Phosphorus nutrition in the growth of *Bauhinia forficata* L. seedlings

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ABSTRACT. One of the greatest problems in the elaboration of forestation programs using native species is the lack ofknowledge about seedling production. This study aimed to evaluate the growth *ofBauhinÚJfoif=ta* seedlings submitted to phosphorus leveis. Eleven-day-old seedlings were transplanted to small tubettes (110 crrr') with pinus bark and vermiculite substratum base. The experiment was conducted in an entirely randomized delineation, with six P treatrnents: TO-control (substratum without P addition), Tl-50, T2-100, T3-150, T4-200 and T5-250 mg drn", with five replications and 20 seedlings per replication, *Mter* 60 days, the seedlings presented a 98.2% survival rate and good root formation. The height varied in function ofP leveis, with maximum production up to the P dose of 250 mg drn "; 60 days after the transplant, similar behavior for leaf area and dry matter production was observed. Furthermore, the P incorporation increased the phosphorus (P), potassiurn (K) and nitrogen (N) accumulation in vegetable tissues. Seedling growth was positively influenced by P leveIs, and the maximum growth occurred up to the P dose of 250 mg drn". In conclusion, this characteristic showed that the species requires high leveIs ofP during initial growth, under the tubette system.

Keywords: seedling production, fertilization, P leveIs, South America native species, *Fab.2ceae,* medicinal plant.

RESUMO. Adubação fosfatada DO crescimento de mudas de *Bauhinia fotftaw* L. Um dos maiores problemas na elaboração de programas de plantios florestais, principahnente com espécies nativas é o escasso conhecimento acerca da produção de mudas. Obietivou-se avaliar o crescimento de mudas de *BauhiniajOrfimli1* a doses crescentes de fósforo (P). Mudas com 11 dias de idade foram repicadas para tubetes de 110 em" contendo substrato à base de casca de pínus e vermiculita média. O experimento foi conduzido no delineamento inteiramente casualizado com seis tratamentos: TO-testemunha, Tl-SO, 1'2-100, TI-1SO, T4-200 e TS-250 mg dm " de P. Ao fmal de 60 dias, as mudas apresentaram um percentual de *98,2"10* de sobrevivência e excelente formação radicular. A altura variou positivamente em função das concentrações de P, tanto aos 30 quanto aos *(:J)* dias, obtendo-se a máxima produção até da dose de 250 mg dm"" de P. Aos *(:J)* dias, comportamento semelhante também foi observado para área foliar e produção de matéria seca. A incorporação de P ao substrato promoveu aumento de fósforo, potássio e nitrogênio nos tecidos vegetais. As concentrações de P influenciaram positivamente a maioria das características de crescimento, sendo estimada a máxima produção até a dose de 250 mg dm" de P, demonstrando ser uma espécie muito exigente em P na fase inicial de crescimento.

Palavras-chave: produção de mudas, adubação, doses de P, espécie nativa da América do Sul. *Fabaceae,* planta medicinal.

Introduction

Bauhinia foifuata Link, Fabaeeae, is a small tree, measuring between 4 m and 10 m tall and 10 em to 20 em of diameter. It oeeurs in northeastem Argentina, southern Bolívia, eastern Paraguay, west Uruguay and Brazil, mainly in the Ombrofilus Dense Forest (Atlantie Forest) frorn 50 m to 1,000 m of altitude and 950 mm to 2,200 mm of rainfall variation. It is a eommon plant in riparian vegetation and shows preferenee for alluvial, deep, permeable, fertile soils, supporting floods (Carvalho, 2003).

As a pioneer plant of fast growth and an important seeondary vegetation eomponent, may be used in mixed plantations for arboreal vegetation recomposition. It ean be used in landseaping, even though other speeies of *Bauhinia* have been used for the same purpose, ali of them exotie. The wood ean be used in eonstruetion, boxes, earpentry, and the branches and stems are useful for firewood and charcoal (Carvalho, 2003).

Some *Bauhinia* species are medicinally used in Mrica, Asia and America, for the treatment of various diseases. Studies have indicated that *Bauhinia forficata* presents diuretic, hypoglycemic and tonic effects. Moreover, there are effects against elephantiasis and glycosuria reduction (Silva and Cechinel Filho, 2002; Menezes *et al.,* 2007; Vasconcelos *et al., 2004).* Additionally, there are antiophidic, anticoagulant and antidiabetic properties (Oliveira *et al.,* 2005; Pinheiro *et al.,* 2(06). These characteristics rnake this species an important alternative for use in the medicai field.

