NODA notes
NODA • EDNO
CANADA ONTARIO
Northern Ontario Development Agreement
Entente de développement du nord de l'Ontario
Forestry • Foresterie

NODA Note No. 21

VEGETATIVE AND SEEDLING REGENERATION OF PIN CHERRY (*PRUNUS PENSYLVANICA*): EFFICACY OF HERBICIDE TREATMENT

A.U. Mallik, G.W. Peterson, and F.W. Bell

INTRODUCTION

Pin cherry (*Prunus pensylvanica* L. f.) is a major competing plant commonly found in young conifer plantations in both boreal and northern hardwood forests (Martin and Hornbeck 1990). To ensure silvicultural success, control of this plant is often necessary. Commonly used forest herbicides, such as Vision® (a.i. glyphosate), can be used to control pin cherry, but regeneration can result from seeds present in the postherbicide environment. Marks (1974) reported that in northern hardwood forests, pin cherry stem density increased with disturbance. No information was available on the pin cherry soil seed bank in the boreal forest. The objectives of the present study were to determine, for pin cherry, a) the ratio of the current year's seedling recruitment vs. previous year's stem density in a 7-year-old jack pine (*Pinus banksiana* Lamb.) plantation, b) seed production, c) the soil seed bank, and d) the efficacy of Vision® herbicide treatment to control this competitor.

STUDY SITE

The field study was conducted in a 7-year-old jack pine plantation in Block 164 of the Seine River Forest Management Area, 58 km north of Atikokan, Ontario. The site was previously occupied by mature jack pine. Major competitors in the young plantation were trembling aspen (*Populus tremuloides* Michx.), pin cherry, green alder (*Alnus viridus* [Chaix.] DC. spp. *crispa* [Dryander ex Aiton] Turrill), and beaked hazel (*Corylus cornuta* Marsh.). The seed bank study was conducted in both control and Vision®-treated plots. Vision® treatment (1.5 kg a.e. glyphosate/ha) was applied aerially in August 1992 to four 2.0-ha plots randomly located throughout the study site. The soil seed bank was studied in the summers of 1993 and 1994.

MATERIALS AND METHODS

Vegetative and Seedling Regeneration

The numbers of current year seedlings, basal sprouts, and root suckers were counted in 0.5 m-radius circular quadrats around the closest mature pin cherry tree, outside a 5-m x 10-m replicate subplot. Each 2.0-ha treatment plot had three 5-m x 10-m subplots. Altogether, 12 subplots were studied in the control plots and 12 in the treated plots.

Seed Production

All pin cherry drupes were collected from a mature tree in each plot in mid-August, and height and crown diameter of the trees were recorded. The drupes were classified into overripe (dark red to black), ripe (red), and unripe (green) categories. Ripe seeds were used for germination experiments.

Soil Seed Bank

Ten-centimeter diameter metal corers were used to collect soil samples from four corners of each subplot. To determine the soil seed reserve, seed extraction and counting, and seedling emergence methods were used. A total of 2 520 cm³ (four cores) of soil was mixed together for each seed extraction composite sample, for a total of 12 samples. For the seedling emergence study, 630 cm³ of soil were taken from each of the 12 composite samples. The soil volumes used were comparable to that used by other researchers (Conn et al. 1984, Ebersole 1988, Benoit et al. 1989, Mladenoff 1990, Brown 1992). For the seed extraction study, the soil samples were air dried for 3 days at 28°C, followed by sieving through a 2-mm screen (Conn et al. 1984, Brown 1992). The remaining debris and seeds were suspended in water and passed through another sieve. The samples were then examined for whole (entire) and partial (fragmented) seeds, according to Ebersole (1988), Flyes (1988), and Mladenoff (1990).

Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts

Ontario
Ministry of Natural Resources / Ministère des Richesses naturelles

For the seedling emergence study, the soil samples were mixed by hand and then spread approximately 1.5 cm thick over a bed of peat moss placed in 21-cm x 21-cm x 5-cm deep aluminium trays. Five trays with only peat moss were kept as controls to determine the natural colonization from airborne seeds in the greenhouse. The greenhouse day and night temperatures were 23°C and 18°C, respectively, with an 18-hour day length supplemented by sodium lamps. The number of emerging seedlings was counted weekly (Schopmeyer 1974), and the experiment was terminated after 4 months.

