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Phosphate fertilization in 'sabiá' (*Mimosa caesalpiniifolia* Benth.) implantation in crop-forest system in semiarid region

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ABSTRACT: The use of fertilizers can increase the production of Forest species, which can be used for the extraction of wood in monocultures or in agroforestry systems. Thus, the objective was to evaluate the application of phosphorus doses in the implantation of *Mimosa caesalpiniaefolia* in a degraded area. The experimental design was a randomized complete block design with four blocks, with treatments at the following doses: 0, 12.5, 25.0, 50.0 and 100.0 g plant^{-1} of P_2O_5 (source: triple superphosphate), whose quantities used were folded the following year and applied in the projection of the crown. The variables measured were biometric attributes (height, stem diameter in base and in breast height), biomass, nutrient accumulation (whole plant) and soil fertility. There was an increase in height and diameter of the plant, biomass, accumulation of phosphorus in the plant and increase of phosphorus concentrations in the soil. The application of 29 g of P_2O_5 in the pit and after implantation, it is recommended to apply 47 g of P_2O_5 per plant in the projection of saplings seedlings in low phosphorus soils, after first year.

Key words: CLFI; Caatinga; phosphate nutrition

Adubação fosfatada na implantação de sabiá (*Mimosa caesalpiniifolia* Benth.) em sistema lavoura-floresta em região semiárida

RESUMO: O uso de fertilizantes pode incrementar a produção de espécies florestais, as quais podem ser usadas para extração de madeira em monocultivos ou em sistemas agroflorestais. Assim, objetivou-se avaliar o desenvolvimento e acúmulo de nutrientes em plantas de sabiá e a fertilidade do solo em função da aplicação de doses de fósforo em sistema lavoura-floresta, anteriormente ocupada por pastagem degradada. O delineamento experimental foi em blocos casualizados, com quatro repetições, cujos tratamentos foram às seguintes doses: 0, 12,5; 25; 50 e 100 g de pentóxido de difósforo (P_2O_5) - fósforo por cova (fonte: superfosfato triplo), cujas quantidades empregadas foram reaplicadas no ano seguinte na projeção da copa (com os quantitativos dobrados). As variáveis mensuradas foram atributos biométricos (altura, diâmetro do caule ou coleto e na altura do peito), biomassa, acúmulo de nutrientes (planta inteira) e fertilidade do solo. Houve incremento em altura e diâmetros da planta, biomassa, acúmulo de fósforo na planta e aumento dos teores de fósforo no solo. Para a implantação de mudas de sabiá em solos com baixos teores de fósforo recomenda-se a aplicação de 29 g de P_2O_5 na cova e a aplicação de 47 g de P_2O_5 por planta na projeção da copa, após o primeiro ano.

Palavras-chave: ILPF; Caatinga; nutrição fosfatada

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Introduction

For the implementation of perennial crops, the use of fertilizers can increase and guarantee full development, especially in areas of low soil fertility.

The *Mimosa caesalpiniifolia* (‘sabiá’) stands out as one of the main wood-producing trees for making fence posts in Northeastern Brazil (Barbosa et al., 2008). Besides this use, this species is considered fast growing, with an average increment of one meter in height per year (Barbosa et al., 2008).

Another possibility of use of this species is the implementation in crop-livestock-forest integration systems, whose utility, besides wood, may be its leaves as food for ruminants in the dry season, given that they have high forage value, besides improving the animal ambience (Dias et al., 2009). In addition, *Mimosa caesalpiniifolia* can act as a phytostabilizer in areas degraded by mining (Garcia et al., 2017).

Although the available information on general assessments of soil fertility in the Semiarid region of Northeastern Brazil still needs further elucidation, some works presented on the subject are consistent in pointing out phosphorus and nitrogen as the main limiting nutrients for plant nutrition (Salcedo, 2006; Menezes et al., 2012; Souza et al., 2014), i.e., they often present contents considered low.

The works with *Mimosa caesalpiniifolia* focused on the evaluation of quality and nutrition in seedling production (Costa Filho et al., 2013; Melo et al., 2018), fertilization when in Caatinga sites (Caldas et al., 2009), and the measurement of burlap production (Ferreira et al., 2007; Freire et al., 2010), but did not test the phosphorus supply when installing *Mimosa caesalpiniifolia* alley cropping.