According to Schurnacher *et ai.* (2004) there is little inforrnation about the nutritional requirements of forest species, in particular native essences. Thus, studies that aimed to evaluate the behavior of forest species that can feature good performance and interesting characteristics for various uses are of great value (Gomes *et al., 2004).*

In regards to nutritional aspects, substratum fertilization is among the most important stages in tree species seedlings production prograrns (Neto *et al.,* 2003), and should be based on an understanding of plant nutrition (Franco and Prado, 2008). Seedlings with appropriate nutritional content present good development and root system growth, resulting in greuer zdsptuion potcmu) í1fter pumirg. lmâcqtutc fertilized substratum results in lower quality seedlings, predisposing them to diseases and, in addition, requiring more time for production.

Phosphoms is an important component of vegetable cell compounds, including phosphate-sugar and phospholipids, which are vegetables membrane compounds (Taiz and Zeiger, 2004). Moreover, it is related to the acquisition, storage and use of energy (Epstein and B1oorn, 2004). P is essential for cell division, reproduction and plant metabolism (photosynthesis, respiration and synthesis of organic substances), because it is part of the formation of organic compounds (Anghinoni and Bissani, 2004). Nutritional issues involving P availability generally limit plant growth (Epstein and Bloom, 2004).

Because of P dynamics in highly weathered soils, low P availability to plants has been highlighted as the reason for the inadequate development of the rnajority of crops in tropical region soils. In these areas, the soils present high capacity for P fixation, and its deficiency is the most important fàctor that restricts plant growth (Sánchez, 1981).

Generally, forest species present distinct growth, depending on the P concentration applied (Fernandes *et al.,* 2000). In a study conducted by Resende *et ai.* (1999), it was observed that pioneer species required more P, indicating the need to supply this element fur the adequate development of these species. However, the characteristics and quantities of phosphate fertilizers applied in the soil will depend on: the needs and characteristics of the species, soil availability (adsorption and fixation power), reaction form and efficiency of these fertilizers, in addition to economic fàctors and operational aspects (Nachtigal *et al., 1994;* Schurnacheretal.,2004).

There are papers that relate the P influence on the initial growth of forest species seedlings (Schumacher *et al.,* 2004; Gomes *et al.,* 2004; Melo *et al.,* 2005; Nicoloso *et al.,* 1999; Nicoloso *et al., 2001;* Koul *et al.,* 1995; Ramos *et al., 2000).*

Ramos *et alo* (2000), while testing nitrogen (N), phosphoms (P) and potassium (K) applications in the growth of *Bauhi.nia forftmta* seedlings, observed a positive *etTect* of P to ali evaluated features. In the initial fertilization, P was the nutrient that showed greatest response, followed by N and K. Koul *et alo* (1995) observed significant influence of P concentrations on biornass production, height, number ofleaves and nodes of *Bauhinia variegata* seedlings.

Nachtigal *et alo* (1994) while studying the initial growth of *Feijoa seJlowiana* Berg., verified that P presented significant influence on ali variables considered. Corrêa *et ai.* (2003) demonstrated in *Psidium gul!Java* seedlings, that the increase in P doses resulted in positive response to dry rnatter production of roots and shoots.

Generally, pioneer species present more restricted initial growth potential under poor soil conditions, showing response to fertilization. On the other hand, with the successive advancements, the growth stimulus provided by fertilization is less pronounced and sometimes absent (Resende *et al., 1999).*

There are few studies that report the *Bauhinia forficata* seedlings production in srnall size plastic tubes related to P fertilization. Based on the exposed accounts, this study aimed to research the initial growth of *Bauhi.nia foifuata* submitted to increasing doses of phosphate fertilization.

Material and methods

The e:xperiment was conducted from November 2006 to Febmary 2007 (summer), in the Plant Propagation Laboratory of Embrapa Florestas, located in Colombo, State of Paraná, Brazil (25"20' S and 49°14' W, 950 m). According to the Kõppen classification, the climate is classified as Cfb, in which the coldest month presents temperatures between -3 and 1SOC, always damp, there is rain in every single month of the year and the hottest month presents temperatures lower than 22"C, but at least 4 months with temperature higher than 10"C.

