# The Effects of Shade Levels and Additional Calcium Nitrate on the Morphology of *Cyrtandrabracheia* B.L. Burt

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ABSTRACT

*The effects of different shade levels and additional calcium nitrate [$Ca(NO_3)_2$] were tested for morphology of Cyrtandrabracheia. Mature C. bracheia plants were collected and the healthy leaves (2nd-3rd leaf from top) were chosen for propagation. After five months (3-4 leaf stage), homogenous new plants were selected as plantlets and grown into 1.5 L pots with peat moss : perlite (50:50) and irrigation was provided three times per day. Black polypropylene net was used to provide 56% shade level (6-9 mol/day) and 86% shade level (2-5mol/day). Standard MARDI hydroponic solution (50 ppm N) was applied at two weeks interval. The plants were subjected to 0, 25, 75 and 100 ppm additional $Ca(NO_3)_2$. Plants under 86% shade showed an increase green color saturation and silvery proportion. In addition, 86% shade with additional $Ca(NO_3)_2$ had increased the leaf SPAD value. Higher leaf SPAD value comes with darker leaves, which is a preferred trait for foliage plants. The plants look shiny with the highest silvery variegation. Silvery proportion showed positive correlation with leaf hue angle and leaf SPAD value but negatively correlated with leaf 'L'. The result that silvery variegation of C.bracheiawas pronounced in bright green leaves. Consequently, C.bracheiacan be classified as 'shade' loving plants because it adapts well under 86% shade level and photosynthetically very efficient. Data collection suggested that five months old C.bracheiacan be used as seedlings under 86% shade level without additional $Ca(NO_3)_2$for vigorous growth, produce wider, greener and shiny leaves to meet consumer preference. The result of this study can be used as a guide in the nursery production.*

**Key words:** *Cyrtandrabracheia*, calcium nitrate, shading, silvery variegation

## Introduction

Malaysian forests are rich in native plant species which have not been fully exploited as ornamental plants. *Cyrtandrabracheia*(*C.bracheia*) is one of the local shrub species with potentials to be a foliage potted plant for indoor landscape. Foliage plants are valued for their leaf variegation in combinations of colors, patterns and texture and their plant forms as well as flowers, shapes and colors (Chen et al., 2005). The uniqueness of *C.bracheia* is on its wide green leaf structure with silver stripes interval patterns which have a highly decorative effect. However, this species is not readily available in nurseries because not fully exploited of its potential.

It is probably best to describe shade plants as those species that tolerate low light conditions. However, many of these species actually grow best in moderate to high light conditions (Faust, 2003). A rule of commercial foliage plant production is to provide plants with environmental conditions that are similar to those found in their natural environment. They do not need maximum irradiance but rather require reduced irradiance for optimum quality (Chen et al., 2005).

$Ca(NO_3)_2$ is an inorganic compound available as white granular product. This colorless salt contains a high percentage of $NO_3^-$ which makes if as one of the most cost effective $NO_3^-$ sources for fertigation. Besides, it can also be used as a source of $Ca^{2+}$ for high value of horticulture and floriculture (Ravensdown

LTD, 2006). $Ca(NO_3)_2$ as foliar spray is commonly used on stock plants than flowering plants because the chance for phototoxicity on bracts is greater than with calcium chloride (Dole & Wilkins, 2005).

Growing an indoor plant is not difficult if the plant meets the environmental requirement of light quantity and humidity. Acclimatized foliage plants have become the standard of the industry and have increased consumer's acceptance of interior plants with their increased tolerance to interior environments. Therefore, cultural practices should also consider proper substrate's such as growth media and nutrient management, to ensure optimal growth and quality. Knowing the cultural needs of *C.bracheia* would increase the chances of selecting good plants that would survive, and even thrive, in home or office spaces.

