Title
Use of nutrients of sewage sludge in the initial development of Copaifera langsdorffii

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Publication Date
2009-07-07

Peer reviewed

Introduction

Brazilian native plants from the Atlantic forest have rarely been included in nutrition and growth studies and their responses to organic residues amendments is poorly described. In recent years there has been a substantial increase in the application of large amounts of organic residues, including sewage sludge, to these species and ecosystems, this study was conducted to determine how these applications might influence plant growth and productivity.

Sewage sludge is composed by Al hydroxide, phosphates, hydroxides precipitates, high organic matter content, remaining bacteria colonies, low Na levels, very high Ca + Mg/K relationship and high levels of some essential elements for plant growth. This residue holds a potential use as fertilizer and soil conditioner (Nolasco et al., 2000).

The species *Copaifera lagsdorffii* belongs to the family Caesalpiniaceae. It is a semi-deciduous plant, with height ranging from 5 to 15 m and diameters at breast height (DBH) 20 to 60 cm. It has moderately dense wood (0.7 g cm^{-3}), with medium to high natural resistance to pests and diseases. The wood can be used for building construction, supplies, tool handles, among others uses. It has a high yield of charcoal, due its high lignin content (Lorenzi, 2000). *Copaifera lagsdorffii* produces oil-resin that is extracted from the trunk and can be used as a fuel for diesel engines, reforestation, urban landscape and also, under a rigorous growth management, as a medicine with antiseptic, healing, expectorant, diuretic, laxative, stimulant, emollient and tonic. It is the largest known natural source of caryophyllene, an important anti-inflammatory (Rain Tree, 2008). A single Copaiba flower has about 2 micro liters of nectar to produce honey (Ferreira & Oliveira, 2002).

Based on *Copaifera lagsdorffii* characteristics and the importance of recycling sewage sludge, our aim was to investigate the response of *Copaifera langsdorffii* to sewage sludge in comparison to growth with inorganic fertilizer.

Material and Methods

The experiment was set up at the *Cia Suzano Bahia* farm, a Brazilian paper and celullose company, in a sandy soil degraded by laminar erosion and high compaction. Based on soil chemical characteristics (Table 1) and sewage sludge (Table 2), 1,089 Mg ha^{-1} dolomitic lime was added, as well N, P and K, following lime and fertilizer recommendations of Gonçalves et al. (1996).

A completely randomized block design was used, with 8 treatments and 4 replicates, with plants at 2 x 3 m spacing. The treatments were: Control (Test), containing only soil; Inorganic Fertilization, containing 260 Kg ha^{-1} from N, P and K fertilizer (6-30-10) + 0.3% B and 1.5 Kg ha^{-1} of zinc sulfate ($ZnSO_4$) at planting; Supplementation with K, containing 26 Kg ha^{-1} of K_2O; and K-supplemented (26 Kg ha^{-1} of K_2O) sewage sludge rates of 2.5 ton ha^{-1}, 5 ton ha^{-1}, 10 ton ha^{-1}, 15 ton ha^{-1} and 20 ton ha^{-1} (dry weight).

The sewage sludge used in this study came from the Jundiaí Sewage Treatment Plant, (Jundiaí, Brazil). This residue does not contain chemical properties unsuitable for application as organic fertilizer in forest species, according to the Brazilian Environmental Protection Agency (CONAMA, Conselho Nacional do Meio Ambiente).

Height and diameters were measured every 6 months after sewage sludge applications. Data were analyzed using one-way ANOVA among treatments (Tukey test at 5%) and linear regression among residues doses, with SISVAR statistical program.

Results and Discussion

Figure 1 shows height and diameters at 6, 12 18 and 24 months after residue applications. At 6 months, differences in diameter were statistically significant between the 15 and 20 t ha^{-1} rates. At that time, the standard deviation for both height and diameter was high, which can be explained by the heterogeneity of the planting area, as a result of degradation, that could affect plant growth. Another important factor is the great genetic variability among plants in the same species.

