Ornamental Horticulture
ISSN 2447-536X | WWW.ORNAMENTALHORTICULTURE.COM.BR

SBFPO Sociedade Brasileira de Floricultura e Plantas Ornamentais

Article

Production of *Dieffenbachia sp.* using controlled release, organic or organomineral fertilizers

Produção de *Dieffenbachia* sp. usando fertilizantes de liberação controlada, orgânico ou organomineral

Giovana Stucchi [1,*], Ariel Moraes Silveira[2], Antonio Gabriel Pontes dos Reis[3], Leandro José Grava de Godoy[3,*] and Marcelo Vieira Ferraz[3,*]

[1] Universidade Estadual Paulista "Júlio de Mesquita Filho", Faculdade de Ciências Agronômicas, Departamento de Bioprocessos e Biotecnologia, Botucatu-SP, Brasil.
[2] Universidade Estadual Paulista "Júlio de Mesquita Filho", Faculdade de Ciências Agronômicas, Departamento de Ciência Florestal, Solos e Ambiente, Botucatu-SP, Brasil.
[3] Universidade Estadual Paulista "Júlio de Mesquita Filho", Faculdade de Ciências Agrárias do Vale do Ribeira, Departamento de Agronomia e Recursos Naturais, Registro-SP, Brasil.

Abstract: *Dieffenbachia sp.* is one of the most used plants in pots for decoration. There is little technical information about its production. The appropriate use of fertilizers and balanced fertilization is one of the main production factors that help in the rapid development of plants and their technical and economic aspects. Taking into account the need to carry out more studies related to the nutrition of the species, this work aimed to evaluate the use of mineral fertilizers (conventional or controlled release), organic or organomineral in the production of *Dieffenbachia sp*. in pots. The experiment was conducted for one year, under a 70% shade cloth, in a completely randomized design, with seven treatments and six replications. The treatments consisted of the following fertilizers: CT (Control – without fertilizer); MF (Mineral - 10-10-10), CRF (Controlled release mineral - 14-14-14), PCRF (Partially controlled release mineral - 15-05-28), MFMi (Mineral with micronutrients - 12-05-18), OM (Organomineral – 08-05-23) and O (Organic). The variables measured in the experiment consisted of measuring the plant's vertical height, leaf width and determining the chlorophyll index (IC) a and b. Only the three-month controlled release fertilizer (CRF) provided gains in growth and green color (chlorophyll index) in *Dieffenbachia sp*., grown in pots, compared to the absence of fertilization (CT). The three-month controlled release fertilizer (CRF) was the treatment that obtained the best values, impacting the production of *Dieffenbachia sp*., both in aspects relating to plant height and color, attributes that increase the value of the product at the time of marketing.
Keywords: *Dieffenbachia sp.*, fertilization, ornamental plant, plant nutrition.

Resumo: A *Dieffenbachia sp.* é uma das plantas mais utilizadas em vasos na decoração. Existem poucas informações técnicas sobre sua produção. O uso adequado de fertilizantes e adubações balanceadas é um dos principais fatores de produção que auxiliam no rápido desenvolvimento das plantas e seus aspectos técnicos e econômicos. Levando em consideração a necessidade da realização de mais estudos relacionados à nutrição da espécie, este trabalho teve como objetivo avaliar o uso de fertilizantes minerais (de liberação convencional ou controlada), orgânicos ou organominerais na produção de comigo-ninguém-pode em vasos. O experimento foi conduzido durante um ano, sob tela de sombreamento de 70%, em delineamento inteiramente casualizado, com sete tratamentos e seis repetições. Os tratamentos foram constituídos pelos seguintes fertilizantes: CT (Controle – sem adubo); FM (Mineral - 10-10-10), FLC (Mineral de liberação controlada - 14-14-14), FLPC (Mineral liberação parcialmente controlada – 15-05-28), FMMi (Mineral com micronutrientes – 12-05-18), OM (Organomineral – 08-05-23) e O (Orgânico). As variáveis medidas no experimento consistiam na medição da altura vertical da planta, largura da folha e determinação do índice de clorofila (IC) a e b. Apenas o fertilizante de liberação controlada de três meses (FLC) proporcionou ganhos de crescimento e coloração verde (índice de clorofila) na *Dieffenbachia sp*., cultivada em vasos, em relação à ausência de adubação (CT). O fertilizante de liberação controlada de três meses (FLC) foi o tratamento que obteve os melhores valores, impactando na produção de *Dieffenbachia sp*., tanto em aspectos referentes a altura das plantas, quanto na coloração, atributos que aumentam o valor do produto no momento da comercialização.
Palavras-chave: adubação, *Dieffenbachia sp.*, nutrição de plantas, planta ornamental.

