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Health Monitoring and Identification of Tree Planting Plants in the Area of Campus Biodiversity Forest of State Islamic University of Maulana Malik Ibrahim, Malang

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Abstract

Forest is an ecosystem unit in the form of a stretch of land with natural resources dominated by trees with all their benefits for living things in the surrounding environment. The urgency of the presence of forest ecosystems related to improving the quality of forest management to guarantee its functions and benefits. State Islamic University of Maulana Malik Ibrahim Malang is one of the actors in forest ecosystem management activities through campus forest areas with tree planting activities. In this study, it was intended to monitor and identify plant health using the Forest Health Monitoring (FHM) method. The samples observed in this study were 71 plants with tree species varying from longan new crystal (Dimocarpus longan), red jackfruit (Artocarpus heterophyllus), alligator avocado (Persea americana), and banyan tree (Ficus benjamina). The results showed that almost all of the samples belonged to the healthy class of the Tree Health Index, except for one sample which was found to have died. Some of the causes of tree damage include pest attacks in the form of insects and sooty mildew as well as spots and discoloration on leaves. Steps to anticipate more severe damage by carrying out maintenance and handling strategies in the form of improving irrigation techniques, embroidery techniques, cleaning pests and weeds, and fertilizing.

1. INTRODUCTION

A forest is an ecosystem unit in the form of the expanse of land with natural resources dominated by trees. Forests have a positive influence on the surrounding environment [1]. The existence of forests has an important influence on various other natural resources around it, one of which is its role in maintaining environmental balance. In addition, the presence of forests also provides ecosystem services such as providing clean air, habitat for animals and plants, and can act as an agent for regulating water and soil fertility. The urgency of the presence of forest ecosystems related to improving the quality of forest management to guarantee its functions and benefits. One of the criteria for achieving ideal forest quality is identifying forest health, where there are efforts to control the level of forest damage. This becomes very important because the health of the forest can influence the functioning of the forest as it should. The sustainability of a forest ecosystem provides functions and benefits as an environmental balance [2].

State Islamic University of Maulana Malik Ibrahim Malang (UIN Malang) is one of the actors in forest ecosystem management activities through the campus forest area. Campus forest which has the nickname "Biodiversity Campus Forest of UIN Malang" has tremendous potential in the context of supporting its role in supporting the environmental services provided. In this case, several collaborations have been carried out related to the conservation of the campus forest ecosystem through tree planting activities involving several parties, especially British American Tobacco (BAT), Ltd. Collaboration of this kind becomes a trigger as well as the realization of forest ecosystem management actions, which is also a form of commitment by the community and related agencies in preserving the surrounding environment. The tree planting activity also involves various parties from certain agencies, both government and non-government.

Forest area management activities are very unfortunate if they only stop at tree planting activities. This is because newly planted trees still require maintenance assistance to reduce the risk of damage or failure of the tree to grow. Tree damage itself can occur due to several factors, both biotic and abiotic, as a result of the interaction between trees and the environment [3]. In determining the damage to this tree, can be determined from the appearance of plant organs that experience morphological abnormalities or disturbing organisms that are also present in the environment where the tree is planted. The impact that results from these conditions is the development and growth of trees that are not optimal, causing losses in the provision of environmental services that are not fulfilled.

Decreasing the health of trees in forest ecosystems will certainly greatly impact the interactions between organisms and the environment in the area [4]. Determination of tree health can be done by monitoring the target area. Monitoring the health of trees in a forest area needs to be done periodically. This is done to evaluate how far the achievements related to the targets in the use of forest areas have come. A tree is said to be healthy if the tree can carry out its physiological functions and has good ecological resistance in dealing with pest disturbances or other external factors [5]. Therefore, monitoring the health of trees in the UIN Malang campus forest is very important to ensure forest sustainability and support the fulfillment of its role in the surrounding environment.

