Study Of Coffee-Based Agroforestry Systems In Community Forests

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Abstract.

Climate is an important factor in the growth and productivity of coffee plants. This research aims to determine the climate conditions regarding the use of shade on the development and productivity of coffee plants. This observation was carried out on agroforestry coffee plantations in Kare District, Madiun Regency. The coffee plants observed were 4 to 6 years old, and the shade used in the observations was Gamal, Dadap, and Sengon trees. Thus, based on the results of observations carried out over four months, it was found that the highest results were in Sengon stands, with an average of 27.2-27.7°C in January and March in terms of air temperature. Meanwhile, the highest observed humidity occurred in the first month and January at 76%. The highest wind speed occurs in April at 4 -5 km/hour. The highest intensity of light produced occurs in April at 8005 LUX. The results of these observations prove that the use of shade plants does not significantly affect the production and growth of coffee plants.

Keywords: *Shade; Community forest; Agroforestry; Sengon and Climate.*

I. INTRODUCTION

Coffee is a strategic commodity with high economic value and good market prospects and contributes to increasing the income and welfare of farmers and their families [1]. The implementation of this self-sufficiency program is the establishment of coffee as a priority commodity. Data from the Ministry of Agriculture (Kementan) processed by the Indonesian Chamber of Commerce and Industry shows that Indonesia has a roadmap for producing, exporting, and consuming Indonesian coffee until 2026 [2]. In detail, coffee production will reach 793.19 thousand tons in 2022. Meanwhile, net exports will be 413.53 thousand tons. Consumption is projected at 379,655 thousand tons [3].The high contribution of coffee contributes to export materials; however, with this commodity, there are still problems with production instability, post-harvest, and storage problems. Production problems are caused by the fact that even though coffee has experienced a production surplus, this surplus does not occur throughout the year because the monthly production of this commodity extraordinarily fluctuates depending on climate/seasonality [4]. Apart from that, there are problems with post-harvest and storage management that are not good, giving rise to supply and price fluctuations. These price fluctuations reflect market symptoms that are less consistent with the influence of supply and demand for these commodities [5].Price fluctuations that are too high and unpredictable can increase price volatility.

The problem of price fluctuations and supply instability will affect the competitiveness of coffee in the world market. Efforts are needed to stabilize prices through modern agriculture, including carrying out production management of coffee seed circulation (coffee sp) [6]. According to the decree of the Minister of Agriculture of the Republic of Indonesia, Number 319/kpts/kb.020/10/2015 date: 30 October 2015 concerning the coffee commodity which plays a vital role in the Indonesian economy, namely as a foreign exchange earner, provider of employment opportunities, maintaining environmental conservation, a source of raw materials for the food and beverage industry and a source of income for farmers [7]. The application of the use of shade for the production of coffee plants (Coffea spp) in community forests is a form of modern agriculture, namely a way of optimizing agroforestry through the application of innovative and appropriate farming to produce quality coffee, both in terms of quality and quantity, as well as paying attention to the principles of continuity and sustainability [8]. This research aims to determine the climate conditions regarding the use of shade on the growth and productivity of coffee plants

II. METHODS

TThe research was carried out in an area belonging to a community forest in Kare sub-district, Madiun district, from January 2024 to December 2024 in Madiun Regency.

Fig 1. Research location: Kare District, Madiun Regency

The research used observation and interview methods and descriptive data analysis. The plants were ± 4 years old and had produced Arabica and Excelsa varieties. The primary and secondary data used in this research are primary and secondary data. Primary data was obtained by direct observation of activities implementing production certification for the circulation of coffee seeds (coffee sp) in community forest areas managed with an agroforestry system and discussions using a Focus Group Discussion (FGD) approach, which 25 coffee farmers attended. Field observations were carried out to observe the variables: (1) vegetative growth of coffee plants, (2) coffee production, (3) incidence of pest attacks, types of pests that attack coffee plants, 4) intensity of pest attacks, coffee fruit rot disease (Colletotrichum sp), for the selection of sampling points, carried out proportional purposive random sampling where data was taken randomly and evenly to represent each level of tree density based on the proportional area of community forest in Kare District, Madiun Regency.

The parameters measured for each land cover include microclimate elements such as air temperature, humidity, sunlight intensity, and wind speed. Microclimate measurements in air temperature, air humidity, sunlight intensity, vegetative growth of coffee plants, coffee production, and intensity of pest and disease attacks were carried out on each Robusta coffee plantation land cover with two data collection locations under coffee trees and in the shade. The microclimate data obtained in the form of air temperature, air humidity, and sunlight intensity are presented in tabulated form and made into graphs. The data obtained was analyzed by presenting tables and charts of the observed fluctuations.