Introduction

The market for garden plants, shrubs, and trees in Brazil has a production area of 15,600 hectares, which represents 8% of the world's production. This area is divided into 530 hectares under shade nets, 1,342 hectares in greenhouses, and 13,738 hectares outdoors. The annual revenue is approximately R$ 19.9 billion, showing an 8% growth in the last year (IBRAFLOR, 2024). The cultivation of flowers and ornamental plants is an activity that has aroused the interest of several producers, due to the profitability of the area, in addition to being another income alternative, within the horticulture sector (Gomes et al., 2022). According to Spier et al. (2020), the floriculture sector is very attractive for producers since the plants occupy small areas with a short production cycle. *Dieffenbachia sp*. fit into these criteria and as it is an ornamental plant produced in pots, it has a consolidated market in Brazil and is easily found in any flower shop.

Dieffenbachia sp. belongs to the Araceae family, originating from Colombia, South America. This genus *Dieffenbachia sp*. it has 30 species and more than 100 cultivars, which have the following characteristics: the colors cream, white, yellow, gold, silver or a combination of them, spotted, striped or speckled with cream on the leaves; measuring 15 to 40 cm or more in length; and while its height is 0.6 to 1.2 m, it can reach up to 2 meters in a pot (Dehgan, 2023; Taemthong, 2021).

According to Eno and Ubi (2020), the *Dieffenbachia sp*. it can be widely used as an ornamental plant, but it is a species that can harm human health through contact, chewing or consumption. Furthermore, Gabriel et al. (2023) mention that *Dieffenbachia sp*. No group of species with interactions are complex between active ingredients, as they have complex mechanisms of action that involve several substances, mainly due to the presence of drusen and raphides of calcium oxalate and saponins in addition to alkaloids. Historically, it is a genus whose toxicity is well known and is monitored by the Fiocruz National Information Program on Toxic Plants. Therefore, it has scenic value, but has a high toxic potential, being extremely harmful to those who handle it (Gabriel et al., 2023).

The high interest in using this species in interior projects is related to its tolerance to closed spaces, due to the plant not requiring high exposure to solar radiation, in addition to the varied foliage that is its attraction (Palazzo Jr, 2021).

Corresponding author: giovana.stucchi@unesp.br; leandro.godoy@unesp.br; marcelo.ferraz@unesp.br | https://doi.org/10.1590/2447-536X.v30.e242770 | Editor: Raissa Rachel Salustriano da Silva-Matos, Universidade Federal do Maranhão, Brazil | Received: July 01, 2024 | Accepted: Oct 08, 2024 | Available online: Nov 11, 2024 |

The appropriate use of fertilizers and balanced fertilization is one of the main production factors that help in the rapid development of plants and their technical and economic aspects (Emer et al., 2020). Among the application methods, the controlled release of nutrients has shown promising results, allowing a reduction in nutrients lost through leaching and the number of applications in the cycle (Vejan et al., 2021; Lawrencia et al., 2021).

Taking into account the need to carry out more studies related to the nutrition of ornamental species, the objective of this work was to evaluate the use of mineral fertilizers (conventional or controlled release), organic or organomineral in the production of *Dieffenbachia sp*. in pots.

Material and Methods

The experiment was carried out in a greenhouse covered with a shading screen, which allows 70% of the light to pass through, in the state of São Paulo, under the coordinates latitude: 24°61’84’’, longitude: 47°84’53’’ and 39 meters in altitude.

The experiment was conducted in a completely randomized design, with seven treatments and six replications, from September 2019 to September 2020. The treatments (Table 1) consisted of conventional or controlled-release mixed mineral fertilizers, organomineral or organic.

Table 1. Treatments used in the experiment and their application periods.

Treatments	Year/Months										
	2019			2020							
	10	11	12	1	2	3	4	5	6	7	8
	Days after the first fertilization										
	0	30	60	90	120	150	180	210	240	300	330
Control – without fertilizer - CT											
Mineral (10-10-10) - MF	*		*		*		*		*		*
Controlled release mineral (14-14-14) - CRF	*			*			*			*	
Partially controlled release mineral (15-05-28) - PCRF	*			*			*			*	
Mineral with micronutrients (12-05-18) - MFMi	*		*		*		*		*		*
Organomineral (08-05-23) - OM	*		*		*		*		*		*
Organic - OM	*			*			*			*	

Note: * Corresponding to treatments that received fertilizer in certain months.

Forty-two pots with plants of the same size were selected for the experiment, containing three seedlings per pot. The seedlings had previously been transplanted into pots. The batch of selected plants was three months from propagation.

The pots with the *Dieffenbachia sp*. plants were distributed in six rows, with seven plants in each, so that the pots were 50 cm apart.

A chemical analysis of the soil used in the seedling pots was carried out (Table 2). The analysis was carried out following the methodology of Raij et al. (2001), and presented the following attributes.

Table 2. Analysis of the soil’s chemical attributes.

