Weed management in forest nurseries in Quebec : problems and possible solutions

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Abstract

Pesticide management is currently undergoing a period of instability : the federal pesticide registration process is

code is under preparaticn. Forest nurseries have taken certain actions aimed at stabilizing the situation : they have applied for the limited registration of one pesticide (Goal) and for the registration of certain other products *(AWK #1,* etc.) under the Minor Use of Pesticides Program. Field tests are being done to identify herbicides which can be used in forest nurseries. These tests focus on several areas : softwood production in the open field, containerized seedlings, hardwood seedlings, perennial weed control, and the search for alternatives to pesticides.

Résumé

La repression des mauvaises herbes dans les pepinieres forestieres au Quebec : *problemes et solutions possibles. Presentement la gestion des pesticides se fait dans un climat instable : revision du systeme federal d'homologation des pesticides, code de gestion provincial des pesticides en cours d'elaboration. Des actions sent prises par les pepinieristes forestiers pour regulariser la situation : demande pour herbicide a emploi restreint (* Goal), *demandes d'homologation par* /e *Programme des pesticides* a *emploi limits (* AWK #1 et *autres). Des essais au champ se continuent afin* de *reconnaitre les herbicides possédant un potentiel d'utilisation en pepiniéres forestieres. Ces essais scat effectues dans plusieurs secteurs : resineux en plein champ, cultures en recipients, culture des feuillus, repression des mauvaises herbes vivaces et meme recherche de methodes alternatives.*

Introduction

In Canada, the use of pesticides is governed by the Pest Control Products Act, which is administered by the federal department of agriculture. Almost a year ago, in response to numerous complaints about the implementation of this legislation, Agriculture Canada began to revise the current pesticide registration process. The concerns and needs of the forest sector, and more specifically of forest nurseries, have been shared with the revision committee.

At the provincial level, Quebec passed the Pesticides Act in June 1987 in order to reduce and rationalize the use of pesticides in this province. The Pesticides Act solidly backs the federal legislation and provides, among other things, for a pesticide management code. A preliminary version of this document was submitted for consultation by Quebec's ministry of environment, and a second version is now being prepared.

Nurserymen therefore find themselves in a period cf instability with respect to pesticide management. It is also an ideal moment for us to take a close look at our approach and practices. With this new legislation, it is increasingly difficult for nurseries to justify their use of pesticides that are registered for agricultural crops. Nurseries must work together and reach a consensus as to which products we wish to continue using. If need be, we will have to apply under the Minor Use of Pesticides Program to have the products we consider essential for seedling production registered for use in forest nurseries.

The herbicidal oil, *AWK #1,* ill ustrates the situation well. *AWK #1* is registered as an agricultural product and is used for carrot, parsnip, parsley, fennel, celery, cranberry and asparagus crops, sometimes in doses much higher than those used on forest seedlings. Canadian forest nurseries have been using this product for several decades now, despite the fact that use of the product on young seedlings is not specified on the label. This irregularity was recently made public in Ontario, where it caused quite an uproar. Quebec nurseries are no longer willing to purchase this very useful product, fearing possible consequences. Despite the fact that nurserymen had been using *AWK #1* safely for many years, tests had to be carried out, and the results submitted along with an application for registration under the Minor Use of Pesticides Program. The registration application, prepared by Mrs. Irvine cf Ontario Natural Resources and *J.* Maxwell of British Columbia's Ministry of Forests, was submitted to Agriculture Canada early this year. We are still waiting for an answer.

Canadian forest nurseries engaged in a second joint effort, this time to obtain limited registration for the use of *Goal* (oxyfluorfen), a herbicide which can currently be used only by onion producers. A national experiment plan was drawn up and sent to the nurseries in order to generate the data needed for registration of this product. All the nurseries agree that *Goal* is an excellent product for weed control with both bareroot and containerized seedlings. They further agree that this pesticide is safe for most softwood species. The Canadian Forest Nursery Weed Management Association and *Rohm and Haas Canada Inc.* therefore sponsored a cost-benefit analysis on the management of competing vegetation in forest nurseries. The analysis was done by a firm of consultants. Agriculture Canada is currently studying the application which was submitted early in 1990. We are still waiting for answer.

