Stenocranus pacificus (Hemiptera: Delphacidae) and Spodoptera frugiperda (Noctuidae; Lepidoptera) are important pests on maize mix-cropped with oil palm in West Sumatra

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Abstract. Maize is commonly planted in monoculture. However, in several areas of West Sumatra, it is also cultivated as polyculture side-by-side with oil palm. The study aimed to investigate the important pests that attack maize plants in oil palm plantations in Pasaman, West Sumatra. This research was conducted in existing and replanting oil palm plantations. Insect pests data collection was purposive random sampled from represented plots of maize plants that were attacked by pests. Five sample plots of 1x1 m2 were taken for assessing insect pests incidence. The average number of maize plant stalks observed 32. Observations were made on the condition of the maize and oil palm agroecosystem, species and populations, and symptoms of insect pests that attack maize. The result showed that Stenocranus pacificus and Spodoptera frugiperda were the most dominant insect pests. The insects damaged the leaves and stems of maize plants. Stenocranus pacificus population was 4.45 individuals/plants, and Spodoptera frugiperda was 1.7 individuals/plants. The maize in West Pasaman is mostly planted on oil palm plantations consisting of monoculture and in oil palms that would be replanted. It was found that two insect pest species were dominant attackers, i.e., Symptoms of the attacks were seen on the leaves and stems of the plants.

Keywords: Agroecosystem, maize, palm, plantation, pest.

1. Introduction
Maize is a source of food. In some areas, maize farming centers are mostly used for animal feed. The need for maize as a source of feed is greater than that of food. Increased maize production is needed to meet the need for these feeds.

Efforts to increase production are carried out in various locations, including additional planting locations, planting areas, and various ways to increase production. Maize planting is done not only by monocultures but also often by polyculture. In locations with large areas of land, monoculture planting is carried out. In other locations, polyculture is considered. Maize polyculture planting techniques are often planted side-by-side with other crops. In the West Pasaman area, West Sumatra Province, maize is widely grown on oil palm plantations.

Polyculture maize planting has a positive impact on the economy. The results obtained are not only from the main crop but also from corn production. An example is in plantations or oil palm plantations where maize is planted. Maize yields are obtained before the oil palm plants produce. This has a positive impact on farmers but affects the surrounding ecosystem. The condition of polyculture plants will affect
the presence of plant pest organisms.

Maize is typically grown in garden conditions with low oil palm plantations. In oil palm plantations, old palm tree areas are also widely used as land for planting maize. Maize is commonly planted on the oil palm land that will be replanted. Farmers plant maize among palms that are nearly dead. Most oil palm farmers destroy old plants by applying herbicides on the shoots of the palms.

Treated oil palm plantations can be used for cultivation techniques or for replanting. This treatment is expected to affect the presence of pests around the agroecosystem. The agroecosystem of oil palm plantations is different from other agroecosystems. Various types of pests are found attacking maize plants grown on oil palm plantations.

The presence of pests that attack maize plants certainly affects production. Many types of pests attack maize in both monoculture and polyculture areas. Maize is attacked starting from the vegetative phase to the generative or harvest phase. Examples of pests that attack during the vegetative phase are corn stem borer (*Ostrinia furnacalis*), seed fly (*Artherigona* sp), and armyworm (*Spodoptera litura*).

Pests that attack during the generative phase include the cob borer (*Helicoverpa armigera*) [1]. At the beginning of 2019, a new pest was found to have invaded, *Spodoptera frugiperda* [2].

The type and level of pest attack on a crop are strongly influenced by the conditions of its environment. In stable agroecosystems, pest attacks are usually not too high, so they have no impact on production. The agroecosystem conditions in oil palm plantations are different from other agroecosystem conditions. The existence of oil palm cultivation treatment, such as the use of herbicides, is expected to affect the surrounding environment. In plantations, oil palm is the main crop, and maize is an intercrop, and it is expected to provide benefits.

To increase farmers’ income, planting maize in oil palm plantations is mostly done in West Pasaman. This research aims to study the agroecosystem model of maize in oil palm plantations and the predominant types of pests that attack maize.

2. Materials and methods

2.1. Study sites

The research was conducted in West Pasaman Regency, West Sumatra Province. Observations were made for two different growing seasons in 2021. Samples were taken from maize cultivations in oil palm plantations in West Pasaman (Figure 1).

![Figure 1. Research location in West Pasaman Regency, West Sumatra.](image-url)
2.2 The condition of the maize plantation ecosystem in oil palm plantations
The condition of the maize plantation ecosystem was observed at the location of the oil palm plantation. Observations were made at three locations of maize cultivation with different conditions. The selected oil palm plantations comprised maize plantations.

2.3 Identification of species, symptoms of the damage, and insect pest populations in maize
Observations of damage were carried out on samples of maize fields found in oil palm plantations. Sampling was carried out on one maize field, and five plots were taken diagonally. Each sample plot measures 1m x 1m. Insect populations were calculated by direct visual observation on the symptomated maize plants and by using a sweep net insect net catch. A sampling of insect pests was carried out on plant samples that showed symptoms of being attacked. Insect pest species were observed in the laboratory based on insect morphology. The observation of attack symptoms and population calculation were carried out in sample plots with 32 stems of maize plants.

