



## *Volume of containers and the organic substrates in the production of guava rootstocks*

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### ABSTRACT

The volume of containers and the organic substrates are factors directly linked to the quality of seedlings. At this work, we conducted an experiment aiming to evaluate the effect of different organic sources and volumes of containers on the production of guava rootstocks. The experiment was realized from June to November 2011, at the Experimental Farm of the Federal Institute of Education, Science and Technology of Paraíba (IFPB), Sousa-PB, Brazil. We used a randomized block in a 3x4 factorial design. The first factor was the organic substrate, with three treatments (cattle manure, sheep manure and earthworm castings), and the second factor consisted of four container volumes (635 mL, 1285 mL, 1800 mL and 3300 mL). Each treatment was replicated four times. The evaluated characteristics were: shoot length, shoot diameter, dry shoot matter and macronutrient contents (N, P, K, Ca, Mg and S) in the aerial dry shoot mass. Based on the results, we recommend a volume of containers of 1285 mL for guava rootstocks, regardless of the organic substrate. The variation in the volume of the containers provided differences in the growth of the rootstocks and the accumulation of N, P, Ca and Mg in the dry mass of the aerial part.

**Keyword:** *Psidium guajava* L.; organic material; pomiculture; high quality seedling.

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## INTRODUCTION

Growing fruit is a strategic activity for agribusiness in Brazil. The diversity of fruit species, the potential of the domestic and international market are factors that contribute to the high fruit productivity, consumption and export. Increased technological development and increased competitiveness require planning at all stages related to the rational exploitation of fruit. In this context, the quality of the seedlings is a determining factor for the crop productivity (COSTA et al., 2010), since is fundamental for the rapid development of planting and a homogeneous and precece crop (FRANCO and PRADO 2008).

The type of substrate and the volume of containers are the first evaluated factors in seedlings production, affecting directly the quality and the final cost of the input (MENDONÇA et al. 2007; CRUZ et al., 2016). Determine the better combination of substrate, suitable containers reduces the production costs, making than accessible to small and medium rural producers (ARAÚJO NETO et al. 2009). The substrate must be uniform, nutritious, have high water retention capacity, the absence of pathogens and pests, and low cost (POZZA et al., 2007; SIMÕES et al., 2012). The choice of the substrate should consider the availability at the region (ALVES et al., 2012) and the composition – type and proportion of materials that increase the potential for development and survival (GUIMARÃES et al., 2013). In this sense, the organic composition for substrates seems an alternative to low-cost production, and the use of waste contributes to the sustainability of agricultural systems and conservation of natural resources. The composition of organic substrates directly influence the organic matter content and soil attributes, with effects on the macro and micronutrient concentrations required by the plants (GARRIDO et al. 2008; OLIVEIRA et al. 2009; DUTRA et al., 2013; GASPARIN et al., 2014; GONÇALVES et al., 2014).

The size of the containers significantly influences the seedlings quality (ZACCHEO et al., 2013). The criterion of choice of this material has technical and economic implications, being ideal to reconcile availability and cost (PEREIRA et al., 2010). In the production of seedlings, there is a trend in the use of smaller volumes containers to reduce costs (VALLONE et al. 2010). However, Arizaleta and Pire (2008) point out, that despite the increase of costs, the use of larger containers contribute to increased of nutrient reserves, water and better root development, although larger volumes may result in unnecessary expenses (VIANNA et al. 2008).

Despite advances in plant propagation techniques, there are gaps in information on the best combinations of substrates and volume of containers that allow the good quality of guava rootstocks. Therefore, the objective of this work was to evaluate the effect of different organic sources and containers volumes on the production of guava rootstocks.

## MATERIAL E METHODS

The experiment was conducted at the seedling nursery of the Federal Institute of Paraíba, Campus de Sousa (IFPB-Sousa, Brazil), from June to November 2011. We used the seeds from healthy and mature guava (*Psidium guajava* L.), from variety Paluma. The fruits were cut in half, separating pulp and seed. The seeds were washed in running water over a fine mesh sieve to eliminate pulp and bark residues. The selection was made through manual harvesting, discarding small and damaged seeds. The drying was carried out in an airy and shaded place during three days.

