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Original Article

Foliar diagnosis of common arrowroot propagated by different forms and fertilized with biofertilizer[1]

Diagnose foliar da araruta comum propagada por diferentes formas e adubada com biofertilizante

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HIGHLIGHTS:

Propagation of arrowroot from the whole rhizome favors greater accumulation of leaf nutrients.
The biofertilizer doses indicated for arrowroot fertilization are between 600 and 1200 mL per plant week^{-1}.
There were antagonistic effects between Zn and Fe, K and Cu, and P and Mn, which changed the nutrient content in arrowroot.

ABSTRACT: Arrowroot (*Maranta arundinaceae*) is a unconventional food plant (UFP) that has relevant nutritional properties. However, few studies on the species regarding its forms of propagation and its nutrition have been performed. In parallel, biofertilizer provides nutrients and stimulates the development of species, as it promotes improvements in soil properties. In this context, the objective in this study was to evaluate the effect of different forms of propagation and doses of biofertilizer on arrowroot nutrition. A randomized block experimental design in a split-plot scheme, evaluating three forms of propagation (whole rhizome, part of the rhizome and stem) and five doses of biofertilizer (0, 300, 600, 900 and 1200 mL per plant week^{-1}) was used. At 268 days after planting, the leaves were collected for analysis of leaf macro and micronutrient contents. Plants propagated by stem have lower accumulation of N, P, K and S and higher accumulation of Na, compared to the other forms of propagation. N and K contents were increased by the application of biofertilizer, reaching values of 20.8 and 18.2 g kg^{-1} at doses of 1200 and 955 mL per plant week^{-1}, respectively. Accumulation of micronutrients was influenced by the forms of propagation and doses of biofertilizer, showing positive responses, especially for Zn at the maximum dose. Propagation by whole rhizome and doses from 600 to 1200 mL per plant week^{-1} are recommended to obtain the best nutritional results in arrowroot.

Key words: *Maranta arundinaceae*, biofertilization, plant nutrition, unconventional food plants

RESUMO: A araruta (*Maranta arundinaceae*) é uma planta alimentícia não convencional (PANC) que apresenta propriedades nutricionais relevantes. No entanto, poucos estudos sobre a espécie quanto às suas formas de propagação e sua nutrição foram realizados. Paralelamente, o biofertilizante fornece nutrientes e estimula o desenvolvimento das espécies, pois promove melhorias nas propriedades do solo. Nesse contexto, o objetivo neste estudo foi avaliar o efeito de diferentes formas de propagação e doses de biofertilizante na nutrição da araruta. O delineamento experimental foi em blocos casualizados em esquema de parcelas subdivididas, avaliando três formas de propagação (rizoma inteiro, parte do rizoma e caule) e utilizando cinco doses de biofertilizante (0, 300, 600, 900 e 1200 mL por planta semana^{-1}). Aos 268 dias após o plantio foi realizada a coleta das folhas para análise do teor de macro e micronutrientes foliares. Plantas propagadas por haste apresentam menor acúmulo de N, P, K, S e maior acúmulo de Na, em relação às demais formas de propagação. Os teores de N e K foram incrementados pela aplicação do biofertilizante, alcançando valores de 20,8 e 18,2 g kg^{-1} nas doses de 1200 e 955 mL por planta semana^{-1}, respectivamente. O acúmulo dos micronutrientes foi influenciado pelas formas de propagação e pelas doses de biofertilizante, apresentando respostas positivas, especialmente para o Zn na dose máxima. A propagação por rizoma inteiro e as doses entre 600 e 1200 mL por planta semana^{-1} são as recomendadas para que se obtenha os melhores resultados nutricionais na araruta.

Palavras-chave: *Maranta arundinaceae*, biofertilização, nutrição de plantas, plantas alimentícias não convencionais

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Introduction

Biofertilizers are biostimulants from organic products capable of acting, directly or indirectly, on plants, stimulating their development and raising their yield, since they participate in the cycling of nutrients and improve soil structure and fertility (Yadav & Sarkar, 2019). In addition, the reuse of organic materials to produce biofertilizer is a strategy to reduce production costs and add value to the product, being an economically viable and environmentally sustainable alternative (Lima Neto et al., 2021).

Liquid biofertilizer is more easily absorbed by crops because it penetrates the roots, providing nutrients for plants more quickly and efficiently (Mącik et al., 2020). The cultivation of unconventional food plants (UFPs) helps to strengthen food security in rural communities, being a viable and low-cost food strategy (Kmiecik & Lucca, 2020).

UFPs are rich sources of macro and micronutrients, in addition to having important properties in disease prevention; however, their cultivation and consumption have decreased in all regions of Brazil (Gonçalves et al., 2021). UFPs include arrowroot (*Maranta arundinaceae* L.), a species that contains in its rhizomes significant amounts of starch, with absence of gluten and presence of inulin, which makes it indicated for nutrition of diabetics and celiacs (Maulani & Hidayat, 2016; Moreno et al., 2017). Souza et al. (2018) mention that due to these properties, arrowroot starch reaches a higher price in the international market than similar products.

