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Initial development of gabiroba *(Campomanesia adamantium)* according to fertilization with nitrogen and phosphorus

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ABSTRACT

Campomanesia adamantium (Cambess.) Berg O. is a native of Savanna, popularly known as gabiroba, guavira, or gabiroba-do-campo, and has many uses, with its fruit being consumed fresh or processed. This study aimed to evaluate different doses of phosphorus and nitrogen in the initial development of gabiroba (*Campomanesia adamantium*) cultivated in pots. Five doses of phosphorus (0, 100, 200, 300, and 400kg ha^{-1} of P_2O_5) and three doses of nitrogen (0, 100, and 200 kg ha^{-1} of N) were tested. The experimental design used was completely randomized in a 5x3 factorial scheme with six replications. The evaluations were carried out 120 days after plant emergence, and the variables analyzed were stem diameter, plant height, and number of leaves. Data were subjected to analysis of variance and F-test. The means were compared by the Tukey test at $p<0.05$. Regression analyzes were adjusted for phosphorus doses. The gabiroba responds significantly to the addition of phosphorus, with the dose of 400 kg ha^{-1} of P_2O_5 providing the highest height and the dose of 300 kg ha^{-1} of P_2O_5 providing the greatest stem diameter and the number of leaves. Up to 120 days old, gabiroba seedlings do not respond significantly to nitrogen fertilization.

Keywords: Myrtaceae, Vegetable nutrition, Fruit growing.

Desenvolvimento inicial da gabiroba (C*ampomanesia adamantium*) em resposta à adubação com nitrogênio e fósforo

RESUMO

A *Campomanesia adamantium* (Cambess.) O. Berg é uma espécie nativa do Cerrado, popularmente conhecida como gabiroba, guavira ou gabiroba-do-campo e possui diversas utilizações, sendo seu fruto consumido *in natura* ou processado. O estudo objetivou avaliar diferentes doses de fósforo e nitrogênio no desenvolvimento inicial de gabiroba (*Campomanesia adamantium*) cultivada em vasos. Foram testadas cinco doses de fósforo (0, 100, 200, 300 e 400 $kg\ ha^{-1}$ *de* P_2O_5) e três doses de nitrogênio (0, 100 e 200 $kg\ ha^{-1}$ de N). O delineamento experimental utilizado foi inteiramente casualizado em esquema fatorial 5x3 com seis repetições. As avaliações foram realizadas aos 120 dias após a emergência das plantas e as variáveis analisadas foram diâmetro do caule, altura da planta e número de folhas. Os dados foram submetidos à análise de variância (teste F) e teste comparativo de médias Tukey para $p < 0.05$. Para as doses de fósforo foram ajustadas análises de regressão. A gabiroba responde significativamente à adição de fósforo, sendo que a dose de 400 kg ha^{-1} de P_2O_5 proporciona maior altura e a dose de 300 kg ha^{-1} de P_2O_5 proporciona maior diâmetro do caule e número de folhas. Até os 120 dias, as mudas de gabiroba não respondem significativamente à adubação nitrogenada

Palavras-chave: Myrtaceae, Nutrição vegetal, Fruticultura.

1. Introduction

Campomanesia adamantium (Cambess.) Berg O. is native from the Cerrado, belonging to the Myrtaceae family and popularly known as gabiroba, guavira, or gabiroba-do-campo (Lion Araujo et al., 2019a), occurring in the states of São Paulo, Tocantins, Mato Grosso, Mato Grosso do Sul, Goiás, Distrito Federal, Bahia, Minas Gerais, and Santa Catarina, reaching the adjacent regions of Argentina and Paraguay (Oliveira et al., 2011).

It has a shrubby growth habit, with a height between 0.5 and 1.5 m; its flowering occurs between September and October, and its fruiting occurs between November and December, forming succulent, citrusy, and slightly sweet fruits (Oliveira et al., 2017). Despite its potential, its use is restricted to extractivism (Leão-Araújo et al., 2019b), and technical and scientific information addressing the agronomic and production aspects of gabiroba are scarce.

There are several uses of the fruit, being consumed fresh or processed in the form of juices, liqueurs, ice cream, and jellies. Its use is also highlighted in the recovery of degraded areas, environmental protection areas, and the formation of domestic and commercial orchards (Souza et al., 2020). It also has medicinal properties, being used as an anti-inflammatory, anti-diarrheal, and antiseptic (Vieira et al., 2011).

The tolerance to low fertility found in native Cerrado species does not eliminate the possibility of a response to fertilization (Dalanhol et al., 2017). Expressive increases in plant development can be achieved through mineral fertilization, reflecting on better development, precocity, and greater field survival (Barbosa et al., 2003). Thus, nitrogen use in plant development can be crucial since it is considered one of the nutrients most in demand by plants.

