OPTIMIZING MATURE COCONUT WATER APPLICATION ON THE GROWTH AND CHEMICAL PROPERTIES OF THE PLANTING MEDIUM FOR ARABICA COFFEE SEEDLINGS

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ABSTRACT

Seedling is the initial stage of coffee cultivation. The use of inorganic fertilizers during nursery will require its costs. Fertilization cost efficiency can be achieved by finding alternative sources of nutrients. Coconut water derived from shredded coconut waste contains nutrients and growth hormones. This experiment aims to determine the effect of the method and frequency of coconut water application on the growth and chemical properties of Arabica coffee seedling planting media. The experiment was conducted in the Ciparanje experimental field, Faculty of Agriculture, Unpad, from April to August 2021. The experiment used a randomized group design (RAK) with nine treatments and repeated three times. The treatments used were urea fertilizer and coconut water application through the soil (twice a week, once a week, once every two weeks, once every three weeks) and through plants (twice a week, once a week, once every two weeks, once every three weeks). The experiment results showed that the three-weekly application of coconut water to the soil generally had the best effect on plant height and leaf number, and the once-weekly application of coconut water consistently had a favorable effect on the chlorophyll index. There was an increase in total N, available P, total P, and K_2O due to coconut water application, which maintained the pH of the planting medium.

Keywords: Coffea; Coconut water; Seedlings; Waste

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INTRODUCTION

Coffee is a commodity that is in high demand these days. The global coffee demand is growing and recovering from the impact of the Covid-19 pandemic (International Coffee Organization, 2021). Many outlets provide coffee drinks in various varieties. Coffee drinks come from coffee beans after a series of cultivation, harvest, and post-harvest activities. Coffee bean qualities are determined by the coffee species, the harvest, and the post-harvest processes accompanying it. The coffee species widely cultivated in Indonesia are Robusta and Arabica coffee. Arabica coffee has advantages such as lower caffeine levels than Robusta, so the taste is not as bitter as Robusta coffee. Robusta coffee contains more caffeine, 1.6 - 2.4%, almost double that of Arabica coffee, which only contains 0.9 - 1.2% (Kuncoro et al., 2018). However, both Arabica coffee and Robusta coffee have their consumers. Another difference between Arabica coffee and Robusta coffee is the altitude at which they are grown. Arabica coffee is generally grown in the highlands, while Robusta coffee is grown in the lowlands. The altitude for Robusta coffee ranges from 100 – 600 meters above sea level, and Arabica ranges from 1,000 – 2,000 meters above sea level (Noraini et al., 2024).

Arabica coffee, which is generally grown in the highlands, requires special cultivation techniques so that it is not susceptible to disease. Traditional species of Arabica coffee (*Coffea arabica*) are susceptible to coffee leaf rust (CLR, *Hemileia vastatrix*) and coffee berry disease (CBD, *Colletotrichum kahawae*) (Vossen, et al., 2009). Coffee cultivation techniques start with the selection of coffee seeds. Seed breeders have produced many coffee seeds. Superior seeds must be planted and maintained correctly to produce quality seedlings that can produce maximum yields when planted in the field. Therefore, seedling management, such as fertilization, is an activity that needs to be considered to obtain quality seedlings. Improving seedling physical quality can be done in the short term, mainly by applying the appropriate cultural practices when seedlings are tended in the nursery (Gregorio et al., 2021).

The media commonly used in coffee nurseries is a mixture of soil and organic materials. However, additional inorganic fertilizers are still needed to fulfill nutritional needs while in coffee nurseries, and based on the Minister of Agriculture Regulation, Number 49/Permentan/OT.140/4/2014, coffee seedlings aged 3-8 months are given 2 g Urea. Urea is given once every 2 weeks, if in the form of a solution with a concentration of 0.2% as much as 50-100 mL/seedling/2 weeks.

