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ARTICLE

The brazilian native orchid *Brassavola tuberculata* Hook.: ornamental potential and reintroduction

A orquídea nativa brasileira *Brassavola tuberculata* Hook.: potencial ornamental e reintrodução

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Abstract: The use of native species in landscaping has gained prominence due to their adaptability and sustainability compared to exotic species. To introduce a new plant into landscaping, it is necessary to define desirable ornamental characteristics. This study aimed to evaluate the ornamental potential and the feasibility of reintroducing the brazilian native orchid *Brassavola tuberculata* Hook. in natural environments, aiming for its use in sustainable landscaping with and without fertilization. The research was conducted in two main stages. In the first stage, the morphological characteristics of three individuals with floral buds were analyzed, focusing on quantitative aspects. The results showed that the species presents elegant inflorescences and fragrant flowers, with slightly yellowish white petals and a labellum articulated at the base. In the second stage, 20 plants originating from asymbiotic seeding, approximately 10 cm in height, were reintroduced into phorophytes of *Hymenaea courbaril*. A mixture of buriti palm fiber and coconut chips was used as the substrate. The plants were divided into two groups: one received 12 g of controlled-release fertilizer (NPK 15-15-15 + micronutrients) and the other received no fertilization. Evaluations were carried out on the day of reintroduction (day zero) and at 7, 14, 21, 30, 60, 90, 120, 180, and 360 days after reintroduction. The results indicate that the morphological aspects of *B. tuberculata* attribute ornamental potential to the species, and it can be successfully reintroduced into natural environments, even without fertilization. The plant demonstrated a remarkable ability to adapt and survive, reorganizing its metabolism to cope with initial stress.
Keywords: landscaping, natural environment, Orchidaceae, substrates.

Resumo: A utilização de espécies nativas no paisagismo tem ganhado destaque devido à sua adaptabilidade e sustentabilidade em comparação com espécies exóticas. Para introduzir uma nova planta no paisagismo, é necessário definir características ornamentais desejáveis. Este estudo teve como objetivo avaliar o potencial ornamental e a viabilidade de reintrodução da orquídea nativa brasileira *Brassavola tuberculata* Hook. em ambientes naturais, visando seu uso no paisagismo sustentável com e sem fertilização. A pesquisa foi conduzida em duas etapas principais. Na primeira etapa, foram analisadas as características morfológicas de três indivíduos com botões florais, focando em aspectos quantitativos. Os resultados mostraram que a espécie apresenta inflorescências elegantes e flores perfumadas, com pétalas brancas levemente amareladas e um labelo articulado na base. Na segunda etapa, 20 plantas oriundas de semeadura assimbiótica, com aproximadamente 10 cm de altura, foram reintroduzidas em forófitos de *Hymenaea courbaril.* Como substrato foi utilizado mistura de paú de buriti e chips de coco. As plantas foram divididas em dois grupos: um recebeu 12 g de adubo de liberação controlada (NPK 15-15-15 + micronutrientes) e outro não recebeu adubação. As avaliações foram realizadas no dia da reintrodução (dia zero) e aos 7, 14, 21, 30, 60, 90, 120, 180 e 360 dias após a reintrodução. Os resultados indicam que os aspectos morfológicos de *B. tuberculata* atribuem à espécie potencial ornamental e pode ser reintroduzida com sucesso em ambientes naturais, mesmo sem adubação. A planta demonstrou notável capacidade de adaptação e sobrevivência, reorganizando seu metabolismo para enfrentar o estresse inicial.
Palavras-chave: ambiente natural, Orchidaceae, paisagismo, substratos.

Introduction

The Orchidaceae family is the largest family of flowering plants, consisting of approximately 899 genera and 31,474 species with accepted names (WFO, 2024). In the Cerrado biome, there are 642 species of orchids distributed across 110 genera (Flora e Funga do Brasil, 2024). The genus *Brassavola* is found throughout the Latin America, from Mexico to Argentina, and due to its high floristic value and hardiness, it is widely used in the production of double and triple hybrids with *Cattleya*, *Laelia*, and *Epidendrum* (Sousa et al., 2015; Silva et al., 2021). The species *Brassavola tuberculata* Hook. is native to several states in Brazil and holds notable ornamental value within this genus (Soares et al., 2023).

