Sun Light Intensity Identification In Cocoa Plant On Variation Of Shading Plant Type In Soppeng Regency

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Abstract: Cocoa plant (Theobroma cacao L.) is a mainstay plant of South Sulawesi. This study aimed to identify the intensity of sunlight in various types of shading plants and pruning plants against cocoa plant. This research was conducted in the Lilirilau sub-district of Soppeng Regency, South Sulawesi Province from January to March 2018. The results of the study showed that the intensity of sunlight on the three types of shading plants measured above the plant canopy was higher, namely (4864.3 Lux) then it was followed by one type of shading plants (4468.8 Lux) and two types of shading plants, namely (4073.1 Lux). Next, it was measured under the plant canopy, where the variations of three types of shading plants were higher (1644.0 Lux), which was followed by variations of two types of shading plants (1173.0 Lux), and one type of shading plants (1139.0 Lux). For air temperature and soil temperature, variations in one shading plant were higher, namely 34.8; 33.3°C, then variations in two types of shading plants were 31.4; 31.2°C, and variations in three types of shading plants were 31.3; 30.6°C while for air humidity (RH) variations of two types of shading plants were higher (68.5%), followed by variations in three types of shading plants (68.0%) and one type of shading plants (60.7%). For maintenance pruning and production pruning, it were respectively (44% and 88%). In other words, in average, respondent farmers did not carry out pruning. Based on the results of statistical analysis, it was found that the intensity of sunlight was different in different types of shading plants.

Index Terms: Light intensity, Cocoa, Shading plant.

1 Introduction

Cocoa planting in South Sulawesi is a community-owned cocoa planting, in which about 96% is managed by the people. Soppeng Regency is one of 23 regencies in South Sulawesi which is a center for cocoa development. The constraints of cocoa development felt by farmers are now influenced by several things, namely the plants are old, so productivity decreases, the conditions of the plants are tall and lush so the fruit gets smaller and provides opportunities for pest and disease attacks. It is known that the natural environment of cocoa plants is tropical forests, so rainfall, air temperature, soil temperature, humidity and sunlight become part of the climatic factors that determine growth and production. Facts on the field indicate that the environment for growing cocoa plantations associated with microclimate such as intensity sunlight, temperature, humidity and soil temperature, soil moisture. Apart from that, the microclimate is closely related to plants in providing photosynthate, which is where the cacao plant is a C3 plant and its growth requires shading plants. In addition, the application of P3S (fertilization, pruning, frequent harvesting, sanitation) is not implemented by GAP (Good Agricultural Practices) which is something that must be implemented.

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Young cocoa plants require approximately 25-60% of sunlight intensity to full light intensity, and for mature cacao plants, for optimum production, it requires approximately 50-70% of sunlight intensity (Abdoellah and Soedarsono, 1996; Prawoto, 2012) Sun irradiation is an important energy source for the life of creatures on this earth. It is also one of the important weather parameters to be measured. The fact in the field shows that farmers use various kinds of shading plants so that these differences will give a different growth environment and micro climate.

2 Objective And Use

This study aimed to identify the distribution of sunlight in various types of shading plants to cacao plants. The results of this study are expected to be useful as reference material and comparison in subsequent studies and as information material for farmers in particular and society in general, that various types of shading plants will provide different sunlight intensity so that it can provide different production.

3 Sample Determination Method

The sampling method was carried out by purposive sampling by selecting respondents who had a cocoa plant of 0.50 - 1.00 hectares with a plant age of 7-25 years. Respondents were selected as many as 10% of 250 cocoa farmers in Lilirilau Subdistrict which was one of the subdistricts which was included as cocoa development centers. Thus, there were 25 respondents for this research. Field survey was carried out from January to March 2018.

3.1 Data Collection

The data collected in this study consisted of two sources, namely primary data and secondary data. Primary data aimed to evaluate the problems of farmers in the field in an effort to increase cocoa productivity by direct interviews with farmers and filling out questionnaires. On the other hand, secondary data was obtained from the Subdistrict Office; the Agriculture Office; the Plantation Service of Soppeng Regency; and the Plantation Office of South Sulawesi Regency; Statistics Office of Soppeng Regency; Climatology, Meteorology and

Giophysics Agency of Class I Maros Climatology Station of South Sulawesi and related offices and other institutions.

