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The Effect of Growing Media Composition and Indole–3–Butyric Acid Concentration on Growth and Flowering Time of Rose Cuttings

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ABSTRACT

The purpose of this study is to increase the propagation success rate of *Rosa centifolia* L. cuttings by examining the interaction of several types of growing media with varying amounts of auxin-based plant growth regulators. A factorial Completely Randomized Design with four treatment groups and three replications. The first factor was the composition of the planting media, which was made up of four tiers of soil: soil:husk (1:1), soil:compost (1:1), and soil:manure (1:1). The second factor was the concentration of indole-3-butyric acid (IBA), which has four levels: Z1 (control), Z2 (500 ppm), Z3 (1000 ppm), and Z4 (1500 ppm). The acquired data were subjected to Analysis of Variance, which was followed by a comparison using the Least Significant Difference test to identify significant treatment effects. The results showed that the soil:compost (1:1) treatment was the most effective planting media composition in terms of shoot length, number of leaves, and flowering time. Providing auxin concentrations is not effective in increasing root growth and rose plant yield through cutting propagation.

Keywords: auxin, flower appearance time, growing media, indole–3–butyric acid, rose cuttings

INTRODUCTION

Rose plant (Rosa centifolia L.) is a flowering plant with a variety of shapes and qualities. Rose cultivation offers promising potential for the growth of horticulture agriculture. The community's need for rose plants increases year after year. Rose production does not keep up with the rising demand for roses. Data from the Central Statistics Agency (BPS 2022) reveal that rose production has fluctuated in recent years. In 2018, rose production was 202,065,050 stalks. In 2019, it reached 213,927,138 stalks, the highest production level during the era. However, production fell rapidly in the following years, reaching 147,658,256 stalks in 2020 and 110,028,394 stalks in 2021. Rose output is currently unstable; efforts are being made to increase rose yield through improved seedling production.

Roses can be propagated using either generative (seed-based) or vegetative methods. Stem cutting is the most used vegetative technique due to its ease and efficiency. While other procedures such as grafting and budding are conceivable, stem cuttings are widely preferred because of their practicality and convenience of application. This method is very useful for large-scale rose seedling production since it allows for faster and easier propagation than grafting or tissue culture techniques. Plant cuttings provide parent-like traits and grow uniform plants in huge quantities (Muslimah et al. 2020). Environmental elements such as temperature, humidity, light, and growing media all have an impact on the success of cuttings taken from mother plants. Stem cuttings can have problems with sluggish root formation, buds, and irregular growth. Slow root and shoot production, as well as poor plant growth, are common barriers to cutting-based propagation.

Rose cuttings have low potential for root initiation under natural conditions, necessitating specialized treatments to improve rooting success. One of the most important approaches to promoting optimal plant development is the use of plant growth regulators, particularly those based on auxin compounds, in conjunction with the selection of a suitable and well-structured growing medium that promotes root formation and overall plant vigor. An ideal growing medium should have properties that promote healthy root development, such as enough aeration, effective water retention, good drainage, and the absence of fungal pollutants and pathogenic bacteria. Growing material used to grow rose plants can have an impact on plant productivity (Marfirani et al. 2014). Soil, manure, compost, and chaff are among the most utilized growing media. The performance of the growing medium can be improved by incorporating additional components that help generate favorable environmental conditions, consequently aiding the healthy growth and development of rose plants. A 1:1 mix of soil and rice husk was found to be the most

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efficient treatment for increasing shoot length, shoot number, leaf number, root number, and root length in rose plant cuttings (Shita et al. 2020).

Auxin is classified into four types: indole acetic acid (IAA), indole–3–butyric acid (IBA), α-naphtalene acetic acid (NAA), and 2,4–dichloro–phenoxy acetic acid (2,4–D) (Wakiah and Budiarto 2018). IBA is a popular synthetic auxin that promotes root growth, promoting root initiation during the propagation process. IBA is a growth regulator that promotes root growth and accelerates cutting growth (Delliana et al. 2017). IBA's efficiency is related to its stable chemical structure, which allows it to function more efficiently and for longer periods of time than other auxins (Asrima and Zahrah 2023). Application of IBA at a concentration of 1000 ppm has been shown to produce excellent results in rose cuttings, notably in terms of root length, number of roots per cutting, fresh and dry biomass of roots and shoots, number of leaves, and shoot elongation (Yeshiwas et al. 2015). This suggests that selecting an adequate auxin type and concentration is critical in increasing the success rate and overall efficiency of plant growth processes.