Works on the nutrition of forest seedlings indicate that pioneer species are more responsive to the supply of phosphorus, pointing out the need for the supply of this nutrient for the proper development of these species, while climactic species have shown little sensitivity to the supply of this nutrient, reflecting a low requirement in the seedling phase (Rangel-Vasconcelos et al., 2016). Also, several works in the literature cite the need for an adequacy in phosphate fertilization in the early stages of forest species (Bazani et al., 2014; Araújo et al., 2020).

The different modalities of CLFI (crop-livestock-forest integration) implemented in agroecosystems deserve special attention and studies, since the presence of the forest component can contribute to improving chemical, physical, and biological attributes by increasing nutrient cycling and soil coverage through the presence of litter (Lima et al., 2018).

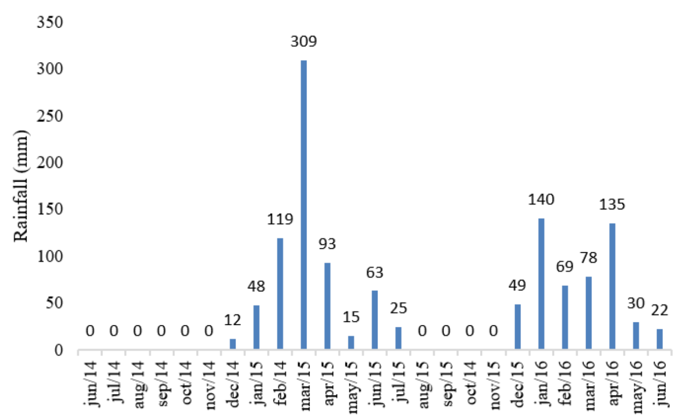
The objective of this study was to evaluate the development and accumulation of nutrients in *Mimosa caesalpiniifolia* plants and soil fertility as a function of the application of phosphorus doses in the implementation of a crop-forest system, previously occupied by degraded pasture.

Materials and Methods

The experiment was set up in Ibaretama, Ceará, Brazil, at Triunfo farm, which has a semi-arid tropical hot climate with rainfall from January to April. The historical average rainfall is 838.1 mm and the average annual temperature is 27 °C, with average annual rainfall of 838 mm (Cunha et al., 2015). The trial was conducted from June 2014 to March 2016, in an area of Planossolo Háplico (Albaquult) according to the Brazilian soil classification system (Cunha et al., 2015; Santos et al., 2018), with signs of degradation, low fertility, according to the analysis presented in Table 1. There was no application of lime for soil correction. Rainfall during the experimental period totaled 1,207 mm, as shown in Figure 1.

The area in question prior to the installation of the experiment was occupied by extensive cattle and sheep farming, whose diet was based on native Caatinga grasslands.

The seedlings of *Mimosa caesalpiniifolia* were produced in the nursery of the Instituto Federal do Ceará, Campus



Source: Triunfo farm.

Figure 1. Rainfall during the experimental period, Triunfo farm, Ibaretama, Ceará, Brazil.

Table 1. Soil chemical and particle-size of ‘Planossolo Háplico’ (Albaquult) at different depths before planting.

Depth (m)	pH	OM ($g\ kg^{-1}$)	P	K	Na	Ca	Mg	Al	H+Al	SB	CEC	BS (%)
			($mg\ dm^{-3}$)		($mmol_c\ dm^{-3}$)							
0-0.2	5.4	6.7	2.57	39	1.6	28	22	2	14	53	67	78
0.2-0.4	5.8	6.1	1.83	39	1.2	46	34	0	27	82	109	75

Depth (m)	EC ($mS\ cm^{-1}$)	Cu	Fe	Mn	Zn	Total sand	Silt	Clay
		($mg\ dm^{-3}$)				($g\ kg^{-1}$)		
0-0.2	0.11	0.36	138.8	58.4	0.78	672.5	285.4	42.1
0.2-0.4	0.24	0.53	132.9	50.2	0.97	666.5	238.3	95.5

pH - H_2O, OM - organic matter, P - phosphorus, K - potassium, Ca - calcium, Mg - magnesium, Na - sodium, H+Al - potential acidity, Al - aluminum, SB - sum of bases, CEC - cation exchange capacity, BS - base saturation, EC - electrical conductivity, OM - Walkley-Black method, P/K/Na - Mehlich 1 method, Ca/Mg - KCl 1M method, H+Al - Ca acetate method. Sand, silt and clay - pipette method.

