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Preferences of Subterranean Termites (*Coptotermes sp*) for Monocotyledonous Plants and Dicotyledonous Plants on Mineral Land

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ABSTRACT

Subterranean termites are recognized for their capacity to damage various plant species, regardless of their productivity. These termites can launch attacks with varying degrees of intensity, targeting both trees and living plants, particularly in agricultural settings such as oil palm and rubber plantations, as well as in industrial forests comprising species like pine and eucalyptus. Characterized by its tropical climate, Indonesia exhibits high levels of environmental humidity, warmth, and organic matter in the soil, which further supports termite activity in a study conducted in the Tj. Keliling Village Plantation area of Salapian District, Langkat Regency, ten bait woods were randomly planted in a rectangular plot measuring 12 meters in length and 7 meters in width. The spacing between the rows of bait wood was set at 30 cm, while the distance between individual bait wood columns was 60 cm. A descriptive method was employed for data analysis. The findings revealed varying percentages of damage among different types of bait wood: 10% for Pinang wood, 5% for coconut wood, 18.3% for oil palm wood, 33.3% for durian wood, 73.3% for teak wood, and the highest damage percentage of 77.3% for kapok wood. The attraction of termites to plants situated on mineral soil is attributed to the latter's role in enhancing humidity, which is a critical factor facilitating the rapid growth and proliferation of subterranean termites. Consequently, the intensity of their attacks can occur at any time until appropriate management measures are implemented.

Keywords: Humidity, Termites, Trees, Tropical, Wood

1. INTRODUCTION

In tropical countries such as Indonesia, termites are regarded as the most significant wood- and building-destroying insects. The infestation of wood and other lignocellulosic materials used in construction has been documented in nearly all provinces of Indonesia. The financial losses caused by their attacks on building structures have continued to increase annually. The estimated loss in 2000 was 3.73 trillion rupiah (Subekti et al., 2008). The risk of termite infestation on buildings, crops, plantations, and forestry is exacerbated by the expansion of forest clearing, land reclamation, and the construction of settlements on agricultural and plantation land. Additionally, termites are classified as social insects that reside in colonies. Approximately 2,648 termite species are recognized globally and are classified into seven families and 281 genera (Supriatna et al., 2017). Additionally, termites facilitate the decomposition of wood and mineral soil (Susanti et al., 2024).

It is a well-documented fact that subterranean termites are capable of causing extensive damage to a wide variety of plants, irrespective of whether they are economically valuable or not. Subterranean termites can inflict significant damage, even on living trees and plants. This is particularly evident in oil palm, rubber, and industrial forest plantation areas, where they target species such as pine and eucalyptus (Aflah et al., 2021). While subterranean termites may not always prioritize plants as a food source, they have been observed to prefer dicotyledonous or monocotyledonous plants.

Subterranean termite attacks on dicotyledonous or monocotyledonous plants are a significant threat to cultivated and non-cultivated plants. A previous study (Subekti, 2010) documented that 10.8% of oil palm plants, 7.4% of rubber plants, and 7.46% of sengon plants had been attacked by termites.

It is well documented that subterranean termites are frequently encountered in oil palm plantations, typically covered by mineral soil. This assertion is supported by the findings of a comprehensive literature review conducted by Subekti et al. (2008). The most commonly encountered termites in oil palm plantations are subterranean. This particular species of termite is highly adaptable to environmental conditions.

Termite infestations significantly affect whether plant species belong to the dicotyledonous or monocotyledonous categories. Subterranean termites are recognized as pests that contribute substantially to economic losses in the woodworking and agricultural sectors. Subekti et al. (2008) state that these termites frequently target plantation and forestry crops in Indonesia, including coconut, rubber, cocoa, oil palm, and pine trees. Furthermore, Aflah et al. (2021) noted that termite damage is classified as severe when it reaches the plant's growing point, potentially leading to the death of the affected plants.

Conversely, Indonesia, a tropical nation, experiences elevated environmental humidity, warmth, and organic matter levels within its soil (Sudarmanto et al., 2024). These conditions are conducive to the proliferation of wood-destroying organisms. While research has been conducted on the distribution of subterranean termites in Indonesia, particularly in Java (Eka Mariana et al., 2013), a comprehensive distribution map specifically for Macrotermes termites has yet to be developed. This particular genus of termites typically inhabits natural forest ecosystems where temperature, humidity, and rainfall remain relatively stable. However, the impacts of global climate change and the alterations in natural forest habitats may lead to shifts in their distribution patterns. This aspect has not been thoroughly investigated in the existing literature.