## Materials and Methods

The study was conducted at MARDI Research Station, Serdang, Selangor. The perennial plants were collected from 'Sungai Congkak' bank at 'Kaki Gunung Nuang' Hulu langat, Selangor Darul Ehsan. The leaves ($2^{nd}$ - $3^{rd}$ leaf from top) from healthy mature plants were chosen for propagation. The selected leaves were then cut at 10 cm x 3 cm and immediately sowed into polystyrene boxes filled with 100% perlite medium (Plate 1 & 2) The uniform liners obtained after 5 months then grown into 1.5 L pots with 50:50 ratio of peat moss : perlite (Plate 3). Shade was provided with black polypropylene material to provide 56% and 86% of maximum irradiation (Plate 4). The percentage of shades for the treatments was determined by measuring Photosynthetic Photon Flux density (PPFD, $\mu$ moles $m^{-2}$ $s^{-1}$) using the quantum sensor of a portable Data Hog (Skye Instrument, Ltd). The percentage reduction of ambient PPFD reading [ (1- (PPFD tray/ PPFD outside) ] x 100. Standard MARDI hydroponic solution (50 ppm N) was applied at two weeks interval. The control ($T_0$) was 50 ppm while the other treatments were added with the control solution and different additional $Ca(NO_3)_2$ concentrations, $T_1$=25 ppm, $T_2$ = 50 ppm, $T_3$ = 75 ppm and $T_4$ = 100 ppm.

The parameters for morphogenesis quantification were the percentage of silvery proportion and foliar color assessment; hue angle, chroma, and 'L' value and leaf SPAD value. The silvery of leaf proportion was measured at the end of the experiment using Win Folia programme. CIELAB coordinates for the leaf surface were measured with Minolta CR-400 Chroma meter (Konica Minolta Sensing, INC.). Chlorophyll meter (SPAD-502 Minolta Corp., Ramsey, NJ, U.S) was used to determine leaf chlorophyll content All the data regarding plants were analyzed using the SPSS 15.0 version software.

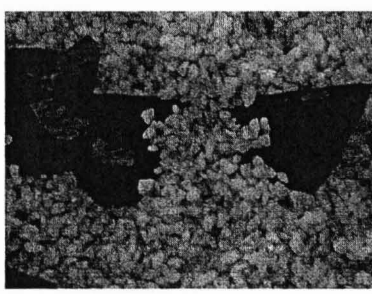


Plate 1: Propagation of Leaf Cutting in PerliteMedium

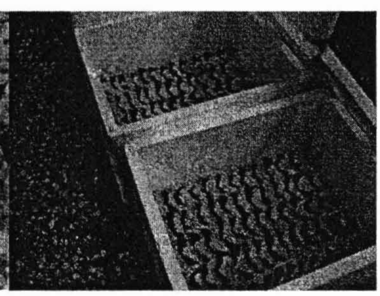


Plate 2: Leaf Cutting Materials in PolystyreneBoxes

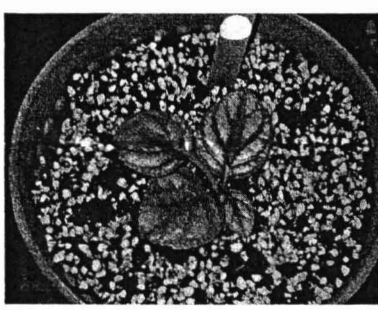


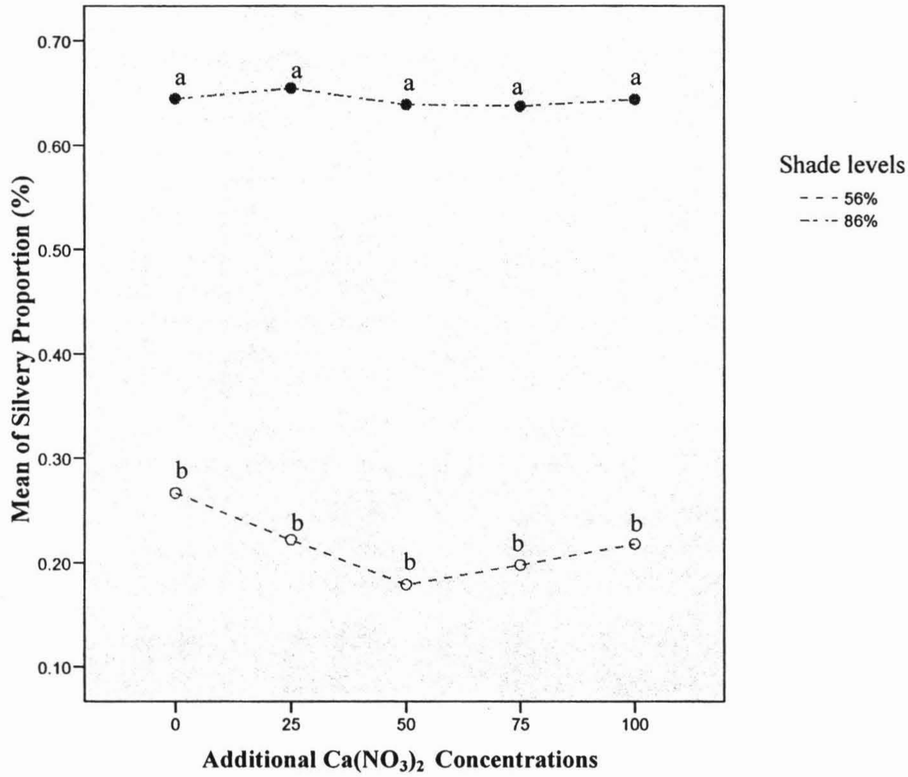
Plate 3: Plantlet Grown in Mixture of Peat Moss: Perlite (50:50 ratio)

