Pruning and Optimization of Fertilizer Dose of Goats to the Agronomic Performance of Kaongkeongkea Coffee Plant

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ABSTRACT

Kaongkeongkea coffee is one of Indonesia's 50-year-old germplasm coffees. However, it has low production and productivity because its cultivation system has never been treated. The purpose of this study was to analyze the response of pruning and the use of goat manure doses to kaongkeongkea coffee yields and to analyze the interaction between pruning treatment and goat manure dosage. This research was carried out from December 2021 to August 2022 in Kaongkeongkea Village, Buton Regency, Southeast Sulawesi, at an altitude of 540 meters above sea level. This research was conducted in the form of a 2-factor factorial experiment. Based on a completely randomized design pattern. The first factor is pruning maintenance and production, which consists of two levels, namely, no pruning (P1) and pruning (P2). While the second factor is the dose of goat manure which consists of four levels, namely without goat manure (K1), goat manure 5 kg per plant (K2), goat manure 10 kg per plant (K3) and goat manure 15 kg per plant. plants (K4). Each treatment was repeated three times and used four sample plants, so there were 96 sample plants. Pruning on 50-year-old Kaongkeongkea coffee plants can increase the number of fresh coffee berries per cluster, the number of stumps per branch, the weight of the stump per branch, the weight of the fresh coffee cherries per branch and the weight of fresh coffee per plant. The dose of goat manure from a dose of 0 kg to 15 kg did not increase the yield of coffee plants, and there was no interaction between pruning and the dose of goat manure.

Key words: Kaongkeongkea; robusta; pruning; assimilate; sink.

Introduction

Indonesia is the fourth coffee exporter in the world after Brazil, Vietnam and Colombia ((ICO), 2022). Coffee in Indonesia has a positive role on income (Mishra & Slater, 2012), socioeconomic (Susilawati et al., 2020; Viartasiwi & Trihartono, 2020), health (Ratna Dewanti et al., 2019) and others. However, cultivated coffee is very sensitive to climate variability, extreme events (Läderach et al., 2011; Vaast et al., 2016) and low productivity (Sarmiento-Soler et al., 2020).

Indonesia has robusta coffee germplasm in almost every province. One of them is in the province of Southeast Sulawesi, Buton Regency, which is known as Kaongkeongkea coffee, with a plant age of 50 years. Kaongkeongkea coffee has a decreasing production and productivity every year. From data from Kaongkeongkea Village, Buton Regency in 2020, the yield of kaongkeongkea coffee plants was only around 200-300 kg per ha. The decrease in crop production was caused by the absence of treatment in the cultivation system. This can be seen in the condition of the agronomic performance of the kaongkeongkea coffee plant, which is too dense, a sign that it has never been done (Ratna Dewanti et al., 2019) pruning of maintenance and production; besides that fertilizer input is also not carried out. This is due to the need for more knowledge of farmers about the coffee cultivation system.

Increased production of coffee plants can be increased with intensive maintenance. Intensive maintenance includes fertilization, pest and disease control, weed control and pruning. Pruning is essential in the coffee cultivation system in order to establish a microclimate in the area of the plant canopy, facilitate the harvest process, remove unproductive shoots (dead or diseased shoots), remove shoots that lead into water shoots, and stimulate productive shoots (Baitelle et al., 2018; Filho et al., 2014, 2016; Sianturi & Wachjar, 2016). The emergence of productive shoots will increase the production of coffee plants.

Increased production through pruning can occur because the distribution of assimilate is going well. Gokavi et al., (2021) found that removing side shoots and unproductive shoots reduces plant growth and translocate nutrients to flower or fruit parts. Sunanto et al., (2019) that coffee production can be increased by fertilization and pruning. Poerwanto & Susila (2021) that plants that are not pruned for a long time cause many leaves to be shaded, thereby reducing the number of fruit formed.

