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Arabica Coffee Plant Response to Atonic Concentration and Production Pruning

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Abstract

This research was conducted to find out the impact of Atonic concentration, pruning, and the interaction between Atonic concentration and pruning on the growth and yield of arabica coffee plants. This research was conducted in Catur Village, Bangli Regency, Kintamani District. The research was conducted for 3 months from September to November 2021. The design used in this research is a Completely Randomized Block Design with two factorially arranged factors. The first factor is Atonic concentration with 4 levels, specifically Ao: 0 ml.L-1, A1: 1 ml.L-1, 2 ml.L-1, the last one is 3 ml.L-1 while the second factor is pruning which contain of 2 levels, without pruning (Po) and with pruning (P1). Observations on the observed variables were carried out every 2 weeks. The variables observed were branch length (cm), number of leaves (strands), number of new shoots (fruit), number of flowers (buds), number of fruit (fruit), and number of the stump (bunch). The results of statistical analysis show that giving Atonic concentrations to coffee plants has a significant to a very significant effect on the variables of leaf number, number of shoots, number of flowers, number of fruits, and no significant effect on branch length and number of buds. Pruning had a very significant effect on all observed variables, but the length of the branches and the number of buds were variable, with no significant effect. The interaction between the treatment of the effect of Atonic concentration and pruning had a significant effect on the number of leaves, a very significant effect on the number of flowers and fruits, and no significant effect on the variables of branch length, number of new shoots, and number of stump.

Keywords : Arabica coffee, Atonic, pruning.

1. Introduction

Coffee is one of the main raw materials of the Indonesian horticultural industry and can be one of Indonesia's major exports and sources of foreign exchange [1]. Indonesia is one of the largest coffee producing countries in the world after Brazil, Vietnam, and Colombia. Indonesian coffee is usually divided into two types: Robusta coffee, which is the most commonly cultivated with the largest proportion (81.96%), and Arabica, which is cultivated in 18.04% of the coffee plantations in Indonesia [15]. Indonesia became the world's fourth largest coffee producer in 2017, with a total world production of 8,000 tonnes, or 639,000 per tonnes year, or 72,8 tonnes and 27.16% arabica coffee [3].

One of Bali's arabica producing areas is in the village of Catur in the Kintamani district of Bangli Regency, Bali. The total area of Kintamani is 3662 ha and 2/3 of the area can be planted with Arabica coffee. This area is a suitable place for coffee farming activities because it is following the climatic conditions and soil conditions of the commodity. In the last few years, the development of arabica coffee commodity production in Bangli Regency has decreased from 2018 to 2020, in 2018 as many as 2252 tons, 2019 as many as 2247 tons, and in 2020 as many as 2249 tons [3]. The decline in Arabica coffee production is strongly influenced by the cultivation method of farmers who have not applied cultivation technology optimally, including the pattern of pruning coffee plants and the

provision of growth regulators. Pruning is an important management practice in coffee production to achieve optimal shape and yield within 2-3 years based on good management [11].

Pruning production branches aims to get rid of unwanted branches, diseased branches, and unproductive branches [27]. Pruning is one of the cultivation techniques that must be applied because it helps in the development of branches that produce fruit. Pruning is also done to keep the plants short and make it easier for farmers to harvest [12]. In addition to paying attention to plant cultivation techniques such as pruning, increasing coffee production yields can also be assisted by the provision of growth regulators. Atonic is a synthetic growth regulator in the form of a brown liquid whose active ingredient is a nitroaromatic compound. In addition, Atonic contains small amounts of S, Bo, Fe, Mn, Zn, Cu, Mo, and Ca [7] increase the absorption of mineral compounds and regulate the concentration of Ca2+ ions in plant cells, accelerating the synthesis of organic compounds and accelerate plant growth and development [13] according to Irawati [18] the effect of pruning coffee plants can increase the percentage of the average yield of normal beans which is high and according to Suwanto [5] pruning coffee plants can make a redistribution of photosynthetic results in the form of photosynthate which is related to the number of fruit bunches which will affect higher production yields.

