

POTENTIAL PLANT GROWTH REGULATORS FROM VARIOUS MATERIALS TO PROMOTE PROLIFERATION OF PURPLE SWEET POTATO (*Ipomoea batatas* L.) IN ACID SULFATE SOIL

*(Potensi Zat Pengatur Tumbuh Tanaman Dari Berbagai Bahan Untuk Meningkatkan Proliferasi Ubi Jalar Ungu (*Ipomoea batatas* L.) Pada Tanah Sulfat Masam)*

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ABSTRACT

The increasing demand for purple sweet potato as a functional food commodity necessitates innovative strategies to improve its growth and yield. One promising approach is the application of plant growth regulators (PGRs), both natural and synthetic, which play essential roles in regulating plant physiological processes. This study aimed to evaluate the effectiveness of different PGR sources on the growth and productivity of purple sweet potato. The experiment was conducted from January to June 2023 in Sidomakmur Village, Marabahan District, South Kalimantan, using a Randomized Complete Block Design (RCBD) with five replications. Treatments consisted of five PGR sources: shallot extract, banana corm extract, coconut water, Growtone (synthetic PGR), and water as a control. Each treatment received 100 mL of solution per experimental unit, resulting in 25 experimental units. Observed parameters included sprout emergence time, plant height, number of leaves, fresh plant weight, and tuber weight. Data were analyzed using the Least Significant Difference (LSD) test at a 5% significance level. The results demonstrated that banana corm extract significantly accelerated sprout emergence and increased plant height compared with the control. This treatment also produced a greater number of leaves and heavier tubers than water alone. In contrast, shallot extract did not show significant differences from other treatments in terms of fresh plant weight. These results indicate the presence of both synergistic and antagonistic interactions among the major phytohormones contained in each material. Overall, the findings highlight the potential of organic materials as sustainable natural sources of PGRs and nutrients to enhance plant growth and productivity.

Keywords: *Natural stimulation, Phytohormones, Proliferation, Sulphate soil, Sweet Potato*

ABSTRAK

Meningkatnya permintaan ubi jalar ungu sebagai komoditas pangan fungsional menuntut adanya strategi inovatif untuk meningkatkan pertumbuhan dan hasil tanaman. Salah satu pendekatan yang menjanjikan adalah penerapan zat pengatur tumbuh (ZPT), baik alami maupun sintetis, yang berperan penting dalam mengatur proses fisiologis tanaman. Penelitian ini bertujuan

untuk mengevaluasi efektivitas berbagai sumber ZPT terhadap pertumbuhan dan produktivitas ubi jalar ungu. Penelitian dilaksanakan pada bulan Januari hingga Juni 2023 di Desa Sidomakmur, Kecamatan Marabahan, Kalimantan Selatan, menggunakan Rancangan Acak Kelompok (RAK) dengan lima ulangan. Perlakuan terdiri atas lima sumber ZPT, yaitu ekstrak bawang merah, ekstrak bonggol pisang, air kelapa, Growtone (ZPT sintetis), dan air sebagai kontrol. Setiap perlakuan diberikan sebanyak 100 mL larutan per satuan percobaan, sehingga terdapat 25 satuan percobaan. Parameter yang diamati meliputi waktu muncul tunas, tinggi tanaman, jumlah daun, bobot segar tanaman, dan bobot umbi. Data dianalisis menggunakan uji Beda Nyata Terkecil (BNT) pada taraf nyata 5%. Hasil penelitian menunjukkan bahwa perlakuan ekstrak bonggol pisang secara nyata mempercepat kemunculan tunas dan meningkatkan tinggi tanaman dibandingkan dengan kontrol. Perlakuan ini juga menghasilkan jumlah daun yang lebih banyak serta bobot umbi yang lebih berat dibandingkan dengan perlakuan air. Sebaliknya, perlakuan ekstrak bawang merah tidak menunjukkan perbedaan yang nyata dibandingkan perlakuan lainnya pada parameter bobot segar tanaman. Hasil ini mengindikasikan adanya interaksi sinergis dan antagonis antarfitohormon utama yang terkandung dalam masing-masing bahan. Secara keseluruhan, temuan penelitian ini menegaskan potensi bahan organik sebagai sumber alami ZPT dan hara yang berkelanjutan untuk meningkatkan pertumbuhan dan produktivitas tanaman.