As presented above, soil termite attacks can affect both monocot and dicot plants. Monocot examples include oil palm, while dicot examples include sengon, rubber, etc. This serves as the basis for the researchers to compare the intensity of soil termite attacks on dicot and monocot plants in mineral soil. Additionally, the researchers present data on the growth of soil termites influenced by climatic factors such as temperature and humidity. This research aims to determine the percentage of termite attacks (*Coptotermes sp.*) on monocot and dicot plants in mineral land.

2. MATERIAL AND METHODS

2.1 Location and Time of Research

This research will be conducted in the plantation area of Tj. Keliling Village, Salapian District, Langkat Regency, North Sumatra. The coordinates of the testing site are N 3° 30' 46.00" E, 98° 19' 7.42" S at an elevation of approximately 165 meters above sea level (Figure 1).

This research was conducted from June to August 2024, encompassing the phases of preparation, implementation, and data processing, with a field observation duration of 30 days.

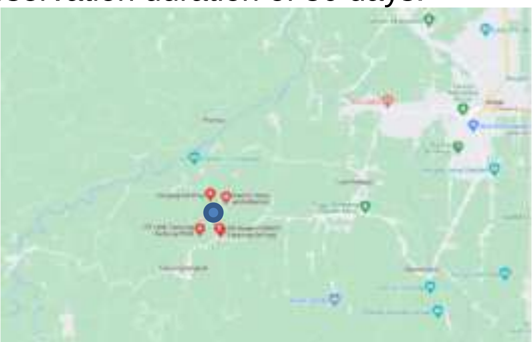

Figure 1. Feed wood sample bait

2.2 Tools and Materials

The materials used in this study were oil palm wood, areca nut wood, coconut wood, kapok wood, teak wood and durian wood. The tools used in the study were plastic rope, calculator, and stationery.

2.3 Research Method

Planting of bait wood in the field as many as 10 bait woods were planted randomly in the Tj. Keliling Village Plantation area, Salapian District, Langkat Regency. The area is rectangular, measuring 12 m (length) 7 m (width); the distance between the row bait woods is 30 cm, while the distance between the bait woods (columns) is 60 cm (Figure 2).

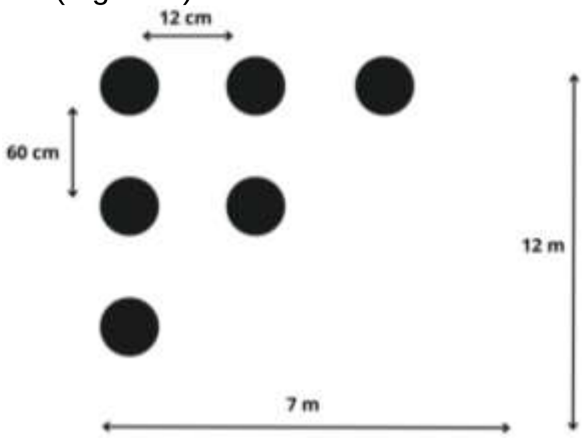

Figure 2. Feed wood sample chart

Planting of bait wood is done vertically until 25 cm of the total length of the wood is immersed in the soil and the tip of the painted bait wood is above the surface of the soil. Each bait wood in each sample plant commodity is 2 with 3 replications (Figure 2).

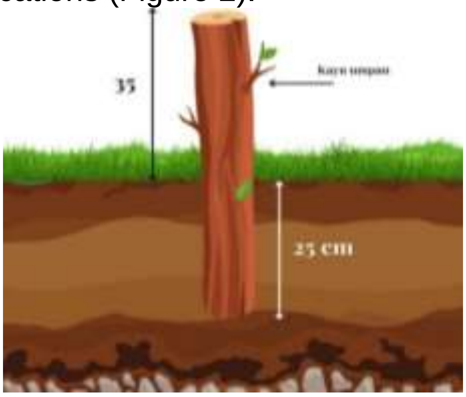

Figure 3. Illustration of planting bait wood

A termite colony usually consists of three castes: the reproductive caste, usually the queen and king; the soldier caste, and the worker caste. Almost all types of subterranean termites have a worker caste that is almost the same in shape, making it very difficult to identify termites with this caste. In general, the identification of termite types is done with the soldier caste because almost all types of termites have soldiers that are different in shape (Tho, 1997).

