Increasing the Growth of Robusta Coffee Seedlings (*Coffea anephora*) Through Application of KNO_3 and Shallot Extract

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Abstract

Coffee is one of the plantation commodities that has an important role for the national economy. The dominance of smallholder plantations has made the seedling process one of the keys to the success of coffee cultivation in Indonesia. Optimal seedling growth can be obtained through a good seedling system. One of the efforts to increase the growth seedlings of robusta coffee is by giving shallot extract as a Growth Regulator because it contains auxin. In addition, the addition of KNO_3 can optimize nutrient provision. This study aims to determine the response of robusta coffee seedlings due to the application of onion extract and potassium nitrate fertilizer (KNO_3). The research was carried out in February – May 2024 at the Jember State Polytechnic Wire House using a Random Group Design Factorial (RGDF) consisting of 2 factors, the first factor was the provision of KNO_3 concentration with 3 levels of P0 treatment: 0%; P1: 0.5%; and P2: 1% and the second factor, namely shallot extract with 3 levels of treatment, including; B0: 0%; B1: 50%; and B2: 75%. The results of the study showed that there was an interaction between KNO_3 and the addition of shallot extract and affected the growth of Robusta coffee seedlings on the parameters are height, stem diameter, root length, wet weight and dry weight of robusta coffee seedlings. The treatment of KNO_3 0.5% and 75% shallot extract (P1B2) gave the best results in Robusta coffee seedlings.

Keywords: KNO_3, Nursery, Robusta Coffee, Shallot Extract

1. Introduction

Coffee is one of the plantation commodities that has an important role for the national economy, especially as a source of foreign exchange for the country and has a fairly high economic value. Indonesia has a large coffee land until 2020, it is recorded that the area of coffee land in Indonesia is 353,880 ha. Coffee plantations in Indonesia are 96% people's plantations, the rest are plantations owned by large state and private companies, so the need for coffee seeds is very important in supporting the sustainability of coffee plantations in Indonesia (Sari, 2018). So far, many coffee farmers in Indonesia still rely on coffee seedlings pulled from the garden without

the provision of good technology so that the growth of seedlings is not optimal and good. This has several negative impacts on the quality and productivity of the coffee plantation as a whole.

Coffee plant propagation can be done vegetatively and generatively. To make an entres or grafting seedling garden, seedlings derived from seeds are needed to be used as rootstocks in plant propagation. Nursery is considered important because this process will affect the condition or productivity of coffee plants after adulthood (Kadir et al., 2020). Quality coffee seedlings include having uniform growth, free from pest and disease attacks, having many roots and being able to produce high when the seedlings are transplanted to the field (M. Ali et al., 2015).

The growth of seedlings is determined by various factors, in addition to genetic factors in the form of varieties and adaptations as well as the characteristics of mother trees and fruits/seeds for seeds, as well as external (environmental) factors and interventions in the preparation and treatment of seeds, preparation and treatment of nurseries and maintenance during the germination and growth phases. One form of effort to support a good seedling process is the use of Growth Regulators in the seedling process. Growth regulator is an organic compound that is not a plant nutrient, active in low concentrations that can stimulate, inhibit or alter plant growth and development. The application of growth regulator aims to control plant growth. Synthetic growth regulator that is often used is relatively expensive and difficult to obtain. As a substitute for synthetic growth regulator can be used with natural materials (Rajiman, 2015). One of the plants that is considered to be able to be used as a natural growth regulator is shallot (*Allium cepa* L.). Shallots contain growth hormones in the form of auxin and gibberellin, so they can spur seed growth (Marfirani et al., 2014).

The application of growth regulator use can be combined with fertilizer application to produce good growth. One type of fertilizer that is able to remind the growth of plant seedlings is potassium nitrate fertilizer (KNO_3), KNO_3 is a type of chemical fertilizer with potassium and nitrogen content in it. KNO_3 fertilizer is a combination of elements N (Nitrogen) and K (Potassium) in the form of K2O. The potassium contained in KNO_3 has an influence as a balancing agent when plants have excess nitrogen, element K can also increase carbohydrate synthesis and translocation, thereby increasing cell wall thickness, stem strength and increasing sugar content. Based on the review, this research was carried out to determine the response of robusta coffee seedlings due to the application of shallot extract as a growth regulator combined with potassium nitrate fertilizer (KNO_3) as an effort to produce and meet the needs of superior coffee seeds in Indonesia.

