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Identification of Pests and Diseasesof Cocoa Plant (*Theobrama Cacao L*) and the Level of Attacks in Metun Village

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Abstract
This study aims to identify the types of pests and diseases and the attack levels on cocoa plants in Metun Sajau Village. A purposive random sampling method was used, with data collection techniques including field surveys, visual identification of pests and diseases, and recording the intensity and percentage of attacks. The results showed that in Location A, several pests were found: Cocoa Pod Borer (CPB) with an incidence rate of 66.66% and an attack intensity of 35.13%; *Helopeltis* spp. (76.34%) with an intensity of 34.17%; squirrels (12.72%) with an intensity of 3.3%; and stem/branch borers (1.14%) with an intensity of 0.38%. The disease identified was fruit rot, with an incidence rate of 13.00% and intensity of 2.41%. In Location B, CPB had the highest incidence rate of 79.03% with an attack intensity of 49.34%; *Helopeltis* spp. (62.25%) with an intensity of 13.69%; squirrels (26.63%) with an intensity of 6.66%; and stem/branch borers (3.50%) with an intensity of 1.16%. Fruit rot disease was also found in Location B, with an incidence rate of 12.17% and intensity of 2.48%. Based on observations at both locations, it can be concluded that Location B has a higher overall pest attack level (76.34%) than Location A (66.66%). These findings provide vital information for developing effective pest and disease management strategies to support sustainable cocoa production.

Keywords: Attack Intensity; Cocoa; Fruit Rot; Helopeltis; Metun Sajau; PBK

Introduction

Cocoa plants (Theobroma cacao L.) are a strategic commodity in the Indonesian plantation economy, especially in tropical areas. Most of the national cocoa production is produced by smallholder plantations, including in North Kalimantan. However, cocoa productivity tends to decline due to plant pests (OPT) which are still a major problem (Adeniyi & Asogwa 2023)

One of the main pests that attacks cocoa is the Cocoa Pod Borer (CPB), Conopomorpha cramerella, which has been reported to cause significant damage and yield reductions of up to 60% in some areas (Niogret *et al.*, 2022). In addition to PBB, Helopeltis spp. is also known to cause young fruit drop and necrotic lesions on fruit stalks, which can drastically reduce the quality of the beans (Siswanto, A., 2020). The main disease that often attacks is fruit rot caused by the fungus Phytophthora spp., especially P. palmivora. This disease can cause damage between 20–

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30% of production in wet tropical areas (Adeniyi & Asogwa, 2023) The combination of pest and disease attacks requires carrying out specific mapping of the types and intensity of attacks in each agroecosystem.

North Kalimantan is one of the provinces in Indonesia which is a producer Cocoa plants, precisely in Bulungan Regency, Cocoa production in Bulungan Regency in 2019 was 49.3 tons, in 2020 it was 42.0 tons and in 2021 it was 53.7 tons (BPS Kaltara, 2022). Metun Sajau Village is one of the villages in Bulungan Regency that has a cocoa plantation with a land area of 57 Ha, a population of 9,657 with 2,318 Producing Plants (TM) and 7,339 Immature Plants (TBM) with a productivity of 1,521 kg/ha in 2023, out of 35 cocoa farmers, 23 are productive cocoa farmers and 12 are unproductive farmers.

Pests are types of animals/insects that can interfere with cocoa plants which have an impact on damage or decreased plant productivity such as cocoa fruit borers (Conopomorpha Cramerella). stem or branch borers (Zuezera spp) and (Glenea spp), fruit-sucking ladybugs (Helopeltis spp), rats, squirrels, fireworms (Darna Trima), inchworms (Hyposidra talaca), leaf-eating beetles (Apogonia sp) and caterpillars (Orgyia postica), while diseases known to attack cocoa plants are cocoa fruit rot (Phytophthora palmivora), stem cancer (Phytophthora palmivora), anthracnose (Colletorichum gleosporioides), white root fungus (Rigidoporus lignosus), red root fungus (Ganoderma philippii), brown root fungus (Fomes Lamaoensis), upas fungus (Corticium salmonicolor), and vascular streak dieback (Oncobasidium theobromae) (Lea *et al*., 2022). However, there is no comprehensive information regarding the types of OPT and the intensity of their attacks. Therefore, it is necessary to identify and map pest and disease attacks in two locations with different garden characteristics.

