# Integrated Forest Vegetation Management in Québec (Canada): An Effective Alternative to Herbicides

Research Note
Tabled at the XII World Forestry Congress – Québec, Canada 2003,
by the *Ministère des Ressources naturelles, de la Faune et des Parcs du Québec*

September 2003

Direction de la recherche forestière (Forest Research Branch)

Ressources naturelles, Faune et Parcs
Québec

# Integrated Forest Vegetation Management in Québec (Canada): An Effective Alternative to Herbicides

**by**

**Vincent Roy[1], Nelson Thiffault[2] et Robert Jobidon[3]**

Research Note
Tabled at the XII World Forestry Congress – Québec, Canada 2003,
by the *Ministère des Ressources naturelles, de la Faune et des Parcs du Québec*

*Ministère des Ressources naturelles, de la Faune et des Parcs du Québec* (MRNFP)
Direction de la recherche forestière (Forest Research Branch)
2700, rue Einstein
Sainte-Foy (Québec) G1P 3W8
CANADA

Telephone: (418) 643-7994
Fax: (418) 643-2165

vincent.roy@mrnfp.gouv.qc.ca
nelson.thiffault@mrnfp.gouv.qc.ca
robert.jobidon@mrnfp.gouv.qc.ca

www.forestrycongress.gouv.qc.ca
www.mrnfp.gouv.qc.ca

[1] Research Scientist, Forest Engineer, Ph.D.
[2] Research Scientist, Forest Engineer
[3] Department Head, Genetics, Propagation and Ecology, Forest Engineer, Ph.D.

## Abstract

Chemical herbicides have demonstrated their effectiveness in controlling competing vegetation. However, with the public's increasing concerns over the potential environmental effects of these products, it is necessary to develop alternative vegetation management approaches. Furthermore, a move towards integrated vegetation management strategies is encouraged in the context of forest certification. This means finding not only technically efficient methods, but those that are compatible with social considerations.

In 1994, the Québec government committed itself to end the use of chemical herbicides in Québec forests in its *Stratégie de protection des forêts* (Forest Protection Strategy). In 2001 it succeeded in reaching the objective. The Strategy favoured a suite of alternative solutions to herbicides in order to ensure the establishment and growth of plantations.

The objective of this brief is to present the results of research projects that were carried out to evaluate the effectiveness of the proposed alternative solutions, and to elaborate on application procedures. Research was able to define an integrated vegetation management approach without herbicides, which is adapted to the ecological characteristics of reforestation sites. The Québec experience shows that integrated control of vegetation, centred on early planting, use of large seedlings (35 to 45 cm in height) and intensive mechanical release, brings plantations to the free-to-grow stage without the use of herbicides on most sites. This scenario is potentially applicable to other boreal and temperate forest ecosystems where competition problems are similar. This strategy, which uses mechanical treatments only where and when they are needed, is part of a sustainable development perspective used to maintain the long-term biodiversity and productivity of forest ecosystems.


**Keywords**: Herbicides, integrated forest vegetation management, large seedlings, plantation silviculture, competing vegetation, mechanical release, site preparation, early planting, forest productivity, temperate and boreal forests

## Introduction

Controlling competing vegetation is an essential silvicultural practice to ensure an environment favourable to the survival and growth of conifer plantations established in temperate and boreal forests. During the plantation establishment phase, the influence of competing vegetation on environmental conditions, as well as the use of environmental resources by this vegetation, can reduce the growth of the planted species (Wagner et al. 2001). For example, after five years, competition by shade-intolerant hardwoods (e.g., *Prunus pensylvanica*, *Populus tremuloides* and *Betula papyrifera*) reduce the diameter of white spruce (*Picea glauca*) by a factor of three (Jobidon 2000). Herbicides have demonstrated their efficiency in controlling competing vegetation (Pitt et al. 1993). In several situations, they are the most economical method to achieve this (McDonald and Fiddler 1993). However, on some sites the increase seedling growth after herbicide release is not significantly different than for mechanical release (Jobidon et al. 1999). Also, with the public's increasing concerns regarding the potential environmental effects of herbicides, it became necessary to develop alternative solutions to control vegetation (Wagner et al. 1998). The current context of forest certification also encourages moving towards integrated vegetation management strategies, which means not only technically efficient methods, but those that are compatible with social considerations (Wagner 1994).