Quixadá, Ceará, Brazil, and presented average height and stem diameter of 52 and 0.22 cm, respectively; and were planted in double row rows in June 2014. The *Mimosa caesalpiniifolia* seedlings were planted in 0.4 × 0.4 × 0.4 m crowned pits, with the application of 2 L pit^{-1} of hydrogel and the area was prepared before planting by passing a disc plow and a harrow. The planting spacing was 3 × 2 m in the two-row row and 10 m between rows, resulting in a swath for growing annual crops (corn, sorghum, millet, sunflower, and cowpea with harrowing in the area before planting) in the 2015 and 2016 agricultural years. The total experimental area with and between hedges totaled 1,444 m^2.

A randomized block design with five phosphorus doses and four blocks was adopted. Each block was made up of a double rows of *Mimosa caesalpiniifolia* and each plot was composed of six plants. Phosphate fertilizer was applied in the pit (mixing phosphorus with soil taken from the pit itself) in the following amounts: 0, 12.5, 25.0, 50.0 and 100.0 g pit^{-1} of P_2O_5, the source of which was triple superphosphate (43% P_2O_5). In the year following the installation of the trial, in March/2015, the quantities applied were doubled (each dose was doubled) in relation to the previous year's treatments in the same plots, and applied in the area of the canopy projection, where a circle was made with homogeneous distribution around the stem obeying a radius of 0.3 m from the trunk.

Considering the low values of potassium in the soil (Table 1), 50 g $plant^{-1}$ of K_2O were applied, in the form of potassium chloride, at 30 days after planting and 100 g $plant^{-1}$ of K_2O at nine months after planting (March 2015), in the projection of the canopy of the plants and similarly to the surface application of phosphorus.

After planting, the plants received 10 L of water per seedling per week from planting until December 2014. Other cultural treatments were pruning (with the residues being left between the rows of plants) and thinning of lateral branches, single stem conduction, and manual control of weeds between the rows of *Mimosa caesalpiniifolia* and insecticides for pest control (control of scales - use of cypermitrin 40 mL per 20 L of water plus mineral oil 150 mL per 20 L of water).

The evaluations were made nine months after planting, and the variables measured were stem height and diameter (five centimeters from the soil). The two plants per plot were considered as useful areas. Twenty-two months after planting, the same biometric data were evaluated, with the addition of diameter at breast height (DBH); in addition, one plant per plot was collected to quantify the dry matter mass of the plants, which was placed in an oven with forced air circulation at 60 °C where it remained until reaching constant mass and measured the mass of the stem and leaves, which with the sum was obtained the total value. Subsequently, the dried materials were ground for macro and micronutrient analysis according to Miyazawa et al. (2009). With the nutrient contents and the dry matter mass of the plant, the nutrient accumulation was calculated.

Soil fertility analysis was performed using simple samples, three per plot, in the 0-0.2 and 0.2-0.4 m layers at the projection of the plant canopy, always at the beginning of the rainy season (before fertilizer application). The collections were made before fertilization, in the years 2015 and 2016, whose variables were: pH (H_2O), organic matter (OM) and P, K, Ca, Mg, H+Al, SB, CEC and BS contents, whose analyses were performed according to Donagemma et al. (2011), by the methods/extractions: pH(H_2O) at a soil:solution ratio of 1:2.5, OM: was determined according to the Walkley-Black method, P and K were extracted with Mehlich-1, Ca, Mg were extracted by KCl 1 mol L^{-1}, H+Al were extracted by Ca acetate, SB, CEC and BS were calculated SB = Ca + Mg + K, CEC = SB + H+Al and BS = SB/CETC*100. .

The experimental data were submitted to variance analysis and, depending on the significance level, regression analysis was performed with the help of the software SISVAR (Ferreira, 2011).