The health of trees in forest ecosystems can be identified through analysis using Forest Health Monitoring (FHM) [6]. This method can assist in the process of identifying tree damage based on several parameters used. Some of these parameters include the location of damage, type of damage, and severity. The information data

obtained from these activities can be used as a basic reference material in preparing the management strategy for the Campus Forest area of UIN Malang. Forest quality can. Thus, this can increase the potential of the forest as one of the forests that can be said to be sustainable. Some of these things are the background for the implementation of plant health monitoring activities resulting from tree planting together with British American Tobacco, Ltd in the Campus Forest of UIN Malang.

2. MATERIALS AND METHODS

Data Collecting

This research was conducted in July 2023 in the Campus Forest area of UIN Malang which is located at the District of Junrejo, City of Batu, East Java. The research location map can be seen in Figures 1 and 2.

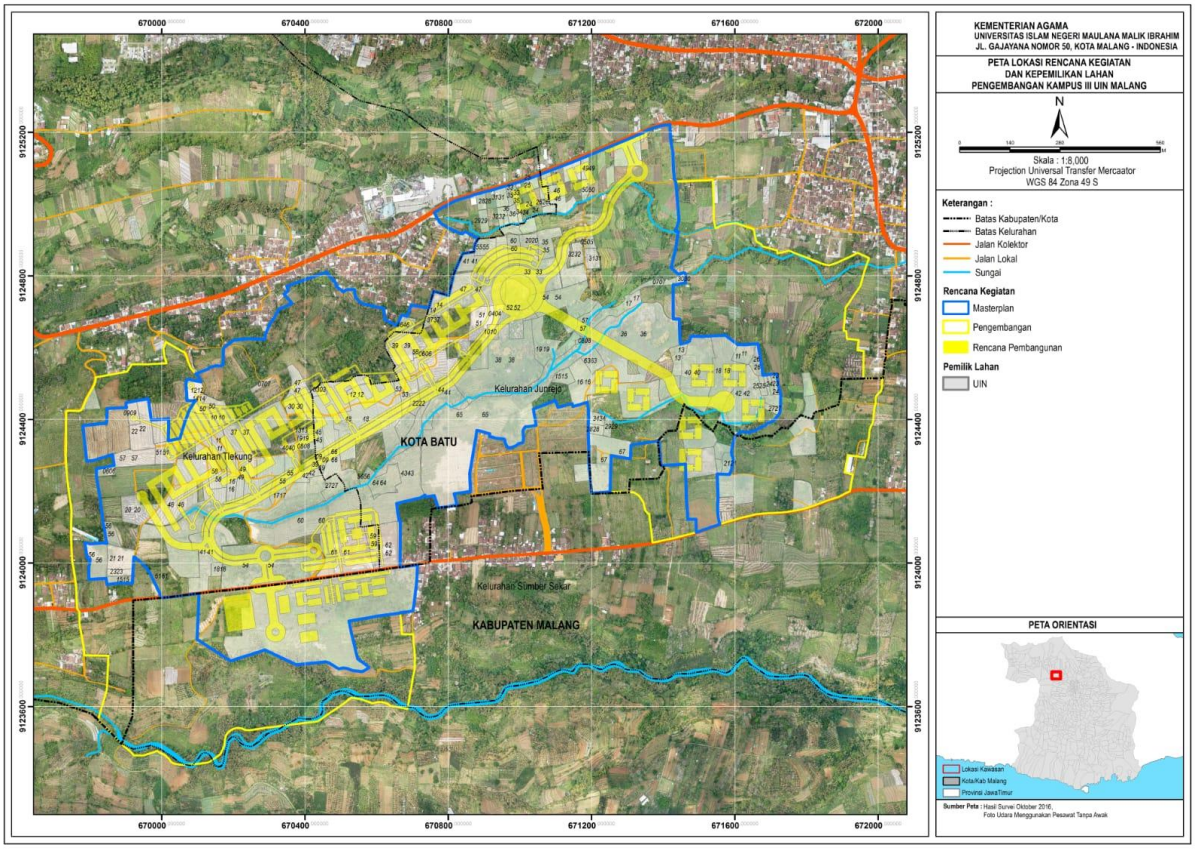

Figure 1. Research Location Map

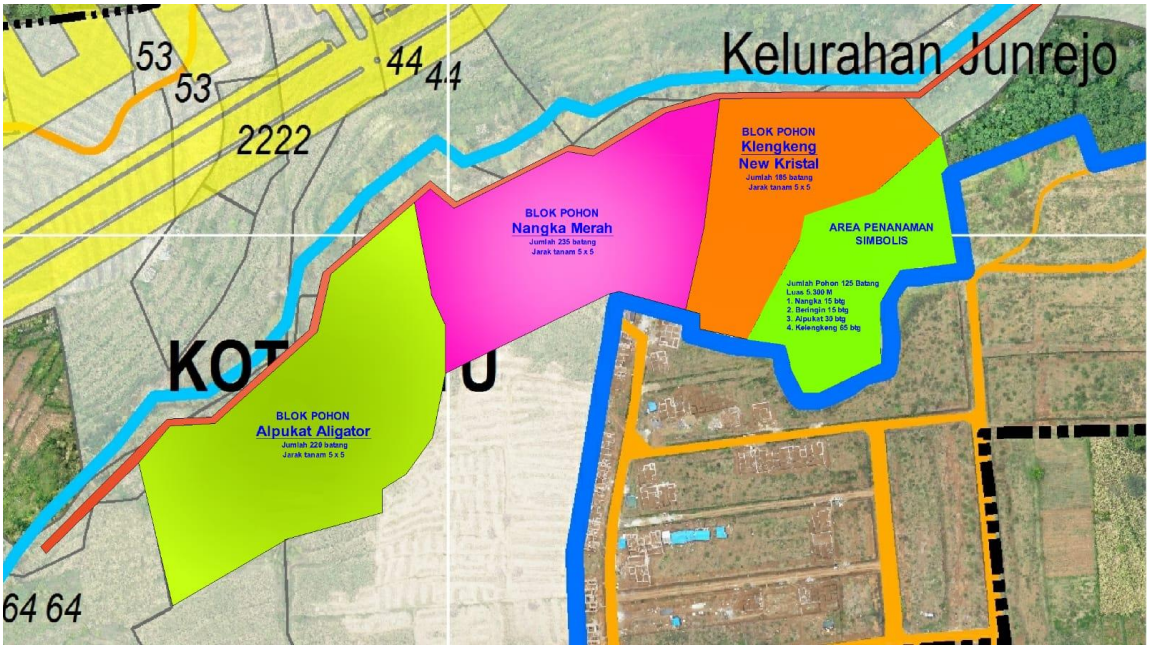

Figure 2. Tree Planting Area

The research data collection was carried out by observing the condition of damage to the trees. The method used in this study is the transect method. A transect is an approach, method or technique, which includes several techniques for identifying, measuring, and involving the community in a participatory manner [7]. Transect lines were made for each block 100 m long, and then plots of 10 m x 10 m were made in the form of a square with alternating positions so that there were 10 plots in each block. The transect plot block design can be seen in Figure 3.

The equipment and materials used in monitoring tree health in the Biodiversity Campus Forest area of UIN Malang include a 100 m field tape measure, 2 pieces of 100m raffia rope and 4 pieces of 10m raffia rope, a GPS navigation device, a camera, a note-taking board, stationery, observation sheets, and personal safety equipment. The materials used in this study were several trees that had been planted in tree planting activities with British American Tobacco, Ltd. Some of the trees observed consisted of several types including the New Crystal Longan plant (*Dimocarpus longan*), Red Jack Fruit (*Artocarpus heterophyllus*), Alligator Avocado (*Persea americana*), and Banyan (*Ficus benjamina*).

Data collection on tree damage was carried out based on the Forest Health Monitoring (FHM) method with tree damage parameters used in observing tree damage, namely location, type and level of damage. Locations of tree damage recorded were roots, stems, branches, crowns, leaves, shoots and shoots [4]. The type of damage recorded is based on the definition of damage that can kill the tree or affect the long-term viability of the tree. The level of tree damage is recorded if it meets the severity threshold value. Codes and descriptions of tree damage conditions are in the Table 1.

