are the egg parasitoid Telenomus sp. and a group of flies (diptera) in their research on the introduction of invasive pests of maize. The presence of natural enemies can certainly reduce the population of S. frugiperda at the same time it will decrease the attack of this pest.

3.4 Number of Larvae That Pupae

The final result in this study was observing the development of larvae that became pupae. It is uncertain how many larvae pupae from the larval population invested. Due to the unfavorable and homogeneous field conditions, it was difficult for researchers to find all the pupae. This larva will enter the soil after passing the 6th instar to turn into a pupa. CABI (2017) states that it takes 9 to 13 days for the pupa to turn into an adult imago, the imago will emerge at night and usually use the natural pre-oviposition period to fly several kilometers before the oviposit, sometimes migrating for long distances, on average. The average adult imago lives for 12 to 14 days. Pupae of S. frugiperda are shorter than adult larvae, on average up to 1 in length, 7 cm and shiny brown. The pupae that were found in this study can be seen in Figure 5.

Figure 5. *Pupae of S. frugiperda found on the ground (Source: Personal Document, 2021)*

The search for pupae is carried out by slowly prying the plot of land that is the planting medium. This is to avoid damage to the pupa body to be sought. Previous research stated that sandy soil conditions were more appropriate for pupa development, because the sandy soil texture made it easier for larvae to enter the soil. In addition, in order to reduce the occurrence of defects in adult imago wings. (CABI, 2017).

In the pupa discovery data contained in this study, it was seen that the highest number of pupae were found in corn plants reaching 4.6% of the invested larvae population or as many as 11 pupae. Followed by the discovery in rice plants as much as 1.27% or as many as 3 pupae and in elephant grass plants only reached about 1.69% or as many as 4 pupae.

Table 2. Number of S. frugiperda pupae found in all plants

No	Plant	Number of pupae	%
1	Corn	11	4, 6
2	Paddy	3	1.27
3	Soya bean	0	0
4	Mung beans	0	0
5	elephant grass	4	1.69

Table 2 shows the data on the discovery of pupae in this study, it can be seen that the highest number of pupae were found in maize, reaching 4.6% of the invested larvae population or as many as 11 pupae. Followed by the discovery in rice plants as much as 1.27% or as many as 3 pupae and in elephant grass plants only reached about 1.69% or as many as 4 pupae.

IV. Conclusion

Farmers need to implement an intercropping system for maize combined with legumes so that the population of S. frugiperda can be controlled. The combination of cropping or various types of plants in a certain area can at the same time increase the diversity of natural enemies (predators and parasitoids) that can suppress the population of S. frugiperda in maize

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