Nitrogen is part of the chemical composition of several cell constituents, such as nucleotides and amino acids, which form structures of nucleic acids and proteins, respectively; it is mainly absorbed as ammonium (NH_4^+) and nitrate (NO_3^-) (Kerbauy, 2013). After absorption, nitrogen is quickly incorporated into growing tissues, such as expanding leaves, root tips, and meristems, and excessive nitrogen fertilization can negatively affect rooting, making proper balance and nutrient supply essential (Emer et al., 2019).

Phosphorus is an essential nutrient that directly participates in compounds and vital reactions for plants, absorbed predominantly in the ionic form of $H_2PO_4^-$ (Kerbauy, 2013), which is accumulated in the cortical cells of the root and transferred within it to the xylem through the symplast, reaching the leaves or growing regions, together with nitrogen being the most readily redistributed element (Taiz and Zeiger, 2010).

Due to its varied use and potential economic importance, studies about *Campomanesia* sp. are essential for its insertion in the consumer market, preserving its natural state and implementing future commercial crops (Oliveira et al., 2011). Furthermore, it is known that it is adapted to its nutritional conditions because it is a plant native to the Cerrado. However, studies related to plant nutritional needs are still insufficient. Within this context, this study aimed to evaluate different doses of phosphorus and nitrogen in the initial development of gabiroba (*Campomanesia adamantium*) cultivated in pots.

2. Material and Methods

The study was carried out in a greenhouse located at the State University of Goiás, University Unit of Ipameri-GO. The climate is defined as Humid Tropical (Aw), consisting of high temperatures with rain in summer and drought in winter. The maximum and minimum temperatures in the external environment during the plant development period were 33.7°C and 17.1°C, respectively. The greenhouse used has modular characteristics, prefabricated and with lateral and superior coverage with polyethylene under additional superior protection of 50% shade.

The experimental design used was completely randomized in a 5x3 factorial scheme with six replications, each plot consisting of a pot with a capacity of 8 liters. Five doses of phosphorus (0, 100, 200, 300, and 400 kg ha^{-1} of P_2O_5) were tested in the form of simple superphosphate (P: 21%) and three doses of nitrogen (0, 100, and 200 kg ha^{-1} of N) in the form of urea (N: 45%).

Soil was collected and prepared fifteen days before sowing. Soil analysis was performed, and it was classified as Latossolo Vermelho-Amarelo, of medium texture, whose chemical characteristics were pH $CaCl_2$ = 4.9; P (mg dm^{-3}) = 1.2; K; Al; Here; Mg (cmolc/dm^{-3}) = 0.03; 0.1; 0.7; 0.3; H+AL, and SB = 2.1; 3.13, respectively, V (%) = 32.91 and organic matter (g dm^{-3}) = 12.0.

Seeds were collected from a population of native plants, occurring in the area belonging to the State University of Goiás, University Unit of Ipameri. Ripe fruits were harvested, removing the seeds with the pulp and leaving it to ferment for a day in the pulp juice. After fermentation, they were washed and placed to dry on paper towels for two days, and then sowing was carried out, with three seeds per pot. After germination and emergence, thinning occurred, leaving only one plant per pot.

Fertilization was carried out with 300 kg ha^{-1} of potassium chloride (K: 58%) and 100 kg ha^{-1} of micronutrients (Ca: 7.1%; S: 5.7%; B: 1.8%; Cu: 0.8%;

Mn: 2.0%; Mo: 0.1%; Zn: 9.0%). Phosphorus was added in a single plot at sowing, and nitrogen was split in three times, the first plot at sowing with 50% of the dosage, the second plot at 70 days after emergence with 25% of the dosage, and the last plot at 100 days after emergence, with 25% of the dosage.

The evaluations were carried out 120 days after plant emergence. The variables analyzed were stem diameter, using a caliper graduated in millimeters and measuring 1 (one) cm above the ground; plant height, using a ruler graduated in centimeters and measuring the ground level until the insertion of the last leaf and Number of leaves, in which the leaves of all plants were counted. Data were subjected to analysis of variance and F-test. The means were compared by the Tukey test at $p<0.05$. Log10 transformed data referring to the variable "plant height". Regression analyzes were adjusted for phosphorus doses. Statistical analyzes were processed using the statistical analysis program R.

3. Results and Discussion

Table 1 presents the results of all characteristics evaluated for the different factors and interactions under study. Significant differences were found among the levels of phosphate fertilization. Nitrogen fertilization and the interaction between factors was not significant, indicating that factors under study act independently and that nitrogen fertilization did not significantly change the analyzed variables. Treatments differed in height, stem diameter, and number of leaves in response to phosphate fertilization.

