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Growth and nutrient dynamics of Douglas-fir seedlings raised with exponential or conventional fertilization and planted with or without fertilizer

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Abstract: The effects of two operational nursery fertilization regimes on the growth and nutrient dynamics of Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco) seedlings after planting were compared. Seedlings were grown in a nursery with nutrients added at a constant rate (conventional fertilization) or at a rate that increased exponentially by 2%·day^{-1} (exponential fertilization) and planted near Barriere and Victoria, British Columbia. At the time of planting, half of the conventionally fertilized seedlings were planted with slow-release fertilizer packets. Growth and nutrient allocation was observed for 2 years following planting. Although the exponential fertilization regime provided 25% more N in the nursery compared with the conventional fertilization regime, exponentially fertilized seedlings were smaller at the time of planting, did not differ significantly in foliar N concentration, and showed no lasting benefits in growth or nutrient allocation. Two years after planting, there were no significant differences between the conventional and exponential fertilization regimes in seedling height, root collar diameter, total dry mass, or whole-plant N concentration. Seedlings fertilized at the time of planting had greater height and dry mass on the Barriere site but not on the dry Victoria site and whole-plant N concentrations did not differ 2 years after planting.

Résumé : Deux régimes opérationnels de fertilisation en pépinière pour les semis de douglas de Menzies (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco) ont été comparés quant à leurs effets sur la dynamique de la croissance et des nutriments après la plantation. Les semis ont été cultivés en pépinière où des nutriments ont été ajoutés à un taux constant (fertilisation conventionnelle) ou à un taux qui augmentait de façon exponentielle à raison de 2 % par jour (fertilisation exponentielle) et ils ont été plantés près de Barriere et de Victoria, en Colombie-Britannique. Au moment de la plantation, la moitié des semis fertilisés de façon conventionnelle ont été plantés avec des sachets de fertilisant à libération lente. La croissance et l'allocation des nutriments ont été observées pendant deux ans après la plantation. Bien que la fertilisation exponentielle eusse fourni 25 % plus de N en pépinière comparativement à la fertilisation conventionnelle, les semis fertilisés de façon exponentielle étaient plus petits au moment de la plantation, leur concentration en N foliaire n'était pas significativement différente et aucun bénéfice durable tant du point de vue de la croissance que de l'allocation des nutriments n'a été observé. Deux ans après la plantation, il n'y avait aucune différence significative entre les deux traitements de fertilisation appliqués en pépinière du point de vue de la hauteur des semis, du diamètre au collet, de la masse anhydre totale et de la concentration de N dans l'ensemble de la plante. La taille et la masse anhydre des semis fertilisés au moment de la plantation étaient plus grandes sur le site de Barriere mais pas sur le site sec de Victoria et la concentration globale de N dans les plants ne différait pas deux ans après la plantation.

[Traduit par la Rédaction]

Introduction

Regeneration of planted interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) trees has proven difficult in British Columbia (Newsome 1997). Limited nutrient availability (Millard 1996), poor planting stock (Simard et al. 1997), summer drought, and frequent frost occurrence (Newsome 1997) have all been blamed for suboptimal conifer regeneration. Improved nutritional management may increase seedling vigour, thereby increasing seedling tolerance of difficult environmental conditions and improving regeneration success.

Conifer seedling nurseries often follow conventional fertilization regimes, in which fertilizer is added to seedlings at a constant rate, regardless of their growth rates (Timmer 1997). This "constant feed" model consists of repeated applications of nutrient solutions at one or two concentrations over the entire nursery period (Timmer 1997). Typically, early nutrient additions in the conventional fertilization regime exceed the young seedling's uptake ability, but later nutrient additions may not meet the seedling's nutritional demands (Timmer 1997). This will result in diluted internal N concentrations (Timmer 1997) and possibly in nutrient deficiency. Alternative fertilization regimes, such as exponential nutrient addition, attempt to increase the internal nutrient concentrations of nursery stock prior to planting, giving seedlings the potential to better withstand difficult environmental conditions (Timmer 1997; Imo and Timmer

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