



# Seed and Seedling Extension Topics

## Robb Bennet - Editor

It is the policy of this newsletter to regularly shift editorship responsibilities between the Seed Services and Nursery Services Sections of Silviculture Branch. Eric van Steenis will edit the next volume of Seed and Seedlings Extension Topics. All future correspondence should be addressed to him at:

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I have greatly enjoyed my two year term as editor and look forward to serving again. For me it was an excellent

introduction to the reforestation business in BC and the people involved in it. Over the past two years new subscriptions have steadily come in and the newsletter is now mailed out to over 400 addresses in North America, Asia, and Europe.

In this issue we explore further the issue of seed orchard seed *versus* natural stand seed with a paper comparing seedlots germinated and grown under various conditions. Additionally there are articles on western white pine stratification trials, quick cone maturity determination, peat plugs, the BC Tree Seed Dealers Association, the 1993 seed orchard cone harvest (a bumper year), and insects as food as well as a variety of shorter notes on diverse topics. Please read on ...

## Saanich Test Nursery Closing Down

In August 1993, BC Ministry of Forests Silviculture Branch decided to close down Saanich Test Nursery on Vancouver Island. The test nursery program will be consolidated with the Green Timbers Reforestation Centre in Surrey.

Saanich Test Nursery was started in the early 1980's by Allan MacDonald and Glen Matthews of Silviculture Branch. Technical assistance on the site has been provided by Susan Zedel, Bevin Wells, and Jean Hale. The move will not result in the layoff of any regular staff as positions are being found in Silviculture Branch (Victoria) and at Green Timbers.

Work at the nursery has been instrumental in the development of stryoblocks, media, fertilizer regimes, stock types, and many other aspects of forest seedling culture in

BC. Trials have also included work on integrated pest management for nurseries. Over the years, the test nursery has cooperated with a number of agencies in the development of these nursery production methods. Cooperators have included the Canadian Forest Service, Nursery Extension Services, Seed Orchard Pest Management (Silviculture Branch), Research Branch, BC Research Corporation, University of Victoria, Simon Fraser University, Beaver Plastics, and ICI Chipman, to name a few. The nursery industry in BC has benefited greatly from the work at Saanich Test Nursery and the facility will be missed.

**Don Summers**  
Nursery Extension Services, Surrey

## The British Columbia Tree Seed Dealers Association

"Tree Seed is the principal means of perpetuation of most tree species from one generation to the next." Despite the fact that seed is such an essential component of almost all reforestation programs in BC, it often does not receive as much consideration as other aspects of silviculture. The BC Tree Seed Dealers Association was formed in 1990 to

improve and promote this aspect of the Forest Industry. The purposes of the Association are:

- to provide a forum for discussion of areas of concern with both Forestry Canada and the BC Ministry of For-

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ests regarding cone and seed collection, seed certification, cone and seed processing and handling, seed registration and testing, and seed distribution;

- to act as a vehicle for communication between seed dealers and users of tree seed;
- to encourage cooperation between seed dealers in areas of mutual concern, particularly seed collection and technology transfer;
- to encourage and assist both Forestry Canada and the BC Ministry of Forests with respect to the direction of forest tree seed research; and
- to provide information to assist tree seed users and to help educate the general public as to the role of tree seed in the reforestation process.

### HISTORY

Tree seeds have been commercially collected in British Columbia since the 1920's. Tree seed was collected for the first tree seedling nursery in BC which started in Victoria in 1927. This nursery moved to Green Timbers near Vancouver in 1930. About the same time, significant quantities of cones were collected, and after processing, the seed was exported to Europe, particularly Great Britain and Germany. Europeans were captivated by the unsurpassed qualities of British Columbia's magnificent tree species. More recently the Scandinavian countries recognized the desirability of Lodgepole pine and speculated that its rapid initial growth would help to alleviate the gap in their wood supply. Since 1970 Forestry Canada has been responsible for certifying the authenticity of origin and quality of seeds collected for export.