Recognizing the potential of native diversity and aligning it with commercial-scale production can be an innovative opportunity for nurseries and landscapers, boosting the floriculture production chain. In landscaping, the use of native species from Brazil's flora has expanded due to their practicality and sustainability compared to exotic species. Research on native ornamental plants is encouraged, especially in areas threatened by urbanization or environmental devastation, to prevent the loss of genetic material before it is studied (Bastos et al., 2020; Silva et al., 2021; Castro et al., 2022).

To introduce a new plant into landscaping, it is necessary to define desirable ornamental characteristics (Zucchi, 2019) and ensure that native species adapt to environmental conditions and meet the expectations of the landscaping project. Additionally, for the Orchidaceae family, cultural practices related to different species may vary according to the life form and geographical location where the plants are cultivated. Thus, one of the challenges for the insertion of these plants in landscaping is understanding the physiology of each species, as well as their adaptations and strategies for nutrient acquisition and utilization under different cultivation conditions (Zhang et al., 2018; Castro et al., 2022).

In this sense, the reintroduction of native orchids is essential to expand knowledge about the biology, ecology, and management needs of the studied plants (Soares et al., 2020). The diversity of native orchids in Brazil offers significant ornamental potential, especially in the context of sustainable landscaping. However, there is still little information about the morphophysiological adjustments of these plants when germinated asymbiotically and cultivated *in vitro*, limiting their use in green areas. Furthermore, understanding the nutritional and substrate requirements is important for defining protocols for the insertion and cultivation of these plants on phorophytes.

Given the above, the objective of this study was to describe the morphological aspects of *Brassavola tuberculata* Hook., aiming to evaluate its ornamental potential and its reintroduction into the natural environment for use in landscaping with and without fertilization.

Materials and Methods

Ornamental Potential

This study was conducted with five-year-old plants of *Brassavola tuberculata* Hook. obtained from *in vitro* cultivation and placed in a

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screened nursery covered by two 50% shading screens (PAR = 235.1 µmol m^{-2} s^{-1}). The experiment was conducted in the nursery of the Faculty of Agricultural Sciences at the Federal University of Grande Dourados (FCA/UFGD) (22°11'53.2" S; 54°56'02.3" W) in August 2018 and July 2019.

The climate of the region, according to the Köppen climate classification, is Cwa (humid mesothermal, hot summers, and dry winters). The total annual precipitation ranges between 1,250 and 1,500 mm. The highest temperatures occur in December and January, while the lowest temperatures are recorded in July and June (Fietz et al., 2017).

To evaluate the ornamental potential of this species, three individuals with floral buds were used, from which quantitative characters were evaluated, totaling three plants and five flowers per plant.

The evaluated characteristics were the number of inflorescences per plant, the number of flowers per inflorescence, the number of leaves, leaf diameter (cm), and aerial part diameter (cm). The plant height (cm) was measured from the base of the leaf/pseudobulb to the apex of the leaf blade. The flower durability (days) was recorded while it remained on the plant. The floral stem length (cm) was obtained from fully developed inflorescences in full bloom. Flower measurements were taken on the horizontal and vertical axes. The lip length (cm) was also measured. All measurements were made with a digital caliper.

The flowers were monitored from anthesis to senescence. At the end of the experimental period, means and standard deviations were calculated for each evaluated character.

Reintroduction

For the study, *B. tuberculata* plants were used. The plants were obtained from the asymbiotic germination of seeds from mother plants in the FCA/UFGD nursery and acclimatized for 12 months in a screened nursery covered by two 50% shading screens (PAR = 235.1 µmol m^{-2} s^{-1})

B. tuberculata plants were reintroduced in March 2019 in the FCA/UFGD area, in Dourados, MS (22°11'48.3"S 54°56'03.1"W). For the reintroduction, 20 individuals approximately 10 cm in height were randomly chosen. The plants were fixed on five Jatobá phorophytes (*Hymenaea courbaril* L.) with synthetic nylon mesh, approximately 3 m from the ground on the east side of the trunk, so that the light incidence on the plants was not direct during the hottest periods of the day. A mixture of buriti palm (*Mauritia flexuosa* L.f.) fiber and coconut chips (1:1, v/v) was used as a substrate.