2.4 Research Implementation

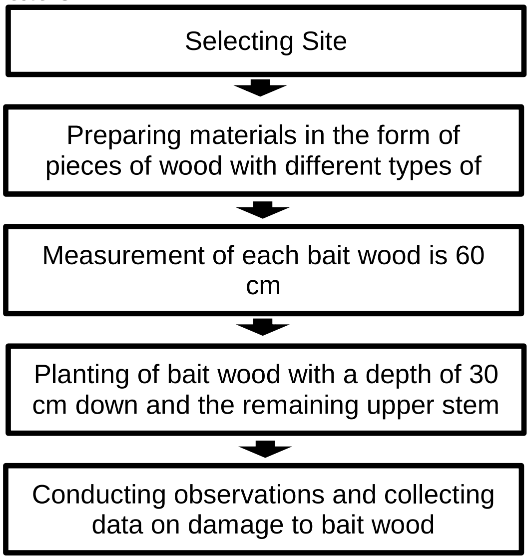

Figure 4. Research Flow Diagram

2.5 Data Analysis

The data analysis used is a descriptive method. The percentage of attacks is obtained based on comparing the number of parts of the tree wood attacked to the total number of parts of the tree in one observation location. The formula used is:

$$wf \frac{PP}{T \times l} \times 100\ \%$$

Notes:

WF : Severe wood damage (%)

PP : Length of penetration of the borehole due to subterranean termite attack in cross-section (cm)

T : Thickness of bait wood before baiting (cm)

l : Width of the bait wood before baiting

3. RESULT AND DISCUSSION

3.1 Result

A recapitulation of the percentage of attacks, the level of damage to the bait wood of each sample plant bait wood, and the category of the level of damage caused by subterranean termites during the research are presented in the table below:

Table 1. Classification of the level of damage caused by Subterranean Termites (*Coptotermes sp*)

No.	Damage Rate (%)	Category
1.	0	Healthy
2.	1-5	Mild
3.	6-20	Medium Damange
4.	+20	Severe Damage

Source: Savitri 2015.

Table 2. Recapitulation of damage level (%) of bait wood in sample plants

No.	Types of bait wood samples	Sample diameter (cm)	Sample length (cm)	Average percentage of damage (%)	Damage category
1.	Kapok	4	60	77.3	Severe
2.	Teak	4	60	73.3	Severe
3.	Durian	4	60	33.3	Severe
4.	Palm Oil	4	60	18.3	Medium
5.	Pinang	4	60	10	Mild
6.	Coconut	4	60	5	Mild

Based on table 2. above, the results of the study show that the highest percentage of damage was obtained in the sample of kapok plant wood bait, which was 77.3%, followed by other plant wood baits such as teak with a percentage of 73.3%, durian plant wood bait with a percentage of 33.3%, oil palm plant wood bait of 18.3%, areca nut plant wood bait of 10% and the lowest percentage of damage was obtained from coconut plant wood bait of 5%. The percentage results of each plant wood bait showed a significant difference in the intensity of attacks from subterranean termites, especially the difference between attacks on dicotyledonous and monocotyledonous plants. This difference is based on the wood planted. soil moisture from the trunk.