The Québec government included these concerns in the *Stratégie de protection des forêts* (Forest Protection Strategy), in which it committed to eliminating the use of herbicides in the forest environment (*ministère des Ressources naturelles du Québec* 1994[4]). This key commitment was achieved, and since January 1, 2001 the use of herbicides is no longer authorized in Québec's public forests. This decision triggered the development of preventive silvicultural strategies, initially directed to protecting natural regeneration after harvesting. Cutting with protection of regeneration and soils systematically replaced all other clear-cutting methods. But, reforestation is used to complement natural regeneration when it does not supply an adequate number of quality seedlings within an acceptable time. In this respect, the Forest Protection Strategy favoured a range of alternative solutions in place of herbicides in order to guarantee the establishment and growth of plantations. The objective of this brief is to present the results of research projects that were carried out to evaluate the effectiveness of the proposed alternative solutions and to describe the application procedures. Research defined a forest vegetation management approach without the use of herbicides that is adapted to the ecological characteristics of reforested sites. This approach, applicable to plantations, includes the use and harmonization of site preparation operations, early planting, use of large seedlings (initial mean height of 35 to 45 cm) and mechanical plantation release. This scenario is potentially applicable to other temperate and boreal ecosystems with similar competition problems.

[4] On April 29, 2003, the *ministère des Ressources naturelles du Québec* (MRN) became the *ministère des Ressources naturelles, de la Faune et des Parcs du Québec* (MRNFP).

## Site preparation

Mechanical site preparation is carried out before planting occurs. It's objective is to create an environment that is favourable to seedling survival and growth, as well as to facilitate subsequent plantation maintenance work (Prévost 1992). This intervention was examined in the context of abandoning herbicide use so as to understand its contribution to the establishment of large planting stock and for controlling vegetation. Our studies show that on rich sites with thin organic layer and with a high risk of competition, soil scarification by disk trenching has little influence on soil thermal and hydric regimes or on the density of competing vegetation (Thiffault et al. 2003). Also, there is no marked effect on the growth or physiology of planted seedlings (Thiffault et al. 2003). These research results, combined with the empirical observations of foresters, led to the current practice, which for these sites consists in limiting site preparation to windrowing logging debris while minimizing soil disturbance. Other more intensive site preparation methods, such as mounding (Sutton 1993) and inverting (Örlander et al. 1998), showed potential for improving seedling establishment. However, the possible risks for reducing site fertility through leaching of soil nutrients by over-mixing of soil is a reason for prudence (Prévost 1992).

## Early planting

Planting seedlings the spring following the final harvest allows them to benefit from favourable establishment and growth conditions, since the cutover has not yet been invaded by competing vegetation. No studies have yet precisely documented the effect of early planting. However, in an early reforestation scenario, our research on several study sites indicates that the seedlings planted in plots with or without vegetation control have the same diameter growth one year after planting. Contrary to this, on a site reforested after a year's delay, Wood and von Althen (1993) indicated that control of competition as soon as white spruce and black spruce (*Picea mariana*) are planted significantly increases the diameter of plants in comparison to unreleased controls. Thus, integrating harvesting operations with reforestation strategies results in better plantation establishment.

## Seedling size

Reforestation with large planting stock to reduce the effect of competition has a positive effect on the growth and survival of several species, especially for *Pseudotsuga menzies*ii (Newton et al. 1993), *Pinus radiata* (Mason et al. 1996), *Pinus elliottii* (South and Mitchell 1999), et *Picea sitchensis* (South and Mason 1993).

In order to evaluate the efficiency of this approach for conditions in northeastern North America, we initiated a study to determine the performance of four dimensions of black spruce and white spruce seedlings planted on three sites in Québec. Results show that the largest seedlings have greater photosynthetic capacity, which results in better growth and improved access to environmental resources, mainly light (Jobidon et al. 1998), without becoming susceptible to greater water stress (Lamhamedi et al. 1998). Thanks to the development of containers adapted to their production, large planting stock have no root deformation (Gingras et al. 2002). After eight years of growth, the large planting stock grown in 340 $cm^3$ containers (initial height = 45 cm, initial diameter = 6 mm) have a volume index of 1.3 to 1.5 times greater than do standard seedlings grown in 110 $cm^3$ containers (initial height = 21 cm, initial diameter = 3 mm) (Jobidon et al. 2003). Moreover, growth gains that result from the combination of using large planting stock while controlling the competition are multiplied. The size of the large planting stock (height and diameter) at the time of planting give them greater growth potential than standard seedlings. Moreover, large planting stock are better suited to grow in the presence of competition, given that their large size endows them with a competitive advantage for light. Reforesting with large planting stock should reduce the need for repeated mechanical release and help to achieve better growth following release.

