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EFFECT OF BIOSTIMULANT TYPE AND CONCENTRATION ON CIPANAS POTATO (*Solanum tuberosum* L.) ACCLIMATIZATION

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ABSTRACT

Potato plantlets produced through tissue culture require an acclimatization phase before transfer to field conditions. Natural biostimulants are expected to enhance plantlet adaptation and growth during this critical stage. This study aimed to determine the effect of the type and concentration of anti-stress biostimulants on the growth of Cipanas potato plantlets during the acclimatization phase. The study employed a split-plot design with two factors: biostimulant type (coconut water and aloe vera extract) and biostimulant concentration (0%, 5%, 15%, and 25%), each replicated three times. The results showed that biostimulant type and the interaction between biostimulant type and concentration had no significant effect on all observed parameters. Biostimulant concentration significantly affected only the root number of potato plantlets at 5 weeks after acclimatization (WAA). Duncan's Multiple Range Test (DMRT) at the 5% significance level showed that the 25% concentration produced a root number that was not significantly different from the control (0%) and showed a better root formation response than the 5% concentration, while the 15% concentration was not significantly different from all treatments. Overall, the application of coconut water and aloe vera extract did not significantly improve plant height increase or leaf number during acclimatization. However, variations in biostimulant concentration showed the potential to support root development in Cipanas potato plantlets during the acclimatization phase.

Keywords**:** Acclimatization, Aloe vera, Biostimulant, Coconut water, Potato

INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important horticultural crop with high economic value and increasing demand. The availability of high-quality planting materials is essential to support potato production, and plant tissue culture has been widely used to produce uniform and disease-free plantlets.

Before transfer to field conditions, tissue-cultured plantlets must undergo an acclimatization stage. This phase is considered critical because plantlets must adapt from controlled in vitro conditions to ex vitro environments characterized by fluctuations in temperature, humidity, light intensity, and growing media. During acclimatization, plantlets are highly susceptible to water loss and physiological stress due to their underdeveloped cuticle layer, limited stomatal function, and weak root systems.

Natural biostimulants such as coconut water and aloe vera extract have been reported to contain plant growth-promoting substances. Coconut water contains auxins, cytokinins, gibberellins, vitamins, and minerals, whereas aloe vera extract contains natural hormones, amino acids, vitamins, and various bioactive compounds that may support plant growth and stress tolerance.

However, information regarding the comparative effectiveness of coconut water and aloe vera extract during the acclimatization of Cipanas potato plantlets remains limited. In addition, the optimum concentration required to improve acclimatization performance has not been clearly established. Therefore, this study aimed to evaluate the effects of biostimulant type and concentration on the growth response of Cipanas potato plantlets during acclimatization.

MATERIALS AND METHODS

The study was conducted at the Agroecology Laboratory, Faculty of Agriculture, Universitas Sultan Ageng Tirtayasa, Indonesia, from November 2025 to January 2026. The materials used were Cipanas potato (*Solanum tuberosum* L.) plantlets derived from tissue culture, coconut water, aloe vera extract, cocopeat, and perlite. The main equipment included a mini greenhouse, seedling trays, hand sprayers, measuring cylinders, and other laboratory tools required for acclimatization.

Plantlets were acclimatized in a cocopeat–perlite medium (1:1, v/v) under mini greenhouse conditions. The experiment was arranged in a split-plot design with three replications. The main plot factor was biostimulant type, consisting of coconut water (A1) and aloe vera extract (A2). The subplot factor was biostimulant concentration, consisting of 0% (B0), 5% (B1), 15% (B2), and 25% (B3). A total of 24 experimental units were used, with three plantlets per experimental unit. Biostimulants were applied by foliar spraying once a week during the acclimatization period. Approximately five sprays (≈1 mL plant^{-1}) were applied to each plantlet until the leaf and stem surfaces were evenly wetted.

The observed variables included plant height increase (cm), leaf number (leaves plant^{-1}), root number (roots plant^{-1}). Plant height increase, leaf number, and survival rate were recorded at 3, 4, and 5 weeks after acclimatization (WAA).

