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Establishment and growth of container seedlings for reforestation: A function of stocktype and edaphic conditions

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ABSTRACT

A properly selected stocktype can greatly enhance reforestation success through increased survival and growth following outplanting. Implementing a robust stocktype trial using stocktypes of equal quality can ensure results lead to the best choice. Six container types, differing primarily in depth and volume, were used to evaluate the performance of ponderosa pine (*Pinus ponderosa* Laws. var. *ponderosa*) seedlings outplanted on two sites that varied in volumetric soil moisture content (θ), average temperature, and total precipitation (mesic and xeric). Seedlings in each container type were cultured specifically to achieve uniform seedling quality. After two growing seasons, seedlings planted at the mesic site showed high survival (>99%) and incremental growth gains of 147, 100, and 794% for height, root-collar diameter (RCD), and stem volume, respectively; container types exhibited differences in total height, RCD, and stem volume with larger containers generally yielding the largest seedlings. Seedlings planted at the xeric site experienced 83% survival, smaller growth gains (25, 46, and 220% for height, RCD, and stem volume, respectively), and also exhibited differences in height, RCD, and stem volume. Regression analysis revealed that for each site, initial seedling morphological characteristics were better at predicting absolute height, RCD and stem volume after the first year than after the second year, with initial seedling height offering the best predictive power ($R^2 = 0.66$, mesic site; and $R^2 = 0.70$, xeric site). Second-year absolute growth prediction was poorest on the mesic site ($R^2 < 0.21$). Regression analysis indicates that initial seedling characteristics lost predictive value with time, especially on the mesic site, as seedlings grew out of their initial, container-induced characteristics and become more limited by current environmental and genetic factors. Conversely, on a xeric site, where absolute growth was reduced, traits determined by the container type persisted longer. Selecting stocktypes for mesic site conditions may only be limited by the minimum growth gains desired. Conversely, xeric sites may benefit from deep-planted quality seedlings or carefully planted long-rooted, large container seedlings.

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1. Introduction

Reforestation using nursery-produced seedlings can be an effective means of ensuring successful establishment and rapid growth following outplanting. Plantation establishment success often hinges on decisions and considerations made prior to planting, such as seedling stocktype, seedling morphology, genetics, site limiting factors, site preparation, the outplanting window, and planting technique (Scagel et al., 1998). The best seedling stocktype for a particular site may differ depending on how these decisions and considerations are made. To simplify this complex situation, the Target Plant Concept was proposed. This concept provides a means of overcoming the critical variables of forest establishment by focusing on morphological and physiological seedling characteristics that are linked to outplanting success (Rose et al., 1990; Landis and Dumroese, 2006). The premise behind the Target Plant Concept is that it identifies seedling characteristics that increase outplanting survival and growth under a particular set of site conditions (Rose et al., 1990).

Over the years, the number of available seedling stocktypes has increased dramatically, especially for container seedlings. It is well known that varying container volume, which usually also causes changes in seedling density, modifies seedling phenotype; this occurs even among seedlings of the same seed source grown the same year (Scarratt, 1972; Landis et al., 1990; Scagel et al., 1998). If a larger phenotype is desired, seedlings are grown in larger containers. Whether these larger containers are deeper or wider, they require more medium, more fertilizer, and more grow-

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