Research Article

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Response of young guava plants cultivar 'Século XXI' to phosphorus fertilization

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Information on nutritional aspects related to phosphorus fertilization is especially important since guava plants are cultivated mainly in tropical regions where P levels are low. The objective of this research was to evaluate the response of young guava plants of cultivar 'Século XXI' to phosphorus applied into the soil. The experiment was carried out in 3 dm^3 pots filled with samples of a dystrophic Red Latosol (P resin: 8 mg dm^{-3}). Treatments consisted of applying doses of 0, 90, 180, 270, and 360 mg kg^{-1} of P, and were arranged in a completely randomized design with four replicates. At 175 days after transplanting, P doses applied into soil increase P levels in both soil and plant tissues, resulting in increasing dry mass of guava plants cultivar 'Século XXI'. The highest development of young guava plants are attained when P is applied from 155 up to 210 mg kg^{-1} into soil and when P level in leaf tissues occurs from 1.1 up to 1.8 mg kg^{-1}.
Keywords: *Psidium guajava* L., P fertilization, plant nutrition.

Introduction

Guava species (*Psidium guajava* L.) is native from the American Continent, where Brazil and Mexico are the main producers. In addition, India, China, Pakistan, and South Africa also cultivate large areas of guava (Pereira and Kavati 2011). In Brazil, fields of guava have increased steadily in the last few years due mainly to a genetic improvement program. So, highly productive cultivars have been selected attaining high quality of fruits for industrial purposes. One of these programs has been conducted by the São Paulo State University (UNESP), Campus of Jaboticabal, São Paulo State, Brazil. A new cultivar designed of 'Século XXI' was recently developed by that program and is under distribution to Brazilian producers to be competitive with cultivars 'Paluma' (the most cultivated) and 'Rica', both introduced in Brazil in 1976.

A well-formed and productive orchard can be reached by an optimum initial establishment of plants in the fields, being of great importance and dependent on the quality of young plants used to crop the orchard. Thus, the substrate used to produce young plants is of substantial importance (Picheth 1987). In this sense, subsoil samples have been used as substrate for young plant growing. Subsoil, although of low fertility, is practically free of weeds and pathogens and contributes to reduce the expansion of degraded areas resulting from soil extraction to develop young plants of guava species (Corrêa et al. 2003).

Soils and subsoil in tropical regions are characterized by low levels of phosphorus and also by being highly efficient in the adsorption/fixation process of this element (Novais and Smith 1999). Phosphorus is known as a very important element for plant roots development (Marschner 1995), playing an important role mainly during the root system establishment of young plants (Novais et al. 1982, Römer and Schilling 1986). So, supplying phosphorus at adequate levels is essential for the development of vigorous young plants (Natale et al. 2000). Research results indicated that moderate doses from 100 mg dm^3 (Natale et al. 2000) up to 200-244 mg dm^3 of P in the soil are adequate for vigorous young guava plants formation (Tavares et al. 1995, Corrêa et al. 2003, Batista et al. 2011). However, these results were obtained with plants directly developed from seeds, using the cultivar 'Paluma', so that information on cultivar 'Século XXI' cultivar is lacking.

The objective of this research was to evaluate the response of young guava plants of cultivar 'Século XXI' to phosphorus applied into the soil.

Material and methods

Young guava plants were grown under greenhouse conditions in Jaboticabal, SP, Brazil, located at $21^o15'22''$ S and $48^o18'28''$ WGr, where an experiment was carried out from April to September, 2010. Samples of a dystrophic Red Latosol (305 g kg^{-1} of clay), collected from a depth of 0.2 to 0.3 m were used in this study. Soil chemical analysis was performed according to procedures of Raij et al. (2001), indicating pH ($CaCl_2$) = 4.9, O.M. = 12 g dm^{-3}, P (resin) = 8 mg dm^{-3}, K = 0.7, Ca = 21, Mg = 9, H + Al = 32 $mmol_c dm^{-3}$, and V = 49%.

Three months before planting, soil acidity was corrected to reach 70% of the saturation of bases which is considered ideal for guava cultivation (Santos and Quaggio 1996). The young guava plants were formed from adult plants. Vegetative plant parts, gathered from adult plants, were kept during 80 days in a nebulization chamber up to initial development of roots. At this point, young guava plantlets were submitted to a trimming procedure by which the length of the roots and of the shoot were reduced and uniformized. Following, plantlets were transplanted to black plastic pots containing 3 dm^3 of soil previously treated where guava plantlets were maintained up total root development, forming the young guava plants.

At transplanting, each pot received 70 mg dm^{-3} of N by ammonium sulfate application (20% of N), 40 mg dm^{-3} of K_2O by potassium chloride application (60% of K_2O), 5 mg dm^{-3} of Zn by zinc sulfate application (22% of Zn), and 0.5 mg dm^{-3} of B by boric acid application (17% of B). Fertilizers were thoroughly mixed with the soil. The plants were irrigated during 100 days. At 25, 40, and 60 days after transplanting, doses of 80 mg dm^{-3} of N by urea application (45% of N) and 60 mg dm^{-3} of K_2O by potassium chloride application (60% of K_2O) were side dressed to the plants.