2. Materials and Methods

The research was carried out in February-May 2024 at the Wire House Soil Laboratory, Politeknik Negeri Jember. The tools and materials used in this research include sand, soil, manure, shallots, KNO3 and distilled water, name tags, blender, sieve, stationery, ruler, measuring cup, digital scale, polybag size 15 x 20cm, plastic lid, 2,5 liter and 5 Liter jerry can. The coffee seeds used are Robusta coffee seeds. The study was prepared using a Random Group Design Factorial (RGDF) consisting of 2 factors, the first factor is the provision of KNO_3 concentration with 3 levels of P0 treatment: 0%; P1: 0.5%; and P2: 1% and the second factor, namely shallot extract with 3 levels of treatment, including; B0: 0%; B1: 50%; and B2: 75%. So that 9 combinations of treatments were obtained. There were three replications of each treatment with five sample plants.

The parameters observed include plant height, stem diameter, root length, wet weight and dry weight of coffee seedlings.

Data analysis

The data were analyzed using Analysis of Variance with 5% of α. The 5% Least Significant Difference (LSD) was chosen as post hoc to show the distances between each treatment and replication. Microsoft Excel was used as statistical software to conduct this analysis.

3. Results and Discussion

3.1. Plant Height

Plant height observations on coffee seedlings were made to assess the effect of KNO_3 and shallot extract application as growth regulators. The combination of the two materials was tested at several concentrations to determine their effectiveness in promoting vertical growth of coffee seedlings. Measurements were taken at regular two-week intervals to understand the pattern and level of growth produced. The application of KNO_3 with the addition of Shallot Extract as a growth regulator at several concentrations had a significant effect on 58, 72, 86 Days After Planting (DAP). The following results were obtained:

Table 1. Average of Plant Height due to KNO_3 and Shallot Extract

Treatment	Average Plant Height (cm) on age … DAP				
	30	**44**	**58**	**72**	**86**
Concentration of KNO_3 (P)					
P0 = Control	7,88	8,41	9,41	10,06	10,63
P1 = 0,5%	8,74	9,10	9,62	10,58	11,24
P2 = 1%	8,67	9,07	9,67	10,47	11,01
LSD 5%	ns	ns	ns	ns	ns
Shallot Extract (B)					
B0 = Control	8,51	8,88	9,63	10,31	10,88
B1 = 50%	8,42	8,79	9,28	10,07	10,77
B2 = 75%	8,36	8,91	9,79	10,72	11,24
LSD 5%	ns	ns	ns	ns	ns
Interaction between KNO_3 Concentration (P) X Shallot Extract (B)					
P0B0	8,17	8,67	9,73 bcd	10,57 bc	11,13 bc
P0B1	7,83	8,23	8,63 a	9,10 a	9,73 a
P0B2	7,63	8,33	9,87 bcd	10,50 b	11,03 b
P1B0	8,30	8,77	9,30 abc	10,10 ab	10,60 ab

P1B1	8,43	8,67	9,20 abc	10,07 ab	11,00 b
P1B2	9,50	9,87	10,37 d	11,57 c	12,13 c
P2B0	9,07	9,20	9,87 bcd	10,27 b	10,90 b
P2B1	9,00	9,47	10,00 cd	11,03 bc	11,57 bc
P2B2	7,93	8,53	9,13 ab	10,10 ab	10,57 ab
LSD 5%	ns	ns	0,84	1,05	1,007

Description: ns= insignificant; DAP = Days After Planting. The number followed by the same letter in the same column does not differ significantly based on the LSD test at the level of 0.05%,

Based on Table 1, it was shown that the interaction between KNO_3 and Shallot Extract (P1B2) at 86 DAP had the best average plant height with a seedling height of 12.13 cm. This happens because the KNO_3 content has a combination of elements N (Nitrogen) and K (Potassium) can increase the water status in plant tissues which can help facilitate the plant metabolic process, especially increasing the photosynthesis process. However, the use of shallot extract and KNO3 alone does not have a significant effect because the combination of shallot extract and KNO_3 or with other ingredients can have a stronger synergistic effect. However, if applied separately, each may not be strong enough to trigger significant growth. By combining onion extract and KNO_3, plants benefit from an increase in hormones (auxin and gibberellin) and nutrients (N and K) at once. This synergistic effect helps coffee seedlings grow faster and stronger than when each ingredient is given separately. The content of KNO_3 when interacting with shallot extract can increase the tall growth of robusta coffee seedlings. This is because the auxin content in shallots is completely absorbed by plants (Armawan et al., 2023). The results of the research by Usodri & Utoyo (2021), show that the use of KNO_3 fertilizer with a concentration of 4% can have a better influence on plant seedlings. The increase in the height of arabica coffee seeds also showed positive results with the application of a 60% shallot extract concentration (Wijaya & Adelina, 2023).