In parallel to the nutrition of arrowroot, another important factor for the development of the species is propagation, because according to Zárate & Vieira (2005), the type and quality of the propagule determine the speed of its rooting, development, production and extension of its cycle. Thus, the objective in this study was to evaluate the effect of different forms of propagation and doses of biofertilizer on arrowroot nutrition.

Material and Methods

The study was conducted at the Piroás Experimental Farm belonging to the Universidade da Integração Internacional da Lusofonia Afro-Brasileira - UNILAB, located in Redenção, CE, Brazil, in 2020, with coordinates 4º 9' 19.39" S and 38º 47' 41.48" W, with an altitude of 231 m. According to Köppen's classification, the climate of the region is characterized as Aw' (rainy tropical), hot semi-arid, with rainfall concentrated from January to April and annual averages of rainfall of 1,097 mm and temperature of 27 ºC. The data were obtained by a pluviometer and a datalogger (HOBO U12 Temperature/Relative Humidity/Light/External, Model: U12-012), respectively, installed in the experimental area.

The experimental assay aimed to evaluate the foliar diagnosis of common arrowroot (*Maranta arundinaceae* L.) grown in 1.0 m × 14.4 m beds, with one plant row per bed at spacing of 1.0 m (between beds) x 0.3 m (between plants), totaling an area of 0.30 m² per plant with a stand of 33,333 plants ha^{-1}. Before applying the treatments, the soil in the area was collected and analyzed, and the fertility results are presented in Table 1.

The experimental design was randomized blocks in a split-plot scheme and four blocks. Plots consisted of five doses of biofertilizer (0, 300, 600, 900 and 1200 mL per plant $week^{-1}$) and subplots consisted of three forms of rhizome propagation: whole rhizome (length of approximately 10 cm; average weight of 50 g), part of the rhizome (length of approximately 5 cm; average weight of 15 g) and stem of plants collected at harvest (cut at 20 cm height). Each subplot was composed of four usable plants, totaling 240 plants, distributed in the beds.

The biofertilizer was produced by aerobic fermentation in a 500 L polyethylene plastic container, using 100 L of fresh cattle manure, 30 L of chicken manure, 5 L of wood ash and 270 L of water, over a period of thirty days. The mixture was aerated twice a day (manual process) to speed up the decomposition process. The doses of biofertilizer were based on studies previously carried out with other crops and aimed at adequate nutrition for the crop.

Aerobic fermentation causes several chemical and biological transformations to occur in the biofertilizer that improve the quality of the final product, leaving nutrients more readily available for plant absorption. After this process, the chemical analysis of the biofertilizer was performed at the Soil, Water and Plant Tissue Laboratory at IFCE - Campus Limoeiro do Norte - LABSAT (Table 2).

At 30 days after planting (DAP), biofertilizer application began to be performed, split, twice a week, through 0.3-m-high PVC pipes placed near the plants, inserted up to a depth of about 0.10 m, thus preventing direct contact with the plant, causing no damage. Pipe cleaning and soil scarification were performed weekly to improve the incorporation of biofertilizer into the soil and also avoid compaction.

Irrigation was performed by the localized method, using a drip system with an average flow rate of 6 L h^{-1}, sized to operate with one lateral line for each planting row. Irrigation depth was calculated considering the values of evaporation

Table 1. Chemical attributes of the soil in the experimental area at 0-20 cm depth

C	OM	P	K	Ca	Mg	Na	Al	H+Al	SB	CEC	V	ESP	m	EC
(g kg^{-1})		(mg dm^{-3})	(mmol dm^{-3})								(%)			(dS m^{-1})
3.46	5.98	6.1	1.97	21.4	6.57	2.01	-	11.1	31.9	42.9	75	4	0	0.62

C - carbon; OM - organic matter; SB - sum of bases; CEC - cation exchange capacity; V - base saturation percentage; ESP - exchangeable sodium percentage; m - aluminum saturation percentage; EC - electrical conductivity

Table 2. Chemical attributes of biofertilizer

N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Na	EC	C	OM	C/N	pH
(g L^{-1})						(mg L^{-1})						(dS m^{-1})	(%)			
1.06	0.46	0.05	1.91	0.49	0.01	194	6	2	27	1	205	6.14	1.09	1.97	10	7.01

EC - electrical conductivity; C - carbon; OM - organic matter from the class A pan, installed next to the experimental area, discounting the rainfall data of the last 24 hours, that is, when rainfall proved sufficient to meet the need of the plants, irrigation was suspended.

Irrigation frequency was daily, and application time was calculated using Eq. 1.

$$Ti = \frac{ECA \times Kp \times Kc \times Ap}{Ei \times Qg} \quad (1)$$

where:

Ti - irrigation time, in hours;
ECA - evaporation measured in the class A pan, in mm day^{-1};
Kp - pan coefficient: 1.0 (tabulated value, dimensionless);
Kc - crop coefficient: (1.0);
Ap - plant area: 0.30 m^2;
Ei - irrigation efficiency: 0.85 (determined in the experimental area); and,
Qg - dripper flow rate: 6 L h^{-1}.