Today, in BC tree seedling nurseries, technological advances in container production and precision sowing have increased the demand for high quality tree seed. Tree seed must be high in germination, clean, and free of damage or disease. BC Tree Seed Dealers strive to provide the best quality seed and services possible. Some of the services they provide include:

1. custom seed collection;
2. sale of seeds from wild stands, seed production areas, and seed orchards;
3. custom seed extraction processing;
4. seed testing,
5. cone crop and seed evaluations;
6. seed quality upgrading and treatment; and
7. seed storage.

The following are members of the BC Tree Seed Dealers Association.

**Pacific Forest Products Ltd.** Tim Hale  
 806 East Saanich Road. Phone: 652-1234  
 RR #1, Saanichton, BC VOS IMO Fax: 652-2800

**Reid Collins Nurseries Ltd.** Paulus Vrijmoed  
 2396-272nd Ave. Phone: 856-6408  
 PO Box 430 Fax: 856-4218  
 Aldergrove, BC  
 VOX IAO

**Silva Enterprises Ltd.** Peter Hellenius  
 Box 2888, Stn. B Phone: 963-8617  
 Prince George, BC Fax: 962-3490  
 V2N 4T7

**Western Tree Seed Ltd.** Frank Bamard  
 PO Box 144 Phone: 675-2463  
 Blind Bay, BC Fax: 675-2202  
 VOE 1H0

**Yellow Point Propagation Ltd.** Don Pigott  
 13735 Quennell Rd. Phone/Fax: 245-4635  
 RR #3, Ladysmith,  
 BC VOR 2E0

The following are Associate Members.

**Forestry Canada** Frank Portlock  
 Pacific Forestry Centre Phone: 363-0699  
 506 West Burnside Road Fax: 363-0775  
 Victoria, BC V8Z 1M5

**Ministry of Forests**  
 Surrey Tree Seed Centre Heather Rooke  
 18793- 32nd Avenue Phone: 574-0461  
 Surrey, BC V4P 1M5 Fax: 574-0262

### Cone and Seed Evaluation Services.

The following lists Silviculture Branch groups, members of the Tree Seed Dealers Association, and others who offer cone and seed evaluation services in BC.

### Pest Activity.

- Identification of cone and seed insects and disease, life cycle information, and significance of pests are reported.
- All persons involved in natural stand and orchard cone and seed collection are invited to make use of these no charge services.

**Ministry of Forests** Robb Bennett  
**Seed Pest Management Services** Bev McEntire,  
 Saanich Seed Orchard Michelle Hall  
 7380 Puckle Road Phone: 652-7613  
 Saanichton, BC VOS IMO Fax: 652-4204

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### Cone and Seed Development and Yield

Half cone and seed sections are performed and an estimate of # of filled seeds, seed development and condition is reported. If pest activity cannot be positively identified or if sample is of particular interest, a sub-sample will be forwarded to the Seed Pest Management Services group.

**Pacific Forest Products**  
(see above)

Kathy Cook  
Phone: 652-4023  
Fax: 652-2800

**Western Tree Seed Ltd.**  
(see above)

Frank Barnard  
(see above)

**Yellow Point Propagation Ltd.**  
(see above)

Don Pigott  
(see above)

**Silva Enterprises Ltd.**  
(see above)

Peter Hellenius  
(see above)

**Reid, Collins Nurseries Limited**  
(see above)

Paulus Vrijmoed  
(see above)

**Ministry of Forests  
Tree Seed Centre**  
(see above)

Heather Rooke,  
Dawn Stublely,  
Debbie Anderson  
(see above)