Plate 4: Plants on Bench Under Shade House

## Results and Discussion

*Silvery proportion*

There was a significant increase in silvery proportion from higher shade level (86%) compared to lower shade level (56%) (Figure 1) at $p \leq 0.05$ level of significance. Thus, the silvery variegation on *C.bracheia* leaves increased under low light intensity. This indicates that, the variegation of silvery proportion is more prominent at 86% shade levels. The *C.brachiea*leaf is pronounced more attractive when the silvery variegation is high. The green color of leaf shows contrast with the silvery proportion and, thus, *C.brachiea*seems to be more shiny. In addition, Yahya and Mokhlas (1998) reported that shiny and greener leaves are considered more attractive and preferred by the consumer.



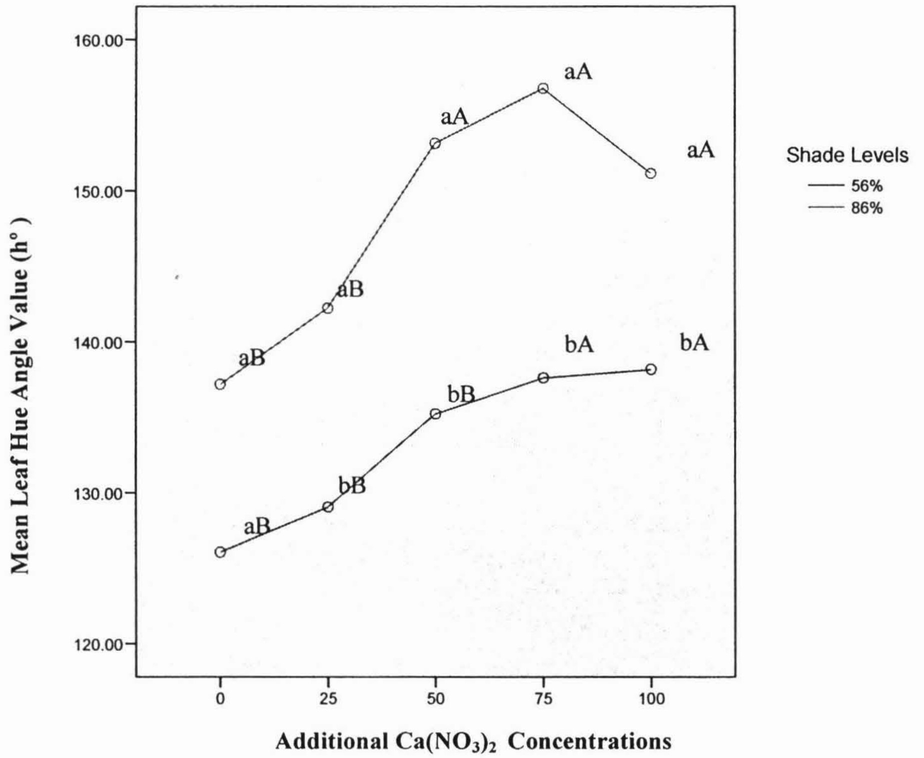

*Mean values between shade levels with the same letter (a or b) indicates no significant difference at $p \leq 0.05$ level of significance according to LSD. Total DLI = 727.94 mol $m^{-2}$ $d^{-1}$ (56% shade level) & 333.46 mol $m^{-2}$ $d^{-1}$ (86% shade level).*

Figure 1: Silvery Proportion on Leaf at Various Shade Levels and Additional $Ca(NO_3)_2$.