At 268 DAP, prior to arrowroot harvest, 20 leaves of each treatment were collected for the analysis of the following nutrients: nitrogen, potassium, phosphorus, calcium, magnesium, sulfur, iron, zinc, copper, manganese, boron and sodium. The oldest and the youngest leaves were discarded, and the selected leaves showed good visual appearance, with dark green color and size larger than 15 cm. These leaves were placed in paper bags, identified and sent to the Soil, Water and Plant Tissue Laboratory - LABSAT, belonging to the IFCE of Limoeiro do Norte, for the analyses according to the methodologies of Malavolta et al. (1997) and EMBRAPA (Silva, 2009).

For statistical analysis, analysis of variance was performed at $p \leq 0.05$. Forms of propagation were analyzed by means comparison test (Tukey), and biofertilizer doses were analyzed through regression, selecting equations that best fitted the data based on the significance of the regression coefficients at $p \leq 0.05$ by F test, using the Assistat 7.7 Beta program. For second-degree equations, maximum points were calculated by derivative of each equation.

Results and Discussion

Macronutrient contents were influenced by the biofertilizer doses, except for S. Forms of propagation significantly influenced N, P, K, Ca and S contents. The interaction between biofertilizer doses and forms of propagation influenced only Ca and Mg contents (Table 3).

Regression analysis of N contents as a function of biofertilizer doses showed that the data were described by the increasing linear model (Figure 1A), indicating a positive response to the addition of biofertilizer, and N contents ranged from 16.4 to 20.6 g kg^{-1}, with an increase of 20.4%. It can be observed that the application of biofertilizer supplied 1.06 g L^{-1} of N to the soil per week (Table 2) and, as the doses were increased, greater amounts of N were made available, which stimulated a greater absorption of N and thus led to higher N contents in arrowroot leaves (Figure 1A). This can be justified by the greater of the plants, the amount of N present in the biofertilizer, and the pre-existing accumulation of this element in the rhizome used for planting. A similar result was observed by Sales et al. (2020) in okra fertilized with biofertilizer. Regarding the forms of propagation, it was observed that N contents were reduced by 9.6% when plants were propagated through stems, indicating that the rhizome propagation of arrowroot promoted greater accumulation of this element (Figure 1B).

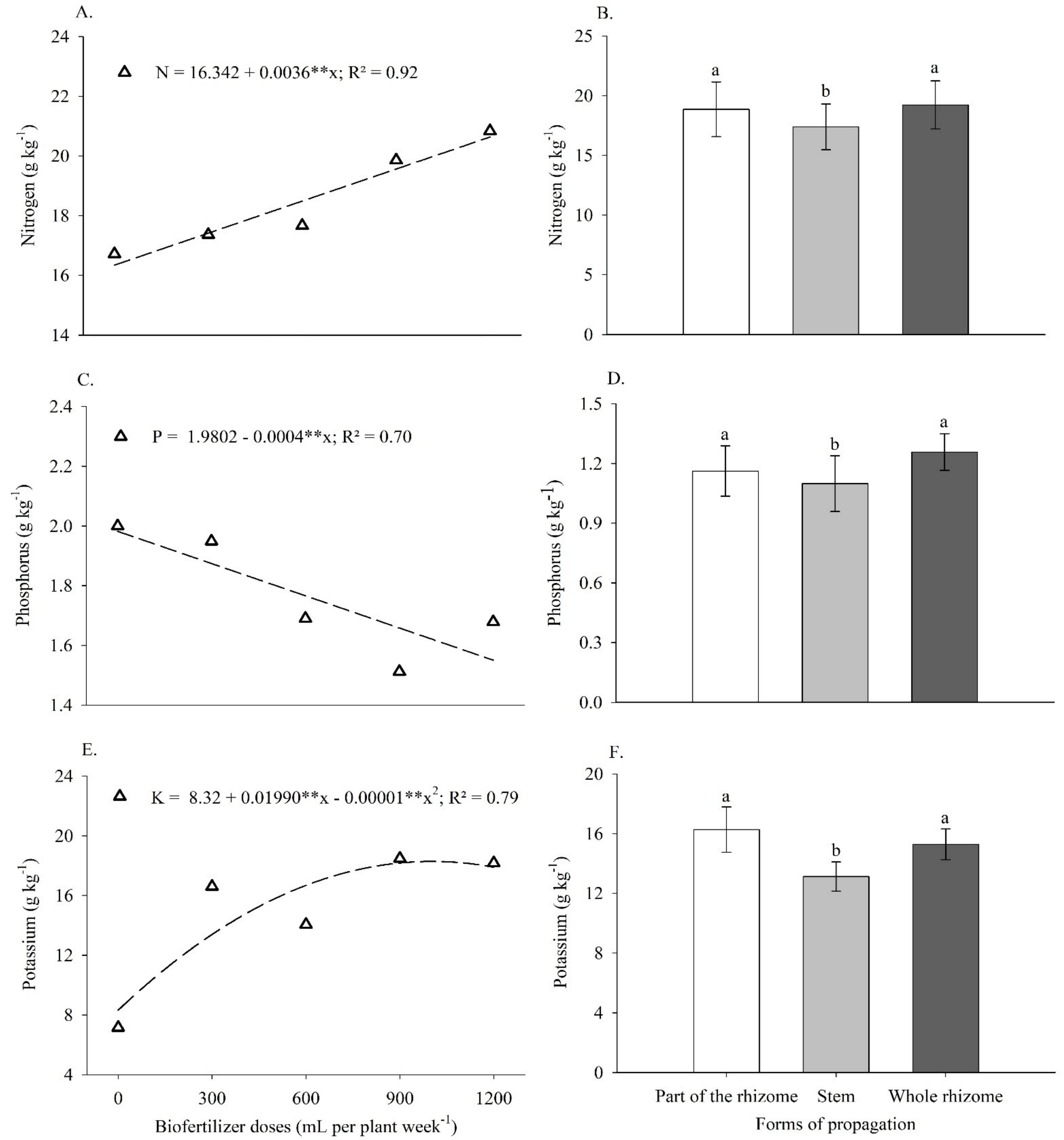
P contents as a function of the biofertilizer doses were described by the decreasing linear model, ranging from 1.98 to 1.51 g kg^{-1}, indicating that the P content decreased 24.2% with the increase in the mixed biofertilizer doses (Figure 1C). The reduction observed with the increase in biofertilizer doses may indicate that the P supplied was not sufficient for complete nutrition of the plants, so that they reallocated the available P to another part of interest, possibly to the rhizomes, in order to increase their production and ensure their reproduction. Other authors have observed that the P contents available in biofertilizers were higher than those found in the present study (Sales et al., 2021; Silva et al., 2022), indicating once again that the supply of P by the studied biofertilizer was not sufficient for arrowroot nutrition.

