



Microclimate Characteristics On Oil Palm (*Elaeis guineensis* Jacq.) And Agarwood (*Aquilaria malaccensis* Lamrk.) Agroforestry System

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ABSTRACT

In general, oil palm plants are cultivated using a monoculture system. The monoculture system is profitable from an economic perspective and harms the environment; one is the microclimate. One of the efforts to reduce the negative impact of the oil palm monoculture system is to apply the oil palm agroforestry system with agarwood. This research is conducted on smallholder oil palm plantations in Bukit Kemuning Village, Tapung Hulu Sub District, Kampar District, Riau Province. This research was conducted using a survey method, which was done by choosing a location intentionally. Determination of the research location using purposive sampling method, that is, on land found agroforestry systems of oil palm plants with agarwood and oil palm monoculture systems in the same location. Microclimate observations are carried out by measuring air temperature, air humidity, and sunlight intensity. Measurement of air temperature and humidity uses the Temperature and Humidity Data Logger, while the sunlight intensity measurement uses the Lux Meter Data Logger tool. Measurements are carried out one day a week for three months, for getting 12 times of data retrieval. The recording is carried out from 07.00 am to 05.00 pm, with 15 minutes intervals. Microclimate data on agroforestry and monoculture systems are analyzed in comparative descriptive analysis. Based on the results of the study, it is concluded that the microclimate in the agroforestry system of oil palm and agarwood was better than that of the oil palm monoculture system, where the light intensity and air temperature in the agroforestry system are lower than the monoculture system, and the humidity in the agroforestry system higher than the monoculture system.

Keywords: *Agroforestry systems, agarwood, microclimate, monoculture systems, oil palm.*

1. INTRODUCTION

Oil palm is the prime commodity of Riau Province, and this primary commodity is the most dominant

commodity compared to other plantation's commodities. Currently, the development and investment in the oil palm plantation sector are increasing.

Oil palm (*Elaeis guineensis* Jacq.) is one of the plantations' plants that has a crucial contribution to the economy in Indonesia because it can produce a vegetable oil that is widely needed by the industrial sector. Riau province is the region that has the most spacious oil palm plantation area in Indonesia, that is, 2.21 million hectares in 2017 or 17.84% of the oil palm plantations total area in Indonesia. In 2018, the oil palm plantation area increased to 3.32 million hectares (BPS, 2019). The oil palm plant has been commonly cultivated in monoculture to date.

A monoculture system is advantageous from an economic point of view and harms the environment, one of which is the microclimate. A microclimate is the air layer closest to the earth's surface with ± 2 meter elevation (Aqil, 2010). Vegetation, climate, and soil are affected by each other. One effort to decrease the negative impact of oil palm plants' monoculture system is by applying the agroforestry system. An agroforestry system combines plantation crop cultivation and other plants contained in one stretch of land. Oil palm plants are highly potential to be combined with agarwood because the plant is the type that requires shade (Suhartati, 2013). Planting an agarwood plant between the oil palm plant was expected to create a better microclimate than the monoculture system. Research about agroforestry systems on oil palm plants and agarwood has been conducted by (Suhartati & Wahyudi, 2011). In this research, the location is different. The research was conducted in Kembangdamai Village, Pagar-antapah Darusalam sub-district, Rokan Hulu (Rohul) Regency, Riau province. The research aims to determine the microclimate characteristics of agroforestry and monoculture systems.

2. MATERIAL AND METHOD

1. Research Location

This research was conducted in a smallholder oil palm plantation in Bukit Kemuning Village, Tapung Hulu sub-district, Kampar Regency, Riau Province. Geographically, Bukit Kemuning Village is located in $0^{\circ} 37' 51''$ NL – $0^{\circ} 39' 27''$ NL and $100^{\circ} 54' 11''$ EL – $101^{\circ} 57' 0''$ EL position. The Light intensity) Lux IC 3433 (70%) is bright, humidity is 60-70 %, and the temperature is 31-32°C. Monoculture and agroforestry system research site was located in the same stretch of land, with each area of 1 ha. The age of the oil palm plants is 20 years, and the agarwood is ten years. The research site plantation area is 1 hectare with a population of 120 oil palms trees and 164 agarwood trees; the planting distance between each plant is 4 meters.