Our chemicals

At Berthier, we have been testing herbicides for several years now, to identify products that are suitable for use in forest nurseries and to gather the data needed for their registration. Many herbicides have been evaluated over the years but, if we must limit ourselves to products that are safe and effective with our crops and that are already registered - at least for agricultural use - then the choice is somewhat more limited. The following are the herbicides *we* normally use:1

(Doses are given in commercial product per hectare.)

Softwoods 1-0:

– preemergence :	*Enide 50 WP*, 12.0 kg *Devrinol 50 WP*, 4.0 kg *Reglone*, 2.0 *L*
– postemergence: (6 weeks)	*Devrinol 50 WP*, 4.0 kg *AWK #1*, 175 *L* *Amizol 90 SP*, 0.5 kg (spruce only) *Fusilade*, 1.0 *L*

Softwoods 2-0:

– before budbreak :	*Simazine 80 WP*, 1.5 to 2.0 kg
– after budbreak :	*AWK #1*, 375 *L* /ha *Amizol 90 SP*, 1.0 kg (spruce only)

Softwoods after transplanting:

– *Simazine 80 WP*, 1.5 to 2.0 kg
– *AWK #1*, 375 *L*/ha
– *Amizol 90 SP*, 1.0 kg (spruce only)
– *Dual EC*, 2.6 *L* (mixed with *Simazine* for yellow nut sedge)
– *Devrinol 50 WP*, 4.5 kg (mixed with *Simazine*)

Hardwoods 1-0:

– after sowing (preemergence) :	*Lorox L*, 3.0 *L*
– postemergence :	*Fusilade*, 1.0 to 2.0 *L*

Hardwoods 2-0:

– before budbreak :	*Ekko 80 W*, 2.0 kg

1 Within the meaning of the Fast Control Products Act, these products are not necessarily registered for use in forest nurseries.

Effect of organic matter on herbicides

Good weed control is essential in the year the crop is sown. The young plants offer very little competition for weeds at this stage of their development, and hand weeding is very costly and uproots or weakens many plantlets. Because of this, in 1989, we drew up a plan for experiments comparing nine herbicides with respect to their weed control capacity and harmlessness with seedlings.

The amount of organic matter in the soil varies from one nursery to the next and even from one sector to another within a given nursery. We felt it would be interesting to compare the action of these nine herbicides in relation to this factor. The soils at Berthier are relatively low in organic matter (1.65 to 2.50%). To simulate a soil with high organic content, we mixed in peat moss, after the seedbed had been shaped. We then added a thin layer of peat moss to the surface. In all, the equivalent of 250 m^3/ha was added (At the Berthier nursery, this has been part of the routine preparation of softwood seedbeds for the past several years).

The results of this test show that peat moss generally protects seedlings against the toxicity of certain herbicides but, at the same time, proportionately reduces the products' ability to control weeds. This matches the theory that organic matter reduces herbicidal action because of its high molecule adsorption capacity. Despite the fact that more weeds were present in the sector with added peat moss, hand-weeding time does not seem to have been proportionately higher. This is because of easier weeding in soil to which peat moss has been added.

In the test, the following parameters were measured for the Norway spruce and red pine in regular soil and soil to which peat moss had been added : seedling height, number of seedlings per given area, and average dry weight of shoots and roots. The overall appearance of the seedlings was also assessed. I have included only the list of recommendations that resulted from the analysis of these data, along with the table indicating post-treatment weed cover and hand-weeding time. These data will be useful in the selection of herbicidal products (Complete test results are available from the Berthier nursery).

In situations requiring a herbicidal product which is safe for both spruce and pine, and effectively controls weeds in soil with low organic content (no peat moss), diphenamid, napropamide and a low dose of lactofen can be used. If organic content is high (peat moss added), the selection is much wider : ethalfluraline, linuron and oxyfluorfen provide interesting results. Diphenamid and napropamide, on the other hand, are less satisfactory because of reduced weed control effectiveness – unless they are mixed with other herbicides. Further tests are required in this area.

Perennial weeds

Certain perennial weeds may become a problem in 2-0 crops or after transplanting. At Berthier, we must deal with yellow nut sedge *(Cyperus esculentus).* In one season, this plant produces rhizomes, develops new seedlings and may spread into large, very dense colonies. Unless all new shoots are eliminated, they in turn will produce tubers which can live for several years (four on average), and the weed will maintain a high reinfestation potential.[2] When possible, crop rotation should be introduced, using crops that compete with sedge. If a herbicide can be used, this will increase the rate of elimination. Our tests at Berthier have shown that, if an infestation has been predicted for the year that conifer seedlings are to be transplanted, metolachlore can be used safely and provides satisfactory control of sedge.

