

# The use of Indole Butyric Acid on the growth of dragon fruit plant stem cuttings

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**Abstract.** *Hernosa SP, Tampubolon SDR, Siregar LAM. 2022. The use of Indole Butyric Acid on the growth of dragon fruit plant stem cuttings. Nusantara Bioscience 14: 211-216.* The difficulty of root growth of dragon fruit cuttings is affected by stem rot; one way to increase the growth of cuttings is to use a growth regulator, namely Indole Butyric Acid (IBA), which is used to stimulate the growth of dragon fruit rootstock cuttings. This research was conducted in Sidorukun Village, Pangkatan Sub-district, Labuhan Batu District, North Sumatra, Indonesia, at an altitude of  $\pm 40$  m above sea level, from June to October 2020. The research design used was a randomized block design with five treatments. The concentration of the IBA hormone consists of B0 : 0 ppm, B1: 4,500 ppm, B2: 5,500 ppm, B3: 6,500 ppm, B4: 7,500 ppm, and five replicates, so the entire experimental plot was 25. Parameters observed were percentage of shoot emergence, age of shoot emergence, shoot length (cm), shoot fresh weight (g), shoot dry weight (g), root length (cm), fresh root weight (g), root volume (g), and root dry weight (g). Data analysis used a linear model followed by Duncan's test. It is known that the administration of Indole butyric acid (IBA) significantly affected the observed parameters on shoot emergence, age of shoot emergence, number of shoots, root length, fresh root weight, root volume, and root dry weight. However, it did not affect the observed parameters, namely, shoot length, shoot fresh weight and shoot dry weight. On the other hand, B4 concentration (7,500 ppm) gave better shoot growth, root weight, and root dry weight.

**Keywords:** Cutting, dragon fruit, growth, Indole Butyric Acid

## INTRODUCTION

Dragon fruit which belongs to the Cactaceae family was once widely grown as an ornamental plant and is now considered a fruit crop (Kasim et al. 2019; Siregar et al. 2021). Red dragon fruit (*Hylocereus polyrhizus* Britton and Rose) is one cactus plant with the potential as an ornamental plant and edible fruit (Utaminingsih et al. 2019). Red dragon fruit is a popular tropical fruit highly regarded for its health benefits, including its high antioxidant content (Jiang et al. 2020). Enthusiasts have been practicing plant propagation through cuttings for a long time. It is simple, rapid, and cheaper than other sexual or asexual methods (seeds) of plant propagation (Stokes et al. 2020). Breeding by cuttings is expected to guarantee the same traits as the mother and a relatively shorter fruiting time.

The auxin plant hormone is a central regulator of plant growth and development; due to auxin playing a critical role in cell division and expansion, plants use several cellular mechanisms to regulate auxin levels and response (Frick and Strader 2018). Plant hormone auxin is critical in plant growth, dependent on its heterogeneous distribution in plant tissues (Allen and Ptashnyk 2020). The plant hormone auxin drives plant growth and morphogenesis. The active auxin Indole-3-Acetic Acid (IAA) levels and

distribution are tightly controlled through synthesis, inactivation, and transport (Korasick et al. 2013). Among these mechanisms is regulating the input from the auxin precursor Indole-3-Butyric Acid (IBA) into the pool of active auxin (IAA) (Frick and Strader 2018).

In the propagation of dragon fruit cuttings, some points need attention are; First, the disease that often occurs is stem rot. This disease attacks new dragon fruit plants; Dragon fruit plants often rot on the rootstock, are brown, and have white threads. The decay is caused by excessive soil moisture so that a fungus appears that causes rotteness, namely *Sclerotium rolfsii* Sacc. All stems become rotten, which can occur if the stems are planted directly. The sap that is still wet gives a rotten effect on red dragon fruit cuttings.