Attribute	Value
pH ($CaCl_2$)	4.9
Organic Matter (M.O.)	75 g dm^{-3}
Phosphorus (P)	508 mg dm^{-3}
Sulfur (S)	86 mg dm^{-3}
Potassium (K)	170 $mmol_c$ dm^{-3}
Calcium (Ca)	106 $mmol_c$ dm^{-3}
Magnesium (Mg)	17 $mmol_c$ dm^{-3}
Aluminum (Al)	1 $mmol_c$ dm^{-3}
Cation Exchange Capacity (CEC)	170 $mmol_c$ dm^{-3}
Base Saturation	75%
Boron (B)	0.37 mg dm^{-3}
Copper (Cu)	10.0 mg dm^{-3}
Iron (Fe)	181 mg dm^{-3}
Manganese (Mn)	15.0 mg dm^{-3}
Zinc (Zn)	10.0 mg dm^{-3}

Fertilizer doses (Table 3) were based on the dose used by the producer (around 90 g of 10-10-10 during the year, per plant, therefore, it was standardized at 9 g of N per plant). The splitting of fertilizers was also based on the producer’s practice (fertilization every 45 days) and the release time of the fertilizers (e.g. controlled release fertilizers 14-14-14 were released for three months, under normal temperature conditions)

Table 3. Amount of nutrients applied (in grams per pot) according to the fertilizers used in the treatments.

Fertilizers	Total Dose	Dose per application	N	P	K	Ca	Mg	S	B	Mn	Zn	Fe	Cu	Mo
	---------- g pot^{-1} ----------													
CT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MF	90	15	9.0	9.0	9.0	-	-	-	-	-	-	-	-	-
CRF	65	16	9.0	9.0	9.0	-	-	5.0	-	-	-	-	-	-
PCRF	60	15	9.0	3.0	16.8	-	1.6	-	0.03	0.05	0.06	-	-	-
MFMi	76	19	9.0	3.8	13.7	1.52	3.04	6.1	0.06	0.08	0.15	0.17	0.04	0.004
OM	114	19	9.0[1]	5.7	26.2	*	*	*	*	*	*	*	*	*
O	752	188	9.0[2]	14.3[2]	27.8[3]	*	*	*	*	*	*	*	*	*

Note: CT: No fertilizer; MF: Mineral fertilizer (10-10-10); CRF: Controlled release fertilizer (14-14-14); PCRF: Partial controlled release fertilizer (50% N and K – 15-05-28); MFMi: Mineral fertilizer with micronutrientes (12-05-18); OM: Organomineral (8-05-23); O: Organic; 1. The contribution of the organic fraction was not considered; 2. Calculated considering the rate of 50% mineralization per year; 3. Calculated considering the rate of 100% mineralization per year; * Values not declared by the manufacturer.

The substrate used was very rich in organic matter (75 g dm^{-3}), phosphorus (508 mg dm^{-3}) and potassium (170 mg dm^{-3}), being a mixture of ravine soil with organic and mineral fertilizers).

Fertilization was carried out manually, from October 2019 to August 2020. It was divided bimonthly for the MF, MFMi and OM treatments, and quarterly for the CRF, PCRF and O treatments. The total amount of nutrients applied in each treatment is presented in Table 3.

For irrigation, micro sprinklers were used with a flow rate of 4 L h^{-1}, activated whenever the producer detected the need for irrigation, taking into account evapotranspiration (Table 4). All pots were placed on ceramic blocks at ground level, thus avoiding direct contact with the ground.

Table 4. Meteorological data from the station closest to the experiment, during the experimental period.

Month	Maximum Absolute Temperature	Minuimum Absolute Temperature	Maximum Monthly Temperature	Minimum Monthly Temperature	Average Temperature	ETP	Preciptation	Ranny days
	---------- ºC ----------					------- mm ------		
Year of 2019								
9	33.2	12.2	19.3	14.0	16.6	13	70	5
10	35.6	14	27.7	17.6	22.7	106	41	16
11	38	11.3	26.2	17.8	22	108	128	18
12	35.4	13.1	28.8	18.3	23.6	125	68	12
Year of 2020								
1	37.4	13.7	30.6	17.7	24.2	135	150	19
2	38.0	14.0	28.7	18.2	23.4	102	233	20
3	34..8	13.8	28.7	16.4	22.6	98	146	14
4	33.8	9.4	26.6	13.1	19.8	69	24	10
5	26.6	2.7	21.8	9.0	15.4	47	27	10
6	25.8	6.3	19.5	9.8	14.7	38	142	19
7	30.2	2.8	20.3	9.8	15.1	37	20	4
8	31.2	5.0	20.1	10.3	15.2	49	113	17
9	35.6	10.2	25.5	16.5	21.0	84	9	11

Source: CIIAGRO Online (2021).

The effect of fertilizers on plants was measured by indirect measurements of chlorophyll a and b carried out with a chlorophyll meter (ClorofiLOG® CFL 1030, Falker®), which measures the amount of radiation transmitted through the leaves, optically, at three different wavelengths (two in the red range close to the chlorophyll absorption peaks and one in the near infrared). For measurement, the central part of the leaf blade was used, approximately 1 cm from the margin of the newly developed leaf. Falker's Chlorophyll meter has the same principle as Konica's SPAD-502® chlorophyll meter, a device already recognized worldwide and with hundreds of studies in the literature that prove the correlation of the equipment's measurement with biochemical analysis of chlorophyll.