2. Research Method

This research was conducted using the survey method. For determining the research location, the researchers applied the purposive sampling method, that is, by selecting a plantation land that has an agroforestry system for oil palm plants and agarwood plant and monoculture system of oil palm plant in one stretch of land, Loggers are placed on agroforestry and monoculture land. Microclimate observation was conducted by measuring air temperature and sunlight intensity. The air temperature measurement and air moisture used *Temperature and Humidity Data Logger* tool. Meanwhile, sunlight intensity measurement used the *Lux Meter Data Logger* tool. The measurement was carried out once a week for three months to obtain 12 times data collection. The location has consisted of a land with oil palm and agarwood agroforestry plantation, and for the monoculture land, it was only planted with oil palm in the same location or one stretch of land. The data recording was carried out on 07.00 am - 5.00 pm with 15 minutes intervals.

3. Data Analysis

The microclimate data was in the form of sunlight intensity, air temperature, and air moisture in agroforestry and monoculture system; afterward, it was analyzed in descriptive comparative.

3. RESULT AND DISCUSSION

1. Light Intensity (Lux)

The average light intensity on agroforestry and monoculture system is presented in Figure 1. The comparison of the sunlight intensity average on agroforestry and monoculture system is presented in Table 1.

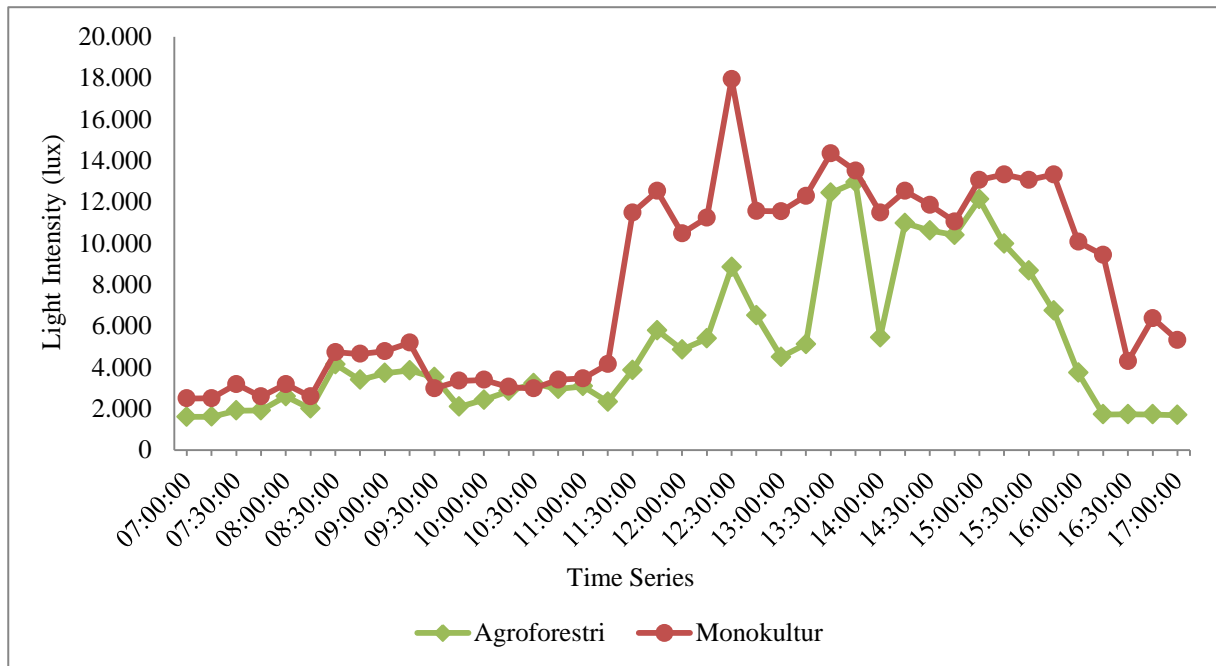


Figure 1. the average result of Light intensity (lux) measurement in 12 measurement days, three months observation in Agroforestry and Monoculture system.