After reintroduction, the plants were subjected to two treatments: half received 12 g of controlled-release fertilizer (NPK 15-15-15) placed in a bag made of synthetic nylon mesh and fixed on the phorophyte just above the individual. The other half did not receive fertilization. Each phorophyte received three to five individuals from different treatments. They were identified by photos for subsequent monitoring.

At the time of reintroduction, bark samples from each phorophyte were also collected and subsequently placed in an oven for 24 hours at 60°C. After this period, the samples were ground and standardized by mass (0.320 g). The plants were immersed in 50 mL of distilled water to measure the hydrogen potential (pH), which was performed at intervals of 0, 4, 24, 48, and 72 hours using a bench pH meter. The resulting values were used to calculate the means and standard deviations of this parameter.

The survival of plants was measured by the presence or absence of the aerial part, since at the time of reintroduction the rhizome and root system were covered with synthetic nylon mesh. Evaluations were performed on the day of reintroduction (day zero – initial parameters) and at seven, 14, 21, and 30 days after reintroduction. After this period, evaluations were made monthly up to six months. A new evaluation was conducted 360 days after reintroduction. The plants were also evaluated for adaptation to the reintroduction phorophyte once a month for six months and, after this period, totaling one year. The evaluated variables were leaf length (cm) (LL) and leaf diameter (cm) (LD). At 360 days after reintroduction, the nylon meshes were removed to evaluate the root system of the plants. The measured parameters were the number of roots (NR), length (cm) (LR), and diameter (cm) of the largest root (DR). All measurements were made with a digital caliper.

A completely randomized experimental design was used, arranged in split plots with two fertilization treatments in the plots and seven evaluation times in the subplots. Ten repetitions of one plant each were performed. The variables were evaluated by analysis of variance, and when significant (F test, $p < 0.05$), the means of survival were compared using the Scott-Knot test, while the other means were compared by Tukey's test at 5% probability.

Results and Discussion

Ornamental Potential

The *Brassavola tuberculata* plants had an average height of 17.67 cm and an aerial part diameter of 26.00 cm. Each individual had about 18 leaves with an average diameter of 2.23 ± 0.12 mm (Table 1).

Table 1. Morphological characteristics of *Brassavola tuberculata* Hook. Mean values (MV) and standard deviation (SD).

Characteristic	(MV ± SD)
Plant height (pseudobulbs + leaf) (cm)	17.67 ± 2.89
Clump diameter (cm)	26.00 ± 0.87
Number of leaves	18.00 ± 1.73
Leaf diameter (mm)	2.23 ± 0.12

The plant height values corroborate the results of Cunha and Forzza (2007) and Noguera-Savelli (2020), who reported heights ranging from 12 to 30 cm. These authors described cylindrical, viscous leaves, striated along their entire length, with an acute apex and a greenish-purple coloration. However, the leaf diameter described by them was 4 to 6 mm, while in this work a smaller diameter of 2.23 mm was found.

Although Moreira et al. (2014) did not specifically study the ornamental characteristics of *B. tuberculata*, they reported that this species is among the natives with high ornamental value in the state of Rio de Janeiro. Moreover, in landscaping projects, it is essential to know the habitat of the species. According to Ostetto (2015), *B. tuberculata* is a species that prefers or tolerates more shaded environments.

Regarding floral characteristics, the species presented, on average, 1.67 terminal raceme inflorescences per plant, with simple green floral stems measuring 13.00 cm in length. Each stem contained, on average, 1.33 flowers with a transverse diameter of 6.10 cm and a longitudinal diameter of 5.67 cm. The flowers had slightly yellowish white petals, lanceolate, with an acute apex, and a labellum articulated at the base, measuring 2.17 cm in length, white with a yellowish central region and slightly wavy margins (Fig. 1) (Table 2).

