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MANGABEIRA SEEDLING MINERAL NUTRITION CULTIVATED IN SUBSTRATES CONTAINING COCONUT FIBER AND FERTILIZED WITH PHOSPHORUS

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ABSTRACT: This research had as objective to evaluate the substrate components effect in different mixtures fertilized with phosphorus on mangabeira seedlings mineral composition. This experiment was carried out in the Centro de Ciências Agrárias, UFPB, situated in the municipal district of Areia-PB. The experimental design was in randomized blocks, with 17 treatments and three replications, being utilized four seedling per experimental unit. The treatments, composed by coconut fiber with concentrations from 0 to 40 %, bovine manure from 0 to 25.5 %, soil from 25 to 70 %, 15 % of sand and triple super phosphate, with doses of 0.0, 5.5 and 11.0 g dm^{-3}, were conditioned in black polyethylene bags. The macronutrients and copper contents from root system and aerial part of the seedlings were evaluated 150 days after seeds germination. The addition of bovine manure and triple super phosphate increased the macronutrients content in the root system and in the aerial part of mangabeira seedlings. The soil and coconut fiber addition resulted in contrary effects. Copper content in the aerial part of the seedlings increased with the increment of soil and coconut fiber concentration in the substrate. The substrate containing 24 % of manure, 51 % of soil, 10 % of coconut fiber, 15 % of sand and 8 g dm^{-3} of triple super phosphate is recommended to obtain the bigger macronutrients and copper contents in the root system and in mangabeira seedlings aerial part.

Key-words: *Hancornia speciosa*, mineral composition, organic residues.

NUTRIÇÃO MINERAL DE MUDAS DE MANGABEIRA CULTIVADAS EM SUBSTRATOS CONTENDO FIBRA DE COCO E ADUBADOS COM FÓSFORO

RESUMO: O presente estudo teve como objetivo avaliar o efeito dos componentes dos substratos em diferentes misturas submetidos à adubação fosfatada sobre a composição mineral de mudas de mangabeira. Este experimento foi executado no Centro de Ciências Agrárias, UFPB, localizado no município de Areia-PB. O delineamento experimental foi em blocos casualizados, com 17 tratamentos, três repetições, e unidade experimental constando de quatro mudas. Os substratos testados foram acondicionados em sacos de polietileno preto, composto de fibra de coco, com valores variando de 0 a 40 %, esterco bovino de 0 a 25,5 %, terra vegetal de 25 a 70 %, 15 % de areia e superfosfato triplo, nas doses de 0,0; 5,5 e 11,0 g L^{-1}. Foi avaliada a composição mineral dos sistemas radiculares e na parte aérea das mudas aos 150 dias após a germinação das sementes, para os teores de macronutrientes e cobre. A adição de esterco bovino e de superfosfato triplo provocaram o incremento dos teores de macronutrientes no sistema radicular e na parte aérea das mudas de mangabeira, ao contrário do efeito da adição de terra vegetal e fibra de coco. O teor de cobre na parte aérea das mudas aumentou com o incremento da concentração de terra vegetal e da fibra de coco no substrato. Recomenda-se a utilização das concentrações de 24 % de esterco, 51 % de terra vegetal, 10 % de fibra de coco, 15 % de areia e 8 g dm^{-3} de superfosfato triplo, para obtenção dos máximos teores estimados de macronutrientes e de cobre no sistema radicular e na parte aérea de mudas de mangabeira.

Palavras-chave: *Hancornia speciosa*, composição mineral, resíduos orgânicos

INTRODUCTION

Mangabeira (*Hancornia speciosa* Gomes) belongs to *Apocynaceae* family and is a fruit tree native from Brazil, where its fruit is quite appreciated because of the excellent organoleptic characteristics and high nutritional value (LEMOS et al., 1989). The production is insufficient to supply the demand of the agro-manufacturing sector, which has been demonstrating an extreme difficulty in obtaining raw materials to guarantee its full operation (LEDERMAN et al., 2000).

Apparently, mangabeira is not demanding in soil fertility, since it vegetates well in poor and acid soils. However, in order to obtain good quality seedlings, the use of substrate is necessary, which should present physical, chemical and biological properties suitable for appropriate nutrients supply, indispensable condition for the plants growth and vegetative development (SILVA et al., 2001).

The substrate influence in the seedlings initial growth has been evaluated by some authors (SANTOS e NASCIMENTO, 1999; VIEIRA NETO, 2001), being evident the use of materials available in the region. Coconut peel, which in some causes troubles to the public cleaning service because of its volume and natural decomposition difficulty, has been processed for use, because, besides its economical and social importance, the coconut peel produces a fiber that can be used as a good quality substratum for seedlings production or in cultivations without soil use (ROSA et al., 2001).

Fertilizers use is indicated in seedlings production, mainly with phosphorus, which is a macronutrient that carries out a key function in the photosynthesis process, in sugars metabolism, in energy storage and transference, in cellular division, in cells enlargement and in genetic information transference, besides promoting the root's initial formation and development and plant growth, which increases water use efficiency for the plant, as well as all the other nutrients absorption and use, no matter if they come from the soil or from the fertilizer (MALAVOLTA et al., 1997).

