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Effect of Coconut Water and Urea on Seedling of Palm Palm *(Elaeis Gueneensis Jacq)* in Pre-Nursery

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Abstract: This research aims to determine the effect of providing coconut water and urea to increase optimal growth of oil palm seedlings. This research was carried out on Medan community land in Amplas Village/Subdistrict, Percut Sei Tuan District. From April to June 2024. This research used a factorial randomized block design (CRD) consisting of 2 treatment factors with the symbol A consisting of 3 levels, namely; (A1) 300 ml/polybag (A2) 400 ml/polybag and (A3) 500 ml/polybag. The second factorial is with the symbol U which consists of 3 levels, namely; (U1) 1 g/polybag (U2) 1.82 g/polybag and (U3) 2 g/polybag. So that 9 treatments were obtained. Each treatment was repeated 3 times. The observation data was then carried out by analysis of variance using the F test at 5% level. If the difference was significant then the test was continued with the Duncan test. From the results of the research and discussions carried out, conclusions were obtained, including: 1). The coconut water treatment had no significant effect on plant height, number of leaves, leaf length and leaf area. And it has a real effect on the root volume of oil palm seedlings. 2). The application of urea dosage had a significant effect on the number of leaves, leaf length, leaf area and root volume. Good growth of oil palm seedlings according to the dosage in this research is 2g/polybag. 3). The interaction between giving coconut water and urea dosage did not have a significant effect on the growth of plant height, number of leaves, leaf length and leaf area of oil palm seedlings.

Keywords: Coconut Water; Palm Oil Seeds; Urea

Introduction

Oil palm *(Elaeis guineensis Jacq.)* is a plantation crop with high economic value because it acts as a producer of vegetable oil. In Indonesia, this commodity has an important meaning in the national economy because it is able to create job opportunities for the community and is a source of foreign exchange for the country. The ever-increasing demand for palm oil has encouraged increased production and expansion of planting areas. These conditions require the availability of seeds in large quantities and of good quality so that oil palm cultivation activities can take place optimally.

Oil palm is included in the palm family which has a higher potential for vegetable oil production compared to other vegetable oil producing plants. This commodity is also one of the raw materials for plantations which plays an important role in Indonesia's economic activities. As a non-oil and gas export commodity, palm oil makes a large contribution to the country's foreign exchange earnings, and Indonesia is even known as the largest producer and exporter of palm oil in the world (Arindra et al., 2024). Apart from that, the plantation subsector is one of the mainstays of national income, with total plantation exports in 2023 reaching 4.48% or around 27.5 million tonnes (Central Statistics Agency, 2023).

Oil palm cultivation, procurement of seeds is an initial problem that determines the success of plants in the field. The use of plant materials or seeds whose source is not clear can cause losses for the garden owner. Apart from that, the handling of seeds from the initial nursery to the main nursery cannot be ignored because the quality of the seeds greatly determines the final

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production of oil palm plants. The initial growth of seedlings is a critical period that influences the success of plants in achieving optimal growth in nurseries (Duryea, 1984; Pahan, 2012).

Oil palm seeding can be done through a one-stage or two-stage system. The one-stage system is generally only recommended if the number of seedlings managed is less than 2,000 stems, while the two-stage system is carried out through pre-nursery for a minimum of three months before the seedlings are transferred to the main nursery. The two-stage nursery system is more recommended because it allows for seed selection in the pre-nursery and main nursery phases, so that the quality of the seeds produced is more guaranteed. In the pre-nursery phase, uniform seedling growth is the main goal before the seedlings are transferred to larger polybags in the main nursery phase.

Apart from appropriate growing media, the use of growth regulators (ZPT) can also support the growth of oil palm seedlings. One natural ingredient that can be used is young coconut water because it contains ZPT which can stimulate germination and seedling growth. PGRs are organic compounds that are given externally to stimulate, inhibit, or change plant physiological processes. Auxin as a type of PGR plays a role in stimulating cell proliferation and elongation, while paclobutrazol as an inhibitor of gibberellin biosynthesis is used to control plant growth (Herani et al., 2023).

Fertilization is also an important factor in supporting the growth of oil palm seedlings because plants in the initial seeding phase need sufficient nutrients. One of the single inorganic fertilizers that is commonly used is urea, which is a fertilizer that contains the element nitrogen (N). Nitrogen is needed by plants to compile protein, chlorophyll, and support the photosynthesis process which plays a role in stimulating vegetative growth. However, nitrogen availability needs to be considered because a lack of nitrogen can inhibit plant metabolic processes, while an excess of nitrogen can cause toxicity and reduce the uptake of phosphorus and potassium due to nutrient antagonism (Cao et al., 2025).

Studies on the use of growth regulators and nitrogen fertilization are an important basis for developing oil palm nursery techniques. Herani et al. (2023) explained that ZPT plays a role in regulating plant physiological processes, especially through auxin activity which is related to cell proliferation and elongation. Nadhira et al. (2022) stated that nitrogen plays an important role in the preparation of proteins, the formation of chlorophyll, and the photosynthesis process which supports plant vegetative growth. However, studies regarding the use of young coconut water as a natural source of ZPT combined with urea doses as a nitrogen source in pre-nursery phase oil palm nurseries still need to be studied further.