Kata kunci: *Fitohormon, Proliferasi, Stimulasi alami, Tanah sulfat, Ubi manis*

INTRODUCTION

Plant growth regulators (PGRs) have become increasingly significant due to growing demands for fruits, vegetables, and ornamental crops. PGRs stimulate faster growth and greater productivity. Synthetic PGRs are commonly used, while the potential of natural alternatives remains underutilized (Mukherjee et al., 2022). Emilda (2020) noted that numerous natural substances can act as PGRs, promoting plant growth and yield.

Natural PGRs offer advantages such as improved growth and reduced production costs due to readily available, low-cost materials. Research shows natural PGRs can enhance growth and abiotic stress tolerance (El-sabagh et al., 2022). However, farmers remain skeptical about their effectiveness compared to synthetic counterparts. Rajiman and Megawati (2022) found that soaking shallot seeds in coconut water improved growth.

Zulmi et al. (2024) demonstrated that 60% coconut water soaking for six hours invigorated chili seeds, enhancing vigor index, germination, and seedling traits. Lukmana et al. (2022) reported that coconut

and fermented rice water improved shoot and leaf development in rubber stumps. Other plant-based solutions, including shallots and mung bean sprouts, promoted tomato seed germination and uniformity (Marlina et al., 2023).

Tuber crops require stimulation for rapid growth due to high demand. Tubers are rich in carbohydrates and antioxidants, providing health benefits. Purple sweet potato contains 150 mg per 100 g of anthocyanin, which can be an antidepressant. Furthermore, the material is composed predominantly of water (77.2%) and carbohydrates (21.1%), with smaller proportions of protein (0.9%), ash (0.7%), and fat (<0.02%). It also contains several amino acids, notably alanine (917.3 mg kg⁻¹), histidine (914.9 mg kg⁻¹), serine (830.2 mg kg⁻¹), glutamic acid (823.9 mg kg⁻¹), and aspartate (803.7 mg kg⁻¹), along with cystine, methionine, and trace amounts of tryptophan (Kurnianingsih et al., 2021). Purple sweet potato is particularly valued for its anthocyanins and anti-diabetic properties (Les et al., 2021; Nurdjanah et al., 2022). (Ho et al., 2010) identified potent anthocyanins in purple sweet potatoes, effective in cancer

treatment and mood regulation. Nutrient profiles support its importance in health.

Farmers propagate purple sweet potatoes through vegetative cuttings or by using tuber segments. These methods often require growth stimulation to prevent dormancy and rotting. Although plants possess endogenous totipotency driven by phytohormones, poor soil conditions can suppress this growth potential. Therefore, exogenous stimulation is essential to activate plant growth potential (Su et al., 2021). However, despite numerous studies on natural plant growth regulators in various crops, there is still limited comparative information regarding the effectiveness of natural versus synthetic PGRs in enhancing the growth and yield of purple sweet potato, particularly under suboptimal soil conditions such as gleysol soils. As a result, it remains unclear whether natural PGRs can provide growth and yield responses comparable to or superior to synthetic PGRs when applied to purple sweet potato cultivated in gleysol soil. This study aims to evaluate various natural and synthetic materials as PGRs in promoting the growth and yield of purple sweet potato in gleysol soil.

MATERIALS AND METHOD

The study was carried out from January to June 2023 on type A tidal land dominated by Gleysols and acid sulfate soils in Sidomakmur Village, Marabahan District. The study area is characterized by acidic soil conditions, with pH values ranging from 4.2 to 5.6. During the study period, ambient temperatures ranged between 26 °C and 33 °C, relative humidity varied from 78% to 93%, and the average monthly rainfall was approximately 243 mm (BMKG, 2023).

Preparation

The first stage of this activity involved preparing beds from gleysol soil in a 50 x 50 cm plot for each block. The second stage is preparing the growth regulator treatment. The ingredients used are shallot extract, banana stem extract, coconut water, and Growtone (a synthetic PGR). This treatment was prepared by grinding shallot bulbs and banana stems using a blender. 60 ml of the extract is taken and mixed with 1000 ml of water to form a solution.