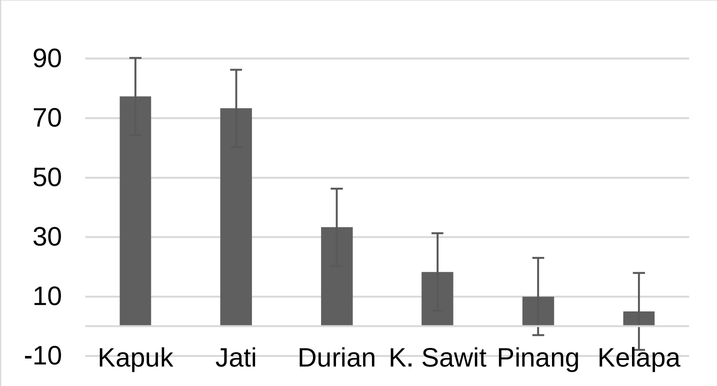

Figure 5. Sample mean and error bar graph

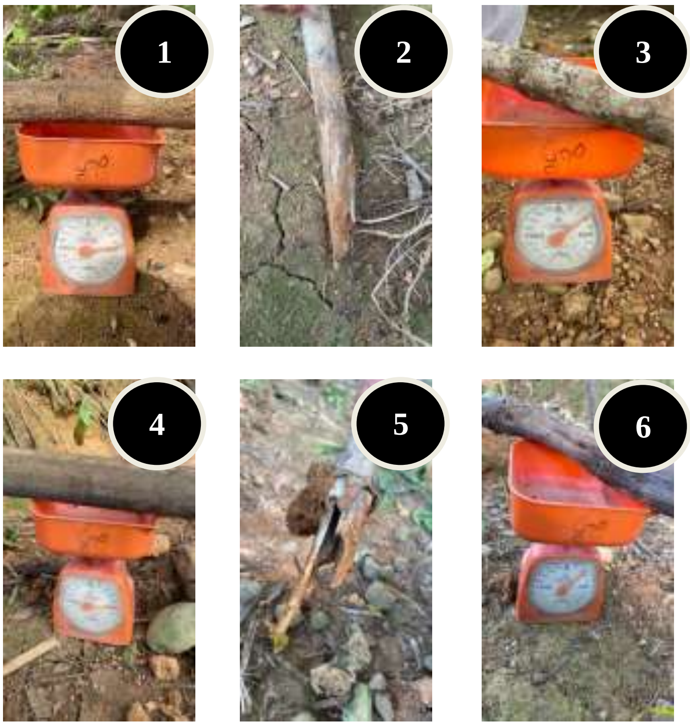

Figure 6. Kapok plant wood bait samples (1), Teak plant wood bait samples (2), Durian plant wood bait samples (3), Oil palm plant wood bait samples (4), Areca nut plant wood bait samples (5), and Coconut plant wood bait samples (6).

Based on previous research (Savitri et al., 2016), the subterranean termite species known as *Coptotermes curvignathus* is Indonesia's most important wood and structure-destroying species. This subterranean termite is very dangerous for buildings around its habitat, and its presence must be watched. Compared to other subterranean termites, the impact of damage and its ability to attack is greater. This insect can adapt to various human-made environments in buildings, therefore, termite attacks from this species must be watched out for by conducting routine inspections of buildings and other properties.

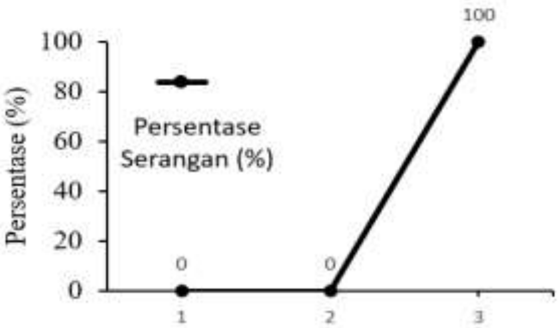

Figure 7. Percentage (%) of subterranean termite attacks on bait wood samples (cotton).

In Figure 7, there are 3 samples of cottonwood bait that are used as materials to test the intensity of subterranean termite attacks (preventive). It is known that all samples have a percentage value of bait wood, namely in sample 1 of 100%, sample 2 83% and sample 3 49%.

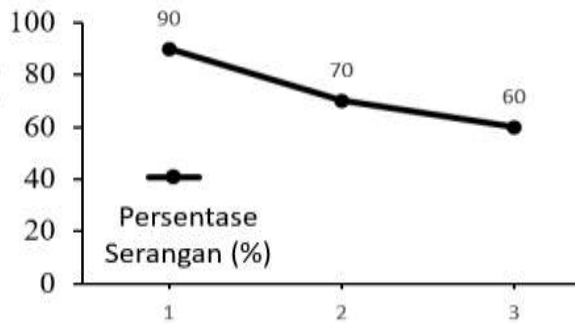

Figure 8. Percentage (%) of subterranean termite attacks for bait wood samples (Teak).

In Figure 8, 3 samples of teak bait wood are used as materials to test the intensity of subterranean termite attacks (preventive). It is known that all samples received a percentage value of bait wood attacks, with the 1st sample being 90%, the 2nd sample being 70%, and the 3rd sample being 60%.