Based on this description, the use of young coconut water as a natural source of ZPT and urea as a nitrogen source has the potential to support the early growth of oil palm seedlings. However, its use requires attention to the correct dosage so that it can have an optimal effect on plant growth. Therefore, this study aims to determine the effect of using coconut water and urea dosage on the growth of oil palm (Elaeis guineensis Jacq.) seedlings in the early pre-nursery seedling phase.

Method

The research was carried out on Jl. Violin No. 18, Percut Sei Tuan District, Deli Serdang Regency, North Sumatra, in May–July 2024. The materials used include oil palm seeds from Kisaran farmers, top soil, urea fertilizer, coconut water, water, 15 × 15 cm polybags, paranets, treatment signs, repeat signs, and other supporting materials, while the tools used include hoes, machetes, meters, raffia rope, knives, analytical scales, cameras, scissors, scissors, calculators and stationery. The research used a 3 × 3 factorial Completely Randomized Design (CRD) with three replications. The first factor is the dose of coconut water (K), consisting of K1 = 300 ml/polybag, K2 = 400 ml/polybag, and K3 = 500 ml/polybag. The second factor is the urea dosage (U), consisting of U1 = 1 g/polybag, U2 = 1.82 g/polybag, and U3 = 2 g/polybag. Thus, nine treatment combinations and 27 experimental plots were obtained. Each plot consisted of three plants, so the total plants used were 81 plants, with a plot area of 1 × 1.5 m, a distance between plots of 15 cm, and a distance between repetitions of 30 cm.

The research began with cleaning the area from weeds, rubbish and remaining plant roots, then continued with making shade using wooden poles and a paranet roof 2 m high in the east direction and 3 m in the west direction. The planting medium in the form of top soil is cleaned, sifted, dried for two weeks, then put into a polybag leaving 1-2 cm from the lip of the polybag. The selected oil palm sprouts are planted in a hole 1–2 cm deep with the radicle at the bottom and the plumule at the top, then covered with fine soil and watered again. Coconut water is applied after the plants are three weeks after planting at intervals of every two weeks until they are three months old according to the treatment dose. Before application, young coconut water is left for three days, then given by watering around the seedlings. Urea is given starting two weeks after planting at intervals of every two weeks until 10 weeks after planting according to the treatment, by sprinkling it on the surface of the soil in polybags in the afternoon after watering.

Plant maintenance includes watering, planting, weeding, hilling, and controlling pests and diseases. Watering is done every day in the morning and evening according to the humidity of the planting medium and rainfall. Insertions are carried out two weeks after planting by replacing abnormal, disease-ridden or dead seeds using prepared insert plants. Weeding is done by pulling out weeds around the plants, while hilling is done using top soil to cover roots that are exposed due to watering or rainfall. Pest control is carried out manually or using pesticides, while disease control is carried out after symptoms appear and accompanied by identification of the disease so that treatment is appropriate.

Observation parameters include plant height, number of leaves, leaf length, leaf width, leaf area, root volume, and leaf chlorophyll. Plant height was measured from the soil surface to the highest part of the plant from 2 to 12 weeks after planting at intervals of every two weeks. The number of leaves is calculated based on leaves that have fully opened from 4 to 12 weeks after planting. Leaf length is measured from the base to the tip of the leaf, while leaf width is measured at the center of the widest leaf. Leaf area is calculated using the formula $A = P \times L \times K$, with A as leaf area, P as leaf length, L as leaf width, and K as the oil palm leaf area constant of 0.57. Root volume was measured at 12 weeks after planting using the water volume displacement method, while leaf chlorophyll was observed at 10 weeks after planting through laboratory analysis. Data were analyzed using analysis of variance (ANOVA) according to factorial RAL, and if the treatment had a real effect, it was continued with the Duncan Multiple Range Test (DMRT) at the 5% level.

Result and Discussion

Results

Plant Height

Data on the height of oil palm seedlings at the ages of 2, 4, 6, 8, 10, and 12 weeks after planting (WAP) due to the provision of coconut water (A) and urea doses (U) are presented in Appendix 54–59, while the average plant height is presented in Table 1.

Table 1. Average height of oil palm seedlings due to the influence of coconut water (A) and urea dose (U)

Treatment	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
A1	1.98	6.94	11.14	15.70	19.89	21.39
A2	2.23	6.98	11.18	15.67	20.01	21.51
A3	2.14	7.11	11.31	16.57	20.15	21.64
U1	1.99	6.83	11.03	15.87	19.47	20.97
U2	2.34	7.34	11.54	16.30	19.90	21.40
U3	2.02	6.86	11.06	15.98	20.68	22.18

Based on Table 1, the height of oil palm seedlings increased at each age of observation. In the coconut water treatment, the highest plant height at 12 WAP was at level A3, namely 21.64 cm, while the lowest value was at level A1, namely 21.39 cm. In the urea dose treatment, the highest plant height at 12 WAP was at the U3 level, namely 22.18 cm, while the lowest value was at the U1 level, namely 20.97 cm. The results of variance analysis showed that when observing the height of oil palm seedlings, treatment A1 was not significantly different from A3, and treatment U1 was not significantly different from U3.

The growth in plant height due to the provision of coconut water is presented in Figure 1. This graph shows that the growth in height of oil palm seedlings at the age of 2-12 WAP is relatively uniform and shows almost no differences between treatment levels. However, at the age of 12 WAP, treatment A3 produced the highest plant height of 21.64 cm, followed by A2 at 21.51 cm and A1 at 21.39 cm. This shows that an increase in coconut water levels tends to be followed by an increase in plant height, although the difference between treatments is relatively small.

