RHIZOSPHERE PROCESSES INFLUENCING SOIL AND FERTILISER PHOSPHORUS AVAILABILITY TO *PINUS RADIATA*

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ABSTRACT

Production of *Pinus radiata* is a major contributor to New Zealand's economy and new plantings are a valuable carbon sink. Phosphorus (P) deficiency and high P fixing capacity of some volcanic ash soils (e.g. Allophanic Soil) may constrain radiata productivity. This thesis investigates the role of ectomycorrhizal (ECM) root processes in the acquisition of P by *P. radiata* from native soil and soil fertilised with two reactive phosphate rock (RPR) fertilisers.

The application of finely-divided RPRs to a P deficient Allophanic Soil significantly increased *P. radiata* seedling growth and P uptake in 10 month pot trials. RPR dissolution was high in this soil, and it was further enhanced by the radiata rhizosphere processes. The development and formation of ECM in radiata seedlings was stimulated by low rates of RPR application but was hindered in unfertilised soils and high rates of RPR application.

The *P. radiata* ECM roots induced acidification and increased oxalate concentration and phosphatase activities in the rhizosphere soil. These changes in rhizosphere biochemical properties were associated with enhanced solubilisation of fertiliser and soil inorganic P and increased mineralisation of organic P, leading to increased P bioavailability in the rhizosphere.

ECM inoculation of *P. radiata* roots with *Rhizopogen rubescens* and *Suillus luteus* stimulated production of phosphatase enzymes and oxalate and induced acidification in the rhizosphere. The extent of root-induced changes in the rhizosphere soils was associated with ECM hyphae length density.

A technique using pulse labelling of radiata shoots with $^{14}CO_2$ showed promise in estimating the active ECM hyphae density. The ^{14}C activity was highly correlated with ECM hyphae density measured by an agar film technique.

Overall, observations made in this thesis indicate that sparingly soluble forms of organic and inorganic P in soils low in plant-available P are readily solubilised and utilised for *P. radiata* growth through ECM rhizosphere processes.

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