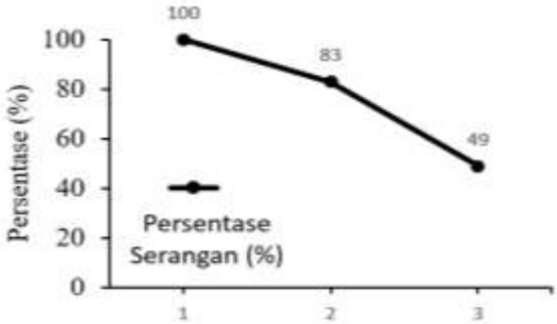

Figure 9. Percentage (%) of subterranean termite attacks for bait wood samples (Durian).

In Figure 9, 3 samples of durian bait wood are used as materials to test the intensity of subterranean termite attacks (preventive). It is known that there is only 1 sample that gets a bait wood percentage value, namely the 3rd sample of 100%.

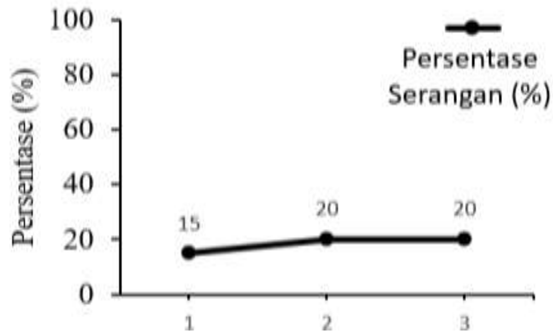

Figure 10. Percentage (%) of subterranean termite attacks on bait wood samples (Oil Palm).

In Figure 10. above are 3 samples of oil palm bait wood used as materials to test the intensity of subterranean termite attacks (preventive). It is known that all samples received a percentage value of bait wood, namely in sample 1 of 15%, sample 2 of 20%, and sample 3 of 20%.

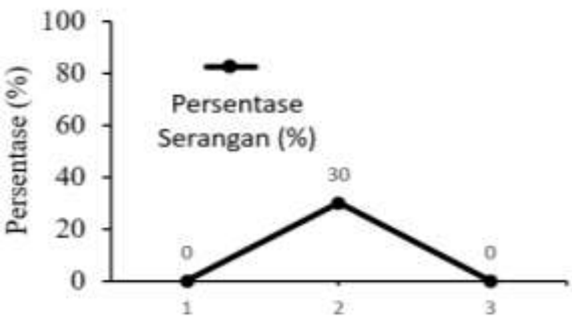

Figure 11. Percentage (%) of subterranean termite attacks on bait wood samples (Pinang).

In Figure 11. above are 3 samples of bait wood used as materials to test the intensity of subterranean termite attacks (preventive). It is known that there is only 1 sample that gets a percentage value of bait wood attacks, namely the 2nd sample of 30%.

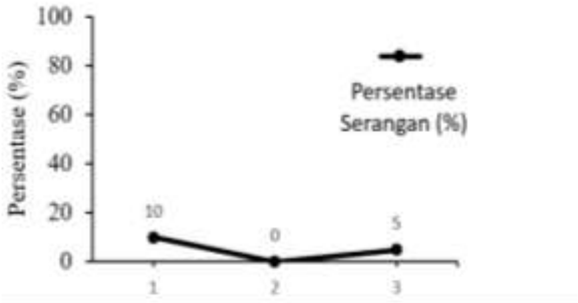

Figure 12. Percentage (%) of subterranean termite attacks on bait wood samples (Coconut).

In Figure 12. above are 3 samples of bait wood used as materials to test the intensity of subterranean termite attacks (preventive). It is known that 2 samples get a percentage value of bait wood attacks, namely the 1st sample of 10%, and the 3rd sample of 5%.

3.2 Discussion

3.2.1 Intensity of Subterranean Termite Attacks (*Coptotermes* sp)

The sampling area covers several prominent areas in each province on North Sumatra Island. The selection of research areas for the percentage of termite attacks was based on climate type and soil conditions, so it is expected to represent the entire habitat of the subterranean termite genus Coptotermes in Langkat Regency.

Figure 13. Subterranean termite samples

Stems of kapok, durian, teak, oil palm, areca nut, and coconut plants were used for sampling. Each stem size of the plant has a length of 60 cm and a diameter of 4 cm. For example, the image below.