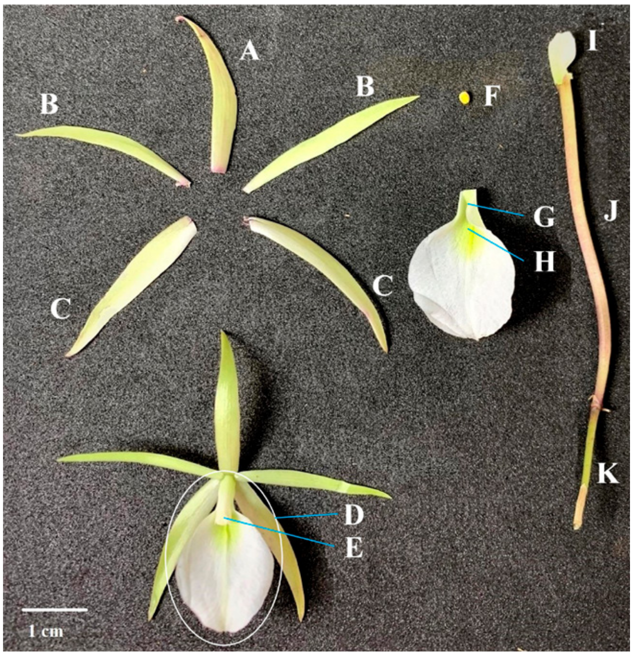

Fig. 1. Floral diagnostic sheet prepared from images of fresh flowers of *Brassavola tuberculata* Hook. A = dorsal sepal; B = lateral petals; C = lateral sepals; D = labellum (median petal); E = pollinia capsule; F = pollinia; G = operculum; H and I = column; J = ovary; K = peduncle.

Table 2. Mean values of flowering characteristics of *Brassavola tuberculata* Hook. Mean values (MV) and standard deviation (SD).

Characteristic	(MV ± SD)
Number of inflorescences/plant	1.67 ± 0.58
Floral stem length (cm)	13.00 ± 1.32
Number of flowers/inflorescence	1.33 ± 0.58
Flower durability (days)	16.67 ± 0.58
Transverse flower diameter (cm)	6.10 ± 0.96
Longitudinal flower diameter (cm)	5.67 ± 0.76
Labellum length (cm)	2.17 ± 0.29

Silva et al. (2021) described that plants of this species produce inflorescences with five to seven flowers, with a slightly yellowish white color, which emit a sweet scent at dusk. Barberena et al. (2019) highlighted that, among the species found in their botanical survey in the APA Abaeté, *B. tuberculata* is a highly ornamental orchid.

The morphological characteristics of *B. tuberculata*, along with the knowledge of its habitat, suggest that these plants can be used in landscaping, both adorning tree trunks and in vertical gardens. The species has aerial roots that grow symbiotically on other plants and surfaces, requiring little maintenance.

The durability of the flowers of this orchid was approximately 16 days (Table 2). In 2018, the flowering period of *B. tuberculata* began in the last fortnight of August and ended on the last day of the same month, while in 2019, flowering started in the last fortnight of July and ended at the beginning of August, within the expected period (Cunha and Forzza, 2007). Silva et al. (2021) also reported that the ornamental potential of the species is associated with its abundant and long-lasting flowering, which extends from June to September, with the peak of flowering in August.

Leal and Biondi (2006) studied 25 native plant species for their ornamental potential and found that only one species (*Aspilia setosa*) bloomed during the winter. During the two years of evaluation, *B. tuberculata* bloomed in winter, which is an advantage for garden ornamentation, bringing beauty at a time when few species are flowering.

The use of native species is a differential in modern and sustainable landscaping projects, reducing the need for exotic species. Native plants are better adapted, reducing the costs of implementation and maintenance of projects (Bastos et al., 2020; Castro et al., 2022), in addition to being an important strategy for the *ex situ* conservation of these species.

Characteristics such as plant height, inflorescence size, number of flowers, and their durability are essential to define the management and ornamental potential of native plants, especially Orchidaceae (Sorgato et al., 2021). When choosing plants for landscaping projects, characteristics such as colors, volumes, textures, shapes, and scents should be considered. The arrangement of *B. tuberculata* leaves in the clump, elegantly projected forward in a disordered manner, as well as the delicacy and fragrance of its flowers, give the plant a differential in its ornamental use (Fig. 2).