**Ecosystems Management Ltd.**  
P.O. Box 1596  
Merritt, BC VOK 2B0

Ingrid Davis  
Phone: 378-2116  
Fax: 387-2116

**Scientificals Consulting**  
9211 Arvida Drive  
Richmond, BC V7A 4K5

Mishtu Banerjee  
Phone/Fax:  
278-4904

### Submitting Cone Samples

- Please contact to confirm whether or not a service charge will apply. Generally (but not always) an as-essment fee is waived if cones are to be processed by either the Tree Seed Centre or Licenced Tree Seed Dealer performing the cone and seed evaluation.
- Cone samples should be collected from the portion of the tree from which cones would be collected operationally, e.g. cone rake - upper crown, felling - from all cone bearing portions.
- At least 20 cones from a minimum of three trees (preferably six) should be collected from each site.
- Contact agency 1 or 2 days in advance of sample arrival.
- Due to the amount of time required to analyze samples, please keep sample numbers to a minimum.
- Freshly picked cone samples should be placed loosely, in paper bags (one sample per bag), in a cardboard box and forwarded overnight by courier. Sample should include information on requesting agency, sample ##, collection date and location, contact name, and phone and fax numbers. Other information such as collection method is useful.

## Ancient Insect Control Methodology is Reborn

If you like to eat such marine arthropodan delights as shrimp, lobster, and crab there is no reason you should quail at the thought of ingesting terrestrial arthropods. In fact, you are probably already doing this inadvertently on a daily basis at meal times but, generally, today few bipedal hominids actively seek out and eat insects or other land-dwehing creepy crawhes.

The reasons behind this Chauvinistic prejudice are probably complex and remain unclear, but, recently, entomologists have been the central driving force behind a rising tide of interest in insects as food.

I participated in my first "Insects as Food" workshop in the mid seventies more in the interest of disturbing the sensibilities of the average Joe than in nutritional extension education. I was quickly surprised to realize that,

not only are insects a major untapped source of protein, vitamins and micronutrients, but many of them taste very good, too! Today, insectophagy in the western world is slowly losing its unwarranted stigma. No longer restricted to a barely supressed grimace and convulsive swallow from an upturned bottle at the end of an evening of ritual mescal abuse, dining on raw and cooked insects is now a credible (indeed fashionable) culinary pastime.

In recent years, at their annual meetings, most of the major North American entomological societies have featured insect dining options ranging from hors d'oeuvres to buffet items and desserts. At this year's joint Annual Meeting of the Entomological Societies of Canada and Ontario, Yves Pr6vost put together a

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selection of delightful side dishes to tickle the palettes of attendees at the evening mixer. Following are some of the recipes featured at the meeting. The culinary connoisseur will note that the recipes are rather basic. Use your imagination and perhaps you will view your next infestation of budworms or june beetle larvae more as a potentially bounteous harvest than a headache.

Got an infestation of waxworm larvae in your bee hives?

### Waxworin Popcorn

Fry waxworm larvae in hot vegetable oil until they puff up (about 30 seconds). Drain on a napkin and serve on toothpicks with dipping sauces.

What farmer or grain storage facility hasn't had a problem with mealworms?

### Mealworm Balls

- 1 egg, beaten
- 2 cloves garlic, minced
- 2 tablespoons onion, minced
- 1 teaspoon salt
- 1/8 teaspoon red pepper
- 6 tablespoons cornstarch
- 1 cup mealworms, finely ground
- vegetable oil
- flour

Combine eggs, garlic, onion, salt, pepper, and cornstarch. Mix in mealworms until smooth then, with floured fingers, shape batter into one inch balls. Sautde in hot oil (375°F) until golden. Drain on a napkin and serve on toothpicks with dipping sauces.

Grasshoppers, locusts, and crickets eating up your profits? Recoup your losses and market those critters.

### Cricket Newburg

- 1/4 cup butter
- 2 1/2 tablespoons flour
- 3/4 teaspoon salt
- cayenne pepper (just a pinch)
- nutrneg (as above)

- 2 cups half and half cream
- 2-3 tablespoons sherry
- hot pepper sauce to taste
- 2 egg yolks
- 2 cups cooked crickets

Melt butter and blend in flour and seasonings. Gradually stir in cream and sherry until smooth and thick. Mix a little hot sauce with the yolks then stir this into the sauce. Add cooked crickets. Serve warm on crackers.