The present study had as objective to evaluate the substrates effect in different components mixtures fertilized with phosphorus on mangabeira seedlings mineral composition.

MATERIAL AND METHODS

This research was carried out from November, 2004 to May, 2005, in Areia-PB, located at 6^0 58' of South latitude and 35^0 41' West longitude, at 618 meters of altitude. The mean temperature during the experiment was 25 ^{0}C, the air relative humidity 78 % and the pluviometric precipitation accumulated was 470 mm.

Seeds were obtained of fruits obtained from Mangabeira trees which presented satisfactory vegetative growth and phyto-sanitary state. Fruits were manually pulped off for seeds extraction, washed with water and dried at a ventilated and partially shaded place during 1 day, when it were sowed at 1 cm of depth in black polyethylene bags with 15 cm of width and 28 cm of length and with capacity for 4 dm^{-3} of substrate. Four seeds were sowed in each bag. At fifteenth and thirtieth day after seeds full germination it was accomplished two rough-hewings, leaving two or one seedling, respectively, with better survival and development conditions.

Treatments were distributed in a randomized block design, with three repetitions and four seedlings per experimental unit. The 17 treatments were obtained through the software Design Expert 6.0 Tria (NIST/STAT-EASE INC., 2005) (Table 1), being composed by the combination of bovine manure (0 to 25.5 %), coconut fiber (0 to 40 %) and soil (25 to 70 %), 15 % of sand as inert material and triple super phosphate with doses of 0.0, 5.5 and 11.0 g dm^{-3} (Table 1). The polyethylene bags were maintained in a nursery covered with transparent canvas and propylene, aiming at a 50 % decrease of solar radiation, until the plants emit the first four leaves.

The irrigation was daily accomplished. In order to favor the drainage irrigation water and to avoid the substrate to flood, two extra hole were done in the bottom and other two in the inferior third of the plastic bags; fungicide application, which active ingredient was metalaxyl-M (Ridomil 50 GR) in the dose of 200 g in 100 dm^{-3}, was performed biweekly, starting from the second definitive leave pair stage.

The experiment had duration of 150 days after seeds germination. The mineral composition of mangabeira's root system and seedlings aerial part was evaluated at the end of the experiment, determining N, P, K, Ca, Mg and Cu contents, adopting the methodology proposed by EMBRAPA (1999).

Table 1 - Substrates components containing coconut fiber, bovine manure, soil, sand and triple super phosphate

Substrata	Coconut fiber (%)	Bovine manure (%)	Soil (%)	Sand (%)	Triple super phosphate (g dm^{-3})
1	0.00	25.00	60.00	15.00	0.00
2	0.00	15.00	70.00	15.00	11.00
3	0.00	25.00	60.00	15.00	11.00
4	0.00	20.00	65.00	15.00	5.50
5	8.50	8.50	70.00	15.00	0.00
6	15.00	0.00	70.00	15.00	11.00
7	17.50	25.50	42.00	15.00	11.00
8	17.50	25.50	42.00	15.00	0.00
9	22.00	14.00	49.00	15.00	0.00
10	25.00	7.00	53.00	15.00	11.00
11	27.50	0.00	57.00	15.00	0.00
12	35.00	25.00	25.00	15.00	11.00
13	35.00	25.00	25.00	15.00	0.00
14	35.00	25.00	25.00	15.00	5.50
15	40.00	0.00	45.00	15.0	0.00
16	40.00	0.00	45.00	15.00	5.50
17	40.00	0.00	45.00	15.00	11.00

The results were submitted to appropriate regression analysis for the experiments with mixtures (CORNELL, 2001), considering up to 5% of significance. Statistical analyses were accomplished with the aim of the software Design Expert Trial 6.0 (STAT-EASE INC., 2005).

RESULTS AND DISCUSSION

Nitrogen content in root, varying from 21 to 29 g kg^{-1}, was not influenced by the triple super phosphate doses (Table 2 and Figure1), being superior to the appropriate content if compared to those obtained by SILVA et al. (1984) and ALVES et al. (1989), which varied from 6 to 9 g kg^{-1}, respectively.

Table 2 - Nutrients contents in the root system (R.S) and in aerial part (A.P) of *Hancornia speciosa* seedlings