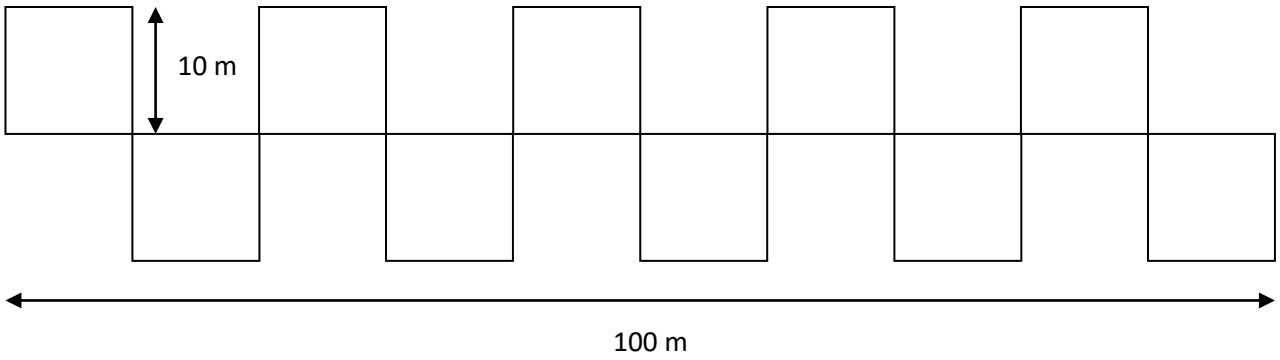

Figure 3. Transect Plot Design for Sample Data Collecting

Table 1. Description and Location, Type, and Level of the Tree Damage Code

Damage Location	Code	Damage Type	Code	Damage Level	Code
No damage	0	Cancer	1	10%	1
Root	1	Conc	2	20%	2
Root and lower stem	2	Open wounds	3	30%	3
Lower stem	3	Resinosis/gummosis	4	40%	4
Upper and lower stem	4	Stems/roots broken	11	50%	5
Upper stem	5	Stems/roots bruises	23	60%	6
Header bar	6	Dead roots	13	70%	7
Branch	7	Dead top	21	80%	8
Buds and Shoots	8	Broken branch	22	90%	9
Leaf	9	Damaged leaves/shoots	24		
		Leaves change color	25		
		Others	31		

Table 2. Description and Location, Type, and Level of the Tree Damage Code Value

Damage Location Code	Value (x)	Damage Type Code	Value (y)	Damage Level Code	Value (z)
0	0	01, 26	1,9	0	1,0
1	2,0	02	1,7	1	1,1
2	2,0	03, 034	1,5	2	1,2
3	1,8	05	2,0	3	1,3
4	1,8	06	1,5	4	1,4
5	1,6	11	2,0	5	1,5
6	1,2	12	1,6	6	1,6
7	1,0	13, 20	1,5	7	1,7
8	1,0	21	1,3	8	1,8
9	1,0	22, 23, 24, 25, 31	1,0	9	1,9

Data Analysis

Assessment of tree damage is analyzed by calculating the Damage Index (DI) by using this following equation.

$$DI = x \times y \times z$$

Where x is the value of the damage location, y is the value of the type of damage, and z is the value of the damage severity. The x, y, and z values vary depending on the type of damage, location of damage, and severity as shown in the Table 2. Then, to determine the class of tree damage refers to the damage index value with the following criteria:

Healthy = 0 ≤ 5
Light Damage = 6 – 10
Moderate Damage = 11 – 15
Heavy Damage = 16 ≥ 20

3. Results

Data that has been taken in the field using the transect method in the Campus Forest of UIN Maulana Malik Ibrahim Malang obtained the results listed in these following tables.