The addition of nutrients, apart from fertilizers, can also be used from other materials that contain nutrients for growth, including coconut water. Coconut water contains macronutrients, micronutrients, and growth hormones. Rosniawaty et al. (2020a) revealed that coconut water contains elements of N, P, K, Na, Ca, Mg, Organic C, Fe, Zn, Cd, B, S, IAA, GA3, Zeatin, cytokinin, and ABA. Several studies have shown the effect of coconut water on plant growth. In immature tea plants, giving 50% coconut water increases stem diameter, number of leaves, shoot length, and number of shoots (Rosniawaty et al., 2018). Furthermore, in tea plants after the second centering in the lowlands, the results of (Rosniawaty et al., 2020b) showed that the application of 50% coconut water and 120 ppm BAP increased the number of branches to 17.16 and 17.67, respectively, and 50% coconut water increased leaf area. Research on cocoa seedlings showed that 50% coconut water concentration is the optimum concentration for better dry matter accumulation and can be an alternative fertilizer for cocoa seedlings (Rosniawaty et al., 2021).

Coconut water is an organic material containing nutrients and growth hormones in liquid form, so its application can be through the soil or the leaves. The advantage of application through the leaves is that nutrients can quickly enter the plant compared to application to the soil, which takes time to absorb. Patil and Chetan (2018) said plants can absorb essential elements through their leaves, stomata, and epidermis. Foliar fertilization is considered better for maximizing the quality and yield of crops (Naz et al.,2022). However, the disadvantage is that it is difficult to determine the appropriate dose of fertilizer. The direct application technique to the soil or leaking method can fulfill the availability of nutrients in the soil, air conditions, and soil moisture are maintained, allowing plant roots to absorb water and nutrients effectively.

The frequency of application is also one of the most important things because the more coconut water is applied, the more it may have adverse effects and additional costs. The research on cocoa seedlings showed that applying coconut water once every 21 days to the plants and to the soil affected the height of the seedlings at the age of 12 MSA (weeks after application) and the diameter of the stem at the age of 8 MSA. However, the application method

and interval did not affect cocoa seedlings' number of leaves and chlorophyll index (Rosniawaty et al., 2021b). In cacao seedlings, the results showed that the application of mature coconut water through the leaves at a dose of 100 mL consistently increased the height, chlorophyll content index, and root volume of cacao seedlings (Rosniawaty et al., 2024). Meanwhile, the dose to the soil of 525 mL had the best effect on plant height and root volume of cocoa seedlings.

There have been few studies on the method and interval of coconut water application in plantation crops, especially in Arabica coffee plants. This study aimed to determine the effect of the method and frequency of coconut water application on the growth of Arabica coffee seedlings and look at the chemical properties of planting media after being given coconut water.

MATERIALS AND METHODS

The experiment was conducted at Ciparanje Experimental Field, Faculty of Agriculture, Padjadjaran University, Sumedang Regency, with an altitude of ±750 meters above sea level, with rainfall type C according to Schmidt-Ferguson (Schmidt-Ferguson, 1951). The experiment was conducted from April 2021 to August 2021.

The materials used in this study were 4-month-old Arabica coffee seedlings using planting media in the form of soil and cow manure in a ratio of 2:1, mature coconut water, urea fertilizer, Polybags measuring 20 x 25 cm, and insecticides with the active ingredient fipronil for pest and disease control. The equipment used was a ruler, a digital vernier caliper, a chlorophyll content meter (CCM-200 Plus), name tags, stationery, and measuring cups.

The design used in this research is a Randomized Block Design (RBD) consisting of 9 treatments with three replications, and each replication consists of three plants, which is a total number of 81 plants. The treatments applied were: A = (2g urea/2 week), B = Soil drench, twice a week, C = Foliar application, twice a week, D = Soil drench, once a week, E = Foliar application, once a week, F = Soil drench, every two weeks, G = Foliar application, every two weeks, H = Soil drench, every three weeks, I = Foliar application, every three weeks. The concentration of coconut water for each plant in each application is 50%. The 50% coconut water concentration was determined by mixing coconut water with water in a volume ratio 1:1. The volume or dose used was based on the previous day's calibration (5 mL in the first two applications and 4 mL in the following three applications).

The variables observed were plant height (measured from the base of the stem to the growing point), number of leaves (counted on leaves that have opened completely), stem diameter (calculated using a digital caliper at the height of 1cm above the surface of the media), and chlorophyll index performed on the third leaf, each sample was measured three times at the base, middle, and tip of the leaf and then the average value was taken). Each variable was measured once every 2 weeks except for the leaf area variable only at the beginning and end of the observation. Data on the chemical properties of planting medium obtained from samples of planting media after the experiment were analyzed at the Laboratory of Soil Chemistry and Plant Nutrition Unpad. Data on growth variables were analyzed using ANOVA; if there were significant differences, the data were further tested using Duncan's multiple range test at the 95% confidence level.