III. RESULTS AND DISCUSSIONS

The impact of applying shade to protect coffee plants (Coffea sp) on the vegetative growth of coffee in community forests. In general, the growth conditions of coffee plants in the field are good, and their development is healthy. The impact of applying shade on coffee plants (Coffea sp) can be seen by recording the coffee production produced by farmers on the variables: (1) vegetative area of coffee plants, (2) coffee production, and (3) pests and diseases.

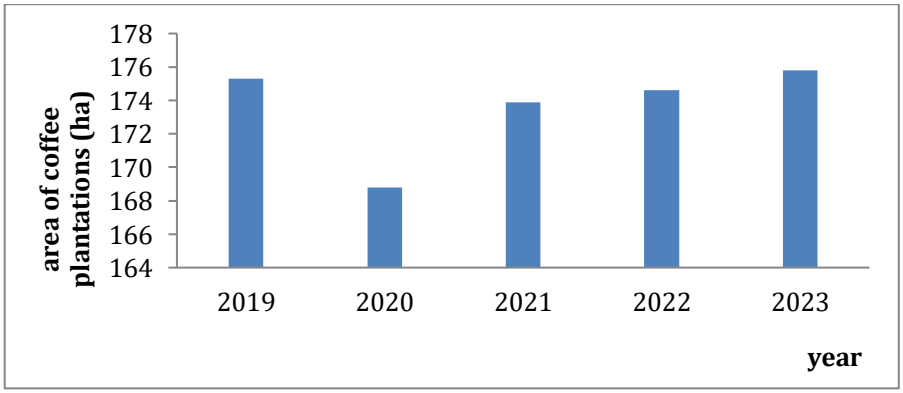

Fig 2. Area of coffee plantations in Madiun Regency 2019-2023

Mountain areas have a different microclimate from lowland areas, affecting vegetative plants' growth and metabolic processes [9]. Climatic conditions that are suitable for plants can support the plant's growth. Still, if the climatic conditions are not appropriate, they can cause the plant to experience disruption in its development. Microclimate observations under Gamal, Sengon, and Dadap shade stands in coffee plantations at various shade levels include air temperature, humidity, wind speed, and light intensity. Based on the observations of the microclimate at various shade levels, it was recorded that the microclimate in the controlled shade had an air temperature of 24.2 s. d 28.5° C, relative humidity of 55. Data can be recorded that air humidity has a significant impact on the vegetative growth of coffee plants. [10] Temperature, humidity, and light intensity can affect the physiological characteristics of coffee plants, and altitude can affect humidity levels. It can also benefit plants because they get water more easily and can reduce evaporation, impacting faster cell formation. The results of measurements on the plantation of air temperature, humidity, wind speed, and light intensity are presented in the following figure:

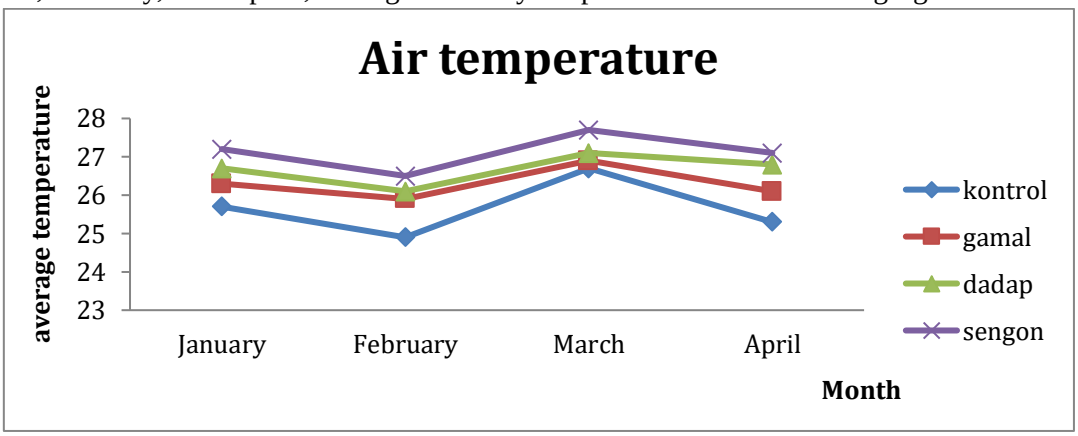

Fig 3. Temperature measurement results

Based on the analysis results in the form of a line diagram above, it can be seen that the air temperature of each shelter in the first month reached 25.5°C to 27.2°C. So, it can be concluded that there is no difference between each shade. This is influenced by the geographical location of agroforestry at the foot of a mountain where the temperature is low, so the presence or absence of shade does not significantly influence the environment around the forest. Meanwhile, the measurement of air humidity is presented in the following figure:

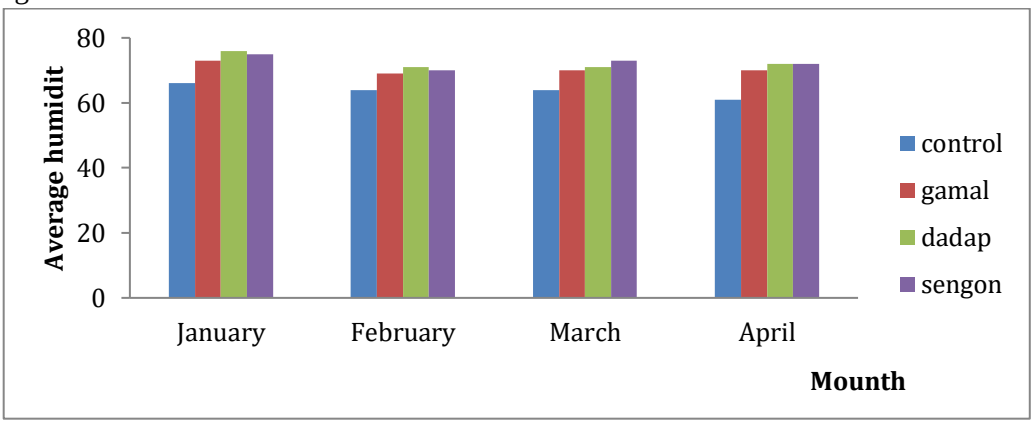

Fig 4. Air Humidity Measurement Results

Based on the results of observations show that the highest humidity occurred in the Gamal shelter in the first week, namely 71%, while for the second week, the humidity reached 62% in the Dadap shade, while in the third and fourth weeks, 71% occurred in the Sengon and control shade. Low humidity can increase the availability of nutrients for coffee plants. The lower the humidity, the better it is for the plants, so humidity greatly influences them. Shade trees can influence humidity because they can regulate air temperature and humidity and control the growth of weeds by reducing sunlight. They can absorb water during the rainy season, which aims to reduce erosion in plantation areas, prevent strong wind shocks, and prevent erosion of the soil [11]. Meanwhile, the third parameter, namely wind speed, is presented as follows:

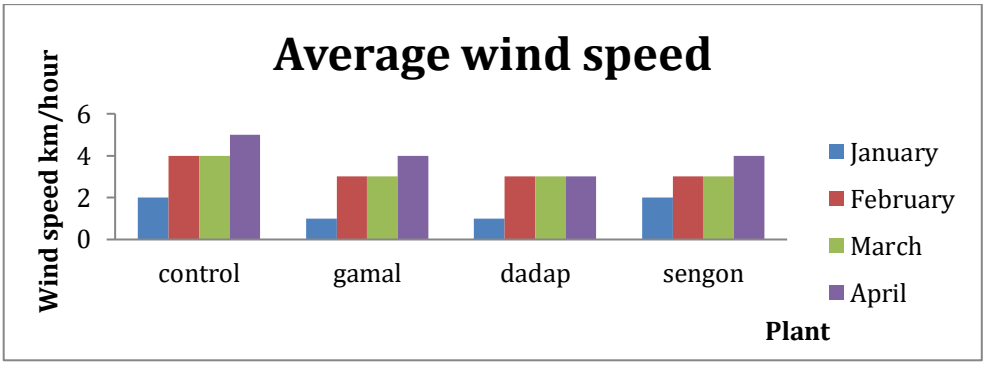

Fig 5. Wind speed measurement

Based on the results of observations of wind speed on shade plants, Gamal, dadap, sengon, and control in January and February reached 4 to 4 km/hour. In March, it reached 4.0 km/hour; in April, it was around 5 km/hour. Wind plays a role in the spread of spores and also causes various diseases in plants. Wind can affect soil temperature and humidity and is one of the factors in erosion and damage to coffee plants [12]. The measurement of light intensity is shown in Figure 6. Here

