Diversitas Journal
ISSN 2525-5215
Volume 9, Issue 4 (Oct./ Dec. . 2024) p. 2244 – 2257
https://diversitasjournal.com.br/diversitas_journal

# Acclimatization of *Cattleya nobilior* Rchb. f. (Orchidaceae) in Field Conditions in a Riparian Forest Area

# Aclimatização de *Cattleya nobilior* Rchb. F. (Orchidaceae) em condições de campo em uma área de mata ciliar

**LOPES, Vaneça Rodrigues[1]; OLIVEIRA, Jaderson Roney Gomes de [2]; CHAGAS, Davi Borges das [3]; LOPES, Fabyano Alvares Cardoso [4]; COIMBRA, Ronaldo Rodrigues [5]; FERREIRA, Wagner de Melo [6]**

[1] 0000-0002-1059-9833; Mestranda, Programa de Pós-graduação em Biodiversidade Ecologia e Conservação, Universidade Federal do Tocantins. Tocantins. Porto Nacional, Tocantins (TO), Brasil. vaneca.lopes@uft.edu.br

[2] 0000-0001-8374-992X; Doutorando em Biodiversidade e Biotecnologia pela Rede Bionorte, Universidade Federal do Tocantins. Palmas, Tocantins (TO), Brasil. jaderson.roney@gmail.com

[3] 0000-0001-5222-1030; Pesquisador do Herbário do Tocantins (HTO), Universidade Federal do Tocantins. Porto Nacional, Tocantins (TO), Brasil. davibchagas@uft.edu.br

[4] 0000-0002-4565-9103; Professor do Programa de Pós-Graduação em Biodiversidade, Ecologia e Conservação, Universidade Federal do Tocantins. Porto Nacional, Tocantins (TO,) Brasil. flopes@uft.edu.br

[5] 0000-0002-2888-7817; Professor do Programa de Pós-Graduação em Biodiversidade, Ecologia e Conservação, Universidade Federal do Tocantins. Porto Nacional, Tocantins (TO), ronaldo.rc@uft.edu.br

[6] 0000-0002-7805-2180; "*in memoriam*" - Professor do Programa de Pós-Graduação em Biodiversidade, Ecologia e Conservação, Universidade Federal do Tocantins. Porto Nacional, Tocantins (TO).

## ABSTRACT

The acclimatization of orchids is an essential process for the conservation of native species and their reintroduction into natural environments, contributing to the preservation of biodiversity and ecological balance. Thus, this study aimed to evaluate the survival and development of *Cattleya nobilior*, originating from in vitro cultivation, on the phorophytes *Acrocomia aculeata* and *Butia capitata*, in a riparian forest area within the Cerrado domain in Porto Nacional, Tocantins. For survival, the number of living individuals at the end of the study was evaluated, and for development, variables such as plant shoot length, number of leaves, shoots, and roots were assessed over a twelve-month period. Four plants were allocated in each phorophyte, one per cardinal point (north, south, east, and west). The study reveals that the acclimatization of *C. nobilior* was more successful in *A. aculeata* than in *B. capitata*, due to more favorable conditions, especially during the dry season. The orientation of the phorophytes towards the North and West cardinal points also positively influenced the survival and acclimatization of the orchids. Temperature and humidity were shown to be key factors during the process, with the rainy season promoting better growth and development. Thus, it emphasizes the importance of considering the specific characteristics of phorophytes and the need for more detailed research to understand the interaction between host and associated plants.

## RESUMO

A aclimatação de orquídeas é um processo essencial para a conservação de espécies nativas e sua reintrodução em ambientes naturais, contribuindo para a preservação da biodiversidade e o equilíbrio ecológico. Desse modo, este trabalho teve como objetivo avaliar a sobrevivência e o desenvolvimento de *Cattleya nobilior*, oriunda de cultivo in vitro nos forófitos *Acrocomia aculeata* e *Butia capitata*, em uma área de mata ciliar no domínio Cerrado em Porto Nacional, Tocantins. Para sobrevivência foi avaliado o número de indivíduos vivos ao final do estudo e para desenvolvimento foram avaliadas as variáveis, comprimento da parte aérea da planta, número de folhas, brotos e raízes para o período de doze meses. Em cada forófito foram alocadas quatro plantas, uma por ponto cardeal (norte, sul, leste e oeste). O estudo revelou que a aclimatização de *C. nobilior* foi mais bem-sucedida em *A. aculeata* do que em *B. capitata*, possivelmente devido a condições mais favoráveis do tronco, especialmente durante a estação seca. A orientação dos forófitos para os pontos cardeais Norte e Oeste também influenciou positivamente na sobrevivência e aclimatização das orquídeas. A temperatura e umidade mostraram-se como fatores-chave durante o processo, com o período chuvoso promovendo melhor crescimento e desenvolvimento. Assim, ressalta-se a importância de considerar as características específicas dos forófitos e a necessidade de pesquisas mais detalhadas para entender a interação entre as plantas hospedeiras e as associadas.

