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Original Research

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Level of Pest Infestation on Cocoa (*Theobroma cacao* L.) Variety BL-50 in Tanah Datar Regency, West Sumatera Province, Indonesia

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Abstract

West Sumatra Province is one of the cocoa production centers in Indonesia. Cocoa farmers in the Lima Puluh Kota District in West Sumatera Province had successfully developed a superior clone of cocoa plants resulting from participatory selection, which was later coded BL-50. The main pests that attack cocoa plants are the urgent problem in cocoa cultivation, resulting in decreased productivity. This study aims to determine the level of significant pest attacks on cocoa varieties BL-50 in Tanah Datar Regency. This research is in the form of a survey with a purposive sampling method. Sampling is carried out systematically diagonally in the field. The highest attack rate of Cocoa Fruit Borer in Tanah Datar Regency is in Rambatan District, with the percentage of affected plants, the percentage of infested fruits, and the highest attack intensity, respectively 51,.25%; 31.58% and 21.10%, the lowest were in Lintau Buo Utara District with 30.93%; 20.70% and 13.96%. The highest attack rate of cocoa fruit-sucking ladybugs in the BL-50 variety is in Rambatan District, 66.09%, 45.07%, and 30.45%. At the same time, the lowest is in the Lintau Buo Utara District, with a percentage value of 41.56%, 27.66%, and 18.30%. Excellent and regular land sanitation activities have played a role in minimizing the level of pest attacks in Lintau Buo Utara.

Keywords

Cocoa pod borer, fruit-sucking ladybug, local clone, P3S, varieties

INTRODUCTION

West Sumatra Province is one of the cocoa production centers in Indonesia. The development of the cocoa land area over the last five years in West Sumatra Province has decreased from year to year. Starting in 2018, the cocoa plantation area in West Sumatra Province was 121,227 ha and then decreased to 68,710 ha in 2022. The reduction in cocoa land area also resulted in a decrease in cocoa production in West Sumatra Province. Total production 2018 reached 59,529 tonnes/ha/year and decreased to 43,528 tonnes/ha/year for the last five years until 2022 (BPS, 2023).

Cocoa has superior cocoa clones that can be an option to be developed, including clones MCC 01 and MCC 02. Clones MCC 01 and MCC 02 resist fruit

borer pests. Both clones are superior clones that resist and respond to significant cocoa pests. It shows that superior clones have a resistance response to the symptoms of the leading pest (Susilo et al., 2014).

The superior cocoa clones used impact the success of cocoa cultivation. The success of cocoa cultivation, especially in cocoa production, is also influenced by many factors, including less-than-optimal plant management on the farms, environmental factors, and the main pests that attack superior clone cocoa plants. These pests include cocoa pod borers and fruit-sucking ladybugs, which can cause a decline in cocoa production (Basir et al., 2013).

Cocoa farmers in the Lima Puluh Kota Regency, West Sumatra Province, had successfully developed a superior clone of cocoa plants resulting from participatory selection, which was later coded BL-50 (an abbreviation of *Balubuih Lima Puluh Kota*). 2015, the BL-50 clone was registered as a new variety with the Centre for Plant Variety Protection. Based on the survey activities of the Centre for Plant Research and Development research team, it was known that the BL-50 clone had been widely developed in the Payakumbuh and Tanah Datar regions (Balittri, 2017).

Tanah Datar Regency is one of the potential cocoa development areas in West Sumatra. Geographically, Tanah Datar Regency is located in the center of West Sumatra Province at 00º17" LS - 00º39" LS and 100º19" East - 100º51" East and has an average altitude of 400-1000 masl. Tanah Datar Regency has a moderate temperature ranging from 12°C-25°C with an average rainfall of more than 3,000 mm per year. Most of the rain falls from September to February. This high rainfall results in sufficient water availability, allowing extensive agricultural endeavors to be developed (BPS Tanah Datar, 2023).

Cocoa plantations are managed mainly by people with minimal maintenance due to limited costs and human resources for cocoa cultivation. Generally, cocoa fields are not well maintained and are not even allowed to grow densely without pruning, so many cocoa fields have become "cocoa forests" due to poorly maintained land. It triggers a high attack level from plant-disrupting organisms (pests) from the pest group (Ikhsan, 2012; Haliatur et al., 2018).

