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Induksi Perakaran Tanaman Jeruk Keprok Borneo Prima (*Citrus Reticulata*) Secara In Vitro Dengan Menggunakan Penambahan Zat Pengatur Tumbuh Alami Pisang Raja (*Musa Paradisiaca* Var. Raja) Dan Sintetik NAA (Naphthalene Acetic Acid)

Root Induction of Borneo Prima Tangerine (*Citrus Reticulata*) By In Vitro Method Using Natural Plant Growth Regulator Raja Banana (*Musa Paradisiaca* Var. Raja) And Synthetic NAA (Naphthalene Acetic Acid)

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Abstract

Jeruk keprok Borneo Prima (*Citrus reticulata*) adalah jeruk yang berasal dari Kalimantan Timur, yang diharapkan menjadi salah satu jeruk unggulan dalam negeri. Keunggulan yang dimiliki adalah dapat tumbuh di dataran rendah, mudah dikupas, umur simpan yang lama, penampilan yang menarik, serta rasa manis dan menyegarkan. Kendala pengembaangan jeruk ini adalah jumlah yang masih terbatas, sehingga diperlukan upaya budidaya tanaman menggunakan teknik *in vitro*. Proses multiplikasi tanaman telah dilakukan, langkah berikutnya adalah perakaran. Penelitian ini dilakukan dengan tujuan mengetahui jenis dan konsentrasi zat pengatur tumbuh (ZPT) yang optimal dalam merangsang pertumbuhan akar pada tanaman jeruk keprok Borneo Prima. Penelitian ini menggunakan rancangan acak lengkap dengan membandingkan pengaruh ZPT alami ekstrak pisang raja dengan konsentrasi 25, 50, 75, dan 100 g/L, dengan ZPT sintetik *Naphthalene Acetic Acid* (NAA) konsentrasi 0,5, 1,0, 1,5, dan 2,0 mg/L. Hasil penelitian menunjukkan penambahan ekstrak pisang raja 75 g/L menghasilkan penambahan tinggi tanaman terbaik 1,90 cm, waktu muncul akar tercepat 3,33 hari. Penambahan NAA 0,5 mg/L menghasilkan jumlah daun dan akar terbanyak, yaitu 8,67 helai dan 4,67 akar. Ekstrak pisang raja 50 g/L menghasilkan akar terpanjang, yaitu 4,50 cm. Hasil ini menunjukkan bahwa penggunaan ekstrak pisang raja memberikan hasil yang lebih baik dan efisien dari NAA.

Kata Kunci: Ekstrak Pisang Raja; *In vitro*; Jeruk Keprok Borneo Prima; Naphthalene Acetic Acid; Pengakaran

Abstract

Borneo Prima tangerine (*Citrus reticulata*) is a plant species from East Kalimantan, which is expected to become one of the leading citrus in the country. Its advantages are that it can grow in the lowlands, easy to peel, long shelf life, attractive appearance, sweet and refreshing taste. The obstacle to developing this citrus is that cultivation is still limited, so efforts are needed to cultivate plants using in vitro techniques. The process of plant multiplication has been done, the next step is rooting. the purpose of this research are knowing the type and concentration of plant growth

regulators (PGR) that are optimal in stimulating root growth in Borneo Prima tangerine plants. This study used a completely randomized design by comparing the effect of natural PGR Raja banana extract with concentrations of 25, 50, 75, and 100 g/L, with synthetic PGR Naphthalene Acetic Acid (NAA) concentrations of 0.5, 1.0, 1.5, and 2.0 mg/L. The results showed the addition of Raja banana extract 75 g/L produced the best plant height of 1.90 cm, the fastest root emergence time of 3.33 days. The addition of NAA 0.5 mg/L produced the highest number of leaves and roots, namely 8.67 leaves and 4.67 roots. Raja banana extract 50 g/L produced the longest roots, which were 4.50 cm. These results indicate that the use of Raja banana extract gives better and more efficient results than NAA.