**ARTICLE INFORMATION**

***Article Process:***
Submitted: 06/14/2024
Approved: 11/02/202x
Published: 12/28/202x



**Keywords*:***
Reintroduction, Orchids, Phorophytes. Cardinal points.

***Palavras-Chave*:**
Reintrodução, Orquídeas, Forófitos, Pontos cardeais.

*DOI: 10.48017/dj.v9i4.3063*

## Introduction

The *Orchidaceae* family corresponds to 70% of epiphytes present in tropical and subtropical forests (Pridgeon et al., 2009). In the Cerrado phytogeographic domain, this family appears third among the most representative of plant biodiversity (Mendonça et al., 2008). This formation contains 705 species, grouped into 125 genera (Barros et al., 2015). One of these genera is *Cattleya*, which, according to Silva et al. (2009), it is widely distributed in the tropical region, occurring from Mexico to Paraguay and is composed of 45 species, 32 of which occur in Brazil. Species *Cattleya nobilior Rchb. f.* stands out in the group. This is due to its characteristics, such as: wide capacity for genetic recombination, structure, with a small size measuring 5 to 10 cm, beauty, and great durability of its flowers, with a color variation from light pink to lilac (Silva, 2014). And regarding the habitat, *C. nobilior* can be rupicolous or epiphytic (Oliveira, 2021). According to Barros et al. (2015); the species is easily found in the Cerrado, although it is not exclusive to this formation, as its distribution can be observed from the Northern Hemisphere to South America.

Oliveira (2021) mentions that, like other orchids, *C. nobilior* has a perennial life cycle and is quite specialized; with seed germination in natural environments only occurring when there is an association with mycorrhizal fungi. This association is necessary because its seeds have little or no nutritional reserves (Soares, 2012). Furthermore, according to Ferreira and Suzuki (2008), the production of seedlings is too slow, due to the costly development, given that these plants require a very long period to reach the reproductive stage.

The slow development, combined with the indiscriminate removal of specimens from the natural environment and the anthropization of these environments, especially fires and the removal of native vegetation, results in a significant threat to the survival of the species in these locations (Silva, 2017). Therefore, for the *Orchidaceae* family, investigations that propose ways of acclimatizing laboratory-produced plants in natural environments can serve as tools for actions aimed at maintaining biodiversity and preserving potentially threatened species or that are subject to possible threats, such as the *C. nobilior* (Sherlock, 2009).

In this context, *in vitro* cultivation techniques for *ex vitro* production and acclimatization become fundamental to accelerate and optimize seedling production, aiming at the conservation of slow-developing species. This is due to the fact that the use of these techniques allows the production of numerous plants at the same time, requires a not very large laboratory and obtains a high level of phytosanitary quality (Oliveira, 2018). In the acclimatization process of orchid seedlings resulting from in vitro cultivation, several factors play crucial roles in the survival of the individuals. In addition to temperature, humidity and light intensity, it is important to consider the substrate in which these plants will be fixed, which in the case of epiphytes this factor is biotic, called phorophyte. Phorophytes are plants that play the role of support for other plants, which are neither benefited nor harmed by the presence of the host plant species. Phorophytes have morphological characteristics suitable for the maintenance and development of host plants, and there is, therefore, a preference for each epiphyte species for certain phorophytes (Kämpl, 2005).

As examples of phorophytes, palm trees stand out, species from the *Arecaceae* family, which have been identified as good hosts for orchids. Many palm trees have, along almost the entire stem, marcescent sheaths resulting from leaf senescence. These sheaths accumulate organic matter, coming from fallen material from surrounding plants, and retain water. This combination of characteristics makes palm trees a favorable environment for the development of epiphytic orchids during the acclimatization process (Mayo et al., 1997).

Studies that investigate behavior under *in vitro* cultivation conditions, acclimatization and reintroduction into natural environments are essential to promote species conservation and preservation measures. Thus, the objective of this work was to evaluate the survival and acclimatization of *C. nobilior* plants in the field, using species *Acrocomia aculeata* (Jacq.) *Lodd. ex Mart.* and *Butia capitata (Mart.) Becc.* as phorophytes in a riparian forest area. This approach aims to understand how orchids adapt more efficiently in natural environments, thus contributing to a conservation strategy.