3.2 Data Analysis

The data obtained from the interviews were arranged in a frequency table, then analyzed using tabulation analysis of each respondent's question results in the form of interviews and quisioner filling, then the data were used to obtain percentage which aimed to find out how many percent of farmers carried out activities, then performed statistical tests using the following formula (Arikunto, 2013; Purwanto, 2011)

The formula used:

$$X = \frac{N}{n} \times 100$$

Where: N = Number of Farmers conducting Activities,
n = Number of respondents
X = % who conducted the activities

4. General Description Of Research Locations

4.1 Geographical Location

Soppeng Regency is one of the regencies in South Sulawesi which was approximately 150 km in the north of South Sulawesi Province. Geographically, it was located between 04° 20' 21.4" South Latitude, 4° 32 North Latitude, and 119° 57' 47.4" East Longitude and was directly adjacent to the area:

- North of Sidrap Regency, South of Bone Regency
- East of Wajo Regency, West of Luwu Regency

The area and production and productivity of cocoa plantations in South Sulawesi greatly determined the level of economic growth. The area and production and productivity varied every year. For this, it can be seen in Table 1:

Table 1. *Data on the area of land, production and productivity of cocoa in South Sulawesi in 2014-2018*

Year	Area of Cocoa Land (ha)	Production (Ton)	Productivity (Kg/ha)
2014	246,233	143,237	807
2015	243,778	143,073	811
2016	240,073	152,972	868
2017	240,374	175,860	1,004
2018	240,727	200,000	1,055

Source: *Data from the Plantation Office of South Sulawesi Province*

From Table 1, it can be seen that the productivity of cocoa plants in each year has increased from the results achieved, where in 2018 the highest productivity was 1,055 kg/ha, this was still far from the desired results. Whereas the total area and production and productivity in some Sub-districts in Soppeng Regency can be seen in Table 2;

Table 2. *Data on area, production, cocoa productivity, detailed in each subdistrict in Soppeng Regency in 2016*

District	Outside the area (ha)	Production (kg)	Average Production/ha	KK
Marioriawa	1.538,80	1.070.810.00	815.00	2.344
Marioriwawo	7.044,52	4.987.418,25	920.27	8.872
Lalabata	477.60	247.050,00	730.87	908
Liliriaja	1.706,00	1.147.720,00	965,75	2.700
Ganra	443,37	112.787,00	856,29	580
Citta	1.411,74	750.067,00	911,35	1.572
Donri-donri	940,00	590.190,00	810,19	1.359
Lilirilau	5.271,89	3.438.250,00	940,54	5.338
Jumlah	18.833,92	12.344292,25	6.950,26	23.67

Source: *Data Agriculture and Plantation Office Soppeng District*

From Table 2 above, it can be seen that the most extensive planting area was Marioriwawo Subdistrict, which was 7,044.52 ha with an average production of 8,872 kg/ha. On the contrary, the smallest was Lalabata Subdistrict with an area of 477.60 ha and an average production of 730.87 kg/ha. Economically, the difference in area can be used as a difference in income and differences in the level of welfare of the population. Another thing was if it was supported by topography, soil type and favorable climate.

4.2 Climate

The climate in Soppeng Regency according to the Clarification of Schmidth and Forgusson, was classififed into type C climate with an average rainfall of 1428 mm, the rainy season lasted from April to September, while the dry season lasted from October to March. The average air temperature ranged from 24°C to 30°C and air humidity (RH) average was 68%. The amount of annual rainfall in Soppeng Regency, Lilirilau Subdistrict can be seen in Table 3;

Table 3. *Monthly Rainfall Data (mm) of Soppeng Regency, Lilirilau Subdistrict in 2015-2018*

Month \ Year	2014	2015	2016	2017	2018
Januari	196	90	143	34	76
Februari	15	85	136	222	43
Maret	97	177	314	63	59
April	200	200	412	184	173
Mei	241	113	220	253	181
Juni	218	337	204	338	280
Juli	121	11	311	60	

Agustus	56	-	57	80
September	-	-	197	101
Oktober	3	-	209	117
November	15	38	131	91
Desember	67	124	98	83
Jumlah	1229	1175	2432	1626

Source: *Climatology Meteriology Agency and Giofisika Region IV Makassar*

From Table 3, it shows the highest average rainfall in Soppeng Regency, Lilirilau Subdistrict for the last 4 years was in 2016 and the lowest average rainfall was in 2015.

