FPInnovations

THINKING BIG WITH THE INFINITELY SMALL

By Guyta Mercier, F. Eng., under the scientific supervision of Patrick Lenz Ph.D., research scientist, Canadian Wood Fibre Centre, Natural Resources Canada

The production of conifer seedlings for reforestation purposes involves the use of genetic improvement techniques that have been around for the last few decades. They have greatly helped increase the hardiness and growth of propagated species. Now, there is also genomic selection and somatic embryogenesis, two techniques made possible by scientific progress in genetics, computer science and cell culture.

First Figuring Out What Nature Does Best

In the beginning of genetic improvement programs, researchers identified and selected natural forest trees, by focussing on rapid growth rate and form. These selected trees were established in first-generation seed orchards which supplied the seeds for nursery stock. Once those trees were mature, crossbreeding of the best trees in the first-generation orchard gave way to second-generation seed orchards. However, it has taken over 20 years to confirm if this progeny actually had the desired traits and build a collection of parents for other selection and breeding cycles. Currently, researchers have the technology to select superior trees for a variety of traits including wood quality, good taper, and resistance to certain insect pests and diseases.

Genomic Selection: From Lab to Forest

Progress in genetics, the improved knowledge of tree genomes[1] and the advent of more powerful computers have opened the door to genomic selection, i.e. the selection of desired traits based on genetic markers. To start, DNA needs to be extracted to determine the genetic markers in the genome. This is where the collection of parents with confirmed traits is used as a reference for building prediction models. The most obvious benefit of genomic selection is the time needed to select for desired traits. As traits are predicted and not measured in growing plantations, genomic selection takes less than 10 years compared with 28 years for the traditional selection method (Figure 1).

Somatic Embryogenesis

To benefit from improved genetics and rapidly produce elite tree seedlings, another scientific advance called somatic embryogenesis is now widely used. This method makes it possible to vegetatively propagate trees with the desired genetic traits and obtain genetically identical seedlings. To do so, embryonic tissue is extracted from stem cells and then cultivated in vitro until a mass of cells is created. The cell mass is then differentiated and spread on a culture medium until embryos develop. The embryos are then grown to maturity to become seedlings (Figure 2).

Figure 1 : Time required for producing improved seedlings

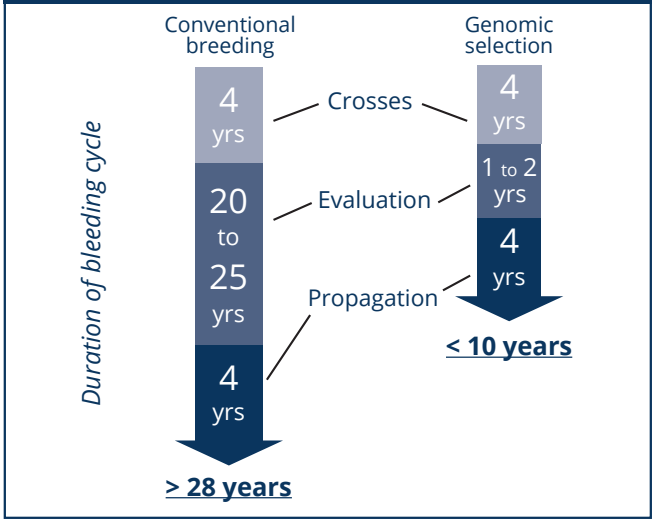
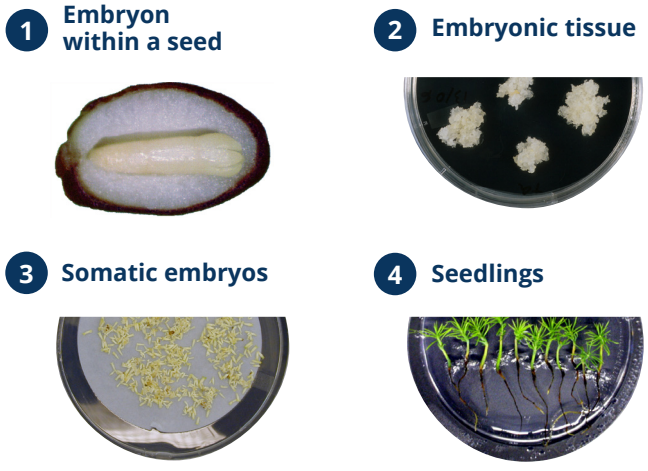


Figure 2 : Somatic embryogenesis stages



[1] The genome represents the complete set of genes or genetic material present in a cell or organism. For spruce trees, the genome has between 27,000 and 30,000 genes.

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