Literature Review

Cocoa (Theobroma cacao L.) remains a leading plantation commodity with high economic value and a significant contribution to farmers' incomes, particularly in tropical regions like Indonesia. Indonesia is currently among the top five cocoa producing countries in the world, but national productivity remains relatively low compared to its genetic potential (BPS, 2023). In areas like North Kalimantan, including Metun Village, cocoa is beginning to develop as an alternative source of income for the community, but the threat of pests and diseases remains a major obstacle to increasing yields.

Key pests such as the cocoa pod borer (Conopomorpha cramerella), pod sucker (Helopeltis spp.), and mealybug (Planococcus citri) are consistently reported to cause significant damage to flowers, fruit, and other plant tissues. Amidst climate change and environmental degradation, cocoa pest population dynamics exhibit erratic trends, often increasing during the dry season or in areas with poor sanitation (Suwandi *et al.*, 2021;Sari et al., 2022). Recent findings indicate that these pests have demonstrated potential resistance to several types of chemical pesticides, necessitating new, more adaptive and environmentally friendly approaches.

Furthermore, diseases such as cocoa pod rot (Phytophthora palmivora), stem canker (Ceratobasidium theobromae), and vascular streak dieback (Oncobasidium theobromae) are major causes of yield decline and gradual plant death. Globally and nationally, efforts to mitigate these

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diseases have evolved toward biological control approaches, the use of tolerant varieties, and bioecologically based agroecosystem management (Darmono, et al., 2020; FAO, 2023).

Limited specific data at the local level, such as in Metun Village, hinders the determination of appropriate control strategies. Research focused on identifying pest and disease types and the actual extent of infestation in local farmers' fields is crucial to bridge the gap between technology and field practices (Muryati, M., & Ristanto, 2022). This research has novelty in terms of a site-specific approach that takes into account local agroecological conditions, and supports the development of an early warning system and integrated control strategy (IPM) that is more adaptive, sustainable, and based on local wisdom.

Research Method

The research was conducted over a period of four months in Metun Sajau Village at two cocoa plantation sites: Location A (residential area) and Location B (plantation area). The tools and materials used in this study included cocoa plants, plastic materials, string, label paper, writing instruments, and a camera. The sampling method employed was purposive random sampling, and data collection involved field surveys, visual identification of pests and diseases, and documentation of the intensity and percentage of affected plants. The attack intensity was calculated using the standard formula described by Sjam *et al*., (2020).

Subsequently, the data were analyzed using a descriptive-comparative approach to observe differences in the level of pest and disease attacks between the two locations, as well as to identify cultivation factors—such as planting systems, sanitation practices, pruning, and fertilization—that may influence the severity of these attacks (Kresnawaty *et al*., 2016). The sampling sites for cocoa plants in Metun Sajau Village were divided into two locations: Location A, situated in a residential area, and Location B, located near the main access road. The percentage of attack for each type of pest and disease in cocoa plants was calculated using the following formula:

$$P = a/b \times 100\%$$

Information:
P : percentage of infected plants
a : number of infected sample plants
b : total number of sample plants

The intensity of the attack can be calculated using the following formula:

$$I = \frac{\Sigma\,(ni \times si)}{N \times S} \times 100\%$$

Information:
I : Attack intensity
Ni : Number of fruits, branches/twigs, sample plants attacked at a certain attack scale
Si : certain attack scale
N : total number of fruits, branches/twigs of sample plants
S :: highest scale value

The percentage of fruit and stems/branches attacked by pests and diseases, use the following formula:

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P = a/b x 100%

Information:
P : percentage of sample plants whose fruit and stems/branches are attacked
a : number of sample plants whose fruit and stems or twigs are attacked
b : total number of sample plants.

Table 1. Symptoms Based On Fruit Sucking Ladybug Attack (*Helopeltis Spp*) On Cocoa Plant

Scale	Symptoms of an attack	Category
1	If the symptoms of blackish brown sunken spots on the fruit are around 0 - f 21%	Light
2	If the symptoms of blackish brown sunken spots on the fruit are around 2>1 - f 50%	Currently
3	If the symptoms of blackish brown sunken spots on the fruit amount to around 5>0%	Heavy

Source: (Hariyono, 2016)

Table 2. Symptoms And Categories Of Fruit Rot Disease Attacks (*Phytophthora Palmivore*) On Cocoa Plants.