Reintroduction

In general, little is known about the correct use of fertilizers and balanced nutrients for the development of native plants (Emer et al., 2020). At 180 days after the reintroduction of *B. tuberculata*, plants that received controlled-release fertilizer showed a survival rate of 60%, which dropped to 50% at 360 days. In contrast, plants grown without fertilization showed a survival rate of 70% at 180 days and 80% at 360 days (resumption of metabolic activity in the plant considered dead - absence of aerial parts at 180 days - due to the emergence of new leaves in response to insect attacks), indicating that fertilization did not favor the establishment of this species under the studied conditions (Table 3).

Fig. 2. General aspects of *Brassavola tuberculata* Hook. Botanical Illustration. Author: Isabella Ribeiro.

Table 3. Survival of *Brassavola tuberculata* Hook. plants as a function of days after reintroduction, with and without controlled-release fertilization.

Days after reintroduction	% Survival	
	With fertilization	Without fertilization
7	100 aA	100 aA
14	90 aA	90 aA
21	80 bA	90 aA
30	80 bA	80 bA
60	70 cA	70 bA
90	70 cA	70 bA
120	70 cA	70 bA
150	70 cA	70 bA
180	60 dA	70 bA
360	50 dB	80 bA
Overall Mean	74	79
C.V. (%)	9.58	

Lowercase letters compare different days within the same treatment, and uppercase letters compare the same day across different treatments. Identical letters do not differ according to Scott-Knott test and t-test.

It was observed that, in both treatments, the greatest variation in the survival rate occurred during the first 30 days of reintroduction, stabilizing between 60 and 150 days (Table 3). This suggests that the plants underwent an initial period of stress (0 to 60 days) until they adapted to the natural environment conditions, reorganizing their metabolism. According to Soares et al. (2020), this behavior is typical of crassulacean acid metabolism (CAM).

Survival of the plants, based on apparent vigor, provides little information about the actual physiological state of the implanted organisms (Soares et al., 2020). The survival of orchids of this species, even under suboptimal conditions, may be related to their CAM metabolism, which adapts to water stress and high temperatures. This metabolism is characterized by the closure of stomata during the day, minimizing water loss, and opening at night to absorb CO_2 (Soares et al., 2020), which favored the adaptability of the plants from 60 days onwards.

Due to the low capacity of orchids to transport water from roots to leaves, these plants have several mechanisms to reduce water loss. Some orchids use their pseudobulbs to store nutrients and water during dry periods (Endres Júnior et al., 2024). *B. tuberculata* plants use their leaves, which are long and fleshy, to store photoassimilates and water, which may have influenced survival during the initial reintroduction period (Silva et al., 2021).

According to Ostetto (2015) and Flora and Funga do Brasil (2024), *B. tuberculata* is a species that prefers or tolerates more shaded environments. Epiphytic orchids reintroduced in environments with isolated trees are exposed to a more intense microclimate, characterized by higher light incidence and more severe drought conditions. Thus, the establishment of these plants may be limited compared to those growing on trees in a forest with a closed canopy (Zhang et al., 2018).

Furthermore, the difficulty in adapting to the natural environment during the first 60 days may be related to the fact that the plants were produced through asymbiotic seed germination and acclimatized in a controlled light environment. *In vitro* cultivated plants exhibit morphological and physiological changes, such as low root efficiency, reduced vascular competence, poorly or non-functional stomata, and poor cuticle formation (Soares et al., 2023).

Even so, prior acclimatization in a nursery may not be sufficient to eliminate the effects of stress during reintroduction, requiring seedlings or new plants to develop adjustment responses (Soares et al., 2020). Adjustment comprises the plant's ability to adapt to new environmental conditions, expressing physiological and/or morphological changes in response to stress (Salsinha et al., 2022).

Although the average pH values obtained from the bark of the phorophytes showed a variation of 0.356, with the lowest value being 5.834 and the highest 6.190 (Table 4), there was no relationship between these values and the survival of the reintroduced plants.

Table 4. Average pH values of the bark of each phorophyte (0, 4, 24, 48, and 72 hours) and the standard deviation.

