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# EVALUATION OF GROWTH CONDITION FOR ACCLIMATIZATION AND CULTIVATION OF HEAT–TOLERANCE CYMBIDIUM IN VIETNAM

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## ABSTRACT

This study investigates the effects of various growing substrates and fertilizer treatments on the acclimatization and growth of heat-tolerant *Cymbidium* orchid (*Cymbidium* Golden Vanguard). The results indicate that substrate quality is a critical factor influencing the survival and growth of in vitro plantlets during acclimatization. Specifically, treated coconut husk pieces and treated coconut coir demonstrated the highest survival rates at 97% and 95%, respectively. In contrast, untreated substrates exhibited lower survival rates, highlighting the effects of residual toxic compounds. The application of NPK 30:10:10 fertilizer significantly enhanced both plant height and leaf number compared to other treatments, demonstrating its effectiveness in promoting vigorous development of orchid plants. The findings emphasize the need for optimal substrate selection and fertilization strategies to enhance the growth of heat-tolerant *Cymbidium* orchid in greenhouse conditions.

**Keywords:** Acclimatization, Fertilizer, *Cymbidium*, Orchid, Substrate, Vietnam.

## I. INTRODUCTION

The *Cymbidium* orchid consists of approximately 50 species that are native to the Himalayan region to China, Japan, Southeast Asia, and Australia. Due to their extensive distribution, *Cymbidium* orchids are commonly categorized into three horticultural groups based on their temperature tolerance: cool, intermediate, and warm. This diverse range of habitats creates a variety of environmental conditions, such as differences in water availability, light exposure, temperature, carbon dioxide ($CO_2$) levels, and nutrients. As a result, different life forms have developed within this genus, including terrestrial, epiphytic, and lithophytic types (Motomura et al., 2008). *Cymbidium* orchids, valued for their vibrant flowers and symbolic meaning, have been cultivated for over 2,700 years, particularly in China. Due to their high value and demand, hybridization has become a common method of recombining the genotypes of parent plants to create hybrids with novel characteristics, thus introducing exciting traits to the floriculture industry (Kishor et al. 2006). Hybrid *Cymbidiums* dominate temperate and subtropical gardens and are vital in the cut-flower industry. Recent breeding efforts have shifted focus toward heat-tolerant varieties to cater to tropical climates where annual temperature variations are minimal. These hybrids, often derived from species like *C. ensifolium*, *C. aloifolium*, and *C. canaliculatum* with cold-growing species, therefore, they thrive without the chilling requirements necessary for standard Cymbidium blooming (Teoh 2021).

In recent years, advancements in plant biotechnology have enabled scientists in Vietnam to propagate various valuable orchid species successfully. However, research has predominantly focused on inducing protocorm formation, accelerating propagation, and enhancing root development from protocorms, with relatively little attention given to cultivation techniques (Davis et al., 2024). This limitation is also evident in *Cymbidium* research, despite Vietnam being located within the diversity zone for these orchids. Considering Vietnam's high temperatures and humidity, the development of heat-tolerant *Cymbidium* hybrids is crucial and then successful cultivation and acclimatization depend on optimizing growth conditions through appropriate combinations of substrate and fertilizers. This study evaluates substrate compositions and fertilizers to enhance plant vigor, adaptability, and growth. The findings will contribute to sustainable horticulture and create economic opportunities in response to the increasing global demand for these orchids.

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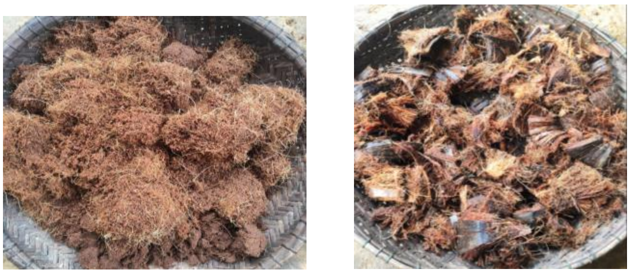
## II. METHODOLOGY

### Plant and growth conditions

The *Cymbidium* Golden Vanguard plants used in this study were cultivated in a controlled greenhouse environment located in Hue City, Thua Thien Hue Province, Vietnam. The average daily temperatures during the experiment ranged from 16–37°C. Plants were irrigated with tap water as needed to avoid water stress. Fertilizer treatments were applied bi-weekly at a dilution of 1/1,000, and the substrates were prepared using various locally available materials, ensuring consistency across all experimental units.