Data were analyzed using analysis of variance (ANOVA). Data that did not meet ANOVA assumptions were transformed using $\sqrt{x + 0.5}$, whereas root number data were transformed twice using the same method. When significant treatment effects were detected, mean separation was performed using Duncan's Multiple Range Test (DMRT) at the 5% significance level.

RESULTS AND DISCUSSION

Plant height increase

Plant height increase was not significantly affected by biostimulant type, biostimulant concentration, or their interaction throughout the acclimatization period (Figure 1). At 3 WAA, plant height increase ranged from 0.81 to 1.50 cm, whereas at 4 WAA and 5 WAA the values ranged from 0.87 to 2.17 cm and 0.69 to 2.16 cm, respectively. Although several treatments showed higher mean values than others, the overall response pattern remained inconsistent among observation periods.

The absence of significant differences suggests that plantlets were still undergoing physiological adaptation to ex vitro conditions. During acclimatization, tissue-cultured plantlets generally possess an underdeveloped cuticle layer, limited stomatal regulation, and weak root systems, making them highly susceptible to water loss and environmental stress. Consequently, a considerable proportion of assimilates and metabolic energy is allocated to survival and adaptation rather than shoot elongation. According to Dewanti *et al*. (2023), acclimatization represents a critical stage during which plantlets must adjust to changes in humidity, temperature, light intensity, and growing media following transfer from in vitro conditions.

The present findings are partially consistent with those reported by Fauzi (2021), who found that Aloe vera gel significantly increased plant height in mung bean plants, although its effects on other vegetative growth parameters were limited. In contrast, no significant response was observed in the present study, indicating that the effectiveness of natural biostimulants may vary according to plant species, developmental stage, and environmental conditions during acclimatization.

Leaf number

Leaf number was not significantly influenced by biostimulant type, concentration, or their interaction at any observation period (Table 1). At 5 WAA, the average leaf number ranged from 1.22 to 1.78 leaves plant^{-1}. Coconut water at 15% and 25% concentrations produced the highest mean leaf number (1.78 leaves plant^{-1}), whereas the lowest value was observed in aloe vera extract at 5% concentration (1.22 leaves plant^{-1}). However, these differences were not statistically significant.

The limited response of leaf development may be attributed to the acclimatization process itself. Newly acclimatized plantlets tend to prioritize the establishment of physiological functions required for survival, including water balance regulation and root development, before allocating resources to leaf production. Pospíšilová *et al*. (2007) reported that tissue-cultured plantlets often exhibit imperfect stomatal function and poorly developed cuticular layers, resulting in high transpiration rates during the early stages of acclimatization. Under such conditions, leaf development is strongly influenced by environmental adaptation rather than by external growth-promoting substances.

The results also suggest that the favorable environmental conditions maintained during acclimatization contributed substantially to leaf formation. Relative humidity was maintained at approximately 80%, which helped reduce excessive water loss and transplant shock. Consequently, the effects of biostimulant application may have been masked by the dominant influence of environmental conditions on plantlet adaptation.

Root development response

Root number was the only parameter significantly affected by biostimulant concentration during acclimatization. As shown in Table 2, root number ranged from 0.44–1.78 roots plant^{-1}

under coconut water treatments and 0.11–1.67 roots plant^{-1} under aloe vera extract treatments. The mean root number across biostimulant concentrations ranged from 1.15 to 1.38 roots plant^{-1}. Duncan's Multiple Range Test (DMRT) indicated that the 0% and 25% concentrations were not significantly different, whereas the 15% concentration did not differ from any treatment. In contrast, the 5% concentration produced significantly fewer roots than the 0% and 25% concentrations.

The positive response observed at higher concentrations may be associated with naturally occurring growth regulators, particularly auxins and cytokinins. Coconut water contains auxins, cytokinins, vitamins, amino acids, and minerals that promote root initiation (Yong et al., 2009), whereas aloe vera extract contains bioactive compounds that enhance plant physiological activity during environmental adaptation (Alizadeh et al., 2020). However, in the present study, these effects were observed only in root development, while plant height increase and leaf number were not significantly affected.