The main pests that attack cocoa plants are the urgent problem in cocoa cultivation, resulting in decreased productivity. Research on the level of attack of major pests on cocoa has been conducted in Indonesia and also in West Sumatra. Oktaviani (2018) reported *Helopeltis sp.* infestation on treated and untreated cocoa plants in the Rambatan sub-district. Untreated cocoa plants had higher infestation than treated cocoa plants. On treated farms, the intensity of the attack was 34.86%, while on untreated farms was 53.33%. Sembiring (2018) reported on identifying and observing pests on cocoa plants in Cubadak Village, Lima Puluh District, Tanah Datar Regency. The type of pest on cocoa plants is *Helopeltis sp.,* which attacks cocoa plants, which are known to be more than one species.

The primary pest with a high population level is an obstacle that needs attention and proper handling. The existence of the local superior clone BL-50 is expected to increase cocoa production and reduce farmer losses to pest attacks. However, differences in geography, climate, cultivation methods, and pest types will undoubtedly impact the resistance of the BL-50 clone. Therefore, information is needed on the types of pests and their attack level in several areas, such as cocoa production centers in Tanah Datar Regency. This was done as a preventive measure and a reference in carrying out selective control measures for pest species to improve the condition of cultivated land and minimize the impact of significant pest attacks.

METHODS

Place and Time of Research

This research was conducted in Tanah Datar Regency, West Sumatra Province. The research implementation time was from December 2022 to February 2023.

Research Materials

The materials used in this study are cocoa plants, the object of observation. Label paper was also used as a sample marker.

Research Equipment

The equipment used in this research was divided into two parts: equipment for the interview and field. Equipment at the time of the interview are stationery and paper questionnaires. The equipment used in the field were harvest scissors, knives, calculators, labels, markers, raffia, meters, stationery, sacks, microscopes, and mobile phone cameras.

Research Procedure

Research Methodology

The research was conducted in Tanah Datar Regency with a survey method by purposive sampling with location criteria, namely land area and cocoa fields produced specifically on BL-50 variety. These criteria determined the research locations to be Rambatan, Salimpaung, and North Lintau Buo Subdistrict. Furthermore, a pre-survey was conducted in each village in each sub-district. The criteria used to determine the sample locations were cocoa farms with a land area of ± 0.5 ha, more than four years old, already in production, and having BL-50 clones. Based on these criteria, 12 sampling points were obtained in 6 villages in the three sub-districts. Then, on the land, 10% of the total plant population in the plantation was determined systematically on the diagonal line of the land with a distance between sample plants ranging from 1 to 2 plants.

The sample points were located in 3 sub-districts in 6 villages called *Nagari*. Nagari Rambatan had 2 sample fields, and Nagari III Koto had 2 sample fields. Nagari Sumanik and Tabek Patah had 2 sample fields each. Nagari Lubuk Jantan had 4 sample fields. Each sample land determined with existing sample points is on the administrative map. Samples that had been determined were then marked and numbered. Furthermore, the sample plants were observed for infested plants and the intensity of the attack that occurred.

Observation of cocoa plant condition

Plant conditions were observed on each research site, including cocoa variety, plant spacing, plant age, and cultivation activities (pruning, sanitation, fertilization, and pest control). Data was obtained by looking directly at the field and interviewing the farm owner to obtain information about cocoa cultivation on the land.

Data Analysis

Percentage of plants infested with major pests

The percentage of infested plants is the ratio between the number of infested plants and the total number of observed plants; the purpose is to obtain information on the distribution of significant pests in the field. The percentage of attacks was observed using the following equation.

$$P = \frac{a}{b}\ x\ 100\%$$

Description:
P: Percentage of plants attacked by the primary pest
a: Number of infested plants
b: Total number of plants observed

Percentage of fruit infested by main pests

The percentage of fruit infested is the ratio between the number of fruit infested with cocoa pests and the total number of plants observed; the purpose is to obtain information on the spread of the main pests on the fruit in the field. The percentage of fruit infestation was observed using the following equation.

$$P = \frac{a}{b}\ x\ 100\%$$

Description:
P: Percentage of fruit attacked by the primary pest
a: Number of infested fruits
b: Total number of fruits observed

Observation of Cocoa Pod Borer (CPB) attack intensity

Attack intensity is a quantity that describes the level of seed damage caused by CPB and analyzes the level of CPB attack on a field. The intensity of the CPB attack was measured by randomly taking 50 fruits, then splitting them, removing the seeds, and calculating the level of attack of each sample using an attack scale. Measurement of CPB attack intensity used four categories based on the number of sticky seeds in each fruit, namely normal (N), light (L), medium (M), and heavy (H).