Keywords: *In Vitro; Borneo Prima Tangerine; Naphthalene Acetic Acid; Raja Banana Extract; Rooting*

INTRODUCTION

Oranges fruit are belong to the Rutaceae family and often consumed fresh (Tuasamu, 2018). Rich in vitamin C, oranges support the fight against free radicals and have the potential to prevent various diseases such as cancer and heart problems (Fitriana and Fitri, 2020). The demand for oranges continues to rise due to population growth, increased income, and interest in quality fruits. However, local production of citrus fruits is still insufficient, so Indonesia has to import from abroad. Therefore, government action is required to improve the quality of local oranges and promote the cultivation of local varieties that have the potential to compete with imported oranges (Rahayu and Poerwanto, 2014).

In 2007, the Ministry of Agriculture Indonesia introduced a new type of tangerine called Borneo Prima (*Citrus reticulata* cv. Borneo Prima). The Borneo Prima tangerine has become a leading horticultural crop in East Kalimantan, especially in the Rantau Pulung District, East Kutai Regency. The uniqueness of the Borneo Prima tangerine is its ability to thrive in lowland areas, its easy-to-peel skin, and its lack of bitterness (Widyawati, 2017). Additionally, this tangerine has a long shelf life, an attractive appearance with a contrasting orange-green color, a refreshing sweet taste, and high productivity (Hamidah, 2018).

Increasing the production of high-quality local oranges like the Borneo Prima tangerine has the potential to meet domestic demand and reduce dependence on imported oranges. Thus, efficient cultivation methods are needed to rapidly increase the number of Borneo Prima tangerine plants. One of the procedures to propagate these plants is through tissue culture methods (Tuwo et al. 2022).

Tissue culture is a method for the isolation and growth of plant parts, such as protoplasts, cells, tissues, and organs, in a microbe-free environment. This allows these parts to multiply and regenerate into whole plants. (Habibah et al. 2021). The advantage of the tissue culture technique is its ability to produce high-quality plants, free from disease, and the ability to produce many plants in large quantities with genetic traits identical to the parent (Loi et al. 2020), efficient space use as it does not require large areas (Cokrowati et al. 2020), ensuring genetic consistency, a sterile environment, precise plant selection, careful environmental control, and the preservation of genetic diversity (Markal et al. 2015).

The proper selection of plant growth regulators (PGRs) is a crucial factor in the success of tissue culture (Handayani et al. 2020). PGRs, which are non-nutrient organic compounds, can stimulate, stop, or alter the course of plant growth and development when present in low concentrations (Kustiani, 2020). PGRs are divided into two types: natural and synthetic. Natural PGRs are those whose materials can be derived from plant parts. Examples of natural PGRs include sprout extract, shallot extract, and banana extract (Emilda, 2020). Synthetic PGRs are PGRs with low concentrations that can interact and balance endogenous PGRs, determin the direction of culture development (Satuhu et al. 2021),. Synthetic PGRs are auxins, such as NAA (Naphthalene Acetic Acid), IBA (Indole Butyric Acid), 2,4-D (2,4 Dichlorophenoxyacetic Acid), cytokinin,

gibberellin and others (Astutik et al. 2021). Auxins play a role in stimulating shoot and root growth, inducing stem bending, promoting lateral root formation, and stimulating adventitious root growth (Dasuha, 2022).

The use of natural and synthetic PGRs in root stimulation has been conducted by several researchers, such as Ulfa and Isda (2020), who found that NAA PGR at a concentration of 1.5 mg/L applied to *Citrus nobilis* explants produced the best number of roots, which was 1.67 roots. According to research by Murkute et al. (2008), the application of NAA PGR at a concentration of 0.5 mg/L to *Citrus jambhiri* explants produced the best root length, which was 2.2 cm. Fajri et al. (2020) stated that Raja banana extract at a concentration of 50 grams/L applied to *Citrus aurantifolia* explants produced the best number of roots, which was 1.50 roots.