### Effects of the substrate on the acclimitation of *in vitro* Cymbidium plants

The experiment evaluated the influence of substrate types on the survival rate and growth of *in vitro* – derived *Cymbidium* plants. Two types of substrate were used - coconut coir and coconut husk pieces (Fig. 1). Four substrate treatments were tested – (A1) Untreated coconut coir, (A2) Treated coconut coir, (B1) Treated coconut husk pieces, (B2) Untreated coconut husk pieces. Coconut coir and coconut husk pieces in A2 and B1 were treated by soaked and washed three times before planting.



(A) (B)

**Figure 1:** Substrate used in acclimitation phase – A: Coconut coir, B - Coconut husk pieces

### Effects of fertilizer on the growth of heat-tolerance Cymbidium plants

Afer 28 days for adaptation in greenhouse, orchird plants were treated with foliar NPK fertilizer at different N:P:K ratios, (F1 - control): No foliar spray, (F2) NPK = 20:20:20, (F3) NPK = 30:10:10

### Data analysis

The study used a randomized block design, 3 blocks and ten replications in each block. The parameters observed included plantlet survival rate during acclimatization, number of leaves, plant height. The plantlet survival rate during acclimatization was observed at 4 weeks, and the calculation is based on the number of surviving plantlets compared to the total number of plantlets. Data were analyzed using one-way analysis of variance (ANOVA), followed by the Tukey HSD test at a 5% level if significant differences were found in R software (R Core Team, 2021).

## III. RESULTS AND DISCUSSION

### The effect of growing substrate on the survival and growth of *in vitro* planets

The growing substrate is one of the determining factors in the acclimatization phase of orchids (Hariyanto et al., 2019). An appropriate substrate for orchid growth should effectively store water and nutrients, be resistant to weathering, provide sufficient air for the roots, be easily obtainable, relatively inexpensive, and not serve as a source of disease (Faria et al., 2018). The *in vitro* plantlets are washed clean of the nutrient gel under running water to remove all gel residue adhering to the roots, and then planted into specialized cups containing the growing substrate, ensuring that the entire root system is placed beneath the substrate, with the junction between the stem and roots (the base) positioned level with the surface of the substrate. *In vitro* plantlets are very sensitive to evapotranspiration, requiring high humidity levels. To study the adaptation of orchid plantlets to microclimate conditions—particularly light intensity, evapotranspiration, and humidity— the differences between substrates made from coconut were tested.

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**Table 1.** Physical and chemical properties of substrates and their effects on plant growth and survival during the acclimatization phase

| Substrates | pH | Nitrogen (N) (mg) | Phosphorus ($P_2O_5$) (mg) | Potassium ($K_2O$) (mg) | Survival rate (%) | Plant heigh (cm) | Number of leaves |
|---|---|---|---|---|---|---|---|
| A1 | 6.0 | 5.3 | 7.7 | 18.4 | 87 | 6.98$^{b}$ | 3.99$^{a}$ |
| A2 | 6.2 | 21.0 | 29.1 | 70.8 | 95 | 7.37$^{ab}$ | 4.20$^{a}$ |
| B1 | 6.6 | 25.1 | 32.3 | 79.8 | 97 | 8.18$^{a}$ | 4.15$^{a}$ |
| B2 | 6.5 | 7.1 | 9.7 | 24.1 | 83 | 6.15$^{b}$ | 3.63$^{a}$ |

*A1 - Untreated coconut coir, A2- Treated coconut coir, B1- Treated coconut husk pieces, B2 - Untreated coconut husk pieces. The means with similar lower case letter within columns did not differ significantly at 5% probability*