Scale	Symptoms of an attack	Category
1	If the surface area of the fruit that is blackened (rotten) is 0>- f 15%	Light
2	If the surface area of the fruit is black (rotten) 5> - f 20%	Currently
3	If the surface area of the fruit is black (rotten) 2>0%	Heavy

Source: (Hariyono, 2016)

Table 3. Category Level Of Fruit Damage Due To Cocoa Fruit Borer Pest Attacks (*Conopomorpha Cramerella Snellen*) On Cocoa Plants

Scale	Symptoms of an attack	Category
0	No sticky sedes	Free
1	There are <10% sticky seeds but all seeds can still be removed from the fruit skin	Light
2	There are between 10%-50% sticky seeds. Most of the seeds can still be removed from the fruit skin.	Currently
3	There are >50% sticky seeds, most of the seeds cannot be removed from the fruit skin.	Heavy

Source: (Suherlina *et al*., 2020)

Table 4. Category Level Of Fruit Damage Due To Stem Borer Pest Attacks (*Z Coffee*)

Scale	Symptoms of an attack	Category
1	If the 1st hole is on the branch	Light
2	If the movement hole 2 on the branch	Currently
3	If the movement hole >3	Heavy

Source: (Lestari & Purnomo, 2018)

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Results and Discussion

The soil on the land has a mixture of types, *Forastero a*nd *Trinity*. Forastero type cocoa has a relatively smooth fruit skin surface because the grooves are shallow and this type of cocoa*Trinity*has very diverse morphological characteristics because it is a hybrid of the cocoa type *Criollo* and *Forastero*.

Generally, the community in Metun Village, based on the results of the visitation conducted, the planting distance for cocoa plantations uses a planting distance of 3 x 3 m both in Location A (village) and location B (main road), and the seeds come from the East Java Coffee and Cocoa Research Center. The land area has several types of plants that are planted using a polyculture system, which combines several types of plants such as durian, elai, langsat, banana, papaya, rambutan and coconut.

In general, cocoa plantation land has cocoa planting conditions that are almost similar in terms of cultivation techniques, many observation lands have not been optimally managed by land owners. Most farmers do not understand the things that need to be considered in cocoa cultivation techniques such as pruning, fertilization, pest and disease control, have not been carried out properly. Fertilization is done irregularly so that many fruits are short-lived or commonly called wilted pentil this is caused by lack of nutrients in the tree. Pest and disease control is done irregularly, causing pests and diseases to freely attack plants.

Table 5. Description Of Cocoa Plantation Land Agroecosystem In Metun Sajau Village

Plantation Condition	Location A	Location B
Age	±7–13 years (Forastero and Trinitario)	±3–7 years (Forastero and Trinitario)
Seed Type and Source	Local and Puslitkoka	Puslitkoka
Plant Spacing	> 3 x 3 m	3 x 3 m
Cropping System	Polyculture (durian, elai, duku, rambutan, papaya, coconut)	Polyculture (banana, duku, papaya)
Pest and Disease Control	Mechanical and Chemical	Mechanical and Chemical
Fertilization	Twice a year (NPK Phonska)	Twice a year (NPK Phonska)
Pruning	Once a year	Once a year
Harvesting	Twice a month	Twice a month

Based on the results of field observations at Locations A and B, it was found that in both areas, the garden maintenance was still not optimal, sanitation was poor, such as there were still many leaf litter under the trees, there were many weeds and harvested fruit that were left in the plantation area and many trees that had not been pruned properly, pruning was lacking so that the branches of the cocoa plants overlapped, thus increasing humidity and causing pests and diseases to easily attack the observation area, the effect of pruning on cocoa plants had a major impact, namely reducing garden humidity, obtaining a healthy microclimate and high production, and effective and timely pruning can help control cocoa plant diseases (Angela, & Efendi, 2015). The frequency of maintenance pruning should be done every 2-3 months. While what farmers do is still not optimal, which is only once a year.

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Pest and disease attacks on cocoa fruit

Based on the results of field observations, there are similar types of pests and diseases in each observation location in Metun Sajau Village. Data on pests and diseases that attack the fruit can be seen in Table 6.