Phorophyte	F1	F2	F3	F4	F5
Average pH	6.190	6.184	6.082	5.834	6.042
Standard deviation	0.184	0.196	0.298	0.164	0.114

Survival of *B. tuberculata* plants after 180 days of reintroduction varied among the different phorophytes. The survival percentages were 80%, 0%, 100%, 100%, and 50% for phorophytes 1, 2, 3, 4, and 5, respectively (Fig. 3a). Dorneles and Trevelin (2011), when reintroducing *Cattleya intermedia* from asymbiotic sowing, observed an overall survival rate of 83% after 180 days, with variation among different phorophytes of the same species. Similar behavior was observed in *B. tuberculata*, possibly related to the light incidence received by each phorophyte, the bark pH (which can vary even within the same species), and the presence of cutting insects, as well as other animals.

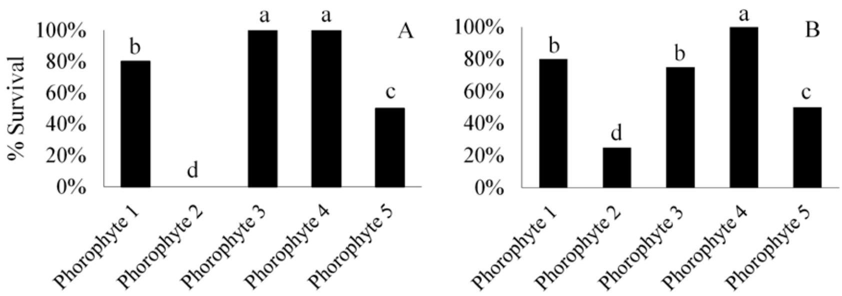

Fig. 3. Survival of *Brassavola tuberculata* Hook. plants on each phorophyte of Jatobá (*Hymenaea courbaril* L.) at 180 days (A) and 360 days (B) after reintroduction. Lowercase letters compare different phorophytes within the same period. Identical letters do not differ according to Scott-Knott test and t-test.

After 360 days of reintroduction, the survival rate also varied among the phorophytes, with percentages of 80%, 25%, 75%, 100%, and 50% for phorophytes 1, 2, 3, 4, and 5, respectively (Fig. 3b). The presence of roots attached to the phorophytes indicates that, after 180 days, *B. tuberculata* plants demonstrated good adjustment of the photosynthetic apparatus to the reintroduction environment conditions. Abiotic factors such as humidity and luminosity, as well as physical characteristics of the phorophytes, can influence the root attachment time of epiphytes (Zarate-García et al., 2020).

The lowest survival percentage was observed for phorophyte 2, where cutting insects were present during the experimental period. After 180 days, only one plant managed to attach to this phorophyte, being counted as a survivor at 360 days. Even in the juvenile phase, there was evidence of resumed metabolic activity of the plant due to the appearance of new leaves in response to insect attacks 360 days after reintroduction on phorophyte 2.

Some authors report that reintroduction into natural environments does not ensure the survival of some Orchidaceae species, requiring the establishment of a symbiotic association prior to reintroduction (Soares et al., 2020). However, when reintroducing *Schomburgkia crispa* Lindl. plants from asymbiotic germination, Soares et al. (2020) observed 100% survival after 21 days of reintroduction, corroborating the data presented in this study, which showed 80% and 90% survival in the same period considering all treatments used.

Overall, *B. tuberculata* showed a satisfactory survival percentage. In the treatment without fertilization, *in vitro* produced and acclimatized plants showed an 80% survival rate after 360 days of reintroduction, even without symbiotic propagation, allowing us to infer that this is the best treatment for plant survival on the phorophyte.

Regarding quantitative characteristics, the analysis of variance showed a significant effect of the interaction between the studied factors only for leaf length (LL) ($p > 0.05$). For the leaf diameter (LD) variable, there was a significant effect ($p > 0.05$) only at the evaluation time.