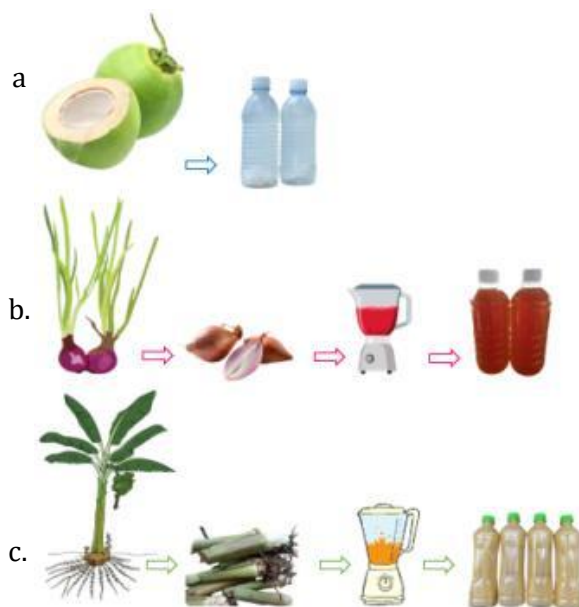


Figure 1. Preparation of natural PGR extracts from (a) coconut water, (b) shallots, and (c) banana corms, each processed through blending and filtration to obtain hormone-rich solutions

In the young coconut water treatment, 60 ml is taken and dissolved in 1000 ml of water (Figure 1), while 6 g of Growtone in powder form is dissolved in 1000 ml (Faizin, 2016; Prayoga et al., 2022; Wibowo & Zahrah, 2022)

The third stage is preparing the planting material, namely purple sweet potatoes cut into 1.5 cm x 1.5 cm pieces, and only the buds are used as planting material. Once everything is prepared, proceed to stage four, which involves soaking the planting material in each solution for 30 minutes before planting it in the soil at a depth of 1 cm.

Application

The application process was divided into three stages. The first stage involves planting purple sweet potato seedlings in the beds. Before planting in the field, the planting material is soaked for 30 minutes in each treatment. Each bed was planted with five seedlings, and a total of 25 (one treatment is control with pure water) were prepared for planting. The second stage involves spreading 3 kg of empty oil palm bunch fiber over the beds. The fiber acts as mulch to retain soil moisture and reduce evaporation, contributing to better root zone conditions and optimal plant growth (Abdillah, 2023). In the third stage, maintenance includes irrigating each bed with 100 mL of treatment solution. These irrigations are performed every four weeks over four months.

Method

Data were collected on shoot emergence, plant height, leaf number, fresh weight, and tuber weight. Observation on the growth and yield of purple sweet potato (*Ipomoea batatas* L.) involves several key parameters, including sprout emergence, plant height, number of leaves, fresh biomass, and tuber weight. Sprout emergence was recorded by observing the number of days after planting (DAP) until the first visible shoot appeared above the soil surface (Setyaningrum et al., 2023). Plant height is measured from the soil surface to the apex of the main shoot using a

ruler or measuring tape, and observations are taken periodically at weekly or biweekly intervals. The number of leaves is counted manually by including only fully expanded and healthy leaves (Tamara et al., 2021). Fresh biomass is assessed at harvest by carefully uprooting the plants and weighing the shoot and root portions immediately to avoid moisture loss. Tuber weight is measured by collecting all marketable tubers per plant, cleaning off soil residues, and weighing them using a digital scale (Julianto et al., 2020). These measurements provide important indicators of vegetative growth performance and yield potential under different treatment conditions. Appropriate timing, adequate replication, and consistency in data collection were implemented to ensure the accuracy and reliability of the experimental results. Observations were conducted over a period of 120 days. The collected data were analysed using SPSS version 25, with normality assessed by the Shapiro–Wilk test and homogeneity of variance evaluated using Bartlett's test. Analysis of variance (ANOVA) was subsequently performed, and mean differences among treatments were further examined using the Least Significant Difference (LSD) test at a 5% significance level (Paiman, 2022).