In 2006, the seedlings were obtained frorn seeds collected in Nova Prata do Iguaçu, Paraná state, Brazil. Mter seed selection and standardization, through the removal of those attacked by insects or ill-formed, a dormancy breach was conducted with a cut in the coat next to aril region. Then, they were sowed 1 em deep in boxes containing vermiculite medium as a substrate, in 2,500 seeds m-z of density. The substrate humidity was monitored daily until germination (10 days after seeding).

At 21 days after seeding, 20 seedlings were randomly sampled to characterize the initial growth. The sampled seedlings were put in a ventilated oven at 60°C until reaching constant weight. Then, the leaves, stem, root, shoot and total dry matter were determinated (Table 1).

Table 1. Morphological characteristics of *Bauhinia foftcafa* seedlings, 21 days afier seeding.

H" , eíght (em seedling')	Steam Diarneter' (mm seedli!1!{')	Main Root Length' (em seedling")	Dry Matt"" Shoot	Root	Total
			(mg seedli!1!f')		
4.3 ± 0A	23 ± 0.2	8.1 ± 0.4	70.4 ± 8.7	9.0 ± 2.1	79.4 ± 9.0

'Data given as: mean ± srandard deviation.

At the same period, the seedlings that presented uniformity as to height, stem basal diameter, with a pair of cotyledons and no damage root system, were transplanted to small-size plastic tubes. During the transplanted process, the main root basal portion was removed with a straight cut, 7 cm average length.

The selected seedlings were transferred to 110 crrr' small-size plastic tubes, with pinus bark and vermiculite-like substratum base (Plantmax®).

Increasing and equidistant P doses were applied, supplied by single super phosphate (SSP) (20% PzOs), whose treatments were: Tü-control (substratum without P addition), Ti-50, TI-100, TI-ISO, T4-200 and T5-2S0 mg dm" of P, respectively. The SSP was incorporated in the substratum before seedling transference. Sodium sulfate ($NaS0_4$) was utilized for the sulfur leveibalancing.

After seedling transference, they were put in metal bars and submitted to the same environmental conditions in a glass greenhouse. Water was supplied daily, to minimize nutrient loss by leaching. Thirty days after replanting, the seedlings were spaced to avoid competition. At the same period, the biometric characteristics total height (H) (stem base to the apical buds), stem diameter (SO) (1 cm to the stem base height), number of nodes and leaves were measured. They were then transferred to an outdoor condition area for the hardening and growth processo

The final evaluation was conducted at 60 days; it measured height; SO; number of nodes and leaves; leaf area (LA) (two leaves next to the terminal bud); heightldiameter ratio (HO); leaves (LOM), stem (SDM), root (RDM), shoot (SHDM) and total (fDM) dry matter; root system totallength (RSTL); root volume (V); and visual analyses of the root formation. RSTL and V were measured using WinRHIZO Software. Dry matter was determined at 60°C, until constant weigh.

Eight plants were randomly selected for N, P and K content determination of the root (R), stem (S), leaves (L), shoot (SH) and total (T) per seedling. The analytic method utilized in laboratory for N determination was designed by ~eIdahl with sulfuric digestion. To measure P and K, nitro-perchloric digestion was utilized; after that, they were determined by colorimetry and photometric flame, respectiveIy, per wetmethod.

The experiment was conducted under a completely randomized design, with six treatments (P doses) and five replications, containing twenty seedlings per replication. The dates were submitted to the Bartlett and Lillieforstests ($p < 0.05$) for variance homogeneity and normality verification, respectively. After that, they were submitted to variance analyses and polynomial regression ($p < 0.05$).

Results and discussion

After the transplant and treatment application, the seedlings presented a high survival percentage. At the end of the experiment (60 days after the transplant), they presented *98.~1o* survival rate, regardless of the P dose applied, indicating the viability of the transplant system and fertilization utilized.

Both 30 and 60 days after seedling transplant, the height variable presented quadratic behavior. At 60 days, the higher P dose (250 mg dm") was an estimated 22 cm of medium value, resulting in an increase of 70.7% in relation to the control (without P) (Figure IA).

The leaf area (LA) varied with P concentrations presented positive quadratic behavior according to regression analysis. The highest IA value was obtained in the P dose of 250 mg dm", 60 days after the transplant (Figure lB).

Ramos *et alo* (2000), under another experimental condition, observed the same standard behavior for the ratio between P doses and *Bauhinia jórjUata* seedlings height. The 90% of the maximum height was estimated below 173.31 mg dm" and 75 mg drn? of P and N concentrations, respectively, which resulted in 24.35 em of seedling height. On the other hand, this value was estimated at 105 days for sealed recipients, with substratum (dystrophic Dark Red Latosol) volume per seedling around 16 times greater (1.8 drrr' seedling") than that utilized in this experiment (110 crrr' seedling").