The leaf length of *B. tuberculata* in the fertilization treatment showed continuous growth during the first 30 (86.06 mm), 60 (92.95 mm), and 90 days (100.64 mm), followed by a decrease at 120 days (95.98 mm) and resumed growth until reaching the highest observed leaf length of 116.45 mm after 360 days of reintroduction. This behavior statistically differs from the values observed at 30 days and 360 days without fertilization. For plants without fertilization, there was no significant difference in leaf length between days 30 (87.72 mm), 60 (90.00 mm), 90 (106.67 mm), 120 (106.82 mm), 150 (111.25 mm), and 180 (112.00 mm). The lowest value was observed at 360 days, which may indicate greater difficulty in photosynthetic adjustment (Table 5).

Table 5. Leaf length (mm) of *Brassavola tuberculata* Hook. plants as a function of days after reintroduction, with and without fertilization.

Leaf length (mm)		
Day	**With fertilization**	**Without fertilization**
30	86.06 bA	88.72 aA
60	92.95 abA	90.00 aA
90	100.64 abA	106.67 aA
120	95.98 abA	106.82 aA
150	108.44 abA	111.25 aA
180	108.65 abA	112.00 aA
360	116.45 aA	88.48 aB
Overall Mean	101.31	100.56
C.V. (%)	8.16	

Lowercase letters compare different days within the same treatment, and uppercase letters compare the same day across different treatments. Identical letters do not differ according to Tukey's test and t-test.

From the perspective of orchid reintroduction, tree canopy cover creates a heterogeneity environment, related to different light conditions under the same phorophyte, resulting in micro-habitats. Additionally, the influence of seasonal changes is an important factor for the establishment of species in this family (Soares et al., 2020). This fact can be evidenced by the characteristic of leaf length, as the use of controlled-release fertilization made *B. tuberculata* plants respond better to these heterotrophic environmental conditions.

Leaf diameter generally decreased over the 180 days of reintroduction, resuming growth and reaching its highest value (2.3 mm) at 360 days (Fig. 4). This result can be attributed to the drop in temperature recorded in the months of June, July, and August (Fig. 5), corresponding to days 120 (2.1 mm), 150 (1.7 mm), and 180 (1.79 mm). The ideal temperature for cultivating Orchidaceae tropical species is 25 ºC (Soares et al., 2020).

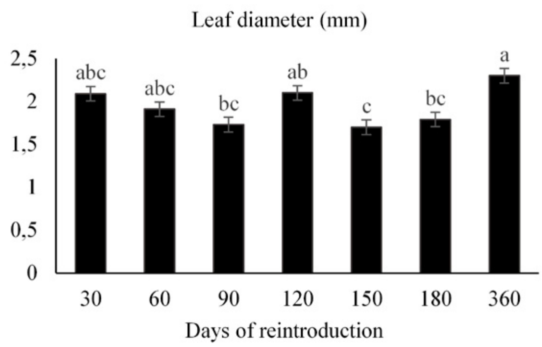

Fig. 4. Leaf diameter (mm) during the reintroduction period of *Brassavola tuberculata* Hook.

Temperatures around 25 ºC were recorded on average only in the initial months of March, April, and May, corresponding to 30, 60, and 90 days of the experimental period (Fig.5).

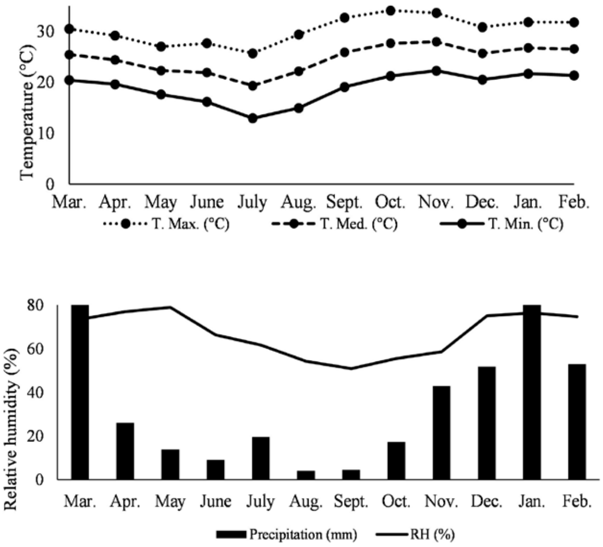

Fig. 5. Climatic data from CEMTEC/MS-Semagro for the city of Dourados – MS, from March 2019 to February 2020, during the reintroduction of *Brassavola tuberculata* Hook.