Now that genetic engineers have developed silk-producing bacteria you may be wondering what to do with your outmoded silk factory. Why not produce silkworm pupae for the supermarket?

### Spicy Silkworm Bisque

- 3 tablespoons butter
- 1 onion, finely chopped
- 1 red pepper, seeded, finely chopped
- 2 sticks celery
- 1 clove garlic, minced
- pinch of dry mustard
- pinch of cayenne
- 2 teaspoons paprika
- 3 tablespoons flour
- 4 cups fish stock
- sprig of thyme
- 1 bay leaf

- 1 cup fresh silkworm pupae
- salt, pepper, chives

Gently cook onion, pepper, celery, and garlic in melted butter until soft. Stir in mustard, cayenne, paprika, and flour. Stir over low heat about three minutes. Stir in fish stock until well blended. Add thyme and bay leaf and bring to boil. Simmer about 5 minutes or until thick, stirring occasionally. Add pupae and cook 5 minutes. Season to taste with salt and pepper. Top with snipped chives.

**Robb Bennett**

*Seed Pest Management Services, Victoria*

## New Publications Available

**Proceedings of the Northeastern Area Nurserymen's Conference, July 27-29, 1992.** Contains 11 articles on topics of nursery culture. Cost is \$8.00 (US) payable to: Northeastern State, Federal, and Provincial Nursery Association

Michigan Dept. of Natural Resources  
Wyman State Forest Nursery  
Route 2, Box 2004  
Manistique, MI 49854

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**Tree Planting in the United States - 1992.** Moulton, R J., R. D. Mangold, and J. D. Snellgrove. 1993, 15 p. Pamphlet available free of charge from:

USDA Forest Service  
Cooperative Forestry  
PO Box 96090  
Washington, DC 20090-6090

**Shelterbelt Varieties for Alberta.** Casement, B., R. Escott, L. Maryniak, and G. Hooke. 1993, 68 p. Available free of charge from:

Alberta Agriculture  
Alberta Tree Nursery and Horticulture Centre  
RR #6  
Edmonton, AL T5B 4K3  
Phone: (403) 422-1789  
Fax: (403) 472-6096

**A Sourcebook for Management of the Gypsy Moth.** Nealis, V. G. and S. Erb. 1993. 48 p. ISBN 0-662-20907-9. Available free of charge from:

Conununications Services  
Canadian Forest Service, Ontario Region  
Great Lakes Forestry Centre  
PO Box 490  
Sault Ste Marie, ON P6A 5M7

**Our Living Legacy - Proceedings of a Symposium on Biological Diversity.** Fenger, M. A., E. H. Miller, J. F. Johnson, and E. J. R. Williams (editors). 1993. 392 p. ISBN 0-7718-9355-8. Containing good to sublime presentations by some world-class biologists (Suzuki, Wade Davis, E. C. Pielou, Geoff Scudder) interspersed with other selections ranging in quality from mundane (but still interesting) to excellent. A fine book valuable as a primer for the initiate and a resource for the professional. Available from:

The Royal British Columbia Museum  
675 Belleville St.  
Victoria, BC V8V 1X4

**Canadian Silviculture Magazine.** The pre-n-tier issue of "Canadian Silviculture Magazine" hit the streets in the summer of 1993. This is a joint publication of the Western Silviculture Contractors Association, the Canadian Silviculture Association, and other provincial associations. Featured in the first issue are articles on BC's and Ontario's silviculture strategies and their implications. This publication incorporates the old WSCA Newsletter and is available only by subscription from:

Canadian Silviculture Magazine  
#310-1070 W. Broadway  
Vancouver, BC V6H 1E7  
Tel: 604-736-8660  
Fax: 604-738-4080