We used completely randomized blocks in a 3x4 factorial design. The treatments were composed of three organic sources (bovine manure, sheep manure and earthworm castings), mixed with clay soil and sand (3: 1 v v<sup>-1</sup>) in the proportion of 40% of the substrate, and four different container volumes (635 mL, 1285 mL, 1800 mL, and 3300 mL). In each experimental plot, we placed ten plants. The treatments were repeated four times.

Samples of organic materials were collected and sent to Embrapa Semi-Arid Soil, Water and Plant Laboratory (Petrolina-PE) to evaluate the substrate composition. Bovine manure was composed of: Organic carbon (CO) = 38.80%, Nitrogen = 19.43 g kg<sup>-1</sup>, Phosphorus (P) = 7.43 g kg<sup>-1</sup>, Potassium (K) = 6.03 g kg<sup>-1</sup>, Calcium (Ca) = 21.30 g kg<sup>-1</sup>, Magnesium (Mg) = 6.50 g kg<sup>-1</sup>, Sulfur (S) = 1.80 g kg<sup>-1</sup> and the carbon/nitrogen fraction (C:N) = 20.00. Ovine manure: CO = 45.79%, N = 22.62 g kg<sup>-1</sup>, P = 5.40 g kg<sup>-1</sup>, K = 17.68 g kg<sup>-1</sup>, Ca = 19.25 g kg<sup>-1</sup>, Mg = 7.35 g kg<sup>-1</sup>, S = 1.83 g kg<sup>-1</sup> and C:N ratio = 20.20. Worm castings: CO = 19.72%, N = 14.21 g kg<sup>-1</sup>, P = 6.06 g kg<sup>-1</sup>, K = 4.51 g kg<sup>-1</sup>, Ca = 18.30 g kg<sup>-1</sup>, Mg = 6.05 g kg<sup>-1</sup>, S = 1.10 g kg<sup>-1</sup> and C:N = 13.90.

The containers were filled manually and taken to the nursery. The sowing was performed on first of June of 2011, placing three seeds per container, at a depth between 1 and 2 cm. The thinning was performed 40 days after sowing, leaving the seedling more vigorous and centralized. The seedlings were watered twice a day (morning and afternoon), providing enough water for raising the substrate moisture near the field capacity. Invasive plants were eliminated manually as soon as they appeared. During the period of the experiment, no cover fertilization was performed.

At the end of 150 days we evaluated the shoot length (the distance between the base and the apex of the stem), stem diameter (measure of the rootstocks 8 cm above the base, with the aid of a digital caliper), dry mass of the aerial part (obtained by samples packed in paper bags, labeled and placed in forced circulation air oven at 65°C, until reach a constant weight), and macronutrient contents (according to EMBRAPA'S METHODOLOGY, 1999).

Significant differences among treatments were tested using an Analysis of Variance (ANOVA). We used the Tukey test for paired comparisons of the means. A Polynomial Regression Analysis was performed for the effects of containers volume. We adopted a 5% level of significance for all analyses. The

statistical procedures were made at SISVAR software (FERREIRA 2008).

A significant interaction between the organic substrate and containers volume was found for aerial shoot length (SL), stem diameter (SD) and dry shoot matter (SDM), thus evidencing the dependence between the two factors (Table 1).

The highest values of shoot length, dry shoot mass and stem diameter was produced in the largest containers (3300 mL), and the highest absolute values were found for the treatments with worm castings (Table 1). Similar results of increased growth with volume of containers were found for other fruit cultures, like the shoot length of yellow passion

**RESULTS AND DISCUSSION**

fruit and papaya seedlings (ZACCHEO et al. 2013, MESQUITA et al. 2012), stem diameter of cupuassu, papaya and umbu seedlings (SANTOS et al. 2010, MESQUITA et al. 2012, CRUZ et al. 2016), and dry shoot mass for guabiroba and umbu seedlings (BARDIVIESSO et al. 2011, CRUZ et al. 2016). The highest amount of substrate available, the best conditions of moisture retention, aeration and nutrient availability are probably the main factors responsible by the better development of the rootstocks in larger containers.

**Table 1** – Average shoot length (PC), dry shoot mass (MSP) and stem diameter (DC), evaluated in guava rootstocks at 150 days of the experiment, as a function of different organic sources (BM, bovine manure; SM, sheep manure; WC, worm castings) and containers volumes. Sousa-PB, IFPB, 2016.