Improving the quality of soil fertility in kaongkeongkea coffee plantations needs to be done through the application of organic fertilizers. One of the organic fertilizers is goat manure. Goat manure in the Kaongkeongkea area is very abundant, and this is because the average coffee farmer owns goats. However, goat manure has not been applied to kaongkeongkea coffee plants. The application of goat manure can increase soil organic matter, increase water holding capacity and increase the number of microbes in the soil (Gomiero et al., 2011; Velmourougane, 2016), improve soil physical, biological and chemical properties such as increasing soil pH, organic C content. soil (Partelli et al., 2012) CEC, reduces the amount of Fe and Al content which can increase P content, increasing enzyme activity in plant root areas (Pujianto, 2013; Wang et al., 2012). The results of research from Partelli et al., (2012) show that the application of organic fertilizer to coffee plants leads to sustainable agriculture.

Based on this description, it is necessary to conduct a study of pruning and utilization of goat manure available in the area in order to improve the agronomic performance of coffee plants and soil fertility. In addition, it maintains local wisdom with its organic attributes. The purpose of this study was to analyze the response of pruning and the use of goat manure doses to kaongkeongkea coffee yields and to analyze the interaction between pruning treatment and goat manure dosage.

Materials and Methods

Research Design

This research was conducted in the form of a 2-factor factorial experiment. Based on a completely randomized design pattern. The first factor is pruning maintenance and production, which consists of two levels, namely, no pruning (P1) and pruning (P2). While the second factor is the dose of goat manure which consists of four levels, namely without goat manure (K1), goat manure 5 kg per plant (K2), goat manure 10 kg per plant (K3) and goat manure 15 kg per plant. plants (K4). Each treatment was repeated three times and used four sample plants, so there were 96 sample plants.

Research Time and Place

This research will be carried out from December 2021 to August 2022, which is located in Kaongkeongkea Village, Buton Regency, Southeast Sulawesi Province, with an altitude of 540 meters above sea level. The coffee plant used as research material is the robusta type kaongkeongea coffee plant belonging to the farmer with a land area of ± 1 Ha.

Tools and Materials

Pruning function treatment activities, scales function to weigh goat manure and harvested coffee cherries, hand counters function to make it easier to count coffee cherries, and goat manure serves as treatment.

Research Procedure

The study used 64 Kaongkeongkea coffee plants. The plants used have the same level of uniformity. The treatments applied were pruning and giving goat manure in pruning treatment, namely by pruning twigs or branches that lead into water shoots, diseased and unproductive. As for the treatment without pruning, the coffee plants were left alone. The treatment dose of goat manure was applied according to the doses of 0, 5, 10 and 15 kg by sprinkling it in a circle in the disc area, which

was 20-30 cm from the base of the coffee plant. Goat manure is obtained from cattle pens owned by local farmers.

Observation Parameter

Observation parameters in this study are as follows:

1. Number of fruit per bunch
The result of the number of fruits per bunch is the number of fruits contained in one bunch in one productive branch.
2. Number of dompol per branch
The result of the number per branch is the number of dots that appear in one branch.
3. Bobo coffee cherries per bunch (g)
The result of coffee weight per bunch is the weight of red coffee cherries in one bunch in the productive branch.
4. Weight of coffee cherries per branch (g)
The result of coffee weight per branch is the total weight of coffee in one productive branch.
5. Weight of coffee cherries per plant (g)
The result of coffee fruit weight per plant is the weight of red coffee fruit in one plant that has just been harvested and weighed immediately.

The data were analyzed by means of variance. The separation of the mean value was carried out by using the Least Significant Difference (BNT) test at a 5% significance level.

Results and Discussion

The experimental results showed that there was a significant effect on the pruning treatment on all observation parameters, while the treatment with goat manure doses from 0 to 15 kg per plant had no significant effect on all observation parameters. There was no interaction between the pruning treatment and the dose of goat manure. This is in line with the research results of Siahaan et al., (2020) that there is no interaction between pruning treatment and organic fertilizer.

Number of Coffee Cherries per Bunch (Fruit)

Pruning treatment on Kaongkeongkea robusta coffee plants aged ± 50 years showed a significant effect on the number of coffee cherries per bunch (Table 1). Pruning coffee plants is one of the activities from the cultivation aspect, which is very important for increasing coffee production.

Table 1. Response of pruning and dose of goat manure on the number of coffee cherries per bunch (fruit).