The main variables observed were the occurrence of *C. Cramella* infestation and the severity of *C. cramella* infestation on cocoa pods. The occurrence of *C. Carmella* infestation was calculated using the following formula.

$$I = \frac{\sum(Ni\ \times Si)}{N\ \times S}\ x\ 100\%$$

Description:
I: Attack intensity
Ni: Number of infested fruits on a particular scale
Si: Specific scale of attack
N: Total number of fruits observed
S: Highest scale value

3. Infestation intensity of cocoa pod-sucking ladybugs (*Helopeltis sp.*)

Intensity observation was done by calculating the attack level on infested cocoa pods. Fruit samples were taken from infested harvested fruits, and 50

samples were taken per farm by random sampling. The intensity of the attack was calculated using the following formula.

$$I = \frac{\sum(Ni \times Si)}{N \times S} x\ 100\%$$

Description:
I: Attack intensity
Ni: Number of infested fruits on a particular scale
Si: Specific scale of attack
N: Total number of fruits observed
S: Highest scale value

RESULTS AND DISCUSSION

Description of Agroecosystem

Observations of cocoa farming conditions and interviews with farmers were conducted in 3 subdistricts in Tanah Datar Regency: Rambatan Subdistrict, North Lintau Buo Subdistrict, and Salimpaung Subdistrict. The total number of villages from the three sub-districts consists of five: Nagari Rambatan, Nagari III Koto, Nagari Sumanik, Nagari Tabek Patah, and Nagari Lubuk Jantan. Farmers generally conduct cocoa land clearing by conventional methods and use various plants as shade crops.

Implementing P3S, such as pruning, fertilization, frequent harvesting, and sanitation, are important activities in cocoa cultivation and can increase production. P3S is one of the observation variables observed in the field. The implementation of P3S in Salimpaung Sub-district and North Lintau Buo Sub-district is done well and routinely, while in Rambatan Sub-district, the implementation of P3S needs to be done better and routinely.

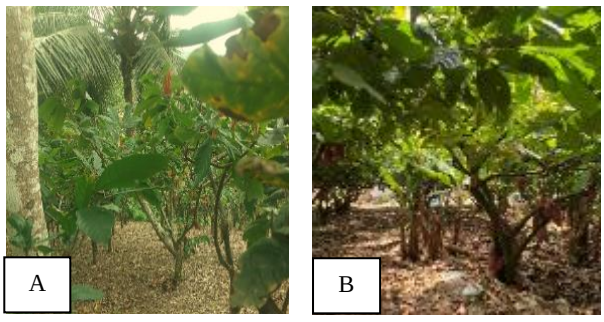

Figure 1. Agroecosystem conditions of farmer cocoa farms. (A) Land condition 3 in Rambatan sub-district with coconut shade. (B). Field 1 in North Lintau Buo sub-district with banana shade

Main Pest Types of Cocoa Plants

The main cocoa pests observed at each research location are fruit-sucking ladybugs and fruit borers. These two pests have different symptom descriptions below.

Cocoa Pod Borer Pest

The Cocoa Pod Borer (*Conopomorpha cramerella Snellen*) attacks cocoa pods that are still young until the fruit is about to ripen. The outward symptoms of the attack are faded skin color and orange-red or yellow-green stripes. When the fruit is split open, the flesh is sticky, wrinkled, light, and black (Figure 2). The attack by cocoa pod borers has a scale of (a) unaffected, (b) mild, (c) moderate, and (d) severe (Sulistyowati et al., 2008).

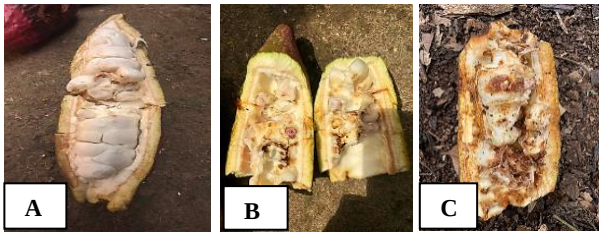

Figure 2: Symptoms of CPB infestation. (A) uninfested, (B) moderate, and (C) heavy infestation

The stage that causes damage is the larval stage, which eats the fruit's flesh and the feeding channels leading to the seeds, but the pest does not attack the seeds.

