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Research paper

Growth phenology of coast Douglas-fir seed sources planted in diverse environments

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The timing of periodic life cycle events in plants (phenology) is an important factor determining how species and populations will react to climate change. We evaluated annual patterns of basal-area and height growth of coast Douglas-fir (*Pseudotusga menziesii* var. *menziesii* (Mirb.) Franco) seedlings from four seed sources that were planted in four diverse environments as part of the Douglas-fir Seed-Source Movement Trial. Stem diameters and heights were measured periodically during the 2010 growing season on 16 open-pollinated families at each study installation. Stem diameters were measured on a subset of trees with electronic dendrometers during the 2010 and 2011 growing seasons. Trees from the four seed sources differed in phenology metrics that described the timing of basal-area and height-growth initiation, growth cessation and growth rates. Differences in the height-growth metrics were generally larger than differences in the basal-area growth metrics and differences among installations were larger than differences among seed sources, highlighting the importance of environmental signals on growth phenology. Variations in the height- and basal-area growth metrics were correlated with different aspects of the seed-source environments: precipitation in the case of height growth and minimum temperature in the case of basal-area growth. The detailed dendrometer measurements revealed differences in growth patterns between seed sources during distinct periods in the growing season. Our results indicate that multiple aspects of growth phenology should be considered along with other traits when evaluating adaptation of populations to future climates.

Keywords: adaptation, assisted migration, budburst, cambium, dormancy, genecology.

Introduction

Understanding how environmental signals affect the timing of periodic life cycle events in plants (phenology) is a key factor in predicting the effects of climate change. Shifts in plant phenology, such as the timing of budburst, present some of the most visible evidence of the impacts of climate change in recent decades (Walther et al. 2002, Menzel et al. 2006). Phenological events are closely tied to environmental signals such as seasonal changes in temperature (Menzel and Sparks 2006). Plants have evolved mechanisms to coordinate the timing of phenological events so that periodic growth and other events occur when environmental conditions are optimal with respect to resource availability and minimizing the likelihood of damage from cold, drought or other factors (Rehfeldt 1978, Howe et al. 2003, Chuine 2010, Wilczek et al. 2010). Adaptation to different environments has produced genetic variation in phenological traits within plant species. This variation is a valuable resource for adapting to climate change as it may provide opportunities to select populations that are well suited to future climates (Millar et al. 2007, St. Clair and Howe 2007, Hamann et al. 2011). Understanding genetic variation in a wide range of phenological traits, and the environmental signals that trigger phenological events, is critical to evaluating both climate change impacts and the value of assisted migration or other mitigation strategies (Wilczek et al. 2010).