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Impact of Shading and Application of Organic Fertilizer on Sorghum Growth and Production

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Abstract. This study aims to evaluate the growth and yield of sorghum planted under coconut trees and the application of organic fertilizer. This research was conducted in Sukajaya Village, Katibung District, South Lampung from July to October 2022. Factors tested in this study: A. Shade, consisting of 1) Without shade (sorghum planted in open land without shade), 2) With shade (sorghum planted between coconut plants), B. Application of organic materials, 1) Without organic materials, 2) Providing Eco-farming fertilizer. These treatments were arranged factorially in a randomized block design with five replications. The parameters observed are plant height, number of leaves, panicle length, number of branches per panicle and productivity of sorghum. In addition, observations were also made on the quality of sorghum which included starch levels and proximate analysis of sorghum grains. The results showed that the growth of sorghum plants is more optimal if planted in open land. The shading reduced yields by about 25%. The highest sorghum yield was obtained in open land without shade and the addition of Eco-farming (8.78 t/ha). The effect of shade appears to vary on starch and proximate levels of sorghum grains.

Key words: Shading, Sorghum, Organic fertilizer

1. Introduction

Sorghum is a cereal crop that has the potential to be developed in Indonesia because of its wide adaptability, making it suitable for development on marginal land with low rainfall in Indonesia (Agustia *et al*., 2010; Siregar *et al*., 2016). In the world, sorghum ranks fifth in food crops after rice, wheat, corn, and barley (Ezward *et al*., 2019). The benefits of sorghum are also very broad such as for feed, food and industrial materials. As a cereal crop, sorghum has high nutritional content, including carbohydrates, fat, calcium, iron and phosphorus.

Indonesia is one of the countries with potential for sorghum development which can be done by extensification and intensification (Directorate of Cereal Cultivation, 2013). Sorghum (Sorghum bicolor (L.) Moench) is in the same family as other cereal crops such as rice, maize, hanjeli and wheat, and even other crops such as bamboo and sugarcane. In taxonomy, these plants belong to a

large family of Poaceae which is also often referred to as Gramineae (grasses) (Mamoudou *et al*., 2006).

It is generally known that environmental factors such as light and temperature greatly influence the growth and yield of plants, including sorghum. However, to overcome the increasing need for food and the decreasing area of agricultural land, it is necessary to optimize the use of land under of annual crops such as rubber, coconut, coffee, etc. Coconut plants as a people's plantation crop are widely planted in Indonesia. The diameter of the coconut canopy is estimated to be between 2.0-2.5 m depending on the type of coconut plant and conventional plant spacing of 8 x 8 m or 9 x 9 m (Barus, 2013).

To increase sorghum production there are several things that can be done, including by applying organic fertilizers. The use of organic fertilizer continues to increase as an alternative to reduce the use of inorganic fertilizer which is increasingly expensive. Eco-farming is one of the organic fertilizers that has been widely used to increase agricultural production. This fertilizer is made from natural ingredients that have been tested on agricultural land and show significant results. Eco-farming organic fertilizer has nutrients, consisting of macro nutrients (N, P, K), secondary nutrients (S, Ca, Mg) and micro-nutrients (Cl, Mn, Fe, Cu, Zn, B, Mo) (Noor, 2020).

Several studies have been conducted to intercrop sorghum with other food crops (Soedradjat *et al*., 2014; Kantur, 2015; Siantar *et al*., 2019). Until now, there are still few reports of intercropping of sorghum plants with coconut plants. Therefore, this research aims to determine the growth and yield of sorghum under the shade of coconut trees combined with the addition of Eco-farming organic fertilizer.

2. Materials and methods

This research was conducted in Sukajaya Village, Katibung District, South Lampung from July to October 2022. Factors tested in this study: A. Shade, consisting of 1) Without shade (sorghum planted in open land), 2) With shade (sorghum planted under and between coconut plants), B. Application of Eco-farming, 1) Without organic materials, 2) Providing Eco-farming fertilizer. Coconut plants (Kelapa Dalam variety) are more than 20 years old with a planting distance of around 10 x 10 m. These treatments were arranged factorially in a randomized block design with five replications.

