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Nutrient-Release Rates of Controlled-Release Fertilizers in Forest Soil

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Abstract: Nutrient-release rates of controlled-release fertilizer (CRF) with four different labeled release periods were evaluated. Samples (30 g) sealed with nylon mesh were buried at a clearcut forest site (Price soil series) in western Oregon, USA, in February 2000 and excavated every 7 weeks for 14 months to determine residual weight and composition. Cool, dry soil conditions apparently prolonged nutrient release beyond labeled rates; the fertilizer with the shortest release period (3–4 months) released approximately 72% of the fertilizer (by weight), whereas that with the longest release period (8–9 months) released 48%. Release varied among individual nutrients [nitrate (NO_3) > ammonia (NH_3) > potassium (K) > sulfur (S) > magnesium (Mg) > phosphorus (P)]. Minimal changes in micronutrient [iron (Fe), manganese (Mn), zinc (Zn), and molybdenum (Mo)] contents were attributed to the formation of insoluble compounds with P. Variable release among individual nutrients demonstrates a limitation toward delivering a full range of nutrients and

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suggests that further refinement of CRF technology is needed to optimize nutrient availability under realistic field conditions.

Keywords: Fertilization, nitrogen, phosphorus, reforestation, seedling nutrition

INTRODUCTION

The use of controlled-release fertilizer (CRF) to enhance forest seedling productivity in the nursery and field has increased considerably during the past decade. Compared to conventional water-soluble fertilizers, CRF can supply seedlings with nutrients for extended periods with a single application. Because of the prolonged nutrient release, potential for seedling damage associated with nutrient toxicities and nutrient loss through leaching can be reduced (Hauck 1985; Donald 1991; Hangs, Knight, and van Rees 2003). Fertilization with CRF can lead to improved nutrient-use efficiency as well as increased growth and competitiveness of forest tree seedlings. When applied at planting to the root zone, CRF stimulated seedling growth of Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] (Strothmann 1980; Carlson and Preisig 1981), western hemlock (*Tsuga heterophylla* Raf. Sarg.) (Carlson 1981; Hawkins, Burgess, and Mitchell 2005), white spruce [*Picea glauca* (Moench] Voss.) (Krasowski et al. 1999), and three hardwood species (Jacobs, Salifu, and Seifert 2005). However, a number of neutral or negative results have been reported following CRF application at planting, which has constrained its potential transfer to operation (Brockley 1988). For instance, application of CRF to the planting hole negatively affected growth and drought avoidance of Douglas-fir seedlings on drought-prone sites in western Oregon, USA (Jacobs et al. 2003; Jacobs et al. 2004). To achieve optimal seedling response to CRF application in the field, fertilizer formulation, nutrient-release behavior, and environmental interactions must be adequately understood. However, little research has been conducted to examine patterns of CRF release under field conditions.

Nutrient-release rates vary widely among CRF products and are a function of the composition and thickness of the coating as well as the environment in which it is applied (Hauck 1985). Release rates can be uneven, with the highest rate occurring during the early part of the release period (Huett and Gogel 2000). The remaining fertilizer release is dependent on time, temperature, and moisture (Lamont, Worrall, and O'Connell 1987; Hicklenton and Cairns 1992). Release periods specified by CRF manufacturers are based on total fertilizer released (by weight) under constant temperature conditions, typically 21 to 25°C in water (Goertz 1993). CRF release patterns have been described under controlled-temperature conditions (Lamont, Worrall, and O'Connell 1987; Cabrera 1997; Huett and Gogel 2000). Such information is useful to nursery growers, who can control and monitor media temperature and moisture. However, this