Treat.	Nitrogen		Phosphorus		Potassium		Calcium		Magnesium		Copper
	R.S	A.P	R.S	A.P	R.S	A.P	R.S	A.P	R.S	A.P	A.P
	g kg^{-1}										mg kg^{-1}
01	24.6	24.3	0.03	0.93	32.1	26.4	3.2	3.6	0.52	1.5	0.78
02	27.2	24.3	0.05	1.07	35.3	24.5	5.7	5.2	0.47	1.4	0.42
03	25.9	20.6	0.03	1.21	32.3	26.9	6.4	4.6	0.87	1.6	0.36
04	26.1	27.8	0.05	0.98	29.2	31.5	6.6	3.9	1.00	1.4	2.21
05	22.9	17.6	0.03	0.58	33.9	23.6	2.1	2.4	0.46	0.9	2.22
06	22.4	15.4	0.02	0.88	30.6	23.6	2.0	3.5	0.40	1.0	3.07
07	27.1	25.4	0.03	1.01	30.6	27.3	4.4	4.4	0.92	1.4	0.36
08	29.1	22.1	0.04	1.05	44.1	32.4	5.2	3.7	1.06	1.3	0.82
09	23.2	23.3	0.02	0.71	27.8	32.0	4.1	3.4	0.67	1.1	3.39
10	22.6	16.9	0.05	0.76	34.3	25.9	3.1	2.8	0.48	0.8	5.36
11	24.7	14.7	0.04	0.77	29.2	28.3	3.6	4.4	0.65	1.0	4.65
12	24.3	20.4	0.05	1.29	37.6	38.5	6.8	4.5	0.73	1.5	0.36
13	25.8	24.8	0.04	1.29	32.1	32.9	4.3	4.6	1.00	1.4	0.62
14	22.6	24.6	0.04	1.07	29.2	31.6	4.8	4.0	0.81	1.3	0.31
15	23.2	12.9	0.03	0.76	28.3	25.0	1.9	2.3	0.55	1.0	0.40
16	23.2	15.9	0.05	0.89	30.6	27.3	2.9	3.5	0.62	1.0	1.33
17	21.7	18.1	0.03	1.29	27.3	28.3	6.2	3.1	0.52	1.2	2.33

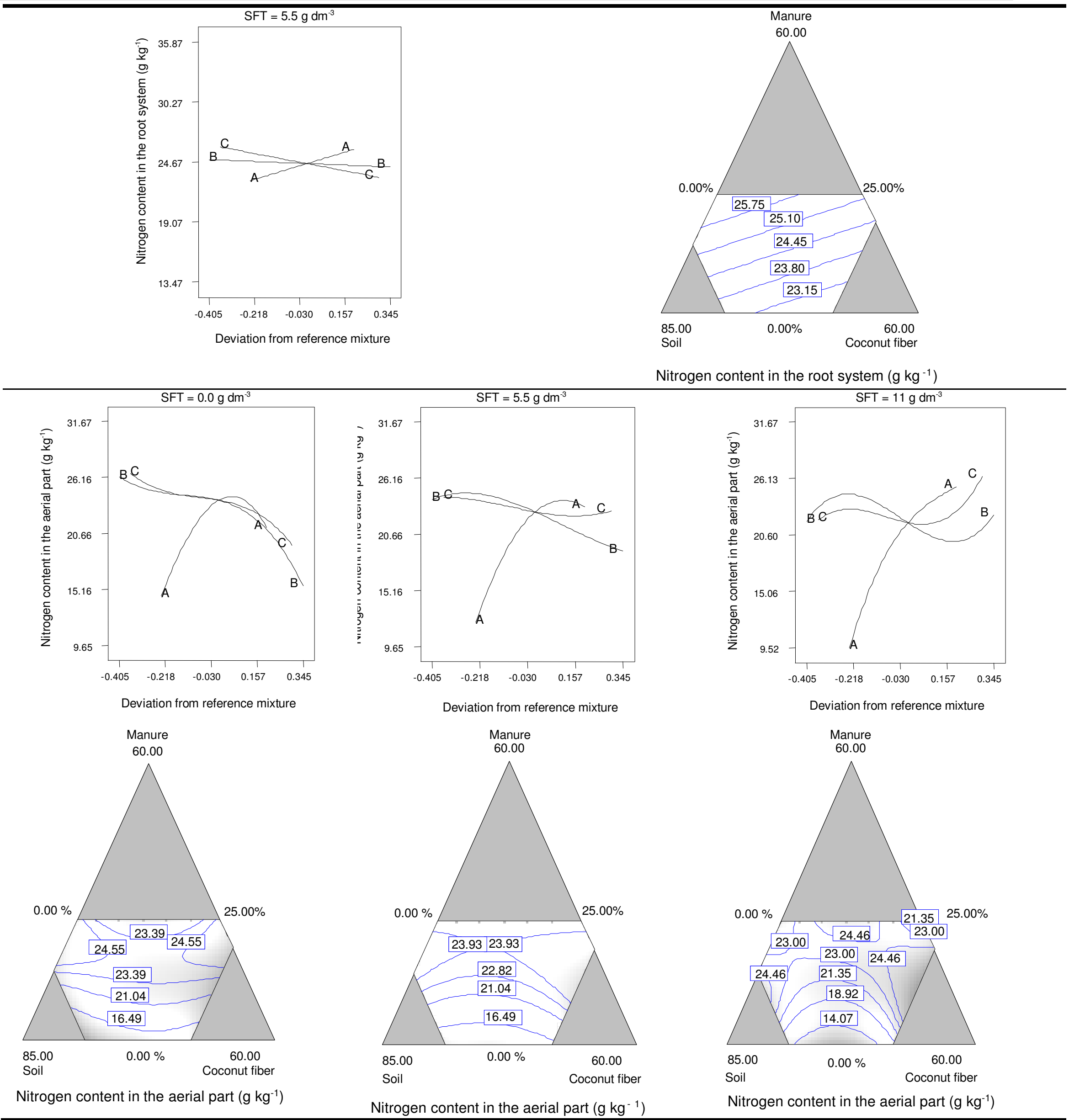

Figure 1- Nitrogen content in the root system and in the aerial part of mangabeira seedlings, to the 150 days, in cultivated substratum containing manure (A), soil (B) and coconut fiber (C), in three doses of triple super phosphate (SFT)

