

Control of *Cronartium ribicola* in *Pinus strobus* plantations

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Summary

After the introduction of white pine blister rust (*Cronartium ribicola*) into North America at the beginning of the century, reforestation with white pine (*Pinus strobus*) became hazardous; the disease caused a high rate of mortality and it was a limiting factor for reforestation. In 1933, a plantation with 300 000 white pines in Valcartier near Quebec City was a complete failure; 60% of the seedlings were killed by the pathogen in less than 20 years. The main control measure applied in the United States during the first half of the century was the eradication of the alternate host, *Ribes* spp. When applied by forest owners in eastern Canada, eradication did not control the disease. Later, pruning was considered as an alternative to eradication. Recent epidemiological studies indicate that the age of the plantation is the critical factor when deciding when it is time to prune. Under conditions prevailing in the Appalachian Mountains in eastern Canada, pruning trials in 11 plantations ranging from 8 to 12 years old indicate very good control of the disease, as very few new infections were observed three years after pruning. In the 14 unpruned plantations, the rate of infection varied from 3% to 35% after three years of observation. It is interesting to note that the diseased trees are located near the *Ribes*, indicating that the short distance infection is very important in the epidemiology of the disease. On these old farm lands, it is recommended to prune white pine 7 to 12 years after planting and to eradicate the *Ribes* that are usually located on old piles of stones.

Key words: *Ribes*

1 Introduction

White pine blister rust (WPBR) caused by *Cronartium ribicola* J.C. Fisch. was observed for the first time in North America in 1906. The disease was introduced from Europe on eastern white pine (*Pinus strobus* L.) seedlings imported mainly from Germany (Maloy 1997). In the province of Quebec, the disease was first observed in 1916 at Macdonald College near Montreal (Pomerleau and Bard 1969). After almost one century on this continent, this disease seems to discourage foresters from growing white pine in eastern Canada. In Quebec, WPBR is the main problem that explains part of the failure of white pine regeneration. In spite of the importance and the great impact of the disease, research on WPBR has decreased during the last fifty

years (Maloy 1997). How do we explain this situation? Is it hopeless to work on this disease or are we waiting for an instant solution that may be provided by new technology?

At the end of this century, in spite of the presence of WPBR, white pine is still present in most of its geographic range, but there are fewer white pines than 100 years ago because of the harvesting of this high value species. It does not regenerate well and when it does, the rust can kill a good portion of the regeneration. Establishment of white pine plantations can help solve the regeneration problem, but again, WPBR is devastating in some regions. Lavallée (1986) divided the province of Quebec into hazard zones based on the work of Van Arsdel *et al.* (1956). However, there are local variations within the hazard zones that can be greater than variations between zones. For example, in hazard zone 1, a northern slope or a humid depression can be as favorable for the rust as in hazard zone 3. Also, there is always the possibility of having "very good years" for the rust as was reported in the first half of the century (Mielke 1943; see Maloy 1997). This means that in northeastern Canada, great care of white pine plantations is needed to achieve success with this species. Foresters and entomologists have to deal with competitive vegetation and white pine weevil, respectively. As pathologists, we have to deal with white pine's most important problem, white pine blister rust, which behaves like a "predator" of this species.

One control measure widely used in the past in the United States was eradication of the alternate host, *Ribes* spp. Its use began in 1909 around tree nurseries and then on a large scale on wild *Ribes* as well as on cultivated ones (Maloy 1997). In Canada, only a few trials were done, like the one reported by Pomerleau and Bard (1969). The efficacy of this treatment was questioned, and in the 1950s, it became less popular with the hope that genetic resistance and antibiotics would solve the problem once and for all. Nevertheless, after 70 years of *Ribes* eradication in the state of Maine, WPBR was reduced significantly (Ostrofsky *et al.* 1988).

Pruning infected branches or systematic pruning is another method to control WPBR (Hunt 1982). When applied in eastern Canada, though, failures to control the disease were commonly recorded. Epidemiological studies showed that under local conditions, age is the critical factor (Lavallée 1992). The incidence starts to increase at the age of 6, 7, or 8 years, and then increases at an exponential rate shortly after that in hazard zone 3, which is very conducive to WPBR.

The objectives of this work were 1) to use systematic pruning to control WPBR in white pine plantations prior to the exponential increase of the disease, and 2) to look at the impact of *Ribes* population in or near a plantation.

2 Material and methods

In 1994, twenty-four white pine plantations located in the Appalachian mountains were selected for this study. Their age varied from 7 to 12 years. These plantations contained between 500 and 6500 stems (mean of 1700) and were all in hazard zone 3 (Lavallée 1986). Since 1994, the incidence of the disease was measured annually, as was the height of the highest infection on the 100 pines sampled at random in each plantation.

In 1995, all the white pines in 10 plantations were pruned up to the height where infection was recorded that year in that particular plantation. Pruning was done with manual pruners. Up to 50% of the whorls were pruned, and at least two whorls were left at the top of the tree in smaller trees. Pines with infection on the trunk were cut down. The other 14 plantations were used as controls. From 1996 on, the incidence of the disease was measured every year the same way in all 24 plantations.

In 1997, all pines of one plantation (A-1-7) were mapped using the software ArcView and infected pines were identified. Using a *Ribes* colony as the center of a circle, percentages of infected trees inside circles of increasing size were calculated.