Nicoloso *et ai.* (2001), while studying the *Apaleia leiocarpa* the mineral nutrition of seedlings, observed that from 60 to 120 days after seedling emergence, P fertilization increased Iinearly to seedling height, in conditions of N and K absence. At 140 days, the effect was quadratic with the maximum response point above the highest P concentration applied (80 mg kg"), in Arenic Paleudalf Soi!. Schumacher *et alo* (2004) observed that 450 mg leg-I ofP concentration presented the highest medium values for *Parapiptadenia rígida* seedling height in Red Yellow Argisol.

4.80 nodes per seedling, 30 days after the transplant. Therefore, 60 days after the transplant, observed medi um value was 6.2 leaves and 6.6 nodes per seedli ng.

The steam diameter (SD) varied with P concentrations presented positive quadratic behavior according to the regression analysis. The highest SD value was obtained in the P dose of250 mg dm", 60 days afier the transplant (Figure 2A). Similar response was observed for height/diameter ratio (HD). The HD, at 60 days after transplanting, presented positive quadratic behavior in function of the treatments. The greatest HD estimated value occurred in P dose of250 mg dm? (Figure 2B).

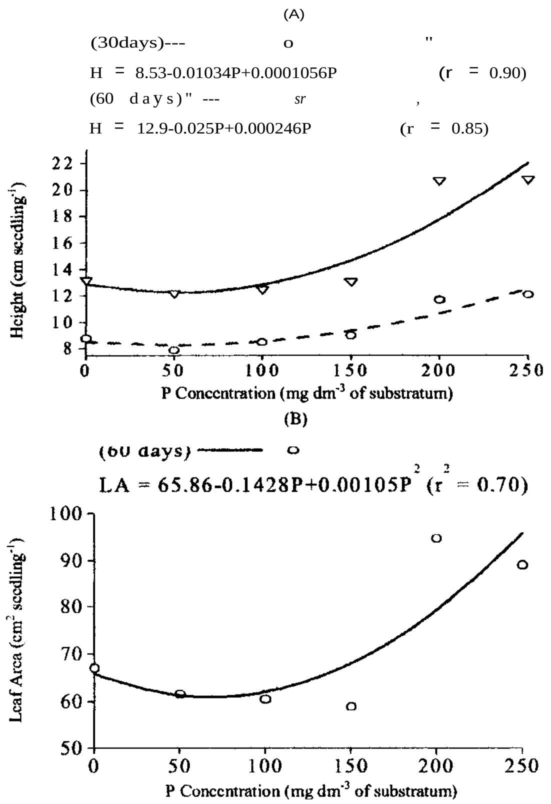

Figure 1. *BauhinitJ fo rficata* seedlings (A) total height (H), 30 and 60 days after transplant and (B) leaf area (lA), 60 days after transplant in function ofP concentrations. *Datas transformed by G" Vlo (p < 0.05).

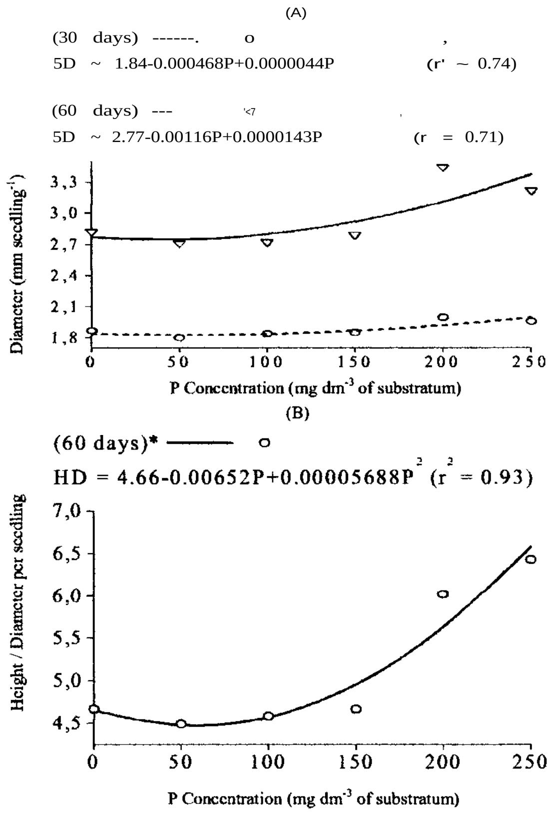

Figure 2. *BauhiniaforflLi1ta* seedlings (A) stem diameter (SD), 30 and 60 days after transplant and (B) height/diameter relation (HD), 60 days after transplant in function of P concentrations. *Datas transformed by G" Vlo (p < 0.05).