***Color Assessment***

i. ***Leaf Hue angle Value ($h^0$)***

Leaf hue angles for 56% and 86% shade levels ranged between $119^0$ to $161^0$ and $124^0$ and $164^0$ respectively. The values of hue angle showed interaction between shade levels and additional $Ca(NO_3)_2$. It clearly indicates that the leaves under 86% had higher hue angle value than 56% shade levels. Figure 2 also shows that within the 56% shade level, there was a significant increase in leaf hue angle at the higher $Ca(NO_3)_2$ concentration (75 and 100 ppm). On the other hand, within 86%, the significant increase in leaf hue angle started at 50, 75 and 100 ppm. In general, leaves at 56% shade level were yellowish green than those at 86% shade were greener (less yellow). The former displays dark green color leaves while the latter shows lesser green color.




*Mean values between shade levelswith the same small letter (a, b) indicates no significant difference at p≤0.05 level of significance according to LSD.Mean values within additional $Ca(NO_3)_2$ with the same capital letter (A, B) indicates no significant difference at p≤0.05 according to LSD. LSD between shade levels = 12.55. LSD within additional = 6.18. Total DLI = 727.94 mol $m^{-2}$ $d^{-1}$ (56% shade level) & 333.46 mol $m^{-2}$ $d^{-1}$ (86% shade level)*

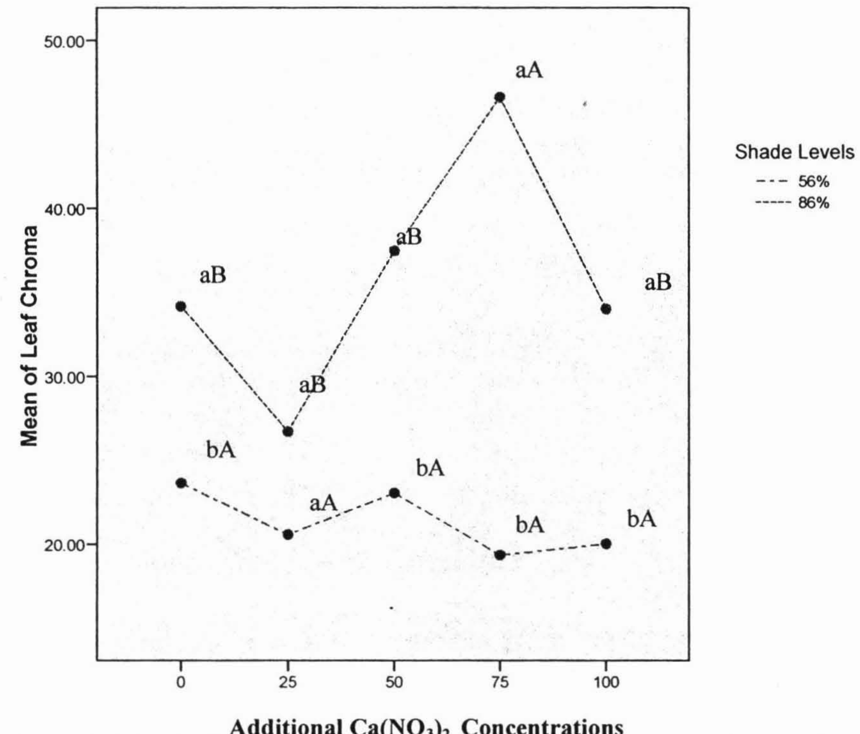
Figure 2: Mean Leaf Hue Angle Value of *C.bracheia* Interaction with Different Shade Levels and Additional $Ca(NO_3)_2$ Concentrations.

### *ii. Leaf Chroma Value and Leaf 'L' Value*

Shade levels had significant interaction with different additional $Ca(NO_3)_2$ concentrations. Results show that *C.bracheia* under 86% had significant increase chroma value at 0, 50, 75 and 100 ppm additional $Ca(NO_3)_2$. However, under 56% shade, *C.bracheia* had no significant difference in chroma value with additional $Ca(NO_3)_2$ (capital letter). At 86% shade levels, the chroma value was the highest at 75 ppm additional $Ca(NO_3)_2$ (Figure 3).

