

# Accelerating the growth of the *phalaenopsis amabilis* orchid by engineering a gutter system cultivation

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**Abstract.** The aim of this research is to obtain a method to accelerate vegetative growth through the provision of nutrient solutions using a planting media immersion system (tach system). This research was conducted in the Greenhouse from July to October 2023. This research uses a factorial Randomized Block Design (RBD). The first factor is the frequency of immersion (F) with 3 levels, and the second factor of chicken manure concentrate (C) consists of 2 concentrations. The results showed that the treatment of soaking frequency and nutrient concentration had a significant interaction effect. The results of the regression test showed a linear interaction pattern for all growth variables, except leaf area. The more often you soak the planting medium, the better the growth of the *Phalaenopsis amabilis*. This shows that plant media soaked in nutrient solution cannot absorb dissolved nutrients for a long time. Based on these results, it was concluded that the more frequent immersion of the planting medium in nutrient solution had a positive effect on the growth of orchid plants. However, this research also shows that although statistically the effect of different treatments is significant on the growth variable, it is not visually obvious.

## 1 Introduction

The most crucial stage for growing moon orchids is the acclimation stage. Acclimation is one of the stages of orchid seedling adaptation from the in vitro environment to the new environment (in vivo). This stage is a critical stage for orchid seedlings that will experience physiological changes due to new environmental factors. Factors that influence the success of seedling growth at the acclimatization stage include: seedling condition, light intensity, temperature, relative humidity, type of planting medium, nutrition and fertilization, and pest and microorganism control [1]. In the acclimatization phase, plant mortality is quite high, which is indicated by the low percentage of seedling growth [2, 3]. This study attempts to overcome these problems by finding alternative suitable planting media and providing plant nutrients.

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Planting media is an important factor in the success of acclimation and enlargement of orchid plants because it supports plants, maintains moisture, and root aeration, and creates conditions for nutrients to be available to plants. Different planting media have different water absorption characteristics, so their effects on orchid seedling growth are also different [4, 5, 6]. Various planting media materials for orchid seedling growth include a mixture of broken bricks, charcoal, bark, cocopeat, and mosses [5,6]. Orchid plants in nature prefer bark that has high pore density and water retention after drying [7, 8]. The growth of *Epidendrum* sp. orchids is best on charcoal and pine bark media, compared to termite nests and sphagnum media [9]. Various studies have shown that phorophyte tree bark can be a contributing factor to this specificity, especially by modulating the microenvironment. Probability interaction models that analyze factors that explain the epiphyte-host network also support this idea and have shown that epiphytes are more commonly found on trees with denser wood or rougher bark [10, 11].

Most orchid nutrition studies in the world have recommended Nitrogen, Phosphate and Potassium as the main elements for orchid growth. There are several reports on the benefits of a combination of organic and inorganic nutrients in orchid plants [12]. The growth of *Dendrobium* sp. orchids is influenced by the time of administration and the composition of NPP nutrients [13, 14]. The proportion of NPP fertilizer 20:20:20 and 20:10:20 given by spraying twice a week showed the best effect on the growth and appearance of *Dendrobium* sp. flowers [15]. Liquid organic fertilizers whose raw materials are added with chicken manure have good element content and are in accordance with Indonesian national standards [16]. The use of liquid organic fertilizers from various basic materials given by spraying plants twice a week with a solution concentration of 1:10 and 1:20 gave the same results as NPP fertilizers [17]. This study used liquid organic fertilizer (LOF) chicken manure. The fertilizer concentrate consists of 30% chicken manure, 30% molasses, and 40% water. The concentrations tested were 10 ppm and 20 ppm.

Orchid cultivation with a gutter system is a cultivation technique similar to the ebb and flow hydroponic system. The provision of water and dissolved plant nutrients with sub-irrigation (soaking for a while) is a modified model of the ebb and flow hydroponic system. The ebb and flow technique is one of the hydroponic techniques that is widely used. This system works by filling the planting medium with nutrient solution and the unabsorbed nutrient solution is drained back into the tub [18, 19]. Research on orchid cultivation with a gutter system is a novelty of this study. Fertilization with a combination of different frequencies and concentrations in the gutter system cultivation engineering will affect the growth of orchid plants. *Dendrobium* sp. orchids are best fertilized every three days [20]. Orchid fertilizer is usually given by spraying it on the roots and leaves. In orchid cultivation with a gutter system, fertilizer is given to the roots by flooding the planting medium through an ebb and flow system. This method is more energy efficient than spraying and is expected to accelerate the vegetative growth of orchid plants.