First, the field is cleared of the remnants of previous plants, then hoeed or plowed 2 times after which it is harrowed and leveled. The sorghum variety used is the Bioguma 1 variety released in 2019 by the Agricultural Research and Development Agency. Planting distance 70 cm x 20 cm. The plot size for each treatment is 2 x 5 m, repeated 5 times. As a basic fertilizer, 2 tons/ha of manure fertilizer was given.

Before use, Eco-farming in the form of 30-gram brickets is fermented first by mixing 1 liter of water and coconut water for 3 days. When used, the fermented Eco-farming product is diluted again with water so that it is enough to spray 1000 m2 of land and plants. Eco-farming application was sprayed into the soil 5 days before planting, 14, 28, and 42 days after planting.

The parameters observed were plant height, number of leaves, panicle length, number of branches per panicle and productivity. In addition, observations were also made on the quality of sorghum which included starch levels and proximate analysis (water content, ash content, protein content, fat content, crude fiber content, and carbohydrate content) of the sorghum seeds produced. Analysis of sorghum quality levels was carried out at the Agricultural Product Technology Laboratory, Lampung State Polytechnic. The data of sorghum growth and yield were subjected to analysis of variance using SPSS v.18 and continued with the DMRT test. Meanwhile, sorghum quality data is analyzed in a qualitative discriptive manner.

3. Results and discussion

Based on Table 1, plants are taller and have more leaves in shaded conditions compared to open land. The response of plants to low light (shade) for each plant depends on the time of shading and the intensity of shading. Shade in this case acts as a regulator of the intensity of sunlight hitting the plants, so that it can reduce the intensity of sunlight hitting the plants. Reducing the intensity of sunlight affects the photosynthetic capacity of plants and affects the process of building biomass and

synthesizing various products used by plants in their metabolic processes. However, overall sorghum plants are more optimal if planted in open land. This can be seen from the panicle length, number of branches per panicle and yield of sorghum were higher in open land than if planted in land under the shade of coconut trees. Sorghum plants throughout their lives require full sun (Siregar *et al*., 2016).

Eco-farming has a significant effect on plant height, panicle length, number of branches per panicle. While the interaction that occurred in general, all observation components showed higher planted in open land with given eco farming (Table 1). This is because organic eco-farming fertilizer can improve soil structure and activate microbial growth so that the process of destroying organic matter runs smoothly, so that it will increase nutrient absorption which results in higher plant growth (Louto *et al*., 2022).

Table 1. The effect of shade and eco farming on plant height, number of leaves, panicle length, number of branches per panicle.

Treatments	plant height (cm)	number of leaves	panicle length (cm)	number of branches per panicle
A. Land Factor:				
1. Land without shade	250,89 a	7.65 b	22.55 a	53.35 a
2. Land with shade	274.75 b	8.55 a	19.15 b	49.05 b
B. Ecofarming factor:				
1. Without eco-farming	247.70 b	7.80 a	20.15 b	49.20 b
2. Giving eco-farming	278.85 a	8.40 a	21.55 a	53.20 a
Land Interaction X Ecofarming:				
A1B1	249.30 c	7.73 b	21.80 b	52.20 ab
A1B2	264.87 b	8.03 ab	23.30 a	54.50 a
A2B1	261.23 b	8.18 ab	18.50 ab	46.20 b
A2B2	276.78 a	8.48 a	19.80 ab	51.90 ab
CV (%)	4.89	9.53	4.35	3.14

Eco-farming fertilizer given, gives a good response to the growth of sorghum plants, this can be seen in the plant height parameters. Where the height of plants given eco-farming, has a higher plant height and was significantly different from plants that were not given eco-farming. Plant interaction with shade showed that sorghum plants given eco-farming even though planted under tall coconut trees were not significantly different from plants planted in open land both those given eco-farming and those not given eco-farming (Table 1).