To determine the parameters relating to plant growth, plant height measurements were taken, considering the height of the substrate up to the plant tips, the width and length of the third leaf, starting from the apex.

The analyzes were carried out right after the first fertilization, 30 days after the first fertilization, and the others were carried out 150, 240, and 330 days after the start of fertilization.

After data collection, the SISVAR v 5.6 program (Ferreira, 2019) was used to submit the data to analysis of variance ($p < 0.05$) using the F test and the means of the characteristics were compared using the Scott test -Knott ($p < 0.05$) and ($p < 0.01$).

For height, a bifactorial interaction was analyzed, comparing fertilizers using the Scott-Knott test, and data related to dates were adjusted using a linear regression model. For the FCI (Falker Chlorophyll Index) data, the interaction was not made because it is an instantaneous measurement that can vary in a way that does not adjust linearly or quadratically (it can increase or reduce during the cycle, unlike the height that always goes increase).

Results and Discussion

In the first 150 days of the experiment, the fertilizers used provided significant gains in height in the plants of *Dieffenbachia sp.*, in relation to the control (Fig. 1), with the plants being 10 to 19 cm taller than the most fertilized plants. However, none of the fertilizers tested promoted different growth than conventional mineral fertilizer 10-10-10.

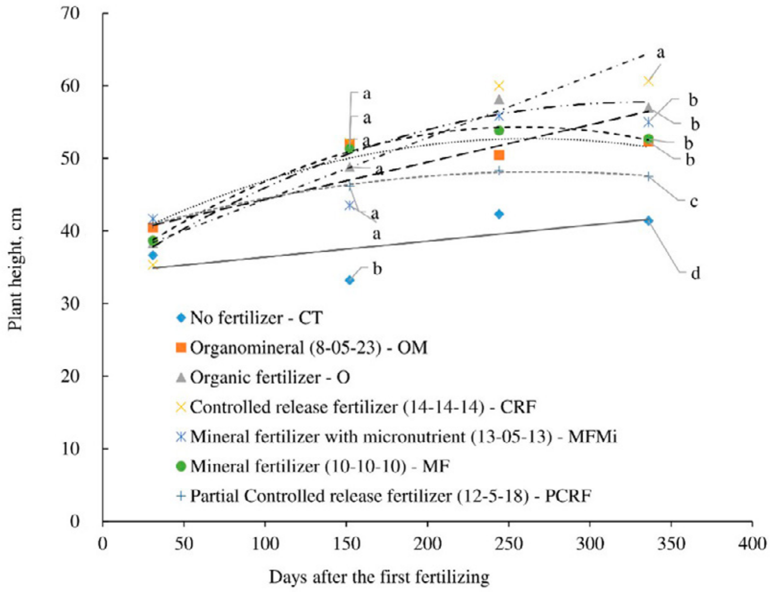

Fig. 1. Plant height depending on the application of different fertilizers over the months of the experiment. Each point represents the average of six repetitions. The mean followed by the same letter does not differ between treatments, within a given data, using the Scott-Knott test. CV = 11.25%. Regression equations: CT – $\hat{y} = 34.204 + 0.022x$; $R^2 = 0.45$; OM (05-08-23) - $\hat{y} = 37.652 + 0.115x – 0.0002x^2$; R^2=0.90; O – $\hat{y}$ = 33,522 + 0.146x – 0.0002x^2; R^2=0.97; CRF (14-14-14) - $\hat{y} = 35.789 + 0.0852x$; R^2=0.89; Mineral fertilizer with micronutrients - $\hat{y} = 39.214 + 0.0514x$; R^2=0.80; MF (10-10-10) - $\hat{y} = 34.235+ 0.156x – 0.0003x^2$; R^2=0.99; Controlled Release Partial Fertilizer (15-05-28) - $\hat{y} = 38.944+ 0.0683x – 0.0001x^2$ +; $R^2 = 0.99$.

At the end of the cycle, 330 days after the first fertilization, the plants fertilized with controlled release fertilizer (CRF) reached the greatest height (60 cm) in relation to the other fertilizers, which in turn provided greater height than the control treatment (41 cm). The fertilizer with partial controlled release (12-5-18) resulted in plants with shorter height than the other fertilizers. Plants that reach greater height, in a shorter time, can be sold earlier, increasing the producer's income. The highest plant height was reached at 234, 260, 288, and 340 days after the first fertilization, for treatments with organic fertilizer, conventional mineral fertilizer (10-10-10), organomineral fertilizer and fertilizers with partial controlled release, respectively. The controlled release fertilizer (14-14-14) provided linear growth in height, with no maximum point, however, at 240 days after the first fertilization, the plants had practically the same height as in the treatment with organic fertilizer.