2.4 Data analysis
The data collected were analyzed by Microsoft Excel. The data is displayed in the form of figures and tables hereafter.

3. Results
3.1 Maize plantation ecosystem in oil palm plantation sites
In general, maize crops were mix-cropped in the oil palm plantations in Luhak Nan Duo village, West Pasaman Regency, West Sumatra Province. Maize crops were cultivated in rows in open spaces between existing oil palm trees. Maize was grown in monoculture plants (Figure 2a), mix-cropped with oil palm plantations (Figure 2b), or on replanted oil palm plantations (Figure 2c).

![Figure 2. Maize plantation area in oil palm plantation location. (a) monoculture maize (b) polyculture (maize – oil palm), and (c) maize on replanted oil palm land.](image)

The condition of the oil palm land in the sample locations in the West Pasaman district is diverse. Oil palm plantations consist of land that was recently planted and has been harvested after the removal of old plants. Monoculture maize cultivation is carried out near oil palm plantations. Polyculture systems include maize that is planted between oil palms (Figure 2b). Meanwhile, in oil palm plantations that are no longer productive and have died, maize is also planted.

The condition of the plantation with unproductive palm trees will be destroyed by the plantation owner. Palm trees are destroyed using herbicides to kill the plants. Herbicides are injected into the shoots, and the palm will slowly die. In plantations with palm trunks still standing, maize is planted around it (Figure 2b).

Maize is also planted on a large area of land on the edge of an oil palm plantation. The cropping pattern...
is in monoculture since there are only maize plants on the land (Figure 2 c). Maize plants planted around oil palm plantations were found to have symptoms of attacks by plant-disturbing organisms. Based on the symptoms found, the types of pests that attacked were observed.

3.2. Identification of pest species and populations
The results of the identification of insect pests that attack maize are:

1. *Stenocranus pacificus* (Hemiptera: Delphacidae)
   This insect pest is known as the "corn planthopper". It attacks the leaves and shoots of maize plants. Maize plants grown in all conditions in oil palm plantations are attacked by this insect. The results of morphological observations can be seen in Figure 3.

![Figure 3. Adult *S. pacificus* on maize leaves.](image)

Insect *S. pacificus* was found in all maize crops during both vegetative and generative phases. This pest was found in almost all maize planting locations around the oil palm plantation. The maize growth phase determines the population in the field. The population was higher in the vegetative phase compared to the generative phase, as shown in Table 1.

| Maize growth phases | *S. pacificus* population (individual±sd) | *S. frugiperda* population (larvae/stem) |
|----------------------|------------------------------------------|----------------------------------------|
|                      | Direct counting                          | Insect net catching                     | Direct counting |
| Vegetative           | 4.45±2.72                                | 40.00±18.33                            | 1.60           |
| Generative           | 2.50±3.40                                | 11.00±3.02                             | 0.12           |

The population in the vegetative phase was higher than in the generative phase, based on either direct observation or using insect nets. Direct population observation found an average of 4.45 individuals/stems in the vegetative phase, a lower number than that using insect nets. Similarly, in the generative phase that was observed directly, it was less than the insect net.

2. *Spodoptera frugiperda* (Lepidoptera: Noctuidae)
   The attacking stage for this insect is the larva stage, and it is found at the base of the corn stalk. The morphology of the larvae is like an inverted 'Y' on the anterior and has spots on the dorsal side (Figure 4).
Figure 4. Stadia of *S. frugiperda* larvae in the host (a) and (b) ventral part.

Larvae are found at the base of the leaves. Symptoms of the damage are found in the leaves and stems of maize. In the damaged leaves and stems, larval secretions were found. Under dry conditions, the larval secretions become like sawdust (Figure 5).

Figure 5. Symptoms of damage caused by *S. frugiperda* on maize.

In severe attack conditions, the symptoms of damage are severe. The maize leaves are torn, and the stems break off. Figure 5 shows torn leaves, and dried larval secretions that resemble sawdust are found on them. The number of symptomatic plants depends on the larval population in the field. The larval population was influenced by the growth phase, while the vegetative phase was higher in the population than the generative phase (Table 1).

*S. frugiperda* larvae were found in all stages of maize growth. Damage was seen in all maize planting locations, especially in the vegetative phase of maize. Newly-planted maize plants that have been attacked by this pest show explicit symptoms that are easy to detect. In high population conditions, almost all the land is attacked, whether it is monoculture, polyculture with oil palm, or maize planted on land to be replanted.

**Discussion**

Oil palm farmers take advantage of their oil palm plantations by planting maize, which is one way to increase their income. Maize is grown in the plantation area, either outside around the oil palm in
plantsations where palm trees are still planted. In old gardens or oil palms that will be replanted, maize is also planted.