Nicoloso *et al.* (1999) observed that P omission was the most limiting factor for leaf production in *Apuleia leiocarpa* seedlings. This behavior was not observed in this study, where estimates of leaf and nodenumber did not vary in function of P concentrations, regardless of evaluation time. The seedlings presented medium value of3.971eaves and

Koul *et al.* (1995) observed a *B. variegata* diameter increase with the raise of the P concentrations. Ramos *et ai.* (2000), studying *B. forfrcata,* observed similar response, where the base stem increased was greater with the raise of the P concentration, and the P dose of 308.33 mg drn" resulted in maximum production (4.5 mm of SD) at 105 days afier the seeding. For *Parapiptadenia rigida,* Schumacher *et alo* (2004) observed that 360 mg kg" P concentration resulted in higher diameter and biomass values. Despite the considerable P leveIs in the substrate, the species responded positively to P fertilization.

RSTL and V did not vary with increase of P concentrations at 60 days afier the seedling transplant. RSTL and V medium values were estimated at 414.15 em and 5.09 em", respectively. This result has occurred probably because the spaçe limitations imposed by the recipient during the evaluating period. In general, the P concentration on the substratum positively influenced seedling growth (Figure 3).

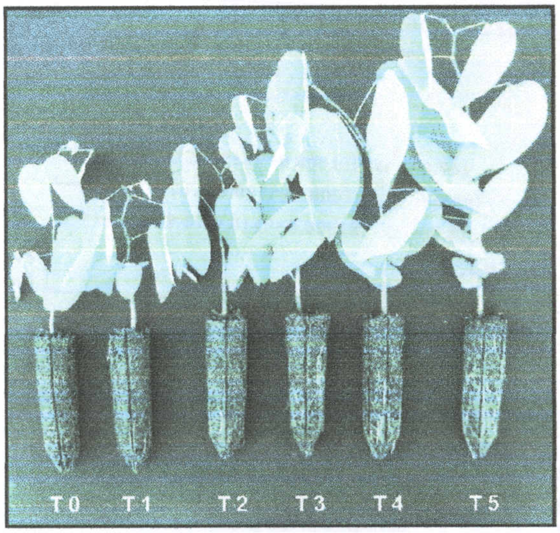

Figure 3. Visual aspect of *Bauhinia forfllata* seedlings in function of phosphorus (P) treatments, (JJ days after the transplanto TO-control (substratum without P addition), TI-50, 1'2-100, TI-ISO, T4-200 and T5-2S0 mg dm" of P. (Source: Plant Propagation Laboratory - Embrapa Florestas).

Ramos *et ai.* (2000) verified in *B. fOtjicata,* among the variables studied, the leaves, shoot, root and total dry matter production per plant were higher with the increase ofP concentrations in substrate. This stimulus was also observed in the present study, where the root, stem, leaves, shoot, and total dry matter production per piam varied with P concentrations, at 60 days after seedling transplant. AII dry matter characteristics presented maximum production behavior on P dose of 250 rng drn? (Figure 4).

Koul *et ai.* (1995) also observed an increase in the leaves, root and total biomass production, with P application in *B. variegata* seedlings. Nicoloso *et ai.* (2001) observed that *Apluleía leiocarpa* demands much P in its initial growth, and the maximum dry matter production of this species was estimated above 80 mg kg".

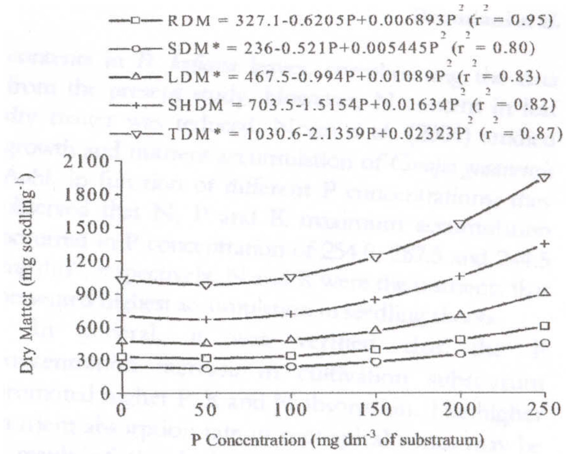

Figure 4. Root (RDM), stem (SDM), leaves (LDM), shoot (SHDM) and total (TDM) dry rnatter of *Ba..mnia fOrfllOta* seedlings, 60 days afier transplant in function ofP concentrations. *Datas transforrned by ~ Viõ (p < 0.05).