Plant height differed between treatments in response to phosphate fertilization (Figure 1). The highest height observed between treatments was 9.29 cm, reached 120 days after emergence under a dose of 400 kg ha^{-1} of P_2O_5. From this result, it is concluded that *C. adamantium* plants require high doses of phosphorus for their growth, which can be explained by considering that phosphorus acts in metabolic processes as an energy supplier and component of numerous protein complexes (Vieira et al. al., 2011).

A study by Vieira et al. (2011) using P and N doses in *Campomanesia adamantium* plants evaluated 261 days after transplanting obtained the best results for plant height at the dose of 380 and 84 kg ha^{-1} of phosphorus (P_2O_5) and nitrogen (N), respectively. Plant height is considered one of the most important parameters to estimate the initial growth of seedlings. However, due to variations depending on the species and production methods, it must be combined with other parameters, such as diameter (Emer et al., 2020).

The stem diameter variable was significantly influenced by phosphorus doses (Figure 2), and the dose of 312 kg ha^{-1} of P_2O_5 showed the best results through regression analysis. The larger diameter of the stem favors the stabilization and translocation of photoassimilates to the growing seedling (Carnevali et al., 2015), which makes it a desirable characteristic in seedlings due to the high correlation with field survival. It is also observed that the height is directly related to the diameter and number of leaves; that is, the larger the plant, the greater the diameter and number of leaves (Guimarães et al., 2019).

As for the Number of leaves, the variable was also significantly influenced by the doses of phosphorus (Figure 3), with the best result being obtained at the dose of 293 kg ha^{-1} of P_2O_5.

Table 1. Summary of the analysis of variance and the comparison test of global means by dose of the analyzed parameters: Plant height (cm), Stem diameter (mm), and Number of leaves of gabiroba subjected to application of doses of phosphorus and nitrogen, developed in the experimental area of the State University of Goiás (UEG).

Treatments	Plant height (cm)	Diameter (mm)	Nº of leaves
P_2O_5 doses (kg ha^{-1})			
0	5.06 $^{(1)}$	1.75 $^{(2)}$	10.7$^{(3)}$
100	5.57	2.14	12.5
200	8.74	2.67	17.4
300	8.67	2.47	15.7
400	9.29	2.59	15.9
N doses (kg ha^{-1})			
0	6.99	2.23	14.3
100	8.16	2.48	14.5
200	7.25	2.26	14.6
F-value			
P_2O_5 doses (A)	7.249**	10.432**	6.814**
N doses (B)	1.154^{ns}	2.301^{ns}	0.032^{ns}
AxB	0.765^{ns}	0.854^{ns}	0.403^{ns}
CV (%)	41.91	21.45	30.85

Significant at the 1% probability level. *Significant at 5% probability level. ^{ns}- not significant. $^{(1)}$ $y= -0.0116x + 5.154$ $r^2=0.85$* $^{(2)}$ $y= -0.000009x^2 + 0.0056x + 1.7406$ $r^2=0.9$* $^{(3)}$ $y= -0.00007x^2 +0.0415x + 10.357$ $r^2=0.84$

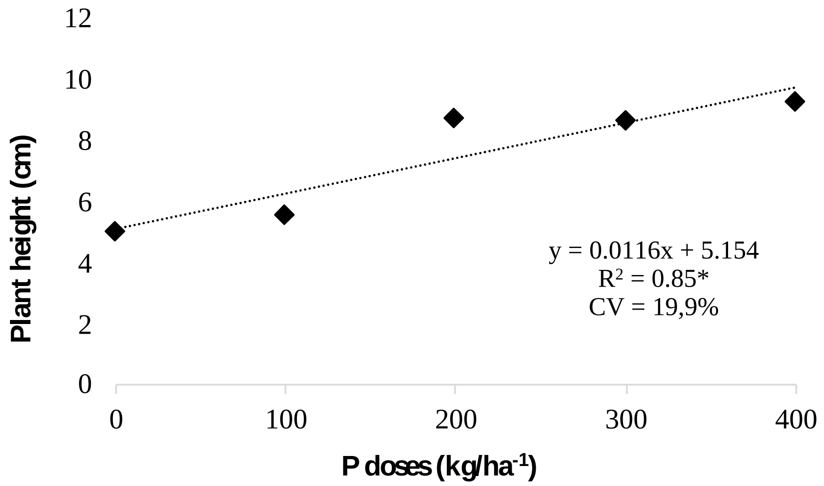

Figure 1. Plant height of gabiroba plants at 120 days after emergence according to the doses of phosphorus.