Research on the use of natural and synthetic PGRs on root growth of Borneo Prima tangerine plants *in vitro* has not been attempted. Therefore, research is needed to determine the most effective type of PGR (natural or synthetic) and the optimal concentration for stimulating root formation in Borneo Prima tangerine plants.

MATERIALS AND METHODS

This research was conducted from December 2022 to April 2023 at the Tissue Culture Laboratory, Technical Implementation Unit of the Plantation Plant Protection Development Office (UPTD P2TP), Samarinda, East Kalimantan, Indonesia.

This study used a completely randomised design (CRD) consisting of 9 treatments and each treatment was carried out 3 times with concentration levels, without PGRs (control), NAA (0.5, 1, 1.5, and 2 mg/L), Raja banana extract (25, 50, 75, and 100 g/L).

Equipment Sterilization

Dissecting sets, petri dishes, beakers, and erlenmeyer flasks are cleaned and dried. Equipment like dissecting sets and petri dishes are wrapped in a layer of HVS paper. These tools are sterilized using an autoclave at 121°C for 15-20 minutes at 1 atmosphere (atm) pressure. Sterilized culture bottles are placed in a clean area, ready for use (Wulandari et al. 2021).

Preparation of Natural PGR (Raja Banana Extract)

Raja banana extract is made by separating the fruit pulp from the skin and seeds. The ripe fruit pulp, which has a soft texture, is weighed in varying amounts: 25 grams, 50 grams, 75 grams, and 100 grams. Banana fruit is then blended to obtain banana extract. This extract is added to the treatment medium according to the desired concentration (Nurfadilah et al. 2018).

Preparation of Synthetic PGR (NAA)

A stock solution of NAA with a concentration of 100 mg/L is prepared by weighing 10 mg of NAA and adding 100 mL of sterile distilled water into a 100 mL beaker. The PGR stock solution is transferred to a reagent bottle, tightly sealed with aluminum foil, labeled, and stored in a refrigerator (Finna et al. 2015).

Preparation of MS Stock Solution

The components of the MS medium are weighed and grouped according to their respective stocks, such as macronutrient stock, CaCl2.2H2O stock, micronutrient stock, iron (Fe) stock, vitamin stock, and Myo-inositol stock, using an analytical balance. Each nutrient stock is dissolved in distilled water using a magnetic stirrer until homogeneous in a beaker. The stock solutions are transferred to reagent bottles, covered with aluminum foil, labeled, and stored in a refrigerator (Widasari et al. 2021).

Media Preparation

Media preparation involves filling a beaker with 500 mL of distilled water, then adding macronutrient stock solution, CaCl2.H2O stock solution, micronutrient stock solution, iron (Fe) stock solution, vitamin stock solution, Myo-inositol stock solution, and PGR stock solution according to the treatment. Next, 30 grams of sugar is added to the solution and homogenized. The volume of the solution is then adjusted to 1000 mL, and the pH is measured using pH paper, with the optimal range being 5.6-5.8. If the solution is too alkaline, a few drops of HCl solution are added, and if too acidic, a few drops of NaOH solution are added until the desired pH is reached.

Subsequently, 8 grams of agar is added, and the solution is heated to a boil. The media is poured into culture bottles, sealed with PP plastic secured with rubber bands. Each bottle is labeled with the media name, concentration, and preparation date using label paper. The media is then sterilized using an autoclave at 121°C for 15-20 minutes at 1 atm pressure. The culture bottles are stored in the incubation room for 3 days to check for media contamination (Widasari et al. 2021).

Preparation of Planting Area

The Laminar Air Flow Cabinet (LAFC) is cleaned with 95% alcohol. Equipment to be used in the planting process, such as tweezers, scalpels, bunsen burners, petri dishes, and culture bottles, are placed in the LAFC after being sprayed with 95% alcohol. The ultraviolet (UV) lamp is turned on for 10-15 minutes before use (Yuniardi, 2020).