Vegetative Regeneration Strategies

The mode of vegetative regeneration of pin cherry was studied by excavating 16 pin cherry clones, including their underground components, from the control plots. The excavated clones were measured for the following above- and belowground parameters: number of shoots per clone, height of shoot, crown diameter, diameter of root at suckering, intersproutal distance, shoot and root biomass, and stem age.

Efficacy of Vision® Treatment

Efficacy of the herbicide treatment in controlling pin cherry was studied by determining the number of living and dead stems in each of the twelve 5-m x 10-m control and treated plots. These data were collected in pretreatment, and in first and second year posttreatment of Vision®. Stem density was expressed on a per hectare basis.

RESULTS

Vegetative and Seedling Regeneration

Vegetative regeneration by suckering was more common than seedling regeneration in the control plots. In Vision® treated plots, all previous year's vegetative or seedling propagules were dead, and pin cherry regenerated exclusively from seedlings (Table 1). The number of overripe, ripe, and unripe fruits were estimated to be 37 500, 225 002, and 10 417 per ha, respectively, in the control plots. All mature pin cherry stems were killed in the Vision®-treated plots.

Soil Seed Bank

Soils of Vision®-treated plots had significantly more pin cherry seeds (955 ± 73 seeds/m^2) when compared to the control plots (191 ± 10 seeds/m^2). When the seed bank at the study site was compared to that of other hardwood and softwood forest sites, large variations were observed (Table 2).

Vegetative Regeneration Strategies

Pin cherry regenerates vegetatively by root suckering and by stem base sprouting. Characteristics of the above- and belowground organs of the shrub in a 7-year-old plantation in northwestern Ontario are presented in Table 3. The proportion of root and shoot biomass is almost equal. A little over two stems per clone having 53 cm between sprouts, indicates that on this particular site stem density was not very high. However, the mean shoot height was equal to or slightly taller than the canopy of the planted jack pines.

Efficacy of Herbicide Treatment

Vision® treatment caused significant mortality of pin cherry shoots. Stem mortality by natural thinning was 20 percent in the control plots, but in the herbicide treated plots it was 66 percent and 86 percent in Years 1 and 2, respectively, after Vision® treatment (Fig. 1).

Table 1. Vegetative and seedling regeneration of pin cherry 1 year after Vision® treatment.

Treatment		Current year's seedlings		Previous year's stems (vegetative)	
		Number per ha	Height (cm)	Number per ha	Height (cm)
Control	Alive	313	16	1 875	114
	Dead	0	–	0	–
Vision®	Alive	3 125	11	0	–
	Dead	0	–	3 187	117

Note: The majority of the previous year's stems were 2–7 years old.

Table 2. Pin cherry soil seed bank in different geographical locations.

Source	Location	Number of seeds/ha	
		Whole seeds (x1000)	Partial seeds (x1000)
Present study (1993)	Atikokan (control)	1 910	1 273
Present study (1993)	Atikokan (Vision®)	19 550	8 913
Marquis (1975)	Pennsylvania hardwood forest	2 134	–
Marks (1974)	New Hampshire hardwood forest	425	2 000
Brown (1992)	Southern Ontario hardwood forest	174	–
Olmsted and Curtis (1947)	Maine 24-year-old softwood forest	108	–
	Maine 50-year-old hardwood forest	2 260	–
	Maine 110-year-old hardwood forest	1 184	–

Note: No pin cherry seedlings were produced during a 4-month-long viable soil seed bank study at the greenhouse.

Table 3. Above- and belowground growth parameters of pin cherry in a 7-year-old jack pine plantation in northwestern Ontario.