The increase of manure concentration in the substrate increased nitrogen content in the aerial part. On the other hand, the root nitrogen content decreased with the increase of coconut fiber and soil concentration, being the dose of 11 g dm^{-3} triple super phosphate that one could provide maximum nitrogen content in the seedlings aerial part. Significant difference was not found among the triple super phosphate doses for nitrogen content in the root system.

Phosphorus content in the root increased with the increment of soil concentration only with 5.5 g dm^{-3} of triple super phosphate (Figure 2). Manure increase, in the 11 g dm^{-3} of super phosphate triple dose, increase the phosphorus content in the root. However, it was in the 5.5 g dm^{-3} dose that the smallest manure concentrations resulted in larger phosphorus contents in the root. Coconut fiber in the doses of 0 and 11 g dm^{-3} of triple super phosphate caused phosphorus increase in the root with its concentration increase, being the dose 5.5 g dm^{-3} the one which resulted in the smallest coconut fiber concentrations and in the largest phosphorus contents in the root.

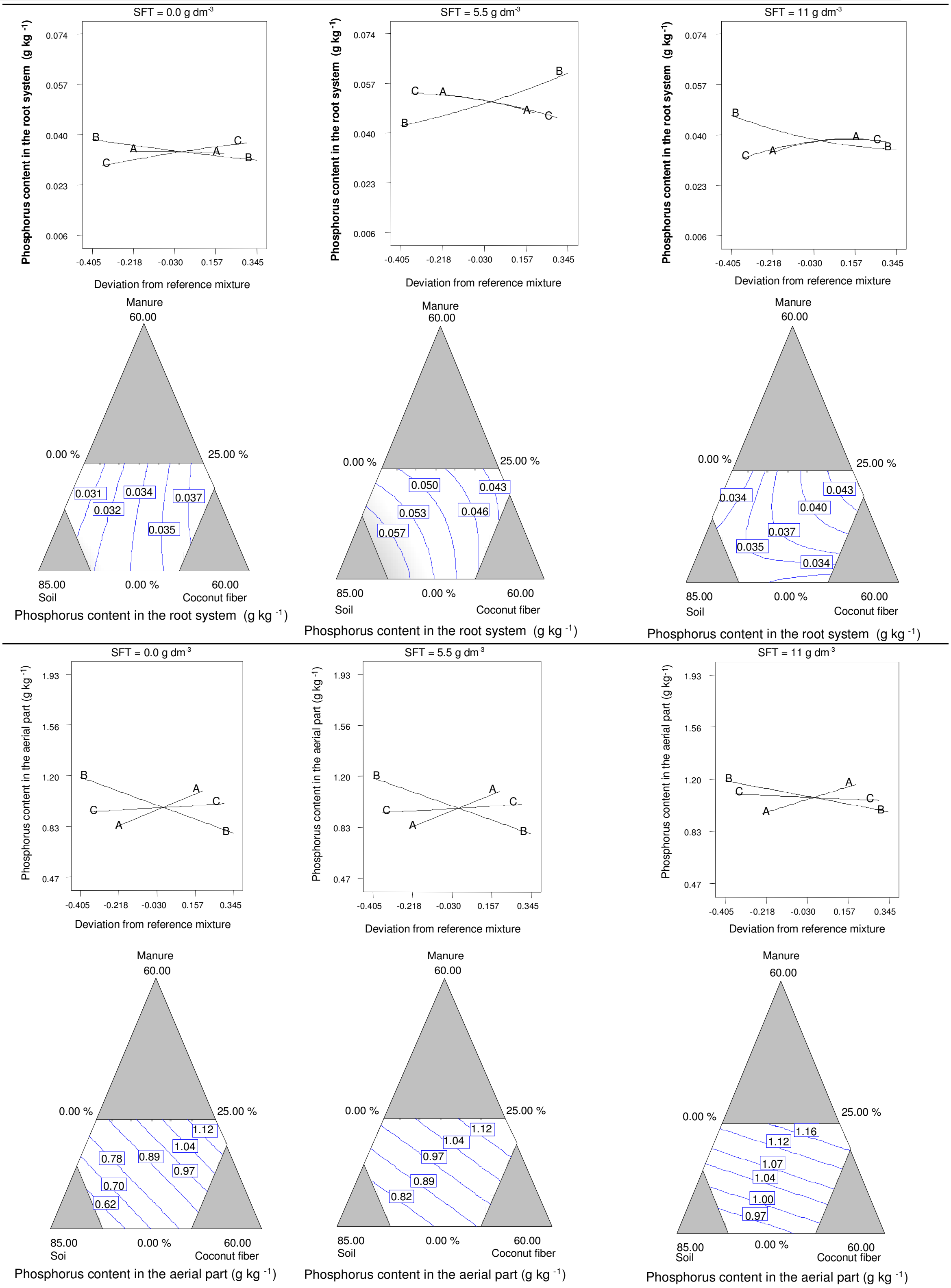

Figure 2- Phosphorus content in the root system and in the aerial part of mangabeira seedlings, in cultivated substratum containing manure (A), soil (B) and coconut fiber (C), in three doses of triple super phosphate (SFT)