The provision of growth regulators aims to accelerate physiological processes in plants that allow the availability of materials to form vegetative organs, to increase the available nutrients [The content of organic nitro compounds in Atonic serves as a stimulant in physiological and metabolic processes so that nutrients in plants and absorption results can be utilized optimally and in a balanced manner. According to Cholid [25], Atonic application (ortho sodium and para nitrophenol, sodium nitro guaiacholate 5) can improve plant quality and quantity. According to Martauli [2] have shown that an Atonic concentration of 2 ml.L-1 water resulted in good plant growth and yield. Based on this, it is necessary to research to determine the appropriate Atonic concentration for the maintenance of arabica coffee plants with pruning treatment.

The purpose of this study is to investigate the effects of Atonic concentration, pruning, and the interaction between Atonic concentration and pruning on the growth and yield of arabica coffee plants.

2. Material and Methods

This study was conducted at Catur Village, Kintamani District, Bangli Regency 1250 m above sea level with a horizontal line of -8.239537° and longitude of 115.241395°. The rainfall in the Kintamani area is 2,990 mm/year, the temperature is in the range of 15-25°C with a relative humidity of 80-90%. This research was conducted from September to November 2021. The design used in this research is a Completely Randomized Block Design (RCBD) with two factorially arranged factors. The first factor is Atonic concentration with 4 levels, specifically Ao: 0 ml.L-1 , A1: 1 ml.L-1 , A2: ml.L-1 , the last one is A3: ml.L-1 while the second factor is pruning which contain 2 levels, without pruning (Po) and with pruning (P1). The coffee plants used in this study were 5 years old on average, selected from up to 24 trees, and were uniform in shape. The selected plants were 2.5 x 2.5 meters apart, plant height of 1 – 1.5 meters, average leaf width of 6 cm, and average leaf length of 14-16 cm.

Pruning coffee plants is done two or three months after harvesting is done using pruning shears. This pruning is carried out on old, unproductive primary branches, other branches that are attacked by pests and diseases, worm branches, turning branches, wild branches, and dry leaves. Furthermore, Atonic growth regulators are given which are applied first with an interval of once a month until November 2021 by spraying Atonic growth regulators that have been mixed according to the treatment given into a hand sprayer and then sprayed under and above the leaf surface. The variables

observed were branch length (cm), number of leaves (strands), number of new shoots (fruit), number of flowers (buds), number of fruit (fruit), and number of the stumps (bunch).

This study used statistical analysis of variance (ANOVA) by study design, the results of the ANOVA showed significantly ($P<0.05$) to very significant ($P<0.01$) interaction effects with treatment, and the Duncan Multi Range Test (DMRT). A single treatment with significant to very significant effects, followed by a 5% level BNT test. Correlation analysis was performed to find the close relationship between the observed variables

3. Results and Discussion

3.1 Results

Based on the results of the statistical analysis, the effects of giving Atonic concentrations and pruning and interaction (AxP) on the variables observed during the study can be seen in Table 1. Table 1 and Table 2 show the average observed variables due to the effect of interaction between the concentration of Atonic (A) and pruning (P). Tables 3 and 4 show the correlation between the variables due to the influence of the Atonic concentration and pruning.

Table1.
Significance of the effect of Atonic concentration (A) with pruning and its interaction (AxP) on coffee plant yield growth

No	Variable	A	P	AxP
1	Branch length	ns	ns	ns
2	Number of leaves	*	**	*
3	Number of new shoots	**	**	ns
4	Amount of interest	**	**	**
5	Number of fruits	**	**	**
6	Number of bunches	ns	ns	ns

Notes: *= significant effect ($P<0.05$), **= very significant effect ($P<0.01$), ns= not significant ($P\geq0.05$)

Table 2.
The average number of fruits due to the interaction effect between Atonic concentration (A) and pruning (P)

Treatment	Interaction of Atonic concentration with pruning							
	AoPo	A1Po	A2Po	A3Po	AoP1	A1P1	A2P1	A3P1
Branch length(cm)	49.33 a	49.00 a	49.33 a	49.83 a	49.83 a	49.17 a	50.00 a	49.50 a
Number of leaves (strands)	209.33 c	211.67 bc	236.67 a	238.33 a	233.00 ab	247.33 a	231.67 abc	243.00 a
Number of shoots new (fruit)	66.33 c	74.00 c	73.33 c	84.33 b	84.67 b	90.33 b	100.33 a	103.33 a
Number of flowers (buds)	23.33 e	11.00 e	37.33 b	14.67 de	15.33 cd	16.00 c	25.33 a	9.67 b
Number of fruit (fruit)	83.33 f	117.67 e	150.67 d	112.67 e	157.00 c	202.67 b	285.33 a	116.33 e
Number of the bunch (bunch)	6.33 a	6.33 a	6.33 a	6.67 a	6.33 a	6.33 a	6.33 a	6.67 a

Note: The numbers followed by the same lowercase letter mean that they are not significantly different at the 5% level of the BNT test (single effect) and the 5% level of Duncan's test (interaction effect).

