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Foliar Mass and Nutrition of *Abies concolor* Christmas Trees following Application of Organic and Inorganic Fertilizer

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ABSTRACT

Fertilization in Christmas tree production is common to increase tree growth and quality, with many recommendations focusing on N as a primary amendment. However, other nutrients may limit growth, or N application may induce deficiency of other nutrients. We applied fertilizer as either ammonium nitrate (AN) or chicken manure compost (CMC) to concolor fir (*Abies concolor* [Gord. and Glend.] Lindl.) at eight sites across central New York in 2003 and measured foliar mass and macronutrient response (N, P, K, Ca, and Mg) to assess the potential for an inducible nutrient deficiency or nutrient limitation other than N. Foliage mass, N concentration, and N content increased following both fertilizer treatments, indicating that N limits growth at these sites. Macronutrient (P, K, Mg, Ca) concentrations were reduced following AN application because of nutrient dilution following increased growth. Compared with published sufficiency nutrient concentrations, concentrations of P and K were diluted to levels considered limiting to growth. In contrast, there was no reduction in macronutrient concentrations for P, Ca, and Mg in the CMC application, indicating the potential for this amendment to maintain balanced tree nutrition with increased growth. Foliar K content was increased in the CMC treatment, and needle mass (as the primary growth response variable), was correlated with foliar K concentration ($r^2 = 0.71$, $P < 0.01$). The results indicate a strong possibility of K limitation in concolor fir across a variety of site conditions. With few exceptions, there were no apparent relationships between soil nutrient pools and foliar nutrition, demonstrating the limitation of soil tests as a guide to nutrient amendments.

Keywords: white fir, potassium limitation, dilution, New York

Fertilization to increase tree growth and quality is common in Christmas tree production (Richards and Leaf 1971, Kopp and Burger 1990, Torbert et al. 1991), but the development of standards and criteria to evaluate tree nutrition (i.e., assess the need for fertilization) is not as widespread. Foliar analysis can be used to evaluate tree nutrition and the need for fertilization. Since foliage is the primary location for metabolic activity in plants (Mengel and Kirby 2001), foliar nutrient status reflects overall plant nutrition, integrating the myriad site factors that influence nutrient availability (e.g., soil properties, competition, water availability). Foliar status reflects those nutrient pools that are actually available for growth compared with the operationally defined potentially available pools determined in soil tests.

Foliar nutrient status can change fairly rapidly in response to many factors, including competition (Imo and Timmer 2002), seasonal climate (Richards and Bevege 1972, van den Driessche 1974), and increased availability of nutrients (Quoreshi and Timmer 1998). The response of nonlimiting (or less limiting) nutrients following fertilization with one or more growth-limiting nutrients is of interest to fertilization programs. Fertilization may induce or exacerbate deficiency of an initially nonlimiting (or less limiting) nutrient (Maftoun and Pritchett 1970, Teng and Timmer 1994, van den Driessche and Ponsford 1995), or nutrient uptake may be able to keep pace with increased demand (Xu and Timmer 1998). Identification of a potentially inducible nutrient deficiency would allow preemptory adjustment of fertilizer application to meet the increased nutrient demands associated with increased growth.

Fertilizer recommendations are usually developed with the use of factorial fertilizer trials followed by evaluation of growth response to identify treatments that maximize growth and/or quality. Fertilizer trials are species-specific and generally applicable under the site conditions (e.g., existing nutrient capital, soil pH) in which they were performed, making them costly in both time and capital. An alternative approach is to apply a complete fertilizer followed by evaluation of the nutritional response with the use of comparative foliar analysis (between control and fertilized trees) (Timmer and Armstrong 1987). Nutrients that increase in both concentration and content following fertilization accompanied by increased growth are potentially limiting (Timmer and Stone 1978). Comparison of foliar nutrient concentration, nutrient content, and foliage mass can also be used to diagnose other nutritional responses to cultural treatments such as dilution, antagonism, and luxury consumption (see Haase and Rose 1995 for review).

The goal of fertilization for trees in Christmas tree production is somewhat different from that of wood production, as emphasis is placed on variables that influence tree quality rather than volume or

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This article uses metric units; the applicable conversion factors are: millimeter (mm): 1 mm = 0.039 in.; centimeters (cm): 1 cm = 0.39 in.; meters (m): 1 m = 3.3 ft; kilometers (km): 1 km = 0.6 mi; gram (g): 1 g = 0.035 oz.