Mangabeira tree presents in its root composition around 0.4 g kg^{-1} of phosphorus according to SILVA et al. (1984) and ALVES et al. (1989). Therefore, the seedlings it were deficient, probably due to phosphorus high

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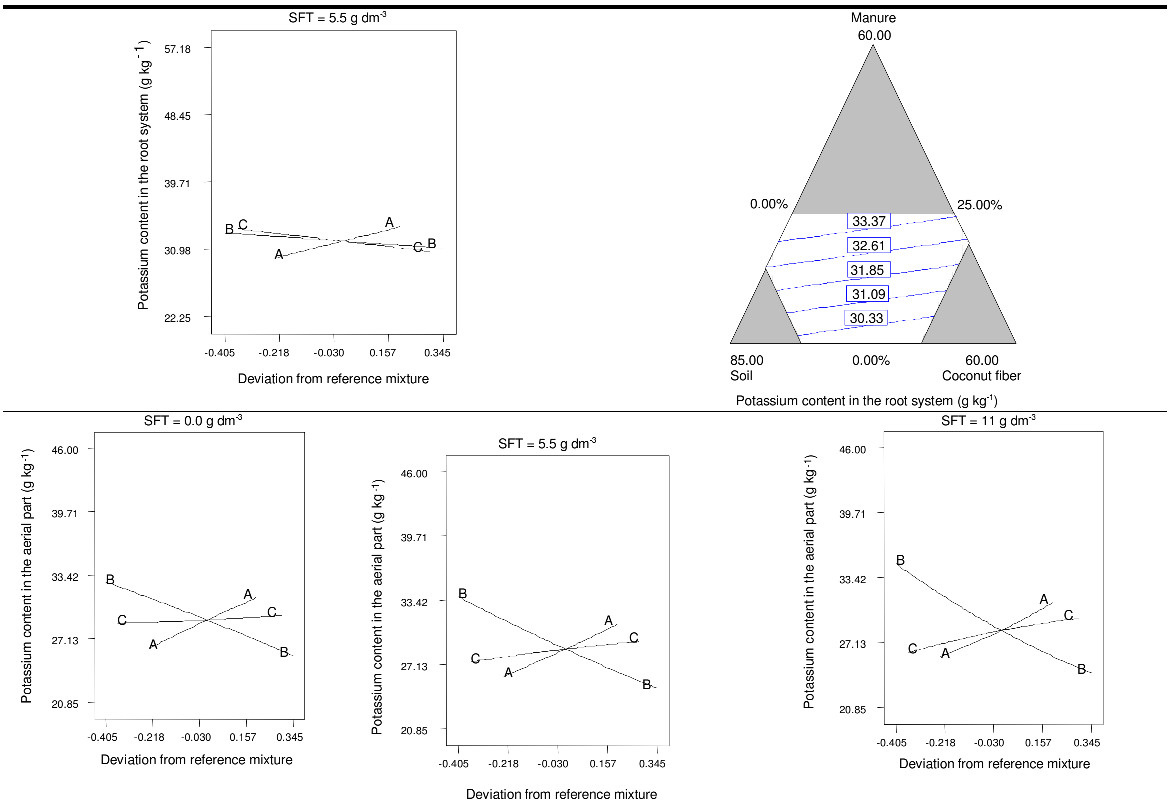
mobility, which is mainly accumulated in the leaves (MOREIRA, 2004). Another possibility is the dilution effect, that is, the nutrients concentration is diluted with larger root growth, and this is an important variation source able to hinder plants nutritional status interpretations (PRADO e FERNANDES, 2001).

The increase of manure concentration in the substrate increased the content of P in the seedlings aerial part (Figure 2). Coconut fiber contributed very little to the phosphorus content increase in the aerial part. Soil concentration increase decreaced the phosphorus content in the aerial part; nevertheless, with the super phosphate dose increase, such decrease was smaller. The phosphorus contents in mangabeira seedlings aerial part can be considered appropriate, if compared to those found by FERREIRA et al. (2003) of 0.86 g kg^{-1} in mangabeira cultivated orchards, by ALVES et al. (1989), of 0.3 g kg^{-1} and for ESPÍNDOLA (1999), of 1.16 g kg^{-1}.