The results of the statistical analysis show that giving Atonic concentrations to coffee plants had a significant effect ($P<0.05$) to very significant ($P<0.01$) on the number of leaves, number, number of new shoots, number of flowers, and number of fruit and had no significant effect ($P\geq0.05$) on branch length and number of buds. The pruning process had a very significant effect ($P<0.01$) on all observed variables except the branch length and the number of buds, with no significant effect ($P\geq0.05$). The interaction between the treatment of the effect of Atonic concentration and pruning

has a significant effect on the number of leaves ($P<0.05$), a very significant effect ($P<0.01$) on the number of flowers and fruit, and an insignificant effect ($P\geq0.05$) on the length branches, the number of new shoots, and the number of buds.

3.2 Discussion

The results of this study show that the maximum number of fruits resulting from the interaction of Atonic concentration treatment (A) with pruning treatment (P) is found in the Atonic concentration treatment of 2 ml.L^{-1} water with pruning (A2P1), specifically, 285.33 fruit, which increased by 242 % compared to the treatment without Atonic and without pruning (AoPo) corresponding to 83.33 fruits shown in Table 2. The high number of fruit planted with Atonic concentration treatment (A) is supported by a very significant correlation in the variable number of flowers (r = 0, 98**) (Table 3), while the correlation is due to the interaction effect between Atonic concentration and pruning shows a very significant correlation on the branch length variable (r = 0.54**) and a significant correlation on the number of flowers variable (r = 0.50*) which can be seen in Table 4.

The highest number of fruits produced from the interaction of treatment with Atonic concentration (A) with pruning treatment (P) was found at week 10 using Atonic concentration treatment of 2 ml.L^{-1} water with pruning (A2P1), specifically, 285.33 fruit which increased by 242 % compared to the treatment without Atonic and without pruning (AoPo) which was 83.33 pieces (Table 2). The number of fruits treated with 1 ml.L^{-1} Atonic concentration with pruning (A1P1), ie 202.67 fruits, increased by 143% compared to the treatment without Atonic and without pruning (AoPo), ie 83.33 fruits, treatment with an Atonic concentration of 3 ml.L^{-1} and pruning (A3P1), ie 116,33, was increased by 40% compared to treatment without Atonic and no pruning (AoPo), especially 83,33.

Table 3.
Correlation value between variables (r) due to the influence of Atonic concentration

	1	2	3	4	5	6
1	1					
2	0.28ns	1				
3	0.33ns	1.00**	1			
4	0.44*	-0.10ns	-0.12ns	1		
5	0.27ns	-0.09ns	-0.13ns	0.98**	1	
6	0.40ns	0.76**	0.80**	-0.53*	-0.61**	1

Table 4.
The correlation value between variables (r) due to the interaction effect of Atonic concentration with pruning

	1	2	3	4	5	6
1	1					
2	0.30ns	1				
3	0.49*	0.68**	1			
4	0.08ns	-0.04ns	-0.35ns	1		
5	0.54**	0.12ns	0.32ns	0.50*	1	
6	0.29ns	0.41ns	0.44*	-0.47*	-0.49*	1

r(0.05;22)= 0.432 r(0,01;22)= 0,537

Information:

1. Branch length
2. Number of leaves
3. Number of shoots
4. Amount of interest
5. Number of fruit
6. Number of the bunches