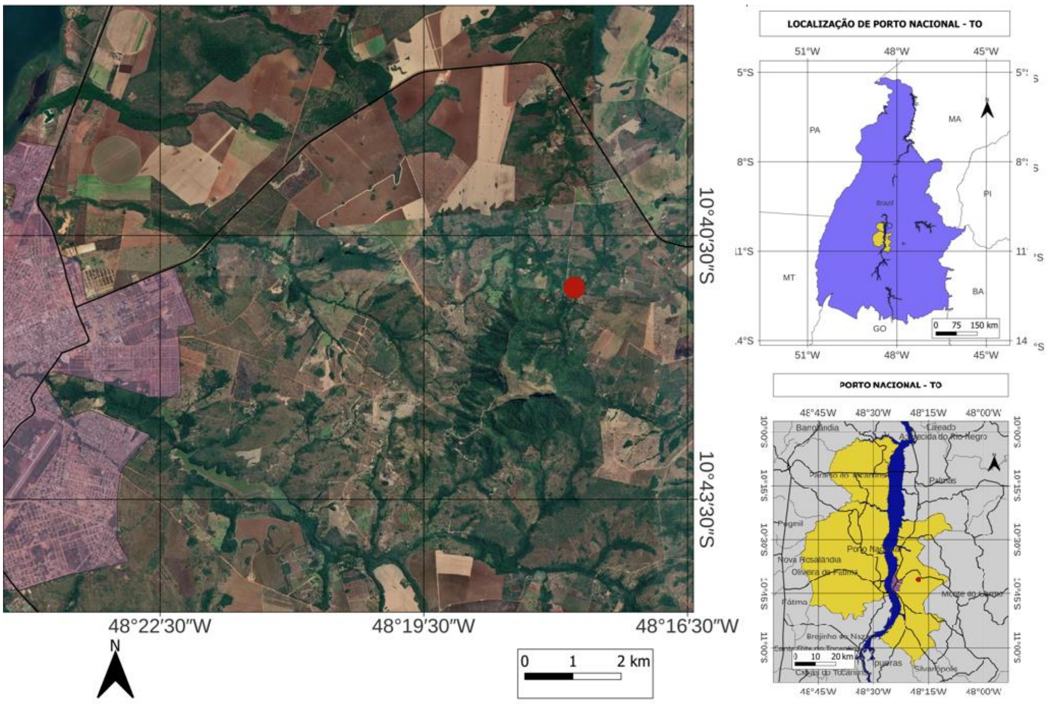
## Materials and Methodology

This study was conducted in the Cerrado domain, in the riparian forest phytophysiognomy (Ribeiro and Walter, 2008), on the Pingo de Ouro farm (Figure 1) located in the Santo Antônio Settlement, municipality of Porto Nacional (10° 41′ 05.5″ S and 48° 17′ 46.7″ W). The region's climate is seasonal tropical (Aw) according to the Köppen classification (Alvares et al., 2013), with a well-defined dry and rainy season, where the rainy period extends from October to April and the dry period from May to September, with average annual precipitation of 1500 mm (INMET, 2023).

For acclimatization, 80 individuals of *C. nobilior* were used, originating from *in vitro* cultivation at the In vitro Plant Cultivation Laboratory, of the Environmental Studies Center (NEAMB), Porto Nacional Campus of the Federal University of Tocantins (UFT). The orchids were removed from the bottles and washed in running water to remove the culture medium adhered to their roots and transferred to transparent plastic containers measuring 30.5 cm long x 18.5 cm wide and 8.7 cm high. The substrate mixture was composed of pine bark and commercial substrate Ouro Negro (Aparecida de Goiânia, GO) in a ratio of 50:50 (v/v).

**Figure 1.**

*Location of the study area at Chácara Pingo de Ouro, Santo Antônio Settlement, in the municipality of Porto Nacional – TO. Composition on Google Earth™ image*




The substrate was moistened after transferring plants, and bottles were kept closed in the growth room for 30 days. After this period, the lid of the pot was simply loosened, and was gradually opened over the next seven days until they were completely open. Then, plants were transferred to individual plastic pots (7 cm height x 6 cm basal diameter), containing the same substrate, in same proportions mentioned above. These were kept in a room with a temperature of 25 °C, with a photoperiod of 16 hours, for a period of 30 days. During this period of time, the plants were watered as needed, when the substrate appeared to be almost dry.

After this period, plants were transferred to the nursery, with natural temperature and humidity conditions and covered by a shade, reducing light intensity by 75%. Plants remained in this location for 60 days, until they were adapted to conditions of the natural environment, measuring approximately 3 cm in length.

In the field, plants were fixed on phorophytes *A. aculeata* and *B. capitata*, with an individual of *C. nobilior* being fixed at each cardinal point of the phorophyte (North, South, East and West), using a compass. Thus, the experimental design used was completely randomized, in a 2×4 factorial scheme (two phorophytes per four cardinal points), with ten replications.

Individuals used as phorophytes are native plants, whose arrangements and distances from each other vary naturally in the environment, and measure at least 10 cm in circumference, as proposed by Endres Júnior et al. (2018). When plants were fixed to the stem of phorophytes at an average height of 170 cm above the ground, the length of the largest leaf was measured, as well as the number of leaves and roots.

The survival rate of *C. nobilior* was calculated 12 months after transferring plants to phorophytes, based on the number of living individuals. To evaluate development, the following morphological variables were used: length of the aerial part (distance between the rhizome and the apex of the longest leaf, cm), number of leaves, number of shoots formed and number of roots formed. This data was measured every three months for a period of one year.

Temperature, humidity and luminosity were also measured monthly, using a digital thermo-hygrometer, positioned next to phorophyte species by cardinal point. Data regarding rainfall were obtained from the National Institute of Meteorology (INMET), from the meteorological station located in Porto Nacional – TO.

Statistical analyzes were conducted using the BioEstat 5.0 program and graphs with Python scripts (version 3.11.4), with the help of the SciPy, Matplotlib and NetworkX libraries. Treatments were compared using the Kruskal-Wallis test, followed by Dunn's test, with a significance level of 5%. The choice of these non-parametric tests is due to the lack of normality in some of the variables analyzed, as verified by the Shapiro-Wilk test, which makes the use of parametric tests unfeasible. Furthermore, a correlation study was conducted involving morphological variables and climatic data using Spearman's correlation, which is also a non-parametric method suitable for data that do not follow a normal distribution. The significance of Spearman correlations was tested with the t test at 5% probability. From the resulting correlation matrices, network graphs were created to better visualize relationships between variables.

## Results and Discussion

Twelve months after transfer to phorophytes in the field, it was observed that the highest average survival rate of *C. nobilior* was in the phorophyte *A. aculeata*, with 65%, while in *Butia capitata* orchids showed an average survival of 27.5% (Chart 1).

Acclimatization consists of a climatic adjustment of orchids, through their progressive transition from *in vitro* conditions to an external, *ex vitro* environment (Silva et. al., 2017). One of the biggest problems encountered in this process is the difficulty in transferring from controlled to uncontrolled media and the high rate of plant mortality in this process, generated by the discrepancy in environmental conditions between the media (Chandra et al., 2010). Mayer et al. (2008) state that plants from *in vitro* cultivation, when transferred to *ex vitro* cultivation, undergo anatomical, morphological and physiological changes that influence development and survival in the new environment, with the ability to revert anatomical characteristics being the main factor that will enable a satisfactory rate of seedling survival during the acclimatization process.