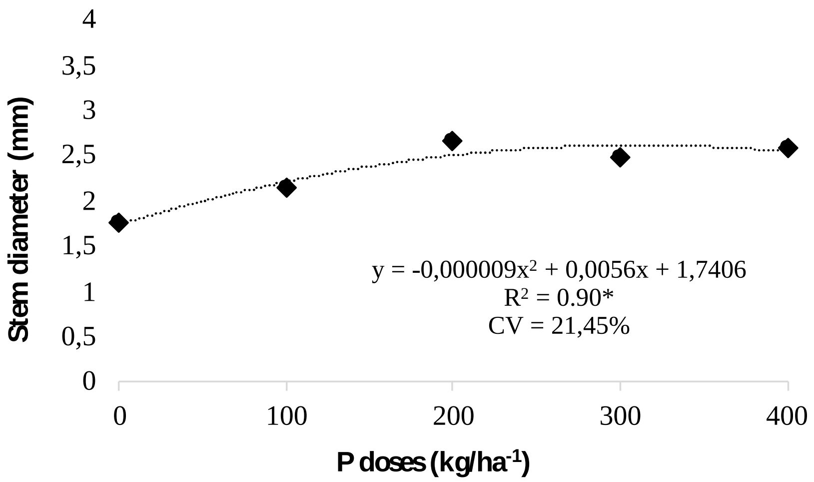

Figure 2. Diameter of the stem of gabiroba plants at 120 days after emergence according to the doses of phosphorus.

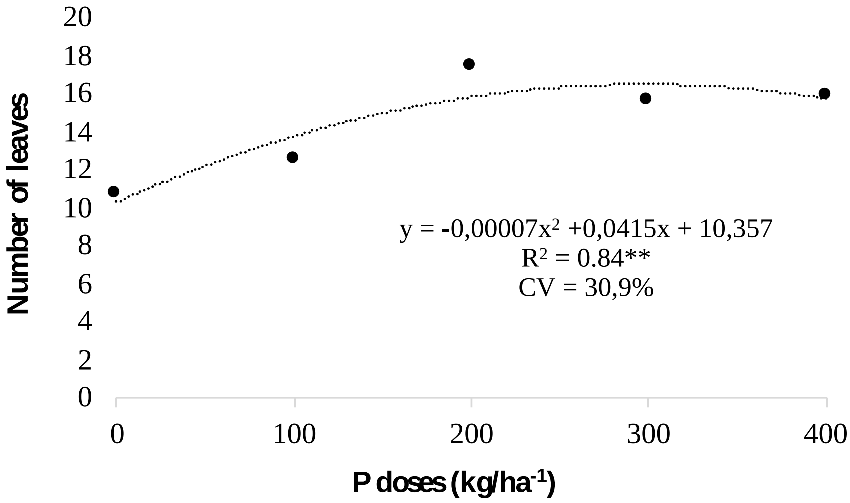

Figure 3. Number of leaves in gabiroba plants at 120 days after emergence according to the doses of phosphorus.

The seedlings responded positively to the application of phosphorus for the variables: height, stem diameter, and Number of leaves, presenting, in the initial phase of growth, relatively high demand for the nutrient, and the initial availability found in the soil is insufficient to meet the nutritional requirements of this species at this stage. The same behavior was observed in *Psidium guajava* L. (guava) (Batista et al., 2011). Generally, native Cerrado species respond with increased biomass production when nutrient P is supplied (Melo et al., 2019).

Native species have different nutritional requirements (Cruz et al., 2006). In this sense, some species respond to nitrogen fertilization (Fonseca et al., 2019), while others do not respond, as we found with the cagaita (*Eugenia dysenterica*), species used in the experiment. This was also verified in studies that evaluated the effect of nitrogen fertilization on other species, such as cagaita (Duboc and Guerrini, 2007). Considering these studies, we can infer that the difference between species is possibly more related to the genetic characteristics of each one, in addition to certain factors, such as the absorption, transport, and use of nutrients (Lima et al., 2008).

4. Conclusions

The gabiroba responds significantly to the addition of phosphorus, with the dose of 400 kg ha^{-1} of P_2O_5 providing greater height and the dose of 300 kg ha^{-1} of P_2O_5 providing greater diameter of the stem and number of leaves. Up to 120 days old, gabiroba seedlings do not respond significantly to nitrogen fertilization.

Authors' Contribution

Jéssica Rodrigues de Mello Duarte contributed to the study data collection, analysis, and writing. Scarlet de Aguiar Basílio participated in data collection and article review. Nei Peixoto contributed to the review of the manuscript and guided all stages of the study. Author Mariana Pina da Silva Berti reviewed and wrote the project and manuscript and guided all stages of development.

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