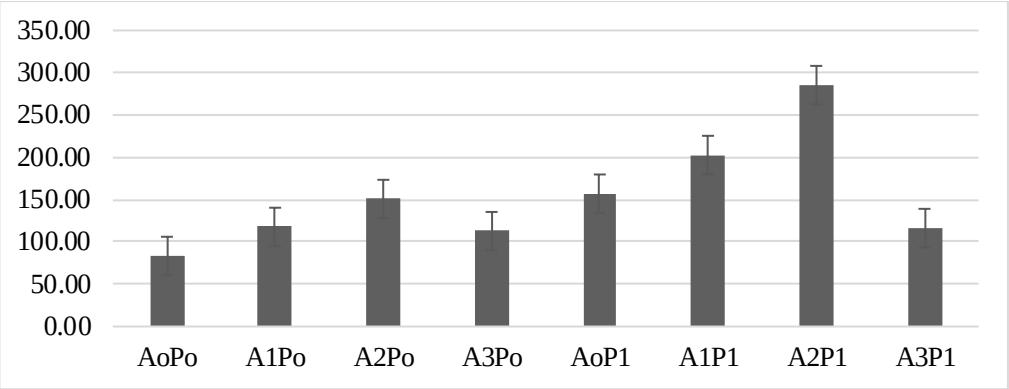

Figure 1.
The relationship between the number of fruits and the interaction of Atonic concentrations with pruning

The large number of flowers that appear can affect the fruit that is formed [28]. Atonic concentration treatment showed the best coffee fruit production when given an Atonic concentration of 2 ml.L^{-1} water (A2) because at that concentration the Atonic active ingredient was in optimum so that it stimulated more auxin. Nutrients absorbed by plants are used for plant survival in the growth process [21]. The Atonic concentration of 2 ml.L^{-1} significantly increased the fruit yield per plant per tree, the number of fruits per bunch, and the weight of fruit yield per plant [8].

Increasing the concentration of Atonic from 2 ml.L^{-1} of water to 3 ml.L^{-1} of water reduces the number of coffee plant fruit because at that concentration the active ingredients of Atonic are in a state that has passed the saturation point so that it does not respond to growth and can even inhibit plant growth. At a concentration of 1 ml.L^{-1} Atonic active ingredients are present in small quantities so that they are not optimal in the plant of growth process.

Application of PGR in large quantities can inhibit plant physiological processes [30]. Administration of auxin that is high above normal will become an inhibitor because the enzyme cannot capture that concentration, thus inhibiting growth and even death for plants [9]. Pruning treatment on coffee plants showed a higher percentage of coffee plants that were not pruned, this was because the less number of vegetative parts of the plant could help the photosynthesis process take place optimally and would produce a large number of fruit [10]. Morphologically, coffee cherries appear on primary, secondary, and tertiary branches, so pruning needs to be done [19].

Pruning is done to increase plant yields by utilizing solar energy for photosynthesis, which plays a role in plant growth and development [20]. Pruning aims to reduce evaporation, shorten trees, promote air and light intrusion [21], and increase crop yields as light intensity increases [22]. Sunlight is the main source of energy in the process of photosynthesis. The energy absorbed by the leaves is 1-5% while the rest is released through transpiration [23].

Young plants store more food, especially carbohydrates, which will be used as the main ingredient for flower formation [24]. Pruning can optimize the number of branches, according to Cholid [25] and Zamzami [26] the more the number of productive branches produced, the more fruit and seeds produced. In addition, pruning is done to reduce the number of leaves so that the leaves can take advantage of sunlight, CO_2, water, and space to grow optimally [27]. Coffee leaves will become wider and thinner if the light intensity received is too little, this condition certainly affects the quality of the leaves when the photosynthesis process takes place [31]. The increase in the number of leaves has a close relationship with the amount of coffee fruit production [17]. Plants that receive pruning treatment become more productive because, in the generative phase, almost all of the photosynthesis results will be used in the formation of flowers and fruit [30]. The rate of photosynthesis is influenced by several factors, one of which is the increased need for sinks. The increase in the sink is directly proportional to the rate of photosynthesis, the higher the sink, the higher the rate of photosynthesis.

This is because plants need photosynthetic products to meet the needs of vegetative and generative growth of plants according to the source and sink theory [31]. The definition of source in physiology means the source, producer, and exporter of photosynthate. The ability of plants to produce photosynthate (source), distribute photosynthesis to sinks, and convert photosynthesis into plant products [32].

4. Conclusion

The best treatment of Atonic concentration for the growth and yield of coffee plants was found at a concentration of 2 ml.L-1 of water. The pruning treatment had a very significant effect on all variables except the length of branches were not affected by the treatment. The interaction between Atonic concentration and pruning treatment gave a very significant effect on the variable number of flowers and the number of fruit, a significant effect on the variable number of leaves and an insignificant effect on the variable length of branches, the number of new shoots and the number of buds.

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