Explant Planting

The explants are Borneo Prima tangerine plants (Figure 1). The explants used have a height of approximately ± 2 cm. Each explant is planted upright into a bottle containing the treatment media. One explant is placed in each bottle. The bottles containing the explants are sealed with plastic and secured with rubber bands. Each culture bottle is labeled according to the treatment and planting date using label paper. The culture bottles are then placed on culture racks in the incubation room.

Figure 1. Borneo Prima tangerine *in vitro* at 0 days after initiation (Personal Document, 2023)

Explant Maintenance

The culture bottles must be kept clean and protected from contaminated media by spraying 70% alcohol. The incubation room conditions are maintained at a temperature of 20-24°C, humidity of 80-99%, and light intensity of 700-1000 lux with 24-hour lighting (Yuniardi, 2020).

Observation Parameters

Observations are made over 12 weeks after planting (WAP). The parameters include plant height increase (cm), number of leaves increase (leaves), root emergence time (days), number of roots, and root length (cm) produced in each treatment.

Data Analysis

Quantitative data obtained from observations will be analyzed using SPSS version 22. If there are significant differences between treatments, further tests using DMRT (Duncan's Multiple Range Test) will be conducted at a 5% significance level and if there are not significant differences between treatments, further tests using Mann Whitney will be conducted at a 5% significance level.

RESULTS

Growth and Development of Borneo Prima Tangerines Treated with Natural (Raja banana extract) and Synthetic (NAA) PGR

One Way ANOVA analysis showed that the addition of Raja banana extract and NAA affected the growth of plant height and number of leaves for 12 weeks after planting (MST) (Table 1). Further testing using DMRT showed significant differences among treatment categories. The average plant growth height and number of leaves are as follows:

Table 1. The effect of adding Raja banana extract and NAA on the average increase in height and the increase in the number of leaves in Borne Prima tangerine plants for 12 weeks after initiation

Treatment	Observation Parameters

	Plant Height Increase (cm)	Increase in Number of Leaves
Control	0.80 ± 0.15[a]	6.00 ± 0.57[abc]
NAA 0.5 mg/L	1.40 ± 0.21[a]	8.67 ± 3.80[c]
NAA 1.0 mg/L	0.67 ± 0.88[ab]	4.67 ± 1.20[abc]
NAA 1.5 mg/L	0.33 ± 0.88[b]	2.00 ± 0.57[ab]
NAA 2.0 mg/L	0.53 ± 0.88[ab]	1.67 ± 1.20[a]
Raja banana extract 20 gram/L	0.83 ± 0.43[a]	3.00 ± 1.50[abc]
Raja banana extract 50 gram/L	0.97 ± 0.12[a]	4.00 ± 2.08[abc]
Raja banana extract 75 gram/L	1.90 ± 0.65[a]	7.33 ± 0.88[c]
Raja banana extract 100 gram/L	0.67 ± 0.31[ab]	3.00 ± 0.57[abc]

Description: Numbers followed by different letters in the same column indicate a real difference in the DMRT test at the 5% significance level

The addition of Raja banana extract and NAA has a significant impact on the growth of plant height and the number of leaves of Borneo Prima tangerine. The best treatment in increasing plant height growth is by using Raja banana extract at a concentration of 75 grams/L, resulting in an average plant height growth of 1.90 cm. To increase in the number of leaves, the best treatment is to use NAA at a concentration of 0.5 mg/L, which produces an average increase of 7.33 leaves. The addition of NAA at a concentration of 1.5 mg/L produced the lowest plant height growth with an average of only 0.33 cm, and the addition of NAA at a concentration of 2.0 mg/L produced the lowest number of leaves with an average of only 1.67 leaves.