Another study with the species *Dieffenbachia sp*., using doses of inorganic fertilizers with different fertilization intervals, found that fertilization intervals longer than 30 days can affect plant growth, being an indication of reduced plant growth in the initial period of 150 days (Divya et al., 2022). In the present experiment, fertilization with conventional mineral fertilizers was carried out every 45 days, with no reduced growth observed.

Other trials found similar results in height with seedlings of the *Campomanesia aurea* species, with intermediate concentrations estimated by regression of controlled-release fertilizers, indicating that the way nutrients were made available had a significantly greater impact than the applied dose (Emer et al., 2020).

The interaction was significant ($p < 0.0008$) between date and plant height, in which it was observed that from day 150 onwards, there was a marked growth of plants in all treatments, with some stability in plant height at 330 days. Height is an important criterion to be observed by producers and buyers of seedlings, since plants are sold in pots of different volumetric capacities, considering the minimum and maximum height of the plants. According to Veiling Holambra (2021), plants are classified and separated into homogeneous lots, with height being one of the criteria that unifies communication between the entire production chain, where producers, wholesalers, retailers, consumers follow the same criteria to determine the quality of the product. product. Therefore, treatments with controlled-release fertilizer and organic fertilizer provided plants with an approximate height of 58 to 60 cm, which can now be sold 240 days after the first fertilization, without the need to apply the last installment, reducing the necessary dose of these fertilizers for plant production.

After 30 days of the first application of fertilizers, it was not possible to observe differences between treatments in the levels of Falker A (Fig. 2A), B (Fig. 2B), and total chlorophyll (Fig. 2C). Due to the short period, the composition of the substrate used by the company probably provided the necessary nutrients for the plant during this period, in addition to the different fertilizers used in the experiment not yet having acted to affect the chlorophyll levels during this period.

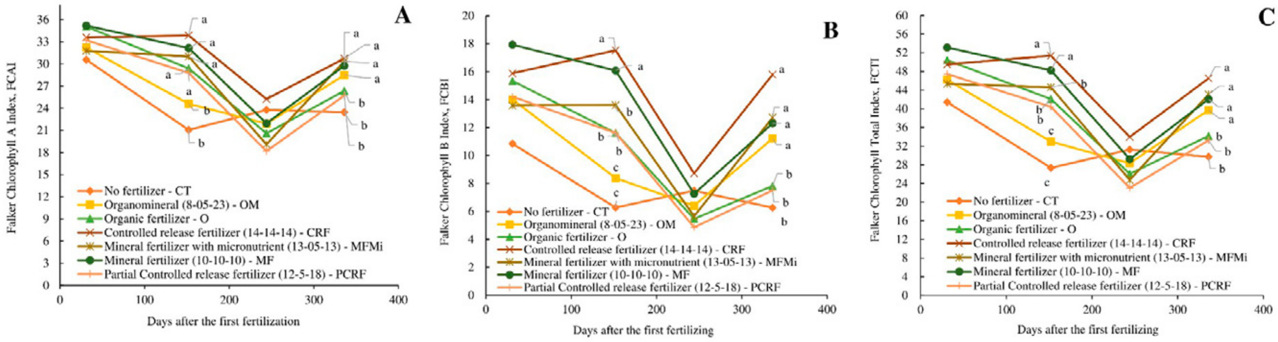

Fig. 2. A. Falker chlorophyll A index (FCAI); **B.** Falker's chlorophyll B index (FCBI) and **C.** Falker's chlorophyll total index (FCTI) in the leaves of the plant with me-nobody-can as a function of the application of different fertilizers throughout the months of the experiment. Each point represents the average of six repetitions. The mean followed by the same letter does not differ between treatments, within a date, using the Scott-Knott test.

After 150 days from the start of fertilization, the lack of application of the nutrient reduced the levels of chlorophyll A, B, and total leaf chlorophyll, leaving the plants in the control treatment and the treatment with organomineral fertilizer with a less intense green color and, therefore, less attractive for commercialization than plants from other treatments. At this time, the highest values of chlorophyll B and total indices were observed in the treatment with controlled release fertilizer (14-14-14) and conventional mixed fertilizer (10-10-10). The effects of controlled-release fertilizers on FCTI were reported in a study with *Impatiens balsamina* in which values higher than the control were obtained (Bezerra et al., 2021).

Controlled-release fertilizers play a crucial role in sustainable management and in reducing environmental impacts (Zapotoski and Ferreira, 2023). By releasing nutrients gradually and in a controlled manner, these fertilizers ensure a more efficient and continuous supply of nutrients to plants, minimizing losses due to leaching and volatilization (Vejan et al., 2021). This results in a reduced need for frequent applications, decreasing the excessive use of fertilizers and, consequently, the associated environmental impact (Liu et al., 2021). Furthermore, by preventing nutrient excess in the soil, controlled-release fertilizers help avoid water contamination and eutrophication, common issues in less controlled agricultural practices (Vejan et al., 2021). Thus, these fertilizers contribute to soil and water quality preservation, promoting more eco-friendly and sustainable agricultural practices (Gonçalves et al., 2024).