The average sunlight intensity in the agroforestry system is lower than in the monoculture system. The range of sunlight intensity varies in the agroforestry system (1,605 lux – 12,964 lux) and the monoculture system (2,492 lux – 14,356 lux). This result occurs because there is a combination of the canopy between oil palm and agarwood trees in agroforestry systems capable of producing higher shade levels. So the sunlight intensity in agroforestry is lower compared to the monoculture system.

Setiayu et al. (2020) state that the high/low of sunlight intensity was caused by canopy density (stand composition) (Suci & Heddy, 2018) also add that the denser or, the thicker the plants' canopy, the lesser the light intensity that can penetrate to the soil surface. Sudomo and Hani's (2014) research results show that the light in sengon with taro plant (35,359 lux) agroforestry system is lower compared to taro monoculture system (18,6670 lux).

Table 1. Comparison of light intensity (lux) average in agroforestry and monoculture system

No.	Time	Light intensity (lux)			
		Agroforestry	Monoculture	Margin	%
1.	Morning (07.00-08.00)	1,925	2,788	862	30
2.	Midday (11.00-13.00)	5,020	10,493	5,473	52
3.	Afternoon (16.00-17.00)	2,116	7,098	4,981	70

The average minimum sunlight intensity occurs in the morning measurement, increasing at midday and gradually decreasing in the afternoon. In the morning (at 07.00 - 08.00 am), the average light intensity of the agroforestry system was 1,925 lux, while in the monoculture system was 2,788 lux, with a margin of 30.95%. At midday time (at 11.00 am - 1.00 pm), the average light intensity of the agroforestry system is 5,021 lux, while in the monoculture system was 10,494 lux, with the margin reaching 52.16%. In the afternoon (at 4.00 - 5.00 pm), the average light intensity of the agroforestry system was 2,117 lux. Meanwhile, in monoculture system was 7,099 lux, with the highest margin of 90.18% (Table 1). The

agroforestry can influence the decreasing of sunlight intensity by 52.16% (at midday) to 90.18% (afternoon) compared to the monoculture system. The differences occurred because of different land covers. The agarwood tree canopy caused this effect, and it can assist in covering the sunlight intensity entering the earth so that, in the agroforestry system, the light intensity is still lower.

2. Air Temperature (°C)

The average air temperature in agroforestry and monoculture system is presented in Figure 2. The average comparison of air temperature in agroforestry and monoculture system is presented in Table 2.