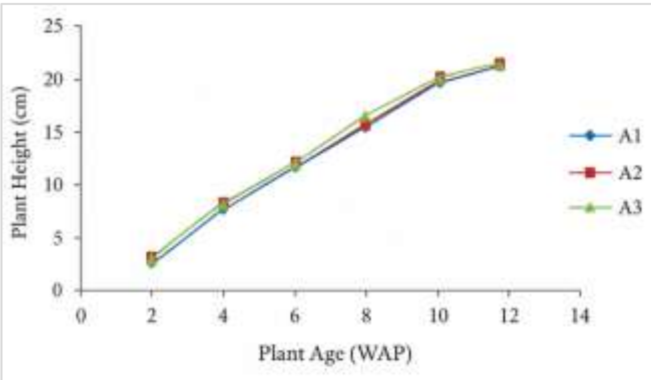

Figure 1. Graph of height growth of oil palm seedlings in coconut water treatment (A) aged 2, 4, 6, 8, 10, and 12 WAP.

The growth in plant height due to urea treatment is presented in Figure 2. The graph shows that plant height growth at the age of 2–10 WAP is relatively uniform, whereas at the age of 12 WAP the U3 treatment gives greater plant height values than U1 and U2. The highest plant height in the urea dose treatment was at the U3 level of 22.18 cm, followed by U2 of 21.40 cm and U1 of 20.97 cm. Thus, giving urea at the U3 level tends to result in better plant height growth, although the difference in values is not too large between treatment levels.

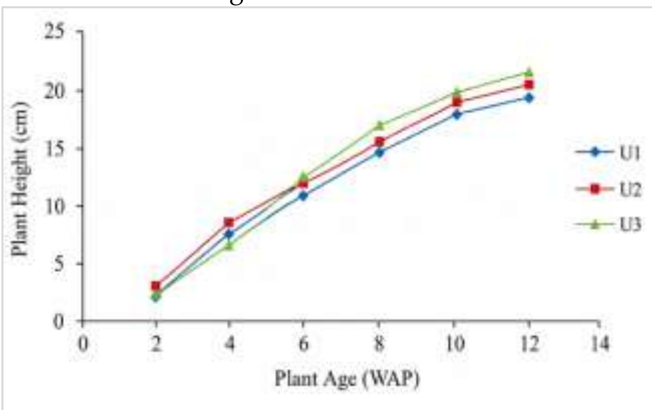

Figure 2. Graph of height growth of oil palm seedlings treated with urea (U) doses aged 2, 4, 6, 8, 10 and 12 WAP

The linear relationship between the provision of coconut water and the height of oil palm seedlings at 12 WAP is presented in Figure 3. Based on the response curve, the provision of coconut water shows a linear relationship with plant height with the regression equation y = 0.0013x + 25.504 and the value of r = 0.9994.

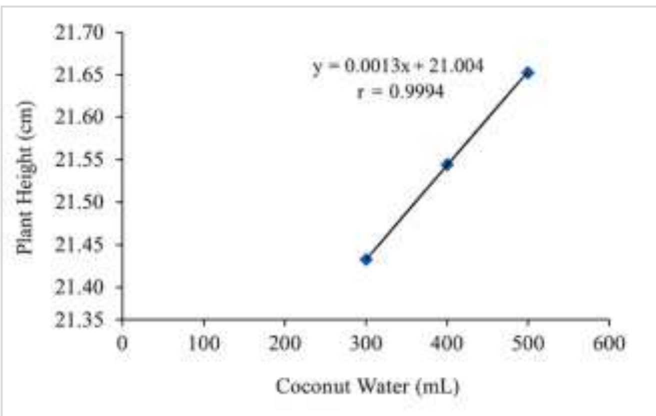

Figure 3. Response curve for the height of oil palm seedlings in coconut water treatment (A) aged 12 WAP

The linear relationship between urea dose and plant height of oil palm seedlings at 12 WAP is presented in Figure 4. The response curve shows that urea administration has a linear relationship with plant height with the regression equation y = 1.001x + 25.407 and r value = 0.756.

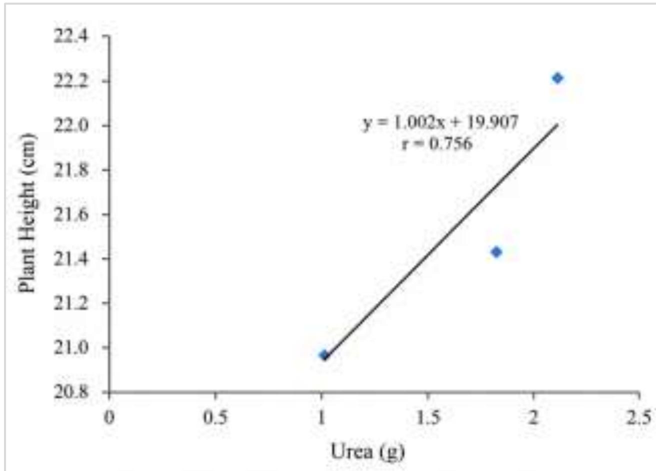

Figure 4. Response curve for the height of oil palm seedlings treated with a dose of urea (U) at 12 WAP

Number of Leaves

Data on the number of leaves of oil palm seedlings at the ages of 4, 6, 8, 10, and 12 weeks after planting (WAP) due to the provision of coconut water (A) and urea doses (U) are presented in Appendix 60-64, while the average number of leaves is presented in Table 2.

