

# Pine seedlings development under sources and rates of phosphate fertilization

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## Abstract

Phosphorus is an essential element for plant growth, the evaluation of seedling development and the possible phosphate solubilization by the root system, are important ways to evaluate the behavior of this nutrient in soil. The present work aimed to evaluate the growth of pine seedlings, as a function of soluble and slowly soluble phosphate fertilization. Pine seedlings were cultivated in plastic bags with 2 kg of substrate, which was composed of 50% of a clayey soil from subsurface horizon of a Ferralsol, and 50% sand, both mixed uniformly. Treatments were constituted of natural phosphate (NP), soluble phosphate (SPS) and a commercial fertilizer of slow solubility (Basacote<sup>®</sup>), both were applied as half, full and twice the recommended rate for that species. Fertilization with the slow solubility fertilizer Basacote have promoted better seedling growth, resulting in higher stem diameter and plant height after 240 days after germination. However, other morphologic parameters are important to be considered to produce vigorous seedlings with good nutritional conditions for future field adaptation and development.

## Key Words

*Pinus elliottii*, soluble phosphorus, natural phosphate, basacote.

## Introduction

One of the main factors that changes plant growth is nutrient availability, mostly, in Brazilian soils, phosphorus (P) availability (Novais and Smyth 1999). Despite the popular knowledge that *Pinus* species cultivated in Brazil have low response to nutritional demands, research has demonstrated that when these plants are cultivated in low fertility soils, their growth is significantly smaller than in high fertility soils, although not presenting any nutritional deficiency symptom. In pine seedlings production, an important factor is the beginning growth, because it is going to interfere in pine development in the field after transplantation. In this way, the use of a nutritional calibrated substrate will contribute to a good seedling development; will result in adequate plant set and initial growth in the field, besides promoting plant resistance to pests and diseases. Phosphorus is an essential element for plant growth, being a component of structural cells, nucleic acids and cell membrane phospholipids, also as metabolic component of energy storage, like ATP. The absorption of P by plants is dependent of the substrate composition and of the solubilization index of it to soil solution (Tisdale *et al.* 1985), which can be changed by the source and way to apply the fertilizers.

Many soil microorganisms, including fungi and bacteria, have the capacity to solubilize phosphates though different ways, especially by organic acids production. These organic acids can compete for soil P with soil adsorption sites, maintaining free P in solution (Guppy *et al.* 2005). The species *Pinus elliottii*, similar to other *Pinus*, has the capacity to create colonies of mycorrhizae fungi in their root system, these colonies contribute to a better soil volume exploitation by the root system and, possibly, solubilize and absorb more P from the soil (Vilela 2006). Sources of phosphate fertilizers of different solubility are normally used in forest areas, at nursery or in the field. Thereby, information about seedling development and solubilization of phosphate and other nutrients by root systems are missing from literature, and are important ways to understand the behavior of the nutrients in the field. Hence, the present work aimed to evaluate the growth of pine seedlings, as functions of rates and sources of phosphate fertilization.

## Material and methods

The experiment, with *Pinus elliottii* seedlings production, was carried at Forestry nursery of Technological Federal University of Paraná, Dois Vizinhos, PR, Brazil, located at latitude 25°42'S, longitude 53°08'W and altitude of about 561 m. Experiment was conducted in the year of 2009, with germination on January 20, 2009. Pine seedlings were cultivated in plastic bags with 2 kg of substrate, which was composed of 50% of clay soil from subsurface horizon of a Ferralsol (WRB-FAO 1998), and 50% sand, mixed uniformly. Experimental design was completely randomized, with plots composed of seven pine seedlings, distributed in a bed of 10 x 1 m, with four replicates. A 50% net shade was used to protect the seedlings against solar

incidence in the beginning phase. Irrigation was made manually everyday. Treatments constituted natural phosphate (NP), soluble phosphate (SPS) and a commercial fertilizer of slow solubility (Basacote®), both applied as half, full and twice the recommended rate by that species, and one witness (control) without P fertilizer. The available nutrients composition of Basacote was 13% of N, 6% of P<sub>2</sub>O<sub>5</sub> and 16% of K<sub>2</sub>O. Natural phosphate (9% of P<sub>2</sub>O<sub>5</sub>) and soluble phosphate (18% of P<sub>2</sub>O<sub>5</sub>) were applied in the quantities of P similar to Basacote treatments. Rates of nitrogen and potassium for the witness treatments, NP and SPS were calculated considering the full rate of Basacote (0.78 kg/m<sup>3</sup> of N as urea and 0.96 kg/m<sup>3</sup> of K<sub>2</sub>O as potassium chloride). Total amount of fertilizer in each treatment is described in Table 1.