The results showed that the treatment of substrates significantly enhances the adaptability of plants during the acclimatization phase. The highest survival rates were observed in Treated coconut husk pieces (B1) and treated coconut coir (A2), with 97% and 95%, respectively. These treated substrates demonstrated improved performance because the treatment process removed harmful substances such as tannins, lignin, and resins, which can inhibit root growth and nutrient absorption. Furthermore, balanced pH levels (6.6 and 6.2, respectively) of these substrates created favorable conditions for plant establishment. In contrast, untreated substrates (A1 and B2) exhibited lower survival rates (87% and 83%). This is likely due to the presence of toxic compounds and lower nutrient availability, as reflected by their lower nitrogen (N) and potassium ($K_2O$) content compared to the treated substrates. The tallest plants were observed in treated coconut husk pieces, with 8.18 cm, followed by treated coconut coir (7.37 cm). The superior growth in these substrates can be attributed to their high levels of phosphorus ($P_2O_5$, 32.3 mg and 29.1 mg) and potassium ($K_2O$, 79.8 mg and 70.8 mg), essential nutrients for root and shoot development. Additionally, the optimal pH and improved aeration in treated substrates likely facilitated better nutrient uptake. Plants grown on untreated substrates (A1 and B2) were significantly shorter, with heights of 6.98 cm and 6.15 cm, respectively. The poor growth may be due to the combined effects of low nutrient levels (N, $P_2O_5$, and $K_2O$) and residual toxic compounds in these substrates. However, the number of leaves did not show statistically significant differences among the substrates. According to Faria and Silva (2010), consistency, good aeration, and ability to retain water without waterlogging are essential because if an inadequate drainage occurs, plants can suffer stress and eventually die. KÄMPF (2000) emphasized that poor drainage can lead to detrimental conditions for root health, ultimately affecting plant growth and survival. For the acclimatization phase of the orchid Cattleya chocolate drop x (*C. guttata x L. tenebrosa*), Colombo et al. (2005) observed that the substrate coconut powder is suitable for the cultivation of Cattleya.

**Effects of fertilizer on the growth of heat-tolerance Cymbidium plants**

**Table 2.** Effects of different fertilizer treatments on plant height and leaf number after 1, 2, and 3 months of development in greenhouse

| Fertilizer type | Plant heigh (cm) – 1 month | Number of leaves – 1 month | Plant heigh (cm) – 2 months | Number of leaves – 2 months | Plant heigh (cm) – 3 months | Number of leaves – 3 months |
|---|---|---|---|---|---|---|
| F1 | 8,02$^{b}$ | 4,27$^{a}$ | 8,12$^{c}$ | 4,37$^{a}$ | 8,17$^{c}$ | 4,43$^{a}$ |
| F2 | 8,92$^{a}$ | 4,23$^{a}$ | 9,23$^{b}$ | 5,03$^{ab}$ | 9,67$^{b}$ | 5,27$^{b}$ |
| F3 | 9,08$^{a}$ | 4,77$^{a}$ | 10,09$^{a}$ | 5,13$^{b}$ | 10,36$^{a}$ | 5,20$^{b}$ |

*F1 - No foliar spray, F2 - NPK 20:20:20, F3- NPK = 30:10:10. The means with similar lower case letter within columns did not differ significantly at 5% probability*

The results indicate that fertilizer type significantly influences plant growth and leaf development during the acclimatization phase. The plants treated with F3 (NPK 30:10:10) showed the best growth in both height and leaf number, demonstrating its effectiveness in promoting strong plant development. F2 (NPK 20:20:20) also improved plant growth, but to a lesser extent compared to F3. On the other hand, F1 (No foliar spray) resulted in the lowest growth, suggesting the importance of proper fertilization in supporting plant development. Overall, the trend indicates that higher nitrogen content in the fertilizer leads to better plant growth and leaf production. The application of NPK 30:10:10 fertilizer has been shown to significantly enhance the growth and flowering of *Dendrobium* orchid (Diem et al., 2021), with studies indicating that this formulation provides optimal nitrogen levels necessary for vigorous shoot and leaf production, as well as promoting subsequent flowering.

## IV. CONCLUSION

The substrates from coconut must be treated by soaking and washing three times before planting. This study shows that the most suitable substrate for *in vitro* – derived heat-tolerance *Cymbidium* is coconut husk pieces substrate treated with dry coconut shell. The most suitable type of fertilizer for plant growth and development is NPK 30:10:10

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