Growth regulators are chemicals that regulate all growth and development factors in plants. The application of plant growth regulators modifies hormone balance and growth, leading to increased yield, enhanced crop tolerance against abiotic stress, and improved physiological traits of crops (Desta and Amare, 2021). The concept of growth regulators begins with the plant hormones concept. Plant growth regulators are mainly exploited to achieve this because of their essential role in plant growth and development (Amoanimaa-Dede et al. 2022). Growth regulators are widely used in modern horticulture,

agriculture, and horticultural crop maintenance. The "correct" plant growth regulators directly interfere with the hormonal status of the plant. They are represented by hormone biosynthesis or translocation inhibitors, plant hormones or synthetic analogs, and hormone receptor blockers (Rademacher 2015). For example, one way to increase the growth of cuttings is to use a type of hormone Indole Butyric Acid (IBA), which is used to stimulate root formation. Using exogenous plant growth regulators is essential for Nepalese cucumber producers as growth regulators have a hasty effect on vegetative and crop yield quality (Gosai et al. 2020).

Based on the description above, the author is very interested in studying the effect of Indole Butyric Acid (IBA) on the growth of rootstock cuttings of red dragon fruit (*Hylocereus costaricensis* (F.A.C. Weber) Britton & Rose) IBA on the growth of rootstock cuttings. Therefore, this study aims to determine the effect of IBA on the red dragon fruit (*H. costaricensis*).

## MATERIALS AND METHODS

This research was carried out in Sidorukun Village, Pangkatan Sub-district, Labuhan Batu District, North Sumatra, Indonesia, with a flat topography of sandy loam soil at an altitude of  $\pm 39$  m from sea level. This study was conducted from June to October 2020.

The materials used include Indole Butyric Acid (IBA) with various concentrations and rootstock cuttings of red dragon fruit plants with a length of 20 cm (Ross et al. 2021). The additional material includes; topsoil, chicken manure, sand label paper, and 25 x 35 cm polybags. The number of each component in the experimental field: number of repetitions; 5 replicates, number of plots; 25 plots, number of plants per plot: 5 plants, number of sample plants per plot; 3 plants, total number of plants, 125 plants, number of sample plants; 75 plants.

Dragon fruit stems are planted for 60 days by watering in the morning and evening with sufficient clean water. The temperature is 25-30 degrees Celsius, and the relative humidity needed by dragon fruit plants is between 70%-95%. The tools used are hoes, shovels, drills, meters, stationery, calculators, analytical scales, ovens, and other tools that support this research. A randomized block design was used with 1 factor, namely the concentration of IBA consisting of B0:0 ppm, B1:4,500 ppm, B2:5,500 ppm, B3:6,500 ppm, and B4:7,500 ppm. The data from the study were analyzed using a linear model to show the result in fingerprint, using the equation as follows:

$$Y_{ij} = \mu + t_i + \beta_j + \varepsilon_{ij}$$

$\varepsilon_{ij}$  = experimental error

The data were then analyzed using IBM Statistical Program for Social Science (SPSS) version 20 (Hernosa et al. 2022). If the fingerprint results show a noticeable difference, it will be continued with the Duncan Multiple Range Test (DMRT) test with a confidence level of 5% (Nikmah et al. 2019).

## RESULTS AND DISCUSSION

### The percentage of the emergence of shoots (%)

Based on the analysis of fingerprints, it is known that the treatment of administering IBA has observed a significant effect on the percentage of shoot emergence (%), as shown in Table 1. Furthermore, the application of various concentrations of IBA has a significant effect on the parameters of the percentage of shoot emergence (%), namely B0 (control) by 80%, then B1 (4,500) ppm, B2 (5,500) ppm, B3 (6,500) ppm, and B4 (7,500) ppm, all by 100% (Figure 1).

### Age appears shoots (days)

The results in Table 2 showed that the cuttings of the dragon fruit plant that sprouted the fastest were obtained at the B2 (5,500 ppm) treatment, with an average of 26 days of seedlings. Meanwhile, the cuttings that sprouted the longest were obtained at the B4 treatment (7,500) ppm, with an average of 33 days (Figure 2).