Table 6. Pests and Diseases That Attack Cocoa Fruit In Metun Village Just

Pests and Diseases	Location	
	A	B
Pest	- Squirrel - PBK - Helopeltis spp	- Squirrel - PBK - Helopeltis spp
Poet	Fruit Rot	Fruit Rot

Cocoa fruit borer (PBK) can attack young cocoa fruit, the length of which is around 8 cm until the fruit is almost ripe and ready to harvest. PBK larvae eat the flesh of the fruit and the food channel leading to the seeds. Symptoms of the attack that are visible from the outside are the color of the fruit becomes faded so that it becomes green, yellow and red-orange stripes or even black, the skin of the fruit becomes hard, when cut the fruit will stick to each other, lightly wrinkled and blackish in color. Symptoms of PBK attacks can be seen in Figure 2.

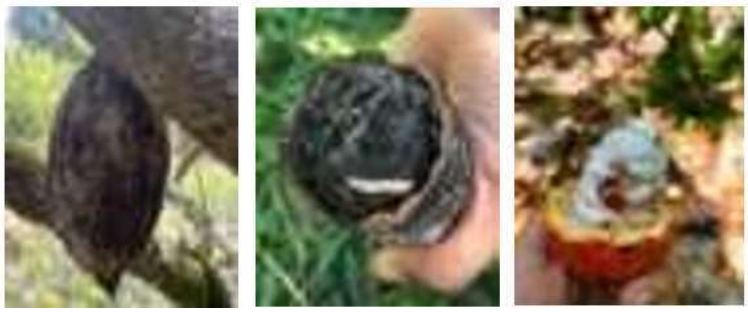


Figure 2. Cocoa Pod Borer (Cpb) Pest Attack

Pest attack *Helopeltis*spp.There are brown concave spots that turn black on the surface of the cocoa fruit skin. Spots on the fruit will cause the surface of the fruit skin to crack, this will inhibit the development of seeds in the fruit. Attacks *Helopeltis*spp. can be seen in Figure



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Figure 3 Pest Attack Helopeltis spp

Attacks caused by squirrel pests include bite holes on the fruit skin that reach the cocoa beans. Squirrel pest attacks can be seen when many cocoa beans are left and scattered because squirrel pests only eat the fruit flesh, not the cocoa beans (Figure 4).



Figure 4. Squirrel Pest Attack (Scandentia)

Attacks caused by *Phytophhtora palmivora*on cocoa fruit, the fruit will become rotten, wet and blackish brown, usually starting from the tip of the fruit or the base near the stalk, sometimes also found in the middle of the fruit. Fruit rot will spread rapidly to all parts of the fruit, so that the entire surface of the cocoa fruit is black. Symptoms of fruit rot attack can be seen in (Figure 5.).



Figure 5. Attack Phytophthora Palmivora

Based on the results of field observations, there are the same types of pests in each observation location in Metun Sajau Village, while diseases that attack the stems were not found. Data on pests that attack the stems of cocoa plants can be seen in table 7.

Table 7. Pests and Diseases of Stems

Junis Hama	Location	
	A	B
Pest	- Stem borer	- Stem borer

Zuezera coffee. attacks cocoa branches or stems at the larval stage. Symptoms of larval attacks*Zuezera coffee*. It can be seen by the presence of reddish-yellow grain- shaped larval feces outside the drill holes which still have larvae in them, while in the holes which no longer contain larvae there are blackish larval feces inside. Attack symptoms*Zuezera*spp can be seen in Figure 2 below.

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Figure 6. Stem Borer Pest Attack*Z. Coffee*

The results of observations at Location A showed that several pests and diseases had attacked cocoa plants, namely the pests consisting of the cocoa fruit borer pest. *Helopeltis*spp. Squirrels, stem/branch borers, the diseases that attack are fruit rot. The percentage of plants attacked by pests and diseases starting from the highest to the lowest is Cocoa Fruit Borer (PBK) (66.66%), then *Helopeltis*spp. (76.34%) followed by squirrel pests (12.72%) and finally stem/branch borer pests (1.14%). while the diseases that attack are Fruit rot with a percentage of (13.00%). The intensity of PBK pest attacks (35.13%) *Helopeltisspp*. (34.17%), stem borers (0.38%), squirrels (3.3%) and Fruit Rot (2.41%)

Table 8. Percentage of Cocoa Plants Affected by Fruit Rot Disease and Attack Intensity at Location A

Disease	Demplot	Affected Plants (%)	Average (%)	Attack Intensity (%)	Average (%)
Fruit Rot	Demplot 1	10.71	13.00	3.92	2.41
	Demplot 2	6.89		0.95	
	Demplot 3	21.42		2.37	

Table 9. Percentage of Infested Cocoa Plants and Attack Intensity by Pest Type at Location A