Table 2. Average Number of Leaves of Oil Palm Seed Plants Due to the Effect of Coconut Water (A) and Urea Dosage (U)

Treatment	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
A1	1.50	2.49	3.63	4.64	5.53
A2	1.61	2.54	3.68	4.69	5.57
A3	1.64	2.67	3.88	4.89	5.61
U1	1.40	2.37	3.34	4.34	5.34
U2	1.51	2.47	3.48	4.48	5.50
U3	1.84	2.87	4.37	5.40	5.87

Based on Table 2, the number of leaves of oil palm seedlings increased at each age of observation. In the coconut water treatment, the highest number of leaves at 12 WAP was at A3 level at 5.61, followed by A2 at 5.57 and A1 at 5.53. In the urea dose treatment, the highest number of leaves at 12 WAP was at the U3 level with 5.87 pieces, followed by U2 with 5.50 pieces and U1 with 5.34 pieces. The results of variance analysis showed that at the age of 12 WAP, treatment A1 was not significantly different from A3, while treatment U1 was significantly different from U3.

The increase in the number of leaves due to the provision of coconut water is presented in Figure 5. This graph shows that the increase in the number of leaves in oil palm seedlings at the age of 4-12 WAP is relatively uniform and shows almost no differences between treatment levels. At the age of 4–6 WAP, the number of leaves at all levels of coconut water treatment showed almost the same increase. Differences begin to appear at the age of 8-12 WAP, with the highest number of leaves at the A3 level. At 12 WAP, treatment A3 produced the highest number of leaves at 5.61, followed by A2 at 5.57, while A1 showed the lowest value at 5.53.

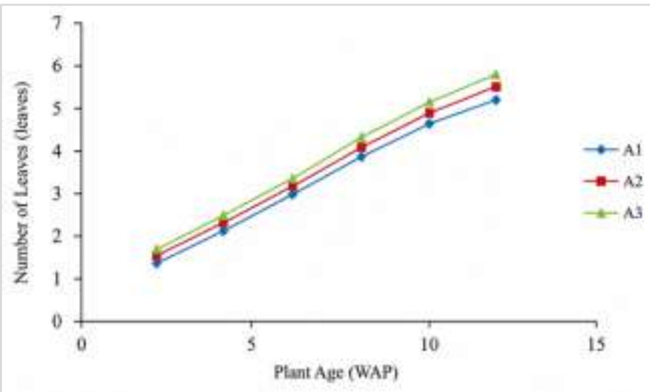

Figure 5. Graph of the increase in the number of leaves of oil palm seedlings in the coconut water treatment (A) aged 4, 6, 8, 10, and 12 WAP.

The increase in the number of leaves due to urea dosage is presented in Figure 6. This graph shows that the number of leaves of oil palm seedlings at the age of 4-12 WAP has increased at each age of observation. The U3 treatment showed the highest number of leaves compared to U1 and U2, while U1 and U2 had relatively almost the same pattern of increasing the number of leaves. At the age of 12 WAP, the highest number of leaves was at the U3 level at 5.87, followed by U2 at 5.50, while the lowest value was at the U1 level at 5.34.

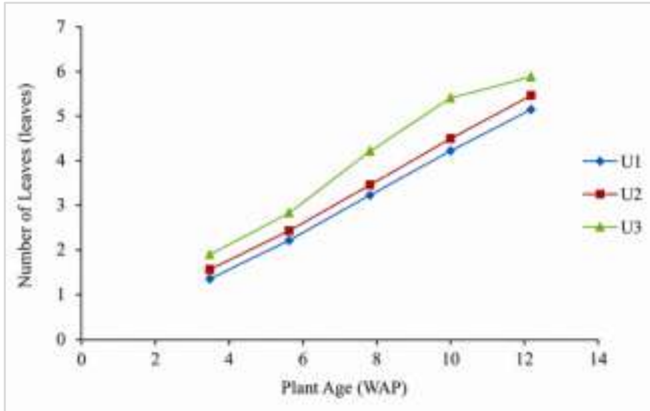

Figure 6. Graph of the increase in the number of leaves of oil palm seedlings treated with urea (U) doses aged 4, 6, 8, 10 and 12 WAP.

Leaf Length

Data on the leaf length of oil palm seedlings at the ages of 4, 6, 8, 10, and 12 weeks after planting (WAP) as a result of coconut water (A) and urea doses (U) are presented in Appendix 65–69, while the average leaf length is presented in Table 3.

Table 3. Average leaf length of oil palm seedlings due to the influence of coconut water (A) and urea dose (U)

Treatment	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
A1	1.62	3.46	5.66	7.60	11.70
A2	1.42	3.38	5.62	7.63	11.79
A3	1.53	3.42	5.63	7.66	11.79
U1	1.48	3.42	5.48	7.48	11.48
U2	1.46	3.34	5.64	7.61	11.61
U3	1.64	3.49	5.79	7.80	12.19

Based on Table 3, the length of the leaves of oil palm seedlings increases at each age of observation. In the coconut water treatment, the longest leaf length at 12 WAP was at levels A2 and A3 with the same value, namely 11.79 cm, while the lowest value was at level A1 at 11.70 cm. In the urea dose treatment, the longest leaf length at 12 WAP was at the U3 level of 12.19 cm, followed by U2 at 11.61 cm, while the lowest value was at the U1 level of 11.48 cm. The results of variance analysis showed that at the age of 12 WAP, treatment A1 was not significantly different from A3, while treatment U1 was significantly different from U3.