**Chart 1**

Comparison of the survival and morphometry of C. nobilior in two species of phorophytes (*A. acuelata* and *B. capitata*) in different cardinal points and evaluation months, from February 2022 to February 2023 in Porto Nacional – TO.

| ***A. aculeata*** | **Survive (%)** | **Comp. leaf (cm)** | **Leaves (un)** | **Sprouts (un)** | **Roots (un)** |
|---|---|---|---|---|---|
| Cardinal points: | | | | | |
| North | 60,0 | 3,65 ± 0,12 a | 3,27 ± 0,54 a | 1,61 ± 0,30 a | 4,66 ± 0,40 a |
| South | 60,0 | 3,60 ± 0,13 | 2,44 ± 0,47 a | 1,34 ± 0,44 a | 3,12 ± 0,17 b |
| East | 60,0 | 2,83 ± 0,19 b | 2,59 ± 0,38 a | 1,65 ± 0,36 a | 3,71 ± 0,34 ab |
| West | 80,0 | 2,94 ± 0,08 b | 2,74 ± 0,43 a | 1,09 ± 0,35 a | 3,15 ± 0,16 b |
| Average | 65,0 | | | | |
| Evaluation: | | | | | |
| Feb/22 | 100,0 | 3,01 ± 0,18 a | 3,75 ± 0,37 a | ------ | 3,98 ± 0,65 a |
| May/22 | 75,0 | 3,05 ± 0,28 a | 2,15 ± 0,23 a | 0,88 ± 0,16 b | 3,39 ± 0,40 a |
| Aug/22 | 70,0 | 3,22 ± 0,21 a | 1,99 ± 0,18 a | 1,18 ± 0,14 ab | 3,18 ± 0,23 a |
| Nov/22 | 67,0 | 3,33 ± 0,18 a | 2,04 ± 0,04 a | 1,16 ± 0,15 ab | 3,39 ± 0,23 a |
| Feb/23 | 65,0 | 3,63 ± 0,28 a | 3,87 ± 0,16 a | 2,48 ± 0,12 a | 4,39 ± 0,41 a |
| ***B. capitata*** | | | | | |
| Cardinal points: | | | | | |
| North | 40,0 | 4,67 ± 0,13 a | 3,42 ± 0,39 a | 1,38 ± 0,38 b | 3,74 ± 0,32 a |
| South | 10,0 | 1,67 ± 0,39 b | 2,59 ± 0,61 a | 1,08 ± 0,34 b | 2,97 ± 0,42 b |
| East | 40,0 | 3,05 ± 0,14 | 3,18 ± 0,77 a | 0,81 ± 0,51 b | 2,87 ± 0,40 b |
| West | 20,0 | 5,28 ± 0,38 a | 3,14 ± a 0,44 | 1,75 ± 0,43 a | 3,02 ± 0,54 b |
| Average | 27,5 | | | | |
| Evaluation: | | | | | |
| Feb/22 | 100,0 | 3,70 ± 0,28 a | 4,90 ± 0,20 a | ------ | 4,32 ± 0,23 a |
| May/22 | 35,0 | 3,48 ± 0,97 a | 2,42 ± 0,43 a | 0,63 ± 0,21 a | 3,01 ± 0,42 a |
| Aug/22 | 35,0 | 3,61 ± 0,99 a | 2,28 ± 0,26 a | 0,92 ± 0,27 a | 2,17 ± a 0,29 |
| Nov/22 | 27,5 | 3,58 ± 0,93 a | 2,14 ± 0,22 a | 1,00 ± 0,20 a | 1,64 ± a 0,28 |
| Feb/23 | 27,5 | 3,98 ± 0,98 a | 3,69 ± 031 a | 2,46 ± 0,21 a | 3,56 ± a 0,33 |
| G. averages: | | | | | |
| A. *acuelata* | 65,0 | 3,25 a | 2,76 a | 1,42 a | 3,66 a |
| B. *capitata* | 27,5 | 2,67 a | 3,08 a | 1,25 a | 3,15 a |

* Values followed by the same letter in the column indicate that samples do not differ from each other at 5% probability using the Kruskal-Wallis test, followed by the Dunn test.

The initial hypothesis suggested that the survival and development of *C. nobilior* plants would be greater in *B. capitata*, since the phorophyte has sheaths that extend throughout almost the entire stem, which results in the accumulation of organic matter, coming from leaves and twigs of other nearby species, in addition to the decomposition of the sheath and retained organic matter, which provides greater water retention, resulting in a favorable microclimate for orchids. However, this hypothesis could not be supported, and it was in the phorophyte *A. aculeata* that greater survival of *C. nobilior* was observed. This may have been due to characteristics of its stem, which has indentations that closely resemble the sphagnum substrate, a type of moss widely used in orchid cultivation and which has a great water retention capacity (Zandorá et al., 2014). The stem with these characteristics, according to Schmitz et al. (2002), in a study with *Aspasia principissa Rchb. f.*, also provided, during the acclimatization and reintroduction phase, water conditions favorable to the survival of plants hosted there.