RESULTS AND DISCUSSION

Results

The statistical analysis showed that the application of mature coconut water has a significantly different effect on the height of coffee seedlings at all observation ages. Data from statistical analysis are listed in Table 1. It can be seen from Table 1 that, in general, treatments A (2g urea/2 weeks) and H (Soil drench, every three weeks) have higher coffee seedling height compared to treatments B (Soil drench, twice a week) and C (Foliar application, twice a weeks).

The results of the variance analysis in Table 2 showed that the application of coconut water significantly affected the growth of the number of leaves of coffee seedlings at the age of 12 and 16 MSA. At 12 MSA, Treatment H (Soil drench, every three weeks) and A (2g urea/2 weeks), and Treatment D (Soil drench, once a week) produced more leaves than Treatment C (Foliar application, twice a week), but not significantly different from other treatments. While at 16 MSA, treatment A had more leaves than treatment B (Soil drench, twice a week), treatment C (Foliar application, twice a week), treatment E (Foliar application, once a week), and I (Foliar application, every three weeks) but not significantly different from other treatments. Treatment H can consistently equal treatment A in the variable number of

leaves. In mature coconut water, cytokinin hormones can encourage the growth of the number of leaves.

The statistical analysis results (Table 3) showed an effect of mature coconut water application (through the method and frequency of application) on chlorophyll index at the age of 12-20 MSA. In general and consistently, it can be seen that treatment E (Foliar application, once a week) gives a higher chlorophyll index and equals treatment A (urea 2g/2 week).

Table 1. Optimizing the Application of Mature Coconut Water on Plant Height of Arabica Coffee Seedlings at 8–20 Weeks After Application (WAA)

Treatments	Height (cm)			
	8 WAA	12 WAA	16 WAA	20 WAA
A	13.06ab	16.42bc	20.53c	22.48c
B	11.09a	12.19a	14.72a	17.01ab
C	12.55ab	13.89ab	14.67a	14.42a
D	12.85ab	16.03bc	17.50abc	19.66bc
E	11.24ab	14.35abc	15.72ab	16.52ab
F	12.79ab	16.12bc	18.33abc	20.50bc
G	13.52ab	16.36bc	18.72abc	20.24bc
H	13.31ab	17.18c	19.59bc	21.31c
I	13.71b	16.39bc	18.33abc	20.22bc

Notes: Numbers followed by the same letter in the same column are similar according to Duncan's Multiple Range Test at the 95% confidence level.

Table 2. Optimizing of Mature Coconut Water Application on the Number of Leaves of Arabica Coffee Seedlings at Age 8–20 WAA

Treatments	Leaves Number			
	8 WAA	12 WAA	16 WAA	20 WAA
A	6.11a	6.22b	7.17c	4.50a
B	6.56a	5.33ab	4.56b	4.89a
C	5.44a	3.33a	2.00a	3.33a
D	7.78a	7.00b	5.67bc	5.28a
E	6.44a	5.33ab	4.56b	3.78a
F	7.00a	5.67ab	5.67bc	5.56a
G	6.00a	5.67ab	5.66bc	5.22a
H	6.56a	6.44b	5.45bc	5.61a

Notes: Numbers followed by the same letter in the same column are similar according to Duncan's Multiple Range Test at the 95% confidence level.

Table 3. Optimizing of Mature Coconut Water Application on Chlorophyll Index of Arabica Coffee Seedling Leaves at Age 8–20 WAA

Perlakuan	8 WAA	12 WAA	16 WAA	20 WAA
	----------(CCI)----------			
A	26.53a	22.26a	30.55d	35.29ab
B	21.14a	19.93a	22.29abc	31.43ab
C	25.65a	23.09ab	15.39a	27.2a
D	18.95a	17.27a	17.35ab	21.91a
E	25.72a	32.57b	24.91cd	44.42b
F	22.27a	20.79a	24.05bcd	27.01a
G	27.43a	23.95ab	24.74bcd	23.36a
H	22.04a	24.88ab	18.98abc	22.00a
I	22.96a	24.52ab	23.29bcd	31.87ab

Notes: Numbers followed by the same letter in the same column are similar according to Duncan's Multiple Range Test at the 95% confidence level.