Results and Discussion

In the surface layer (0-0.2 m), significant was found for the concentration of phosphorus in the soil in the two years evaluated (Tables 2 and 3). The highest soil phosphorus content was seen with the use of the doses of 70 g pit^{-1} of P_2O_5 and 104 g $plant^{-1}$ of P_2O_5 in 2015 ($y = -0.0013x^2 + 0.181x + 4.32$) and 2016 ($y = -0.0015x^2 + 0.314x + 4.815$), respectively, based on the maximum points obtained from the regression equations presented in Tables 2 and 3. Employing these doses, it was found that the gain obtained in relation to the control (zero dose) for the element phosphorus in the soil ranged from 145 and 341% for the years 2015 and 2016, respectively.

For the 0.2-0.4 m layer there was significance only for phosphorus in 2016 (Tables 2 and 3). In relation to the average values, an increase in the content of this nutrient from one year to the next was observed, a fact that can be explained by the increase in the amounts applied, even if superficially, in the projection of the canopy, combined with a sandy soil texture.

The concentration of phosphorus in response to the application of this nutrient in the 0.2-0.4 m layer followed a quadratic model ($y = -0.0018x^2 + 0.371x + 5.6$), whose maximum point was obtained when a dose of 103 g $plant^{-1}$ of P_2O_5 was used (Table 3). In the second year of evaluation, the doses that provided higher phosphorus contents in the 0-0.2 and 0.2-0.4 m layers were similar.

Regarding the biometric characterization and dry matter mass production, a statistical difference was observed in the first evaluation performed (9 months after planting) for the characteristics height and stem diameter (Table 4), while in the second evaluation performed twenty-two months after planting a significant effect was verified for the characteristics height and diameter of breast height, besides the dry matter mass of leaves and total. Also noteworthy is the increase in height and average stem diameter verified in the 13-month interval, whose values were of the order of 132 and 112%, respectively.

Table 2. Soil chemical attributes as a function of phosphate fertilization on *Mimosa caesalpiniifolia* plants in the 0-0.2 and 0.2-0.4 m layer, 2015.

Doses P_2O_5 (g pit^{-1})	pH	OM (g dm^{-3})	P	K	Ca	Mg	H+Al	SB	CEC	BS (%)
			(mg dm^{-3})		(mmol$_c$ dm^{-3})					
0-0.2 m										
0	5.7	7.5	4.8	42	21	23	25	45.1	70.1	64
12.5	6.1	5.5	5.5	42	39	47	20	87.1	107.1	81
25	6.2	7.0	8.3	46	37	50	20	88.2	108.2	82
50	5.9	6.5	10.3	46	31	32	23	64.2	87.2	74
100	6.0	6.5	9.3	55	29	32	21	62.4	83.4	75
Averages	6.0	6.6	7.6	46	31	33	22	69.4	91.2	75
F Test	ns	ns	**1	ns	ns	ns	ns	ns	ns	ns
CV (%)	5.4	20.3	19.3	15.8	38.1	41.5	13.4	37.8	26.8	11.6
0.2-0.4 m										
0	6.9	5.5	6.0	46	61	101	15	163.2	178.2	92
12.5	6.7	5.0	5.0	48	61	102	16	164.2	180.2	91
25	6.7	5.5	5.0	48	64	98	16	163.2	179.2	91
50	6.8	5.5	5.0	47	68	98	17	167.2	184.2	91
100	7.0	6.0	4.0	52	75	106	15	182.3	197.3	92
Averages	6.8	5.5	5.0	48	66	101	16	168.0	183.8	91.4
F Test	ns	ns	ns	ns	ns	ns	ns	Ns	ns	ns
CV (%)	3.9	18.4	36.8	21.6	25.0	17.4	13.1	17.3	15.7	2.2

ns, * and ** - not significant and significant at 5 and 1%, respectively. [1] Equation: $y = -0.0013x^{**2} + 0.181x^{**} + 4.32$ / $R^2 = 0.95^{**}$.

Table 3. Soil chemical attributes as a function of phosphate fertilization on *Mimosa caesalpiniifolia* plants in the 0-0.2 and 0.2-0.4 m layer, 2016.