Table 3. Sample Data of New Crystal Longan (*Dimocarpus longan*) Block

Individual Number	Breast-Height Diameter (cm)	Height Total (cm)	Branch-Free Height (cm)	Damage Location Code (x)	Damage Type Code (y)	Damage Level Code (z)	Damage Index (x × y × z)	Status
K036	1	140	80	9	14	1	1,1	Health
K077	1	100	35	9	14	1	1,4	Health
K061	1	100	60	0	0	0	1,1	Health
K025	1	150	110	9	14	1	0	Health
K088	1	110	30	9	14	1	1,1	Health
K024	1	150	110	9	14	3	1,2	Health
K021	2	180	100	9	14	1	1,1	Health
K044	1	110	60	9	14	1	1,3	Health
K039	2	140	40	9	14	1	1,1	Health
K001	1,5	160	110	6	12	5	1,1	Health
K020	1	140	40	9	14	2	1,1	Health
K055	1	155	50	0	0	0	1,1	Health
K037	1	120	50	9	14	1	1,1	Health
K083	0,5	100	60	9	14	1	1,8	Health
K057	0,5	110	50	9	14	1	1,2	Health
K070	1	100	60	9	14	1	1,2	Health
K067	1	90	5	9	14	1	0	Health
K085	1	110	50	9	14	1	1,1	Health
K075	1	80	30	9	14	1	1,2	Health
K054	1	140	60	0	0	0	1,1	Health
K060	1	100	5	6	12	2	1,1	Health
K118	1	130	60	9	15	1	1,1	Health
K123	1	120	80	5	10	3	1,1	Health
K209	0,7	130	85	9	14	3	1,1	Health
K215	0,5	100	60	9	14	1	1,1	Health

K222	1	90	45	9	14	1	1,1	Health
K221	0,7	90	70	9	14	2	1,1	Health
K223	1	105	85	9	14	2	1,1	Health
K130	0,7	145	100	9	14	1	0	Health
K133	0,7	80	65	9	14	1	1,1	Health
K206	0,7	117	70	9	14	3	0	Health
K224	1	100	70	9	14	1	1,44	Health

Table 4. Sample Data of Red Jack Fruit (*Artocarpus heterophyllus*) Block

Individual Number	Breast-Height Diameter (cm)	Height Total (cm)	Branch-Free Height (cm)	Damage Location Code	Damage Type Code	Damage Level Code	Damage Index (x × y × z)	Status
N043	1	150	57	9	14	1	1,1	Health
N044	1,5	157	60	9	15	1	1,1	Health
N035	0,5	146	85	9	14	1	1,1	Health
N045	1	140	70	9	15	1	1,1	Health
N046	1	170	35	9	14	1	1,1	Health
N237	0,4	32	42	9	14	1	1,1	Health
N121	1	150	82	9	15	1	1,1	Health
N117	0,7	100	25	9	15	2	1,2	Health
N194	0,3	133	22	0	0	0	0	Health
N195	0,4	101	28	5	12	3	2,34	Health
N208	0,5	140	69	0	0	0	0	Health
N239	1	120	60	9	14	3	1,3	Health
N238	1	160	50	9	14	2	1,2	Health
N223	0,5	120	78	0	0	0	0	Health
N224	1	90	42	9	14	1	1,1	Health
N205	1	130	42	0	0	0	0	Health
N206	1	138	25	9	14	1	1,1	Health
N051	0,7	110	36	9	15	1	1,1	Health
N052	1	150	40	9	17	1	1,1	Health
N012	2	135	30	9	14	1	1,1	Health
N010	1	120	40	9	17	2	1,2	Health
N321	0,5	103	46	4	5	5	4,32	Health
N222	0,5	135	67	4	10	4	0	Health
N213	1	152	52	0	0	0	0	Health

The limitations of the data are caused by the affordability of access to samples that are difficult to make observations so that only affordable samples are observed