The purpose of this study wis to investigate the composition of growth media and the application of auxin. However, information on the growing media composition and the optimal auxin concentration for successful rose cutting propagation (Rosa centifolia L.) is limited.

METHODS

The research was conducted over a four-month period, from September to December 2023, within the controlled environment of the greenhouse facility and subsequently followed by laboratory analyses at the Plant Physiology and Breeding Laboratory, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang.

The plant material employed for this research consisted of stem cuttings from red cabbage rose plants (*Rosa centifolia* L.), specifically selected from the middle portion of the stem characterized by a greenish-brown coloration. Additional materials included IBA as the root-inducing hormone, distilled water, soil, compost, and manure. The tools and equipment employed during the experiment encompassed 25 × 25 cm polybags, measuring cylinders, hand drills, scissors, transparent plastic covers, and buckets.

The experimental framework employed in this research followed a Completely Randomized Design arranged in a factorial layout in a 4 × 4 format, where each combination of treatments was repeated three times. The first factor under investigation was the type of growing media, which included four compositions: M1: soil, M2: soil:husk (1:1), M3: soil:compost (1:1), and M4: soil:manure (1:1). The second experimental factor involved varying concentrations of IBA, consisting of four levels: Z0: 0 ppm, Z1: 500 ppm, Z2: 1000 ppm, and Z3: 1500 ppm.

The experimental procedures encompassed several key stages, including research preparation, media preparation, formulation of IBA solutions, application of the auxin treatment, planting, maintenance, observation, data collection, and statistical analysis. During the preparation phase, rose cuttings were collected from one-year-old plants, focusing on the middle segments of secondary and tertiary branches. Each cutting measured approximately 15 cm in length and included at least two viable buds. To enhance rooting potential, the basal ends of the cuttings were trimmed at a 45-degree angle, thereby increasing the surface area for root emergence.

Growing media treatments of soil, soil:husk, soil:compost, and soil:manure (each in a 1:1 volume ratio) were evenly distributed into 25 × 25 cm polybags. Auxin solution was prepared using treatments of 0, 500, 1000, and 1500 ppm. Cuttings were made from the secondary and tertiary branches of one-year-old rose bushes. Stem cuttings were clipped 15 cm long and contained at least two buds. Each cutting material's base was cut at a 45° angle to increase the surface area available for root growth. The cuttings were then soaked in the appropriate auxin solutions for two hours before planting. Following treatment, the cuttings were planted and covered in transparent plastic hoods to keep them humid. During the growth stage, weed and pest management were done manually, without the use of chemicals. The observation period lasted until the plants flowered, which happened around 12 weeks after planting (WAP).

The characteristics measured in this study included bud length, leaf count, root volume, root length, number of roots, and time to flower initiation. The experiment's data were evaluated using analysis of variance (ANOVA) to determine statistical differences, and when significant differences between treatments were discovered, the Least Significant Difference test was used at a significance level of 5%.

RESULTS AND DISCUSSION

Bud Length

The analysis of variance revealed that the composition of the growing medium had a statistically significant influence on the bud length of emerging shoots, although the concentration of auxin and their interaction had no effect on the shoots' length characteristics (Table 1). The composition of the growth media has a significant effect on shoot length development. The treatment with a 1:1 soil-to-compost ratio produced the most dramatic shoot elongation, with an average length of 23.72 cm. This medium composition was significantly different than the other treatments, which included soil alone, soil mixed with husk (1:1), and soil mixed with manure (1:1). However, there was no statistically significant difference between the treatments including soil, soil:husk (1:1), and soil:manure (1:1). The improved efficacy of the soil:compost (1:1) medium in fostering shoot growth is most likely due to its sufficient nutritional content. According to Sunansyih *et al*. (2022), the benefits of compost include plants becoming greener, which aids the photosynthetic process, faster plant growth, and increased cell division due to the N element in compost media.