Furthermore, lower chlorophyll levels may reflect lower photosynthetic rates, reducing plant growth, as observed in the present experiment (Fig. 3). The reduction in FCTI was also observed by Milani et al. (2021), in the cultivation of cutting gerberas, grown in pots, due to the absence of nitrogen fertilizer.

Fig. 3. With *Dieffenbachia sp.*at the beginning of the experiment (A); With *Dieffenbachia sp*. at 60 days after the start of the experiment (B); With *Dieffenbachia sp*. at 90 days after the start of the experiment (C); With *Dieffenbachia sp*. at 180 days after the start of the experiment (D); With *Dieffenbachia sp*. at 240 days after the start of the experiment (E); With *Dieffenbachia sp*. at 365 days after the start of the experiment, corresponding to the end of the experiment (F).

At 330 days after the first fertilization, at the end of the production cycle, the lowest values of the FCAI, FCBI, and FCTI indices were observed in the control treatments, with partial controlled release fertilizer and with organic fertilizer.

With the exception of the control treatment, all treatments showed an increase in FCIs (A, B or T) at 330 days after the first fertilization. This increase is partly due to the lower light intensity at this time, leading plants to produce more chlorophyll. Between days 210 and 240 of the start of fertilization, there were 19 days of rain, which further characterized the reduction of light. The increase in chlorophyll index due to lower solar irradiation was also observed by Xiong et al. (2015).

The quality of color is observed when selling ornamental plants. Yellowed leaves can compromise the sale of plants, as they can indicate a series of problems with them. Veiling Holambra (2021) mentions that it is considered a serious defect when there are yellowed or burned leaves due to phytotoxicity, devaluing the quality, which can disqualify the plants when symptoms occur in 5% of the batch, reaching up to 10% of the leaf. In Fig. 4, it is possible to notice plants, from 60 days after the first fertilization, that have yellowed (senescent) leaves, representing that the fertilization used is not sufficient. In this sense, the highest FCAI and FCBI in plants represent plants with a more suitable green color, thus improving quality and price.

Broschat (2015) observed that *Dieffenbachia sp*. grown in sandy or calcareous soils, with low P content, can grow properly and maintain good quality, without the need for phosphate fertilizer.

Another important characteristic for the commercialization of me-nobody-can plants is the size of the leaves. Leaves with wider and longer leaves are more attractive to consumers. Leaf width was influenced by fertilizers at 240 and 330 days after the first fertilization (Fig. 4A). On the first date on which there was influence of fertilizers, leaf width was greater in treatments with controlled release fertilizer, organic fertilizer, conventional fertilizer (10-10-10) and NPK fertilizer with micronutrients (13-05-13). In the last evaluation, only the control treatments (without fertilization) and with partial controlled release fertilizer, presented plants with leaves that were less wide and shorter than the other treatments (Fig. 4A and 4B).

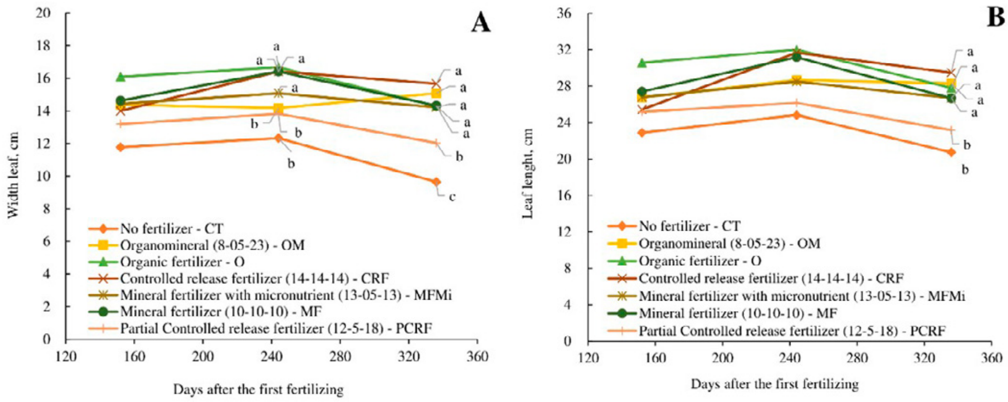

Fig. 4. A. Width of leaf 3; B. Length of leaf 3 of *Dieffenbachia sp*. depending on the application of different fertilizers over the months of the experiment. Each point represents the average of six repetitions. The mean followed by the same letter does not differ between treatments, within a date, using the Scott-Knott test.