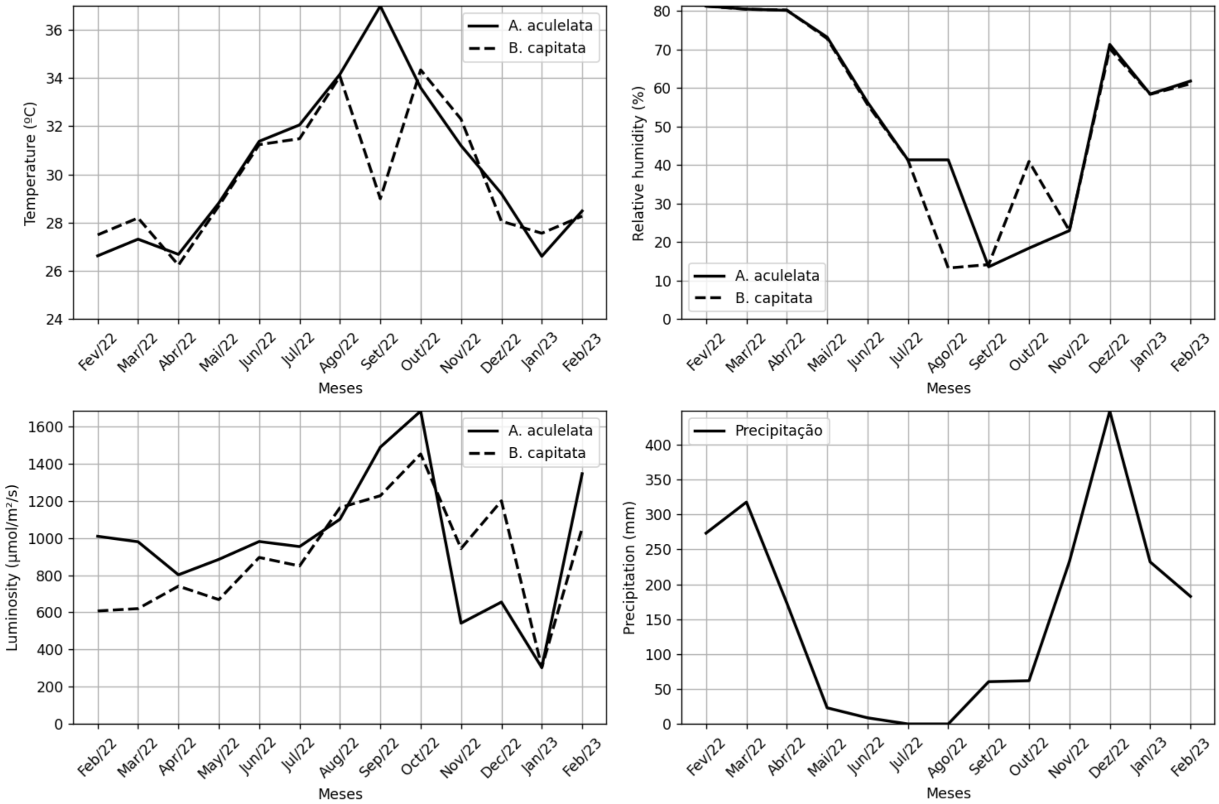
The percentage of survival of *C. nobilior* individuals in phorophytes studied also varied according to geographic positioning (North, South, East and West), with a higher survival rate being observed in *A. aculeata* in the West quadrant, while in *B. capitata* it occurred greater survival in the North and East quadrants (Chart 1).

In the phorophyte *A. aculeata*, the length of the *C. nobilior* leaf was greater in the North and South quadrants. On the other hand, in *B. capitata* the greatest growth was observed in the North, East and West quadrants. Leaf length did not show significant differences in different months of evaluation, both for plants fixed in *A. aculeata* and for those in *B. capitata* (Chart 1).

It can be seen that, in *A. aculeata*, there was a tendency for leaf length to increase over time, although not significant. In the *B. capitata* phorophyte, there was initially a decreasing trend, probably related to leaf senescence and then a recovery trend, indicating that this variable in this phorophyte had a more difficult field acclimatization process. During acclimatization, the stress arising from the process of moving from the nursery to the field generates a series of anatomical, physiological and morphological changes, such as roots that are still fragile for the adequate transport of nutrients (Faria et al., 2012). Another factor that may have corroborated this trend of decreasing leaf size are climatic factors, since in the third and fourth quarters of evaluation the air humidity is lower and the temperature rises in the study area (Chart 2), indicating seasonal growth for this species. This seasonality is an adaptation mechanism of plants that cease growth and physiological activities to reduce the influence of extreme environmental conditions.

In the general comparison between leaf length averages, no significant differences were found between *C. nobilior* fixed on *A. aculeata* and *B. capitata*, with their averages being 3.25 and 2.67 cm, respectively (Chart 1). Although differences are not significant, it is observed that leaf growth was more pronounced in the period from August/2022 to February/2023, possibly caused by the beginning of the rainy season, as the first significant rains in the region after the dry season were recorded in month of October (Chart 2). This result was probably caused by the development of roots, which provides greater water absorption, minimizing dehydration and, as a consequence, allows for greater net assimilation of $CO_2$, development and survival of the plant (Souto et al., 2010).

**Chart 2**
Temporal and spatial analysis of environmental conditions and the growth of *C. nobilior* in phorophytes *A. aculeata* and *B. capitata*, from February 2022 to February 2023 in Porto Nacional – TO.




The amount of *C. nobilior* leaves was not significantly influenced by their positioning at different cardinal points in both phorophytes. There were also no significant differences in relation to the number of leaves in the different months of evaluation (Chart 1). However, a tendency to reduce the amount of *C. nobilior* leaves can be seen in both phorophytes from the second quarter of evaluation onwards, indicating that there was a loss of leaves during the acclimatization process. One year after implementing the experiment, the amount of leaves returned to its initial level. The response to stress caused by the environment, such as low humidity, as well as the acclimatization process, can induce the plant to enter a phase of leaf senescence (Faria et al., 2012), a mechanism that guarantees plant survival. The general average of leaves of *C. nobilior* in phorophytes *A. aculeata* and *B. capitata* also did not differ significantly, with averages being 2.76 and 3.08 leaves per plant, respectively (Chart 1).