Plant parameters	Mean value ± s.e.
Number of shoots/clone	2.3 ± 0.4
Height of shoot (cm)	131 ± 7
Crown diameter (cm)	77 ± 8.4
Root diameter at suckering (cm)	1.41 ± 0.15
Intersproutal distance (cm)	53 ± 20
Shoot biomass (g)	238 ± 46
Root biomass (g)	6 ± 0.7
Stem age (yr)	77 ± 8.4

DISCUSSION

Mode of Regeneration

Pin cherry regenerates from seeds, and vegetatively from root suckers and basal sprouts. Vegetative regeneration has a distinct advantage over seed regeneration because it is not dependent on seedbed conditions and is supported by the parent root system (Zasada 1971). In this study, seedling regeneration was most common in the Vision®-treated plots, whereas root suckering was characteristic of the control plots. However, this may be misleading, because 69 of the 72 quadrats had no form of propagule. The presence of many seedlings in the treated plots and few in the control plots is in agreement with the findings of Marks (1974). Thompson (1978) suggested that to avoid extinction, plants on a regularly disturbed site produce more seeds than those on undisturbed sites. Zasada et al. (1992) suggested that the dead parent plant acts as a nurse to stems, moderating the microclimate to enhance germination. In undisturbed plots, the plants allocate more energy for vegetative growth to outcompete the surrounding vegetation. Marquis (1975) found very few pin cherry seedlings under a closed canopy. Seed production in the control plots (272 918 drupes/ha) was much lower than that obtained from a 15-year-old hardwood stand (2.76 million drupes/ha) in New Hampshire (Marks 1974). The young age of the plants and the northern location of the study site may be responsible for low drupe production.

Soil Seed Bank

The number of whole seeds (1 910/ha) in control plots is comparable to that obtained by others in the hardwood forests of the northeastern United States (Olmsted and Curtis 1947; Marquis 1975). Large numbers of partial seeds in the soil seed bank of both control and treated plots indicate a significant degree of seed predation. The total soil seed bank in the Vision®-treated plots was nearly six times greater than in control plots. However, nearly one-half of the soil cores from the Vision®-treated plots had no pin cherry seeds. Most of the seeds were found in the three closely replicated plots; therefore, the large soil seed bank in Vision®-treated plots may be an artifact of the sampling method. A large sample size and stratified random sampling, rather than a simple random design, may solve the problem. Brown (1992) found that at least 100 samples were required to bring the variance to within 10 percent of the mean. No reference to the size of pin cherry seed banks was found in the literature that dealt with disturbed forests.

The lack of pin cherry seedlings found using the emergent method is to some extent in agreement with Brown (1992), who found little correlation between the emergent and extraction methods. Pin cherry has very specific temperature and moisture requirements for germination (Schopmeyer 1974) that may not have been met under the greenhouse conditions.

Efficacy of Herbicide Treatment

Vision® herbicide treatment significantly reduced live stem density of pin cherry, with a concomitant increase in the density of dead stems, thereby indicating that successful control of pin cherry can be achieved by using this herbicide.

CONCLUSIONS

1. Vegetative regeneration in the form of root suckering and basal sprouting is the principal mode of regeneration of pin cherry, although the shrub can also regenerate from seeds.

2. Release treatment with Vision® may effectively control the shrub's vegetative growth. However, it regenerates by seedling establishment following the herbicide treatment.

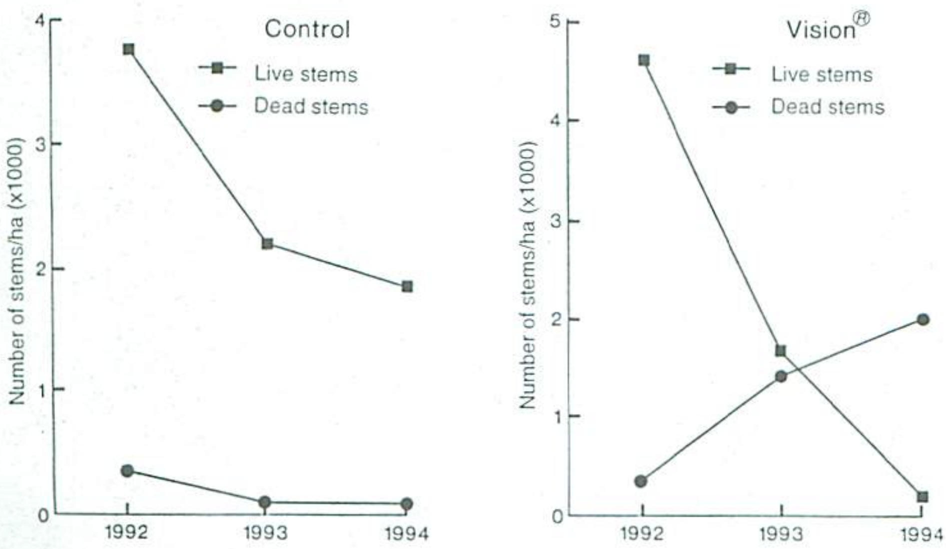

Figure 1. Number of live and dead pin cherry stems in the year before and the 1 and 2 years after Vision® treatment.