## 2 Methodology

The research was conducted for 4 (four) months, from July to October 2023. The research was conducted in the Greenhouse, Malang City, East Java, Indonesia. The average temperature is 22-30 °C, air humidity ranges from 79-86% with an altitude of 440–667 meters above sea level. The tools used in this study were analytical scales, tweezers, gutters, buckets, rulers, scissors, and ovens. The materials used in this study were  $\pm$  10-month-old tissue culture orchid seedlings, fine pine bark planting media, water, Liquid Organic Fertilizer (LOF) chicken manure, Dithane M-45 fungicide. The research design used was a factorial Randomized Block Design (RBD), where the first factor was the frequency of soaking (F) at 3 levels, namely: F<sub>1</sub>

(soaking once every 2 days), F<sub>2</sub> (soaking once every 4 days), F<sub>3</sub> (soaking once every 6 days), with a soaking time of 10 minutes. Orchids were planted on pine bark media by soaking for 10 minutes each time treatment. The second factor was the concentration of chicken manure LOF (K) consisting of 2 concentrations, namely K<sub>1</sub> (10 ppm), and K<sub>2</sub> (20 ppm). The combination of the two factors became 6 treatment combinations. Each treatment was repeated 3 times. So, 18 treatment combinations were obtained. Each experimental unit had 2 plant samples. The observed plant growth variables were; number of leaves, leaf length, and leaf area, which were measured once every 2 weeks for 5 times. The percentage of root development, root length development, and plant fresh weight development were observed 2 times, namely when planting in pots (0 WAP) and at 10 WAP, the plants were removed from the planting medium in the pot. The data obtained was then analyzed using analysis of variance (ANOVA) with a test level of 5%. If there are analysis results that have a significant effect, a further LSD test is carried out at a level of 5% to determine the differences between treatments.

### 3 Results and Discussion

Based on the results of the analysis of variance that have been carried out, it shows that there is a significant interaction effect between the frequency of soaking and the concentration of chicken manure LOF on the variable number of leaves in observations 2–6 Weeks After Planting (WAP), and the variable length of leaves in observations 2–10 WAP (Tables 1 and 2).

**Table 1.** Average number of leaves at observation age (weeks after transplanting)

Treatment	Average Number of Orchid Plant Leaves (Sheets)				
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
F <sub>1</sub> K <sub>1</sub>	2,17 ab	2,17 ab	2,17 ab	3,04	3,73
F <sub>2</sub> K <sub>1</sub>	2,56 b	2,56 b	2,56 b	3,14	3,67
F <sub>3</sub> K <sub>1</sub>	2,11 a	2,11 a	2,11 a	3,49	3,00
F <sub>1</sub> K <sub>2</sub>	2,00 a	2,00 a	2,00 a	3,39	3,72
F <sub>2</sub> K <sub>2</sub>	2,00 a	2,00 a	2,00 a	3,00	3,10
F <sub>3</sub> K <sub>2</sub>	2,00 a	2,00 a	2,00 a	3,06	3,06
LSD	0,44	0,44	0,44	ns	ns

Note: Numbers followed by the same letter in each column indicate no significant difference based on the 5% LSD test. WAP: weeks after planting.