At 12 months, the treatments with sludge rates equal to 2.5, 5 and 10 t ha^{-1}, showed no statistically significant differences on both height and diameter and had no influence on plant growth. The 15 and 20 t ha^{-1} rates show statistically significant differences for both height and diameter. The smaller plants were observed on the mineral fertilizer and control treatments, probably due to low organic matter content in the soil. At 18 and 24 months, the results were statistically significant for height under the 20 t ha^{-1} of sludge rate.

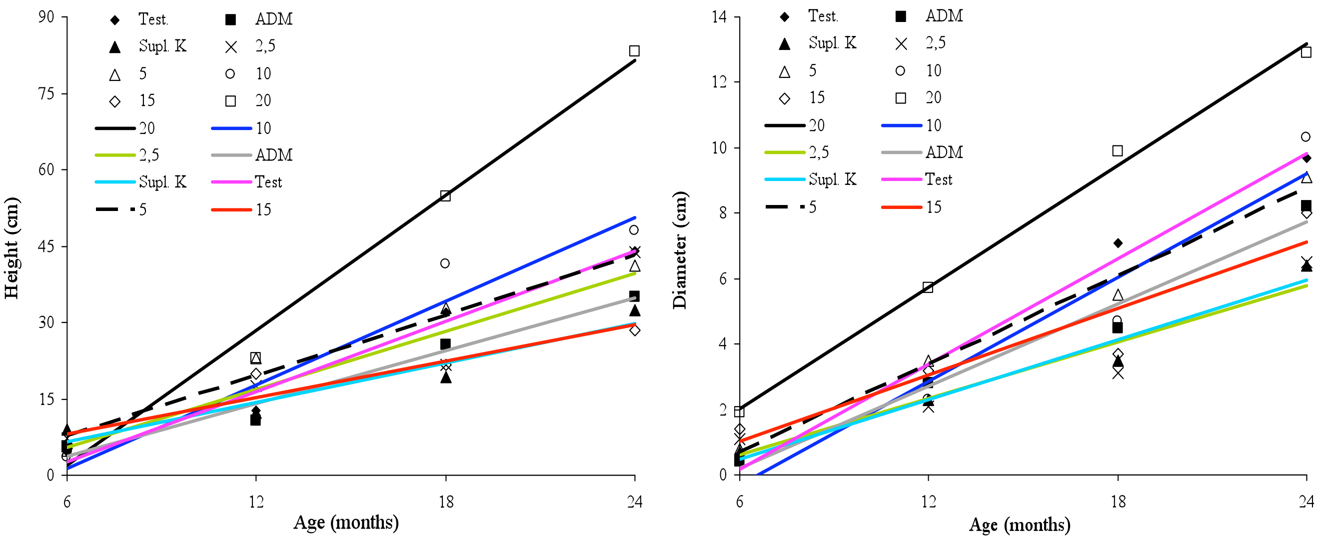

Figure 1: Copaiba height and diameter measurements, submitted to the treatments Control (Test), mineral fertilizer (ADM), potassium supplementation (Supl. K) and sewage sludge doses (2.5, 5, 10, 15 e 20 t ha^{-1}), ate the 6, 12, 18 and 24 months

Table 1: Soil chemical analysis before experiment implantation.

CHEMICAL ANALYSIS									
pH	M.O.	Al^{+3}	K	Ca	Mg	SB	H+Al	CTC	V%
$CaCl_2$	$g.dm^{-3}$				$mmol_c.dm^{-3}$				
4,4	9	4	0,43	4,3	1	5,3	23,3	28,3	18,5

CHEMICAL ANALYSIS					
P_{res}	B	Cu	Fe	Mn	Zn
		□G/dm^3			
4,3	12,6	4,6	27,6	0,6	0,1

Table 2: Sewage sludge chemical characteristics.

Elements	Concentration (□G kg^{-1})	Elements	Concentration (mg kg^{-1})
Copper	850	Enxofre	19,2
Chromium	162,7	Organic Matter	440
Lead	196,4	Organic Carbon	200
Zinc	573	Humidity	55 %
Cádmium	8,24	C/N	7,9
Níquel	37,8	pH	5,0
Manganese	584	Sódium	1500
Nitrogen	25,3	Iron	25950
Phosphorus	16,6	Mangnesium	2,3
Potássium	1,9	Arsenium	0,1
Cálcium	12,1		

(*) Concentration date are based on dray weight