



Plant Archives

Journal homepage: <http://www.plantarchives.org>

DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.2.002>

EFFICACY OF COCOPEAT FOR ACCLIMATIZATION AND PRIMARY HARDENING OF *IN VITRO*-DERIVED *Philodendron* 'EL CHOCO RED' PLANTLETS

Madhuri Hosamani¹, N. Seenivasan², M. Manasa Lakshmi³, Gopala Krishna⁴,
D. Laxminarayana⁵ and P. Gouthami⁶

¹Department of Floriculture and Landscaping, Post Graduate Institute for Horticultural Sciences,
Sri Konda Laxman Telangana Horticultural University (SKLTGHU), Mulugu, Siddipet - 502 279, Telangana, India.

²Controller of Examinations and Director of Industrial and International Programmes,
Sri Konda Laxman Telangana Horticultural University (SKLTGHU), Mulugu, Siddipet-502279, Telangana, India.

³Branch Manager, R & D Tissue Culture Head, Ethereal DNA Pvt. Ltd., Vantimamidi, Siddipet - 502 279, Telangana, India.

⁴Heartfulness Institute, Kanha Shanti Vanam, Kanha Village - 509 328, Hyderabad, Telangana, India.

⁵Sri Konda Laxman Telangana Horticultural University, (SKLTGHU) Mulugu, Siddipet - 502 279, Telangana, India.

⁶Floricultural Research Station, Sri Konda Laxman Telangana Horticultural University (SKLTGHU), Rajendranagar,
Hyderabad - 500 030, Telangana, India.

(Date of Receiving-01-06-2026; Date of Revision-23-07-2026; Date of Acceptance-09-08-2026)

ABSTRACT

The successful acclimatization of micro-propagated plantlets is a critical step determining the commercial applicability of tissue culture protocols. The present study was undertaken to evaluate the efficacy of cocopeat as a primary hardening substrate for the acclimatization of *in vitro*-derived *Philodendron* 'El Choco Red' plantlets under protected polyhouse conditions. Well-rooted plantlets regenerated through *in vitro* culture were transplanted into jiffy bags filled with cocopeat following fungicidal treatment and maintained under high humidity, which was gradually reduced during the hardening period. A total of 40 plantlets were evaluated after 30 days of acclimatization for survival percentage, plant height and number of leaves. The acclimatization protocol resulted in a survival rate of 72.5%, with surviving plantlets attaining a mean plant height of 4.03 cm and producing an average of 5.24 leaves per plant. The favourable physical properties of cocopeat, including high water-holding capacity, excellent aeration and an optimum root-zone environment, promoted rapid establishment and healthy vegetative growth of the plantlets during the transition from *in vitro* to *ex vitro* conditions. The findings demonstrate that cocopeat-filled jiffy bags provide a simple, effective and commercially feasible system for the primary hardening of tissue culture-derived *Philodendron* 'El Choco Red' and can be recommended for large-scale production of healthy planting material.

Key words : *Philodendron* 'El Choco Red', Acclimatization, Primary hardening, Cocopeat, Micropropagation, Survival percentage, Tissue culture.

Introduction

Philodendron (Family: Araceae) is one of the largest ornamental aroid genera, comprising approximately 447 recognized species distributed throughout the tropical and subtropical regions of Central and South America and the West Indies (The Plant List, 2019; Mayo *et al.*, 1997). Owing to their attractive foliage, diverse growth habits and adaptability to indoor environments, philodendrons

have become highly valued foliage ornamentals in the global floriculture industry. Among them, *Philodendron* 'El Choco Red' (*Philodendron rubrijuvenile*) is an attractive climbing hemi-epiphytic species characterized by velvety, heart-shaped leaves with a dark green adaxial surface and a distinctive reddish abaxial surface. The prominent venation and striking foliage colour make this cultivar highly desirable for interior landscaping and premium ornamental plant markets (Mayo *et al.*, 1997;

Croat, 1997).

The increasing commercial demand for elite philodendron cultivars has encouraged the adoption of micropropagation as an efficient method for large-scale multiplication. Compared with conventional propagation through seeds or stem cuttings, tissue culture enables rapid multiplication of disease-free and genetically uniform planting material throughout the year. Furthermore, tissue culture-derived philodendron plants produce multiple basal shoots, resulting in compact and well-branched plants that are more suitable for container production than conventionally propagated plants (Henley *et al.*, 2005). Consequently, micropropagation has become an important tool for meeting the increasing domestic and international demand for high-quality ornamental planting material.