Creeping yellow cress *(Rorippa sylvestris)* is another perennial that must be keep under control. This weed appeared in the nursery fields at Berthier three years ago. Amitrole is the only chemical that controls this weed among seedling crops, but new control methods must be found as this active ingredient may not always be commercially available. Other nurseries must deal with other specific perennials : coltsfoot *(Tussilago farfara),* which usually grows along the edge of ditches, is found increasingly among the crops at Duchesnay, while field horsetail *(Equisetum arvense)* and tufted vetch *(Vicia cracca)* are an ongoing problem at Sainte-Luce. Perennials are particularly difficult to eliminate. Control methods must be adapted to each species, taking both seedling characteristics and weed biology into consideration.

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2 Daniel Cloutier, *Regie des populations de souchet. In :* Rapport sur la journee d'information sur la malherbologie, Conseil des productions vegetales du Quebec, 1986.

Table 1 : Recommendations based on the effects on conifer seedling growth of preemergence treatments applied **to soil with** and without **peat moss**

No.	Product	Rate a.i. kg/ha	With peat moss		Without peat moss	
			Norway spruce	Red pine	Norway spruce	Red pine
1	*Diphenamid*	6.0	–	–	–	2 *L*
2	*Ethalfluraline*	1.5	–	–	X	X
3	*Ethalfluraline*	3.0	X	X	X	X
4	Hexazinone	0.125	X	2 *L*	X	X
5	Hexazinone	0.250	1 *L*	–	–	X
6	*Lactofen*	0.5	–	–	–	–
7	*Lactofen*	1.0	1 *L*	–		X
8	*Linuron*	1.0	–	1 *L*	X	X
9	*Linuron*	2.0	X	X	X	X
10	*Metobromuron*	1.0	X	1 *L*	–	X
11	*Metobromuron*	2.0	X	X	X	X
12	Napropamide	2.0	–	–	–	–
13	Napropamide	4.0	–	–	–	1 *L*
14	*Oxyfluorfen*	0.5	–	–	X	X
15	*Oxyfluorfen*	1.0	X	X	X	X
16	*Prometryne*	1.12	1 *L*	2 *L*	–	1 *L*
17	*Prometryne*	2.24	X	–	X	X
18	*Lactofen* + napropamide	0.3 + 2.0	–	–	–	1 *L*

X = Not recommended. This symbol is obtained when one or more growth characteristics are significantly lower than for seedlings in the weeded control, or when general appearance rates lower than 90%.
L = The accompanying number indicates how many growth characteristics obtained !ow results without differing significantly to the weeded control.
- = Results not significantly different to those obtained in the control.

Growing containerized softwoods

While greenhouse or tunnel cultivation reduces weed infestation during the first growing season, cultivation in containers does have its share of weed-related problems. In mid-season of the first year of growth, liverwort *(Marchantia polymorpha,* a primary plant) germinates and starts to grow in the containers. In fall, the seedlings are placed outside to complete their development. During the second season, envigorated by the warm, humid conditions of the tunnel, the liverwort continues to develop. A serious liverwort infestation not only competes with the seedlings for water and nutrients, but may also promote the development of "adventurous roots," i. a roots which grow on the surface of the container because of the moisture created by the accumulation of liverwort thalli.

Improved humidity control in the tunnel will discourage the establishment of liverwort. If, despite this precaution, an infestation is predicted for the second season, the weed must be eliminated with a chemical.

Tests done at Berthier have shown that oxadiazon *(Ronstar G),* when applied as soon as liverwort first appears in the tunnel, controls and prevents its development for more than one season. This product, which is entirely safe for use with seedlings, has not yet been registered in Canada. Oxyfluorfen *(Goal))* prevents liverwort germination but is totally ineffective once the weed is established. Because this chemical is toxic for seedlings 1-0 under tunnel, it is used only during the second year, before budbreak on 2-0 seedlings. If, during this period, liverwort thalli from the previous year are found in the

Table 2 : Weed **cover and** hand-weeding time in conifer seedling beds given preemergence herbicidal **treatments in soil with and** without peat moss