## Container Tree Nursery Manual Update

*Ed. note: the following is taken from Forest Nursery Notes, July 1993. To subscribe to this newsletter or for more information contact: Tom Landis, Western Nursery Specialist, USDA Forest Service, PO Box 3623, Portland, OR 97208-3623 (Ph: 503-326-2729, Fax: 503-326-5569).*

As many of you know, I'm working on a publication called the "Container Tree Nursery Manual" (CTNM). All seven volumes of the Manual are being serially published as Agricultural Handbook 674, but are being issued out of numerical sequence. Four volumes of the Manual have been printed so far: Volumes Two, Three, Four, and Five. Currently, we are working on Volume One: Container Nursery Planning, Development, and Management and hope to have it published by late this year. The publication schedule and availability of the published volumes is outlined in the following table (dates enclosed in parentheses are estimates):

Volume	Title	Date	Publication Stock Number and Price
One	Container Nursery Planning, Development, and Mgmt.	(12/93)	—
Two	Containers and Growing Media <b>(Free Copies Still Available)</b>	1990	001-001-00644-2 \$9.50 (US) \$11.88 (Foreign)
Three	Atmospheric Environment <b>(Free Copies Still Available)</b>	1992	001-001-00648-3 \$16.00 (US) \$20.00 (Foreign)
Four	Seedling Nutrition and Irrigation <b>(Out of free copies)</b>	1989	001-001-00635-1 \$15.00 each \$18.75 (Foreign)
Five	Biological Influences: Nursery Pests and Mycorrhizae <b>(Out of free copies)</b>	1990	001-001-00633-5 \$30.00 (US) \$37.50 (Foreign)
Six	Seedling Propagation	(1994)	—
Seven	Seedling Processing, Storage, and Outplanting	(1995)	—

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As noted above, I still have a limited supply of free copies of Volumes Two and Three. You can purchase copies of any of the published CTNM volumes from the US Government Printing Office in Portland (address below). Several are in limited supply. We are working to get them reprinted but may run out of copies before the new ones become available. When ordering, use the stock numbers and prices listed in the Table. Prices include shipping and handling (foreign orders have a 25% surcharge). You can order by mail, phone, or FAX and all orders must be

prepaid by cash, check payable to "Superintendent of Documents", or charged to Visa or Mastercard.  
U.S. Government Printing Office  
1305 SW First Avenue  
Portland, OR 97201-5801  
USA  
Phone: 503-221-6217  
Fax: 503-225-0563

**Tom Landis**  
USDA Forest Service, Portland

## The Advanced Forest Pest Management Training Program

The Advanced Forest Pest Management Training Program (AFPM) is designed to provide forest managers and other interested parties with expert training in forest pest management. AFPM offers four courses:

1. Advanced Forest Herbicides,
2. Forest Insect Management,
3. Integrated Forest Pest Management, and
4. Integrated Pest Management for Forest Nurseries.

The courses are presented in two week blocks and may be taken in any order. Lectures, group discussions, group projects, case studies, computer modelling sessions, field demonstrations, and field trips are integrated to - for different learning styles. Approximately - instructors with international technical reputations and superior teaching skills are responsible for the effective delivery of course material. The AFPM Co-ordinator is responsible for overall course continuity.

During the Practicum, course participants are divided into small groups. These groups are charged with developing cost-effective and environmentally and socially acceptable pest management strategies and prescriptions for an assigned land base. The result of each group's work is presented to an audience of instructors, other course participants, and interested members of the public.

For information on eligibility, tuition, financial support, course content, *et cetera*, contact:

Eileen M. Harvey  
AFPM Co-ordinator  
Forest Pest Management Institute  
1219 Queen Street East  
Sault Ste Marie, Ontario  
Canada P6A 5M7  
Tel: (705) 949-9461  
Fax: (705) 759-5700

## Obituary

*Ed. note: the following comes from "Branch Lines" Vol. 4(2), the newsletter of the UBC Faculty of Forestry.*

Dr. Vladin-dr Krajinina passed away on May 31, 1993 at the age of 88. Krajinina was the founder of British Columbia's

Biogeoclimatic Classification System and Ecological Reserve Program. Few people have left such a lasting positive legacy for forestry in British Columbia.