Despite the advantages of *in vitro* propagation, successful commercialization largely depends on the efficient acclimatization of regenerated plantlets. Plantlets produced under *in vitro* conditions develop in an environment characterized by high relative humidity, low irradiance, limited gaseous exchange and continuous nutrient availability. Such conditions often result in poorly developed cuticles, non-functional stomata and fragile root systems, making the plantlets highly susceptible to desiccation and transplant shock immediately after transfer to *ex vitro* conditions (Conover and Poole, 1984; George *et al.*, 2008). Therefore, the acclimatization stage represents one of the most critical phases in the micropropagation process and frequently determines the overall success of plant production.

The choice of an appropriate hardening substrate plays a pivotal role in improving plant survival and growth during acclimatization. Cocopeat has gained wide acceptance as a primary hardening medium because of its excellent water-holding capacity, high porosity, favourable aeration and ability to maintain an optimum root-zone environment. These physical properties facilitate rapid root establishment, reduce transplant stress and improve the survival of micro-propagated plantlets during the transition from *in vitro* to *ex vitro* conditions (Pospisilova *et al.*, 1999; George *et al.*, 2008). However, information on the acclimatization behaviour of tissue culture-derived *Philodendron* 'El Choco Red' under primary hardening conditions remains limited.

Therefore, the present investigation was undertaken to evaluate the suitability of cocopeat as a primary hardening substrate for the acclimatization of *in vitro*-derived *Philodendron* 'El Choco Red' plantlets. The study aimed to assess plant survival and early vegetative growth under protected conditions and to develop a simple

and effective acclimatization protocol for the commercial production of healthy and vigorous planting material.

Materials and Methods

Well-rooted *in vitro* regenerated plantlets of *Philodendron* 'El Choco Red' were used for the acclimatization study. The plantlets were carefully removed from the culture vessels, and the adhering culture medium was completely washed off using sterile distilled water to minimize microbial contamination. Individual plantlets were separated carefully to avoid injury to the roots and shoots. Before transplanting, the roots were treated with the fungicide Aliette WDG (Bayer) to protect the plantlets from fungal infection during the hardening period.

The treated plantlets were transplanted individually into jiffy bags filled with cocopeat and maintained under protected polyhouse conditions for primary hardening. Initially, high relative humidity was maintained to reduce transplant stress and was gradually lowered over the hardening period to facilitate adaptation to ambient environmental conditions. Irrigation was provided regularly to maintain adequate moisture in the cocopeat while preventing waterlogging.

A total of 40 rooted plantlets were evaluated during the acclimatization experiment. Observations were recorded after 30 days of primary hardening. The survival percentage was calculated based on the number of successfully established plantlets relative to the total number transplanted. Growth performance was assessed by recording plant height (cm) and the number of leaves produced per surviving plant.

The experiment was conducted as a single-treatment evaluation to assess the suitability of cocopeat as a primary hardening substrate for tissue culture-derived *Philodendron* 'El Choco Red'. The recorded data were summarized using descriptive statistics and expressed as survival percentage, mean plant height and mean number of leaves per plant.

Results and Discussion

Survival Percentage

The successful acclimatization of *in vitro*-derived plantlets is a critical prerequisite for the commercial application of micropropagation protocols. In the present investigation, the acclimatization protocol employing cocopeat-filled jiffy bags under protected polyhouse conditions resulted in a 72.5% survival rate, with 29 out of 40 transplanted plantlets surviving after 30 days of primary hardening (Table 1).

The satisfactory survival observed in the present

Table 1 : Effect of cocopeat on survival per cent of plant, mean plant height (cm) and number of new leaves formed after 30 days of acclimatization.