3 Results

In 1996 and 1997, the incidence of the disease in pruned plantations was stable with nearly 3% of the pines infected; all these infected trees had cankers on the trunk or branches which had not been detected in 1995 (Fig. 1). New infections on the shoots began to appear in 1998; the incidence went up to 10% that year. The increase would have been around 6% but two of the 10 plantations were responsible for the overall high rate of infection. In unpruned (control) plantations (Fig. 1), the incidence rate is continuously increasing, leveling in 1996 and 1997 at 11%, but reaching 18% in 1998.

In the unpruned plantations, the incidence of the disease was higher in plantation number A-1-7 than in the other ones, reaching 35% in 1998 (Fig. 2). There are more infected trees near the infection centre, and the infection rate decreases with distance from the centre (Fig. 3).

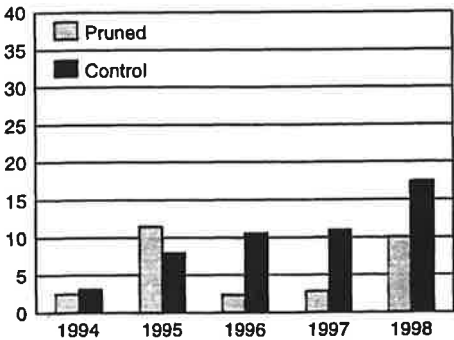


Figure 1. Incidence of white pine blister rust expressed in percentage from 1994 to 1998. The means were calculated for the 10 pruned plantations and for the 14 unpruned (control) ones.

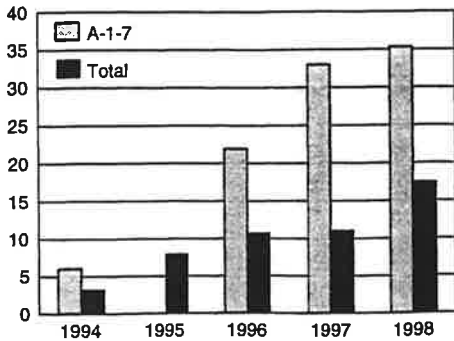


Figure 2. Incidence of white pine blister rust expressed in percentage from 1994 to 1998 in the unpruned plantation A-1-7 as compared with the means of all unpruned (control) plantations.

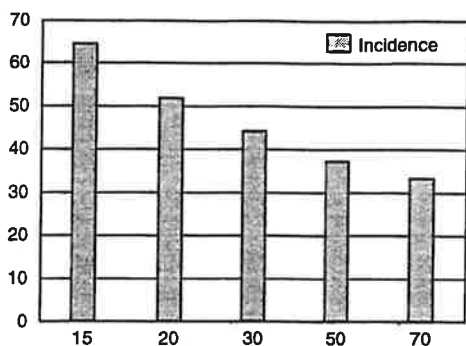


Figure 3. Incidence of white pine blister rust expressed in percentage in plantation A-1-7 with the inside circles increasing in size (meters) from the infection center.

4 Discussion

To be efficient, pruning must be used when white pine plantations are young. The incidence of WPBR does not increase at the same rate everywhere inside a hazard zone; local conditions are very important to determine the age to prune. This is why we recommend evaluating the incidence and severity of the disease in a plantation before any intervention, to help make a decision on the year and height of pruning.

Eradication of *Ribes* may not appear to be a very efficient way of controlling the disease throughout a country. On the scale of a plantation, it is clear that *Ribes* promotes a sharp increase in the incidence of WPBR; the destruction of the alternate host will reduce the annual rate of infection. On old farm land in the Appalachian region, we recommend destroying *Ribes* in and around plantations; *Ribes* is relatively easy to find because it is restricted to stone piles or fences.

Finally, a combination of both pruning and eradication is a very promising tandem in the control of WPBR. Successive pruning may be necessary to keep the incidence of the disease at a low rate. This is not an obstacle, as pruning increases the quality of the logs and it prevents decay by *Fomitopsis pinicola* (Sw.:Fr.) P. Karst., which causes wood decay after entering through branch stubs.

There are other promising paths to control WPBR in forest management practices. In tree nurseries, chemical control can be efficient (Bérubé 1996). The choice of the plantation site is also a very important preventive measure (Lavallée 1986). Biological control is not to be neglected, as thousands of endophytic fungi are not known, offering an enormous source of potential antagonist fungi to pathogens.

References

- Bérubé, J.A. 1996. Use of triadimefon to control white pine blister rust. *Forestry Chronicle* 72: 637–638.
- Hunt, R.S. 1982. White pine blister rust in British Columbia I. The possibilities of control by branch removal. *Forestry Chronicle* 58: 136–138.
- Lavallée, A. 1986. White pine blister rust infection hazard zones. Information Leaflet LFC 23E. Canadian Forestry Service, Sainte-Foy, Quebec, Canada.

- Lavallée, A. 1992. The spread of white pine blister rust in young white pine plantations. Information Report LAU-X-101E. Forestry Canada, Quebec Region, Sainte-Foy, Quebec, Canada.
- Maloy, O.C. 1997. White pine blister rust control in North America: A case history. *Annual Review of Phytopathology* 35: 87–109.
- Ostrofsky, W.D., Rumpf, T., Struble, D. & Bradbury, R. 1988. Incidence of white pine blister rust in Maine after 70 years of a *Ribes* eradication program. *Plant Disease* 72: 967–970.
- Pomerleau, R. & Bard, J. 1969. Les plantations de pin blanc et la rouille vésiculeuse dans le Québec. *Phytoprotection* 50: 32–37.
- Van Arsdel, E.P., Riker, A.J. & Patton, R.F. 1956. The effects of temperature and moisture on the spread of white pine blister rust. *Phytopathology* 46: 307–318.