### Shoot length (cm)

Based on the analysis of fingerprints, it is known that the treatment of giving various concentrations of Indole Butyric Acid (IBA) has no noticeable effect on the parameters of the longevity of shoots on 30, 45, and 60 days after planting (cm). The average length of the shoots on 30, 45, and 60 can be seen in Table 3.

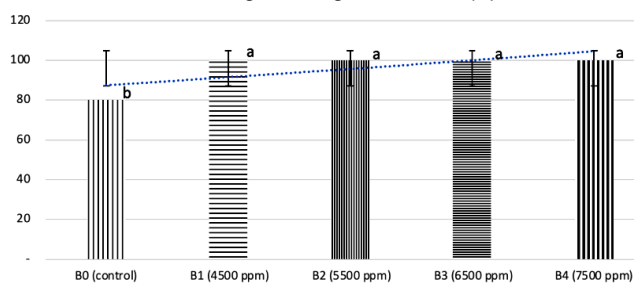
### Number of shoots

Table 4 shows that the highest number of shoots of stem cuttings at 30 days after planting the dragon fruit plant was found in the B2 treatment with 0.87 shoots, and the lowest number of shoots was found in the B0 treatment with 0.27 shoots. Furthermore, the highest number of dragon fruit stem cutting shoots at 45 days after planting was found in the B2 treatment with 1.60 shoots, which were significantly different from the B0, B3, and B4 treatments, and the lowest was found in the B0 control treatment with 0.33 shoots. The highest number of shoots at 60 days after planting was found in the B4 treatment with 2.33, which was significantly different from the B0, B1, and B3 treatments, and then the lowest number at 60 days after planting was found in the B0 treatment with 0.53 shoots.

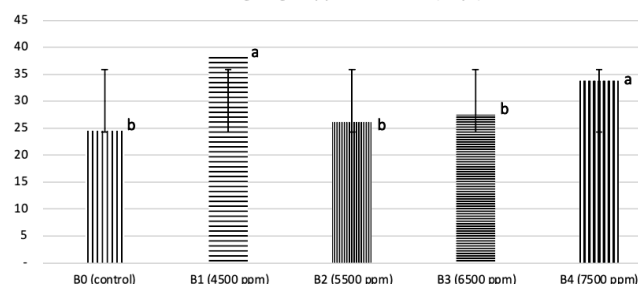
**Table 1.** The percentage of the emergence of shoots (%) on the treatment of Indole Butyric Acid (IBA)

Treatment	Percentage of emergence of shoots (%)	
	Average (%)	
B0 (control)	80b	
B1 (4500 ppm)	100a	
B2 (5500 ppm)	100a	
B3 (6500 ppm)	100a	
B4 (7500 ppm)	100a	

Note: Numbers followed by the same letter in columns and rows are insignificant according to DMRT 0.05



**Figure 1.** The percentage of the emergence of shoots (%) on the treatment of Indole Butyric Acid (IBA) with standard deviation display



**Figure 2.** The average age of emergence of shoots with a standard deviation display

**Table 2.** Age of emergence of shoots (days) seedlings of dragon fruit plant cuttings on various treatments and their concentration

Treatment	Repeat					Total	Average
	1	2	3	4	5		
B0	-	-	-	24.00	25.00	49.00	24.50b
B1	32.00	35.00	25.00	20.33	29.00	141.33	28.27a
B2	25.50	20.00	30.50	31.33	23.33	130.66	26.13b
B3	32.00	20.00	33.66	26.00	26.00	137.66	27.53b
B4	27.00	49.75	34.00	28.66	29.50	168.91	33.78a
Total	116.50	124.75	123.16	130.32	132.83	627.56	-
Average	23.30	24.95	24.63	26.06	26.57	-	28.04
SD	0.13	0.36	0.19	0.19	0.11	2.72	-