The increase in leaf length due to the provision of coconut water is presented in Figure 7. This graph shows that the increase in leaf length of oil palm seedlings at the age of 4-12 WAP is relatively uniform and shows almost no differences between treatment levels. Levels A1, A2, and A3 show almost the same pattern of increasing leaf length. At the age of 12 WAP, the longest leaf length was at level A3 at 11.79 cm and had the same value as A2 at 11.79 cm, while the lowest value was at level A1 at 11.70 cm.

The leaf length increase due to urea dosage is presented in Figure 8. The graph shows that leaf length increase in oil palm seedlings at each urea treatment level follows a nearly identical pattern in each treatment. At 4–10 WAP, leaf length increase was relatively uniform, while at 12 WAP, the U3 treatment showed a slight difference compared to U1 and U2. The highest leaf length was found at the U3 level at 12.19 cm, while the lowest value was found at the U1 level at 11.48 cm.

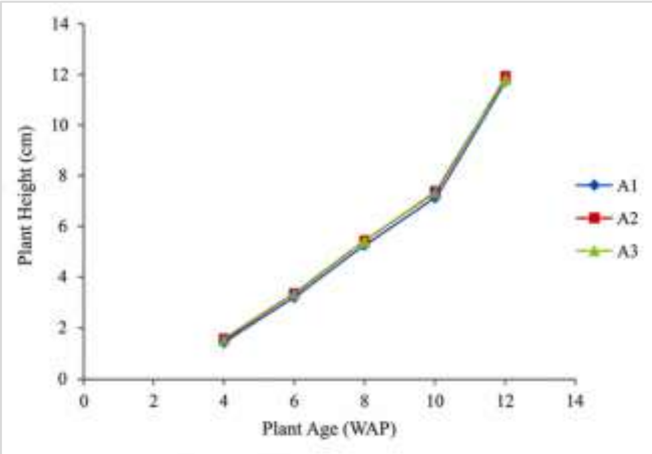

Figure 7. Graph of leaf length increase in oil palm seedlings treated with coconut water (A) at 4, 6, 8, 10, and 12 WAP.

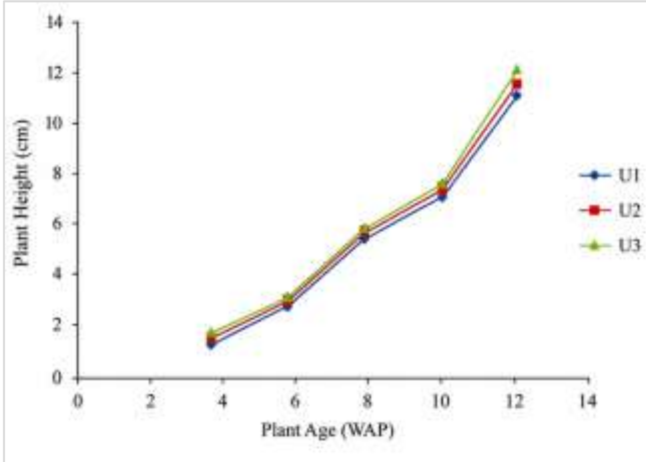

Figure 8. Graph of leaf length increase in oil palm seedlings treated with urea dosage (U) at 4, 6, 8, 10, and 12 WAP.

Leaf Width

Data on the leaf width of oil palm seedlings at 4, 6, 8, 10, and 12 weeks after planting (WAP) following coconut water (A) and urea (U) application are presented in Appendices 70–74. The average leaf width of oil palm seedlings following coconut water and urea application is presented in Table 4.

Table 4. Average Leaf Width of Oil Palm Seedlings Due to the Effect of Coconut Water (A) and Urea (U) Application

Treatment	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
A1	1.33	3.50	5.48	8.92	11.10
A2	1.22	3.50	5.71	8.91	11.11
A3	1.32	3.61	5.84	9.07	11.30
U1	1.21	3.36	5.37	8.71	10.88
U2	1.22	3.50	5.64	8.90	11.07
U3	1.44	3.76	6.02	9.29	11.57

Based on Table 4, the average leaf width of oil palm seedlings increased at the age of 4–12 WAP. At the age of 10 WAP, the widest leaf width due to the application of coconut water was at the A3 level of 9.07 cm, whereas in the urea treatment it was at the U3 level of 9.29 cm which was very significantly different from U1 and not significantly different from U2. At the age of 12 WAP, the widest leaf width due to the application of coconut water was also at the A3 level of 11.30 cm, while in the urea treatment the highest value was at the U3 level of 11.57 cm which was very significantly different from U1 and not significantly different from U2.

The increase in leaf width due to the provision of coconut water is presented in Figure 9. This figure shows that the increase in leaf width of oil palm seedlings at all treatment levels was relatively uniform at the age of 4–12 WAP. The increase in leaf width between levels of coconut water treatment had values that were not much different. At the age of 12 WAP, the highest leaf width was at level A3 at 11.30 cm, followed by A2 at 11.11 cm, while the lowest value was at level A1 at 11.10 cm.