Gomes *et al.* (2004) observed that *Anadenantheta colubrina,* either Fabaceae, presented positive response to the P application. In this study, P concentrations of 127 and 126 mg drn? promoted 90% shoot dry matter maximum production, under 40 and 60% base saturation eonditions, respeetively.

Sixty days afier the transplant, the P content on *B. jorficata* tissues was increased with the raise of P concentration in the substratum. P accumulation presented positive quadratic behavior in root system, leaves, shoot and total per seedling. Positive linear accumulation response was observed only for the stern. Analyzing P total accumulation in the plant, there was an increase in P of 40% in the concentration of 250 mg dm? in relation to the control (Figure 5A).

K content in the root and stem tissues did not vary in function of the P treatments. They presented 19.04 and 12.11 g kg" ofK content medium value, respectively. On the other hand, a positive quadratic effect was observed for K content in leaves, shoot and total tissues per plant (Figure SB).

Similar response was observed for N, in root and stem tissues. Its contents did not vary significantly and presented medium value of 13.21 e 10.54 g kg", respectively.

Leaves, shoots and total tissues presented positive quadratic behavior for N contents, i.e., where the P concentration in the substratum was higher, the N accumulation in the seedling tissues was increased (Figure SC). K (Figure SB) and N (Figure SC) content did not vary in root and stem tis sues, consequently the regression analysis did not adjust equation for them.

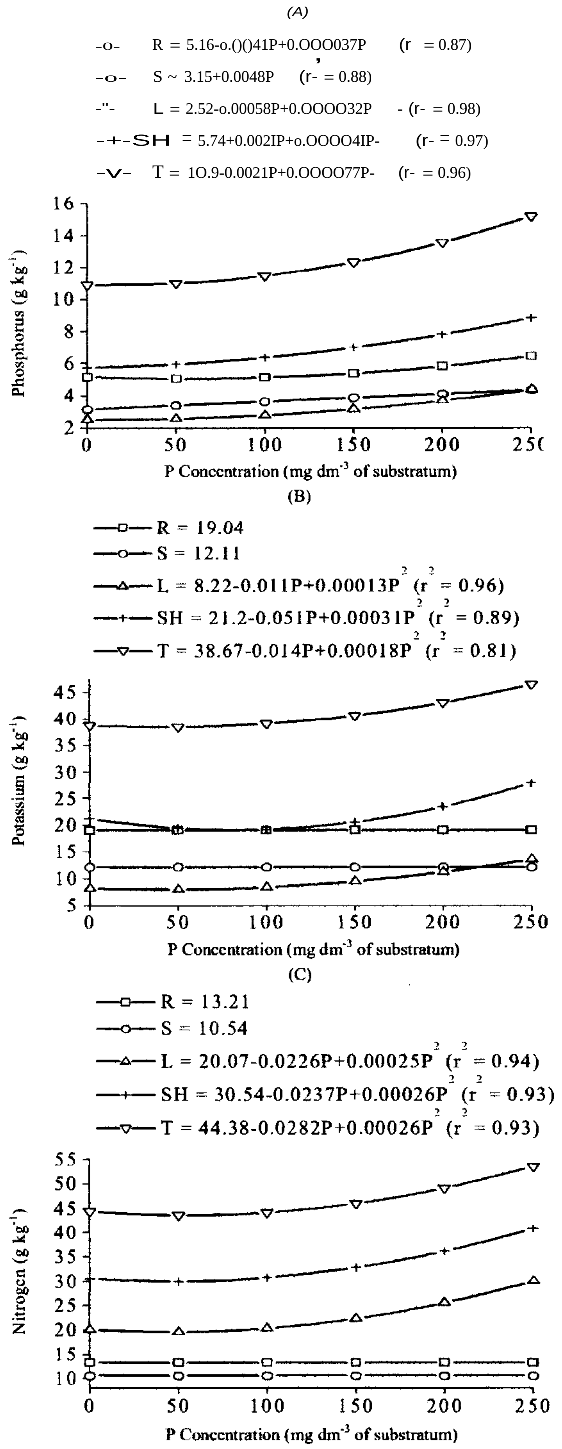

Figure 5. Nutritional content values of (A) phosphorus, (B) potassium and (C) nitrogen in the root (R), stem (S), leaves (L), shoot (SH) and total (1) dry matter of *Bauhinid forflCata* seedlings, 60 days after lhe transplant in function of lhe P concentrations.