Table 5. Sample Data of Alligator Avocado (*Persea americana*) Block

Individu	Breast-	Height	Branch-	Damage	Damage	Damage	Damage	Status

Number	Height Diameter (cm)	Total (cm)	Free Height (cm)	Location Code	Type Code	Level Code	Index (x × y × z)	
A114	1	100	40	9	14	2	1,2	Health
A077	1	120	25	9	14	2	1,2	Health
A052	2	110	30	9	14	1	1,1	Health
A073	2	120	30	9	15	2	1,2	Health
A181	2	120	40	9	14	2	1,2	Health
A001	1	67	30	9	14	1	1,1	Health
A103	1	70	37	0	0	0	0	Health
A116	1	110	40	9	14	3	1,3	Health
A128	1	100	35	9	14	6	1,6	Health
A008	1	56	25	9	14	1	1,1	Health
A099	1	75	25	9	14	1	1,1	Health

The limitations of the data are caused by the affordability of access to samples that are difficult to make observations so that only affordable samples are observed

Table 6. Sample Data of Banyan Tree (*Ficus benjamina*) Block

Individu Number	Breast-Height Diameter (cm)	Height Total (cm)	Branch-Free Height (cm)	Damage Location Code	Damage Type Code	Damage Level Code	Damage Index (x × y × z)	Status
B024	0,75	120	5	9	14	1	1,1	Health
B023	0,7	110	70	9	15	1	1,1	Health
B022	1	110	90	9	15	2	1,2	Health
B026	0,5	70	30	9	14	1	1,1	Health

The limitations of the data are caused by the affordability of access to samples that are difficult to make observations so that only affordable samples are observed

Table 7. Inventory of Plantation Tree Samples in Campus Forest UIN Malang Area

Tree Species	Scientific Name	Number of Samples
New Crystal Longan	*Dimocarpus longan*	32
Alligator Avocado	*Persea americana*	11
Red Jack Fruit	*Artocarpus heterophyllus*	24
Banyan Tree	*Ficus Benjamina*	4
Total		71

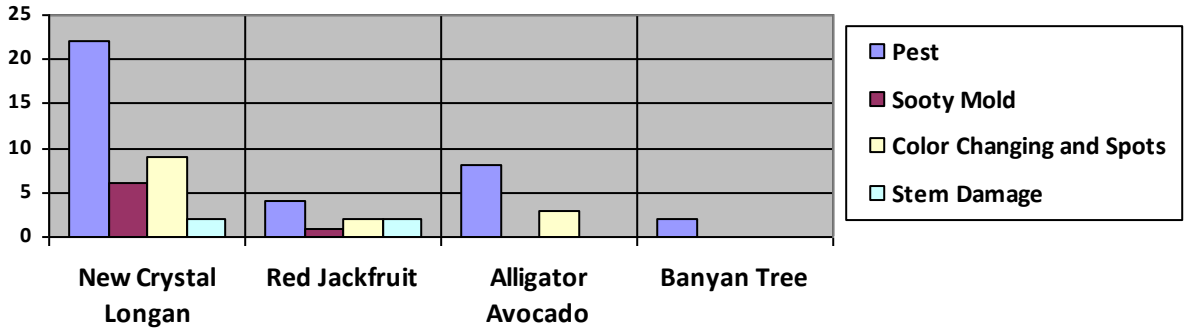

Figure 3. Tree Damage Cause Diagram

4. Discussion

Observations from the entire blocks show that in the new crystal longan block, even though the status of most of the plants is in the healthy class, there is some damage to the trees that occurs. Most of the damage to trees is caused by sooty mildew disease and the bites of insect pests. This sooty mold disease is caused by a *Capnodium citri* Berk. & Desm. Which has black mycelium scattered and covering almost the entire surface of plant leaves [8]. The spread of dew disease has a relatively fast spread speed. One of the solutions for controlling sooty mildew is usually by using a fungicide solution. The fungicide solution has been shown to significantly reduce the intensity of sooty mildew attacks [8].