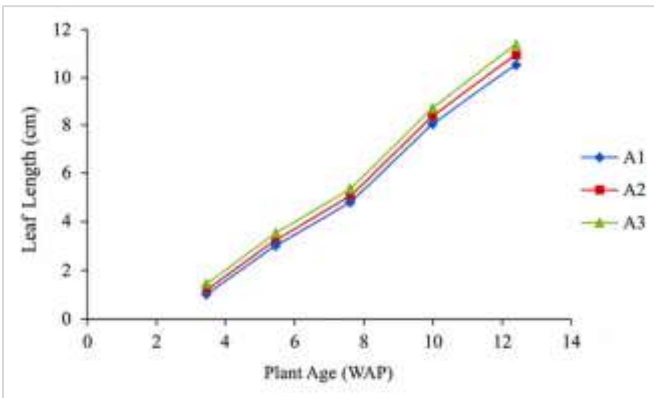

Figure 9. Graph of increase in leaf width of oil palm seedlings in coconut water treatment (A) aged 4, 6, 8, 10, and 12 WAP.

The increase in leaf width due to urea dosage is presented in Figure 10. This figure shows that the increase in leaf width of oil palm seedlings at the urea treatment level has almost the same pattern in each treatment. At the age of 6–10 WAP, the increase in leaf width at the U1 and U2 levels grew relatively evenly, while the U3 level showed a slight difference. At 12 WAP, the largest leaf width in the urea treatment was at the U3 level of 11.57 cm, while the lowest value was at the U1 level of 10.88 cm.

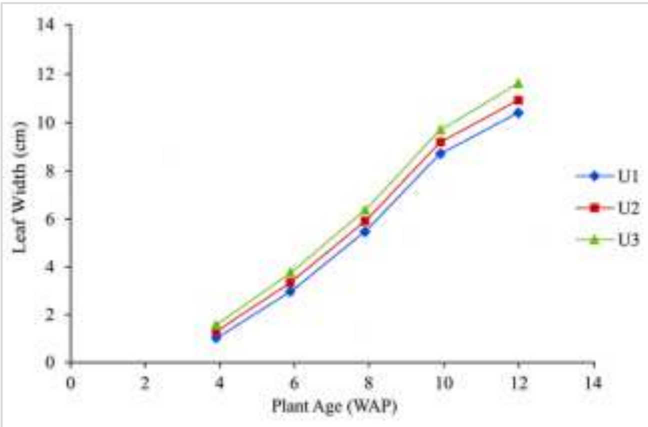

Figure 10. Graph of increase in leaf width of oil palm seedlings at 4, 6, 8, 10 and 12 WAP treatment with urea (U) doses.

Leaf Area

Measuring the leaf area of oil palm seedlings was carried out manually using the formula A = P × L × K, with A as leaf area, P as leaf length, L as leaf width, and K as the oil palm leaf area constant of 0.57 in the pre-nursery phase. Leaf area data is presented in Appendix 75–79, while the average leaf area resulting from coconut water (A) and urea dose (U) is presented in Table 5.

Based on Table 5, the leaf area of oil palm seedlings increases at the age of 4–12 WAP. In the coconut water treatment, the largest leaf area at 12 WAP was at A3 level at 76.04 cm², followed by A2 at 74.68 cm² and A1 at 74.07 cm². In the urea dose treatment, the largest leaf area was at the U3 level at 80.38 cm², followed by U2 at 73.26 cm² and U1 at 71.16 cm². The results of variance analysis showed that at the age of 12 WAP, treatment A1 was not significantly different from A3, while treatment U1 was significantly different from U3.

The increase in leaf area due to the provision of coconut water is presented in Figure 11. This figure shows that the increase in leaf area of oil palm seedlings at all treatment levels was relatively uniform at the age of 4–12 WAP. At the age of 12 WAP, the highest leaf area was at level A3 at 76.04 cm², followed by A2 at 74.68 cm², while the lowest value was at level A1 at 74.07 cm².

Table 5. Average leaf area of oil palm seedlings due to administration of coconut water (A) and urea dose (U)

Treatment	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
A1	1.24	6.92	17.71	38.67	74.07
A2	1.03	6.76	18.32	38.79	74.68
A3	1.21	7.08	18.82	39.63	76.04
U1	1.03	6.56	16.77	37.13	71.16
U2	1.06	6.70	18.18	38.63	73.26
U3	1.39	7.50	19.91	41.34	80.38

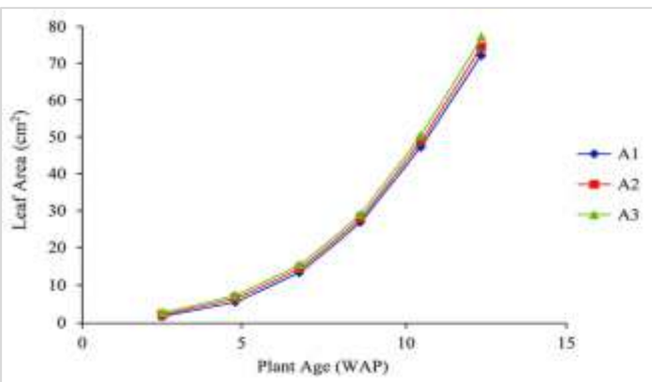

Figure 11. Graph of increase in leaf area of oil palm seedlings in coconut water treatment (A) aged 4, 6, 8, 10, and 12 WAP.