Analysis of the planting media of Arabica coffee seedlings after being treated with coconut water at different doses and intervals is shown in Figure 1 and Figure 2. Based on Figure 1, soil pH decreased during the experiment. The most minor decrease in pH was found in treatment H (coconut water application through the soil every three weeks) by 0.9. The most significant pH decrease was found in treatment A (2g urea/2 weeks) by 2.09. This condition showed that applying inorganic fertilizers reduces the pH of the growing media. The total N of treatment E decreased compared to the beginning of the experiment; this is in line with the high C/N. The decrease in total N also occurred in treatment A (Figure 2). The highest total P was in treatment E, while the highest available P was seen in treatment H. The high available P in treatment H resulted in good plant growth (plant height and number of leaves). There was an increase in K_2O from all treatments compared to the beginning of the experiment.

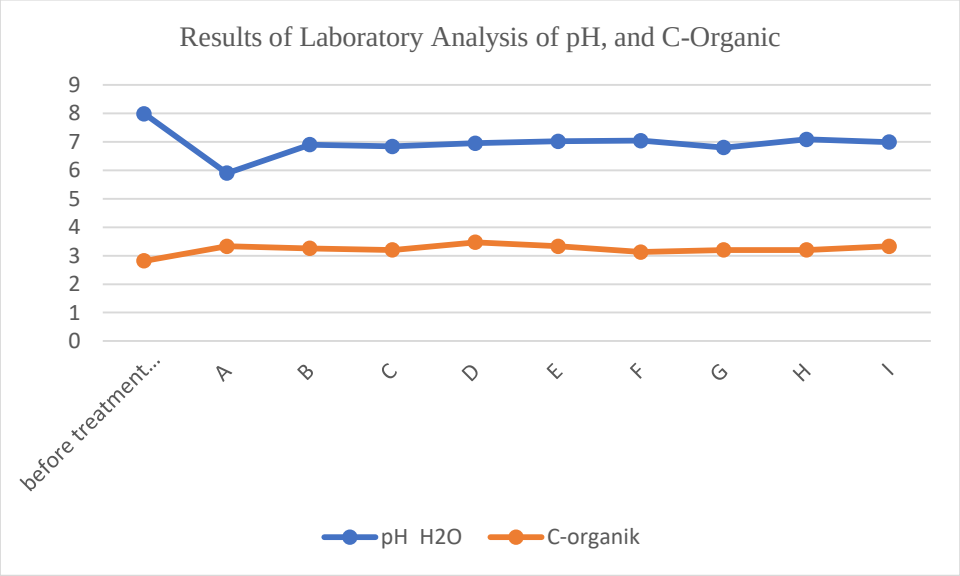

Figure 1. Results of Laboratory Analysis of Arabica Coffee Seedling Planting Media after Application of Mature Coconut Water