Doses P_2O_5 (g plant^{-1})	pH	OM (g dm^{-3})	P	K	Ca	Mg	H+Al	SB	CEC	BS (%)
			(mg dm^{-3})		(mmol$_c$ dm^{-3})					
0-0.2 m										
0	5.4	8.0	5.0	64	18	23	27	42.6	69.6	61
25	5.8	7.5	9.8	66	34	39	22	74.7	96.7	77
50	5.8	7.0	19.8	70	28	33	23	62.8	85.8	73
100	5.7	7.7	20.3	82	27	33	24	62.1	86.1	72
200	5.8	7.0	9.5	45	29	35	24	65.2	89.2	73
Averages	5.7	7.4	12.9	65	27	32	24	61.5	85.5	71
F Test	ns	ns	*1	ns	ns	ns	ns	ns	ns	ns
CV (%)	6.0	20.2	47.2	58.3	42.7	41.5	13.4	38.1	25.1	12.2
0.2-0.4 m										
0	6.2	5.0	5.0	41.6	57	83	18.5	141.1	159.6	88
25	6.6	5.5	9.8	55.9	76	85	17.0	162.4	179.4	91
50	6.3	6.3	28.3	41.6	48	56	19.7	105.1	124.8	84
100	6.7	5.0	20.3	41.9	68	80	16.8	149.1	165.9	90
200	6.6	5.0	9.5	50.7	78	102	17.0	181.3	198.3	91
Averages	6.5	5.4	14.6	46.3	65.4	81.2	17.8	147.8	165.6	88.9
F Test	ns	ns	*2	ns	ns	ns	ns	ns	ns	ns
CV (%)	5.5	18.6	66.7	9.3	26.5	25.1	13.5	24.9	21.9	4.5

ns, * and ** - not significant and significant at 5 and 1%, respectively. [1] Equation: $y = -0.0015x^{**2} + 0.314x^{**} + 4.815$ / $R^2 = 0.92^{**}$. [2] Equation: $y = -0.0018x^{**2} + 0.371x^{**} + 5.6$ / $R^2 = 0.69^{*}$.

Both height and stem diameter showed the highest values in the first evaluation at the doses of 29 and 42 g pit^{-1} of P_2O_5, respectively, which were applied in the pit (Table 4).

Regarding the evaluations carried out in 2016, the biometric characteristics height and diameter at breast height, leaf and total dry mass showed maximum points with the use of doses of 55, 51, 124 and 47 g plant^{-1} of P_2O_5, respectively (Table 4). Thus, it can be seen that in relation to the first year, when the maximum points for height and diameter are analyzed, there was an increase in the values that provided the greatest heights and diameters; still when we analyzed the total dry mass the best model that fitted the data was the Gaussian (Figure 2).

Considering plant height as a parameter for fertilizer recommendation for the planting of *Mimosa caesalpiniifolia*, and in the first year after planting the attribute total dry matter mass, the doses to be suggested would be 29 and 47 g plant^{-1} of P_2O_5, respectively.

Regarding nutrient accumulation, there was a significant effect only for phosphorus (Table 5), whose average values of accumulated elements were in descending order N > Ca > K > Mg > P > S and Fe > Mn > B > Zn > Cu, respectively, for macro and micronutrients. Analyzing Table 6, it can be seen that the greatest accumulation of phosphorus in the plant was obtained with the use of the dose 102 g plant^{-1} of P_2O_5.

Table 4. Biometric attributes and biomass production as a function of phosphate fertilization in *Mimosa caesalpiniifolia* plants in 2015 and 2016.