Raja banana extract and NAA had a significant impact to root emergence time, number of roots, and root length for 12 weeks after planting (**Table 2**). The average fastest emerging root time, number of roots, and root length are as follows:

Table 2. The effect of adding Raja banana extract and NAA on the average root emergence time, number of roots, and root length in Borneo Prima tangerine plants for 12 weeks after initiation

Treatment	Observation Parameters		
	Root Emergence Time (days)	Number of Roots	Root Length (cm)
Control	5,00 ± 0,00[a]	1,00 ± 0,00[b]	2,10 ± 0,35[ab]
NAA 0.5 mg/L	4,33 ± 0,74[a]	4,67 ± 0,53[a]	1,71 ± 0,73[ab]
NAA 1.0 mg/L	6,33 ± 0,13[a]	1,00 ± 0,00[b]	0,47 ± 0,45[ab]
NAA 1.5 mg/L	5,00 ± 0,58[a]	1,33 ± 0,33[b]	0,34 ± 0,11[ab]
NAA 2.0 mg/L	7,00 ± 0,11[a]	1,00 ± 0,00[b]	0,60 ± 0,13[ab]
Raja banana extract 20 gram/L	4,33 ± 0,64[a]	0,67 ± 0,17[b]	0,40 ± 0,13[ab]
Raja banana extract 50 gram/L	6,00 ± 0,11[a]	1,00 ± 0,00[b]	4,50 ± 0,61[a]
Raja banana extract 75 gram/L	3 ± 0,54[a]	1,00 ± 0,25[b]	3,57 ± 0,76[a]
Raja banana extract 100 gram/L	0,00 ± 0,00[b]	0,00 ± 0,00[b]	0,00 ± 0,00[b]

Description: Numbers followed by different letters in the same column indicate a significant difference in the Mann Whitney test at the 5% significance level

Raja banana extract and NAA has an impact on fastest emerging root time, number of roots, and root length of Borneo Prima tangerines. The best treatment to accelerate fastest emerging root time is to use Raja banana extract 75 g/L, with an average root emergence time 3.33 days. The highest number of roots was with NAA 0.5 mg/L, with 4.67 roots. The longest root length, was with Raja banana extract 50 g/L, with average root length 4.50 cm. The treatment using Raja banana extract at a concentration of 100 g/L produced the longest emerging root time, the lowest number of roots, and the shortest root.

DISCUSSION

Height Increase of Borneo Prima Tangerine Plants

Raja banana extract with a concentration of 75 g/L on MS media showed the best results in plant height increment, 1.90 cm (Figure 2). This indicates that the concentration of 75 g/L is the optimal concentration to increase plant height growth compared to other concentrations. This finding is in line with the research of Rahayu et al. (2021) that complex organic PGRs, including Raja banana extract, has the potential to stimulate shoot growth by increasing plant height. The process of stem elongation occurs through a series of steps involving division, growth, and elongation of cells at the stem tip.

Raja banana extract is one type of organic PGRs that contains carbohydrates, vitamins, phytohormones (Amaliya et al., 2022) and as a source of energy. Therefore, Raja banana extract can act as a source of energy in the metabolic process of plants, and increase plant growth to be higher (Heriansyah, 2019).

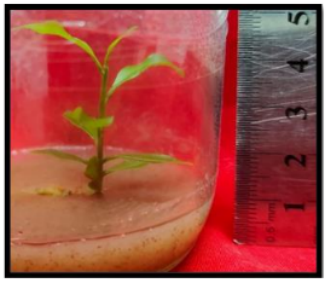

Figure 2. The best plant height increase with Raja banana extract treatment at 75 grams/L at 12 week after planting

NAA with a concentration of 1.5 mg/L shows the lowest average plant height growth, only 0.33 cm. This may be due to the fact that the plants already have sufficient levels of endogenous auxin, so that the provision of additional exogenous auxin is not needed and can even be toxic to plants. The increasing the concentration of NAA can inhibit plant height growth (Anwar et al. 2021). Low plant growth can be caused by the non-optimisation of exogenous PGRs concentrations in accordance with plant needs (Samanhudi et al. 2021). The growth and development of plant is influenced by a complex relationship between endogenous and exogenous plant hormones (Lisnawati et al. 2022).