Potassium content in the root system was considered more appropriate than average, between 6 and 12 g kg^{-1}, according to SILVA et al. (1984) and ALVES et al. (1989), because the contents varied between 27 and 44 g kg^{-1} (Table 3). In relation to substrate components, only manure contributed to the potassium content increase in the mangabeira seedlings root system (Figure 3). Potassium content in the aerial part of the seedlings increased with the increase of manure and coconut fiber concentration in the substrate (Figure 3). Nevertheless, the increase of soil concentration decreased potassium content. The potassium content in the seedling was appropriated if compared to those contents found by ESPÍNDOLA (1999), of 7.4 g kg^{-1}, by ALMEIDA (2000), of 7.6 g kg^{-1} and by ESPÍNDOLA et al. (1998), of 22.5 g kg^{-1}. In thi reearch, the foliar potassium contents varied between 23 and 38 g kg^{-1} (Table 2).



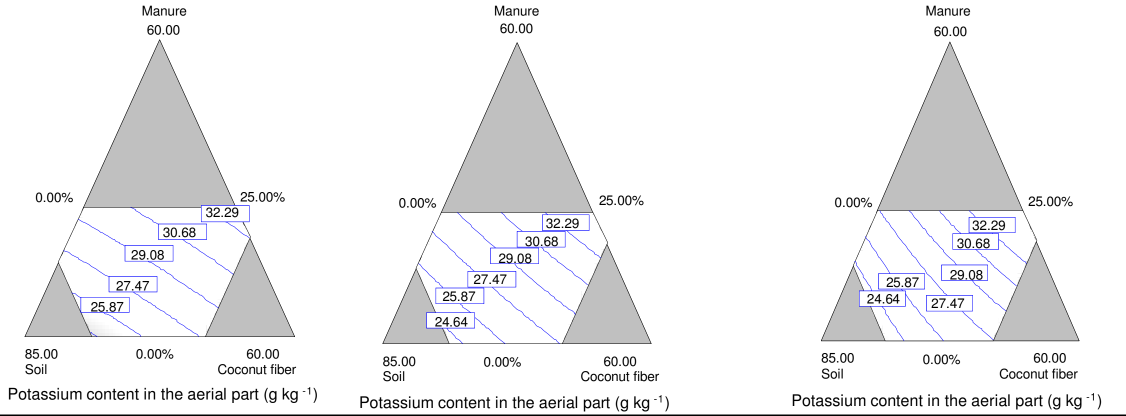
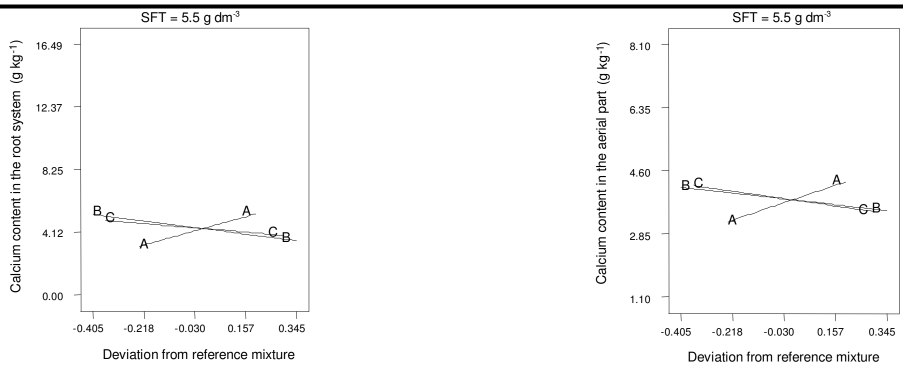


Figure 3- Potassium content in the root system and in the aerial part of mangabeira seedlings, in cultivated substratum containing manure (A), soil (B) and coconut fiber (C), in three doses of triple super phosphate (SFT)

It was verified that only manure increased calcium content in mangabeira seedlings (Figure 4). In this research, calcium contents were superior to those observed by SILVA et al. (1984) and ALVES et al. (1989), ranging from 1.2 to 2.8 g kg^{-1} for root and leaves, respectively. In spite of the high calcium contents in the seedlings tissues, higher than 1.91 g kg^{-1} for the root system and 2.36 g kg^{-1} for the aerial part (Table 2), there were not toxicity visual symptoms. MARSCHNER (1995) considers calcium as a non toxic nutrient, even when it is found in high concentrations.

Calcium contents in the seedlings root part were higher than to those one found in the aerial part, because its mobility between cells and phloem is very low, but even though it is indispensable for the growth points (meristems), where continuous myotic division is processed, so as in the root development, acting in prolongation processes and cellular division (MASCARENHAS, 1977).

Magnesium contents in the root system increased with the increase of manure concentration in the substrate. However, 11 g dm^{-3} of triple super phosphate decreaded magnesium content in the roots (Figure 4). The increase of coconut fiber concentration decreaced magnesium content in the roots, being less accentuated in the dose of 11 g dm^{-3} of triple super phosphate. Soil, in the doses of 0 and 5.5 g dm^{-3} of triple super phosphate, practically didn't influence the root magnesium content. Nevertheless, in the dose of 11 g dm^{-3}, the increase of soil concentration reduced magnesium content in mangabeira seedlings roots.



