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Acid Phosphatase Activity in Forest Soil

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ABSTRACT. Acid phosphatase activity in soil was significantly higher in a red alder forest and in a mixed red alder–Douglas-fir forest than in pure stands of Douglas-fir, ponderosa pine, lodgepole pine, or western juniper or in a pasture. FOREST SCI. 25:567–568.

ADDITIONAL KEY WORDS. *Juniperus occidentalis*, *Pseudotsuga menziesii*, *Alnus rubra*, *Pinus ponderosa*, *Pinus contorta*, enzymes, red alder, Douglas-fir, ponderosa pine, lodgepole pine, western juniper.

BIODEGRADATION of complex organic materials into simple molecules is an essential link in mineral nutrient cycles. The translation of soil nutrient reserves into plant available nutrients is related to soil enzyme activity (Kramer and Yerdei 1958). In soil, phosphatases catalyze the hydrolysis of organic phosphorus to inorganic phosphorus. Phosphatase was first discovered in agronomic soils by Rogers in 1942. Since that time, however, no work has been reported on phosphatase activity in forest soils. To determine if activity differs appreciably between different combinations of soil and forest type, soil was examined in seven different forest types and in one agricultural area.

Material and Methods.—Soil samples were taken in October 1976 from seven stands on both sides of the Coast Ranges and from the east side of the Cascade Range in Oregon: pure western juniper (*Juniperus occidentalis* Hook.), pure ponderosa pine (*Pinus ponderosa* Laws.), pure lodgepole pine (*P. contorta* Dougl.), two stands of pure Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), pure red alder (*Alnus rubra* Bong.), and a mixed forest of alder and Douglas-fir. A pasture in the Willamette Valley was also sampled for comparison. Seven soil samples were taken randomly in each area, at least 15 m apart and no closer than 3 m from the nearest tree. Soil was collected from around 10 cm below the leaf litter in the A horizon. The samples were air-dried and then screened to remove particles greater than 2 mm in diameter. The pH value of each sample was determined on air-dried soil in a 1:1 ratio with water.

Soil phosphatase activity was assayed by the method of Tabatabai and Bremner (1969). One gram of air-dried and screened soil, 4 ml of modified universal buffer adjusted to pH 6.5 (Gomori 1955), 0.25 ml of toluene, and 1 ml of 0.115 *M* disodium *p*-nitrophenylphosphate tetrahydrate were mixed in a 50-ml Erlenmeyer flask. The flasks were stoppered and placed in a 37°C water bath for 1 hour. Then 1 ml of 0.5 *M* calcium chloride and 4 ml of 0.5 *M* sodium hydroxide were added to each flask and mixed well. Finally, the soil suspension was filtered through #1 filter paper and the filtrate placed in a spectrophotometer tube for measurement at 420 nm. The amount of *p*-nitrophenol in the sample was then calculated against the standard.

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TABLE 1. Acid phosphatase activity in forest and pasture soils in Oregon.

Tree species	Location	County	Soil texture	Soil pH range	Acid phosphatase activity (μ mole/g)
Pseudotsuga menziesii	Woods Creek	Benton	Sandy clay	6.5–6.8	0.129
Juniperus occidentalis	Redmond	Deschutes	Pumice	6.4–6.8	0.114
Pinus contorta	Sand Lake	Tillamook	Sand dune	6.5–6.8	0.062
Pinus ponderosa	Sisters	Deschutes	Sandy loam	6.9–7.0	0.119
Pseudotsuga menziesii	Cascade Head	Tillamook	Sandy clay	5.9–6.3	0.129
Alnus rubra	Cascade Head	Tillamook	Sandy clay	4.4–4.7	2.089**
Pseudotsuga menziesii + *Alnus rubra*	Cascade Head	Tillamook	Sandy clay	4.7–5.0	0.999**
Pasture (mixed fescue and rye grass)	Corvallis	Benton	Clay	5.8–6.0	0.130

** Significantly greater than others at 1 percent P.

Data from the eight plant-soil combinations were subjected to analysis of variance. The Scheffé test was used to determine significance of differences between all possible paired comparisons.

Results.—Acid phosphatase activity was significantly greater in soils of pure red alder and red alder–Douglas-fir forests than in pure conifer forests or in the pasture (Table 1). The soils of pure conifer forests and pasture did not differ significantly in acid phosphatase activity.

Discussion and Conclusions.—Acid phosphatase in soil originates from cellular materials and is normally released from roots to the rhizosphere during plant growth and as extracellular enzymes of microorganisms (Rogers and others 1942, Neal 1973). Franklin and others (1968) found higher amounts of available phosphorus in the upper 30 cm of soil in red alder (4.48 kg/ha) or in mixed stands (3.03 kg/ha) as compared to pure Douglas-fir stands (2.58 kg/ha). The higher amount of available phosphorus in soils under red alder corresponds to the higher level of acid phosphatase activity detected in this study.

Eivazi and Tabatabai (1977) reported that acid phosphatase predominates in acid soil. The high activity and low pH of the soil under pure red alder and red alder–Douglas-fir mixture as compared to the other soils conform to that generality.

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