At the research location, Pasaman Barat is the area with the most extensive oil palm plantations in the West Sumatra Province. The total area of oil palm plantations in several districts is 219,663 Ha. Maize is planted in the oil palm plantation. West Pasaman Regency is one of the centers of maize production in West Sumatra. The districts that also produce corn are Fifty Cities, Tanah Datar, PadangPariaman, and Solok Regencies. Corn production in West Sumatra reached 935,716 tons in 2020. The highest production came from the West Pasaman Regency [3]. The high corn production in the West Pasaman Regency is because most of the oil palm plantations are always planted with maize. Maize planting is done by farmers in monoculture or polyculture techniques or between replanting palm trees. The conditions of oil palm plantations affect maize cropping patterns. Monoculture maize cultivation involves the growth of only maize on extensive areas of land. Polyculture is maize planted together with oil palm. Maize seeds are planted between young palms. In contrast to maize planted in gardens to be replanted, maize is found between old palms, which will be destroyed and replaced with new plants. This condition is expected to affect the maize ecosystem. Plant pest organisms are influenced by plant cultivation techniques. Pest and plant diseases are influenced by the host and the environment.

Pest species will be present and develop in a habitat if there is a host plant. Maize plants have several types of pests that attack from the beginning of planting to harvesting or in storage. The main pests of maize include the corn stem borer (Ostrinia furnacalis Guen), Grayak caterpillar (Spodoptera littura), corn cob borer (Helicoverpa armigera Hbn. Noctuidae: Lepidoptera), seed fly (Atherigona sp), and powder beetle (Sitophilus zeamais).

West Pasaman, besides producing palm oil as its main commodity, also grows maize to increase economic value. The pattern of planting maize in or near garden areas in West Pasaman is very diverse. Maize grown in one bed consists of several varieties [4].

The attack of a pest species is influenced by many factors, such as the presence of the host and the environment. Maize plants planted in oil palm plantations were found to contain pests, including S. pacificus, which attacks the leaves, and S. frugiperda, which attacks both leaves and stems. S. pacificus, or the corn planthopper, of the order Hemiptera and family Delphacidae, was found in the vegetative and generative growth phases (Table 1). This is under [5], which states that the vegetative growth phase is preferred by insects. If observed visually, the population is lower when compared to observation using insect nets. This occurs because when observations are made, most of these insects fly and move to other plants. Meanwhile, if you use an insect net, all individuals on the leaves will be caught. S. pacificus is mostly found in the leaves of maize plants. The habit of this pest is the young leaves of maize plants.

S. pacificus is an important pest for maize [6]. The spread of this pest in West Sumatra was found on almost all maize crops [7].

Another pest that has also been found in maize is S. frugiperda (Lepidoptera: Noctuidae). This pest was discovered and reported for the first time in the West Pasaman Regency, as well as in Indonesia.

S. frugiperda attacks maize grown in oil palm plantations. For all maize varieties grown in oil palm plantations starting from 2019 to date, S. frugiperda has spread to all of these varieties for all maize plantations.

The fall armyworm, or S. frugiperda, is an invasive pest originating from the Americas. FAW control technique has been researched in America [8]. It began to spread and was discovered in 2016 on the Asian continent. In China, this pest has grown and spread to several maize cultivation locations [9]. In 2011, it was found on the continent of Central Asia [10], 2018 in Africa [11]. In March 2019, it was reported in West Pasaman, Indonesia (2). The results of the genetic analysis of S. frugiperda spread in West Sumatra belong to two groups. Genetically, S. frugiperda in West Sumatra is very closely related to other Asian countries such as Japan and China [12]. S. frugiperda was also found in Lampung and showed genetic similarities with other populations [13].

The morphology of the larvae can be recognized from the characteristics of the anterior part, which resembles an inverted “Y” (Figure 4). In the early larval stage, the shape or characteristics of the larvae are not very clear. The presence of larvae are secretions from the larvae that can be easily seen to identify
the attack. The secretions are yellowish flakes, and when dry, they resemble sawdust.

The attack of *S. frugiperda* in the vegetative phase was higher than in the generative phase. The larval population found in maize plants was higher during the early stages of growth (Table 1). Symptoms of attacks on maize plants are easy to observe. In young leaves, the symptoms include torn and broken leaves (Figure 3). *S. frugiperda* larvae attack all maize varieties in the field. Larvae will eat young leaves, and a high population is also found on stems [14]. Maize grown in oil palm plantations consists of several varieties, namely, Pioneer 32, Pertiwi, Bisi 18, NK7328, and NK212. Almost all of the maize varieties planted were attacked by *S. frugiperda* [4]. The control of this pest merits further investigation because it is strongly influenced by its environment [15].

4. Conclusion

Maize crops in West Pasaman Regency are mostly planted within or around oil palm plantations. Maize planting patterns are monoculture on land around oil palm plantations, polyculture in which maize is planted together in oil palm plantations, and also replanted oil palm land. The dominant pests that attack maize are *Stenocranus pacificus* and *Spodoptera frugiperda*. These two pests attack in all conditions of maize cultivation in oil palm plantations. The pest population is higher in the vegetative phase than in the generative phase.

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