Figure 14. Wood Sample

Table 2 above shows the highest damage data on dicotyledonous plant bait wood, kapok commodity. The data shows the highest results with a percentage of 77.3% while the lowest results on the monocotyledonous type, namely coconut wood bait of 5%, this data was obtained based on the average results of 4 bait wood samples from each plant. Based on research data, it is known that the highest percentage of attacks on dicotyledonous plants compared to monocotyledonous plants is caused by dicotyledonous plants, the wood is preferred by termites compared to monocotyledonous wood for several reasons related to differences in structure and chemical composition between the two types of wood:

1. **Chemical Composition**: Dicotyledonous wood (such as wood from broadleaf trees) generally contains more cellulose and lignin than monocotyledonous wood (such as wood from palm trees). Termites feed on cellulose and lignin, making wood rich in these materials more attractive.
2. **Cellular Structure**: Dicotyledonous wood has a different cellular structure than monocotyledonous wood. Dicotyledonous wood usually has larger pores (vessels) and a more complex structure, making it easier for termites to penetrate and damage the wood.
3. **Gum or Resin Content**: Monocot wood often contains more resins or

saps that act as barriers, making them less attractive to termites. These saps or resins have antimicrobial properties and can reduce the wood's susceptibility to termite attack.

4. **Density and Texture:** Monocotyledonous wood often has a denser density and texture, making it more difficult for termites to penetrate compared to dicotyledonous wood which is more easily rotted and damaged (Reyes et al., 1992).

In dicotyledonous wood, termites form a different wood gallery pattern than monocotyledonous wood, namely a straight pattern. This is because dicotyledonous wood has a different connective tissue structure than monocotyledonous wood, which is arranged in a circle and has straight wood fibers (Ayu et al., 2016). Termite feeding activity on monocotyledonous wood forms a scattered gallery pattern, while dicotyledonous wood forms a straight wood gallery pattern. This is because monocotyledonous plants have variations in lignin content in the stem caused by the arrangement of the scattered vascular tissue.

In addition, the high percentage of dicotyledonous plants is also influenced by the commodities planted in most mineral soil; as we know, mineral soil will support stable humidity in the surrounding environment. Following previous research by (Sudarmanto et al., 2024), data shows that the number of termite nests found in mineral soil is the largest compared to the number of termite nests found in sandy and peat soils.

In dicotyledonous plants, namely kapok wood bait, the highest level of damage by subterranean termites is 77.3%, because kapok wood has certain characteristics that make it susceptible to termite attacks, namely kapok wood has a fairly high cellulose content. Cellulose is the main component of plant cell walls that termites eat as a food source. The density and softness of kapok wood tend to be softer and less dense than several other types of wood. The soft wood structure makes it easy for termites to penetrate and damage it. Kapok wood has a slightly porous texture, making it easier for termites to access and eat the inside of the wood (Kim & Chung, 2022). While in teak wood it is also high, namely 73.3% this is because teak wood has an oil and resin content that can protect against termite attacks. However, if teak wood is not properly maintained or is damaged, the oil and resin can decrease in effectiveness in fighting termites. If teak wood is damaged or is in humid conditions, the natural protection provided by oil and resin can be reduced. In such conditions, teak wood becomes more susceptible to termite attacks. Teak wood that is exposed to damp or wet conditions, especially if not properly maintained, can become more accessible to termites. In addition, if teak wood has begun to rot, it will be easier for termites to eat the damaged parts (Lukmandaru et al., 2017). Durian wood also has a termite attack intensity of 33.3%, whereas durian wood contains cellulose and lignin like many other types of wood. Cellulose is the main component of plant cell walls that termites eat. Although durian wood has a hard structure, this component is still attractive to termites. If durian wood is in damp or wet conditions, the risk of termite attack increases. Moisture can weaken the wood structure and reduce its natural protection, making it more susceptible to termite damage. Durian wood that is not adequately maintained or that has physical damage, such as cracks or rot, can become more accessible to termites. This damage can create gaps where termites can enter and begin to damage the wood (Susanti et al., 2022)