In the phorophyte *A. aculeata*, there was no significant difference in relation to the number of *C. nobilior* shoots in the different cardinal points. However, in the phorophyte *B. capitata*, a greater number of shoots were observed in the West cardinal point. There was a tendency for the number of shoots to increase over time in both phorophytes. However, the difference between months of evaluation was significant only in *A. aculeata*, where it was found that there were fewer shoots in the month of May. In general, the average number of shoots in *C. nobilior* did not differ between two phorophytes, being 1.42 shoots.plant-1 in *A. aculeata* and 1.25 shoots.plant-1 in *B. capitata* (Chart 1).

The number of roots in *C. nobilior* plants varied according to the cardinal point in the *A. aculeata* phorophyte, being higher in the North (4.66) and East (3.71) cardinal points (Chart 1). In *B. capitata*, the greatest number of roots was observed in the North cardinal point. There were no significant differences in root length in relation to the months of evaluation in both phorophytes. Although in *B. capitata* a trend of decreasing roots was observed in the intermediate evaluation months (May/22, August/22 and November/22). However, it can be seen that there was no significant root growth during the experiment, with the general average being 3.66 cm for *A. aculeata* and 3.15 cm for *B. capitata*.

Rooting is crucial for the survival of orchid individuals, as it allows for increased absorption and storage of water, nutrients and association with fungi (Slump, 2004). It is also important to highlight that the root performs the function of supporting plants in phorophyte species and in these circumstances, for Seeni and Latha (2000), damage to plant roots negatively influences the acclimatization process.

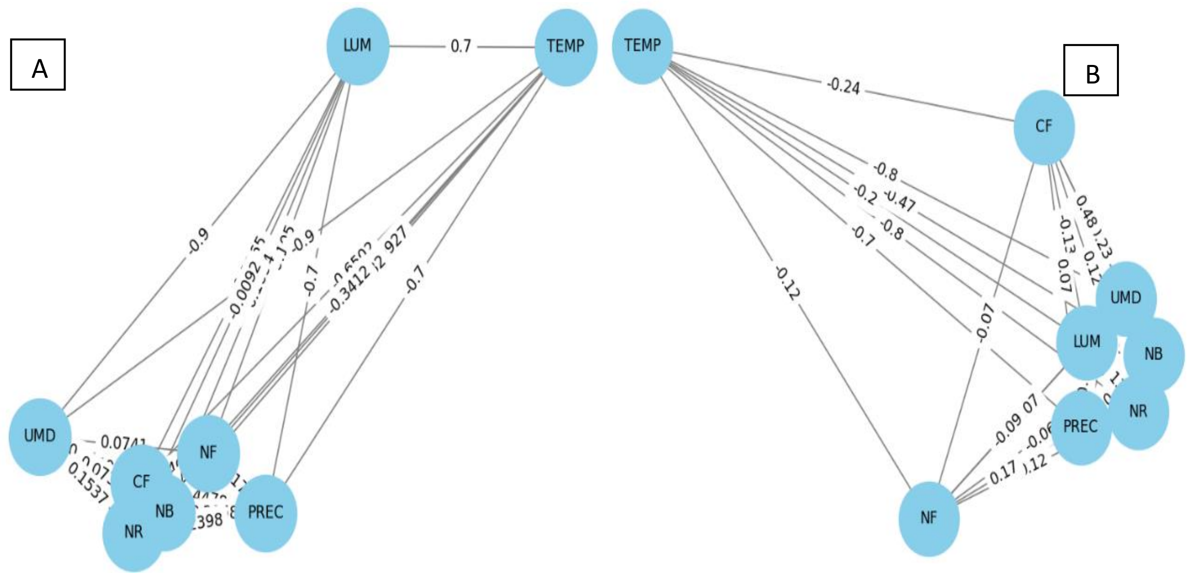
Roots of epiphytic orchids have a layer of dead, spongy cells known as the velamen. During the dry season, this layer is crucial for absorbing air and water from dew, which are stored for plant survival. During the period of greatest precipitation, high ambient humidity improves the absorption capacity of the roots, favoring the development of orchids. These effects were observed in the final phase of the study, as highlighted by Moreira et al. (2013). Similarly, Dorneles and Trevelin (2011) found comparable results in their study on the acclimatization and reintroduction of *Cattleya intermedia*. They noticed growth and the emergence of new leaves only at the end of a year of study.

In relation to the arrangement of orchid plants by cardinal points, the North point stands out in the phorophyte *A. aculeata* and *B. capitata*. A condition that can be explained by the fact that the luminosity at this point is greater than at the others, since, despite the cover of phorophyte canopies presenting shading, this point is the one that receives light intensity during most of the day, as the Sun, when moving in an East-West direction, gradually passes over the entire surface of the plant. Furthermore, it is known that the *Cattleya genera* and their hybrids prefer brighter locations (Takane et al., 2006).

In the phorophyte *B. capitata* (Chart 3), it is observed that temperature is negatively correlated with all morphological variables, mainly with leaf length, where there is a negative and significant correlation ($r = 0.65$, $p < 0.01$). This means that the higher the temperature there is a tendency for the length of the leaves, number of leaves, roots and shoots to be smaller. Luminosity did not correlate strongly with morphological variables. On the other hand, the higher the humidity and precipitation, the higher values tend to be observed in the morphological variables.

**Chart 3**

Network graph generated from the Spearman correlation matrix, including morphological variables (leaf length - CF, in cm; number of leaves - NF; number of shoots - NB; number of roots - NR) and climatic parameters (temperature - TEMP (ºC); humidity - UMD (%); luminosity - LUM (μmol/m2/s); rainfall – PREC (mm), for C. nobilior in the phorophytes *B. capitata* (A) and *A. aculeata* (B) obtained in the region of Porto Nacional, Tocantins.