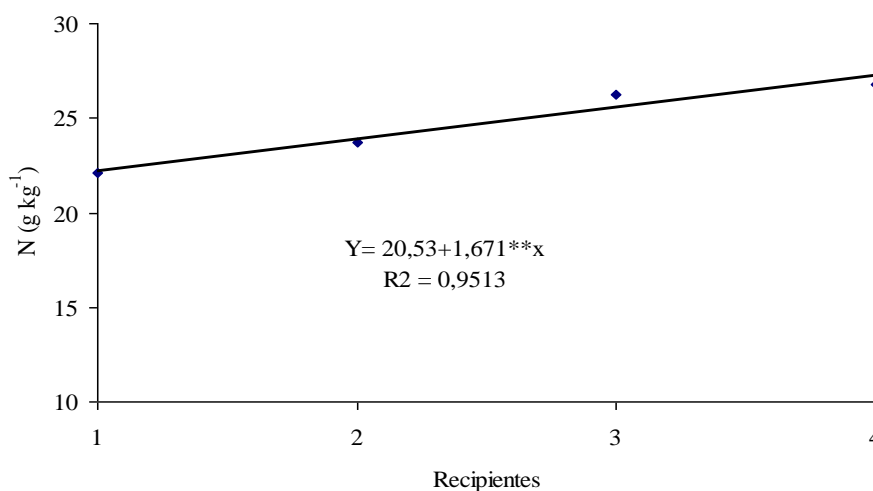
Container (mL)	ASL (cm)			ASDM (g plant <sup>-1</sup> )			SD (mm)		
	BM	OM	WC	BM	OM	WC	BM	OM	WC
635	65.77cAB	72.68 cA	56.99 cB	8.61 cA	10.70 cA	7.59 cA	4.68 cA	4.77 cA	4.30 cA
1285	81.81 bA	87.19 bA	84.84 bA	16.67 bA	15.95 bA	15.91 bA	5.88 bA	5.90 bA	5.69 bA
1800	85.52 bA	89.16 bA	85.46 bA	16.72 bA	17.06 bA	15.41 bA	5.94 bA	5.74 bA	5.67 bA
3300	98.68 aB	111.53 aA	111.80 aA	25.04 aB	33.77 aA	36.00 aA	6.71 aA	7.30 aA	7.76 aA

Means followed by the same capital letter (in the rows) and lower case (in the columns) do not differ by the Tukey test at the level of 5 (%) probability.

A non-significant interaction between substrate and container volume was found for N, P, K, Ca, Mg, and S contents in the dry shoot mass (Figures 1, 2, 3 and 4) showing, thus, the independence between the two factors.

We found an increase in N content with the increase in containers volume (Figure 1). This increase of nitrogen with

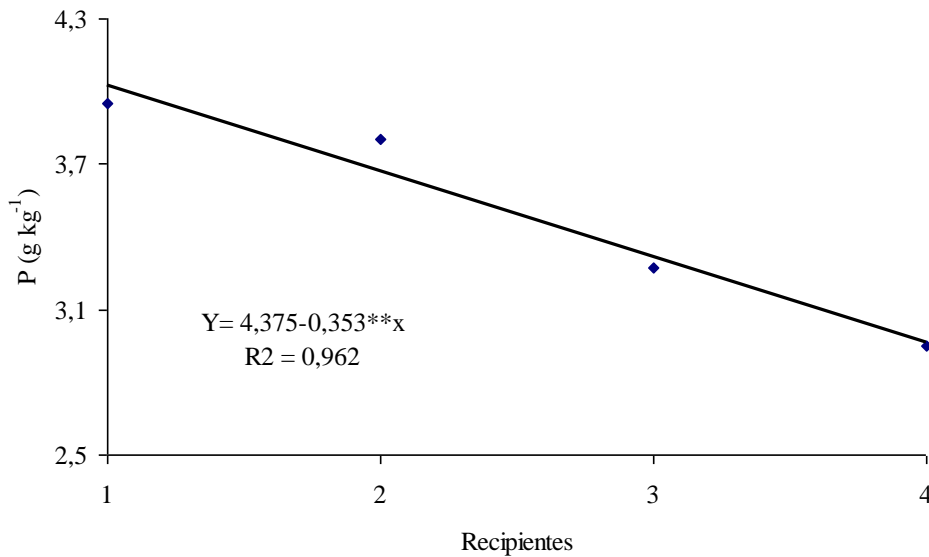
the volume of the container is a result of the greater availability of the nutrient in the organic substrate. Different behavior was observed by Arizaleta and Pire (2008) studying coffee seedlings in various container sizes.