Pest Type	Demplot	Infested Plants (%)	Average (%)	Attack Intensity (%)	Average (%)
Cocoa Pod Borer (PBK)	Demplot 1	28.57	66.66	10.08	35.13
	Demplot 2	82.14		26.79	
	Demplot 3	89.28		68.53	
Helopeltis spp.	Demplot 1	71.42	76.34	22.40	34.17
	Demplot 2	86.20		17.70	
	Demplot 3	71.42		62.42	
Stem/Branch Borer	Demplot 1	-	1.14	-	0.38
	Demplot 2	3.44		1.14	
	Demplot 3	-		-	
Squirrel	Demplot 1	3.57	12.72	0.83	3.30
	Demplot 2	31.03		8.57	
	Demplot 3	3.57		0.35	

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Table 10. Level of Pest Attacks on Cocoa Plants at Location B

Pest Type	Plot	Infested Plants (%)	Average (%)	Attack Intensity (%)	Average (%)
Cocoa Pod Borer (PBK)	1	86.95	79.03	14.84	49.34
	2	73.68		60.52	
	3	76.47		72.66	
Helopeltis spp.	1	56.52	62.25	6.35	13.69
	2	71.42		22.80	
	3	58.82		11.75	
Stem/Branch Borer	1	-	3.50	-	1.16
	2	10.52		3.50	
	3	-		-	
Squirrel	1	13.04	26.63	0.84	6.66
	2	31.57		10.50	
	3	35.29		8.55	

Table 11. Level of Pest and Disease Attacks on Cocoa Plants at location B

Disease Attacked	Plot	Plant (%)	Average (%)	Intensity Attack (%)	Average (%)
Fruit rot	1	4.34	12.17	2.41	2.48
	2	26.31		2.56	
	3	5.88		-	
PBK	1	86.95			14.84

Discussion

The results of this observation show that several pests and diseases have attacked cocoa plants in Metun Sajau Village, namely pests consisting of cocoa fruit borer pests. *Helopeltis*spp. squirrels, stem/branch borers, the diseases that attack are fruit rot. The percentage of plants attacked by pests and diseases starting from the highest to the lowest is Cocoa Fruit Borer (PBK) (71.34%), then*Helopeltis*spp. (69.29%) followed by squirrel pests (19.67%) and finally stem/branch borer pests (2.32%). while the diseases that attack are fruit rot with a percentage of (12.67%). The intensity of pest attacks *Helopeltis*spp. (23.93%), PBK (42.21%), trunk borer (0.77%), squirrel (4.98%) and Fruit Rot (2.48%).

PBK is an attack with the highest percentage based on the results of observations of the conditions of location A and location B, garden sanitation is still lacking, this can be seen from the many scattered leaves and fruit skins left from the harvest left scattered in the garden area, causing PBK pests to increase. According to Suherlina *et al.*, (2020) sanitation activities can suppress the PBK pest population. This is because in early ripe fruit, PBK larvae are already in the fruit, and if the fruit skin and placenta are burned directly and land cleaning is carried out indirectly, it will break the PBK life cycle, making it very easy for PBK to reproduce, on the other hand, if routine sanitation is carried out, pruning, and monitoring can reduce the development of PBK (Niogret *et al.*, 2022).

On the land there are still many wild grasses, other plants and weeds, and when pruning there are still many water shoots, overlapping branches, this can increase the pest population, according to (Indriati *et al.*, 2014). pruning and garden sanitation can reduce pest attacks*Helopeltis*spp. Pruning by removing water shoots (wiwilan) around the main branches every two weeks, water shoots are one of the places where eggs are laid*Helopeltis*spp. so

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that by pruning it will be able to reduce the population*Helopeltis*spp. Dirty gardens support the development of this pest because many weeds are alternative hosts, so it is necessary to clean weeds around the cocoa plantation. The presence of pests*Helopeltis*spp. is usually supported by the condition of the farmer's land itself. Land with good management can suppress the development of pests*Helopeltis*spp. so that the intensity of pest attacks will also decrease, while land that is not managed properly will increase attacks by cocoa fruit sucking ladybugs (Indriati *et al*., 2014).