With regard to the forms of propagation, it was found that the P contents were increased by 12.6 and 5.4% when the plants were propagated through the whole rhizome or part of the rhizome, respectively (Figure 1D), as occurred with N. The best results for both N and P accumulation can be associated with the efficiency of absorption and accumulation of these nutrients by the rhizome, which may have enhanced the redistribution of nutrients to the leaves. Souza et al. (2019) state that it is very important to know the type and size of propagules for the production of arrowroot seedlings, as these factors influence the speed of rooting, growth, nutrient accumulation and production.

Table 3. Summary of analysis of variance for the leaf macronutrients nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S) of arrowroot as a function of biofertilizer doses and forms of propagation

Source of variation	DF	Mean square					
		N	P	K	Ca	Mg	S
Blocks	3	5.5724^{ns}	0.1770^{ns}	23.2138*	0.32440^{ns}	1.5756^{ns}	1.2331^{ns}
Doses (D)	4	37.3656**	0.8134**	261.3708**	9.2762**	24.1028**	0.5556 ^{ns}
Residual (a)	12	6.6429	0.0658	6.6101	1.3346	0.5696	0.41
Propagation (P)	2	18.9156**	0.6903**	52.0382**	67.0896**	0.3697^{ns}	0.5355*
D x P	8	3.1998^{ns}	0.0908^{ns}	5.4164^{ns}	5.7374**	2.3694**	0.3358^{ns}
Residual (b)	30	1.7799	0.0417	6.6926	1.561	0.666	0.1492
Total	59	-	-	-	-	-	-
CV (a) %		13.94	14.20	17.26	10.63	10.15	16.96
CV (b) %		7.22	11.31	17.37	11.5	10.97	10.23

^{ns}Non-significant. ** and *Significant at $p \leq 0.05$ and 0.01, respectively, by F test; DF- Degree of freedom



**Significant at p ≤ 0.01 by F test

Figure 1. Contents of nitrogen (A and B), phosphorus (C and D), and potassium (E and F) of arrowroot as a function of biofertilizer doses and forms of propagation

K contents as a function of the biofertilizer doses were described by the quadratic polynomial model, and the maximum value obtained was 18.2 g kg^{-1} at the dose of 955 mL per plant $week^{-1}$ (Figure 1E). For the leaf K contents in arrowroot as a function of the forms of propagation (Figure 1F), it was observed that in plants propagated by whole rhizome and part of the rhizome, the K contents were higher (19.4 and 14.2%, respectively) than those found in plants propagated from the stem.

This may have occurred because plants propagated by whole rhizome and part of the rhizome remained for longer under the action of the biofertilizer within the soil and, as the biofertilizer provided 0.05 g L^{-1} (Table 2), this caused greater accumulation of the nutrient, which was directed to the leaves. It is important to point out that, according to Marschner (2012), the K contents considered critical are 30-60 g kg^{-1} for most crops, while the critical contents for starchy plants, such as cassava, are 13-20 g kg^{-1} (Malavolta et al., 1997). In this context, the K contents found in arrowroot show that the results are close to those of cassava and that the crop was not under deficiency, since the polynomial equation indicates a decrease in K accumulation from the dose of 955 mL per plant $week^{-1}$.