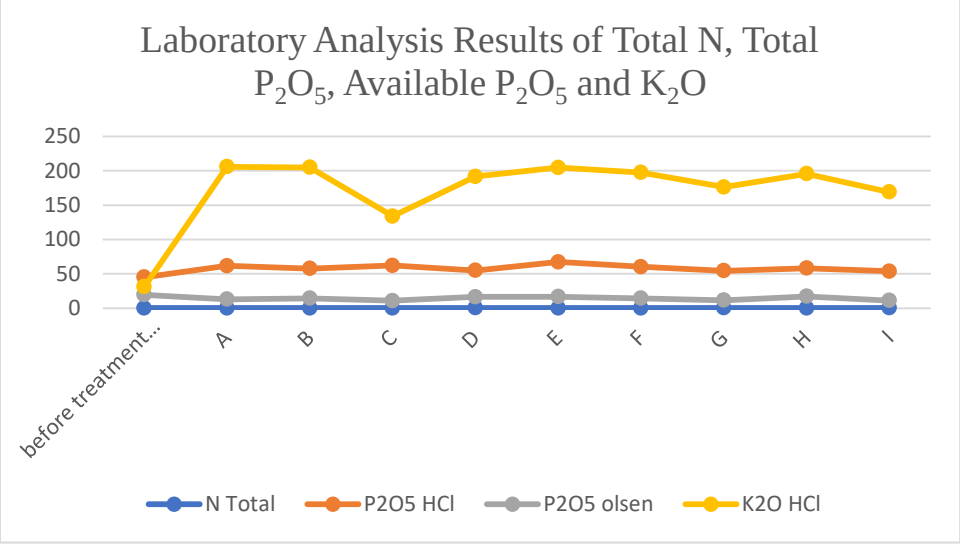

Figure 2. Results of Laboratory Analysis of Arabica Coffee Seedling Planting Media Nutrients after Mature Coconut Water Application

Discussion

The best plant height by treatment A can be caused by urea fertilizer, which has a high nitrogen content (45%), which can provide the nitrogen element needed for the high growth of coffee seedlings. Element N plays a vital role in plants' biochemical and physiological functions (Leghari, 2016), so it can support the vegetative growth of plants, especially plant height. Another case is applying coconut water once every three weeks to the soil, which can match the height growth of seedlings treated with urea because coconut water contains macro elements, microelements, and growth hormones that increase plant height, although the levels are negligible. Coconut water also contains the hormone auxin, which Jamil (2021) stated that Auxin stimulates plant cells to elongate and promotes stem elongation.

Treatment H can equal treatment A in the number of leaves; this can be caused by old coconut water containing the growth hormone cytokinin, which can help leaf formation. The frequency of application, once every three weeks, can be sufficient for the needs of leaf growth. According to (Wu et al., 2021), cytokinins affect many aspects of biological processes that affect plant growth and development, such as cell division, bud initiation and growth, phyllotaxis, and nutrient absorption. Cytokinins maintain the growth potential (pluripotency) of shoot apical meristems, which provide stem cells for generating leaf primordia during the initial stage of leaf formation (Wu et al., 2021).

It can be seen that the more frequently sprayed coconut water, the higher the chlorophyll index can increase, and the application through the leaves is quite effective in increasing the chlorophyll index. Coconut water contains N and Mg, two of the components of chlorophyll. Yousaf et al. (2021) said that Magnesium is integral to chlorophyll. Meanwhile, Wang et al. (2023) stated that Mg is involved in chlorophyll synthesis.

Applying inorganic fertilizers reduces the pH of the growing media. Shetty et al. (2019) revealed that adding urea results in soil acidification. The research results by Fageria et al. (2010) showed that soil pH decreased linearly with the provision of N through urea fertilizer.

Increasing C content can be caused by the presence of organic C in coconut water at 1.38%, so when applied to the soil once a week, it can increase the organic C content of the planting media. In line with Rosniawaty et al. (2020a), the laboratory analysis results showed an organic C content in coconut water of 1.20%. Therefore, the more often it is applied to the soil, the more organic C content of the planting media.

Urea fertilizer can decompose into ammonia (NH_3) through hydrolysis. If plants do not immediately absorb urea or decompose quickly, ammonia can evaporate into the atmosphere, resulting in nitrogen loss from the growing medium. There was an increase in total N from the beginning of the experiment in each coconut water treatment given. Increasing nitrogen can be because coconut water can also add N elements to the growing medium, given that there is N content in coconut water. Rosniawaty et al. (2021b) suggested that there is 0.018% N in mature coconut water.

Plants need the element P as an energy source for metabolism and plant growth. As stated by Kayoumu et al. (2023), Phosphorus (P) is required for plant metabolism of adenosine triphosphate (ATP), nicotinamide adenine dinucleotide phosphate hydrogen (NADPH), nucleic acids, and phospholipids, as they all have essential roles in plant growth, production, signal transduction, and photosynthesis.

Increasing potassium can be caused by coconut water containing element K. Element K is influential in N metabolism and activates dozens of essential enzymes, such as protein synthesis, sugar transport, and photosynthesis (Xu et al., 2020).

CONCLUSION

The results showed that a three-weekly application of coconut water to the soil generally affected the best plant height and the number of leaves, and a once-weekly application of coconut water consistently had a favorable effect on the chlorophyll index. There was an increase in total N, available P, total P, and K_2O due to coconut water application, which maintained the growing medium's pH.

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