The leaf 'L' value shows significant interaction between shade levels and additional $Ca(NO_3)_2$. Thus, this indicates that the effect of shade levels on 'L' value depends on additional $Ca(NO_3)_2$ concentration. The leaf lightness was significantly higher at 56% than 86% shade levels. However, under 56% shade level at 100 ppm additional $Ca(NO_3)_2$, the 'L' value significantly reduced. Plants under 86% did not show significant reduction in 'L' value with additional $Ca(NO_3)_2$ (Figure 4). Generally, 86% shade levels produced bright leaves compared to leaves under 56%.

Leaf lightness value is the highest under 56% shades which pronounce light green, showing *C.bracheia* having chlorosis symptoms. This condition is not preferred by consumers. The green leaves with high silvery variegation enhances the aesthetic value of this species. It clearly showes that *C.brachiea*produces shiny green leaves when the species is located under 86% shade. This may increase the aesthetic value of when the plants. Brand (1997) reported that shade improves foliar color by decreasing lightness 'L', decreasing chroma and changing hue angle from yellow to darker green. *Chlorophytumcomosum* 'vittatum' (foliage indoor plants) treated at lower light intensity (80-90% shade level) increase foliar light green from 38% to 48% (Chen et al., 2007). Studies by Andersonet al. (1985) also support this result. They observed that tobacco under high shade level has less yellow hue and brightness (lightness). Karen (2008), in his article, found that most healthy plants have a high level of chlorophyll, thus, appear bright green.

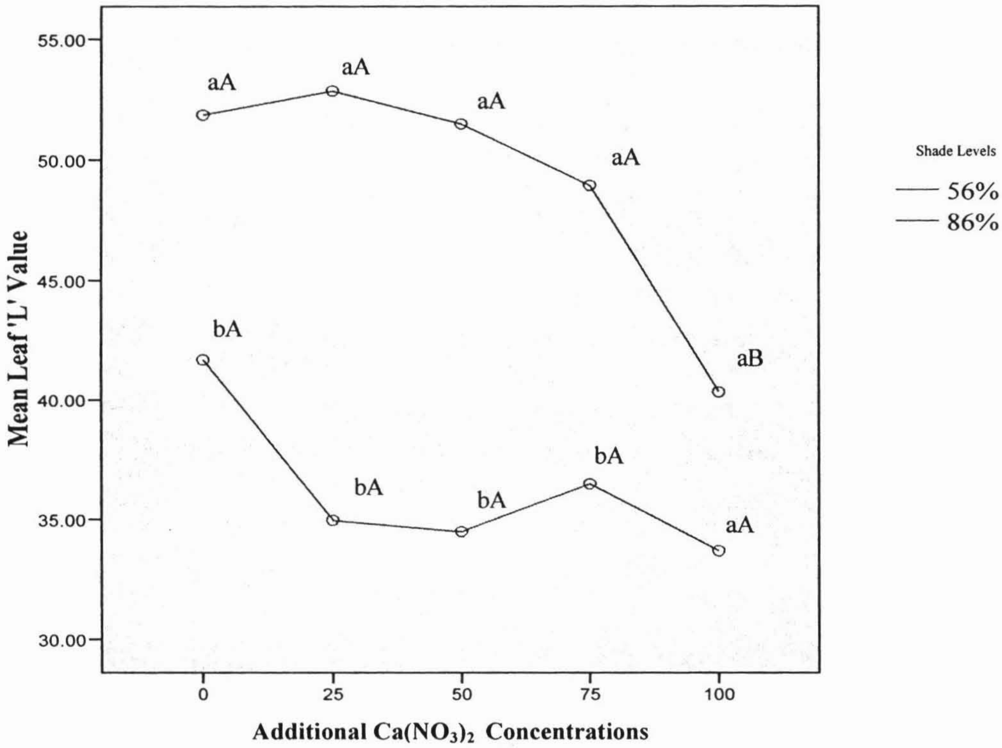



*Mean values between shade levels with the same letter (a, b) indicates no significant difference at p≤0.05 level of significance according to LSD.*

*Mean values within additional $Ca(NO_3)_2$ with the same capital letter(A, B) indicates no significant difference at p≤0.05 according to LSD.*

*LSD between shade levels = 8.70; LSD within additional = 7.73. Total DLI = 727.94 mol $m^{-2}$ $d^{-1}$ (56% shade level) & 333.46 mol $m^{-2}$ $d^{-1}$ (86% shade level)*

Figure 3: Mean Leaf ChromaValue of *C.bracheia* Interaction with DifferentShade Levels and Additional $Ca(NO_3)_2$Concentrations.