The symptoms of CPB infestation are only visible from the outside when the fruit is ripe in the form of faded fruit skin and orange stripes, and when the fruit is shaken, it does not make a sound. CPB infestation on cocoa pods will cause the seeds to stick together, making the shape small and wrinkled. The sticky cocoa beans make breaking the fruit more difficult and slower than fruits not attacked by CPB pests (Dinata et al., 2012).

Fruit Sucking Ladybird Pest

Symptoms of *Helopeltis sp.* attack are sunken spots of light brown color that can become blackish on the cocoa pod skin (Figure 3). The spots on the fruit will fuse and cause the surface of the cocoa pod skin to crack, inhibiting the seed development inside the fruit. The attack by cocoa pod-sucking pests has three categories of attack level on the fruit: (a) light, (b) medium, and (c) heavy.

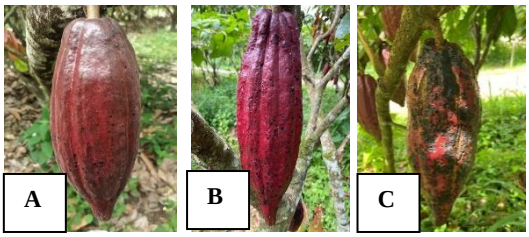

Figure 3: Symptoms of fruit-sucking ladybird infestation. (A) mild, (B) moderate, (C) severe

Infestation of older cocoa pods is characterized by the appearance of light brown sunken spots that gradually turn blackish. Heavy infestation of young cocoa pods causes the skin surface to crack and deform, inhibiting seed development. Infestation of small fruits causes wilting of the seedpods, and generally, the fruit dries up and falls off. If fruit growth continues, the skin will harden and crack. Stunted growth will cause a change in the shape of the cocoa fruit, which can inhibit the seeds' development (Mahdona, 2009).

Cocoa fruit-sucking ladybird pests can be controlled by sanitation, pruning, frequent harvesting, fertilization, randomization, and biology. Fertilization is done to increase plant resistance to attack by pests. After pruning with the right type, dose, and time, fertilization is done. In addition to healthy cocoa pods, plants will produce more (Karmawati et al., 2010).

Level of Pest Infestation on BL-50 Cocoa Plants

The main pests found on cocoa plants of local variety BL-50 in 3 sub-districts are cocoa pod borers and cocoa pod-sucking ladybugs. The level of infestation of these main pests can be seen from the percentage of infestation caused by these main pests and the intensity of the infestation.

Cocoa Pod Borer Pests

Plants Infested by Cocoa Pod Borer Pests

The percentage of Helopeltis sp. infested plants in January or week 1 in Rambatan Sub-district was 48.75%, Salimpaung Sub-district was 33.15%, and North Lintau Buo was 27.5% (Figure 4). In the second week, the percentage of infestation increased. The increase in the percentage of pest infestation was influenced by high rainfall in January in week 2. In the third week, the percentage of infested plants in the Rambatan sub-district was 51.25%, the Salimpaung sub-district was 36.12%, and the North Lantau Buo sub-district was 31.25%. The lowest percentage of infestation occurred in the North Lintau Buo Sub-district because the plantation is managed very well, such as pruning and cleaning cocoa tree litter.

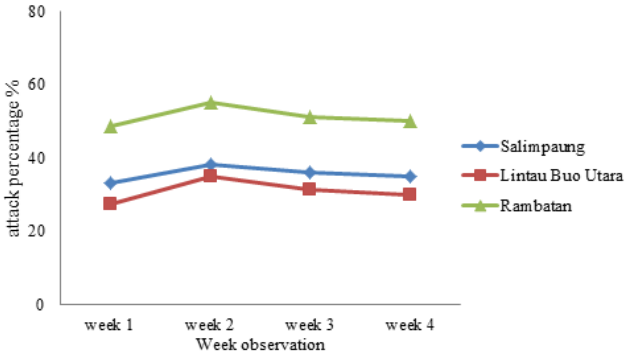

Figure 4. The percentage of plants infested with cocoa pod borer pests in 3 sub-districts in Tanah Datar Regency