## Mechanical release

Mechanical release of plantations is now the principal method used to control vegetation in Québec. Studies of the effects of mechanical release, carried out for over 15 years in Québec, show that significant gains in diameter growth of black spruce after 5 and 10 years are obtained (Jobidon and Charrette 1997; Jobidon et al. 1999). Moreover, seedlings in release plots have a greater growth rate than do controls. This differential is significantly accentuated over time (Jobidon et al. 1999).

The vigorous vegetative reproduction (either by stump sprouting, root suckering or both) of several competitive species results in the rapid closure of the vegetative cover after it is cut. A second release treatment is sometimes necessary. Research on mechanical release has nevertheless identified the optimal conditions for release. Undertaking release operations during the growth season gives better results in height and diameter growth of conifers (Jobidon and Charrette 1997), because fewer competitive species return.

To ensure that the plantation provides a yield that reflects both the quality of the planted material and the site, it is important to monitor the competitive condition of the seedlings and to release them as soon as conditions dictate. To that effect, one of the commitments of the Forest Protection Strategy was to improve prescription methods for mechanical release, in order to do it at the proper time (number of years after planting) and thereby limit interventions to only when needed. In Québec, an objective decision-making tool was developed to prescribe release treatment based on the quantity of light received by the seedlings in a competitive environment where the height growth of competitive species is finite (e.g., *Rubus idaeus*) (Jobidon 1992; Jobidon 1994). This tool identifies the competitive status of seedlings and the necessity of releasing the plantation. Nevertheless, for sites that have been invaded by shade-intolerant species, the competitive condition may change rapidly because of the difference in growth rate between the conifers and these species. This is why it is important to improve the tool and define the parameters that determine the necessity for plantation release.

We established a network of 14 experimental plantations in three ecological regions to study the combined effect of early reforestation with large planting stock and mechanical release on seedlings and competing vegetation. Treatments studied consist of mechanically clearing some plots after a variable number of years following planting. The analysis of seedling growth curves and invasion patterns of competitive species will help to refine release prescriptions for various ecological conditions. Other aspects of the strategy also need refining. The proposed scenario is, in point of fact, less performing on sites severely invaded by some species, especially *Rubus idaeus*. Indeed, mechanical release results in the accidental cutting of some of the planted conifers, which are hidden by the dense competition. The effect of cutting these young trees on the plantation's productivity has not yet been quantified, but the problem seems a real one.

## Conclusion

The increasing needs of society for timber and its interest in the total preservation of natural forests bears out the importance of plantation forestry for the coming years. Competing vegetation management must consider the principles of integrated forest resource management. Miscellaneous management recommendations regarding the conservation of plantation biodiversity have been drawn up (Hartley 2002), especially concerning the restricted use of herbicides. In this respect, Québec is in the avant-garde since applying the recommendation in the Forest Protection Strategy to eliminate the use of herbicides in public forests. In spite of abandoning herbicides for vegetation control in plantations, the integrated vegetation management strategy, which involves early planting, use of large stock and intensive mechanical release helps bring seedlings to free-to-grow status and maintain their productivity on the majority of reforested sites. The attainment of this important objective is a first in Canada. Eliminating the use of herbicides, as well as using scarification and mechanical release only where and when needed are part of a sustainable development perspective used to maintain the long-term biodiversity and productivity of forest ecosystems.

## References

Gingras, B.M., Richard, S. et Robert, N. 2002. Performance de cinq ans en plantations comparatives de plants résineux de fortes dimensions et de feuillus cultivés dans des récipients à parois ajourées. Mémoire de recherche forestière 141, Direction de la recherche forestière, Forêt Québec, Ministère des Ressources naturelles, Québec, QC. 100 p.

Hartley, M.J. 2002. Rationale and methods for conserving biodiversity in plantation forests. Forest Ecology and Management 155:81–95.

Jobidon, R. 1992. Measurement of light transmission in young conifer plantations: A new technique for assessing herbicide efficacy. Northern Journal of Applied Forestry 9:112–115.

Jobidon, R. 1994. Light threshold for optimal black spruce (*Picea mariana*) seedling growth and development under brush competition. Canadian Journal of Forest Research 24:1629–1635.