Pruning	Dosage of goat manure (kg per plant)				Average	CV (%)
	0	5	10	15		
Non-pruning	8,33	6,67	7,67	7,00	7,42b	14,13
Pruning	15,33	17,67	16,33	17,67	**16,75a**	

Note: The numbers in the same column followed by the same letter are not significantly different at the 5% test level (BNT)

Based on the table above shows that the 50-year-old Robusta-type Kaongkeongkea coffee plants that were treated with pruning had an average number of coffee cherries per bunch of 16.75. This number was higher when compared to coffee plants that were not pruned, producing an average of 7.42 coffee cherries per bunch. Colodetti et al., (2018) reported that a low number of coffee cherries formed under dense branches and twigs. One of the factors that contributed to this was allegedly due to the low light entering the branch area.

Increasing the number of coffee cherries per bunch through pruning due to pruning can arrange productive branches to become a strong source of photosynthesis and coffee cherries into zinc. Pruning management is essential for the rejuvenation, regrowth and stability of coffee yields in plantations, with a direct influence on plant physiological processes (Filho et al., 2014). The results of the research by Sianturi & Wachjar, (2016)

showed that pruning arabica coffee plants in the Belawang garden can regulate photosynthetic competition between fruit and leaves.

Weight of Coffee Cherries per Bunch (g).

The increase in the number of coffee cherries per bunch through pruning treatment impacts the weight of the coffee cherries per bunch. This can be seen in table 2, which shows that the response to pruning treatment on coffee plants can increase the weight of coffee fruit per bunch by an average of 26.77 when compared to coffee plants that are not pruned at an average of 15.25.

Table 2. Response of pruning and dose of goat manure on coffee fruit weight per bunch (g).

Pruning	Dosage of goat manure (kg per plant)				Average	CV (%)
	0	5	10	15		
Non-pruning	15,60	14,40	15,37	15,60	15,24b	5,61
Pruning	26,03	28,17	26,47	26,40	**26,77a**	

Note: The numbers in the same column followed by the same letter are not significantly different at the 5% test level (BNT)

The weight of coffee cherries per plant increased due to the high number of coffee cherries per bunch produced. Pruning causes a change in the microclimate within the coffee tree which changes its status from a shaded one to a state that is more exposed to sunlight. Branches that are too dense will cause light competition (Andrade et al., 2014; Pereira et al., 2013). Valadares et al., (2013) reported that denser plants would take advantage of sunlight by changing the surface morphology of coffee leaves to capture light so that they produce more photosynthate for increased production.

The entry of sunlight causes the leaves to capture more light for the photosynthesis process, which will later produce carbohydrates as a source of coffee fruit formation. The research results by Pereira et al., (2013) showed that pruning of arabica coffee plants after six months of harvest produced large amounts of assimilate and carbohydrates.

Number of Dompol per Branch (Fruit)

They were pruning the 50-year-old Kaongkeongkea coffee plant by removing unproductive branches, thereby stimulating new, productive branches. New productive branches will be a solid source for producing vital zinc. This can be seen from the results of the study, which showed that a strong branch would produce a high number of dompoles. The number of stumps per branch produced was an average of 5.06 higher when compared to plants that were not pruned, which was an average of 2.91 Table 3.

Table 3. Response of pruning and dose of goat manure to the number of stumps per branch (fruit).

Pruning	Dosage of goat manure (kg per plant)				Average	CV (%)
	0	5	10	15		
Non-pruning	2,83	3,25	2,75	2,83	2,92b	11,72
Pruning	5,33	4,92	4,83	5,17	**5,06a**	

Note: The numbers in the same column followed by the same letter are not significantly different at the 5% test level (BNT)

Increasing the number of dompol per branch can increase productive branches. The process of forming flowers and fruit in the branch area of the coffee plant is determined by the productive branches of the pruning. Pruning coffee plants makes it easier for light to enter, so the branches are more accessible during photosynthesis, and the photosynthate flow is shorter. This will stimulate the formation of evenly distributed flowers and the fruit lumpy as a strong sink. Pruning coffee plants facilitates the entry of light, thereby stimulating the formation of even flower primordia, perfect flowering and uniform

coffee beans. This is in line with the results of research (Sianturi & Wachjar, 2016) that pruning will facilitate the entry of light, thereby stimulating branches to be productive in producing fruit and Fernandes et al., (2016); Rademacher (2015) added that to support coffee plants can be produced continuously. Karim et al., (2021) suggested that regular pruning is carried out in several Arabica coffee-producing countries, such as India, to facilitate harvesting.