Fruit Infested by Cocoa Pod Borer Pests

The percentage of fruit infested by CPB in January week 1 in the Rambatan sub-district was 30%, the Salimpaung sub-district was 21.5%, and North Lintau Buo was 18.85% (Figure 5). In week 2, the graph below shows that the percentage of infested fruit in the three sub-districts increased. The increase in the infestation rate was caused by high rainfall in the second week of January. In week 3, the data for the Rambatan sub-district was 31.95%, the Salimpaung sub-district was 23.95%, and North Lintau Buo was 21.35%. The CPB infestation level in North Lintau Buo Sub-district is relatively low compared to Rambatan and Salimpaung Sub-districts because the cocoa plantation location has been subjected to various treatments to prevent CPB infestation. The cocoa plantation has implemented the P3S system as an initial step to prevent the spread of CPB attacks in the cocoa plantation. The P3S system (pruning, fertilization, regular harvesting, and sanitation) combines treatments that can minimize the development of CPB pests. Based on the results of interviews with farmers to reduce the height of CPB pest attacks, farmers conduct P3S (Syatrawati & Asmawati, 2015).

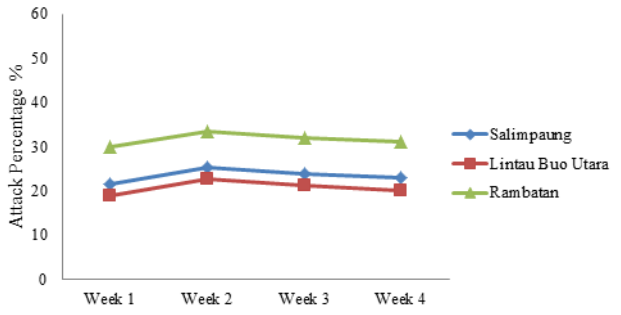

Figure 5. The percentage of fruit infested with cocoa pod borer pests in 3 sub-districts in Tanah Datar Regency

Intensity of Cocoa Pod Borer Attack

The intensity of cocoa pod borer infestation in the first week of January in Rambatan Subdistrict was 20.55%, Salimpaung Subdistrict was 15.16%, and North Lintau Buo was 13.39% (Figure 6). In the second week of January, infestation intensity increased and became the highest among all weeks. The increase in pest attack intensity was influenced by the high rainfall in January in week 2, increasing the attack level that week. The percentage of infested plants in week 3 in the Rambatan sub-district was 21.55%, the Salimpaung sub-district was 17.00%, and North Lintau Buo was 13.55%. The week-by-week observation graph below explains that the highest infestation intensity was in the Rambatan sub-district, and the lowest was in the Lintau Buo sub-district. This is related to technical culture measures such as pruning, garden sanitation, and harvesting, which are carried out regularly. The high and low intensity of CPB infestation on cocoa pods is related to the implementation of P3S by farmers through pruning, garden sanitation, and harvesting, which are carried out routinely. Fluctuations in the number of infested plants and fruits infested by pests depend on control activities carried out by farmers (Pratama et al., 2021)

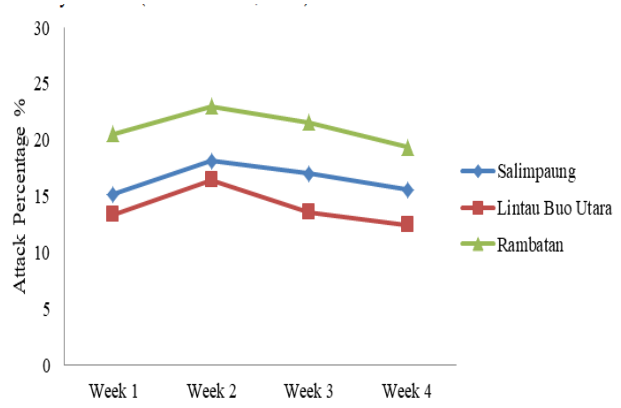

Figure 6. The intensity of cocoa pod borer infestation in the three sub-districts in Tanah Datar Regency

Cocoa pod-sucking ladybirds

Plants Infested with Cocoa Pod Sucking Ladybird Pests

The percentage of plants infested with Helopeltis sp. from week 1 to week four has increased and decreased in percentage value. The percentage of cocoa pod-sucking ladybird infestation in week 1 January in 3 sub-districts, namely Rambatan, Salimpaung, and North Lintau Buo, was 65%, 42.5%, and 40%, respectively (Figure 7). The percentage of plants infested by sucking ladybugs increased in week 2. Then in week 3, the three sub-districts were 67%, 45%, and 42.5%. The high infestation in the Rambatan Sub-district is because farmers still need to fulfill proper cultivation techniques, such as pruning, sanitation, and pest and disease control. Pruning is one of the critical factors in controlling this pest. This causes the condition of the cocoa plants in the Rambatan Sub-district to be irregular, and the leaves are lush, which can increase the humidity around the plants and cause a high population of pests. Sukarata (2016) suggests that pruning cocoa plants can improve air circulation and reduce air humidity around the cocoa plantation to provide an unfavorable environment for developing *Helopeltis sp.* pests.