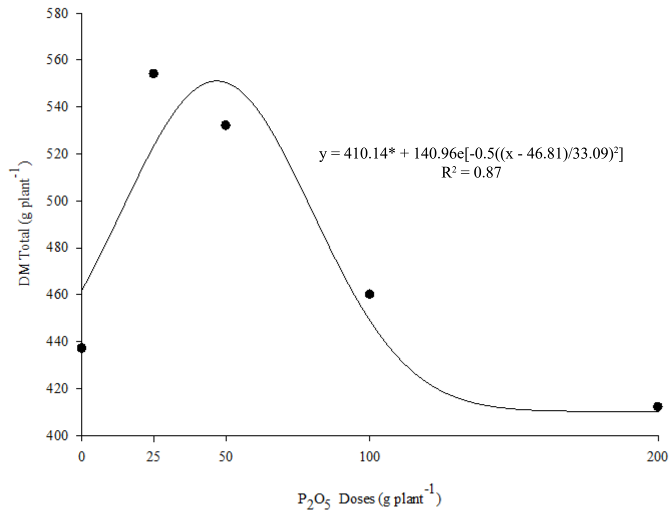
Doses P_2O_5 (g pit^{-1})	Height	SD	DBH	DM Leaves	DM Stem	DM Total
	(cm)			(g plant^{-1})		
			2015			
0	113	1.16	-	-	-	-
12.5	128	1.38	-	-	-	-
25	143	1.28	-	-	-	-
50	121	1.28	-	-	-	-
100	111	1.15	-	-	-	-
Averages	123	1.24	-	-	-	-
F Test	**[1]	*[2]	-	-	-	-
CV (%)	9.6	7.3	-	-	-	-
			2016			
0	257	2.50	1.60	39	398	437
25	316	2.76	1.83	79	475	554
50	305	2.46	1.83	97	435	532
100	287	2.73	1.66	72	388	460
200	263	2.70	1.51	82	330	412
Averages	286	2.63	1.69	74	405	479
F Test	*[3]	ns	*[4]	**[5]	ns	*
CV (%)	7.3	10.3	11.3	22.1	20.3	16.4

SD = stem diameter; DBH = diameter at breast height; DM Leaves = leaf dry mass; DM Stem = stem dry mass; DM Total = total dry mass. ns, * and ** - not significant and significant at 5 and 1%, respectively. [1] Equation: $y = 110.39^{**} + 34.18^{*}e[-0.5(x-28.83^{*})/13.75^{*})^2]$ / $R^2 = 0.99$. [2] Equation: $y = -0.000517x^{*2} + 0.0044x + 1.22$ / $R^2 = 0.52^{*}$. [3] Equation: $y = 258.47^{*} + 56.93e[-0.5((x-55.43)/34.63)^2]$ / $R^2 = 0.70$. [4] Equation: $y = 1.50^{**} + 0.36e[-0.5((x-50.92)/36.51)^2]$ / $R^2 = 0.94$. [5] Equation: $y = -0.0025x^{*2} + 0.623x^{*} + 53.49$ / $R^2 = 0.43^{*}$.

Confronting the average soil values of 2015 and 2016, referring to the phosphorus content in the soil, there is an increase, even, from the low to medium concentration range, according to the fertilization and liming recommendation bulletin for the state of Ceará (Fernandes, 1993).

For the potassium nutrient, the application of fertilizer (KCl) in equal amounts to all treatments, due to the low values present in the soil, also promoted an increase in concentrations, moving from the low to medium classification range (Fernandes, 1993). With regard to the other elements, it is observed that there was no difference between the treatments evaluated on the concentrations of these nutrients.

Some works indicate that there is distribution of phosphorus with applications of high rates of this element for layers 0.2-0.4 and 0.4-0.6 m, and that in sandy soils (the same as in the present study) it shows less adsorption capacity (Donagemma et al., 2016), a fact that was verified in the present work. It is also important to point out that the pit used had a depth of 0.4 m, and the fertilizer applied at planting was all mixed with the soil that later filled the pit, which may have corroborated the observed result. However, the no difference for the first soil sample (2015) can be justified by the non occupation of all adsorption sites, and the mixing of the pit soil with the fertilizer, which invariably may have homogenized the layers (0-0.2 and 0.2-0.4 m), which present distinct contents not providing difference with the doses in the 0.2-0.4 m layer in 2015, but in 2016.



* - significant at 5%.

Figure 2. Total dry mass of *Mimosa caesalpiniifolia* plants as a function of phosphorus doses, in 2016.

Studies with the application of phosphate fertilization in *Mimosa caesalpiniifolia* were conducted in sites implanted in Caatinga, but no significant effects of the use of this nutrient on the plant were found. This was justified by the low mobility of phosphorus in the soil and the fact that fertilization was localized, which may have induced competition for the nutrient, because neighboring plants did not receive fertilization, and may have been strong competitors (Caldas et al., 2009).