GROWERS' NOTES

BC Seed Orchard Cone Harvest 1993

Interior (Ministry) Seed Orchards (Maarten Albricht)

The interior seed orchards have produced the largest cone crop to date this year (Table 1). At the time of writing harvesting of lodgepole pine cones is still in progress. Figures for that species in the following table are estimates. The data presented cover only the 1993 crop year. Previous inventories for the producing orchards are not included. A portion of the seed from the breed arboreta is class A seed (controlled pollination). The remainder is class B seed (wind pollinated). Where two or more seedlots are for the same planning zone(s) the requirements were prorated on the basis of the 1993 crop.

Coastal Seed Orchards (David Reid)

Coastal seed orchards generally had a good year for cone harvests (Table 2) especially with Douglas-fir and hemlock. This year saw the first sizeable collectable crop at the Cobble Hill Englemann spruce orchard and a small first crop from the Surrey (Mid-Coast) Douglas-fir orchard. Seedling estimates were calculated using Silviculture Branch's latest estimates of yield per hectolitre of cones (updated September 1993).

Maarten Albricht
Interior Seed Orchards, Vernon
David Reid
Coastal Seed Orchards, Saanichton

Table with 8 columns: SITE Orchard, Species, Planning Zones, Collected hl, Seedlings -000-, Zone Needs Seedlings -000-, Year Supply. Rows include PGTIS, SKIMIKIN, KALAMALKA, and Total all orchards.

Table 1. Cone collection data for BC Ministry of Forests interior seed orchards, 1993.

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Owner	Orchard Number	Location	Species	Seedlot	Cones (Hl)	Estimated yield (kg)	Estimated seedlings
BCMoF	120	Dewdney low	Fdc	60035	103.8	39.2	1,840,000
		Dewdney high	Fdc	60036	224.6	85.4	4,009,000
	131	Cobble Hill	Se	60033	34	17.3	4,118,000
	146	Surrey	Fdc	60032	3	1.9	91,000
	151	Cobble Hill	Sx	60034	0.25	0.1	30,000
	143	Camp. River	Hw		3.5	2.5	615,237
<b>Sub-total Ministry orchards</b>					<b>369.15</b>	<b>146.371</b>	<b>10,703,237</b>
<b>Private Orchards</b>							
CFP	116	Sechelt	Fdc	60105	26	10.1	473,803
	133	Sechelt	Hw	60106	0.67	0.5	117,774
FCCL	134	Mt. Newton	Fdc		40	15.5	728,928
	154	Mt. Newton	Fdc		25	9.7	455,580
	130	Mt. Newton	Hw		18	12.7	3,164,076
	140	Mt. Newton	Cw		1	0.8	238,445
	129	Mt. Newton	Ba		2	4.5	20,893
MB	135	Nanaimo	Ba		4.5	10.2	47,009
	139	Nanaimo	Cw		0.15	0.1	35,767
	137	Nanaimo	Cy		3	4.3	126,500
	163	Nanaimo	Hw		0.25	0.2	43,945
	150	Nanaimo	Hw		1	0.7	175,782
PFP	132	Nanaimo	Hw		4	2.8	703,128
	109	Saanichton	Fdc	60180	17.3	6.7	315,261
	111	Saanichton	Fdc	60181	58.8	22.8	1,071,524
	121	Saanichton	Fdc	60182	69.5	27.0	1,266,512
	136	Saanichton	Hw	60183	5.8	4.1	1,019,536
	165	Saanichton	Hw	60184	0.8	0.6	140,626
WFP	160	Saanichton	Ba	N/A	0.1	0.2	1,045
	126	Lost Lake	Hw		23.5	16.6	4,130,877
	127	Lost Lake	Hw		3.1	2.2	544,924
	156	Lost Lake	Hw		1.7	1.2	298,829
	128	Lost Lake	Cw		4.8	3.9	1,144,534
	155	Lost Lake	Cw		18.5	15.0	4,411,225
	157	Lost Lake	Ss		1.1	0.6	133,228
	142	Lost Lake	Ss		6	3.1	726,696
<b>Sub-total Private orchards:</b>					<b>336.57</b>	<b>176.1</b>	<b>21,536,447</b>
<b>Total all Coastal orchards:</b>					<b>705.72</b>	<b>322.5</b>	<b>32,239,684</b>

