

Effects of plantation forest species on soil properties



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Rationale and Objectives

- The overall productivity and stability of natural and managed ecosystems are commonly determined by the amounts and forms of phosphorus (P) in the soil.
- Land-use change such as reforestation-afforestation of long-established grazed grassland environments has been shown have a dramatic impact on the quantity, distribution, dynamics and bioavailability of P in the soil.
- Little is known about the timeframe of changes in soil P following forest establishment on grassland or the effect of different tree species.
- The objective of this study was to investigate and quantify the effects of three contrasting tree species (cypress, eucalypt, pine) on soil P biogeochemistry over a 10 year period following tree planting into temperate semi-permanent grazed pasture in New Zealand.



Materials and Methods

- A large-scale replicated field trial was established in 1999 at Orton Bradley Park on Banks Peninsula, New Zealand to investigate the effects of afforestation of grassland with three different tree species (*Cupressus macrocarpa*, *Eucalyptus nitens*, *Pinus radiata*) on soil properties and processes over time.
- Samples of mineral topsoil (0-5cm) were taken from 5 sites randomly located midway between tree rows in the middle of each replicate plot in September 1999 (at trial establishment), September 2004 (5 years after planting) and November 2009 (10 years after planting).
- Various forms of inorganic and organic P were determined using sequential extraction of soil with 1M NaCl, 0.5M NaHCO₃, 0.1M NaOH (NaOH I), 1M HCl and 0.1M NaOH (NaOH II).

2004



2009



Results

Mean concentrations of inorganic P (Pi) and organic P (Po) determined in different sequential fractions in topsoil (0-5 cm) sampled under three tree species in 1999, 2004 and 2009.

	NaCl		NaHCO ₃		NaOH I		HCl	NaOH II		Total
	Pi	Po	Pi	Po	Pi	Po	Pi	Pi	Po	
1999	2.2	13.6	26.4	86.7	105.8	221.5	46.5	29.4	37.5	568
2004	2.3	16.5	39.1	94.1	123.2	163.4	43.6	25.1	36.6	544
2009	1.0	6.5	26.0	58.3	106.5	159.8	34.8	40.2	41.0	474

Data in red indicates that means for P concentration were significantly different ($P < 0.05$) compared with the other years.

- Changes in soil P with time were similar to all three tree species.
- Total extractable soil P decreased by 16% from 568 $\mu\text{g g}^{-1}$ in 1999 to 474 $\mu\text{g g}^{-1}$ in 2009.
- Significant decreases in NaCl, NaHCO₃ and NaOH-I extractable organic P pools occurred between 1999 and 2009.

Conclusions

Significant depletion of topsoil P over 10 years following establishment of plantation forest on grassland was mainly attributed to enhanced mineralisation of readily extractable organic P due to a combination of factors including decomposition of pasture residues, tree uptake, and the actions of mycorrhizal fungi associated with tree roots.

