Accomplishments and challenges of conifer somatic embryogenesis for the implementation of multi-varietal forestry

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Multi-Varietal Forestry

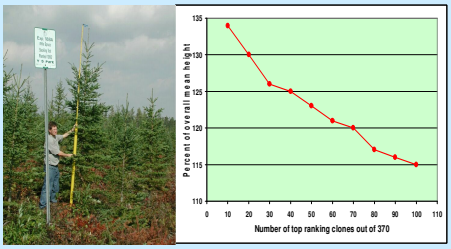
Multi-varietal forestry (MVF) may be defined as the use of genetically tested tree varieties in commercial plantation forestry.

Advantages of MVF

There are many advantages to MVF, including:

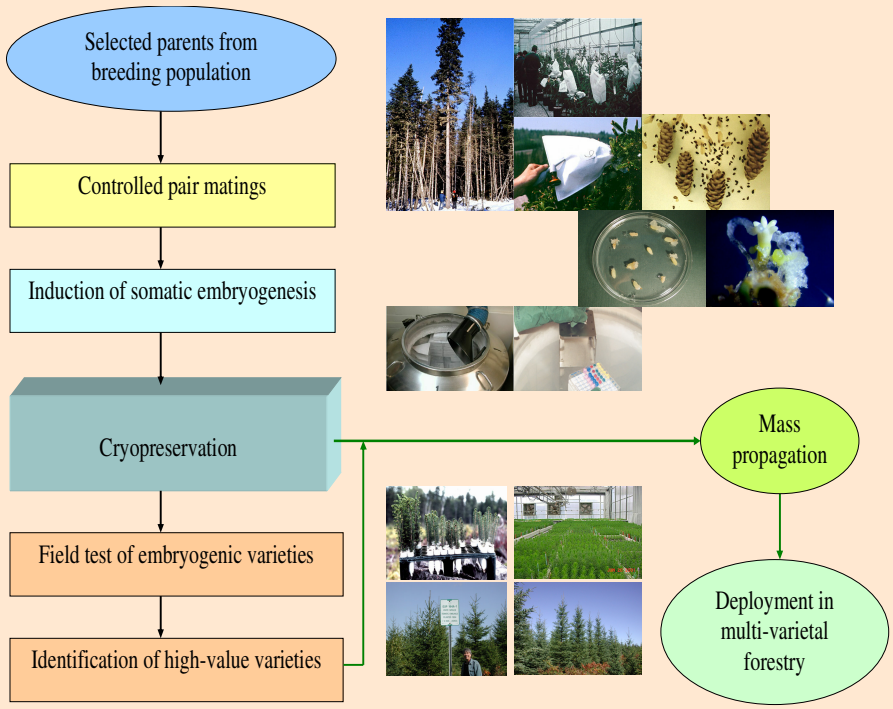
- much greater genetic improvement than is possible through conventional tree breeding techniques;
- suitable varieties can be rapidly introduced to meet changing breeding goals, site conditions, and environment change;
- diversity in plantations can be carefully managed by using appropriate mixtures of tested varieties in time and space.

Potential genetic gains with MVF



- Clonally replicated genetic test of *P. glauca* evaluated at age 9 for height
- Test included 370 clones from 72 full-sib crosses
- Test planted at 3 locations with 16 ramets per location

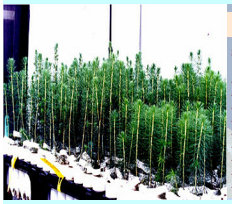
Schematic presentation of implementing MVF using somatic embryogenesis



Challenges and Accomplishments

Somatic embryogenesis and cryopreservation are the primary enabling technologies for implementing MVF. The implementation of MVF requires four critical steps:

Step 1. The development of a sufficiently refined SE system must be achieved, and this is currently available for several conifer species.



Achievements in SE initiation and conversion rates

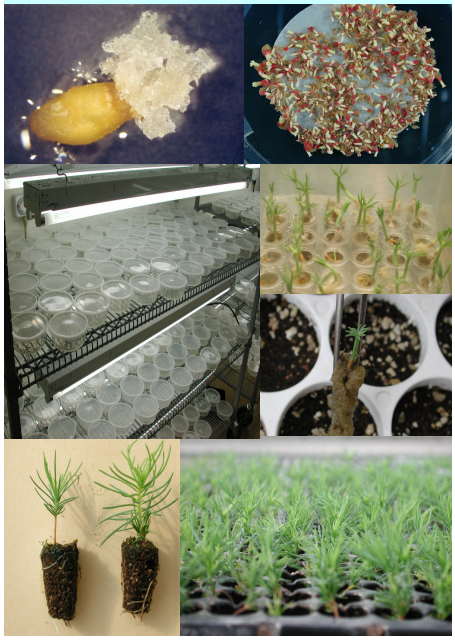
Species	Immature ZE	Mature ZE	Conversion
Picea glauca	68%	20%	89%
P. mariana	65%	21%	85%
P. abies	75%	29%	80%
Pinus strobus	61%	2%	76%
P. monticola	6%	0%	75%
P. banksiana	4%	0%	90%
P. taeda	36%	0%	66%
P. pinaster	76%	0%	58%
P. sylvestris	20%	0%	85%

Step 2. The development of high-value varietal lines is required, which involves tree breeding and field testing while maintaining SE lines being tested in cryogenic storage.

Varietal testing scheme in NB, Canada

- *200-300 varieties from 20-30 elite crosses*
- *3-4 test sites in New Brunswick*
- *12 ramets of each variety are planted per site*
- *Evaluation every 5 years*
- *Currently, over 2,000 lines in the field tests*

Step 3. Mass vegetative propagation must be achieved in a cost-effective manner. Artificial seed and an automated embryo handling system are currently being developed, e.g., *micro-plug system*.



Step 4. Deployment and management of diversity in MVF. The deployment of embryogenic varieties in plantations requires a careful balancing act to optimize genetic gain yet maintain plantation diversity. Once an appropriate number of varieties has been decided, a deployment strategy must consider the configuration of deployed varieties. Over time, diversity among plantations will also be managed by introducing new clones during each breeding cycle.

Public perception and issues of MVF

"The deployment of SE varieties may lead to increased vulnerability to insects and diseases"

- *For known pests, MVF is better prepared by deploying resistant varieties*
- *For unknown or introduced pests, protection is limited despite the large variability in forest trees; however, the deployment of multi-vaietal mixtures may alleviate the problem*

Deployment strategies for MVF

- *Mosaic of Monoclonal Mixtures (MOMs)*
- *Widespread Intimately Mixed Plantations (WIMPs)*
- *Mixture of Varieties and Seedlings (MOVAS)*
- *Desired Gain Mixtures – Set a level of genetic gain to maintain a desired level of diversity*
- *Linear Deployment – Greater representation of better-known varieties*
- *Species Mixture*

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