In a study conducted by Ramos *et al.* (2000), it was verified that increased P doses promoted increased P contents in *B. fürfieata* leaves, corroborating rhe data from the present study. However, N content in leaf dry matter was reduced. Neves *et al.* (2004) studied growth and nutrient accumulation of *Carapa guianensis* Aubl. in function of different P concentrations; they observed that N, P and K rnaximum accumulation occurred in P concentration of254.0, 287.5 and 244.5 mg drn", respectively.N and K were the nutrients that presented highest accumulation in seedling shoots.

In general, it was verified that the P concentration increase in cultivation substratum promoted higher P, K and N absorption. The higher nutrient absorption rate in root apical zones may be a result of the high nutrient availability in the substratum (Taiz and Zeiger, 2004; Anghinoni and Bissani, 2004). Purthermore, the fact of P is involved in energy metabolism processes influences root growth and development and nutrient active absorption processes (Epstein and Bloom, 2004; Taiz and Zeiger, 2004), which may have influenced the higher efficiency of nutrient absorption.

The root surtãce increase is a determinant tãctor for nutrient absorption, especially in the cases of K and P, which undergo uptake by ditfusion mechanisms. It only occurs in response to a gradient, which results of the K and P concentrations ditferences between root surface and rhizosphere. This absorption mechanism needs for the nutrient to stay in contact with the root surface (Meurer, 2006). The synergistic interaction between P and N may have influenced the increase in N absorption, and because of this interaction, when both nutrients are in adequate concentrations, they promoted increases in vegetal production (Epstein and Bloom, 2004).

Comparing the data of this study with that in literature related to the species characteristics in function ofP fertilization, *B.foifu:ata* presented high exigency in P during the initial growth and, the utilization of seedling production system in srnall-size plastic tubes to this species presented promising results.

Condusion

In relation to growth, *Bauhinia forfu:ata* presented positive response for P concentration increase in the substratum, which showed that it requires this element in its initial growth.

The etfects in seedling growth was positive until the P dose of 250 mg drn? and, the P addition at substratum contributed to P, K and N accumulation in the majority of the tissues.

Acknowledgments

The authors wish to thank the Federal U niversity of Paraná (UFPR), CNPq and Embrapa Florestas-CNPF for ali the support given.

References

ANGHINONI, L; BISSANI, C.S: Fósforo e adubos fosfatados. *In:* BISSANI, e.A. *et aI.* (Ed.). *Fertilidade dos solos e manejo de adubaçôo de culturas.* v. 1. Porto Alegre: Gênesis, 2004. p. 117-137.

CARVALHO, P.ER *Espécies arb6reas brasileiras.* v. 1. Brasília: Embrapa Informação Tecnológica, 2003.

CORRÊA, M.e.M. *et aI.* Respostas de mudas de goiabeira a doses e modos de aplicação de fertilizante fosfatado. *&V. Bras. Fruticult.,Jaboticabal,* v. 25, n. 1, p. 164-169,2003.

EPSTEIN, E; BLOOM, A. *Nutrição mineral de plantas:* princípios e perspectivas. Londrina: Planta, 2004.

FRANCO, C.r.. PRAIX>, RM. Nutrição de micronutrientes em mudas de goiabeira em resposta ao uso de soluções nutritivas. *Acta Sei. Agron.,* Maringá, v. 30, n. 3, p. 403-408, 2008.

FERNANDES, L.A. *et alo* Crescimento inicial, níveis críticos de fósforo e frações fosfatadas em espécies florestais. *Pesq. Agropecu. Bras.,* Brasília, v. 35, n. 6, p. 1191-1198,2000.

GOMES, Ke.O. *et aI.* Influência da saturação por bases e do fósforo no crescimento de mudas de angico-branco. *Reu. Arvore,* Viçosa, v. 28, n. 6, p. 785-792, 2004.

KOUL, V.K *et alo* Effect of N and P application on nutrient uptake and biomass production in *Bauhinia variegata* Linn. seedlings. *lndian For.,* Dehradun, v. 121, n. 1, p. 14-22,1995.