Jobidon, R. and Charette, L. 1997. Effet, après 10 ans, du dégagement manuel simple ou répété et de la période de coupe de la végétation de compétition sur la croissance de l'épinette noire en plantation. Canadian Journal of Forest Research 27:1979–1991.

Jobidon, R., Charette, L. and Bernier, P.Y. 1998. Initial size and competing vegetation effects on water stress and growth of *Picea mariana* (Mill.) BSP seedlings planted in three different environments. Forest Ecology and Management 103:293–305.

Jobidon, R., Trottier, F. and Charette, L. 1999. Dégagement chimique ou manuel de plantations d'épinette noire? Étude de cas dans le domaine de la sapinière à bouleau blanc au Québec. The Forestry Chronicle 76:973–979.

Jobidon, R. 2000. Density-dependent effects of northern hardwood competition on selected environmental resources and young white spruce (*Picea glauca*) plantation growth, mineral nutrition, and stand structural development—a 5-year study. Forest Ecology and Management 130:77–97.

Jobidon, R., Roy, V. and Cyr, G. 2003. Net effect of competing vegetation on selected environmental conditions and performance of four spruce seedling stock sizes after eight years in Québec (Canada). Annals of Forest Science (*Accepted*).

Lamhamedi, M.S., Bernier, P.Y., Hébert, C. and Jobidon, R. 1998. Physiological and growth responses of three sizes of containerized *Picea mariana* seedlings outplanted with and without vegetation control. Forest Ecology and Management 110:13–23.

Mason, E.G., South, D.B. and Weizhong, Z. 1996. Performance of *Pinus radiata* in relation to seedling grade, weed control, and soil cultivation in the central North Island of New Zealand. New Zealand Journal of Forest Science 26:173–183.

McDonald, P.M. and Fiddler, G.O. 1993. Feasibility of alternatives to herbicides in young conifer plantations in California. Canadian Journal of Forest Research 23:2015–2022.

Ministère des Ressources naturelles du Québec. 1994. Une stratégie : Aménager pour mieux protéger les forêts. Gouvernement du Québec, FQ94-3051.

Newton, M., Cole, E.C. and White, D.E. 1993. Tall planting stock for enhanced growth and domination of brush in the Douglas-fir region. New Forests 7:107–121.

Örlander, G., G. Hallsby, P. Gemmel and C. Wilhelmsson. 1998. Inverting improves establishment of *Pinus contorta* and *Picea abies*—10 years results from a site preparation trial in Northern Sweden. Scandinavian Journal of Forest Research 13:160–168.

Pitt, D.G., Thompson, D.G., Payne, N.J. and Kettela, E.G. 1993. Response of woody eastern Canadian forest weeds to fall foliar treatments of glyphosate and triclopyr herbicides. Canadian Journal of Forest Research 23:2490–2498.

Prévost, M. 1992. Effet du scarifiage sur les propriétés du sol, la croissance des semis et la compétition : Revue des connaissances actuelles et perspectives de recherches au Québec. Annales des Sciences Forestières 49:277–296.

Sutton, R.F. 1993. Mounding site preparation: A review of European and North American experience. New Forests 7:151–192.

South, D.B. and Mason, W.L. 1993. Influence of differences in planting stock size on early height growth of Sitka spruce. Forestry 66:83–96.

South, D.B. and Mitchell, R.J. 1999. Determining the "optimum" slash pine seedling size for use with four levels of vegetation management on a flatwoods site in Georgia, U.S.A. Canadian Journal of Forest Research 29:1039–1046.

Thiffault, N., Jobidon, R. and Munson, A.D. 2003. Performance and physiology of large containerized and bare-root spruce seedlings in relation to scarification and competition in Québec (Canada). Annals of Forest Science (*Accepted*).

Wagner, R.G. 1994. Toward integrated forest vegetation management. Journal of Forestry 92:26–30.

Wagner, R.G., Flynn, J. and Gregory, R. 1998. Public perceptions of risk and acceptability of forest vegetation management alternatives in Ontario. The Forestry Chronicle 74:720–727.

Wagner, R.G., Bell, F.W. and Campbell, R.A. 2001. Vegetation Management. *In* Regenerating the Canadian Forest: Principles and Practices for Ontario. R.G. Wagner and S.J. Columbo, Eds., Fitzhenry & Whiteside.Markham, ON. pp. 431–457.

Wood, J.E. and von Althen, F.W. 1993. Establishment of white spruce and black spruce in boreal Ontario: Effects of chemical site preparation and post-planting weed control. The Forestry Chronicle 69:554–560.