

BREEDING FOR WEEVIL RESISTANCE IN NORWAY SPRUCE: BALANCING ATTACK, GROWTH AND WOOD QUALITY USING MULTI-TRAIT GENOMIC SELECTION

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Increasing pressure of pest and disease on forest plantations is becoming a growing issue in the context of climate change. Breeding approaches using genomics may offer efficient and flexible tools to face this pressure. Norway spruce (*Picea abies* (L.) Karst.) has been introduced to North America more than a century ago and is valued for its superior growth compared with native spruces. Initial selection efforts were focussing on growth and hardiness traits. In Canada, Norway spruce plantation can get heavily attacked by the white pine weevil (*Pissodes strobi* Peck). In the present study, we targeted genetic improvement of Norway spruce resistance to the native white pine weevil. Single and multi-trait genomic selection (GS) models and selection indices were developed considering the relationships between weevil resistance, intrinsic wood quality, and growth traits. Moderate to high heritability was detected for average wood density, acoustic velocity as a proxy for mechanical wood stiffness and weevil resistance. Weevil resistance was genetically positively correlated with tree height, height to diameter ratio, and acoustic velocity. The accuracy of the different GS models tested (GBLUP, Threshold GBLUP, Bayesian Ridge Regression, BayesC π) was high and did not differ among those methods. Multi-trait models performed similarly than single trait models when all trees were phenotyped. However, with an increasing proportion of missing values, e.g. when weevil attack survey could not be extended to all trees, weevil resistance was more accurately predicted by integrating genetically correlated traits into multi-trait GS models. A genomic selection index that corresponded to the breeders' priorities achieved near maximum gains for weevil resistance, acoustic velocity, and height growth, but a small decrease for DBH. The results of this study indicate that it is possible to breed for high quality, weevil resistant Norway spruce reforestation stock with high accuracy achieved from single-trait or multi-trait genomic selection.