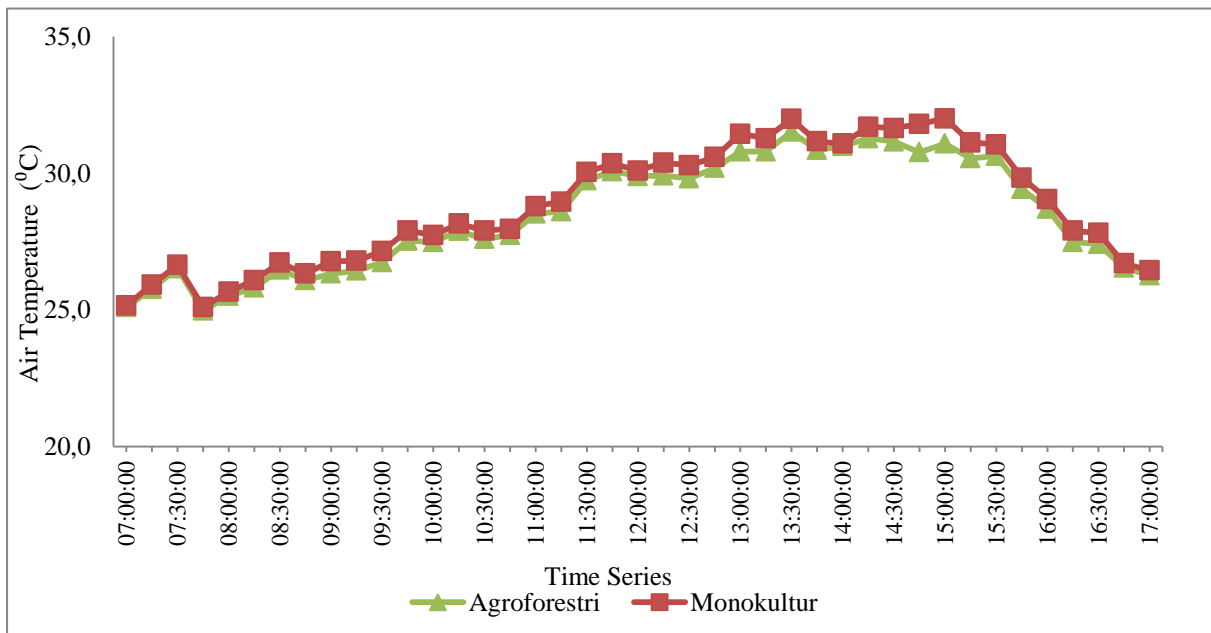


Figure 2. The average result of air temperature (°C) measurement in 12 measurement days, for three months observation in Agroforestry and Monoculture system

Table 2. The average comparison of air temperature (°C) in Agroforestry and Monoculture system

No.	Time	Air Temperature (°C)			
		Agroforestry	Monoculture	Margin	%
1.	Morning (07.00-08.00)	25.6	25.7	0.1	0.48
2.	Midday (11.00-13.00)	29.7	30.1	0.4	1.26
3.	Afternoon (16.00-17.00)	27.3	27.6	0.3	1.10

In Figure 2, it is seen that the maximum average air temperature was reached at midday, that is, a few moments after the maximum sunlight intensity was reached. Thus, the temperature at midday will be higher compared to morning time and afternoon. The average air temperature in every 15 minutes interval on the agroforestry system is lower compared to the monoculture system. The air temperature ranges vary in the agroforestry system (25.0 oC – 31.5 oC) and the monoculture system (25.1 °C – 32.0 °C). The agroforestry can affect the air temperature decrement occurred at midday, that is, as much as 1.26% compared to the monoculture system (Table 2). This effect was caused by the air temperature influenced by sunlight intensity. The lower the sunlight intensity, the air temperature will also become lower. In the agroforestry system of oil palm plants with agarwood plants, the

light intensity is lower compared to the oil palm plantation by monoculture system (Figure 1). Purba (2018) states that the lower the sunlight intensity, the air temperature will also become lower. This result corresponds to the research result *et al.* (2016) that air temperature in an agroforestry system (31,12°C) is lower compared to a teak monoculture system (31.44°C). Firdaus and Arifin's (2019) research result also reveals that air temperature in pine and coffee agroforestry system (22,21°C) is lower compared to pine monoculture system (23.13°C).

3. Air Moisture (%)

The average air moisture in agroforestry and monoculture system is presented in Figure 3. The average comparison of air temperature in moisture in agroforestry and monoculture system is presented in Table 3.