The treatment of B0, B1 and B2 had no real effect. This is due to the fact that the concentration of 50% of the amount of auxin contained in shallots is lower, while at the increase in concentration up to 75% the amount of auxin contained is too high for the growth of robusta coffee seedlings. According to Thahir et al., (2021) plants need appropriate concentrations of auxins for their growth. Effective growth regulators can affect growth in certain amounts, concentrations that are too low or high cause ineffective growth regulators. The addition of a significant average value of the height of coffee seedlings indicates that the growth of the seedlings is good. So based on the data, the higher the dose given better the growth of the coffee seed.

3.2. Stem Diameter

Observation of stem diameter in coffee seedlings was carried out to determine the effect of KNO_3 and shallot extract application as growth regulators in strengthening plant structure. Measurement of stem diameter was carried out periodically at a certain point with an interval of two weeks to ensure optimal and consistent stem growth using a push rod. The data obtained is expected to provide an overview of the effectiveness of the treatment on stem thickness as an indicator of the sturdiness and health of coffee seedlings. The ANOVA results of the number of

leaves of robusta coffee seedlings at the age of 30, 44, 58, 72, and 86 DAP showed that the application of shallot extract had a real effect on 44 DAP. There was a significant interaction between KNO_3 Concentration and Shallot Extract at 86 DAP. The highest value of the average stem diameter was 44 DAP in the B1 treatment of 1.57 mm. The following results were obtained:

Table 2. Average of Stem Diameter due to KNO_3 and Shallot Extract

Treatment	Average Stem Diameter (mm) on age … DAP				
	30	**44**	**58**	**72**	**86**
Concentration of KNO_3 (P)					
P0 = Control	1,44	1,50	1,63	1,73	1,87
P1 = 0,5%	1,49	1,56	1,63	1,71	1,83
P2 = 1%	1,41	1,48	1,59	1,66	1,82
LSD 5%	ns	ns	ns	ns	ns
Shallot Extract (B)					
B0 = Control	1,44	1,49 a	1,64	1,72	1,84
B1 = 50%	1,48	1,57 b	1,63	1,72	1,84
B2 = 75%	1,42	1,48 a	1,58	1,66	1,83
LSD 5%	ns	0,078	ns	ns	ns
Interaction between KNO_3 Concentration (P) X Shallot Extract (B)					
P0B0	1,47	1,50	1,70	1,80	1,97 c
P0B1	1,47	1,57	1,60	1,70	1,80 ab
P0B2	1,40	1,43	1,60	1,70	1,83 abc
P1B0	1,47	1,50	1,60	1,73	1,83 abc
P1B1	1,50	1,60	1,67	1,70	1,80 ab
P1B2	1,50	1,57	1,63	1,70	1,87 abc
P2B0	1,40	1,47	1,63	1,63	1,73 a
P2B1	1,47	1,53	1,63	1,77	1,73 a
P2B2	1,37	1,43	1,50	1,57	1,80 ab
LSD 5%	ns	ns	ns	ns	0,14

Description: ns= insignificant; DAP = Days After Planting. The number followed by the same letter in the same column does not differ significantly based on the LSD test at the level of 0.05%,

Applying shallot extract at a concentration of 60% can increase plant height, leaf count and stem diameter. These results are in accordance with the research of Usodri & Utoyo (2021), that the application of KNO_3 can increase plant diameter. This proves that the application of nitrogen and potassium, which are the main ingredients in KNO_3 fertilizer, is able to affect the growth rate which is closely related to plant physiology. According to Jayanti et al. (2019), the

application of shallot extract to seedlings has a real effect on plant growth, leaf count and seed quality. This is because the auxin content contained in shallots is able to lengthen cells vertically. The results of the research of Ali et al. (2023), The increase in the diameter value of robusta coffee seedlings is estimated to be closely related to the wider roots of coffee seedlings formed. A good root system so that the roots are able to absorb nutrients and water in the soil more optimally, which will result in coffee seedlings being able to grow and develop better and optimally. The existence of optimal nutrients for the plant, the growth of the stem diameter of Robusta coffee seedlings can be increased.