RESULT AND DISCUSSION

The immersion treatments successfully induced shoot development and tuber formation, though with varying growth indices among treatments. The fastest growth of shoots resulted from soaking the tuber cake with a banana corm solution. The sprouts soaked in the banana corm solution grew faster, as seen on the 7th day after planting, while the control treatment showed the slowest shoot growth, which was only seen rising on the 21st day. The immersion treatment with a solution of coconut water and Growtone showed shoot growth on the 14th and 17th days. Based on the LSD α 5% test, the banana corm solution treatment

differed from the other treatments, due to the phytohormone content (Figure 2).

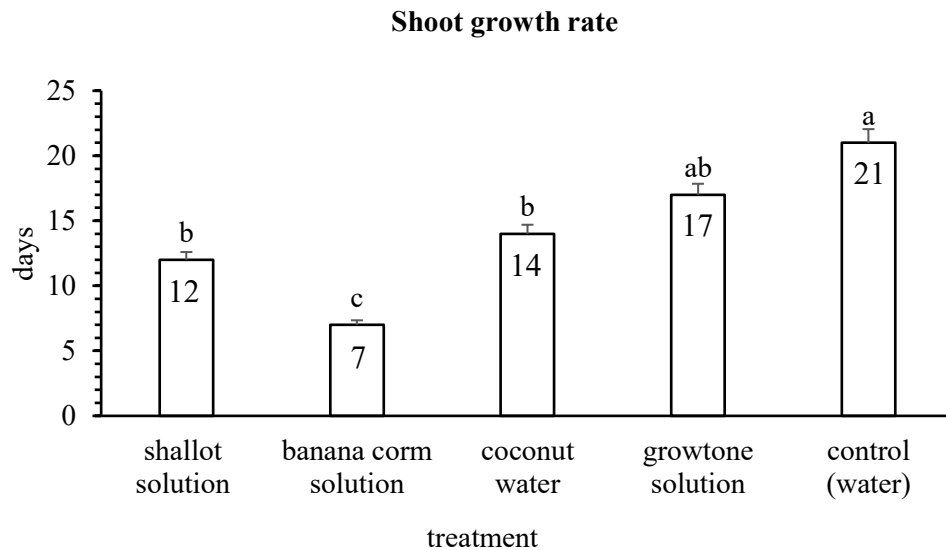


Figure 2. Effect of PGRs on shoot growth rate. Bar graphs followed by the same letter above indicate not significant difference in Fisher's LSD test at α 5%.

The application of banana corm solution, administered once every four weeks, significantly enhanced the growth of purple sweet potato plants, as reflected by increased plant length and leaf number at 120 days after planting. Plant length reached 373.4 cm under the banana corm treatment, whereas the control treatment resulted in a

plant length of only 77.6 cm. Watering with banana corm solution significantly influenced plant length compared with treatments using coconut water, Growtone, and the control (water), but showed no significant difference when compared with the shallot solution (Figure 3).