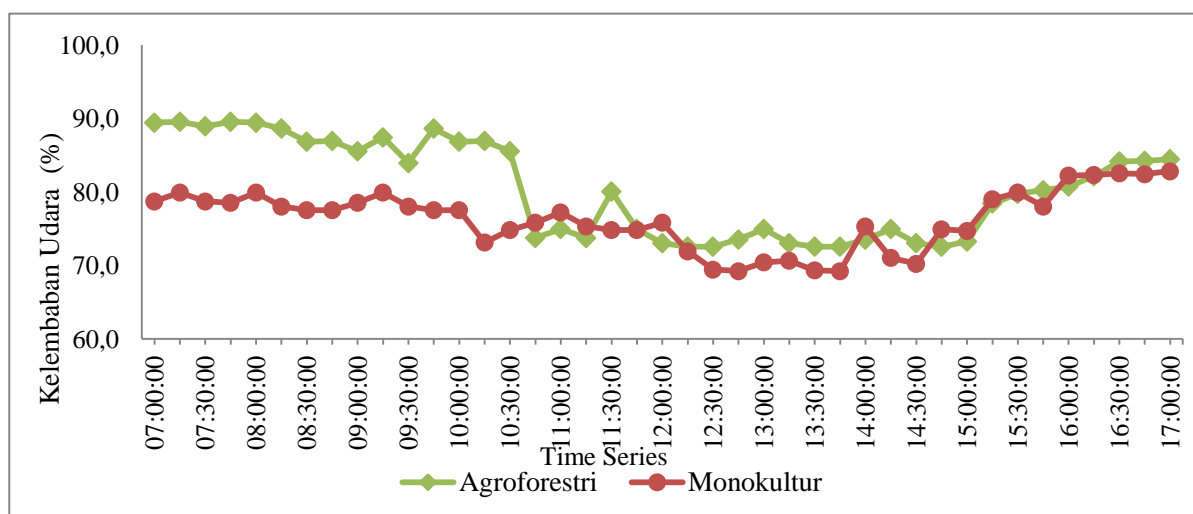


Figure 3. The average result of air moisture measurement (%) in 12 measurement days for three months observation in Agroforestry and monoculture system

Table 3. The average comparison of air moisture (%) in Agroforestry and Monoculture system

No.	Time	Air Moisture (%)			
		Agroforestry	Monoculture	Margin	%
1.	Morning (07.00-08.00)	89,38	79,17	10,22	12,91
2.	Midday (11.00-13.00)	74,48	73,23	1,25	1,71
3.	Afternoon (16.00-17.00)	83,14	82,47	0,68	0,82

The average air moisture in every 15 minutes interval on the agroforestry system is higher compared to the monoculture system. The ranges of air moisture average are pretty varied in an agroforestry system (72.5% - 89.5%) and a monoculture system (71.9% - 79.9%). The average air moisture in the morning is relatively high, decreasing at midday, but it gradually rises again in the afternoon. The average air moisture in the agroforestry system at morning time is 89.4%, and monoculture is 79.2%. The agroforestry system influences the air moisture increment that occurs in the morning time, reaching up to 12.91% compared to the monoculture system (Table 3). This result is because air moisture is influenced by sunlight intensity. The air moisture will get higher if the sunlight intensity becomes lower. In the oil palm plant and agarwood plant agroforestry system, the light intensity is lower than in the oil palm plant by monoculture system (Figure 1). Due to some part of the light being absorbed by the oil palm tree canopy, the low light intensity also causes air temperature to become low (Figure 2). The low air temperature will cause air moisture to increase. The combination of oil palm and agarwood plants in the agroforestry system causes the canopy closure to be denser compared to the monoculture system, which only has one plant. Wijayanto and Nurunnajah (2012) state that a tree canopy closure influences air moisture. The denser canopy will lead to less light intensity breaching the ground to get higher air moisture. Purwowidodo (1998) also adds that the factor

influencing air moisture is the availability of tree stand, particularly the dense tree stand. Research results by Firdaus and Arifin (2019) show that air moisture in the pine and coffee tree agroforestry system (77.59%) is higher compared to the pine monoculture system (70.15%).

4. CONCLUSION

The research result concluded that microclimate characteristics in the oil palm and agarwood plant agroforestry system are better than the oil palm monoculture system. In which sunlight intensity and air temperature in agroforestry are lower than in the monoculture system, and air moisture in the agroforestry system is higher than in the monoculture system.

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