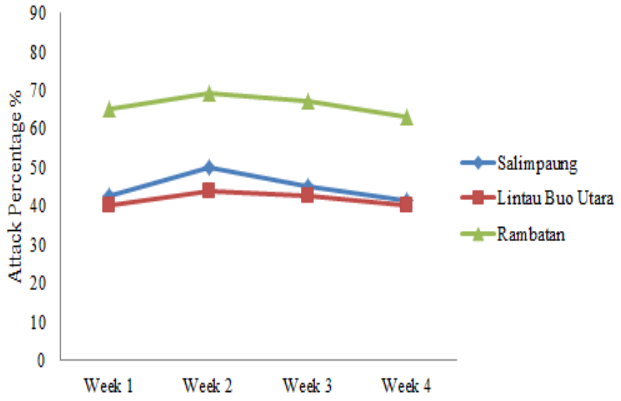

Figure 7. The percentage of plants infested with cocoa pod-sucking ladybugs in 3 sub-districts in Tanah Datar Regency.

Fruit Infested by Cocoa Pod Sucking Ladybugs

The percentage of fruit infested with sucking ladybugs from week 1 to week four has increased in week 2. Data on the percentage value in January or week 1 of sucking ladybird pests in 3 sub-districts, namely in Rambatan, Salimpaung, and North Lintau Buo sub-districts, were 42.2%, 28%, and 25.5%, respectively (Figure 8). The percentage data in week 3 was 48.03%, 32.19%, and 27.83%, respectively. The decrease and increase in the percentage of pest infestation was influenced by higher rainfall in January, namely in the second week of January. The high rainfall in January, as a result, the percentage of infested plants in week 2 had the highest percentage value of all other weeks. This is to research conducted by Karmawati (2009) in Wonogiri. The emergence of *Helopeltis sp*. pests is influenced by the high intensity of rainfall that occurred from May to June. The emergence of *Helopeltis sp*. pests decreased the following month due to the lack of rainfall.

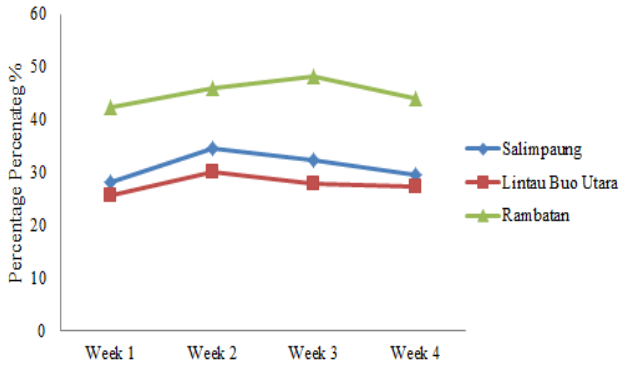

Figure 8. The percentage of fruit infested by cocoa pod-sucking ladybirds in 3 sub-districts in Tanah Datar Regency

Attack Intensity of Cocoa Fruit Sucking Ladybird Pests

The intensity of sucking ladybird infestation in week 1 to week three has increased, and in week 4, there has been a decrease. The graph data below in January shows that the percentage of sucking ladybird infestation in 3 sub-districts, namely Rambatan, Salimpaung, and North Lintau Buo sub-districts in week 1 was 28%, 22% and 16% respectively (Figure 9). The graphical data on the intensity of cocoa pod-sucking pest infestation in week 3 in the three sub-districts were 32.99%, 25.76%, and 20.5%, respectively. The lowest infestation intensity occurred in the North Lintau Buo Sub-district due to well-managed farms and clean land conditions. Farmers there prune and clean cocoa tree litter and spray insecticides. This differs from what farmers do in the Rambatan Subdistrict, where farmers must prune and regularly clean cocoa tree litter correctly. According to Sulistyowati (2008), pruning should be done at least twice a year so that light enters the cocoa plantation and air circulation in the cocoa plantation will be better.