Despite the positive response at the 25% concentration, root number was not significantly different from the control, suggesting that the cocopeat–perlite (1:1) medium already provided favourable conditions for root growth. The medium maintained adequate moisture and aeration, allowing root development even without biostimulant application (Irsyadi, 2021). Overall, these findings indicate that root development during acclimatization was influenced by both biostimulant concentration and the suitability of the growing medium.

CONCLUSION

1. Biostimulant type had no significant effect on the acclimatization of Cipanas potato planlets.
2. A 25% biostimulant concentration produced root development comparable to the control (0%), while the 15% concentration did not differ significantly from any treatment.
3. The interaction between biostimulant type and concentration had no significant effect on any of the observed growth parameters.

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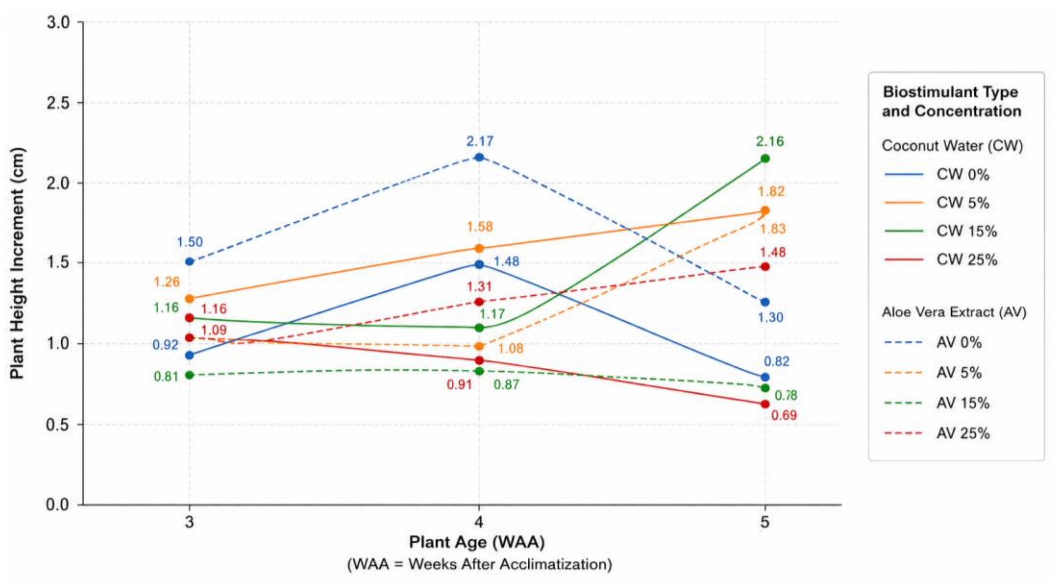

Figure 1. Plant Height Increase of Cipanas Potato Planlets During Acclimatization

Table 1. Leaf Number of Potato Planlets at 5 WAA

Plant Age (WAA)	Biostimulant Type (A)	Biostimulant Concentration (B)				Mean
		0%	5%	15%	25%	
-----------------------leaves (plant^{-1}) -----------------------						
5	Coconut Water	1,56	1,44	1,78	1,78	1,64
	Aloe Vera Extract	1,78	1,22	1,56	1,67	1,56
Mean		1,67	1,33	1,67	1,73	1,6

Table 2. Root Number of Potato Planlets at 5 WAA

Plant Age (WAA)	Biostimulant Type (A)	Biostimulant Concentration (B)				Mean
		0%	5%	15%	25%	
-----------------------roots plant^{-1} -----------------------						
5	Coconut Water	1,78	0,44	0,89	0,89	1,00
	Aloe Vera Extract	1,33	0,11	1,67	1,38	1,12
Mean		1,38^{a}	1,15^{b}	1,28^{ab}	1,34a	

Explanations: Means followed by the same letter within a row are not significantly different according to Duncan's Multple Range Test (DMRT) at the 5% significance level