Note: -: No shoots appear

**Table 3.** Shoot length (cm) aged 30, 45, and 60 days after planting on the treatment of various concentration of Indole Butyric Acid (IBA)

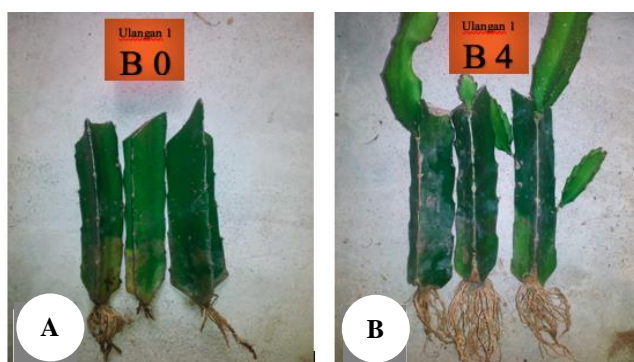
Treatment	Shoot length (cm)		
	30 DAP	45 DAP	60 DAP
B0 (control)	2.53	4.50c	7.80d
B1 (4500 ppm)	4.28	6.09a	11.19a
B2 (5500 ppm)	4.28	6.52a	14.35a
B3 (6500 ppm)	1.47	5.40b	8.77c
B4 (7500 ppm)	0.28	2.23d	8.19c
Average	2.51	4.94c	10.06b
Standard Deviation	0.0722	0.0720	0.1243

Note. DAP: days after planting. Numbers followed by the same letter in columns and rows are insignificant according to DMRT 0.05

**Table 4.** Number of shoots aged 30, 45, and 60 days after planting in the treatment of various concentrations of Indole Butyric Acid (IBA)

Treatment	Number of shoots (shoots)		
	30 DAP	45 DAP	60 DAP
B0 (control)	0.28	0.34c	0.54c
B1 (4500 ppm)	0.74	1.41a	1.80b
B2 (5500 ppm)	0.88	1.61a	1.74b
B3 (6500 ppm)	0.48	0.88b	1.80b
B4 (7500 ppm)	0.34	1.01b	2.34a
Average	0.54	1.05	1.64
Standard Deviation	0.0179	0.0236	0.0278

Note. DAP: days after planting. Numbers followed by the same letter in columns and rows are insignificant according to DMRT 0.05



**Figure 3.** Comparison of control treatment B0 (control), B1 (4,500 ppm), B2 (5,500 ppm), B3 (6,500 ppm), and B4 (7,500 ppm)

#### Fresh weight of shoots (g)

Table 5 shows that the highest fresh weight of the stem cuttings of the dragon fruit plant was found in the B1 treatment at 25.65 g, and the lowest shoot fresh weight was found in the B0 dose at 10.68 g. The observations of fingerprints on the parameters of fresh weight of shoots Table 5 found that the treatment of giving various concentrations of IBA was insignificant.

#### The dry weight of shoots (g)

Based on the analysis of fingerprints, it is known that the treatment of various concentrations of Indole Butyric Acid (IBA) has no noticeable effect on the parameters of the dry weight of shoots (g). Therefore, the average dry weight of the shoots can be seen in Table 5.

**Table 5.** Several parameters in the treatment of various concentrations of Indole Butyric Acid (IBA)

Treatment	Fresh weight of shoots (g)	The dry weight of shoots (g)	Root length 60 days after planting	Fresh weight of the roots (g)	Root volume (mL)	The dry weight of roots (g)
B0 (control)	10.69	1.64	9.31c	0.43d	2.01c	0.24d
B1 (4500 ppm)	25.66	3.85	11.91b	0.69c	2.31b	0.35c
B2 (5500 ppm)	23.84	3.34	11.65b	0.91b	2.61a	0.32c
B3 (6500 ppm)	18.90	2.17	13.45a	0.79b	2.41b	0.40b
B4 (7500 ppm)	18.37	2.65	14.18a	1.16a	2.71a	0.52a
Average	19.49	2.73	12.1	0.79	2.41	0.36
Standard deviation	0.227	0.0399	0.077	0.0123	0.982	0.0072