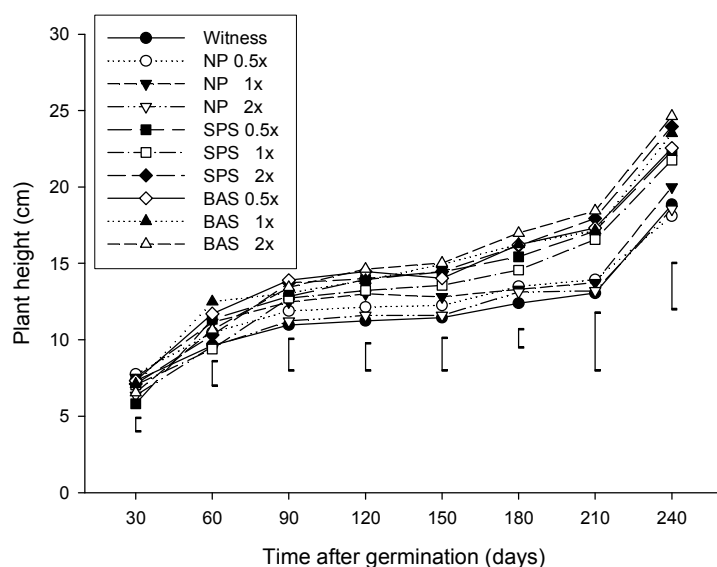
**Table 1. Amount of fertilizer applied in the moment of substrates preparation before pine sowing. UTFPR, Dois Vizinhas, PR, Brazil.**

Treatment	Description	Treatment	Description
Witness	No P fertilization	SPS 1x	2.12 kg/m <sup>3</sup> Super Phosphate Simple
NP 0.5x	2.0 kg/m <sup>3</sup> of natural phosphate	SPS 2x	4.24 kg/m <sup>3</sup> Super Phosphate Simple
NP 1x	4.0 kg/m <sup>3</sup> of natural phosphate	BAS 0.5x	3.0 kg/m <sup>3</sup> of Basacote
NP 2x	6.0 kg/m <sup>3</sup> of natural phosphate	BAS 1x	6.0 kg/m <sup>3</sup> of Basacote
SPS 0.5x	1.06 kg/m <sup>3</sup> Super Phosphate Simple	BAS 2x	12.0 kg/m <sup>3</sup> of Basacote

Morphological parameters evaluated, like stem diameter and plant height, were measured each 30 days after germination (DAG), until 240 days. Evaluation of plant dry mass production and nutrient concentration in tissue were determined at 150 DAG in half of plants of each plot. This is the time when plant seedlings normally are transplanted to the field. Soil P availability was measured at 150 DAG, also. These data are not presented, but will be part of the presentation at the congress. The data were submitted to ANOVA analysis and significant means were compared by t test (LSD) at 5%, by the program SAS 8.2 (SAS Institute 2001).

## Results and discussion

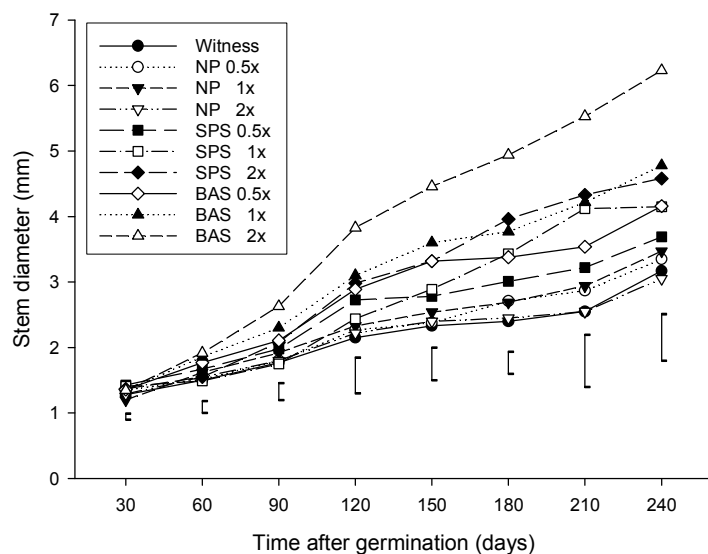
The results of plant height from germination to 240 days are presented in Figure 1. Evaluating for field conditions, it seems that slow solubility fertilizer has promoted better plant growth. The data in the Figure 1 indicate this, as plant height was higher for the treatments with Basacote. Soluble phosphate presented plant height a little bit lower than Basacote, but higher than witness. Statistically, Basacote and soluble phosphate promoted higher plant height 60 DAG, irrespective the rate used of these products. Natural phosphate promoted the worst results, showing plant P deficiency symptoms and lower growth than other treatments, being similar statistically to the witness.



**Figure 1. Pine seedling height, to 240 days after germination, for different rates and sources of phosphate fertilizers. UTFPR, Dois Vizinhas, PR, Brazil.**

Stem diameter showed better development 60 DAG, being higher for Basacote and soluble phosphate treatments, increasing stem diameter as the rate increased (Figure 2). Development obtained by twice the recommended rate of Basacote (BAS 2x) increased substantially stem diameter 60 DAG when compared to

other treatments, in the field, the seedlings were more vigorous and stronger than for other treatments. Possibly, the use of slow solubility fertilizers, like Basacote, has promoted better development because nutrient solubilization occurs gradually, supplying plant demands exactly at the time it is necessary, promoting in this way, vigorous plant seedlings. Natural phosphate and witness presented similar results, as already observed for plant height.



**Figure 2. Stem diameter of pine plants, 240 days after germination, for different rates and sources of phosphate fertilizers. UTFPR, Dois Vizinhos, PR, Brazil.**

## Conclusion

Fertilization with slow solubility fertilizers, like Basacote, promoted better seedling growth, resulting in vigorous plants, with higher stem diameter and plant height after 240 days after germination. However, other morphologic parameters should be considered to produce seedlings with good nutritional conditions for future field adaptation and development.

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