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Tree growth and soil response to P fertilization in a 24-year-old tropical forest on an Oxisol

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Mature, humid, lowland tropical forests are generally considered to be P limited and to cycle P efficiently. Whether this P limitation extends to younger secondary tropical forests that are re-growing on a large portion of the lowland tropics, however, remains uncertain. As such, there is a knowledge gap between expectations of P limitation and direct observations of such limitations. The objective of the current study was to fill this gap by fertilizing a natural secondary tropical forest that was 24-years-old. In February 1999 six 20x20 m plots were randomly established in the secondary forest area of Fazenda Vitoria Ranch in Paragominas. After one year of pre-treatment tree measurement, 50 kg ha⁻¹ of phosphorus as simple super-phosphate was supplied in January 2000 and 2001. Measurements over the following six years (age 25 to 31) demonstrated no increased tree growth. Over the seven years of measurements (age 24 to 31) rates of biomass accumulation average 3.9±1.3 kg ha⁻¹ yr⁻¹. Most sequential P fractions (Resin, HCO₃-Pi, NaOH-Pi, NaOH-Po, and 1M HCl) demonstrated significant increases shortly after fertilization and could account for nearly all the 50 kg ha⁻¹ of added P at each date. By January 2002, concentrations of P were declining in all pools other than Resin P and by June 2006 concentrations had returned to initial levels. Interestingly, during this same period, P concentrations in all pools of the control plots declined. P fixation capacity in the surface 0-20 cm layer is relatively low (~120 ug g⁻¹) while fixation increases to ~180 ug g⁻¹ at 20-50 cm and approaches ~500 ug g⁻¹ for all layers below 50 cm. This fertilization trial clearly demonstrated no growth limitation from low soil P within this secondary forest.

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