5. RESULTS AND DISCUSSION

Identification of types of shading plants was closely related to the intensity of sunlight received by cocoa plants, not all sunlight that reached the surface of the plant would be absorbed by plants. Based on the results of the identification carried out in several locations, it showed that the use of shading plants varied greatly in one planting area, among others: 1) Use of one type of shading plant, Coconut (Cocus nucifera), Gamal (Gliricidia sepium), Bitti Wood (Vitex coffasus), Banana (Musa sp), White Teak (Tectona grandis L.). 2) Use of two types of shading plants in the form of Gamal and Banana; White Teak and Gamal; Coconut and Gamal; Coconut and Banana. 3). The use of three types of shading plants in the form of, Gamal, Coconut, Banana; Gamal, White Teak, Coconut; Gamal, White Teak, Banana;

Table 4. *Variations in Shading Plants and Percentage of Number of Respondent Farmers who have cocoa plantations in Lilirilau Subdistrict Soppeng Regency*

Variations in Shading Plants	Amount (People)	Percentage (%)
One Variations *)	6	24
two Variations **)	13	52
tri Variations ***)	6	24
Amount	25	100

Source: *Primary Data After Processing, 2018*

Description:

*) Coconut; Gamal; Bitti Wood; Banana; White Teak.

) Gamal+Banana;** White Teak+Gamal**;** Coconut+Gamal**;** Coconut+Banana.

***) Gamal+Coconut+Banana**;** Gamal+White Teak+Coconut**;** Gamal+White Teak+Banana**.**

Table 4. The above shows that 6 people or 24% of the respondent farmers had planting land with one type of shading plant, 13 people or 52% of the respondent farmers had planting land with two variations of shading plants and 6 people or 24% of respondents had planting land with three variations of shading plants. Pruning on cocoa plants was important because it related to the microclimate around the first place. Maintenance pruning was carried out in stages if the cocoa canopy met each other (covering each other) then it needed to be trimmed. Maintenance pruning needed to be done routinely by looking at the condition of plant growth, such as: growth of secondary, tertiary branches and chupon growth. The percentage of respondents who did maintenance pruning can be seen in Table 5.

Table 5. *Percentage and Number of Respondent Farmers on Maintenance Pruning in Lilirilau Subdistrict, Soppeng Regency.*

Maintenance Pruning	Amount (People)	Percentage %
Routine Implement	5	20
Implement	9	36
No Implement	11	44
Amount	25	100

Source: *Primary Data After Processing, 2018*

Table 5 shows that those who perform routine maintenance pruning were 5 people or 20%, carrying out routine but non-routine maintenance pruning as many as 9 people or 36% and not carrying out maintenance pruning as many as 11 people or 44%. Based on the table above, it can be seen that there were more respondent farmers who did not carry out maintenance pruning, this was because the respondent farmers did not understand and know the functions and objectives that would be achieved if maintenance pruning were carried out regularly. Maintenance pruning in cocoa plants aimed to maintain a balanced plant frame, improve air circulation, thereby increasing the ability of plants to produce. Production pruning was one of the most important pruning and aimed to regulate the sunlight entering the plant canopy at an optimum level. On this basis, it was necessary to emphasize that the object of production pruning was non-branch leaves. Referring to this basis, in carrying out production pruning, cutting large branches must be avoided. As for the percentage and number of respondent farmers who made production pruning, it can be seen in Table 6.