No.	Product	Rate a.i. kg/ha	Weed cover (%)		Hand weeding (min/plot)	
			with*	without*	with*	without*
1	*Diphenamid*	6.0	24.3 b	8.3 b	4.20 b	3.97 b
2	*Ethalfluraline*	1.5	2.3 f	1.0 d	X	X
3	*Ethalfluraline*	3.0	0.5 f	0 d	X	X
4	Hexazinone	0.125	23.0 bc	2.5 cd	X	X
5	Hexazinone	0.250	7.8 ef	0.3 d	X	X
6	*Lactofen*	0.5	11.0 cdef	8.5 b	1.34 cd	1.17 cde
7	*Lactofen*	1.0	2.8 f	2.5 cd	0.54 d	0.56 de
8	*Linuron*	1.0	10.3 def	1.0 d	1.71 cd	0.32 e
9	*Linuron*	2.0	2.0 f	0 d	0.25 d	0.05 e
10	*Metobromuron*	1.0	13.0 bcdef	2.8 cd	1.95 cd	1.49 cd
11	*Metobromuron*	2.0	6.8 ef	0.3 d	0.92 d	0.61 de
12	Napropamide	2.0	21.8 bcd	9.3 b	3.82 b	1.98 c
13	Napropamide	4.0	9.3 def	6.8 bc	2.97 bc	2.22 c
14	*Oxyfluorfen*	0.5	4.0 ef	0.4 d	0.69 d	0.35 de
15	*Oxyfluorfen*	1.0	0.8 f	0 d	0.25 d	0.27 e
16	*Prometryne*	1.12	25.5 b	1.0 d	X	X
17	*Prometryne*	2.24	16.3 bcde	0 d	X	X
18	*Lactofen* + napropamide	0.3 + 2.0	3.8 ef	1.0 d	0.57 d	0.37 de
19	Unweeded control bed		63.0 a	61.8 a	7.70 a	8.12 a
20	Weeded control bed					
		LSD (0.05) =	(12.63)	(4.85)	(1.77)	(1.16)

= Soil with or without peat moss.
X = No data.
Means followed by the same letter are not significantly different.

containers, it is best to use low doses of simazine or chloroxuron *(Tenoran)* (Our next tests will determine the doses required for all species grown in containers). Chloroxuron provides longer-lasting liverwort control, although simazine is more effective with others weeds. Simazine, oxadiazon and, to a lesser degree, oxyfluorfen also control the moss that often grows along with liverwort in the containers.

Other than the very special problem of liverwort and moss, which can sometimes cause considerable loss, a wide variety of weeds is found among container-grown seedlings. These include grasses, broadleaf species, members of the sedge family and undesirable hardwoods. Depending on the year, the type of seedlings, and the type of container, these weeds may be present in more or less significant numbers. It is not always easy to attain chemical control adapted to each weed, especially if the problem becomes apparent only during the seedlings' growing season. It is easier to prevent the growth of weeds by using preemergence herbicides early in the season, rather than trying to control them once the seedlings have emerged.

The seedlings are also less vulnerable early in the season, before the buds have broken. Further tests are needed in the area of weed management with containerized seedlings.

Hardwoods

Intensive hardwood production in nurseries is a fairly recent phenomenon in Quebec, as is the experimental use of herbicides in this area. The herbicides normally used in softwood production are not necessarily adapted for use with hardwoods. To date, herbicide test results indicate that there is a wide range of tolerance among the hardwood species. Testing will have to be done with all the reforestation species grown in nurseries.

Linuron *(Lorox)* has proven to be the most satisfactory of all the preemergence herbicides used against weeds in hardwood production. This product is very selective with respect to the high-value hardwoods tested : maples, oaks and walnuts. At the same time, linuron prevents the germination of undesirable hardwoods such as poplars and willows, which occasionally infest the seedling crop. If some grasses persist after treatment with linuron, fluazifop-butyl *(Fusilade)* can be used with post-emergence hardwoods. This product is selective for numerous hardwoods.

New techniques

At Berthier, we have been using a *Bartschi* mechanical brush with some crops, where soil conditions permit. The brush reduces, but does not eliminate, the need for hand weeding.

We are currently undergoing our first attempts at intercropping. In theory, intercropping competes with weeds without harming the main crop, thus reducing the need for herbicides.

Herbicides are effective, relatively low-cost tools. At the same time, alternative weed management methods do exist and are worth developing and integrating into a weed management program. We are working on it !

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8	*Linuron*	1.0	10.3 def	1.0 d	1.71 cd	0.32 e
9	*Linuron*	2.0	2.0 f	0 d	0.25 d	0.05 e
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