3.3. Root Length, Dry Weight and Dry Weight

Observations of root length, dry weight, and fresh weight of coffee seedlings were conducted to evaluate the effects of KNO_3 and onion extract application as growth regulators in the early phase of plant development. Measurement of root length aims to understand the growth of the root system, while dry weight and fresh weight provide an overview of the accumulation of plant biomass. These observations were made periodically every 2 weeks to assess the effect of the treatments on the overall quality and growth of the coffee seedlings. The results of the study on the application of KNO_3 and shallot extract on the parameters of root length, wet weight and dry weight were obtained as follows:

Table 3. Average of root length, wet weight, dry weight due to the application of KNO_3 and shallots.

Treatment	**Parameters**		
	Root Length	**Dry Weight**	**Dry Weight**
Concentration of KNO_3 (P)			
P0 = Control	13,34ab	2,34 a	0,57 a
P1 = 0,5%	12,79 a	2,79 ab	0,62 a
P2 = 1%	13,91 b	2,93 b	0,67 b
LSD 5%	0,98	0,28	0,06
Shallot Extract (B)			
B0 = Control	13,73	2,62 ab	0,60
B1 = 50%	12,98	2,86 b	0,63
B2 = 75%	13,33	2,57 a	0,63
LSD 5%	ns	0,28	ns
Interaction between KNO_3 Concentration (P) X Shallot Extract (B)			
P0B0	15,00 d	2,40 ab	0,59 a
P0B1	11,50 a	2,18 a	0,53 a
P0B2	13,53 bc	2,44 ab	0,61 b
P1B0	12,70 b	2,79 bc	0,58 ab
P1B1	11,93 ab	2,84 c	0,61 b

P1B2	13,75 c	2,73 bc	0,66 b
P2B0	13,50 bc	2,68 bc	0,62 b
P2B1	15,52 d	3,56 d	0,76 c
P2B2	12,70 b	2,54 b	0,63 b
LSD 5%	0,98	0,28	0,06

Description: ns= insignificant; DAP = Days After Planting. The number followed by the same letter in the same column does not differ significantly based on the LSD test at the level of 0.05%,

Roots are vegetative organs that have the function of absorbing water from the soil. The length of the roots is measured by measuring the length of the roots from the top to the bottom using a ruler. The application of KNO_3 and shallot extract showed different results not real. Observation of root length is carried out at the end of the observation. Based on the results of table 3. the results show that the average root length of robusta coffee seedlings has different results in each treatment. The longest root is in the treatment of 75% shallot extract (B2) has a length of 13.91 cm, because it is supported by the use of shallot extract because it contains auxin hormone, the hormone functions in cell development, root growth (Jayanti et al., 2019). Apart from the effective application of shallot extract, an important factor in the formation of root length is environmental factors, especially in the place where the seedlings take root, loose media can make it easier for the seedlings to penetrate the soil so that the seedlings can make it easier during the root elongation process. One of the important nutrients in KNO_3 is potassium (K), which has a special role in the formation of new roots. Healthy and strong roots are very important because they function to absorb water and nutrients from the soil, which are then used in the process of photosynthesis (Jatsiyah et al., 2020).

The wet weight of the plant is the metabolic activity of the plant, and the value of the wet weight of the plant is influenced by the water content of the tissue, nutrients and the metabolic results of the plant. These compounds then form tissues and organs. Based on table 3, it shows that the average wet weight of robusta coffee seedlings has different results in each treatment. The highest wet weight in the 1% KNO_3 treatment was combined with 50% shallot extract (P2B1) with a wet weight of 3.56 grams. This is suspected to encourage the growth of Robusta coffee seedlings. The growth characteristics of coffee as a plantation plant require a relatively long period of time compared to other types of plants, and the roots are not able to absorb nutrients optimally, especially at a young age. According to Ratnasari et al. (2015), the total wet weight of the plant indicates the presence of water and photosynthesis contained in it. This means that water is the main component of wet weight. The wet weight of the plant reflects the amount of water stored in the plant's tissues, as well as the result of photosynthesis in the form of organic compounds that are stored as energy reserves. At the beginning of growth, the formation of roots is very important so that plants can absorb nutrients and water and form other vegetative organs. Giving shallot extract can stimulate root growth because of its auxin hormone content.