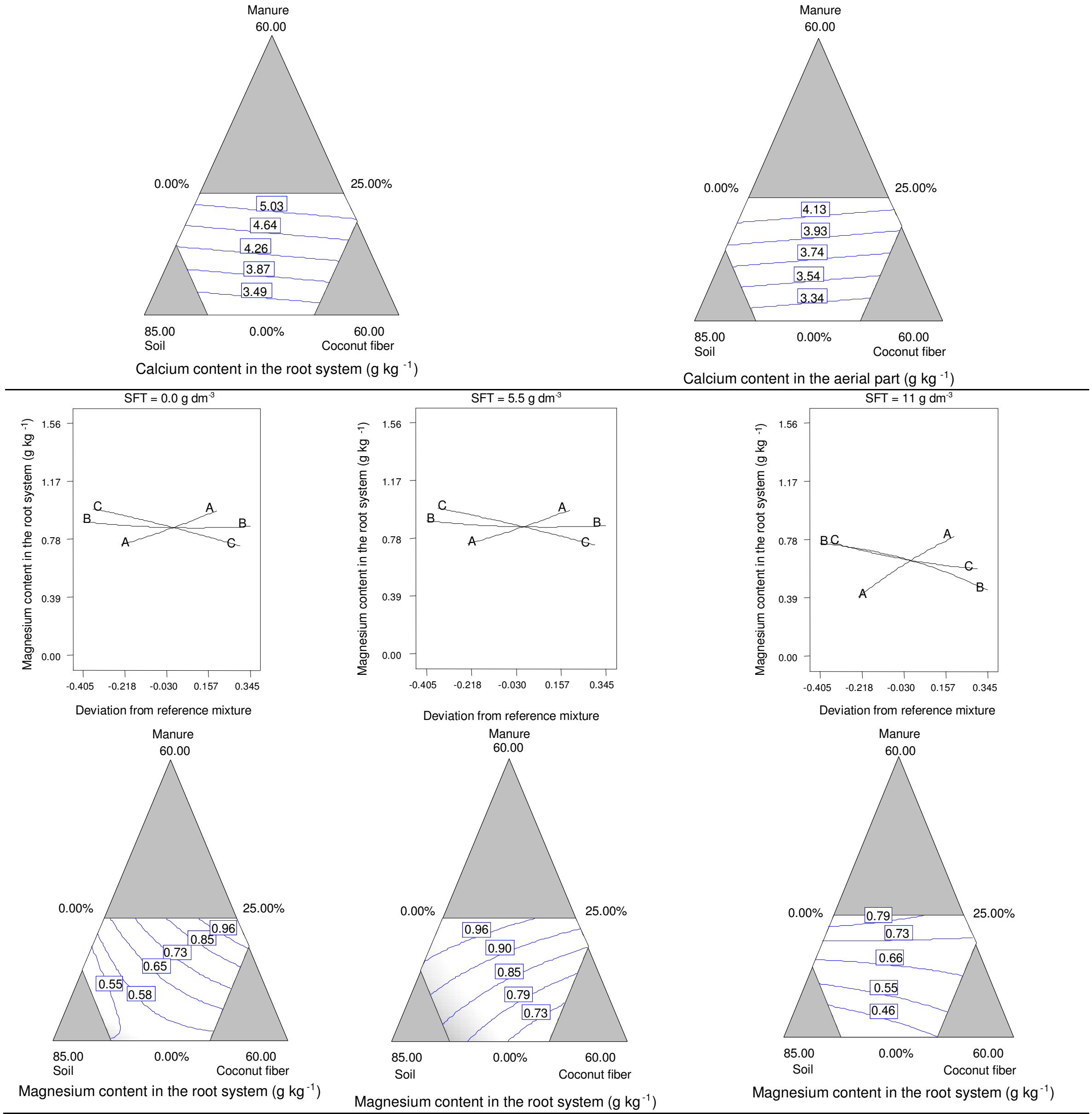


Figure 4- Calcium and magnesium contents in the root system and in the aerial part of mangabeira seedlings, in cultivated substratum containing manure (A), soil (B) and coconut fiber (C), in three doses of triple super phosphate (SFT)

Magnesium contents in the aerial part, which ranged from 0.84 to 1.60 g kg^{-1} (Table 2), can be considered appropriate if compared to those verified by ALVES et al. (1989), of 1 g kg^{-1} in mangabeira tree leaves. But, if compared to the values obtained by SILVA et al. (1984), of 2.6 and 1.9 g kg^{-1} by ESPÍNDOLA (1999), such contents can be considered from medium to low. The increase of manure concentration contributed to the increase of magnesium content. However, the increase of coconut fiber and soil concentration reduced magnesium content in the leaves (Figure 5).