In the New Crystal Longan block, most of the plants are also attacked by insect pests, which are commonly found in the planting area. These insect pests attack plants in almost all blocks, both the jackfruit block, the avocado block and also the banyan block, furthermore in the avocado block and banyan block, all of the diseases found are caused by insect pest attacks (Table 5 and 6). Insects are the main pests for many types of plants cultivated by humans, especially for plants that are still relatively not mature yet. Aside from being plant pests, several groups and types of insects are also a source of disease in plants in the form of viruses or fungi. Treatment of plants that are attacked by pests from the bites of plant destroying animals can be done by spraying pesticides on the plants [9]. Insects as plant pests need to be controlled because they can cause damage and loss of production from plants, both in quality and quantity [10].

In the Red Jackfruit block, there were 24 plants with details of 5 of them being healthy plants without damage and 1 plant that died. In addition, 19 jackfruit plants that had damage to the stems and leaves. There were 8 plants with identified details of their leaves being eaten by insects, 5 plants experiencing yellowing leaves, and 2 plants with black spots on their leaves (Table 4). Changes in leaf color happen because chlorophyll is not formed, the causes of which can be pathogens, poisons, mineral deficiencies, air pollution, drought, dryness or chemical burns [11]. The absence of chlorophyll in the leaves can disrupt the photosynthetic mechanism of plants, which can affect crop production.

Management control and care for plants experiencing drought can be done with irrigation efforts, one of which is through drip irrigation techniques. The drip irrigation technique is carried out by providing water to the planting area which is carried out in a limited manner. This technique uses a container that acts as a water reservoir while the bottom is accompanied by a hole as a gap for water to slowly come out to the ground to wet the ground [12]. This technique can be used to optimize water use so as to reduce the

risk of running out of water due to too high temperatures or drought. However, for plants that have a risk of not being able to grow properly, embroidery techniques can be treated (replacement). This technique is carried out by replacing tree seedlings that are not growing well, so that the maximum plant population is obtained [13].

Handling plants affected by weeds also needs to be done routinely. Weed removal is an important part of maintaining healthy plants. Weeds can compete with the desired plants for water, nutrients, and sunlight, thereby inhibiting the growth and productivity of the desired plants. The simplest way in this technique is by removing weeds. Another technique in handling weeds is the mulching technique by spreading a layer of organic matter such as straw, sawdust, or chaff around the plant. This can help suppress weed growth because the mulch not only blocks sunlight from reaching the weeds, but also helps maintain soil moisture. In addition, the use of herbicides or other chemicals can help control weed growth [14].

Handling pests on plants is a step that is no less important in maintaining the health and productivity of plants. Pests can damage plants by sucking up nutrients, damaging leaves, stems or roots, and spreading disease. Some pest management methods that can be done are pruning techniques. Pruning infected leaves or plant parts can help limit the spread of the pest. Be sure to clean pruning tools with disinfectant after using them on infected plants. In addition, the use of natural and artificial pesticides can also be used to help control pest populations [15]. In addition, plant maintenance and management activities that are equally important are fertilization. In this case, fertilization is the process of providing nutrients needed by plants for optimal growth, development and production. These nutrients can be macro nutrients (nitrogen, phosphorus, and potassium) and micronutrients (iron, zinc, copper, manganese, boron, molybdenum, and chlorine). There are at least three methods of fertilizing plants including basic fertilizing before planting to provide initial nutrients. Furthermore, side fertilization is given throughout the growing season to maintain the supply of nutrients and foliar fertilizer to be sprayed directly on the leaves for fast absorption [16].

A **B**

Figure 4. (a) Leaves Black-spot Diseases; and (b) Pest-Damaged Leaves

5. CONCLUSION

The conclusion of this monitoring plant health from the 71 plant samples studied, all of the plants were still in health status. This shows that the conditions for plant growth are in good condition. However, some of these healthy plants still have several causes of health decline such as several sooty mildew infections, yellowing leaves, leaf spots, and pest attacks. This encourages the need for handling and caring for trees to maintain plant growth. One of the strategies for handling and caring for trees that can be carried out includes embroidery techniques during the summer season, increasing irrigation during the rainy season, routine weed cleaning, periodic pest spraying, and fertilization to meet the nutrients needed by plants. Thus, plant growth can be maintained properly..

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