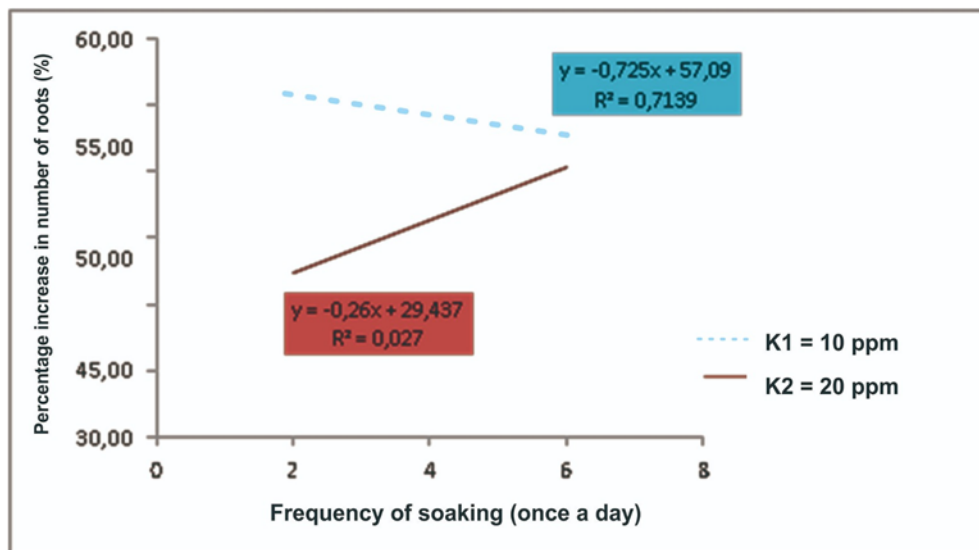
These results indicate that the frequency of soaking is related to the levels of nutrients absorbed in the planting medium. However, the interaction effect of application frequency with nutrient concentration shows a different pattern in the variables of percentage increase in the number of roots and percentage increase in root length.

**Table 2.** Average leaf length at observation age (weeks after transplanting)

Treatment	Average Length of Orchid Leaves (cm)				
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
F <sub>1</sub> K <sub>1</sub>	3,15 d	3,45 c	3,59 c	3,69 b	3,84 b
F <sub>2</sub> K <sub>1</sub>	2,58 cd	2,94 bc	3,14 bc	3,32 b	3,43 b
F <sub>3</sub> K <sub>1</sub>	2,24 bc	2,54 ab	2,70 ab	3,02 ab	3,27 b
F <sub>1</sub> K <sub>2</sub>	1,64 ab	1,85 a	1,95 a	2,41 a	2,67 a
F <sub>2</sub> K <sub>2</sub>	1,75 abc	1,94 a	2,11 a	2,48 a	2,63 a
F <sub>3</sub> K <sub>2</sub>	1,34 a	2,08 a	2,21 a	2,42 a	2,63 a
<b>LSD</b>	<b>0,89</b>	<b>0,79</b>	<b>0,76</b>	<b>0,74</b>	<b>0,58</b>

Note: Numbers followed by the same letter in each column indicate no significant difference based on the 5% LSD test. WAP: weeks after planting.

The more frequently applied nutrient concentration of 10 ppm (K<sub>1</sub>) has a positive effect on the number and length of roots. Consequently, the more frequently applied concentration of 20 ppm (K<sub>2</sub>) has a negative effect on the growth of the number and length of roots (Figures 1 and 2).

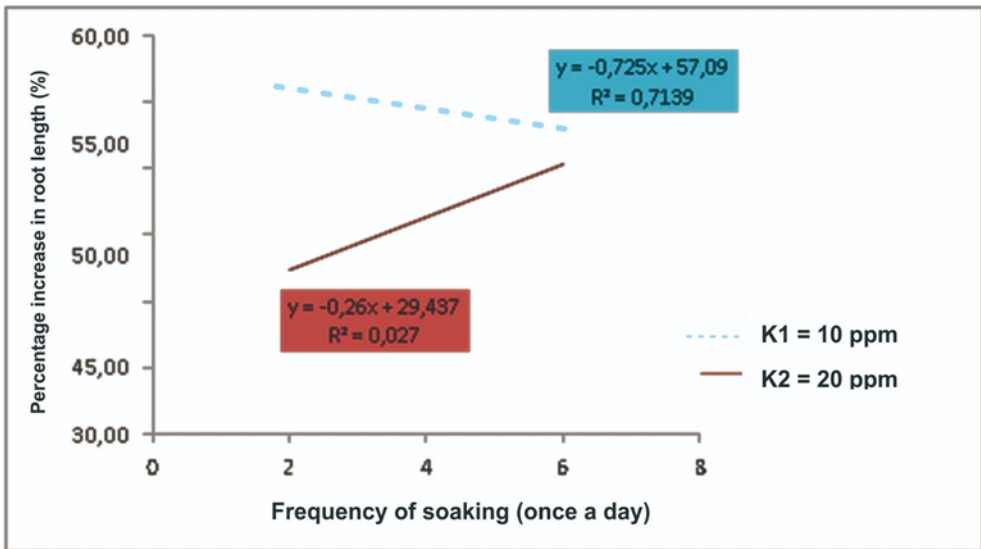


**Figure 1.** The regression test result curve of the percentage increase in the number of roots in the combination of soaking frequency and liquid chicken manure concentration treatments.