Parameter	Plant survival percentage (%)	Plant height (cm)	Number of new leaves
Assessment of Survival	72.5	4.03	5.42

$$\text{Survival percentage (\%)} = \frac{\text{Number of plants forming at least two new leaves after hardening}}{\text{Total number of plants subjected to hardening}} \times 100$$

study indicates that cocopeat provided a favourable environment for the successful transition of plantlets from *in vitro* to *ex vitro* conditions. The high water-holding capacity, excellent aeration and low bulk density of cocopeat maintained adequate moisture around the developing root system while ensuring sufficient oxygen availability for root respiration. These properties minimized transplant shock, reduced moisture stress and promoted rapid root establishment during the critical hardening phase. In addition, maintaining high relative humidity immediately after transplantation followed by its gradual reduction enabled the plantlets to adapt progressively to ambient environmental conditions, thereby improving their physiological stability.

The present findings are in agreement with those of Pospisilova *et al.* (1999), who reported that substrates possessing favourable physical properties significantly improve the survival of micro-propagated plants during acclimatization. Similar observations were made by George *et al.* (2008), who emphasized that gradual environmental adaptation combined with appropriate hardening substrates is essential for minimizing transplant mortality and improving acclimatization success. Therefore, the results demonstrate that cocopeat-filled jiffy bags provide an effective and commercially suitable substrate for the primary hardening of tissue culture-derived *Philodendron* 'El Choco Red'.

Plant height

The acclimatized plantlets attained a mean plant height of 4.03 cm after 30 days of primary hardening (Table 1), indicating satisfactory vegetative growth following transfer from *in vitro* culture.

The increase in plant height may be attributed to the favourable root-zone conditions created by cocopeat, which facilitated rapid root establishment and efficient uptake of water and nutrients. Improved root development enhanced physiological activity and photosynthetic efficiency, thereby promoting active shoot elongation during the acclimatization period. Furthermore, gradual adaptation to *ex vitro* environmental conditions enabled the regenerated plantlets to restore normal growth and

continue vegetative development without severe transplant stress.

These observations are consistent with the findings of George *et al.* (2008), who reported that successful acclimatization promotes vigorous vegetative growth through improved root function and physiological adaptation. Likewise, Pospisilova *et al.* (1999) concluded that appropriate hardening substrates contribute significantly to post-transplant shoot growth by maintaining optimum moisture and aeration around the developing root system. The present results therefore confirm that cocopeat effectively supports vegetative establishment during the primary hardening phase.

Number of leaves

The acclimatized plantlets produced an average of 5.24 leaves per plant after 30 days of primary hardening (Table 1), indicating active vegetative growth and successful adaptation to *ex vitro* conditions.

The production of new leaves is considered an important indicator of successful acclimatization because leaves formed under *ex vitro* conditions possess improved anatomical and physiological characteristics compared with those developed *in vitro*. The emergence of new foliage reflects the restoration of normal photosynthetic activity, improved nutrient assimilation and enhanced plant vigour following transplantation. The favourable physical characteristics of cocopeat provided continuous moisture availability while maintaining adequate aeration, thereby supporting sustained root activity and leaf development throughout the hardening period.

Similar findings were reported by Pospisilova *et al.* (1999), who observed that successful acclimatization is associated with vigorous leaf production and improved photosynthetic competence in tissue culture-derived plants. George *et al.* (2008) also emphasized that the development of healthy new leaves is an important indicator of successful adaptation during the transition from *in vitro* to greenhouse conditions. The present findings therefore demonstrate that cocopeat effectively supports early vegetative development during primary



Fig. 1 : *In-vitro* derived *Philodendron* 'El Choco Red' plants acclimatized under *ex vitro* conditions in primary hardening chamber.

hardening.

Overall Acclimatization performance

The overall performance of *in vitro*-derived *Philodendron* 'El Choco Red' plantlets during primary hardening clearly demonstrated the suitability of cocopeat as an acclimatization substrate. The combination of 72.5% survival, satisfactory plant height (4.03 cm) and healthy leaf production (5.24 leaves per plant) indicates that the regenerated plantlets successfully established under *ex vitro* conditions within 30 days of transplantation.

The favourable response observed in the present study may be attributed to the excellent physical characteristics of cocopeat, which maintained an optimum balance between moisture retention and aeration while promoting rapid root establishment. The gradual reduction in humidity during acclimatization further facilitated physiological adaptation by improving stomatal regulation, reducing water loss and enhancing photosynthetic efficiency. Collectively, these factors contributed to improved survival and vigorous vegetative growth of the regenerated plantlets.