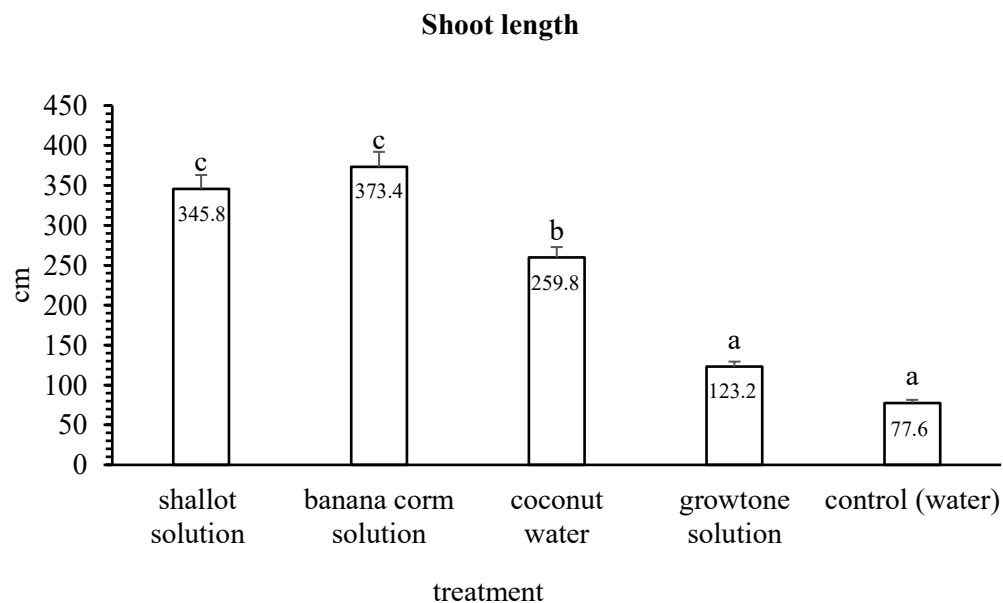


Figure 3. Effect of PGRs on shoot length. Bar graphs followed by the same letter above indicate no significant difference in Fisher's LSD test at α 5%.

The application of plant growth regulators significantly affected leaf number. Irrigation with shallot solution resulted in 245 leaves, which was not significantly different at the 5% LSD level from the banana corm solution treatment that produced 295 leaves. However, both treatments differed

significantly from the Growtong treatment, which yielded 97 leaves, and from the coconut water application, which resulted in 114 leaves. The control treatment using water alone produced the lowest leaf number, with only 50 leaves (Figure 4).

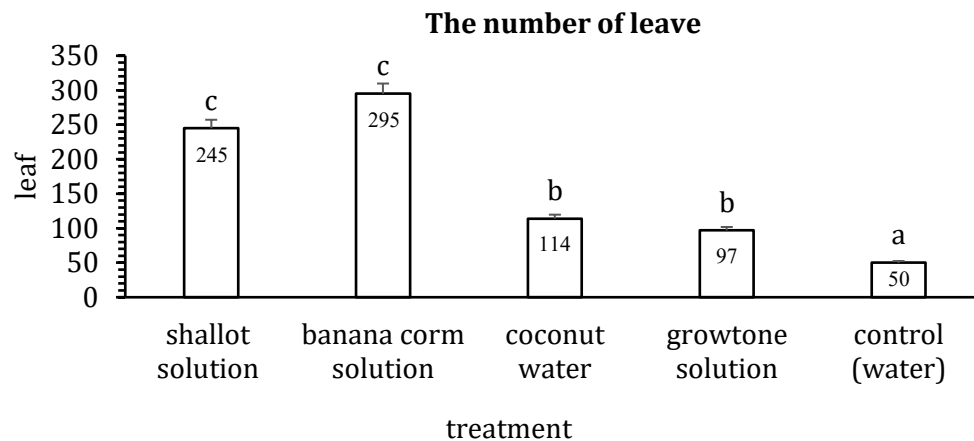


Figure 4. Effect of PGRs on the number of leaves. Bar graphs followed by the same letter above indicate no significant difference in Fisher's LSD test at α 5%.

The application of PGRs had a significant effect on plant fresh weight. Watering the banana corm solution on the plants affects leaf growth and elongation, so it accumulates in the plants' fresh weight. Based on the 5% LSD test (Figure 5), it was stated that the fresh weight of the heaviest purple sweet potato plants resulted from the treatment of watering the shallot solution at 435.62 g, not

different from the banana corm at 356.2 g, which was very significantly different from the other treatments. The fresh weight of the plants was the smallest, resulting from the control treatment (water) at 119.4 g, while it was not significantly different from the Growtong treatment compared with coconut water.