Table 6. *Percentage and Number of Respondent Farmers on Cacao Plant Production in Lilirilau Subdistrict, Soppeng Regency.*

Maintenance Pruning	Amount (People)	Percentage %
Routine Implement	22	88
Implement	3	12
No Implement	0	0
Amount	25	100,0

Source: *Primary Data After Processing, 2018*

Table 6 shows that those who did production pruning were 3 people or 12%, while those who did not carry out production pruning were 22 people or 88%. Based on the table above, it can be seen that there were more respondent farmers who did not carry out production pruning. This was because the respondent farmers did not understand and know the objectives to be achieved if production pruning were carried out routinely. Actually, production pruning aimed to maximize plant productivity. Production pruning was done by cutting the leaves so that they were not too lush so that sunlight was spread evenly throughout the leaf organ so that the photosynthesis process went as it should so that the plant could produce optimally. Pruning aimed to get optimal ILD. The optimal value of cacao ILD according to (Alvim et al., 1972) was 3-5, which was equivalent to photosynthesis of 3.5-5.0 mg dry material/dm^2/day or 12.8-18.2 tons/ha/year. Variations in different types of shading plants will provide different sunlight intensities, as measured by using a digital Lux meter tool either above the plant canopy or under the plant canopy of cocoa, as well as air humidity (RH)%, air temperature (°C) which were measured with Thermohygrometer and soil temperature (°C) which was measured by Psychrometer in each cocoa planting area. Measurements were made on 1) Cocoa planting with one shading plant, 2) Cocoa planting with two varieties of shading plants, 3) Cocoa planting in three varieties of shading plants. For variations in shading plants, sunlight intensity, air humidity, air temperature and soil temperature and the percentage of the number of farmers who have planting areas can be seen in table 7.;

Table 7. *Variations in Shading Crops, Sunlight Intensity, Air Humidity, Air Temperature, Soil Temperature and Percentage and Number of Cocoa Plants' Respondent Farmers in Lilirilau Subdistrict, Soppeng Regency.*

Variations in Shading Crops	Sunlight Intensity measured above the canopy (Lux)	Sunlight Intensity measured under canopy (Lux)	Air Humidity (RH) %	Air Temperature (^{0}C)	Soil Temperature (^{0}C)	Respondent Farmers (people)
One Variation	4468,8	1139,0	60,7	34,8	33,3	6
Two variations	4073,1	1173,0	68,5	31,4	31,2	13
Tri variations	4864,3	1644,0	68,0	31,3	30,6	6

Source: *Primary Data After Processing, 2018*

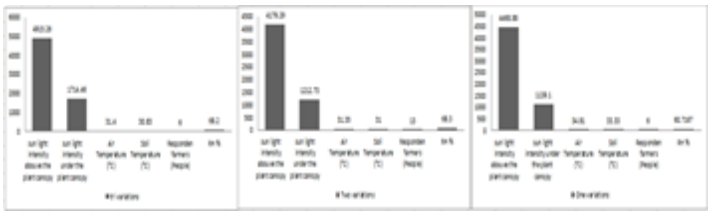

Figure 1. *Relation of Shading Plant Variation to Sun Light Intensity (Lux) Above the Canopy of Cocoa Plant, Air Humidity (RH)%, Air Temperature and Soil Temperature (°C), Percentage of Respondent Farmers in Lilirilau Subdistrict, Soppeng Regency.*

Table 7 (Fig. 1) shows that the intensity of sunlight on the three types of shading plants measured above the plant canopy was higher, namely (4864.3 Lux) then followed by one shading plant (4468.8 Lux) and two types of shading plants, namely (4073.1 Lux). Furthermore, the intensity of sunlight measured under canopy variations of three types of shading plants was higher (1644.0 Lux) followed by variations in two types of shading plants (1173.0 Lux), and one type of shading plants (1139.0 Lux). Whereas according to Peter (2011) that the intensity of sun exposure when direct irradiation in Lux units was 32,000 to 130,000 Lux. To see the relationship of variations in the type of shading plants with the intensity of sunlight above the canopy and the intensity of sunlight under the canopy (Lux), it can be seen in Figure 2.;

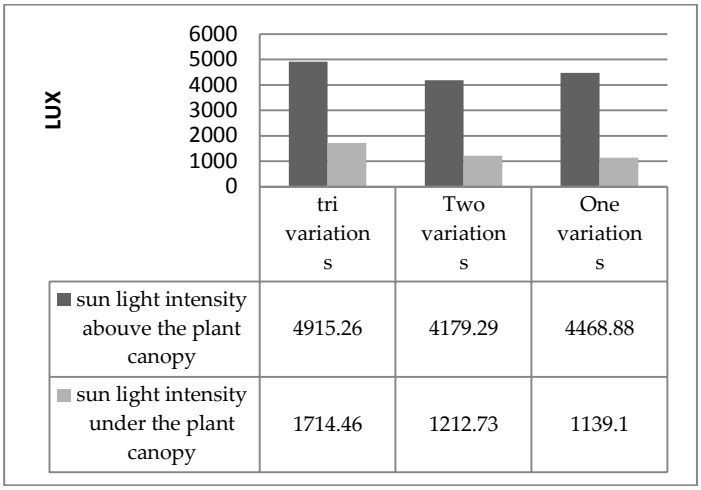

Figure 2. *Relationship of Shading Plant Variations to Air Temperature and Soil Temperature*

