

Canada Yew (*Taxus canadensis* Marsh.) and Taxanes: a Perfect Species for Field Production and Improvement through Genetic Selection

Daoust, G.¹ and G. Sirois²

¹Natural Resources Canada, Canadian Forest Service, 1055 du P.E.P.S., P.O. Box 3800, Sainte-Foy, Quebec, Canada G1V 4C7

²Forestry Consultant, 11 Simard, Saint-Urbain, Quebec, Canada G0A 4K0

Introduction

Canada yew (*Taxus canadensis* Marsh.) is a native coniferous shrub that grows in small colonies under the forest canopy in northeastern North America. Like all the other species of the genus *Taxus*, Canada yew contains taxanes, namely paclitaxel (PACL) and its precursors 10-deacetylbaccatin III (10-DAB) and 13-acetyl-9-dihydrobaccatin III (DHB). These taxanes are extracted from biomass coming from natural stands and are used on the biopharmaceutical scene to develop anti-cancer and other drugs.



Since little is known about variation in taxane concentration among populations and among trees within populations of Canada yew and among years, a study was undertaken to identify and describe the levels and patterns of variation.

Material and methods

In the fall of 2001, 50 individuals from each of the following three wild populations, Clermont (CLER), Saint-Aimé-des-Lacs (STAL) and Sainte-Marie (STMA), from the Charlevoix region, Quebec, Canada, were sampled. In 2002, 15 out of 50 individuals were randomly chosen and re-sampled in each population.



CLER



STMA



STAL

Each time, 10 three-year-old twigs were collected on each individual. The twigs of each individual were weighed dry after a drying process (48 hours at 65°C in a forced-air oven). Thirty grams of dried ground biomass (1-mm screen) per individual were used for the HPLC analysis. Data were subjected to MANOVA to adjust partial correlation coefficients between log biomass and concentrations of taxanes for population effects.

Results

- No significant differences were revealed between populations for PACLI, 10-DAB and DHB (Figure 1);
- Taxane concentrations varied greatly within populations (Figure 2) and were positively intercorrelated in every comparison;
- Some variations in taxane concentrations between 2001 and 2002 were found (Figure 1);
- Correlations revealed that the individuals with a high content of taxanes in 2001 also had a high content in 2002;
- Significant differences were revealed between populations for biomass (Figure 1); quality of the station (fertility, water availability, etc.) is believed to be the main factor that explain the differences between populations;
- In general, biomass was negatively and weakly correlated to taxanes (Figure 2);
- Important improvements in taxane concentrations can be achieved through phenotypic selection within populations and among individuals having shown above average biomass production (Table 1);

Figure 1. Taxane concentrations (%) and biomass (g) for the three Canada yew populations sampled in 2001 and 2002

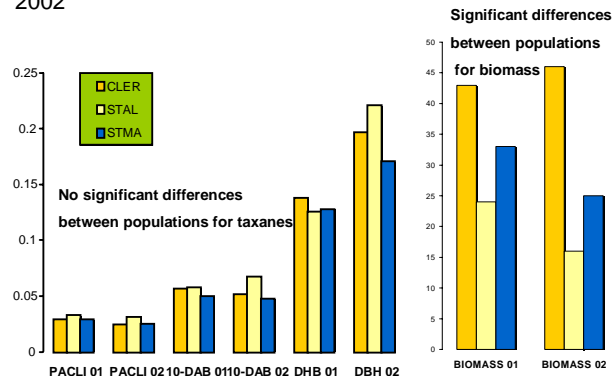


Figure 2. Correlation between PACLI and biomass for the three Canada yew populations sampled in 2001

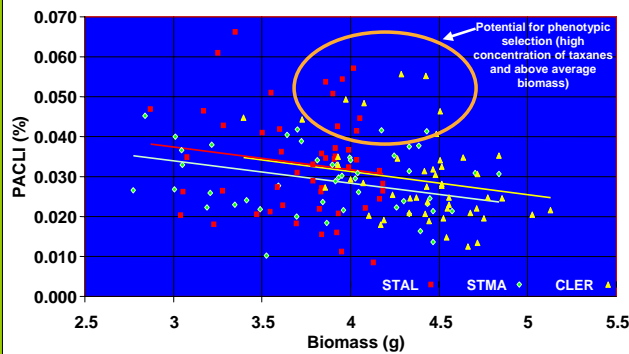


Table 1. Effect of phenotypic selection for PACLI concentration and above average biomass production on total PACLI extracted

Selection intensity	Average PACLI concentration (%)	Biomass (kg) harvested	PACL (kg) extracted	Relative gain
None	0.033	30 000	1.0	-
20% (30/150)	0.053	30 000	1.6	60%
10% (15/150)	0.058	30 000	1.74	74%

The value of 1 kg of PACLI is approximately 335 000 euros.

Conclusion

- Concentration of taxanes in Canada yew varies greatly within but not among populations and seems to be strongly influenced by genetic factors;
- Despite a weak negative correlation between biomass and taxane concentrations, it should be possible to improve taxane concentrations by phenotypic selection without negative impact on biomass production;
- As Canada yew is very easy to propagate by cutting, these findings open the way to domestication programs and could eventually reduce biomass harvesting in wild populations and help to protect this natural resource.
- Future: Three clonal tests including all the individuals sampled in this study were established and will allow us to evaluate the effects of genetic and environmental factors on taxane concentrations.

