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Foliar Fertilization During Bud Initiation Improves Container-Grown Ponderosa Pine Seedling Viability

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ABSTRACT. *Our objective was to determine if avoiding nutrient stress during bud initiation of ponderosa pine* (Pinus ponderosa *var.* ponderosa) *grown in a container nursery would enhance seedling viability. Nitrogen stress was avoided by applying foliar fertilizer atrates between 324 and 972 ppm N to greenhouse-grown seedlings. Foliar fertilization maintained higher seedling nitrogen levels and increased root collar diameter by 45%. Height was slightly increased, cold-hardiness slightly reduced, and root growth potential unaffected by foliar fertilizer applications. Nursery managers can improve seedling viability by adding foliar fertilizer applications to their growing regimes. West. J. Appl. For. 11(4):114-119.*

Growers of container seedlings for reforestation commonly manipulate fertilizer application rates, especially nitrogen (N), to regulate growth of their crops (Landis et al. 1989). In general, seedlings receive about 50 ppm N during establishment and hardening, and about 150 ppm N during the rapid growth phase (Tinus and McDonald 1979, Landis et al. 1989). The abrupt reduction from high N rates to lower rates, water stress, and further reduction of nutrient uptake because of reduced root growth and lower mass flow and diffusion of nutrients (Timmer and Armstrong 1989) are intended to stop height growth and initiate bud formation. However, continuing applications of low levels of N during the remainder of the hardening phase may never allow seedlings to recover prebud formation N concentrations (Montville and Wenny 1990). Seedlings require proper nutrition, especially N, to develop carbohydrate reserves late in the growing season for optimum survival and growth after outplanting (Tukey and Meyer 1966, Ericsson et al. 1983, Miller and Timmer 1994).

Because Douglas-fir *(Pseudotsuga menziesii* var. *menziesii)* (Miller 1981) and slash pine *(Pinus elliotii)* (Eberhardt and Pritchett 1971) trees absorb foliar applied nutrients, we hypothesized that foliar-applied N absorbed by container-grown ponderosa pine *(Pinus ponderosa* var. *ponderosa)* seedlings could be used to avoid nutrient stress during bud initiation and subsequent seedling hardening, thus improving seedling viability (Langerud 1991). Our objective was to determine the effect of foliar-applied N on the timing of seedling budset, seedling morphological characteristics, root growth potential and cold-hardiness, and seedling nutrition, particularly foliar N concentration.

Methods

Ponderosa pine seeds, collected at 900 m elevation, 15 km northeast of Moscow, Idaho, were sown the first week of April (week 0) into 21 trays each containing 200 Ray Leach® pine cells (66 ml) filled with a 1:1 peat : verm

Trays were randomized on greenhouse benches within a production crop. During every irrigation, phosphoric acid was added (41 ppm P) to lower pH. From week 2 through 5, all seedlings received Peters' Conifer Starter® (N:P:K = 4:25:35) at 42 ppm N twice per week as soil drenches (see Table 1 and Wenny and Dumroese 1987). During weeks 6 through 9, all seedlings were fertilized twice per week as a soil drench; Peters' Conifer Grower® (N:P:K = 20-7-19) at 120 ppm N was alternated with calcium nitrate (N:P:K:Ca = 15.5-0-0-19) at 92 ppm N. Throughout the growing season, during each fertilization with a Peters' fertilizer, micronutrients were added at the rate of 0.5, 2.25, 31, 18, and 35 mgL^{-1} of B, Fe, Mn, Mg, and S, respectively.

When seedlings attained a target height of 12-15 cm (week 10) intermittent all-night lighting was suspended Eighteen trays of seedlings were randomly assigned to receive Peters' Foliar Feed® (N:P:K = 27:15:12) twice each