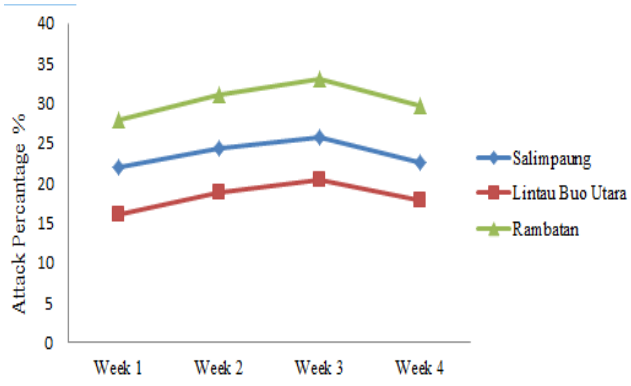

Figure 9. The intensity of cocoa pod-sucking ladybug infestation in 3 sub-districts in Tanah Datar Regency

The main pests that attack BL-50 cocoa plants are fruit-sucking ladybirds (*Helopeltis sp.*) and cocoa pod borers (*Conopomorpha cramerella*). Fruit-sucking ladybirds have the highest infestation rate in Tanah Datar Regency compared to cocoa pod borers (CPB).

The highest level of cocoa pod borer infestation on BL-50 variety in Tanah Datar Regency is in Rambatan Sub-district, where the percentage of infested plants, percentage of infested fruits, and the highest intensity of infestation are 51.25%, 31.58%, and 21.10% respectively. The lowest cocoa pod borer infestation level on the BL-50 variety in Tanah Datar Regency is in the North Lintau Buo Sub-district. However, the value of the infestation level is similar to Salimpaung Sub-district. North Lintau Buo Sub-district has the percentage of infested plants, infested fruits, and intensity of cocoa pod borer infestation, respectively 30.93%, 20.70%, and 13.96%.

The cause of high and low pests attacking cocoa plants is caused by P3S factors, namely pruning, fertilization, frequent harvesting, and sanitation. The P3S method in cocoa is one of the methods to handle and control pests which can improve cocoa plants through four ways, namely pruning, balanced fertilization, frequent harvesting, and cocoa sanitation (Sadori et al., 2023; Heliawaty & Nurlina, 2009).

One of the causes of the high level of cocoa pod borer pest infestation is poor pruning. Farmers in the Rambatan Sub-district need to prune correctly, and thus, they have the highest infestation rate among other sub-districts. This makes the environmental conditions of the land in the Rambatan Sub-district suitable for the development of CPB in the field. According to Baharudin et al. (2004), suitable conditions for the development of CPB insect pests are cropping conditions with heavy shading and humidity, so to reduce humidity, it is necessary to prune cocoa plants and shade plants as an effort to prevent attacks from CPB pests.

Cocoa farmers in the North Lintau Buo Sub-district generally often conduct routine fertilization activities so that CPB pests in this Sub-district have a low attack rate value; it is different in the Rambatan Sub-district where farmers do not conduct routine fertilization. Fertilization is done to increase plant resistance to attacks by pests. Fertilization is done after pruning with the right type, dose, and time. Besides being healthy, cocoa plants will produce more (Karmawati et al., 2009).

Farmers in Rambatan Sub-district must implement P3S properly, such as not harvesting frequently. CPB attack is influenced by several factors, one of which

is not harvesting frequently. According to Sulistyowati (2004), frequent harvesting followed by good sanitation can reduce the population of CPB because, in early ripe fruit, the CPB larvae have not come out, so the larvae inside the fruit will die. Cocoa pods and placentas are burned or buried in the ground. So, frequent harvesting and sanitization of harvested fruit skins can break the CPB life cycle.

Existing pest attacks are due to suboptimal cultivation, such as poorly sanitized gardens, resulting in a high rate of CPB infestation in cocoa. Harvested fruit peels are generally piled up in cocoa fields, for example, in the Rambatan Sub-district research location. On the other hand, in the Salimpaung and Lintau Buo Utara sub-districts, sanitation is done regularly, and the harvested fruit shells are collected and buried or burned. Good sanitation also plays a significant role in the development of CPB pests. According to Siregar et al. (2000), cocoa fruit shells that are buried in the soil are a source of nutrients for cocoa plants; even if they are made into compost, the nutrient content that can be obtained can be better and can also control the development of CPB pests. This activity is generally not done by many farmers in the Rambatan Sub-district, and some farmers do not do it at all. This is confirmed by Baharudin et al. (2004) that sanitation that is done irregularly or not done at all by cocoa farmers causes the condition of the land area to become a development and a suitable living place for this cocoa plant pest.