For air temperature and soil temperature, one shading plant was higher, namely 34.8; 33.3°C, then variations in two types of shading plants were 31.4; 31.2 °C, and variations in three types of shading plants were 31.3; 30.6 °C. To see the relationship of variations in shading plant type to air temperature, soil temperature (°C), it can be seen in Figure 3.;

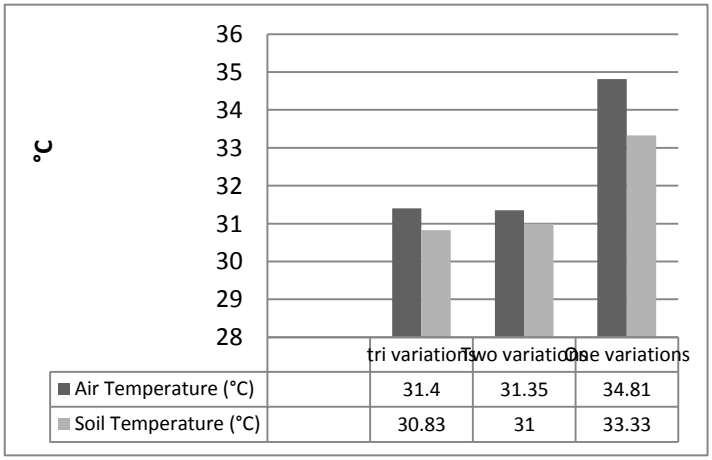

Figure.3 *Relationship of Shading Plant Type Variation to Air Temperature and Soil Temperature (°C).*

Whereas for air humidity (RH) variations of two types of shading plants were higher (68.5%) followed by one type of shading plants (68.7%) and variations of two types of shading plants (60.7%). To see the relationship between variations in shading plants and air humidity, it can be seen in Figure 4;

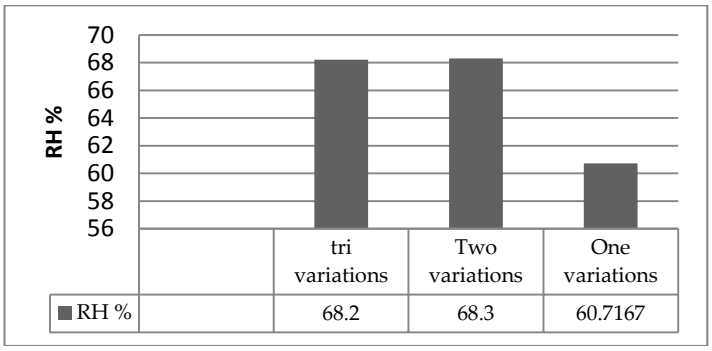

Figure 4. *Relationship between Plant Type Variation in Shading to Air Humidity (RH)%*

CONCLUSION

Variations in shading plants provided different effects on climatic factors. The highest intensity of sun light above the canopy was obtained in three variations of shading plants, namely (4864.3 Lux) then it was followed by one type of shading plants (4468.8 Lux) and two types of shading plants, namely (4073.1 Lux). Next, it was measured under the plant canopy, where the variations of three types of shading plants were higher (1644.0 Lux), which was followed by variations of two types of shading plants (1173.0 Lux), and one type of shading plants (1139.0 Lux). For air temperature and soil temperature, variations in one shading plant were higher, namely 34.8; 33.3°C, then variations in two types of shading plants were 31.4; 31.2°C, and variations in three types of shading plants were 31.3; 30.6°C while for air humidity (RH) variations of two types of shading plants were higher (68.5%), followed by variations in three types of shading plants (68.0%) and one type of shading plants (60.7%).

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