MELO, A.S. *et alo* Desenvolvimento de porta-enxertos de umbuzeiro em resposta à adubação com nitrogênio e fósforo. *Cienc. Rural,* Santa Maria, v. 35, n. 2, p. 324-331, 2005.

MENEZES, F.S. *et aI.* Hypoglycemic activity of two Brazilian *Bauhinia* species: *Bauhinia jóifu:ata* L. and *Bauhinia monandra* Kurz. *Reu. Bras. Farmocognosia,* Curitiba, v. 17, n. 1, p. 08-13, 2007.

MEURER, E.J. Potássio. *In:* FERNANDES, M.S. (Ed.). *Nutrição mineral de plantas.* Viçosa: Sociedade Brasileira de Ciência do Solo, 2006. p. 281-298.

NACHTIGAL, j.C, *et alo* Efeito do fósforo no desenvolvimento inicial de mudas de goiabeira serrana. *Sei. Agric.,* Piracicaba, v. 51, n. 2, p. 279-283, 1994.

NETO, S.P.M. *et alo* Produção de mudas de espécies arbóreas nativas com combinações de adubos de liberação controlada e prontamente solúveis. *Reo. Arvore,* Viçosa, v. 27,n. 6,p. 779-789,2003.

NEVES, O.S.e. *et al.* Crescimento, produção de matéria seca e acúmulo de N, P, K, Ca, Mg e S na parte aérea de mudas de andiroba *(Carapaguianensis* Aubl.) cultivadas em solo de várzea, em função de diferentes doses de fósforo. *&v. Arvore,* Viçosa, v. 28, n. 3, p. 343-349, 2004.

NICOLOSO, F.T. *et aI.* Exigências nutricionais da grápia *(Apuleia leiocarpa* Vogo Macbride) em solo Podz6lico Vermelho amarelo. *Cienc. Rural,* Santa Maria, v. 29, n. 2, p. 225-231, 1999.

NICOLOSO, F.T. *et alo* Nutrição mineral de mudas de grápia *(Apuleía leiomrpa)* em Argissolo Vermelho Distr6fico arênico: (1) efeito da adubação NPK no crescimento. *Cienc. Rural,* Santa Maria, v. 31, n. 6, p. 1-08,2001.

OLIVEIRA, e.Z. *et alo*Anticoagulant and antifibrinogenolytic properties of lhe aqueous extract from *Bauhinia jóifu:ata* against snake venoms.J. *EthtwpharmaaJI.,* Amsterdam, v. 98, n. 1-2, p. 213-216,2005.

PINHEIRO, T.S.D.E. *et ai.* Comparative assessment of kaempferitrin from medicinal extracts of *Bauhinia jórfit:ata* Link. *J. Pharm. Biomeâ. Anal.,* Amsterdam, v. 41, n. 2, p. 431-436, 2006.

RAMOS, M.Re. *et ai.* Influência da aplicação de nitrogênio, f6sforo e potássio no crescimento e composição mineral de mudas de pata-de-vaca *(Bauhinia jóifu:ata* Link). *Rev. Bras. PI. Med.,* Botucatu, v. 3, n. 1, p. 79-86, 2000.

RESENDE, A.V. *et alo* Crescimento inicial de espécies florestais de diferentes grupos sucessionais em resposta a doses de f6sforo. *Pesq. Agropecu. Bras.,* Brasília, v. 34, n. 11, p. 2071-2081, 1999.

SANCHEZ, P.A. *Suelos dei trôpico:* características y manejo. San josé: nCA, 1981.

SCHUMACHER, M.V. *et alo* Influência de diferentes doses de fósforo no crescimento de mudas de angico-vermelho *(Parapíptadenia rígida* (Bentham) Brenan). *Rev. Arvore,* Viçosa, v. 28, n. 1, p. 149-155,2004.

SILVA, KL.; CECHINEL FILHO, V. Plantas do gênero *Bauhinia:* composição química e potencial farmacol6gico. *Quim. Nova,* São Paulo, v. 25, n. 3, p. 449-454, 2002.

TAIZ, L.; ZEIGER E *Fisiologia vegetal.* 3. ed. Porto Alegre: Artmed, 2004.

VASCONCELOS, F. *et alo* Insulin-like effects of *Bauhinia jóifu:ata* aqueous extract upon *Tityus serrulatus* scorpion envenoming.J. *Ethnopharmacol.,* Amsterdam, v. 95, n. 2-3, p. 385-392, 2004.

Receioed onJanuary 30, 2008.
Accepted onJune 02, 2008.