Number of Leaves

The analysis of variance (ANOVA) results revealed that the composition of the growing media had a statistically significant impact on the leaf count formed, whereas neither the different concentrations of auxin used nor the interaction of the two had a significant effect on the parameters of the number of leaves (Table 2). The treatment with a 1:1 soil-to-compost ratio generated the most leaves per plant, with an average of 30.42 leaves. This result was significantly better than those obtained in the other four media compositions. Nonetheless, the number of leaves produced in the soil treatment was statistically comparable to that in the treatment with a 1:1 blend of soil and manure, indicating that both media provided comparably favorable circumstances for leaf growth. In contrast, the treatment with soil:husk (1:1) was less successful in encouraging leaf production. This lower performance may be linked to the physical and chemical features of husk, which may not provide sufficient nutrients or optimal moisture retention to sustain vigorous early vegetative growth. It is well acknowledged that the features and content of the planting media are critical throughout the early stages of plant growth, particularly in encouraging root development, which influences the emergence of shoots and leaves. As a result, the compost-based medium is anticipated to have improved nutrient availability and substrate structure, boosting the physiological processes involved in leaf growth. According to Fahmi (2019), good growing media has the proper composition and can offer plants with the nutrients they require.

Root Volume

The analysis of variance revealed that varying auxin concentrations had a statistically significant effect on the root volume of propagated rose cuttings, whereas the composition of the planting medium and their interaction had no significant effect on root volume (Table 3). The volume of rose cutting roots at auxin concentrations of 1000 ppm is greater than that at 0 ppm and 500 ppm, but equivalent to that at 1500 ppm. Treatment with concentrations of 0 and 500 ppm yielded the same outcomes as concentrations of 1500 ppm. This occurs because of the application of plant growth-stimulating hormones, including IBA. Sari *et al.* (2014) specified that IBA is recognized for its significant role in promoting cell division and growth, particularly during the early stages of root development.

Root Length

The analysis of variance demonstrated that both the composition of the planting media and the concentration of auxin applied had a significant impact on root length, but the interaction between these two components had no discernible effect (Table 4). The usage of auxin at a concentration of 1500 ppm resulted in the largest root extension, with a mean root length of

Table 1 Bud length treatment of growing media composition and auxin concentration

Growing media	Auxin concentration (ppm)				Average
	0	500	1000	1500	
	(cm)				
Soil	18.78	10.44	16.00	17.69	15.73b
Soil:husk (1:1)	4.67	15.17	13.17	10.03	10.76b
Soil:compost (1:1)	25.89	27.72	8.92	32.33	23.72a
Soil:manure (1:1)	12.97	12.36	18.61	12.43	14.09b
Average	15.58	16.42	14.17	18.12	

Description: * Different superscripts in the same column show a significant difference (p <0.05).

Table 2 Number of leaves treatment composition of growing media and auxin concentration

Growing media	Auxin concentration (ppm)				Average
	0	500	1000	1500	
	(leaves)				
Soil	19.33	19.67	20.33	24.67	21.00b
Soil:husk (1:1)	9.67	15.67	14.67	12.67	13.17c
Soil:compost (1:1)	32.33	30.00	28.00	31.33	30.42a
Soil:manure (1:1)	16.00	20.67	24.67	27.33	22.17b
Average	19.33	21.50	21.92	24.00	

Description: * Different superscripts in the same column show significant differences (p <0.05).

20.84 cm, demonstrating that this treatment was effective. In contrast, the treatment with 1000 ppm auxin concentration resulted in the shortest average root length, measuring 15.23 cm. The hormone IBA, which contains auxin, has a significant impact on the growth of rose root cuttings. Hairani *et al.* (2020) suggested that IBA is one of the growth hormones that has a major influence on root growth by stimulating the performance of endogenous auxins originating from within plants. The elevation of auxin levels through the application of exogenous auxin can enhance the processes of cell division, differentiation, and overall cellular growth, thereby accelerating the development of callus tissue.

Number of Roots

The analysis of variance revealed that the concentration of auxin had a significant influence on the number of roots, however neither the composition of the planting media nor their interaction had any substantial effect on the number of roots (Table 5). Auxin administration at a dose of 1500 ppm had a substantial influence on root production, with the highest average number of roots (15.67 per cutting). Auxin concentrations of 1500 ppm create root counts that are similar to those of 0 ppm. The treatments with auxin doses of 500 ppm and 1000 ppm produced no statistically significant difference in root number compared to the control treatment (0 ppm). However, both were significantly different from the 1500 ppm concentration, which resulted in a significantly larger number of roots. The IBA hormone is thought to influence cutting growth by stimulating cell division in plants. The IBA hormone causes the receiving cell to release H^+ ions into the cell wall, which lowers the pH and causes cell wall flexing. According to Sylviana *et al*. (2019), the IBA hormone stimulates cell division, specifically in epidermal cells. Auxins in plants promote root development.