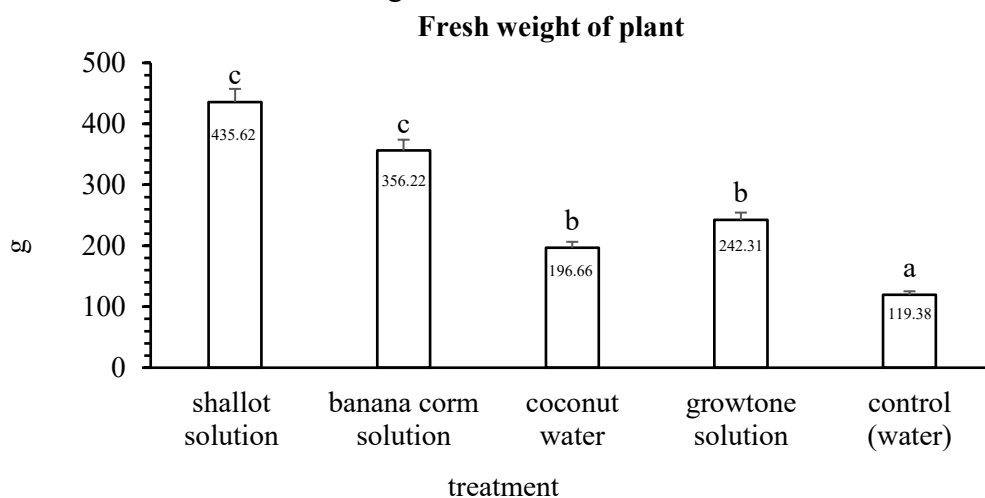


Figure 5. Effect of PGRs on fresh weight. Bar graphs followed by the same letter above indicate no significant difference in Fisher's LSD test at α 5%.

The tuber weight is influenced by tuber filling and metabolic processes. Nutrient uptake affects the formation and filling of carbohydrates in tubers. The higher the formation of photosynthetic organs, the greater the tuber yield potential. The weight of tubers treated with a banana corm solution showed very different results from other

treatments. The tuber weight resulting from this treatment was 254.1 g, while the lowest tuber weight resulted from the water control treatments, which was 4.8 g (Figure 6). The Growtome watering showed results that weren't different from the water, which produced a weight of 25.8 g.

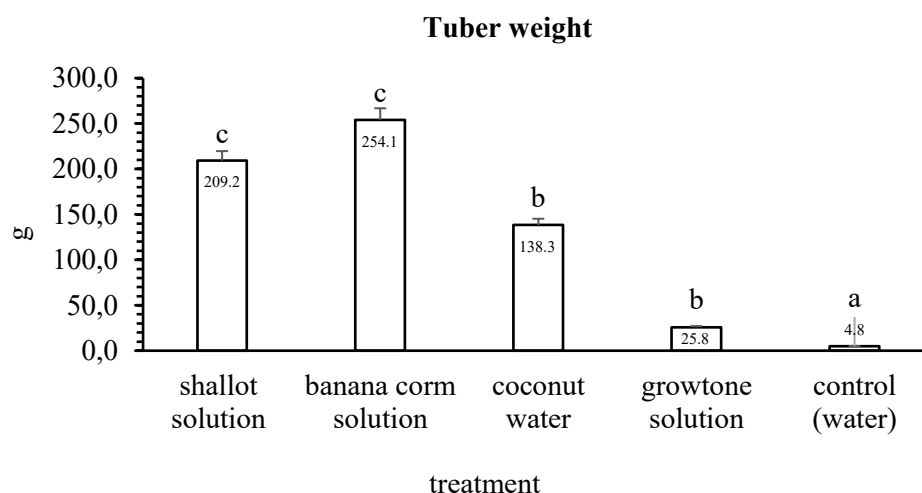


Figure 6. Effect of PGRs on tuber weight. Bar graphs followed by the same letter above indicate no significant difference in Fisher's LSD test at α 5%.

The application of different plant growth regulator sources affected the growth and yield of purple sweet potato. Among the treatments evaluated, banana corm extract is recommended for wider use due to its strong positive response, which is likely associated with its phytohormone content (Hamidon et al., 2020). The application of auxin compounds as phytohormones stimulated the growth of *Antigonon leptopus* (Maulana et al., 2023). However, in some cases, several types of phytohormones can be antagonistic to one another (Kurepa et al., 2019). This causes several PRGs that have different effects on the growth of purple sweet potatoes.

The results showed that applying banana corm accelerated shoot growth compared to other treatments. The complete phytocompound from banana trunks can be an exogenous hormone for other plants

(Islam et al., 2022; Oliveira et al., 2007). The rate of shoot growth is primarily influenced by cytokinin (CK) compounds, particularly BAP (6-benzylaminopurine) and small amounts of kinetin (Kn), which promote rapid shoot development. Both BAP and Kn were present in comparable levels in the banana corm, whereas the shallot treatment exhibited relatively higher auxin content. This hormonal imbalance may have diminished the cytokinin effect in the shallot treatment, thereby reducing the stimulation of shoot growth. Cytokinins function as key plant hormones regulating various developmental processes, including organ formation, bud activation, apical dominance, and the delay of leaf senescence (El-showk et al., 2013).