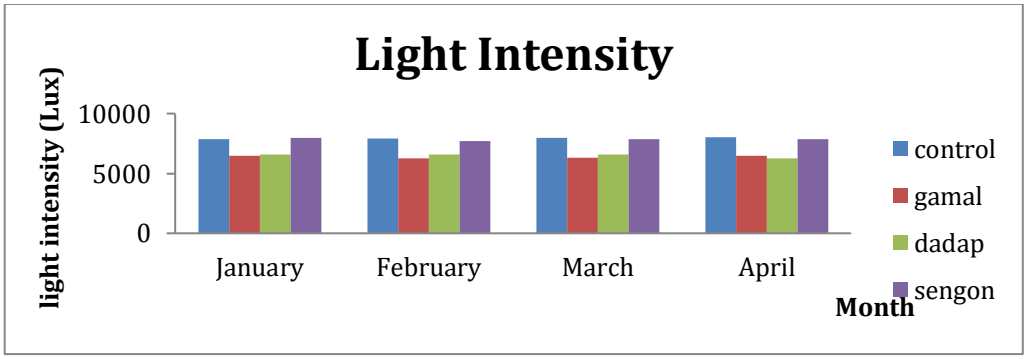

Fig 6. Light Intensity

Based on the results of observations over four weeks, the lowest light intensity occurred in the Dadap and Gamal plants in the first month, reaching 6564 Lux and 6452 Lux, while the highest light intensity occurred in the control shade plants in the first month, reaching 7854 Lux. Light intensity dramatically influences the growth and development of plants or pests on coffee plants. The higher the light intensity, the lower the intensity of attacks on coffee plants. This was stated by [13] that the higher the light intensity, the higher the air temperature around the plant. The incidence of coffee pests and disease attacks in community forests. The circulation of coffee plant seeds (coffee sp) and the incidence of disease attacks on coffee can be seen in Figure 7. The disease incidence in the field is as follows: *Hypothenemus hampei* (Fruit borer), b. *Xylosandrus sp*. (branch borer), *Coccus viridis* (green flea), *Ferrisia virgate* (white flea), *Zeuzera coffee* (stem borer), and coffee diseases such as leaf rust (*Hemilleia vastatrix*). Figure 7 pests that attack coffee plants.

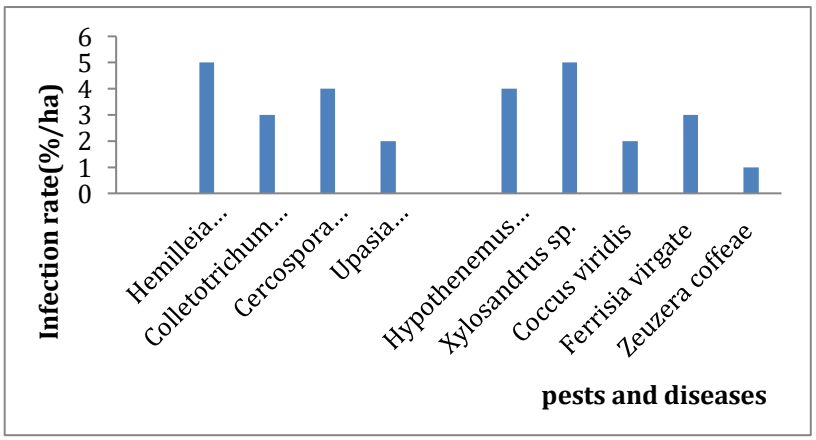

Fig 7. pest and disease attacks on coffee plants

Likewise for leaf rust (*Hemilleia vastatrix*), coffee fruit rot (*Colletotrichum sp.*), Coffee Leaf Spot (*Cercospora coffee cola*), and *Upasia salmonicolor*) with the development of climatic conditions. Figure 7. Incidence of disease in coffee plants in areas, community forests. Figure 7. The incidence of disease in coffee plants in agricultural climates with shaded staple crops is very low. This is thought to be due to the presence of Trichoderma viridae in biological fertilizers in modern agriculture, where T. viridae is an antagonistic microbe to control soil-borne diseases

IV. CONCLUSION

The observations show that the highest humidity occurs in the Dadap shelter in January, namely 76%, while in February, the moisture reaches 71% in the Dadap shelter, while in April, it is 71%. Low humidity can increase the availability of nutrients for coffee plants. The lower the humidity, the better it is for the plants, so humidity significantly influences them. Shade trees can influence humidity because they can regulate air temperature and humidity and control the growth of weeds by reducing sunlight. They can absorb water during the rainy season, which aims to reduce erosion in plantation areas, prevent strong wind shocks, and prevent soil erosion.

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