Table 2. Cone collection data for BC coastal seed orchards, 1993.

## A Quick Method for Determining Interior Spruce Cone Maturity

Cone collection timing in a seed orchard situation is a topic which has not been widely covered in current literature. At Kalamalka Seed Orchards we believe we have developed an efficient, accurate field method of determining collection readiness of interior spruce cones.

In a seed orchard, collection timing presents some issues that may be irrelevant to most wild stand collections. Cones can mature very quickly and unpredictably in the hot weather of the Okanagan.

Also, genetic variation in each orchard leads to wide variation in cone maturity timing in comparison to a single wild stand collection (the timing of seed fall within one orchard from the earliest to the latest ripening clones can be as great as five weeks). Clearly it would be inappropriate to collect from the entire orchard as soon as the earliest clones are ready.

Assessing cone ripeness is essential to ensure good seed

quality as well as for logistics reasons. Given a limited supply of ladders and orchard lifts it is important always to be picking trees that are closest to the seed shed. As we neared harvest time in 1993, thousands of trees had to be checked and prioritized for collection and then monitored during the collection period. The definitive seed cutting test for seed maturity (where embryo length and endosperm condition are assessed) is too time consuming on a large scale. We required a quick test for maturity that is as effective as the seed cutting test.

The outward appearance of cones is not a reliable predictor of seed maturity. Before opening, some cones turn brown and soft as the seeds mature while others can be brown and soft and still contain immature seed. Still others may be green and hard one day and fully open and shedding mature seed the next. We found

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that examining the cone axis gives us the best estimate of seed maturity. Cones are quickly cut in half lengthwise with a pair of pruning shears in the field. A brown, dried-out cone axis indicates a collectable cone (i.e., the tree is no longer "feeding" the cone); moisture in the axis (easily detected by running the pruner blade along the axis) shows that materials are still being supplied to the cone by the tree and the seeds are probably immature and in little danger of

being shed. A desiccated axis indicates that and therefore the cone can be picked.

The axis test is readily learned and understood by otherwise inexperienced staff. It enabled us to identify trees for cone collection confidently, quickly, and easily.

**Gary Giampa, Chris Walsh**  
*Kalamalka Seed Orchards, Vemon*

## Peat Plugs versus Styroblock Plugs

*Ed. note: the following is excerpted from Canadian Forest Service Impact Note #5. For further information contact the New Brunswick Maritime Regional Office of CFS (PO Box 4000, Fredericton, NB E3B 5P7, Tel: 506-452-3500, Fax: 506-452-3525.*

Studies conducted at Natural Resources Canada (Maritimes Region) show that seedlings reared in mesh-covered peat plugs are superior to those reared in walled containers. Additional plantation establishment costs (which may run as high as \$900/ha) can be substantially reduced or avoided as replanting will be less extensive. Established free-to-grow seedlings will also experience increased growth rates.

Peter Salonijs of Natural Resources Canada, in the Maritimes, observed that seedlings grown in mesh-covered peat plugs develop improved root form in comparison to seedlings from walled containers, whether they were reared in the nursery for a few weeks or several months. Root

growth occurs along the entire length of the mesh plug, resulting in better root regeneration capacity, higher survival rates, and up to double the early growth rate.