Although phosphorus is the macronutrient accumulated in smaller amounts compared to the others, this nutrient has a significant effect on productivity, whose increase in wood production is estimated on the order of 30 to 50% (Bazani et al., 2014).

Table 5. Nutrient accumulation as a function of phosphate fertilization in *Mimosa caesalpiniifolia* plants.

Doses P_2O_5 (g plant^{-1})	N	P	K	Ca	Mg	S	B	Cu	Fe	Mn	Zn
			(g plant^{-1})						(mg plant^{-1})		
0	9.53	0.67	2.58	4.03	1.31	0.48	9.92	3.29	34.27	24.47	7.97
25	14.76	1.14	4.63	5.31	1.81	0.74	15.64	4.23	51.83	23.44	12.46
50	10.63	1.03	3.65	5.06	1.34	0.47	8.53	3.80	60.55	22.32	9.48
100	10.18	0.98	3.08	4.63	1.47	0.56	12.37	3.05	28.13	20.12	7.95
200	9.65	0.85	3.08	4.75	1.41	0.46	8.06	2.46	26.01	15.42	7.21
Averages	10.95	0.935	3.41	4.76	1.47	0.54	10.90	3.36	40.16	21.16	9.01
F Test	ns	*[1]	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	28.7	19.1	25.8	24.4	34.2	26.7	55.4	24.4	46.1	28.5	28.2

ns, * and ** - not significant and significant at 5 and 1%, respectively. [1] Equation: $y = -0.026x^{*2} + 5.306x^{*} + 815.9$; $R^2 = 0.42$.

In a study on Ultisol, Caldas et al. (2010) applied doses of 100 and 200 kg ha^{-1} of phosphorus in an area of *Mimosa caesalpiniifolia* with approximately 13 years of age. According to the authors, phosphate fertilization did not promote effects on morphological characteristics and chemical composition only for tannins and FDN in *Mimosa caesalpiniifolia* plants, whose justification was the highly developed root system of the plants. The authors also justify that the levels studied can be considered low or medium, since high levels of P_2O_5 were not applied to the point of markedly modifying the composition of the soil and the plant, as well as it´s morphological components.

In an evaluation of macronutrients (NPK) in *Mimosa caesalpiniifolia* seedlings, the application of phosphorus was the one that promoted significant effects on seedling growth, with recommended doses ranging from 312 to 600 mg dm^{-3} of P in soil of this nutrient, while for nitrogen this recommendation ranges from 50 to 200 mg dm^{-3} of N in soil, while for sulfur this recommendation ranges from 20 to 80 mg dm^{-3} of S in soil (Gonçalves et al., 2010). It is noteworthy that nitrogen fertilization was not used in this experiment, because *Mimosa caesalpiniifolia* is a legume that has the ability to symbiotically associate with nitrogen-fixing bacteria, a fact that has been attributed to the large amount of nitrogen accumulated in *Mimosa caesalpiniifolia* plants.

Conclusions

Considering the planting of *Mimosa caesalpiniifolia* seedlings in soils with low levels of phosphorus, in the conditions studied, we suggest the application of 29 g of P_2O_5 in the pit based on the height of the plants. For the second year after planting, 47 g $plant^{-1}$ of P_2O_5 is suggested, which should be applied at the canopy projection.

Phosphate fertilization in the pit at planting and in the canopy projection at planting increases the P content of the soil in the 0-0.2 and 0.2-0.4 m depth layers and the accumulation of P in the plant of *Mimosa caesalpiniifolia*.

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Compliance with Ethical Standards

Author contributions: Conceptualization: HAS, RCFFP, RGT, FEPF; Data curation: HAS, RCFFP, RGT, FEPF; Formal analysis: HAS, RCFFP; Methodology: HAS; Project administration: HAS; Resources: HAS; Supervision: HAS; Validation: AAP, ACMF, LFCL; Writing – original draft: HAS, RCFFP, RGT, FEPF, AAP, ACMF, LFCL; Writing – review & editing: HAS, RCFFP, RGT, FEPF.

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