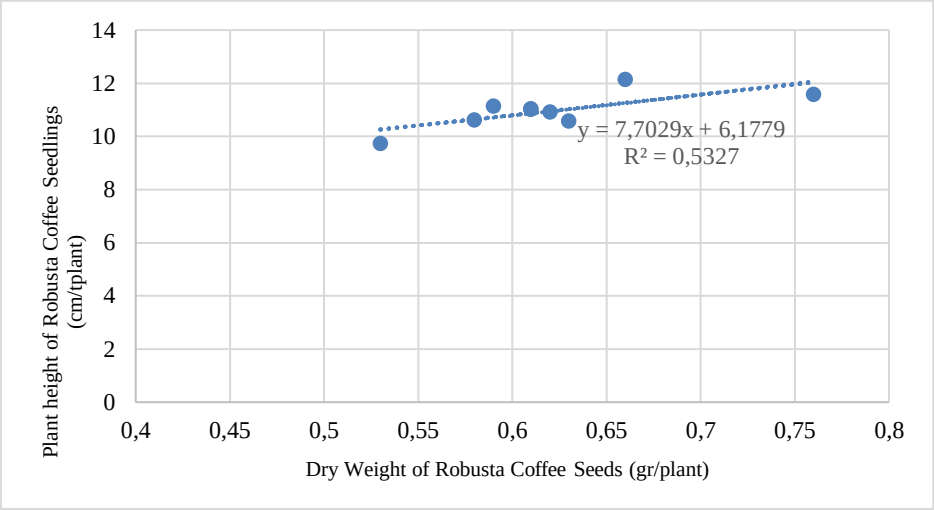

Figure 1. The Relationship between Plant Height and Dry Weight of Robusta Coffee Seeds

The highest dry weight in the 1% KNO_3 treatment was combined with 50% shallot extract (P2B1) with a wet weight of 0.76 grams. The results of the study of robusta coffee seedlings showed the effect of decreasing the level of water availability due to the oven so that the weight of the roots became dry. The decrease in dry weight of roots is due to the increasingly minimal availability of water and the inhibited rate of photosynthesis. Lack of water reduces the ability of roots to absorb important nutrients from the soil, which inhibits growth and dry weight gain.

Plant dry weight is an important indicator that reflects the ability of plants to absorb and utilize nutrients from the soil. KNO_3 contains potassium which affects the dry weight of plants. The availability of potassium plays a role in the formation of new roots which will later be used for the absorption of water and nutrients in the soil so that it can increase the photosynthesis process. Figure 1 shows that the dry weight of the plant is directly proportional to the height of the coffee seedlings produced with an R2 value of 0.5. This illustrates that the higher the dry weight formed, the better the plant growth will be.

According to Wijiyanti et al. (2019), Dry weight in plants: a description of the photosynthesis process during growth. In addition, water is a component that greatly affects plant weight and shows an effect on plant dry weight. Water serves as the main solvent for nutrients absorbed by the roots from the soil. Lack of water reduces the ability of roots to absorb important nutrients such as nitrogen, phosphorus, and potassium and reduces the efficiency of photosynthesis as the stomata on the leaves close to prevent water loss through transpiration, which reduces CO_2 absorption. This is reinforced by Karnilawati et al. (2020), stating that dry weight explains the addition and subtraction of organic compounds that plants have successfully synthesized from inorganic compounds (water, nutrients, and carbohydrates), the higher the weight of the crop crop means the better the growth of seedlings.

4. Conclusion

Application of Shallot Extract combined with KNO_3 had a significant effect on increasing the height growth of robusta coffee seedlings, but had no effect on a single effect. The interaction between shallot extract and KNO_3 can increase plant height, stem diameter, root length, wet

weight and dry weight of robusta coffee seedlings. The treatment of KNO_3 0.5% and 75% shallot extract (P1B2) gave the best results to increase the growth of Robusta coffee seedlings.

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