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Effect of Foliar-Applied Gibberellin A_3 on Male and Female Strobilus Production and Cone and Seed Quality in Western Redcedar (Thuja plicata Donn)

J.H. Russell and O. Hak

ABSTRACT

Western redcedar *(Thuja plicata* Donn) foliar-applied gibberellin A_3 (GA_3) induction trials were performed over a 4-year period at a number of different seed orchards in coastal British Columbia. The effects of GA_3 timing, concentration, and frequency on male and female strobilus production, as well as timing on seed quality, were studied. Male and female strobili were induced over the complete span of shoot elongation from May to August, indicative of a less-precise induction period than species in the Pinaceae family. Female strobilus production was correlated with shoot increment, such that maximum cone production was associated with maximum shoot elongation. In addition, seed quality decreased with decreasing shoot increments in August. For operational efficiency, a one-time foliar application of 200 mg/l GA_3 is sufficient for adequate female strobilus production. To increase the female-to-male strobilus ratio, a two-time folior application of GA_3 mid-May and mid-July, concentrating on vigorous shoots, is recommended. Results are discussed in relation to seed orchard management techniques that may potentially influence selfing rates.

Keywords: western redcedar, gibberellin A_3, strobili, seed orchards

Western redcedar *(Thuja plicata* Donn) is an important component of Pacific Northwest forests, both ecologically and economically. Harvesting pressures have resulted in an extensive regeneration program including the establishment of seed orchards in coastal British Columbia, Washington, and Oregon. Up to 10 million seedlings are planted annually in British Columbia alone, with over 80% of the seed coming from managed orchards located on the South coast of British Columbia.

Western redcedar exhibits a mixed-mating system. Both natural and orchard seed lots exhibit on average 30% selfing, with reported selfing rates varying from 0 to 100% (El Kassaby et al. 1994, O'Connell et al. 2001, Ritland et al. 2004). There is no evidence of early life cycle inbreeding depression; selfed seed germinate on average the same as outcrossed seed, and subsequent seedlings have similar survival and growth rates in a greenhouse environment (Owens et al. 1990, Cherry 1995, Russell et al. 2003). However, selfed trees have been shown to grow 10% slower than outcrossed trees at the age of 9 years in the field (Russell et al. 2003). This translates to 8% on average volume reduction at rotation (Wang and Russell 2006). Thus, it is important to minimize selfing in orchard seed through appropriate management practices.

At sexual maturity, western redcedar is a prolific seed producer. Even though each cone contains only a few seeds, trees are capable of producing abundant seed cones (Owens and Molder 1980). In addition, western redcedar can be artificially induced with gibberellin A_3 (GA_3) to enhance female and male strobili and seed cone production in orchards (Pharis et al. 1969), and it responds well to induction treatments at a very young age (Owens and Molder 1984).

Western redcedar has indeterminate shoot growth with no fixed bud cycle, which results in a less definable cone initiation period compared with the Pinaceae species (Owens and Molder 1984). In natural conditions, western redcedar male strobili are initiated under long and increasing day lengths, and female strobili are initiated under long but decreasing day lengths (Owens and Pharis 1971). Consequently, it has been suggested that treatments with GA_3 applied over long days increase the proportion of male strobili induced, and treatments applied during short days increase the proportion of female strobili induced (Pharis et al.1969, Owens and Pharis 1971, Owens and Molder 1984). Owens and Molder (1984) suggested that foliar application of GA_3 at a concentration of 100 mg/l twice weekly for about 6 weeks results in the maximum promotion of male and female flowering. Cones develop normally if the treatments occur early enough for them to differentiate fully before dormancy (Owens and Molder 1984). Stress treatments such as heat, girdling, and root pruning are ineffective with western redcedar when used in conjunction with GA_3 (Owens and Molder 1984).

The focus of this study was to investigate foliar-applied GA_3 induction techniques for male and female strobili to improve the

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