**Figure 1.** Nitrogen content (N) in the dry shoot mass of guava rootstock, after 150 days of experiment, according to different organic sources and container volumes.

The phosphorous content at the dry shoot mass showed an inverse linear relationship with container volume (Figure 2). We found a minimum value of 3.21 g kg<sup>-1</sup> and a maximum of 4.15 g kg<sup>-1</sup> in the volume containers 3300 mL and 635 mL, respectively (Figure 2). Two factors can explain this result: a high efficiency in absorption and utilization of soil

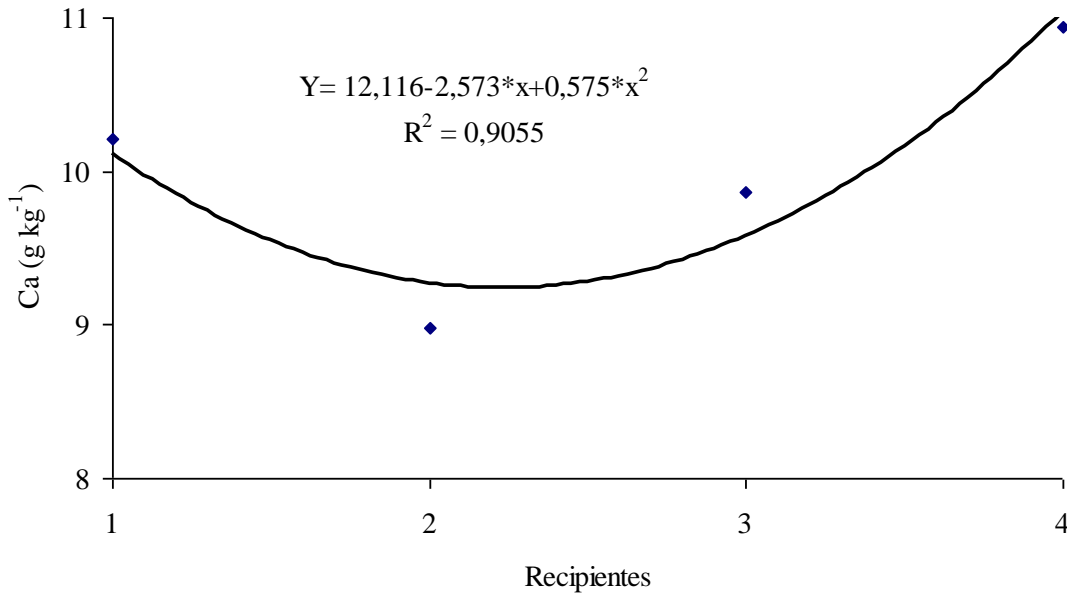
phosphorus as a reflection of its adaptation to low fertility soils (SAMARÃO and MARTINS 1999); or, a possible dilution effect due to the high dry mass production in large containers. A similar result was observed by Arizaleta and Pire (2008) studying coffee seedlings in different container sizes.



**Figure 2.** Phosphorus content (P) in the dry shoot mass of guava rootstocks, after 150 days of experiment, according to different organic sources and container volumes.

Calcium content in dry shoot mass was adjusted to a quadratic regression model. An estimated minimum of 9.24 g kg<sup>-1</sup> was found for seedlings at the 2234 mL volume container, a mean of 9.90 g kg<sup>-1</sup> in the 3300 mL containers and a maximum estimation of 10.71 g kg<sup>-1</sup> in the 635 mL