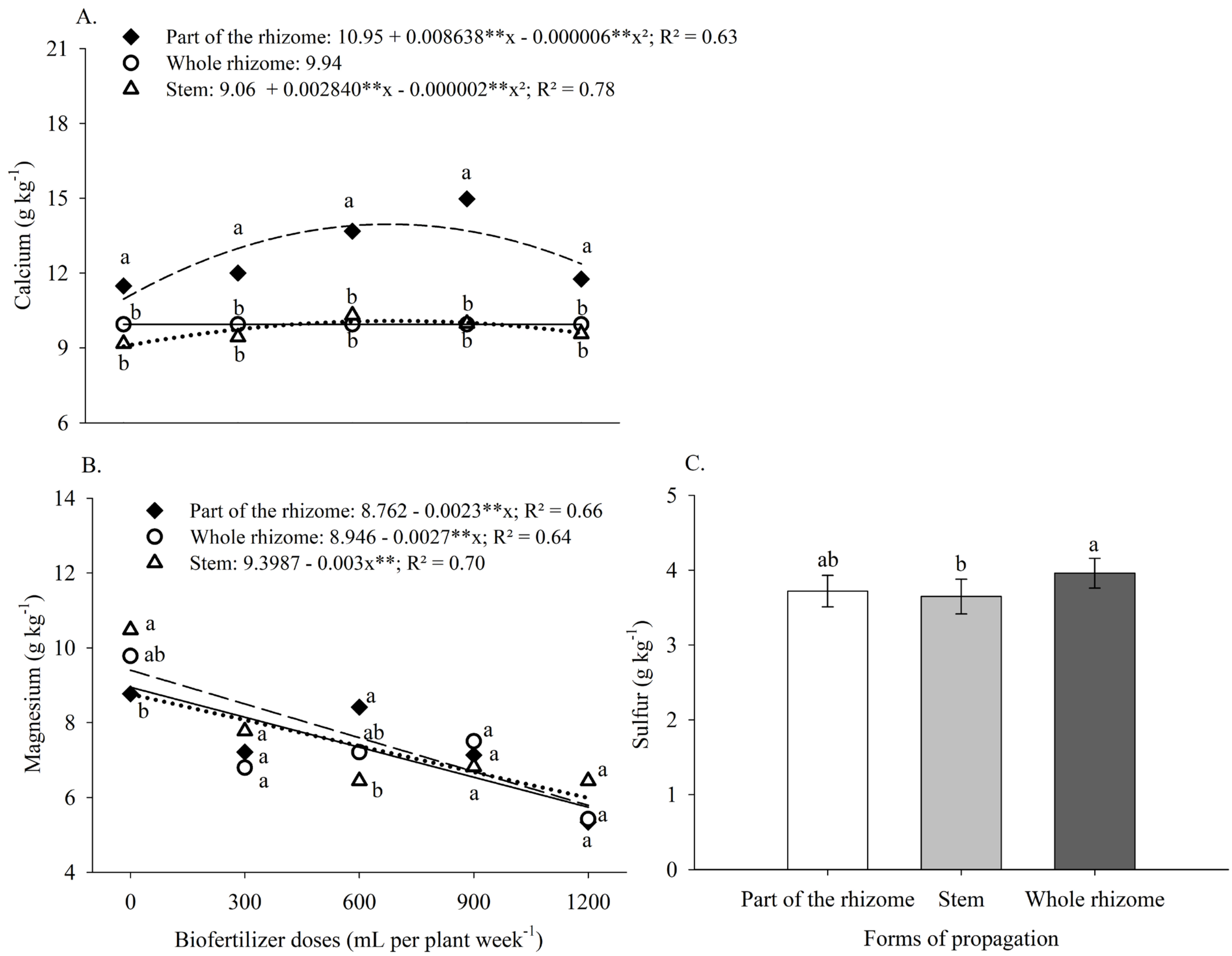
Ca contents as a function of biofertilizer doses and forms of propagation were described by the quadratic polynomial model for the propagation by part of the rhizome and stem (Figure 2A). Data related to the form of propagation by whole rhizome were not described by any regression model tested. For the propagation by part of the rhizome, the Ca content reached its maximum value of 14.06 g kg^{-1} for the biofertilizer dose of 719.8 mL per plant $week^{-1}$. In the propagation by stem, it was observed that the dose of 710 mL per plant $week^{-1}$ led to maximum Ca content of 10.07 g kg^{-1}. As for the propagation by whole rhizome, the values ranged from 9.02 to 11.49 g kg^{-1}.

In general, the supply of Ca through biofertilizer (1.91 g L^{-1}) promoted an increase in its contents up to the dose of 719.8 mL per plant $week^{-1}$. In addition, when the plants were propagated by part of the rhizome, they showed higher contents of this element compared to those propagated by stem. The adequate Ca contents obtained in this study result from the supply of this nutrient by the biofertilizer (Table 2) and indicate that its application positively stimulates the leaf contents of nutrients, being an excellent fertilization strategy for the crop. In this context, Mitter et al. (2021) state that biofertilizers improve plant nutrition through mobilization and increased availability of nutrients, which positively influences soil fertility and nutrient accumulation by plants.