Note: Numbers followed by the same letter in columns and rows are insignificant according to DMRT 0.05

The observation of the dry weight of shoots in Table 5 showed the highest value in the B1 (4,500 ppm) treatment at 3.84 g and the lowest in the B0 (the control) treatment at 1.63 g. That shows that the dry weight of the shoots depends on the amount of nutrient uptake.

#### Root length (cm)

The average length of the roots can be seen in Table 5. The results of the observation of root length parameters are known that the treatment of giving various concentrations of Indole Butyric Acid (IBA) has a significant effect on the root length parameters (cm), with the highest average in the B4 (7,500 ppm) treatment at 14.17 cm.

#### Fresh weight of roots (g) and volume of roots

The results of the observation of the parameters of fresh weight of roots and root volume in Table 5 are known that the treatment of giving various concentrations of Indole Butyric Acid (IBA) has a significant effect on the parameters of fresh weight of roots (g) and root volume (mL), with each of them the highest for the fresh weight of roots B4 (7,500 ppm) at 1.15 g and root volume B4 (7,500 ppm) at 2.71 mL.

#### The dry weight of roots (g)

Based on the analysis of fingerprints, it is known that the treatment of giving various concentrations of Indole Butyric Acid (IBA) has an areal impact on the dry weight parameters of the roots (g). The average dry weight of the roots can be seen in Table 5. The root's dry weight is the root's weight after being dried in the oven, so its moisture content has been lost, and only chemical compounds are left in the root. Table 5 shows that the dry weight of the roots of the lower stem cuttings of the dragon fruit plant was highest in the B4 treatment at 0.51 g, which was significantly different from the B0, B1, and B3 treatments, and the lowest was found in the B0 the control treatment of 0.23 mL.

#### Discussion

The application of various concentrations of IBA was significant to the parameter of the percentage of shoot emergence (%), namely B0 (the control) of 80%, then B1 (4,500 ppm), B2 (5,500ppm), B3 (6,500ppm) and B4 (7,500 ppm) of 100%. The most effective method for promoting adventitious rooting was IBA addition,

especially in top-performing individuals (Barron et al. 2020). The higher concentration of IBA increased the thickness root production (Barroso et al. 2018). That is because IBA (Indole Butyric Acid) can stimulate root growth because IBA has a chemical content that is more stable and works longer so that it can stimulate root growth

The results in Table 2 show that the cuttings of the dragon fruit plant that sprouted the fastest were harvested at B2 (5,500 ppm) treatment, with an average of 26 days. Meanwhile, the cuttings that sprout the longest were obtained at the B4 treatment (7,500 ppm), with an average of 33 days. Because the B4 (7,500 ppm) application has exceeded the optimum value, cell lengthening and division activity have decreased. Auxin is a major phytohormone that coordinates plant responses to the environment and controls numerous aspects of plant development (Brumos et al. 2018). Auxin is a crucial phytohormone involved in multiplying plant developmental processes. Spatiotemporal regulation of auxin levels is necessary to develop organs in the proper place and at the proper time (Damodaran and Strader 2019).

Indole Butyric Acid's (IBA) behavior was insignificant by observing lifelong length parameters of 30, 45, and 60 days after planting in Table 3. It is suspected that environmental factors affect the growth of dragon fruit cuttings, among others; temperature, the intensity of sunlight, and the influence of care in dragon fruit cuttings. Plant growth factors control or influence plant characteristics as well as adaptation. Light is one of the most factors that affect plant growth. Although photosynthesis has been extensively investigated, knowledge is still limited about how light quality affects the production of horticultural crops, especially fruits and vegetables (Kuniga 2020).