Treatments consisted of doses of 0, 90, 180, 270, and 360 mg kg^{-1} of P applied into the soil, provided by application of triple superphosphate fertilizer (44% of P_2O_5). Treatments were arranged in a completely randomized design with four replicates.

Plant and soil samples were taken at 125 days after transplantation, when young plants were ready to be planted in the field. Young guava plants were cut at soil level and the roots were thoroughly washed in running water and in distilled water. Dry mass weight of shoot and root of guava plants were determined after drying plant materials in air convection oven at 65-70 ºC during at least 96h. P and Zn contents in shoot were also determined, and soil P concentration was also determined following procedures described by Raij et al. (2001).

Data were submitted to regression analysis by using the statistical software SigmaPlot (StatSoft, version 8.0, USA).

Results and discussion

Statistical analysis indicated that the P content in the soil increased linearly when the doses of P applied into the soil augmented (Figure 1). The angular coefficient of the equation (-0.4228) showed that applying 360 mg kg^{-1} of P resulted in an average P content of 154 mg kg^{-1}, indicating a recovery of 42% of P extracted by the resin method, corroborating results of Batista et al. (2011).

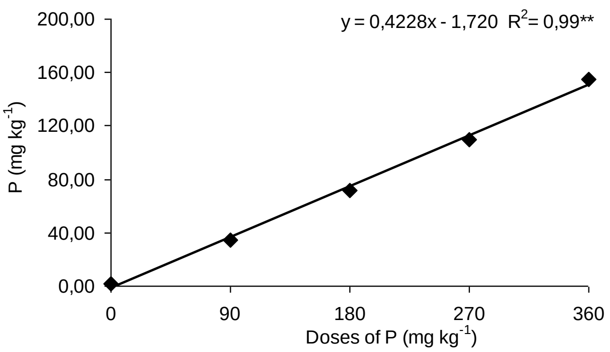

Figure 1. Content of P in the soil after applying P doses into a soil cultivated with guava plants cultivar 'Século XXI'. Jaboticabal, Brazil, 2011.

P applied into the soil provided a quadratic increment in the P content in the soil (Figure 2). In the shoot of guava young plants, a linear increment was verified (Figure 3). Similar results were reported by some authors such as Correa et al. (2003) and Batista et al. (2011).

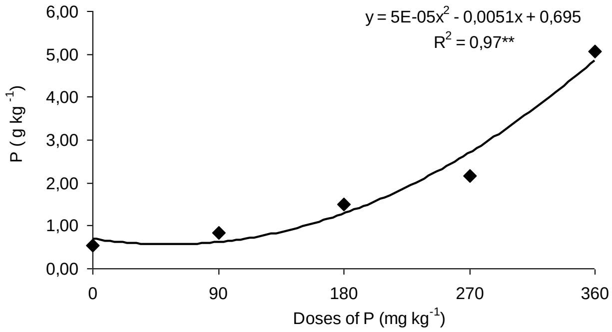

Figure 2. Content of P in the shoot tissues of guava plants cultivar 'Século XXI' cultivated in pots whose substrate had been fertilized with different P doses. Jaboticabal, Brazil, 2011.

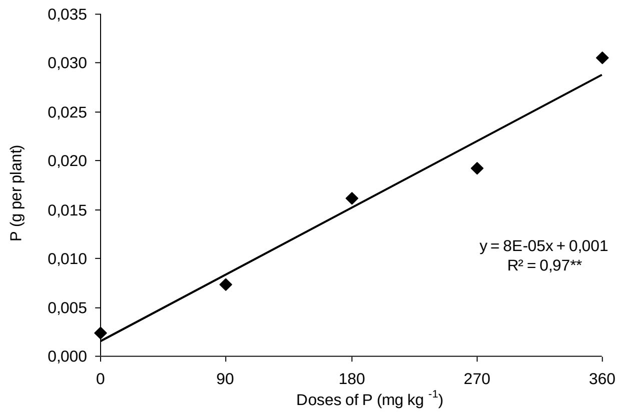

Figure 3. Accumulation of P in the shoot tissues of guava plants cultivar 'Século XXI' cultivated in pots whose substrate had been fertilized with different P doses. Jaboticabal, Brazil, 2011.

The application of P into the soil resulted in a quadratic increment of Zn in the shoot of young guava plants (Figure 4). The highest Zn level in plant tissues was by 17.5 mg kg^{-1}, being provided by the P dose of 180 mg kg^{-1}. Doses of P higher than that one resulted in decreasing levels of Zn in plant tissues, being caused due supposedly to antagonistic interactions between these two nutrients when high doses of P are applied to the soil. Doses up to 180 mg kg^{-1} of P stimulated root growth (in volume) that would increase the plant capability of absorbing nutrients from the surrounding soil (Batista et al. 2011).