In relation to Mg contents, regardless of the type of propagation, negative linear equations were fitted, highlighting a decreasing response to the increase in biofertilizer doses. Mg contents ranged from 8.7 to 6.0 g kg^{-1}, decreasing 31% for propagation by parts of the rhizome, from 8.95 to 5.7 g kg^{-1}, decreasing 36.3% for propagation by whole rhizome, and from 9.4 to 5.8 g kg^{-1}, decreasing 38.3% for propagation by stem, according to the equations (Figure 2B).

The linear reduction regardless of the form of propagation, with the increase in biofertilizer doses, is possibly due to this negative interaction between Mg and K, since it was observed that the application of biofertilizer in the soil promoted positive accumulation of K, as the doses increased up to 955 mL per plant $week^{-1}$ (Figure 1E). In this context, according to Castro et al. (2020), a situation that can affect the absorption of Mg by plants, reducing leaf contents and limiting their yield, is the negative interaction between this element and K.

For S contents, it was observed that arrowroot plants propagated from the whole rhizome had the highest S content (3.96 g kg^{-1}). When comparing the highest mean with the lowest mean (3.65 g kg^{-1}), obtained in leaves of arrowroot plants propagated by the stem, a superiority of 8.5% of S in the leaves was observed (Figure 2C).



**Significant at $p \leq 0.01$ by F test

Figure 2. Contents of calcium (A), magnesium (B) and sulfur (C) of arrowroot as a function of biofertilizer doses and forms of propagation

The greater accumulation of S in arrowroot propagated by whole rhizome can be attributed to the cumulative effect of the biofertilizer, which provided more S and, as the rhizome had higher amounts of this element, the plants were able to redistribute S to their leaves, resulting in higher leaf contents (Figure 2 C). Thus, as observed in the results of S presented here, Souza et al. (2021) evaluated the contents of macronutrients in the stems and rhizome of ornamental ginger (*Zingiber spectabile* Griff.) subjected to nutrient solutions and observed that S contents in the rhizome were higher than those in the stems.

For the contents of iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), boron (B), and sodium (Na) in arrowroot leaves, there was influence of both the individual factors (biofertilizer doses and forms propagation) and the interaction between the factors (Table 4).

Fe contents in arrowroot plants propagated from the whole rhizome were described by a quadratic equation, with maximum point of 141.3 mg kg^{-1} of Fe for the dose 670 mL per plant $week^{-1}$. As for plants propagated by part of the rhizome and by the stems, they showed linear reductions of 42.9 and 43.6%, respectively, as a function of the increase in biofertilizer doses, with values between 79.2 and 138.8 mg kg^{-1} for propagation by part of the rhizome and values between 85.84 and 152.2 mg kg^{-1} for propagation by stem (Figure 3A). Regarding Zn contents, the opposite response was observed; the increase in biofertilizer doses caused an increasing linear response 118.4 and 42.2% for propagation by part of the rhizome and whole rhizome, respectively, while the data related to propagation by stem were not described by any model tested (Figure 3B).

The results presented in Figures 3A and 3B demonstrate a competitive relationship between Fe and Zn, since as the Zn contents increased as a function of the biofertilizer doses, the arrowroot plants showed a significant reduction in Fe contents in their leaves. Similarly, Kume et al. (2021) evaluated nutritional disorders caused by Zn deficiency and excess in maize plants and found an inverse relationship between the leaf contents of these elements; Fe contents decreased as Zn contents increased.

The results presented for the variation in the leaf contents of these elements in arrowroot can be justified by this competitive relationship; as the biofertilizer provided both Fe and Zn, it can be assumed that this crop has a higher requirement of Zn for its full development. Thus, the inversely proportional correlation between Zn and Fe in leaves is due to the similarity between their atomic radii, competing for the same absorption site (Gupta et al., 2016).

With regard to Cu contents, the data related to the forms of propagation by part of the rhizome and stem were not described by any model tested, as occurred for the propagation by stem when evaluating the Mn contents. However, when arrowroot plants were propagated by whole rhizome the results obtained for Cu and Mn contents were described by inverse linear equations (Figure 3C and 3D), indicating that Cu contents decreased 38.4% with the increase in biofertilizer doses, while Mn contents increased 30.9%. For plants propagated by part of the rhizome, a significant reduction was observed in Mn contents, and a reduction of 22.5% was observed when comparing the lowest dose with the highest dose (Figure 3D).

The reduction in Cu and Mn contents as a function of biofertilizer doses, when plants were propagated by whole rhizome and part of the rhizome, respectively, is due to the antagonistic relationships between K and Cu and between P and Mn (Kabata-Pendias, 2011). It can be observed that K and P contents increased up to certain doses of biofertilizer, which may have inhibited the absorption of the micronutrients Cu and Mn, affecting the leaf contents of these elements.