*Mean values between shade levels with the same letter (a, b) indicates no significant difference at $p \leq 0.05$ level of significance according to LSD.*
*Mean values within additional $Ca(NO_3)_2$ with the same capital letter (A, B) indicates no significant difference at $p \leq 0.05$ according to LSD.*
*LSD between shade levels = 9.04; LSD within additional = 9.04. Total DLI = 727.94 mol $m^{-2}$ $d^{-1}$ (56% shade level) & 333.46 mol $m^{-2}$ $d^{-1}$ (86% shade level)*

Figure 4: Mean Leaf 'L' Value of *C.bracheia* Interaction with Different Shade Levels and Additional $Ca(NO_3)_2$ Concentrations.

*Leaf SPAD Value*

The SPAD reading value is an indicator of chlorophyll content in leaf which is associated with photosynthesis efficiency (Ramlan et. al., 1999). Chen et al. (2005) stated that shade-grown leaves have a single, poorly developed palisade layer with larger chloroplast dispersed throughout the palisade cells, while sun-grown leaves have one or two layers of well developed palisade cells with the chloroplast aligned primarily along the radial walls. Chloroplast is organelles that plays an important role to produce chlorophyll which present green color to leaves. *C.bracheia* treated under 86% shade levels and highest additional $Ca(NO_3)_2$, shows an increase in SPAD value (Table 1). Higher SPAD value means darker leaves, which is a preferred trait for ornamental plants.

Table 1: Leaf SPAD value of *C.bracheia* at different shade level and additional$Ca(NO_3)_2$ concentrations.

| $Ca(NO_3)_2$ (ppm) / S.L (%) | SPAD value |
|---|---|
| Shade levels (%) | |
| 56 | 30.79[b] |
| 86 | 34.07[a] |
| S x N | n.s |

*Correlation of Silvery Proportion with Leaf Hue angle, 'L' and Leaf SPAD Value.*

The correlation between silvery proportion and leaf hue angle value was significant. However, silvery proportion showed negative correlation with leaf 'L'value. This means that silvery proportion would increase with decreasing leaf 'L' value. The result also shows that leaf SPAD value had positive correlation with silvery proportion. This means that the highest green pigment (high SPAD value) in *C.bracheia*leaf observed was associated with increased silvery proportion (Table 2).

Table 2:Correlation coefficient between silvery proportion, hue angle, lightness and leaf chlorophyll content on *C.bracheia* after 12 weeks grown under different level of shading and additional $Ca(NO_3)_2$ concentrations

| | Silvery | Hue angle | Lightness | Chlorophyll |
|---|---|---|---|---|
| Silvery | | 0.500** | -0.607** | 0.290** |
| Hue angle | | | -0.540** | 0.500** |
| Lightness | | | | -0.408** |
| Chlorophyll | | | | - |

** Correlation is significant at the 0.01 level.

## Conclusion

As conclusion, in the foliage plant industry, the value of a particular species are closely associated with its appearance, foliar variegation, colors as well as good growth. *C.brachiea*, a native from the Malaysian tropical forest, can be introduced as interior landscape plants considering of their tolerance to 86% shade levels (2-5 mol/day or 100-200 u mol $m^{-2}$ $s^{-1}$), therefore can be recommended to be used for decorating interiors. The interior location could be in commercial spaces such as airports, hospitals, offices and private homes however, it depends on the location of the interior environments, light intensity varies widely. Through the study observation, *C.brachiea* can be recommended as an interior landscape plant suitable for porch areas and living rooms with 90- 150 $\mu$ mol $m^{-2}$ $s^{-1}$and 20-100 $\mu$ mol $m^{-2}$ $s^{-1}$respectively. The expectation to maintain their aesthetic appearance can be met by placing them at the right locations and providing the plants with appropriate care. Five month plantlet of *C.bracheia*can be used as seedling and cultivated under 86% shade level with standard MARDI hydroponic solution is adequate $Ca(NO_3)_2$ to produce more leaves, wider, greener and shiny leaves to meet consumer's preference. The result of this study can be used as a guide in the nursery production. In future, there should be more studies on the role of *C.brachiea*in recovering the radioactive indoor air. This can further enhance the species and, thus, promote *C.bracheia*to increase their wholesale.

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