Mineral fertilizers, such as 10-10-10 and 12-05-18, provide nutrients quickly and immediately, but their release is less controlled, which can lead to losses through leaching and volatilization, requiring more frequent applications. Controlled-release mineral fertilizers, like 14-14-14, offer a gradual and continuous release of nutrients, reducing the need for frequent applications and minimizing losses (Vejan et al., 2021). Fertilizers with partially controlled release, such as 15-05-28, combine both rapid and controlled release, providing an initial quick response and prolonged nutrient availability (Jariwala et al., 2022).

Organomineral fertilizers, like 08-05-23, combine organic and mineral components, promoting a slower and more prolonged nutrient release while improving soil structure and quality (Morais et al., 2023). Organic fertilizers release nutrients slowly as they decompose, providing continuous and sustainable nutrition, as well as enhancing soil fertility and health (Verma et al., 2020). Each type of fertilizer has distinct characteristics that affect the efficiency and duration of nutrient release, impacting fertilization management and plant health (Vejan et al., 2021).

Conclusion

The controlled-release fertilizer (14-14-14) and the organic fertilizer, divided into three applications, provided the production of *Dieffenbachia sp*. plants, grown in pots, in less time than the other treatments. However, only the first provided plants with a darker green color, more attractive for commercialization.

Acknowledgments

The authors would like to thank Mr. Rubens Shimizu for providing the plants and the experimental area. We also thank the companies that supplied the fertilizers used in the experiment, Forth and Adubasul. To the students of NEEPP (Teaching, Extension, Research Center in Landscaping) and the Tutorial Education Program in Agricultural Engineering (PET UNESP Agro Registro) who helped with the execution of the work.

Author contribution

GS: Investigation, Writing, Review. **AMS:** Resources. **AGPR:** Data Curation. **LJGG:** Metodology, Writing, Review. **MVF:** Investigation, Analysis, Writing, Review &Editing.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability Statement

Data will be made available on request.

References

BEZERRA, J.C.M.; SANTOS, P.L.F.; JÚNIOR, W.A.R.; JUNIOR, L.H.S.; CASTILHO, R.M.M. Uso de adubo de liberação lenta e convencional no cultivo de *Impatiens balsamina*. **Revista Cultura Agronômica**, v.30, n.1, p.14-23, 2021. https://doi.org/10.32929/2446-8355.2021v30n1p14-23

BROSCHAT, T.K. Fertilization of landscape palms to reduce nitrogen and phosphorus inputs to the environment. **HortScience**, v.5, p.469–473, 2015. https://doi.org/10.21273/HORTSCI.50.3.469

CIIAGRO ONLINE. **Resenha Agrometeorológica por local**. Available in: http://www.ciiagro.sp.gov.br/ciiagroonline/Listagens/Resenha/LResenhaLocal.asp Accessed on: 26 jun. 2024.

DEHGAN, B. **Angiosperms**: flowering plants. In: DEHGAN, B. Garden Plants Taxonomy: Volume 1: Ferns, Gymnosperms, and Angiosperms (Monocots). Cham: Springer International Publishing, 2023. p.173-603.

DIVYA, K.; PRASANTH, P.; KUMAR, A.K.; SALMA, Z.; VIJAYA, D.; CHARY, D.S. Effect of Different Inorganic Fertilizers on Growth and Development of *Dieffenbachia seguine* (Jacq.) Schott. **International Journal of Environment and Climate Change**, v.12, n.11, p.1723-1731, 2022. https://doi.org/10.9734/ijecc/2022/v12i1131165

EMER, A.A.; WINHELMANN, M.C.; TEDESCO, M.; FIOR, C.S.; SCHAFER, G. Controlled release fertilizer used for the growth of *Campomanesia aurea* seedlings. **Ornamental Horticulture**, v.26, n.1, p.35-44, 2020. https://doi.org/10.1590/2447-536x.v26i1.2020

ENO, I.P.; UBI, G.M. Toxic Effect of the floristic dumb cane (*Dieffenbachia amoena*) phytochemicals and anti-nutritional factors on household. **Journal of Agriculture and Food Sciences**, v.5, n.1, p.13-24, 2021.

FERREIRA, D.F. SISVAR: A computer analysis system to fixed effects split plot type designs. **Revista brasileira de Biometria**, v.37, n.4, p.529-535, 2019.

GABRIEL, M.M.; BETIM, F.C.M; OLIVEIRA, C.F.; BIANCHINI, A.; MOURA, P.F.; DALARMI, L.; MONTRUCCHIO, D.P.; FERNANDES, I.C.; DIAS, J.F.G.; MIGUEL, O.G; MIGUEL, M.D. Metabólitos bioativos e atividades biológicas, tóxicas e farmacológicas de plantas ornamentais: uma revisão das espécies *Hydrangea macrophylla, Euphorbia milii, Dieffenbachia seguine* e *Dracaena trifasciata*. **Arquivos de Ciências da Saúde da UNIPAR**, v.27, n.6, p.2623-2640, 2023. https://doi.org/10.25110/arqsaude.v27i6.2023-032