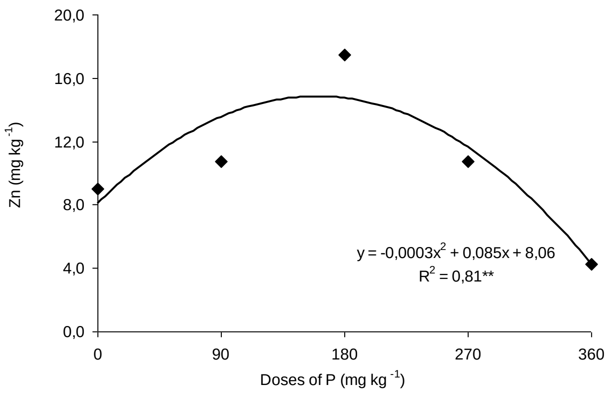

Figure 4. Content of Zn in the shoot tissues of guava plants cultivar 'Século XXI' cultivated in pots whose substrate had been fertilized with different P doses. Jaboticabal, Brazil, 2011.

Benefic effects of P provided a quadratic increment of the dry mass of shoot and root of young guava plants (Figure 5). The dry mass production by shoot and root reached a maximum value when P doses were between 155 and 211 mg kg^{-1}. Data reported by other authors showed that the highest dry mass accumulation occurred when P doses were between 200 and 244 mg dm^{-3}, for both plants resulted from sexual (Tavares et al. 1995) or asexual (Correa et al. 2003, Batista et al. 2011) methods of propagation. In addition, adequate doses of P increased the dry mass of shoot and root approximately by 2.4 and 4.0 times in comparison to the check treatment. This more pronounced effect of P on the development of roots than on the development of shoot is a well-documented event described in the literature (Marschner 1995).

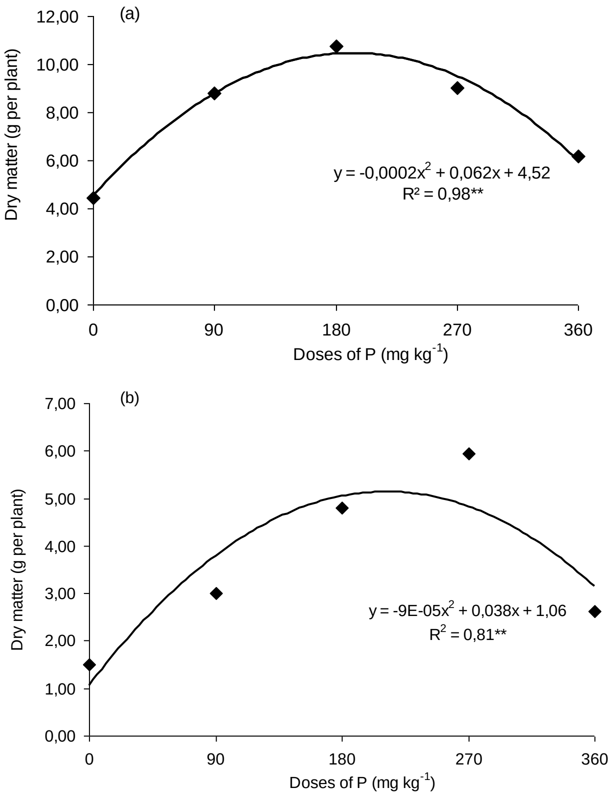

Figure 5. Dry mass accumulation in the shoot tissues (a) and root (b) of guava plants cultivar 'Século XXI' cultivated in pots whose substrate had been fertilized with different P doses. Jaboticabal, Brazil, 2011.

The highest production of dry mass by shoot and root (Figure 5) was observed to be associated with P levels in guava shoot by between 1.1 and 1.8 g kg^{-1}, respectively (Figure 2). These values are quite close to those ones reported by Prado et al. (2003) (1.6 g kg^{-1}) and Prado et al. (2002) (1.8 g kg^{-1}). Batista et al. (2011) reported values slightly higher than ones found in this research (2.3 g kg^{-1}).

We have to emphasize that high doses of P led to reductions in the dry mass weight of plants (Figure 5) caused due probably to antagonistic relations between P and Zn (Prado 2008) since Zn levels in plant tissues underwent reductions with increasingly high P doses (Figure 4). Batista et al. (2011), in guava, and Prado et al. (2005), in passion fruit, also observed the same relation between Zn and high doses of P.

Conclusions

P doses applied into soil increase P levels in both soil and plant tissues, resulting in increasing dry mass of guava plants cultivar 'Século XXI'. The highest development of young guava plants are attained when P is applied from 155 up to 210 mg kg^{-1} into soil and when P level in leaf tissues occurs from 1.1 up to 1.8 mg kg^{-1}.

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