The increase in leaf area due to urea dosage is presented in Figure 12. This figure shows that the increase in leaf area of oil palm seedlings at the urea treatment level has almost the same growth pattern in each treatment. At the age of 12 WAP, the U3 level gave the highest leaf area value of 80.38 cm², while the lowest value was at the U1 level of 71.16 cm².

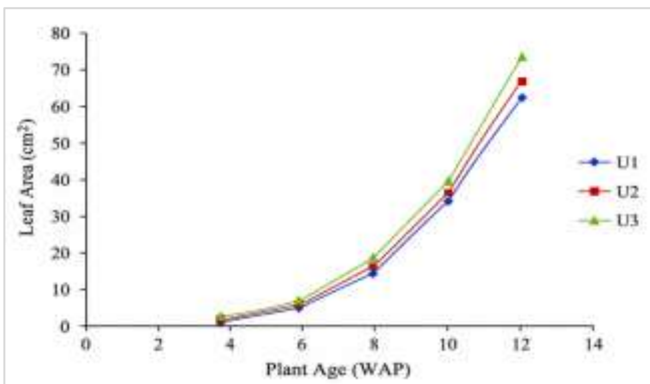

Figure 12. Graph of increase in leaf area of oil palm seedlings treated with urea (U) doses aged 4, 6, 8, 10 and 12 WAP.

Root Volume

Root volume was measured when the plants were 12 WAP or at the end of the study. Data on the root volume of oil palm seedlings resulting from the application of coconut water (A) and urea dose (U) are presented in Appendix 80, while the average root volume is presented in Table 6.

Table 6. Average root volume of oil palm seedlings due to the influence of coconut water (A) and urea dose (U)

Factor A	U1	U2	U3	Average
A1	11.07	16.27	17.53	14.96a
A2	16.73	16.83	17.53	17.03b
A3	14.67	18.10	19.13	17.30b
Average	14.16a	17.07b	18.07b	

Based on Table 6, the root volume of oil palm seedlings at 12 WAP shows the highest value in the A3U3 treatment combination of 19.13 ml, while the lowest value is in the A1U1 combination of 11.07 ml. The highest average root volume in the coconut water factor was at level A3 at 17.30 ml, while in the urea factor it was at level U3 at 18.07 ml.

The linear relationship between the provision of coconut water and the root volume of oil palm seedlings at the age of 12 WAP is presented in Figure 13. The response curve shows that the provision of coconut water has a linear relationship with root volume with the regression equation y = 0.0117x + 11.741 and the value r = 0.8341.

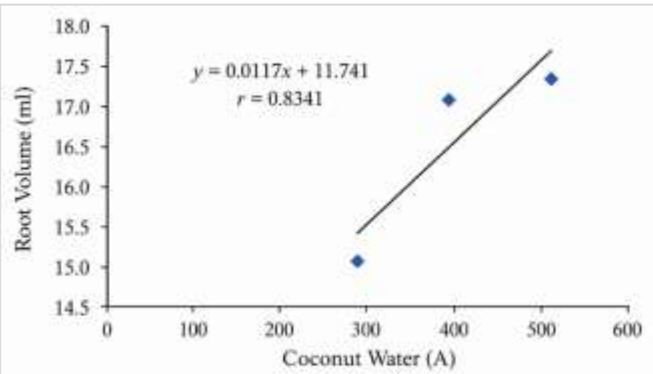

Figure 13. Root volume response curve for oil palm seedlings treated with coconut water (A) aged 12 WAP.

The linear relationship between urea dose and root volume of oil palm seedlings at 12 WAP is presented in Figure 14. The response curve shows that urea administration has a linear relationship with root volume with the regression equation y = 3.8x + 10.324 and r = 0.9938.

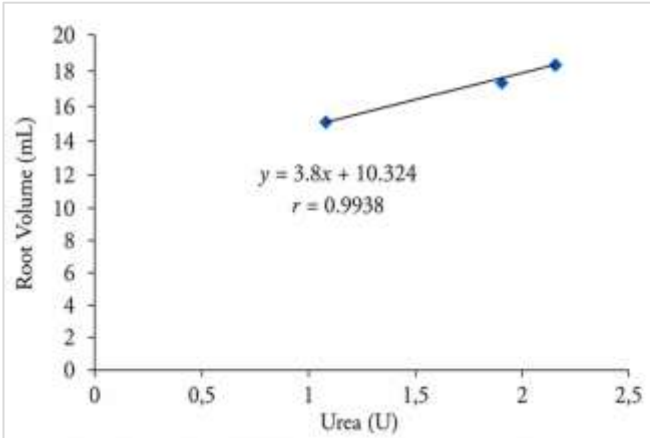

Figure 14. Root volume response curve for oil palm seedlings treated with urea (U) dose at 12 WAP.

Leaf Chlorophyll

Observations of leaf chlorophyll were carried out at the age of 10 WAP due to the application of urea (U). Leaf chlorophyll data from laboratory tests using the Arnon (1945) formula are presented in Table 7.

Based on all observed variables at 12 weeks after planting (WAP), coconut water administration showed a tendency to increase oil palm seedling growth at the A3 level, or 500 ml/polybag. This level produced the highest values for plant height, number of leaves, leaf length, leaf width, leaf area, and root volume compared to other coconut water levels. In the urea treatment, the U3 level, or 2 g/polybag, showed the highest results for plant height, number of leaves, leaf length, leaf width, leaf area, root volume, and leaf chlorophyll. Overall, the A3U3 treatment combination provided the best growth response, particularly for root volume, with a value of 19.13 ml, while the lowest value was found in the A1U1 combination at 11.07 ml. These results indicate that administering 500 ml of coconut water/polybag and 2 g of urea/polybag tends to have a better effect on oil palm seedling growth in the pre-nursery phase.