The number of shoots describes the plant's nutritional status and determines growth and yield quality. In this study, Table 4 shows the observation results on the number of shoots that significantly influenced the application of Indole Butyric Acid (IBA). Figure 3 shows that for 45 days after planting and 60 days after planting, Indole Butyric Acid (IBA) given to the cuttings of dragon fruit plants affects by the lengthening of plant cells, namely by spurring specific proteins in the plasma membrane of plant cells to pump H<sup>+</sup> ions into the cell wall. The plasma membrane (PM) H<sup>+</sup>-ATPase is an important ion pump in the plant cell membrane. This pump energizes the PM by

extruding protons from the cell and generating a membrane potential, a prerequisite for growth (Falhof et al. 2016).

Table 5 shows that the treatment of administration of various concentrations of Indole Butyric Acid (IBA) was insignificant. However, it is clear that the highest value treatment is B1 (4,500 ppm) at 25.65 g, and the lowest is the B0 (the control) treatment at 10.68 g, which means there remains a difference between the B0 treatment (the control) and the B1, B2, B3, and B4 treatments. Indole Butyric Acid (IBA) influences cell lengthening, cell division, and cell differentiation, stimulating cambium activity and forming phloem and xylem vessels. Plant hormones regulate the interactions between plants and their complex biotic and abiotic environments. Each hormone initiates a specific molecular pathway, and these different hormone pathways are integrated into a complex network of synergistic, antagonistic, and additive interactions (Aerts et al. 2021).

Table 5 shows the highest values at treatment B1 (4,500 ppm) at 3.84 g and the lowest at treatment B0 (the control) at 1.63 g, which shows that the dry weight of the shoots depends on the amount of nutrient uptake. High nutrient uptake causes photosynthesis to increase, contributing to the plant's increasing dry weight. Therefore, the plant will grow well if photosynthesis proceeds well, followed by increased dry weight.

In the dragon fruit cultivation case, techniques for the subsequent development of these shoots should be removed, and only one should be maintained. Cuttings with two or more shoots must be removed, and only one sprout must be maintained, considering dragon fruit is nutrient-greedy cacti. Selected shoots are large shoots with no attacks of pests or diseases, long shoots, and usually growing ones. The removal of the shoots is carried out after the seedlings are planted in the field; this is because when transferring the seedlings to the field, there is often damage to the seedlings, such as broken shoots, so these broken shoots must be removed and what is maintained is a good sprout. If the removal of shoots is carried out in a nursery, it is feared that there is no shoot reserve to be maintained, waiting for the next shoot, which is very detrimental.

The results showed that indole butyric acid (IBA) treatment had no noticeable effect on observing the parameters of longevity shoots of 30, 45, and 60 days after planting. Therefore, it is suspected that environmental factors affect the growth of dragon fruit cuttings, among others; temperature, the intensity of sunlight, and the influence of care in dragon fruit cuttings. Factors affecting growth are internal factors and external factors; internal factors consist of the rate of photosynthesis, respiration, differentiation, and influence of genes, while external factors include light, temperature, water, organic matter, and nutrient availability.

Indole Butyric Acid (IBA) has better and more effective properties in increasing the percentage of rooted plants, accelerating root growth, increasing the number of roots, and improving root quality. Phytohormones are chemical substances that regulate plant growth, reproductive processes, longevity, development, and even death. One of the most typical representatives of this group is indole-3-

butyric acid (IBA), which is widely applied in various branches of agriculture (Kaczmarek et al. 2020)

Suppose the fresh weight of the roots formed is high. In that case, the ability of the roots to absorb nutrients is also higher, and the photosynthesis process goes well so that the photosynthetic allocated to all parts of the plant is included for root growth, increasing root growth and root volume. Different IBA applications are likely to continue to be developed in the future with a concern for environmental protection and the sustainability of human life (Bandarra et al. 2021).

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