Number of Leaves of Borneo Prima Tangerines

NAA with concentration of 0.5 mg/L in MS media showed the best results for the increase in number of leaves, 8.67 leaves (Figure 3). This is the optimal concentration because exogenous hormones with minimal concentration can encourage the increase in the number of leaves. Accordance with the research of Mawaddah et al. (2021), that the addition of auxin with a low concentration cause a response to increase the number of leaves compared to no addition or the addition of auxin with a high concentration. Various hormones, such as auxin, cytokinin, and gibberellin, can affect leaf growth and development in plants (Akhiriana et al. 2019). The main function of auxin is to stimulate root formation, promotes the growth and development of meristem tissues in prospective leaves (Islamia et al. 2022).

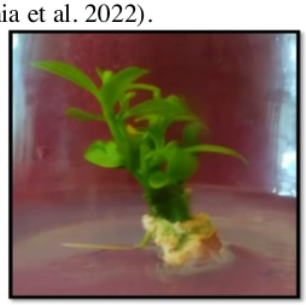

Figure 3. The highest increase in the number of leaves with NAA treatment at 0.5 mg/L at 12 weeks after planting

NAA, as a synthetic auxin, has the ability to stimulate cell division in leaves, which contributes to an increase in leaf number. The quantity of leaves is significant in the process of photosynthesis, plant metabolism, and nutrient absorption because leaves are vital organs for plants. (Indriana et al. 2020). Photosynthesis produces carbohydrates that are essential for plant growth and development (Yuniastuti et al. 2018). In in vitro culture, the number of leaves that can grow is an important indicator in observing the potential of cells to regenerate. This potential refers to the ability of each plant cell to transform into a perfect new individual under suitable environmental conditions. Optimal growth is characterised by an increase in the number of leaves, indicating an optimal level of growth and development of the explants (Samanhudi et al. 2021).

NAA treatment with a concentration of 2.0 mg/L has the lowest average number of leaves, which is 1.67 leaves. NAA concentration of 2.0 mg/L causes changes in leaf color to brown, so it cannot carry out the photosynthesis process properly. Increasing levels of auxin hormones can stimulate ethylene production, which in turn triggers changes in leaf colour to brown, wilt, and eventually fall (Samanhudi et al. 2021).

Root Emergence Time of Borneo Prima Tangerine

The treatment of Raja banana extract with a concentration of 75 g/L on MS media was the best result for the fastest root emergence time, which was 3.33 days (Table 2). This means that the concentration of 75 g/L is the optimal concentration for root emergence time, because the exogenous hormone can already encourage continuous cell division in the formation of root candidates. The balance between exogenous and endogenous auxin hormones in the optimal Raja banana extract treatment media can form roots quickly (Andany and Ratnasari, 2023). The initial stage of root emergence, the base of the shoot changes colour to yellowish, which is then followed by swelling of the base of the shoot and the appearance of white root candidates. In Siamese orange (*C. nobilis*) explants, in vitro shoots are able to produce roots because the explants are able to absorb nutrients from the appropriate media, which in turn stimulates rapid root formation (Ulfa and Isda, 2020).

Raja banana extract treatment with a concentration of 100 g/L did not produce roots until the end of observation (12 weeks after planting) (Table 2). This means that the concentration of 100 g/L is a concentration that is not optimal for root emergence time compared to other concentrations, because this concentration causes inhibited plant root growth caused by too high exogenous hormones. According to Lutfiani et al. (2022), high exogenous hormones can inhibit root formation, so only low or no exogenous hormones are needed to fulfil root formation.

Number of Roots of Borneo Prima Tangerine

NAA concentration of 0.5 mg/L in MS media produced the most optimal increase root growth, 4.67 roots (Figure 4). This indicates that the concentration of 0.5 mg/L is the optimal level to stimulate root formation compared to other levels. The PGR functions in root formation is auxin (Budi, 2020). Auxin given in optimal concentrations, can trigger cell division that initiates root formation (Astutik et al. 2021), has a major impact in stimulating and accelerating root growth, as well as increasing both the quantity and quality of roots (Mawaddah et al. 2021).