The highest infestation of cocoa pod-sucking ladybugs is in the Rambatan Sub-district based on the variables of the percentage of infested plants, percentage of infested fruits, and intensity of infestation, which are 66.09%, 45.07%, and 30.45%, respectively. The lowest level of cocoa pod-sucking pest infestation on BL-50 variety in Tanah Datar Regency is North Lintau Buo Sub-district. North Lintau Buo Sub-district has the percentage of infested plants, infested fruits, and intensity of cocoa pod-sucking pest infestation, respectively: 41.56%, 27.66%, and 18.30%.

The highest infestation of fruit-sucking ladybugs is in the Rambatan sub-district, while the lowest infestation of this pest is in the North Lintau Buo sub-district. The cause of high and low pests attacking cocoa plants is caused by P3S factors, namely pruning, fertilization, frequent harvesting, and sanitation. The P3S method is one of the methods to handle and control this pest, and it improves cocoa plants in four ways: pruning, balanced fertilization, frequent harvesting, and sanitation (Heliawaty & Nurlina, 2009).

Cocoa plant maintenance, such as pruning, is essential to reduce humidity in the farmer's garden, allowing sunlight to enter the tree canopy and smooth airflow. Lush cocoa plantations are affected by a lack of pruning, which causes the high Helopeltis sp. infestation in the Rambatan Sub-district. Generally, the lands in the Rambatan Sub-district have dense vegetation, and more maintenance and pruning are needed. Pruning of water shoots also needs to be done because Helopeltis sp. pests not only lay eggs on cocoa pod stalks but also lay eggs on young leaf stalks. According to (Wahyudi et al., 2008), pruning cocoa by removing water buds regularly once a fortnight can reduce the attack of Helopeltis sp. pests because Helopeltis sp. eggs contained in water buds will be removed due to pruning. Furthermore, Sulistyowati (2008) suggests that pruning is not done twice a year so that light enters the cocoa plantation and air circulation in the cocoa plantation becomes better.

The level of pest infestation in the Rambatan Sub-district is the highest among the other Sub-districts; this is because farmers in this Sub-district only sometimes carry out frequent harvesting activities by predetermined procedures. Frequent harvesting is the activity of picking fruit that has been physiologically ripe on certain plants, which is one of the factors that can reduce the high attack by pests. If frequent harvesting is carried out correctly and routinely, this method will reduce CPB attacks and improve the quality of cocoa beans (Karmawati et al., 2010).

Cocoa farmers in North Lintau Buo Subdistrict generally conduct routine fertilization so that pests in this Subdistrict have a low value. Pests can be controlled by fertilization. Fertilization is done to increase plant resistance to pest attacks. Fertilization is done after pruning with the right type, dose, and time. In addition to healthy plants, plants will also produce more (Karmawati et al., 2009).

The level of pest attacks in North Lintau Buo is the lowest, and farmers there generally carry out land sanitation activities properly and regularly, so the level of pest attacks in the District is low. Land sanitation by clearing litter, weeds, and remnants of cocoa pods after harvesting by burning or burying them in the ground is an action that can affect the life of pests that attack cocoa plants. According to Safitri et al. (2021), the Helopeltis sp. pest can be controlled

by agricultural activities such as sanitation, pruning, frequent harvesting, and fertilization.

CONCLUSIONS

The highest level of CPB pest attacks on the BL-50 variety in Tanah Datar Regency is in Rangkat District, while the lowest is in North Lintau Buo District. The percentage of infected plants and fruit, as well as the highest intensity of attack, was in Rangkat District, namely 51.25%, 31.58%, and 21.10%. North Lintau Buo District has values for the percentage of plants attacked, fruit attacked, and the intensity of attacks by cocoa pod borer pests, namely 30.93%, 20.70%, and 13.96%.

The highest level of attack by ladybugs that suck cocoa pods on the BL-50 variety is in Rangkat District. Based on the variables, the percentage of plants attacked, fruit attacked, and the intensity of the attack were 66.09%, 45.07%, and 30.45%. The level of pest attacks Helopeltis sp. The lowest for the BL-50 variety was North Lintau Buo District, with percentage values of attacked plants, attacked fruit, and the intensity of cocoa pod borer attacks, namely 41.56%, 27.66%, and 18.30%.

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