GOMES, I.B.; FERREIRA, M.F.; QUEIROZ, G.M.; SANTOS, L.A.C. Uso de resíduos de castanha-do-Brasil para o cultivo de cactos globulares na região Amazônica. **Revista Verde de Agroecologia e Desenvolvimento Sustentável**, v.17, n.3, p.221-226, 2022. https://doi.org/10.18378/rvads.v17i3.9333

GONÇALVES, A.K.S.; SILVA, A.F.S., FERRETTI, A.S.Z. Compostagem de resíduos da produção agrícola de café e milho como forma de estratégia de conservação do solo: um estudo de caso no município de Linhares, Espírito Eanto. **Revista Multidisciplinar do Nordeste Mineiro**, v.6, n.1, 2024.

IBRAFLOR. Instituto Brasileiro de Floricultura. **O Mercado de Flores no Brasil**. Available in: https://www.ibraflor.com.br/_files/ugd/b3d028_2ca7dd85f28f4add9c4eda570adc369f.pdf Accessed on: 26 jun. 2024.

JARIWALA, H.; SANTOS, R.M.; LAUZON, J.D.; DUTTA, A.; WAI CHIANG, Y. Controlled release fertilizers (CRFs) for climate-smart agriculture practices: a comprehensive review on release mechanism, materials, methods of preparation, and effect on environmental parameters. **Environmental Science and Pollution Research**, v.29, n.36, p.53967-53995, 2022.

LAWRENCIA, D.; WONG, S.K.; LOW, D.Y.S.; GOH, B.H.; GOH, J.K.; RUKTANONCHAI, U.R.; TANG, S.Y. Controlled release fertilizers: A review on coating materials and mechanism of release. **Plants**, v.10, n.2, p.238, 2021. https://doi.org/10.3390/plants10020238

LIU, L.; ZHENG, X.; WEI, X.; KAI, Z.; XU, Y. Excessive application of chemical fertilizer and organophosphorus pesticides induced total phosphorus loss from planting causing surface water eutrophication. **Scientific Reports**, v.11, n.1, p.23015, 2021.

MILANI, M.; PRADELLA, E.M.; HEINTZE, W.; SCHAFER, G.; BENDER, R.J. Nitrogen and calcium fertilization on the growth and development of gerbera cultivated in pots for cut flowers. **Ornamental Horticulture**, v.27, n.3, 2021. https://doi.org/10.1590/2447-536X.v27i3.2236

MORAIS, E.G., SILVA, C.A.; MALUF, H.J.G.M.; PAIVA, I.D.O.; PAULA, L.H.D. Effects of compost-based organomineral fertilizers on the kinetics of NPK release and maize growth in contrasting oxisols. **Waste and Biomass Valorization**, v.14, n.7, p.2299-2321, 2023.

PALAZZO JR, J.T. **A Natureza No Jardim**. 5ª ed. Joinville: Clube de Autores, 2021.

RAIJ, B. VAN; ANDRANDE, J.C.; CANTARELLA, H.; GUAGGIO, J.A. **Análise química para avaliação da fertilidade de solos tropicais.** Campinas: Instituto Agronômico, 2001. 285p.

SPIER, J.; SILVA, V.N.; LEITE, J.G.D.B. Ornamental plants in Chapecó: market characteristics and opportunities for family farms. **Ornamental Horticulture**, v.26, n.3, 2020. https://doi.org/10.1590/2447-536X.v26i3.2152

TAEMTHONG, W. Air quality improvement using ornamental plants in classrooms. **Journal of Green Building**, v.16, n.2, p.201-216, 2021.

VEILING Holambra. **Areca bambu e palmito juçara (*Euterpe*).** (2021) Available in: http://veiling.com.br/uploads/padrao/areca-bambu-e-palmito-jussara-po.pdf. Accessed on: 26 jun. 2024.

VEJAN, P.; KHADIRAN, T.; ABDULLAH, R.; AHMAD, N.; VEJAN, P. Controlled release fertilizer: A review on developments, applications and potential in agriculture**. Journal of Controlled Release**, v.339, p.321-334, 2021. https://doi.org/10.1016/j.jconrel.2021.10.003

VERMA, B.C.; PRAMANIK, P.; BHADURI, D. Organic fertilizers for sustainable soil and environmental management. In: MEENA, R. (eds) **Nutrient dynamics for sustainable crop production**. Singapore: Springer, 2020. p.289-313.

XIONG, D.; CHEN, J.; YU, T.; GAO, W.; LING, X.; LI, Y. SPAD-based leaf nitrogen estimation is impacted by environmental factors and crop leaf characteristics. **Nature**, v.5, n.13389, 2015. https://doi.org/10.1038/srep13389

ZAPOTOSKI, R.G.T.; FERREIRA, K.C. Agrominerais-fertilizantes e corretivos de acidez do solo. **Revista Foco**, v.16, n.12, p.e3622-e3622, 2023.