Weight of Fresh Coffee Cherries per Branch (g)

An increase in the number of pods per branch showed a positive correlation with the weight of fresh coffee cherries per branch. The weight of fresh coffee cherries per branch treated with pruning produced an average of 130.51 grams heavier when compared to coffee plants that were not pruned, an average of 88.37 grams per branch (Table 4).

Table 4. Response of pruning and dose of goat manure on fresh coffee fruit weight per branch (g).

Pruning	Dosage of goat manure (kg per plant)				Average	CV (%)
	0	5	10	15		
Non-pruning	89,13	87,50	89,13	87,70	88,37b	2,26
Pruning	128,80	132,13	129,77	131,33	**130,51a**	

Note: The numbers in the same column followed by the same letter are not significantly different at the 5% test level (BNT)

The weight of fresh coffee cherries per branch is closely related to the number of pods per branch. This is because the number of pods formed from the pruning treatment is more, thus affecting the increase in fresh coffee cherries formed in productive branches. The formation of fresh coffee cherries in large quantities will result in heavy fresh coffee cherries in the pruning treatment. This is reinforced by the research of Fernandes (2012), that pruning can reduce competition for assimilating use between plant organs. The reduced assimilate competition indicates that each plant organ gets more assimilated, so the growth and development of plant organs, especially fresh fruit, is more optimal. The results of the study (Muliasari et al., 2021) showed that pruning treatment on arabica coffee has a very significant effect on fresh fruit yield per branch and dry yield per ha in the second harvest compared to no pruning.

Coffee Fruit Weight per Plant (g)

Table 5 shows that the pruning treatment significantly affected coffee weight per plant, with an average of 1,216 g; compared to the treatment without pruning, it yielded an average of 1,112 g. This is in line with the results of research by Karim et al., (2021) that pruning of arabica coffee plants affects increasing the weight of coffee yields per plant. The results of research by Silva et al., (2016) showed that pruning Arabica coffee that is 4.5 years old can increase productivity when compared to plants that are not pruned.

Table 5. Response of pruning and dose of goat manure on coffee fruit weight per plant (g).

Pruning	Dosage of goat manure (kg per plant)				Average	CV (%)
	0	5	10	15		
Non-pruning	1114,00	1114,00	1110,67	1111,33	1112,50b	11,72
Pruning	1215,67	1217,67	1217,67	1216,00	**1216,75a**	

Note: The numbers in the same column followed by the same letter are not significantly different at the 5% test level (BNT)

Pruning causes the plant crown to open. The open crown of the plant allows sunlight to enter, and the leaves are not shaded. The more sunlight the leaves receive, the more carbohydrates are formed in photosynthesis. Pruning results in shorter carbohydrate translocations. These carbohydrates are used for the formation and development of fruit. According to Poerwanto & Susila (2021), in trees that are left unpruned for an extended

period, the canopy is dense and limits the entry of light so that the leaves on the shaded branches photosynthesize just above the light compensation point, causing the formation of flower buds to decrease and the fruit to be of low quality.

The weight of coffee cherries per plant resulted from an increase in the number of buds per branch and fruit weight per branch. This is in line with the results of the research by Castro-Tanzi et al., (2014) that fruit weight per plant is based on the number of coffee cherries per branch, the weight of the branched coffee fruit produced and the number of productive branches per plant. The results of research by Karim et al., (2021) showed that one of the essential cultivation techniques applied to coffee farming is pruning because it can help in growing branches that produce fruit. Pruning management by removing branches that have produced 70% by replacing new, more productive branches can increase arabica coffee yields (Filho et al., 2016).

Conclusions

Pruning on 50-year-old Kaongkeongkea coffee plants can increase the number of fresh coffee berries per cluster, the number of stumps per branch, the weight of the stump per branch, the weight of the fresh coffee cherries per branch and the weight of fresh coffee per plant. The dose of goat manure from a dose of 0 kg to 15 kg did not increase the yield of coffee plants, and there was no interaction between pruning and the dose of goat manure.

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