Based on Figure 1, the highest sorghum yields were obtained in open fields with Eco-farming (7.48 t/ha). According to the description of the Bioguma 1 variety, its average yield is 7 t/ha (Ministry of Agriculture, 2019). So the results obtained in this research are in the range expected in the description of the variety. Giving Eco-farming increase the yield, sorghum grown on open land without eco-farming (7.16 t/ha) and yield of sorghum given eco-farming (7.48 t/ha). On land with shade, the effect of Eco-farming can be seen to significantly increase sorghum yields compared to without Eco-farming.

While the other two treatments were sorghum planted under coconut trees yielded low yields below its description, both those given eco-farming (6.82 tons/ha), even without eco-farming (6.10 tons/ha) (Figure 1). The application of organic fertilizers improves soil structure and have a positive effect on the physio-chemical properties of soil (Barus *et al*., 2023), thereby improving growth and increasing crop yields. In this study, no significant pests and diseases were found. Sorghum plants are declared more resistant to pests and diseases than other food crops (Koten *et al*., 2012).

To determine the nutritional quality of sorghum seeds produced, an analysis of starch levels and proximate levels of sorghum was carried out, which are presented in Table 2. The results of the analysis of sorghum starch levels listed in Table 2 show that no eco-farming treatment produces sorghum with higher starch levels, both on open land and on land under coconuts.

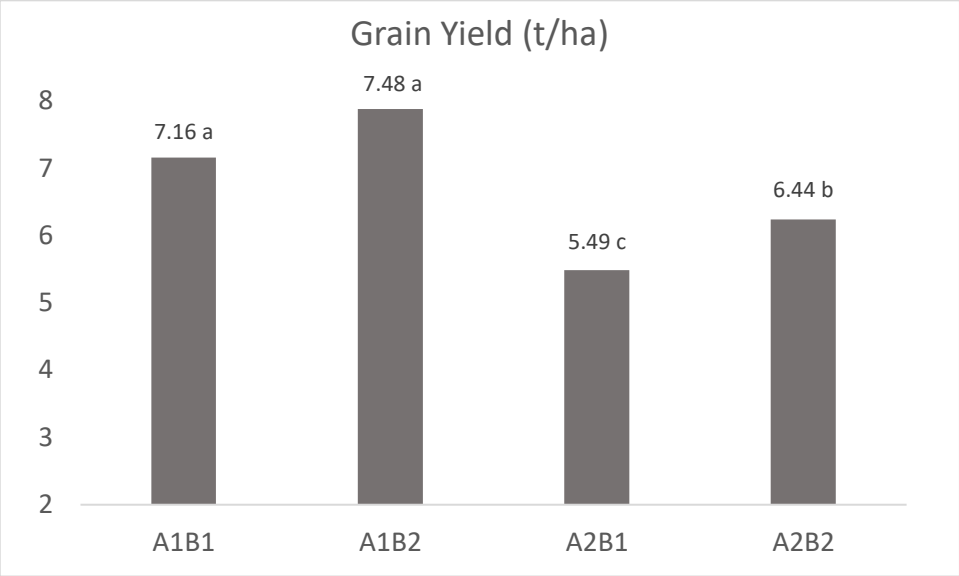

Figure 1. The interaction effect of shade and eco-farming on yield of sorghum
AE0 = Land without shade and no eco-farming; AE1 = Land without shade and with eco-farming; BE0 = Land with shade and no eco-farming; BE1 = Land with shade and with eco-farming

It is suspected that this is due to the influence of enzymes produced by microbes contained in eco-farming causing a decrease in starch levels in sorghum seeds. Some microbes contained in eco-farming fertilizers can produce amylase enzymes that play a role in the process of breaking down carbohydrates into starch and into simpler compounds (Kathiresan and Manivannan, 2006; Osman, 2011).