Cytokinins are known to exhibit antagonistic interactions with auxins and also coordinate with other plant hormones to

regulate plant growth and development (Nursandi et al., 2024). Azizi et al. (2015) reported that shoot growth is promoted by cytokinins through the stimulation of cell division and the suppression of cell differentiation, whereas auxins contribute to organ primordia initiation by inhibiting cytokinin biosynthesis. Therefore, a balanced interaction between cytokinins and auxins within cellular compartments is essential for the rapid formation of shoot primordia. Consistent with this mechanism, the application of various cytokinin compounds has been shown to enhance shoot proliferation and induce shoot formation in *Chlorophytum borivilianum* (Ashraf et al., 2014). In contrast, auxin application, particularly indole-3-butyric acid (IBA), promoted root elongation, whereas indole-3-acetic acid (IAA) in combination with 6-benzylaminopurine (BAP) contributed to shoot elongation (Justin et al., 2023; Khadr et al., 2020; Qureshi et al., 2021). Rustikawati et al. (2021) reported that the CK compound in the form of 6-Benzyl Aminopurine affected *Curcuma zedoaria* Roch. and *Curcuma zedoaria* Val. to trigger faster shoot growth. The growth of purple sweet potatoes with coconut water could be more optimal, and the auxin content is relatively high. The hormonal composition of coconut water was dominated by auxins, with lower levels of cytokinins, gibberellins, abscisic acid, and salicylic acid (Yong et al., 2009). The auxin content is higher if fermentation occurs, even for a moment. (Ningsih et al., 2021; Setiawan, 2017).

Apart from PGRs, nutrients also play an active role in promoting plant elongation, leaf formation, and the formation of plant biomass (Shah et al., 2023). The application of banana corm solution significantly affected plant stem elongation and leaf formation, so it was significant for plant fresh weight gain. The results that can be seen in Figure 3 (shoot length), Figure 4 (number of leaves), and Figure 5 (fresh weight) show a significant impact of the banana corm solution compared

to watering with other solutions, except for the shallot solution watering treatment. That is due to the role of phytohormone compounds from banana corm and a relatively high supply of macronutrients, especially potassium. However, the shallot solution has a positive impact on plant weight, indicating a preferential stimulation of vegetative biomass rather than assimilate partitioning toward storage root development. The contrasting response compared with Mangais et al. (2022) may be related to differences in crop type, harvested organs, and soil conditions, as purple sweet potato allocates assimilates primarily to storage roots rather than vegetative biomass. This outcome may be attributed to the presence of phytohormones such as zeatin, kinetin, and thidiazuron in the applied materials. Among these hormones, zeatin has been shown to consistently promote greater rooting and shoot elongation, resulting in increased plant length compared with other phytohormones, which likely contributes to its strong capacity to induce shoot formation from the meristem (Masekesa et al., 2016). Riyandani et al. (2021) reported that using banana stems can increase the availability of nutrients in the soil, especially potassium. Therefore, the combined effects of phytohormonal stimulation and enhanced nutrient availability from banana corm extract contribute to more efficient assimilate allocation, ultimately optimizing the growth and yield of purple sweet potato plants (Huan et al., 2020; Shitikova & Povarnitsyna, 2022; Zhou et al., 2023). The harvest index is correlated with the efficiency of assimilate partitioning for tuber formation (Rahajeng et al., 2021).

CONCLUSIONS

Soaking purple sweet potato cuttings in banana corm extract significantly accelerated shoot emergence and increased tuber weight, indicating a synergistic effect of hormones and nutrients. Shallot extract enhanced vegetative biomass but was less

effective in promoting tuber yield. Compared with synthetic PGRs and the control, banana corm extract showed superior performance, suggesting its potential as a natural PGR alternative for improving purple sweet potato cultivation in gleysol soil. Further studies are recommended to optimize dosage and application frequency.

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