Flowering Time

The analysis of variance results showed that both the composition of the planting media and the concentration of auxin had a significant effect on the time of flower emergence. However, the interaction of these two parameters had no significant effect on the flower emergence time (Table 6). Composting has been shown to significantly shorten the flowering period of rose cuttings, with an average flowering time of 73.58 d. In this scenario, a shorter flowering time signifies a better outcome. The planting medium with a 1:1 ratio of soil and compost had a considerably

Table 3 Root volume treatment composition of growing media and auxin concentration

Growing media	Auxin concentration (ppm)				Average
	0	500	1000	1500	
	--------------------------------ml--------------------------------				
Soil	4.67	2.67	4.67	4.67	4.17
Soil:husk (1:1)	3.33	6.67	8.00	5.33	5.83
Soil:compost (1:1)	4.67	3.33	5.33	4.67	4.50
Soil:manure (1:1)	3.33	4.67	6.67	4.00	4.67
Average	4.00b	4.33b	6.17a	4.67ab	

Description: * Different superscripts on the same line show significant differences (p <0.05).

Table 4 Root length treatment of growing media composition and auxin concentration

Growing media	Auxin concentration (ppm)				Average
	0	500	1000	1500	
	--------------------------------(cm)--------------------------------				
Soil	17.20	18.53	15.83	21.60	18.29b
Soil:husk (1:1)	20.23	26.83	17.57	21.73	21.59a
Soil:compost (1:1)	16.23	18.87	13.60	18.97	16.92b
Soil:manure (1:1)	19.90	18.67	13.90	21.07	18.38b
Average	18.39a	20.73a	15.23b	20.84a	

Description: * Different superscripts in the same column and row show a significant difference (p <0.05).

Table 5 Number of root treatment composition of growing media and auxin concentration

Growing media	Auxin concentration (ppm)				Average
	0	500	1000	1500	
	-------------------------------(roots)------------------------------				
Soil	14.33	13.00	15.33	17.00	14.92
Soil:husk (1:1)	15.00	14.00	13.00	14.67	14.17
Soil:compost (1:1)	13.67	12.33	9.33	17.33	13.17
Soil:manure (1:1)	13.67	15.00	13.67	13.67	14.00
Average	14.17ab	13.58b	12.83b	15.67a	

Description: * Different superscripts on the same line show significant differences (p <0.05).

different (faster) flowering period than other media compositions, such as soil alone, soil:husk (1:1), and soil:manure (1:1). Conversely, the medium made of soil and manure (1:1) had the longest average flowering duration (77.58 d). However, the prolonged flowering period was not significantly different from that found in the soil-only and soil:husk (1:1) treatments. These data indicate that compost has a greater favorable effect on encouraging earlier flowering in rose cuttings than other organic components utilized in the planting media.

According to Table 6, an auxin concentration of 1000 ppm is efficient for accelerating the flowering period of rose cuttings, which has a flowering time of 75.00 days. Flowering times at 1000 ppm auxin concentration did not change significantly from those at 500 ppm and 1500 ppm. Meanwhile, there was no significant difference in blooming time between the treatments with 0 and 500 ppm auxin concentrations. These findings show that, while moderate to high auxin concentrations (500−1500 ppm) produce equivalent flowering responses, the absence of auxin (0 ppm) has no significant effect on blooming time compared to the 500 ppm treatment. The longest flowering period was seen at a concentration of 0 ppm, with an average flowering duration of 78.67 d. Plants flower faster when cultivated vegetatively, such as by cuttings. According to the data, roses cutting blossom substantially earlier, at 73.58 d or 10 WAP. Puspitasari (2018) found that cabbage types flowering between 3 and 4 months old, or 12 and 16 WAP.

CONCLUSION

According to the study's findings, the soil:compost (1:1) treatment was the most effective planting media composition in terms of shoot length, leaf count, and flower appearance time. Increasing auxin concentrations does not promote root growth or rose plant yield by cutting propagation.

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Table 6 Flower emergence time growing media composition and auxin concentration

Growing media	Auxin concentration (ppm)				Average
	0	500	1000	1500	
	---------------(day)---------------				
Soil	78.33	77.67	77.33	75.00	77.08a
Soil:husk (1:1)	79.00	77.33	78.00	75.67	77.50a
Soil:compost (1:1)	79.00	74.67	68.33	72.33	73.58b
Soil:manure (1:1)	78.33	77.67	76.33	78.00	77.58a
Average	78.67a	76.83ab	75.00b	75.25b	

Description: * Different superscripts in the same column and row show a significant difference (p <0.05).

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