3. The size of the soil seed bank in the control plots corresponds with the volume of seed production. The seed bank in Vision®-treated plots was greater, but this may be due to the small sample size and the random sampling design. Further studies with a large sample size and stratified random design may alleviate the problem.

4. The emergence method is not suitable for testing the soil seed bank of pin cherry because of the absence of seedling emergence, whereas strong evidence of a soil seed bank was obtained by using the seed extraction method.

ACKNOWLEDGMENTS

This research was funded by the Northern Ontario Development Agreement (NODA), Northern Forestry Program. The authors wish to thank C. Hollstedt of the Ontario Ministry of Natural Resources, Northwest Region Science and Technology Unit, and J. Keene of Rainy River Forest Products for their assistance in field work logistics. Comments of the reviewers were useful in revising the manuscript.

LITERATURE CITED

Benoit, D.L.; Kennel, N.C.; Cavers, P.B. 1989. Factors influencing the precision of soil seed bank estimates. Can. J. Bot. 67:2833–2840.

Brown, D. 1992. Estimating the composition of a forest seed bank: A comparison of the seed extraction and seedling emergence methods. Can. J. Bot. 70:1603–1612.

Conn, J.S.; Cochrane, C.L.; DeLapp, J.A. 1984. Soil seed bank changes after forest clearing and agricultural use in Alaska. Weed Sci. 32:343–347.

Ebersole, J.J. 1988. Role of the seed bank in providing colonizers on a tundra disturbance in Alaska. Can. J. Bot. 67:466–471.

Flyes, J.W. 1988. Seed bank populations in upland coniferous forest in central Alberta. Can. J. Bot. 67:274–278.

Marks, P.L. 1974. The role of pin cherry (*Prunus pensylvanica* L.) in the maintenance of stability in northern hardwood ecosystems. Ecol. Monogr. 44:73–88.

Marquis, D.A. 1975. Seed storage and germination under northern hardwood forests. Can. J. For. Res. 5:478–484.

Martin, C.W.; Hornbeck, J.W. 1990. Regeneration after strip cutting and block clearcutting in northern hardwoods. North. J. Appl. For. 7:65–68.

Mladenoff, D.J. 1990. The relationship of the soil seed bank and understory vegetation in old-growth northern hardwood–hemlock treefall gaps. Can. J. Bot. 68:2714–2721.

Olmsted, N.W.; Curtis, J.D. 1947. Seeds of the forest floor. Ecology 28:49–52.

Schopmeyer, C.S. 1974. Seeds of woody plants in the United States. USDA For. Serv., Washington, DC. Agri. Hdbk. No. 450. 883 p.

Thompson, K. 1978. The occurrence of buried viable seeds in relation to environmental gradients. J. Biogeog. 5:425–430.

Zasada, J.C. 1971. Natural regeneration of interior alaska forests: Seed, seedbed, and vegetative reproduction considerations. p. 231–246 *in* C.W. Slaughter, R.J. Barney and G.M. Hansen, eds. Proc. Fire in the Northern Environment. 13–14 April 1971, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. USDA For. Serv., Washington, DC. 275 p.

Zasada, J.C.; Sharik, T.L.; Nygren, M. 1992. The reproductive process in boreal forest trees. p. 85–125 *in* H.H. Skujart, R. Leemans and G.B. Bonan, eds. A System Analysis of the Global Boreal Forest. Cambridge University Press, Cambridge, England.

Additional copies of this publication are available from:

Natural Resources Canada
Canadian Forest Service–Sault Ste. Marie
Great Lakes Forestry Centre
P.O. Box 490
Sault Ste. Marie, Ontario
P6A 5M7
(705)949-9461
(705)759-5700(FAX)

Catalogue No. Fo 29-41/21-1996E
ISBN 0-662-24096-0
ISSN 1198-2233

This report is printed on recycled paper.

Canada