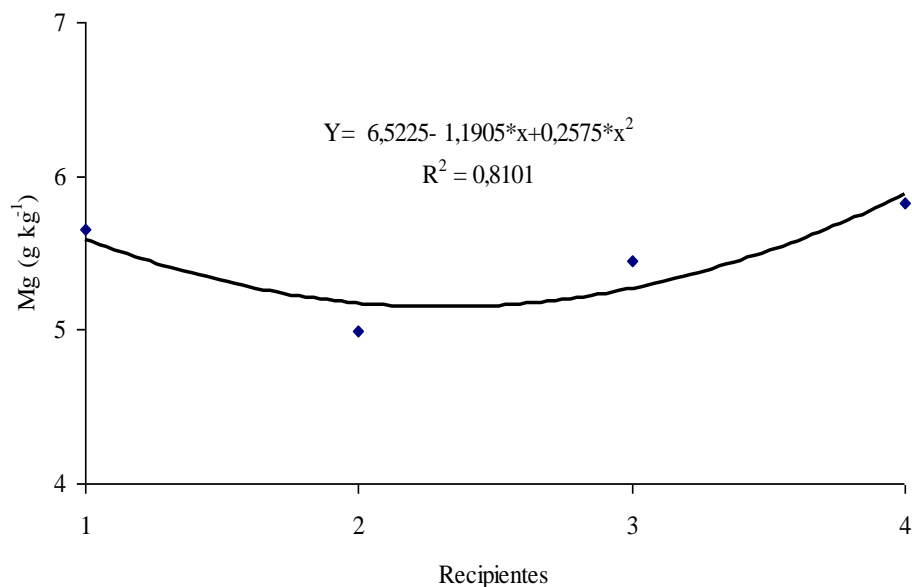
volume container (Figure 3). Different results were obtained by Torres Neto and Campos Trini (2009) studying the influence of the volume of the containers on the mineral nutrition of the aerial part of coffee seedlings.



**Figure 3.** Calcium content (Ca) in the dry shoot mass of guava rootstocks, after 150 days of experiment, according to different organic sources and container volumes.

Magnesium content was fitted to a quadratic regression, with a minimum value of 515 g kg<sup>-1</sup> at the container of 2316 mL, higher values at the smaller and larger containers (635

and 3300 mL) (Figure 4). Torres Neto and Campostrini (2009) reported similar results in the shoot of coffee seedlings.



**Figure 4.** Magnesium content (Mg) in the dry shoot mass of guava rootstocks, after 150 days of experiment, according to different organic sources and container volumes.

The content of phosphorous, potassium, calcium and sulfur at the dry shoot mass were significantly different between organic substrates (Table 2). Higher values of phosphorous and sulfur were found in seedlings cultivated with earthworm castings (Table 2). Our results demonstrate the efficacy of worm castings source in the production of seedlings. Lima et al. (2009) reported similar results of higher P content in soursop fruit cultivated with worm castings.

Higher potassium concentrations were found in seedlings cultivated with bovine manure (Table 2). Natale et al. (1996) considered a content of 14 to 17 g kg<sup>-1</sup> on leaves as adequate for three years old guava. Lima et al. (2006) also observed

that there was a significant difference between the organic sources for K contents in the leaf and cauline tissues of the acerola, differing only in the predominant source, which was the earthworm castings.

Seedlings from earthworm castings and bovine manure showed the higher values of calcium than seedlings cultivated with ovine manure (Table 2). Natale et al. (1996) considered a calcium content of 7 to 11 g kg<sup>-1</sup> on leaves as adequate for three years old guava. Higher values of calcium content (26.8 g kg<sup>-1</sup>) were found in seedlings of acerola cultivated with worm castings.

**Table 2.** Mean values of macronutrients content at dry shoot mass (MSA) of guava rootstocks, after 150 days of experiment, according to different organic sources.

Fontes	MSPA					
	(g kg <sup>-1</sup> )					
Orgânicas	N	P	K	Ca	Mg	S
EB	24.20	3.46 b	28.93 a	7.73	5.47 a	1.86 b
a				b		
EO	25.46	3.22 b	24.87 b	10.7	5.58 a	2.12 b
a				3 a		
HM	24.46	3.81 a	24.64 b	11.5	5.40 a	2.54 a
a				5 a		
CV	11.20	10.31	10.30	13.7	8.07	15.51
(%)				1		
Média	24.71	3.50	26.15	10.0	5.48	2.17
				0		

<sup>1</sup> Means followed by the same letter in the column do not differ by Tukey test at the level of 5 (%) of probability.

## CONCLUSIONS

Considering that, for rootstocks, the characteristic diameter of the stem defines the moment of grafting, it can be concluded, regardless of the organic source used, the container of 1285 mL can be recommended to produce guava

rootstock. The volume of the container affected significantly the growth of rootstocks and the accumulation of N, P, Ca and Mg in the dry shoot mass of guava. The accumulation of macronutrients in rootstocks had the following order: K> N> Ca> Mg> P> S.

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