For boron contents, a quadratic equation was fitted, with a maximum point of 23.0 mg kg^{-1} at the dose 599.5 mL per plant $week^{-1}$ (Figure 4A), from which there was a reduction. Regarding sodium contents, plants propagated by stem had the highest means (84.87 mg kg^{-1} of Na) compared to the other forms of propagation, 38.9% higher than the mean obtained for whole rhizome and 20.1% higher than the mean obtained for part of the rhizome (Figure 4B).

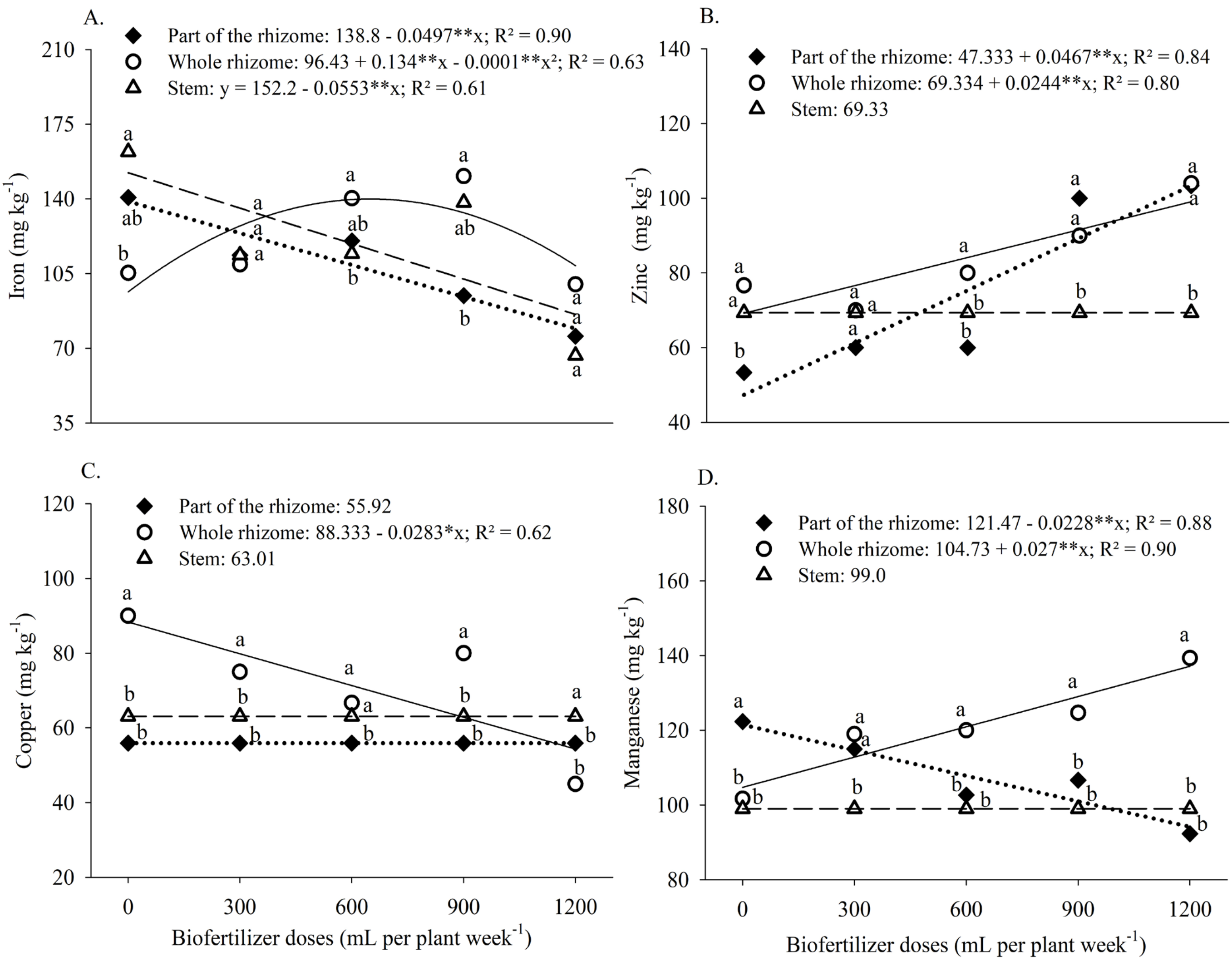
Boron is an important nutrient that participates in tissue cell division, showing a major effect on plant growth and tuber production (Ewais et al., 2020). The biofertilizer applied provided 1 mg L^{-1} of B (Table 2), which ensured its supply to arrowroot plants and positively influenced their development. Likewise, Cordeiro et al. (2022) observed that the application of microalgae biofertilizer promoted increments in growth and production and stimulated the metabolism of amino acids in potato (*Solanum tuberosum*). Similarly, Ferreira et al. (2022) found that the application of organomineral fertilizer favored the accumulation of nutrients, yield and quality of potato (*Solanum tuberosum*).