Table 7. Data on leaf chlorophyll of oil palm seedlings due to urea (U) application

Treatment	A663	A645	Dilution Factor	Chlorophyll A	Chlorophyll B	Total Chlorophyll
U1	2.282	1.707	0.2	0.487	0.568	1.055
U2	2.321	2.757	0.02	0.495	0.587	1.082
U3	2.374	2.882	0.02	0.501	0.639	1.141

Discussion

The Effect of Coconut Water on Oil Palm Seedling Growth

Based on the results of statistical analysis, coconut water administration did not significantly affect most of the observed parameters, namely plant height, number of leaves, leaf length, leaf width, and leaf area of oil palm seedlings. This is likely due to the insufficient concentration of coconut water administered to show a clear difference in growth response, resulting in relatively uniform growth of oil palm seedlings at each treatment level. Coconut water is known to contain potassium, which can stimulate plant growth. However, using concentrations that are too low or too high can inhibit growth and even be potentially toxic to plants (Viza & Ratih, 2018). Nevertheless, observations indicate that coconut water still provided a fairly good growth response at all concentrations administered.

Coconut water is an endosperm fluid that contains growth regulators, particularly auxins and cytokinins, which play a role in cell division, root and stem development, shoot elongation, and support seedling growth (Pardede et al., 2023). In this study, coconut water administration significantly affected the root volume of oil palm seedlings. These results align with research by Susanti (2011), which found that administering young coconut water to kale significantly increased root volume. The cytokinin content in young coconut water plays a crucial role in cell division and plant growth. Furthermore, cytokinins have been shown to stimulate shoot tissue differentiation and promote organogenesis, thus accelerating leaf and root growth (Asghar et al., 2023).

The Effect of Urea Dosage on Oil Palm Seedling Growth

The results of statistical analysis based on the analysis of variance test indicate that urea application significantly affected oil palm seedling growth parameters, including plant height, leaf number, leaf length, leaf width, leaf area, root volume, and leaf chlorophyll. This influence is related to the role of nitrogen as a key nutrient essential for plants, especially during the vegetative growth phase. Wang et al. (2024) stated that nitrogen is the primary factor influencing seedling height because adequate nitrogen availability can accelerate cell division, stimulate overall growth, and stimulate stem growth.

Nitrogen is an essential nutrient that plays a role in root, stem, and leaf growth. Setyati (2008) stated that adding sufficient nitrogen can accelerate the rate of cell division and elongation, resulting in faster root, stem, and leaf growth. This finding is supported by Rosmarkam & Yuwono (2002), who stated that the nutrients N, P, and K play a crucial role in supporting plant growth, improving soil physical properties, and increasing soil biological activity. Thus, the provision of urea as a nitrogen source can support the vegetative growth of oil palm seedlings in the early nursery phase.

Laboratory tests on leaf chlorophyll showed that the chlorophyll content of oil palm seedlings in each urea treatment did not differ significantly. Differences in chlorophyll content in plants can be influenced by plant age, leaf morphology, genetic factors, and physiological stage. Leaf age and physiological condition are important factors determining chlorophyll content. Chlorophyll distribution in leaves can also vary, influenced in part by leaf color. The greener the leaf, the higher the chlorophyll content. Differences in chlorophyll levels in plants can also be caused by the dominance of other pigments in the leaves or by the plant's adaptation to its environment (Dharmadewi, 2020).

Effect of the Interaction of Coconut Water and Urea Dosage on the Growth of Oil Palm Seedlings

The results of the analysis showed that the interaction between giving coconut water and urea dosage had no significant effect on plant height, number of leaves, leaf length and leaf width of oil palm seedlings. However, the interaction of the two treatments had a significant effect on root volume. The apparent lack of interaction effects on several growth parameters is thought to be caused by the young age of the seedlings and the relatively short research time, so that plant organ growth has not occurred optimally. Under these conditions, the effect of the combination of coconut water and urea does not appear to influence each other statistically.

It is thought that treatment interactions will be more visible if the plants have entered a more advanced growth phase and the observation time is longer. Hardi (2008) states that plants can develop well if the hormones and nutrients provided are available in sufficient quantities and are in a form suitable for plants to absorb. In addition, the growth and development of plants treated with growth regulators is controlled by the balance and interaction between endogenous PGR and exogenous PGR. Therefore, exogenous administration of ZPT can affect plant growth, including the development of vegetative organs such as leaves and roots (Lavender, 1984; Marlin, 2005).

Conclusion

Based on the research results, the coconut water treatment did not have a significant difference in plant height, number of leaves, leaf length, leaf width and leaf area, but had a significant effect on the root volume of oil palm seedlings. The urea treatment had a significant effect on all observation parameters, with the best growth of oil palm seedlings at a dose of 2 g/polybag. The interaction between giving coconut water and urea had no significant effect on plant height, number of leaves, leaf length, leaf width and leaf area of oil palm seedlings. Based on these results, it is recommended to carry out further research by continuing to use coconut water and urea and increasing the dose in each treatment in order to obtain more optimal results for the growth of oil palm seedlings.

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Conflicts of Interest
The authors declare no conflict of interest.

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