Table 2. Data on starch and proximate levels of sorghum

No.	Treatments	Starch	Water	Ash	Fat	Protein	Crude Fiber	Carbohydrates
		%						
1.	AE0	51,94	12,14	1,22	2,78	8,44	4,07	71,35
2.	AE1	44,68	12,14	1,35	4,10	9,12	6,76	66,53
3.	BE0	60,95	12,14	1,20	3,15	6,63	7,14	69,74
4.	BE1	34,63	12,14	1,09	2,83	5,04	5,33	73,57

AE0 = Land without shade and no eco-farming; AE1 = Land without shade and with eco-farming; BE0 = Land with shade and no eco-farming; BE1 = Land with shade and with eco-farming

If the microbes in eco-farming fertilizers produce these enzymes and the amount is significant enough in the soil used to grow sorghum, then it is likely that the starch levels in sorghum seeds will decrease. This is because the process of decomposing starch by these enzymes will convert starch into simpler compounds, so that starch levels in sorghum seeds will decrease. However, the influence of enzymes produced by microbes in eco-farming fertilizers on starch levels in sorghum seeds is indirect, because it is also influenced by other factors such as soil conditions, sorghum varieties, and other environmental factors (Svihus et al., 2005). The results of this study also showed that eco-farming on open land (AE1), produced sorghum with higher ash, fat, and protein content compared to other treatment.

Eco-farming on open land can improve the quality and quantity of sorghum crops in several ways. One of the reasons why sorghum grown with eco-farming fertilizer has higher ash content, fat content, and protein content compared to other treatments is because eco-farming fertilizer contains microbes that help improve the quality and quantity of nutrients in the soil. Microbes contained in eco-farming fertilizers can help increase the availability of essential nutrients for plants, such as nitrogen, phosphorus, and potassium.

In addition, these microbes can also help break down organic compounds in the soil into nutrients that are more easily absorbed by plants, such as amino acids and proteins. According to Taliwang (2012/, eco farming fertilizer is an organic fertilizer that can increase plant productivity, by improving damaged soil texture to meet plant nutrient needs, including in terms of pest control in plants. The increase in ash content in the resulting sorghum seeds can be caused by an increase in the availability of nutrients in the soil, especially important minerals such as calcium, magnesium, and potassium which are important components of plant ash. The increase in fat content in the resulting sorghum seeds may be due to the increased content of essential fatty acids in sorghum seeds, because some types of microbes in eco-farming fertilizers can produce essential fatty acids, such as omega-3 and omega-6, which have health benefits for humans.

The increase in protein levels in the resulting sorghum seeds can be caused by an increase in nitrogen availability in the soil. Nitrogen is an important nutrient for plant growth and development can increase the protein content in sorghum seeds. However, this can be influenced by various factors, such as soil conditions, sorghum varieties, and crop management techniques used. Therefore, further research is needed to ascertain the effect of eco-farming fertilizer on ash content, fat content, and protein content in sorghum seeds specifically. Sorghum grown under coconuts without the addition of eco-farming produced the highest fiber content compared to other treatments.

Sorghum grown under coconuts without the addition of eco-farming produces the highest fiber content due to certain factors in the growing environment that affect the fiber content in sorghum. Sorghum planted under coconuts tends to grow in drier conditions, because coconut palms have deep root systems and absorb water quickly which can reduce water availability for sorghum plants. This dry condition can affect the growth and development of sorghum plants, so that sorghum plants experience stress and respond by increasing fiber production as a defense mechanism (Purbayanti et al., 2019). In addition, sorghum grown under coconuts may experience nutrient competition with coconut plants that have high nutrient requirements. This can affect the nutrient content in sorghum, including fiber content.

4. Conclusions

1. The growth and productivity of sorghum plants is more optimal if planted in open land, but with the provision of eco-farming on sorghum plants, their growth can be maximized even though they are planted under the shade of coconut trees.
2. Sorghum plants that are not given-produce sorghum seeds with higher starch levels compared to sorghum plants that are given eco-farming, both on open land, and on land under coconuts.
3. Eco-farming on open land, resulting in sorghum with higher ash, fat, and protein content compared to other treatments.

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