A significant correlation was observed between leaf length and number of shoots (r = 0.74, p < 0.01), indicating a positive association between these variables. This result suggests that the increase in shoot number is associated with a corresponding increase in leaf length. Furthermore, there was a positive correlation between the number of shoots and the number of roots (r = 0.65, p < 0.01), reinforcing the favorable relationship between shoot growth and root development.

In the phorophyte *A. aculeata*, temperature was also negatively correlated with morphological variables, mainly with the number of roots (r=-0.80, p<0.001). It can be seen that the variables number of roots and number of shoots were positively correlated with parameters humidity, light and precipitation.

Comparatively, between two phorophytes studied, a similar pattern of correlations between morphological variables and climatic parameters is observed. In both phorophytes, there is a significant negative correlation between temperature and morphological variables, particularly leaf length. This suggests that an increase in temperature is associated with a corresponding decrease in leaf size, as well as the number of leaves, roots and shoots, in both the phorophyte *B. capitata* and *A. aculeata*. Furthermore, both increased humidity and precipitation are positively correlated with morphological variables in both phorophytes. However, a notable difference is observed in the correlation between the number of shoots and the number of roots, which is positive only in the phorophyte *B. capitata*. Despite similarities in general trends, specific differences in correlations between phorophytes highlight the complexity of interactions between environmental factors and morphological characteristics of orchid species studied.

**Final Considerations**

In the phorophyte *B. capitata*, *C. nobilior* plants faced greater difficulties in the acclimatization process in relation to leaf growth, greater senescence and impacts generated by the dry season, which in the end resulted in lower survival. It can be concluded that the phorophyte species *A. aculeata* provided better conditions for acclimatization, survival and development for *C. nobilior*. In general, the North and West cardinal points provided greater survival and better acclimatization of *C. nobilior*.

It is observed that temperature and humidity are climatic variables that have the greatest influence on the entire process of acclimatization, survival and development, since the best growth results, increase in the length of the aerial part, emergence of new shoots and increase in the number of roots were verified in the rainy season, where temperatures are mild and air humidity is high.

Data was not found in the literature on the acclimatization and development of *Cattleya nobilior* or any other species of the *Orchidaceae* family, with reference to their positioning by cardinal points in phorophytes. Therefore, there is a clear need to carry out other studies with this and other species of orchids, using the methodology of arranging phorophytes in relation to the cardinal points.

Thinking about results presented, it is noticeable that variations in climatic conditions play a significant role in the morphology and survival of orchid species in the acclimatization process. Both the phorophytes *B. capitata* and *A. aculeata* demonstrated a negative correlation between temperature and morphological variables, indicating an adaptive response to warmer environmental conditions. On the other hand, increased humidity and precipitation seem to favor the development of morphological characteristics in both species. The presence of positive correlations between shoot number and root number only in the phorophyte *B. capitata* suggests subtle differences in growth strategies between species.

This present study highlights the importance of considering not only general characteristics of phorophytes, but also their specific characteristics, such as stem structure, when evaluating their suitability as hosts for other plant species. Furthermore, it highlights the need for more detailed research to better understand the mechanisms involved in the interaction between host plants and associated species.

## BIBLIOGRAPHIC REFERENCES


Alvares, C. A., Stape, J. L., Sentelhas, P. C., De Moraes, G., Leonardo, J., & Sparovek, G. (2013). Köppen's Climate Classification Map for Brazil. *Meteorologische Zeitschrift*, 22(6), 711-728.

Ayres, M., Ayres Jr, M., Ayres, D. L., Santos, A. A. S. Bioestat 5.0 aplicações estatísticas nas áreas das ciências biológicas e médicas. Belém: IDSM, 2007.364p.

Barros, F. de, Vinhos, F., Rodrigues, V. T., Barberena, F. F. V. A., Frafa, C. N., Pessoa, E. N., Forster, W., Menini, N. F., Furtado, S. G., Nardy, C., Azevedo, C. O., & Guimarães, L. R. S. (2015). Orchidaceae. In Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Disponível em: http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB22653. Acesso em: 04 jun. 2021.

Chandra, S., Bandopadhyay, R., Kumar, V., & Chandra, R. (2010). Acclimatization of tissue cultured plantlets: From laboratory to land. *Biotechnology Letters*, 32(9), 1199-1205.

Dorneles, L. T., & Trevelin, V. (2011). Aclimatização e reintrodução de *Cattleya* intermedia Graham ex Hook (Orchidaceae) obtidas por propagação in vitro. *Iheringia*, Série Botânica, 66(2), 167-174.

Endres Júnior, D., Sasamori, M. H., Schmitt, J. L., & Droste, A. (2018). Survival and development of reintroduced *Cattleya* intermedia plants related to abiotic factors and herbivory at the edge and in the interior of a forest fragment in South Brazil. *Acta Botanica Brasilica*, 32(4), 555-566.

Ferreira, W. M., & Suzuki, R. M. (2008). O cultivo in vitro de orquídeas como alternativa para a preservação de espécies nativas ameaçadas de extinção. In M. I. B. Loiola, I. G. Baseia, & J. E. Lichston (Orgs.), *Atualidades, desafios e perspectiva da botânica no Brasil* (pp. 67-68). Natal: Imagem Gráfica.

Instituto Nacional de Meteorologia - INMET. (2024). Disponível em: http://www.inmet.gov.br/portal/index.php?r=bdmep/bdmep. Acesso em: 01/05/2024.

Kämpf, A. N. (2005). *Produção comercial de plantas ornamentais* (2ª ed.). Guaíba: Agrolivros.