Apart from land conditions that support an increase in the number of pest populations, the presence of natural enemies at the research location is the reason for the high number of pest attacks. *Helopeltis*spp. of all the observed land, no land had black ants. Black ants (*D. thoracic*) is a natural enemy that can be used to control pests. *Hellopetltis*spp. black ant activitycan cause*Helopeltis*spp. do not have time to insert their razor blades or kneel on the cocoa plant so that the plant can be free from attack*Helopeltis*spp (Indriati *et al.*, 2014). Not only being a natural enemy*Helopeltis*spp. black ants are also able to control other pests such as cocoa fruit borer pests (*conopomorpha cramerella*). In addition, black ants can also disturb and repel squirrel pests, because mice and squirrels do not like fruit covered by black ants, because control using black ants does not involve control using chemical pesticides, then cocoa plants that implement control using black ants can produce cocoa beans that are free from chemical pesticides (Saleh*et al*., 2020).

Based on observations at locations A and B, squirrel pest attacks were caused by farmers using coconut, durian, elai and rambutan trees as protective plants. The selection of protective trees should be given more attention to prevent squirrel pest attacks. One of the requirements for ideal protective trees for cocoa plants is that they do not become hosts for cocoa pests and diseases. The type of permanent protective tree that is widely used in Indonesia is lamtoro (*Leucaena*spp.), gamal (*Gliricidia sepium*), dadap (*Erythrina*sp.), and sengon (*Paraserianthes falcataria)* (Lukito *et al.*, 2004). In addition, squirrel pest attacks are also more often found in the observation area of location B. This is because location B is far from settlements so that squirrel pests find it easier to attack cocoa fruit (Hariyono, 2016). stated that the existence of a location far from settlements causes squirrel pests to freely attack cocoa fruit.

Stem/branch borer pests are pests with the lowest percentage of attacks, caused by poor sanitation in planting areas, suboptimal pruning, lack of maintenance and careless harvesting processes, so that the bark of the cocoa plant peels off or becomes injured. *Z. coffee* lay eggs in the cracks of the bark (Lestari & Purnomo, 2018).

Lack of cocoa pruning, poor sanitation and flooding are the causes of cocoa in Locations A and B being attacked. *phytophthora palmivora.* The fungus that starts the infection in the fruit comes from the soil or roots, leaves. The infected stem attacks *Phytophthora palmivora*not easy to control because this pathogen can live for several years in the soil. Environmental factors affect the development, spread, and infection of this pathogen such as temperature, air humidity, and light intensity. Fruit rot disease can occur during the rainy season, this is because the humidity level will be higher, and the splash of rainwater from the soil will facilitate the spread *P. palmivora* from the soil to the aerial tissue of the plant (Wartono & Taufiq, 2021).

Conclusion

The types of pests and diseases attacking cocoa plants found in Sajau Metun Village at the two

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locations are: Cocoa Pod Borer (Helopeltis spp.), Zeuzera Coffeae Squirrel, and Fruit Rot (Phytophthora palmivora). Several types of pests and diseases were identified attacking cocoa plants in Sajau Metun Village at two observation sites, namely Location A and Location B. At Location A, the main pests found were Cocoa Pod Borer (*Conopomorpha cramerella*) with an incidence rate of 66.66% and an attack intensity of 35.13%, *Helopeltis* spp. with 76.34% incidence and 34.17% intensity, squirrels with 12.72% incidence and 3.30% intensity, and stem or branch borers with 1.14% incidence and 0.38% intensity. The main disease found was fruit rot caused by *Phytophthora palmivora*, with an incidence of 13.00% and an attack intensity of 2.41%. Meanwhile, at Location B, Cocoa Pod Borer showed a higher incidence of 79.03% and attack intensity of 49.34%, followed by *Helopeltis* spp. (62.25% incidence, 13.69% intensity), squirrels (26.63% incidence, 6.66% intensity), and stem/branch borers (3.50% incidence, 1.16% intensity), while the incidence of fruit rot disease was 12.17% with an attack intensity of 2.48%.

This research identifies pest and disease species and their incidence rates, which can be used as a basis for developing integrated pest and disease management (IPM) strategies. Furthermore, these results enrich the scientific literature on the distribution and impact of major pest attacks, such as Conopomorpha cramerella and Helopeltis spp., and Phytophthora palmivora, in local cocoa agroforestry systems. This information is crucial for supporting further research on pest population dynamics, cocoa variety resistance to plant pest attacks, and the relationship between environmental factors and attack intensity. Overall, this research broadens scientific understanding of the interactions between cocoa plants and their pests at the local scale and can be used as a reference for developing sustainable agricultural policies.

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