In monocotyledonous plants, the bait of oil palm, coconut and areca nut wood has a low level of attack intensity because monocotyledonous wood is generally less preferred by subterranean termites compared to dicotyledonous wood. One of the main reasons why monocotyledonous wood tends to be less attractive to subterranean termites is that many types of monocotyledonous wood contain natural resins or oils with antimicrobial properties. These compounds can suppress the activity of microorganisms and insects, including termites. This resin or oil can function as a chemical barrier against termites. Monocotyledonous wood often contains higher amounts of lignin compared to dicotyledonous wood. Lignin is a structural component that makes plant cell walls harder and more damage-resistant. Because lignin is difficult for termites to digest, monocotyledonous wood becomes less attractive. The fiber structure of monocotyledonous wood has a different fiber structure than dicotyledonous wood. The fibers are usually longer and denser, making it more difficult for termites to penetrate and eat the wood. Monocotyledonous wood usually has a more homogeneous and less porous structure than many dicotyledonous woods. This structure makes it more difficult for termites to access and damage the interior of the wood. Monocot wood often has lower levels of cellulose and hemicellulose than dicot wood. Cellulose is the main component of the cell walls of plants that termites eat. Therefore, monocot wood may not provide enough food for termites. Regarding humidity, monocot wood tends to have lower moisture and humidity content than dicot wood. Subterranean termites usually prefer damp and wet wood because moisture helps the digestion of cellulose and makes it easier for them to damage the wood (Liu et al., 2015).

3.2.2 Intensity Factors of Subterranean Termite Attacks (*Coptotermes* sp)

Table 3. Percentage of ambient temperature and humidity levels

No	Parameter	Percentage (%)
1.	Temperature	36-41
2.	Moisture	47-73

Environmental factors affecting termite populations' development include rainfall, temperature, humidity, food availability, and natural enemies. These factors interact and influence each other. Humidity and temperature are factors that affect termite activity together. Changes in environmental conditions cause changes in the development, activity, and behavior of termites.

High humidity is also avoided by termite activity, especially Coptotermes. Previous research by Nandika (2003) stated that subterranean termites such as Coptotermes, Macrotermes, and Odontotermes require high humidity. Its optimum development is achieved in the 75-90% humidity range. In contrast, dry wood termites and cryptotermes do not require water or high humidity.

The statement above aligns with previous research conducted by Hasman, Muin, and Taskirawati (2019), which stated that Observation and measurement of environmental conditions were also conducted at the research location. The temperature and humidity range at each research location point was not much different, around 29-34ºC and humidity 55-80%. In these conditions, termites have the potential to develop their colonies. This aligns with Nandika, Rismayadi, & Diba (2003) findings that the optimal temperature for termite development is 15-38°C and optimal humidity is around 60-90%.

High humidity refers to mineral soil that is generally low in clay sand and high in organic matter, this is following literature studies (Simbolon et al., 2015), state that Termites live in certain types of soil, but in general, subterranean termites prefer soil types that contain much clay. These insects do not like sandy soil because this type of soil has a low organic matter content.

In addition to the influence of the type of wood on each commodity, the influence of the surrounding climate greatly affects the level of distribution of subterranean termites, this is following literature studies which state that humidity and temperature are strong factors that together affect termite activity. Changes in environmental conditions will cause changes in termite behavior and habitat conditions in termite nests (Luth, 2019) The level of wood density can also be claimed as a factor in the high attack of subterranean termites. As can be seen in the table. 2. the wood trunks of dicotyledonous plants include the highest percentage compared to monocotyledonous plants, with a damage value of 77.3%. In contrast to the average percentage of dicotyledonous plants, monocotyledonous plants are considered lower, namely only 11%.

This is because wood with a dicotyledonous plant type such as durian for example, has a relatively low density, based on previous research stated by (Eka Mariana et al., 2013) in his research, namely based on the results of testing the average density value of durian wood of 0.384 g / cm, this shows that the density of durian wood is included in the low density. This follows what was stated by Kasmudjo (2010), that wood with a specific gravity of less than 0.6 g / cm is included in the classification of wood with a low specific gravity. According to Kasmudjo (2010), durian wood is included in the IV-V durability class, with an average specific gravity of 0.64. So it can be concluded that monocotyledonous wood has a high density, allowing more tissue in it and water content as a general factor for increasing the humidity level around.

4. CONCLUSION

From the results of the study on the preference of subterranean termite attacks on dicotyledonous plants and monocotyledonous plants on mineral land are as follows:

1. The percentage of subterranean termite attacks on samples of kapok wood bait plants obtained the highest percentage of damage of 77.3%, and followed by other wood bait plants such as teak with a percentage of 73.3%, durian wood bait with a percentage of 33.3%, while on oil palm wood bait it was 18.3%, areca nut wood bait was 10% and the lowest for the percentage of damage was obtained from wood bait on coconut plants of 5%.
2. *Coptotermes sp* termites prefer dicotyledonous plants compared to monocotyledonous plants, because dicotyledonous plants have a more complex tissue structure and are rich in lignin which can be a source of nutrition for termites

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