Mayer, J. L. S., Ribas, L. L. F., Bona, C., & Quoirin, M. (2008). Anatomia comparada das folhas e raízes de *Cymbidium* Hort. (Orchidaceae) cultivadas ex vitro e in vitro. *Acta Botanica Brasilica*, 22(2), 323-332. https://doi.org/10.1590/S0102-33062008000200003.

Mayo, S. J., Bogner, J., & Boyce, P. C. (1997). *The genera of Araceae*. Continental Printing, Belgium.

Mendonça, R. C., Felfili, J. M., Walter, B. M. T., Silva Júnior, M. C., Rezende, A. V., Filgueiras, T. S., Nogueira, P. E., & Fagg, C. W. (2008). Flora vascular do cerrado: Checklist com 12.356 espécies. In S. M. Sano, S. P. Almeida, & J. F. Ribeiro (Eds.), *Cerrado: Ecologia e flora* (pp. 417-1279). Embrapa-CPAC, Planaltina.

Moreira, A. L., Silva, A. B., Santos, A., Reis, C. O. D., & Landgraf, P. R. C. (2013). *Cattleya walkeriana* growth in different micropropagation systems. *Ciência Rural*, 43, 1804-1810.

Oliveira, S. L. A. de, Silva, K. L. F., Oliveira, R. J. de, Souza, M. J. de, Oliveira, J. R. G. de, & Ferreira, W. de M. (2021). In vitro germination, initial development and acclimatization of *Cattleya nobilior* Rchb. f. (Orchidaceae): An approach to curb the eventual endangerment of this exuberant, near-threatened Cerrado species. *Diversitas Journal*, 6(2), 2167-2191. https://doi.org/10.17648/diversitas-journal-v6i2-1592.

Oliveira, J. R. G. (2018). *Análise da multiplicação e desenvolvimento inicial in vitro, e aclimatização de Encyclia flava (LINDL.) Porto & Brade (Orchidaceae)*. Dissertação de Mestrado, Universidade Federal do Tocantins, Porto Nacional.

Pridgeon, A. M., Cribb, P. J., Chase, M. A., & Rasmussen, F. N. (2009). *Genera Orchidacearum, Epidendroideae* (Part Two) (5ª ed.). Oxford University Press.

Python Software Foundation. (2024). Python 3.11.4. Disponível em https://www.python.org

Ribeiro, J. F., & Walter, B. M. T. (2008). Fitofisionomias do bioma Cerrado. In S. M. Sano, S. P. Almeida, & J. F. Ribeiro (Eds.), *Cerrado: Ecologia e flora* (pp. 151-212). Embrapa-CPAC, Planaltina.

Schmidt, G., & Zotz, G. (2002). Inherently slow growth in two Caribbean epiphyte species: A demographic approach. *Journal of Vegetation Science*, 13(4), 527-534.

Seeni, S., & Latha, P. G. (2000). In vitro multiplication and eco-rehabilitation of the endangered Blue Vanda. *Plant Cell, Tissue and Organ Culture*, 61, 1-8.

Sherlock, E. M. (2009). *Propagação in vitro de Encyclia alboxanthina Fowlie (Orchidaceae): Espécie endêmica da Chapada Diamantina-Bahia* (Dissertação de Mestrado). Universidade Estadual de Feira de Santana.

Silva, A. B., Lima, P. P., Oliveira, L. E. S., & Moreira, A. L. (2014). In vitro growth and leaf anatomy of Cattleya walkeriana (Gardner, 1839) grown in natural ventilation system. *Revista Ceres*, 61, 883-890. http://dx.doi.org/10.1590/0034-737X201461060001.

Silva, C. S., Araújo, L. G., Sousa, K. C. I., Silva, D. M., Sibov, S. T., & Faria, P. R. (2017). Germinação e desenvolvimento in vitro de orquídea epífita do Cerrado. *Ornamental Horticultura*, 23(1), 96-100. http://dx.doi.org/10.14295/oh.v23i1.923.

Silva, E. F., Villa, F., & Pasqual, M. (2009). Meio de cultura Knudson modificado utilizado no cultivo in vitro de um híbrido de orquídea. *Scientia Agraria*, 10(4), 267-274. ISSN 1519-1125.

Silva, J. A. T. da., Hossain, M. M., Sharma, M., Dobránszki, J., Cardoso, J. C., & Songjun, Z. (2017). Acclimatization of in vitro-derived Dendrobium. *Horticultural Plant Journal*, 3(3), 110-124. http://dx.doi.org/10.1016/j.hpj.2017.07.009.

Slump, K. (2004). Lessons from the roots. *Orchids Magazine*, 74, 252-254.

Soares, J. S., Rosa, Y. B. C. J., Macedo, M. C., Sorgato, J. C., Rosa, D. B. C. J., & Rosa, C. B. C. J. (2012). Cultivo in vitro de Brassavola tuberculata (Orchidaceae) em meio de cultura alternativo suplementado com diferentes concentrações de açúcar e carvão ativado. *Magistra*, 24, 226-233.

Souto, J. S., Morimoto, J. M., Ferreira, W. M., Nakabashi, M., & Suzuki, R. M. (2010). Efeitos do ácido naftalenoacético no desenvolvimento in vitro de Cattleya bicolor (Orchidaceae). *Revista Brasileira de Biociências*, 8, 179-185.

Takane, R. J., Faria, R. T., & Altafin, V. L. (2006). *Cultivo de orquídeas*. Brasília: Editora LK.

Zandorá, A. P., Faria, R. T., Lone, A. B., & Hoshino, R. T. (2014). Substratos alternativos ao esfagno na aclimatização de plântulas de Arundina graminifolia “alba” (Orchidaceae). *Revista Brasileira de Horticultura Ornamental*, 20(1), 7-12.

*amental*, 20(1), 7-12.