The greater accumulation of Na in arrowroot plants propagated by stem may have caused some kind of stress,

Table 4. Summary of analysis of variance for leaf micronutrient contents of arrowroot as a function of biofertilizer doses and forms of propagation

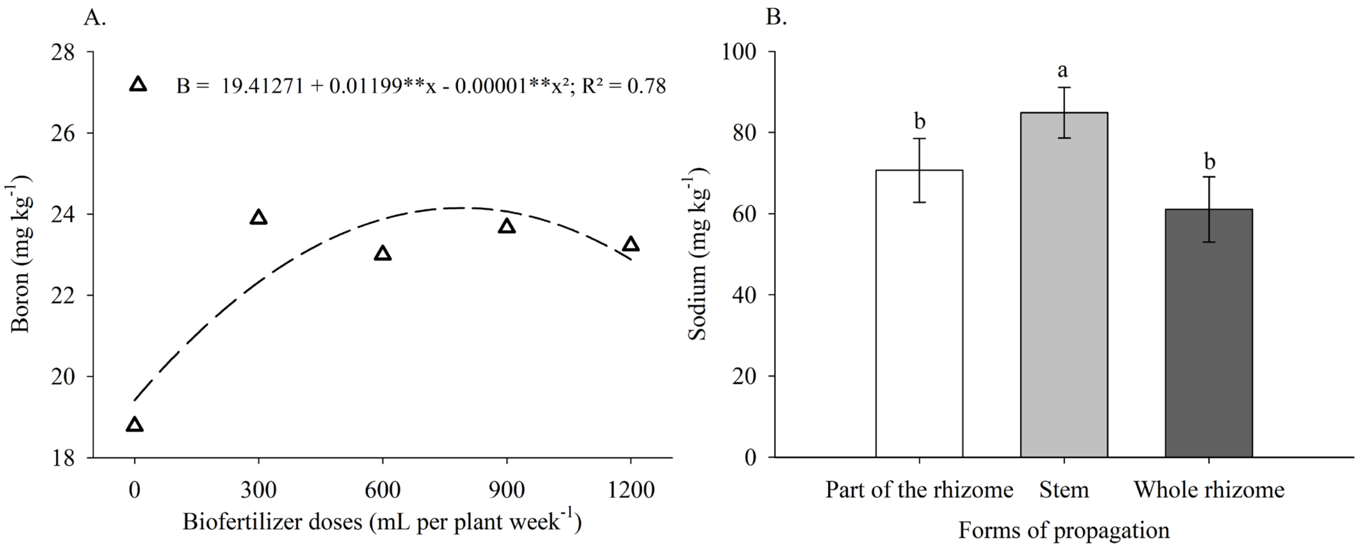
Source of variation	DF	Mean square					
		Fe	Zn	Cu	Mn	B	Na
Blocks	3	288.637^{ns}	0.903^{ns}	1.966^{ns}	2370.326^{ns}	2.548^{ns}	657.733^{ns}
Doses (D)	4	5629.525**	26.118**	11.793*	288.770^{ns}	53.748**	1222.178^{ns}
Residual (a)	12	617.396	1.125	3.048	700.529	6.363	375.233
Propagation (P)	2	839.229^{ns}	10.874**	11.903*	2436.652**	5.896^{ns}	2867.466**
D x P	8	1964.082**	9.874**	6.715*	1103.948**	5.859^{ns}	627.133^{ns}
Residual (b)	30	497.2	1.014	2.560	308.933	2.666	307.755
Total	59	-	-	-	-	-	-
CV (a) %		21.35	13.92	27.52	24.23	11.21	26.83
CV (b) %		19.16	13.22	25.22	16.09	7.25	24.30

^{ns}Non-significant. ** and *Significant at p ≤ 0.05 and 0.01, respectively, by F test; DF- Degree of freedom



*, **Significant at p ≤ 0.05 and p ≤ 0.01 by F test, respectively

Figure 3. Contents of iron (A), zinc (B), copper (C) and manganese (D) of arrowroot as a function of biofertilizer doses and forms of propagation



**Significant at p ≤ 0.01 by F test

Figure 4. Boron (A) and sodium (B) contents of arrowroot as a function of biofertilizer doses and forms of propagation

which negatively affected the absorption of essential elements, as observed for the primary macronutrients N, P and K (Figure 2). In this context, excessive accumulation of Na in leaf tissue can interfere with plant metabolism, causing cell damage, inhibiting plant development, and causing nutritional imbalances, especially due to competition with other nutrients (Farouk & Al-Huqail, 2022; Veloso et al., 2022).

Conclusions

1. Supplying nutrients through the biofertilizer stimulated greater absorption and accumulation of nutrients in arrowroot, especially at the doses of 600 to 1200 mL per plant $week^{-1}$.

2. Arrowroot plants accumulated more nutrients when they were propagated by whole rhizome, so this form of propagation is indicated for multiplication of the species.

3. Fertilization with biofertilizer met the nutritional needs of arrowroot plants, being a viable strategy.

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