Environmental characteristics such as temperature, relative humidity (RH), precipitation, and wind speed, as well as canopy cover and rainwater capture (Zhang et al., 2018; Soares et al., 2020), may have influenced the variables evaluated in the reintroduction of *B. tuberculata*. The thermal variations recorded during the experimental period, with a minimum of 12.92 ºC and a maximum of 31.76 ºC, as well as relative humidity (RH) and precipitation, were expected for the city of Dourados, where the summer is hot and humid and the winter is cold and dry (Fig. 5).

At 360 days after reintroduction, the characteristics of the root system were evaluated. The analysis of variance showed no significant difference between treatments for any of the evaluated variables (RL, RD, and NR).

All plants that survived during the 360 days after reintroduction had their roots completely attached to the phorophyte (Fig. 6). The fact that *B. tuberculata* plants, when reintroduced, already had established roots in the substrate during the acclimatization phase, without these being damaged at the time of reintroduction, may have contributed to continuous growth. Damaged roots could hinder the establishment of individuals (Endres Júnior et al., 2015).

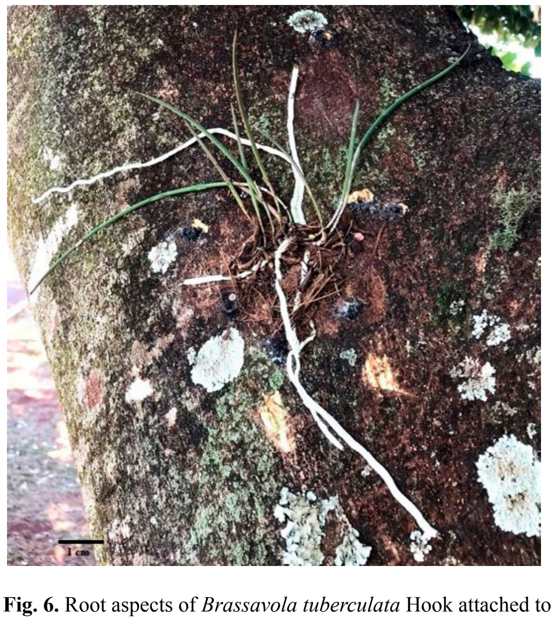

Fig. 6. Root aspects of *Brassavola tuberculata* Hook attached to the phorophyte 360 days after reintroduction into the natural environment.

Soares et al. (2020) emphasize that, for the introduction of new ornamental species into the production chain, it is necessary to invest in research and find ways to make production viable. Given the presented results, it can be inferred that *B. tuberculata* possesses characteristics that allow its development even in the face of environmental limitations, such as leaf succulence and roots with velamen, which provide the plants with greater drought resistance (Zhang et al., 2018; Noguera-Savelli et al., 2020).

In Brazil, several studies with native and endemic species for use in landscaping have shown positive results, highlighting new perspectives for national floriculture (Castro et al., 2022). As there is no detailed information on the maximum expression of the ornamental potential of *B. tuberculata*, as well as on the most suitable landscaping environments for its use, it is suggested to use this species in clumps. In addition to offering more abundant flowering, this configuration creates a favorable microclimate for the plant's development.

Conclusions

The morphological aspects of *B. tuberculata* such as plant architecture, flowering season, flower color and size, as well as its durability are characteristics considered attractive for ornamental purposes, giving the species ornamental potential for use in landscaping.

It is recommended to reintroduce *B. tuberculata* plants into the natural environment without the use of controlled-release fertilizer (NPK 15-15-15).

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Author Contribution

ISR: execution and experimental evaluation, interpretation, discussion of results, and writing; **LMR:** planning, execution, and experimental evaluation; **JCMR**: experimental evaluation, literature review, and writing; **JSS:** planning, literature review, and writing; **JCS:** planning, execution, interpretation, discussion of results, and writing.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work on this article.

Data Availability Statement

Data will be made available on request.

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