Figure 4. The largest number of roots with NAA treatment at 0.5 mg/L at 12 weeks after planting

Plant height growth is influenced by root growth. In the research of Gupitasari et al. (2019), stated that the increase plant height is influenced by the number of roots and root length. Roots are an essential organ for plants because they play a role in maintaining the stability and sustainability of plants (Sari et al. 2020). Its functions include as a plant intertwine into the growing medium, the main channel for delivering nutrients from the absorption site to various plant organs, an important place for metabolic activities such as respiration, storage of energy sources such as carbohydrates, and production of phytohormones such as cytokinins (Aflah et al. 2022).

Raja banana extract treatment with a concentration of 100 g/L did not produce roots (Table 2). This means that the concentration of 100 g/L is a concentration that is not optimal for the number of roots compared to other concentrations, because the concentration is too high and and blocking root growth. The application of high concentrations of exogenous PGR has an effect on the difference in the concentration of endogenous hormones in these plants. The interaction between endogenous hormones and exogenous hormone causes the physiological processes of plants to be inhibited, one of which can result in inhibition of root formation (Mulia et al. 2020).

Root Length of Borneo Prima Tangerines

The treatment of Raja banana extract with a concentration of 50 g/L on MS media gave the best results for the longest root length, which was 4.50 cm (Figure 5). Its means that the concentration of 50 g/L is the optimal concentration for root length because the exogenous hormone given can spur cell elongation in the roots. Raja banana extract contains the hormone auxin which functions as the growth and development of vegetative organs, especially roots (Fajri et al. 2020).

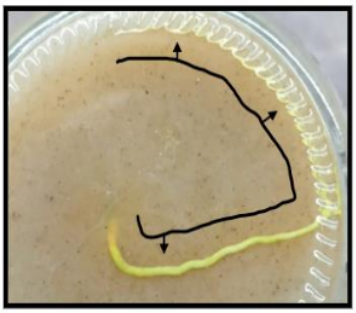

Figure 5. The longest root length with Raja banana extract treatment at 50 grams/L at 12 weeks after planting

Raja banana extract contains thiamine, which can accelerate root growth by accelerating cell division in the root meristem (Rahayu et al. 2021). Auxin affects cell elongation in plants, including roots, by regulating cell wall flexing. Auxin stimulates the activity of specific proteins

in the plant cell membrane, which activates the pumping of H+ ions into the cell wall, this causes the cell to elongate due to water absorption through osmosis. After elongation, the cell continues to grow by reconstructing cell wall material and cytoplasm (Setiawan et al. 2020).

The Raja banana extract treatment with a concentration of 100 g/L did not produce roots (Table 2). This means that the concentration of 100 g/L is a concentration that is not optimal for root length compared to other concentrations, because this concentration can cause inhibition of root formation because it is toxic to plants. The application of plant hormones as external PGR does not need to be done in excess because plants have the ability to produce plant hormones naturally (Desy et al. 2023). External application of low concentrations of auxin will stimulate root cell growth, but high concentrations of auxin can inhibit cell growth and root formation (Kholifah et al. 2022).

CONCLUSION AND SUGGESTION

Based on the results, it can be concluded that Raja banana extract with a concentration of 75 g/L is the best concentration to produce the fastest root emergence time, which is 3.33 days and the highest plant increase, which is 1.90 cm. NAA with a concentration of 0.5 mg/L produced the highest number of roots, 4.67 root and the highest number of leaves, 8.67 leaves. The best concentration for root length was Raja banana extract with a concentration of 50 g/L, which was 4.50 cm.

Further research should be carried out at the acclimatisation stage for Borneo Prima tangerine planlets with the right type and combination of media. It is expected that Borneo Prima tangerine seedlings will be produced in large quantities and uniformly.

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