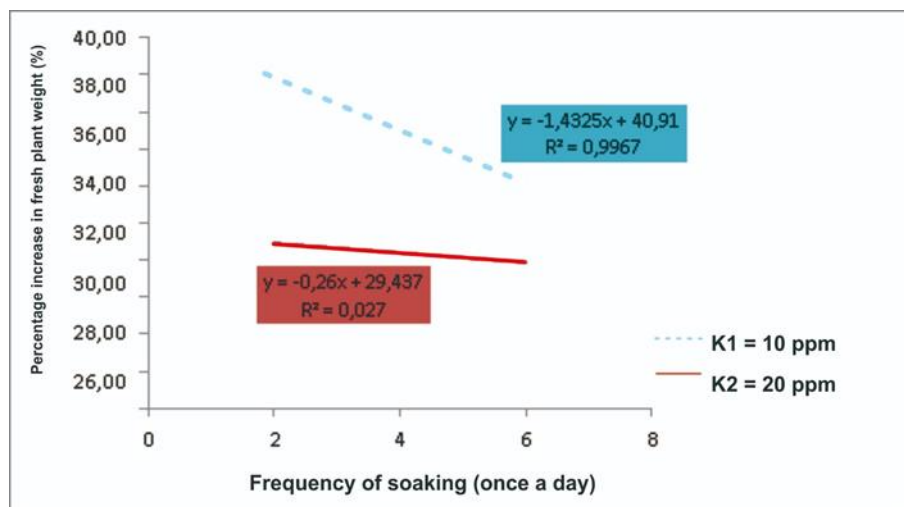
Pine bark planting medium is able to absorb water quite well, so it is able to absorb and bind nutrients. Planting media is a supporting substrate for upright plant growth as well as providing oxygen, water, and nutrients for plants [21]. The characteristics of the planting medium will affect every aspect of plant growth and yield, especially related to water and nutrient absorption [22]. Sufficient nitrogen supply supports vegetative plant growth as indicated by higher number of leaves, leaf length, and photosynthesis results [23]. Figure 3 confirms that the more frequent nutrient application, the better its effect on growth. The regression curve even shows that the concentration of chicken manure LOF nutrients of 10 ppm and 20 ppm contributes positively to the photosynthesis results of *P. amabilis* orchid plants. This indication is shown by the percentage of fresh weight growth of the plant. Broiler chicken manure contains 16.10% C-Organic; 2.44% N, 0.67% P; and, 1.24% K [24], the C-

organic content, and NPP of chicken manure meet the Indonesian national standards for solid organic fertilizer. While liquid organic fertilizer has a minimum N content of 0.5% with a minimum C-organic of 10%. Although the nutrient content in liquid organic fertilizer is relatively low, it is already in a state that is available to plants [25]. That is what causes the concentration of liquid organic fertilizer 10ppm to have a better effect than 20 ppm.

The assimilation results are indicated by the fresh weight of *P. amabilis* orchid plants applied with chicken manure LOF with a concentration of 10 ppm. Results decreased if applied with a less frequent frequency. The regression curve in Figure 3 shows a negative regression equation. This means that the longer the soaking interval, the lower the plant assimilates results will be. The regression coefficient value of R square = 99.67% indicates a very strong relationship between the two combined factors.



**Figure 2.** The regression test result curve of the percentage increase in root length in the combination of soaking frequency and liquid chicken manure concentration treatments.



**Figure 3.** The regression test result curve of percentage increase in fresh plant weight combined with treatment of immersion frequency and concentration of liquid chicken manure.

## 4 Conclusion

Based on the results of the study, it can be concluded that the cultivation of the gutter system can accelerate the growth of orchid plants. There is a significant interaction effect between the frequency of application and nutrient concentration on the growth of moon orchid seedlings (*Phalaenopsis amabilis*). The concentration of liquid chicken manure fertilizer of 10 ppm shows a strong correlation pattern with a regression coefficient value (R square) above 90%. Moon orchids (*P. Amabilis*) cultivated with the gutter system require more frequent immersion applications, so the better.

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