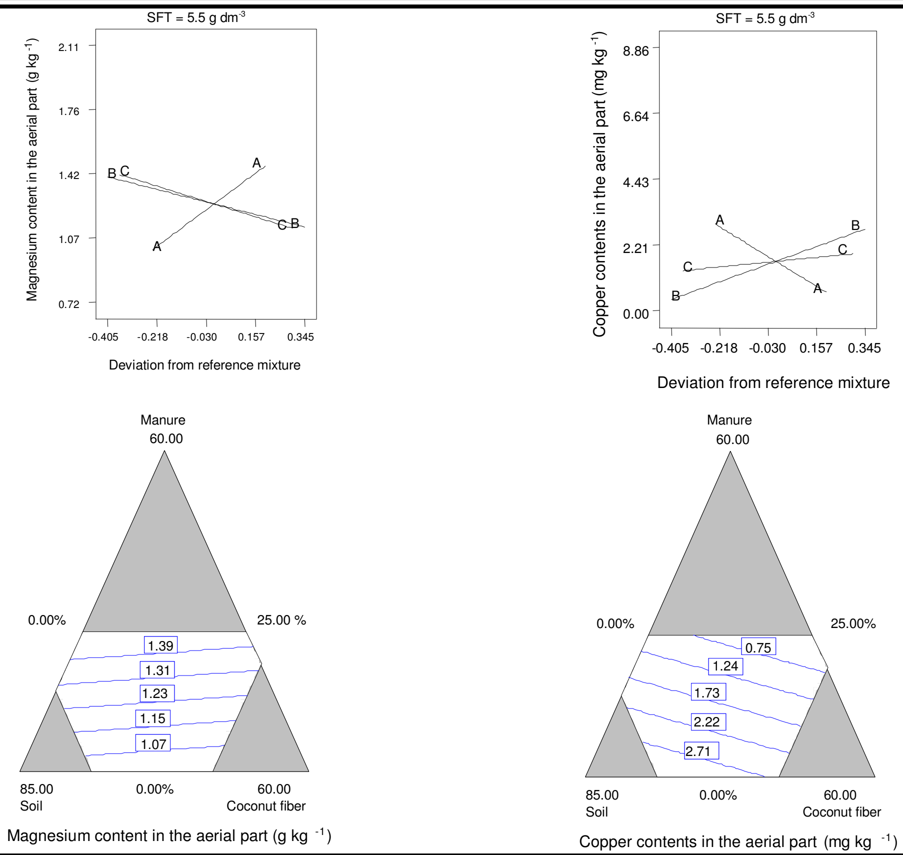


Figure 5- Magnesium and copper contents in the aerial part of mangabeira seedlings, to the 150 days, in cultivated substratum containing manure (A), soil (B) and coconut fiber (C), in the dose of 5,5 g dm^{-3} of triple super phosphate (SFT)

Soil, when compared to coconut fiber, was the one which more increased copper content with the increase of its concentration in the substrate. Copper contents in the leaves averaged from 0.31 to 5.36 mg kg^{-1} (Table 2). Such values, when compared to those found by ALVES et al. (1989), can be considered appropriate, as well as ESPÍNDOLA (1999), who found 3.1 mg copper kg^{-1} in mangabeira leaves. Nevertheless, SILVA et al. (1984) affirm that copper medium contents found in mangabeira leaves from Brazilian Northeast are smaller than 5 mg kg^{-1}.

The estimated maximum content of nitrogen, phosphorus, potassium, calcium, magnesium and copper in the root system and in the aerial part was obtained with the substrate contituited by 24 % of manure, 51 % of soil, 10 % of coconut fiber, 15 % of sand and fertilized with 8.1 g dm^{-3} of triple super phosphate (Table 3).

Table 3 – Estimated concentration of subtrate to obtain the ideal concentration of mineral nutrients in *Hancornia speciosa* seedlings

E	T	F	STF	Content	N	P	K	Ca	Mg	Cu
--------- % ---------			g dm^{-3}		------------------- g kg^{-1} -------------------					mg kg^{-1}
24.0	51.0	10.0	8.1	R.S	26.16	0.05	33.77	4.97	0.97	-
				A.P	23.02	1.02	44.38	4.22	1.43	1.25

E = bovine manure; T = soil; F = coconut fiber; SFT = triple super phosphate; N = nitrogen; P = phosphorus; K = potassium; Ca = calcium; Mg = magnesium; Cu = copper; R.S = root systems; A. P = aerial part.

In general, the substrate presented good fertility resulting from the used components. That probably happened due to the physical and chemical characteristics propitiated by the components, mainly for manure addition, because the organic matter is the main nutrient source for the soil or substrate, (LEA e MOROT-GAUDRY, 2001).

Seedlings were nutritionally balanced, due to the appropriate avaliability of added nutrients for the substrate, which will probably result in larger growth of seedlings and a better establishment of the seedlings in the field. However, in spite of the 24 % manure indication in the substratum composition, it was observed that bovine manure addition in high concentration harmed root growth (DIAS, 2006).

CONCLUSIONS

The substrate constituited by organic matter, coconut fiber and soil supplied mangabeira seedlings nutritional demands.

In mangabeira seedlings, the estimated largest nitrogen, phosphorus, potassium, calcium, magnesium and copper contents are obtained with the following substrate: 51 % of soil, 10 % of coconut fiber, 24 % of manure and 15 % of sand, fertilized with 8.1 g dm^{-3} of triple super phosphate.

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