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Pollination and seed production in western white pine

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Abstract: The reproductive biology of western white pine (*Pinus monticola* Dougl. ex D. Don) at the Saanich seed orchard (SSO: a coastal seedling seed orchard) and the Kalamalka seed orchard (KSO; an interior clonal seed orchard) is described. Seed-cone development and morphology determine seed potential and affect filled seed production. Seed potential was high, commonly over 200 seeds per cone and filled seeds per cone averaged 50-60 at both orchards in 1999 from open pollinations combined with operational supplemental mass pollinations (O.P-SMP). Filled seeds per cone at SSO in 2004 averaged 115 with open pollinations and OP-SMP. About 30% of ovules aborted before pollination. Another 25% aborted probably because of self-incompatibility at fertilization. Seed efficiency (SEF) was only 5% at KSO with open pollination but increased to 30% with OP SMP. SEF was the same at SSO with or without OP-SMP. Reproductive success was very low at KSO without OP-SMP but increased to about 10%, similar to that of SSO, with OP-SMP. The optimal time for control pollinations was at cone stages 4 and 5 and optimal amount of pollen per pollination bag was 0.3–0.4 mL. Western white pine is a very good seed producer and can be easily managed in seed orchards to give very high seed production per cone and per tree.

Résumé : La biologie de la reproduction du pin blanc de l'Ouest (*Pinus monticola* Dougl. ex D. Don) dans un verger à graines côtier (« Saanich seed orchard ») et un verger à graines clonal situé plus à l'intérieur des terres (« Kalamalka seed orchard ») est décrite. Le développement des cônes et la morphologie déterminent la production potentielle de graines et affectent la production de graines viables. La production potentielle de graines était élevée, communément au-delà de 200 graines par cône, et la production de graines viables par cône atteignait en moyenne 50-60 graines par cône dans les deux vergers en 1999 grâce à la pollinisation naturelle combinée à la pollinisation artificielle supplémentaire. Il y avait en moyenne 115 graines viables par cône dans le verger côtier en 2004 avec la pollinisation naturelle et artificielle. Environ 30% des ovules ont avorté avant la pollinisation et un autre 25% lors de la fertilisation, probablement à cause de l'auto-incompatibilité. La production effective de graines était de seulement 5% dans le verger situé à l'intérieur des terres avec la pollinisation naturelle mais augmentait à 30% avec la pollinisation artificielle. La production effective de graines était la même dans le verger côtier avec ou sans pollinisation artificielle. Le succès reproducteur était très faible dans le verger situé à l'intérieur des terres sans la pollinisation artificielle mais augmentait à 10%, comme dans l'autre verger, avec la pollinisation artificielle. Les stades 4 et 5 étaient le moment optimal pour la pollinisation artificielle et la quantité optimale de pollen par sac de pollinisation était de 0,3 à 0,4 mL. Le pin blanc de l'Ouest est un très bon producteur de graines et peut facilement être géré dans des vergers à graines afin de donner une très forte production de graines par cône et par arbre.

[Traduit par la Rédaction]

Introduction

In British Columbia, the Pacific Northwest, and the Inland Empire West, western white pine (*Pinus monticola* Dougl. ex D. Don) has considerable commercial potential. However, this potential has been severely restricted since the middle of the last century. Before then, western white pine dominated the moist, midelevation, mixed-species forests in the Inland Northwest from about 700 in to 2200 in elevation.

Many trees lived to be about 350 years old with the oldest up to 450-500 years old. They commonly reached 50 to 100 in diameter and provided high-quality, light-colored, fine-grain lumber that dried and took paint well and was excellent for furniture, window frames, and general construction (Rorie 1970). The species commonly grew in mixed stands but was more resistant to insects and disease than Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and grand fir (*Abies grandis* (Dougl.) Lindl.) and more resistant to drought and decay than western hemlock (*Tsuga heterophylla* (Raf.) Sar.) found in these mixed stands. Stands containing western white pine commonly produced twice the number of board feet per acre (50 000) than mixed stands lacking western white pine. At the start of the 20th century, western white pine forests held promise for riches in the forest industry because, by then, the supply of old-growth eastern white pine (*Pinus strobus* L.) in the eastern and Great Lakes regions of the United States and Canada was nearly done (Fins et al. 2001).

About 1910, white pine seedlings infected with white pine blister rust, caused by the fungus *Cronartium ribicola* J.C.

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