The present results corroborate the findings of Pospisilova *et al.* (1999) and George *et al.* (2008), who reported that successful acclimatization of micro-propagated plants depends largely on the use of suitable hardening substrates together with gradual environmental adjustment. Therefore, the use of cocopeat-filled jiffy bags provides a simple, reliable and commercially feasible hardening system for large-scale production of healthy *Philodendron* 'El Choco Red' planting material and may be recommended for commercial nursery production.

Conclusion

The present investigation demonstrated that cocopeat is an effective substrate for the primary acclimatization and hardening of *in vitro*-derived *Philodendron* 'El Choco Red' plantlets under protected polyhouse conditions. The acclimatization protocol resulted in a survival rate of 72.5%, with the surviving plantlets attaining a mean plant height of 4.03 cm and producing an average of 5.24 leaves per plant after 30 days of primary hardening. These observations indicate that the regenerated plantlets successfully adapted to *ex vitro* conditions and resumed active vegetative growth.

The satisfactory survival and growth achieved in the present study can be attributed to the favourable physical characteristics of cocopeat, including its high water-holding capacity, excellent aeration and optimum root-zone environment, which promoted rapid root establishment and minimized transplant shock. In addition, maintaining high relative humidity during the initial stages of hardening, followed by gradual exposure to ambient conditions, facilitated physiological adaptation and reduced moisture stress. Similar observations have been reported by Pospisilova *et al.* (1999) and George *et al.* (2008), who emphasized that an appropriate hardening substrate and gradual acclimatization are essential for improving the survival and establishment of micro-propagated plants.

Overall, the findings demonstrate that cocopeat-filled jiffy bags provide a simple, reliable and commercially viable system for the primary hardening of tissue culture-derived *Philodendron* 'El Choco Red'. The protocol developed in the present study can be adopted for large-scale commercial production of healthy and vigorous planting material, thereby facilitating the successful transfer of micro-propagated plantlets from laboratory to nursery conditions. Further investigations involving different substrate combinations, nutrient supplementation and environmental management practices may help to further improve acclimatization efficiency and subsequent plant growth.

Acknowledgement

I sincerely thank my Major Guide, Dr. Natarajan Seenivasan, for his invaluable guidance, encouragement and unwavering support throughout this research. I gratefully acknowledge Ms. M. Manasa Lakshmi, Ethereal DNA Pvt. Ltd. for providing the necessary

facilities and technical assistance for this study. My heartfelt appreciation also goes to my Advisory Committee for their insightful suggestions and constant encouragement. Lastly, I extend my deepest gratitude to Padi Mahesh Reddy, Ph.D scholar for his continuous guidance, assistance and support during the course of this work.

References

- Bogner, J. and Boyce P.C. (1997). *Philodendron*. In : Croat T. B. (ed.). *Aroideana*, **20**, 1–24.
- Conover, C.A. and Poole R.T. (1984). Acclimatization of indoor foliage plants. *Horticult. Rev.*, **6**, 119–154.
- Croat, T.B. (1997). A revision of *Philodendron* subgenus *Philodendron* (Araceae) for Mexico and Central America. *Annals of the Missouri Botanical Garden*, **84(3)**, 311–704.
- George, E.F., Hall M.A. and De Klerk G.J. (2008). *Plant Propagation by Tissue culture*. 3rd Edition. Springer. Netherlands. 747p.
- Hazarika, B.N., Teixeira da Silva J.A. and Talukdar A. (2006). Effective acclimatization of *in vitro* cultured plants: Methods, physiology and genetics. *Floriculture, Ornamental and Plant Biotechnology*, **2**, 427-438.
- Henley, R.W., Chase A.R. and Osborne L.S. (2005). Philodendrons - Self-heading types. CFREC-A Foliage Plant Research Note RH-91-27. 8 Sept. 2019.
- Mayo, S.J., Bogner J., Boyce P.C., Catherine E. and Gardens K.R.B. (1997). *The genera of Araceae*.
- Posposilova, J., Ticha I., Kadlec P., Haisel D. and Plzakova S. (1999). Acclimatization of micropropagated plants to *ex vitro* conditions. *Biologia Plantarum*, **42(4)**, 481-497.
- The Plant List (2019). *Philodendron*. 17 Sept. 2019.