Salonijs reared jack pine and black spruce seedlings in walled and mesh systems for various lengths of time before outplanting. Three years after outplanting, he compared the seedlings' root system. Of the walled container grown seedlings only fragile plugs (12 weeks from seeding) produced good support roots, but these plugs could not be readily extracted from the cavities for typical piece work planting operations. The firm plugs, amenable to normal handling (more than 16 weeks from seeding), rooted mainly from the bottom of the planted plug, greatly increasing the risk of toppling.

Planting stock specifications often demand rejection of plugs that do not hold together when extracted. Seedlings from mesh covered plugs have very low cull rates because the root systems are kept intact by the mesh. Walled containers have cull rates at shipping of up to 40%.

## Dimethoate Controls Cone Maggots in Tamarack Seed Orchards

*Ed. note: the following is reprinted from the introduction to Canadian Forest Service Technical Note #2845 by I. Sweeney, K. Tosh, and W. MacKinnon. The complete report is available from the Maritime Regional Offices of CFS (PO Box 4000, Fredericton, NB E3B 5P7, PO Box 667, Truro NS B2N 5E5; PO Box 190, Charlottetown, PEI C1A 7K2).*

Dimethoate (Cygon 480-E) controlled damage by cone maggots and significantly increased filled seed yields in tamarack. The insecticide was applied to the foliage to the point of runoff, at a rate of 0.25% active ingredient (5.2

mL of formulation per liter of water), using either a hydraulic sprayer or mist blower. The applications were made 3 weeks after pollination, after most egg-lay by the larch cone maggot, *Strobilomyia laricis*, was complete. A second application, made 10 days after the first, provided no better control than the single application. There was no evidence of phytotoxic effects on foliage, cones or seeds. An application has been made for minor use registration of Dimethoate 480 for control of cone maggots in tamarack.





## Sample Collection Method and Sequential Sampling Plans for Mites (*Oligonychus ununguis*) and Aphids (*Cinara laricifex*) on Tamarack

*Ed. note: the following is reprinted from the introduction to Canadian Forest Service Technical Note #278 by R. Webster. The complete report is available from Maritime Regional Offices of CFS (PO Box 4000, Fredericton, NB E3B 5P7; PO Box 667, Truro NS B2N 5E5; PO Box 190, Charlottetown, PEI C1A 7K2).*

Spider mite (*Oligonychus* sp.) and aphid (Adelgidae and Aphidae - *Cinara laricifex* in particular) infestations are a recurrent problem in a number of seed orchards in New Brunswick. High population levels cause yellowing of foliage, needle loss, and, presumably, loss of tree vigor.

Currently there are no established quantitative methods for sampling population levels of spider mites and aphids on any conifer species in seed orchards or plantations. For this reason a study, funded by NBFAC, was conducted by the Research and Productivity Council (RPC) in 1990 to develop suitable sampling methods for routine assessment of black larch aphid (*Cinara laricifex*) and spruce spider mite (*Oligonychus ununguis*) populations on tamarack and black spruce. Tamarack was chosen because population levels of the black larch aphid and the spruce spider mite have been traditionally high.

## New Products Available

*Ed. note: the following information was extracted from "BC Pest Monitor", Vol 2(2), Nov. 1993.*

DowElanco has the marketing rights in Canada to Spectrum® the commercial product containing the **fatty acid herbicide** originally developed by Safer's (TopGun® is the domestic product). Results are reported to be visible the same day; treated areas can be replanted in 3 days. Because it has no systemic or translocation effect it can be used up to the base of trees. Technical and sales information available from:

K. Sanfleben  
DowElanco Canada Inc.  
9639-45 Ave.  
Edmonton, AB T6E.5Z8  
Phone: (403) 436-6131  
Fax: (403) 437-3665

*Ed. note: information on the following two products was extracted from "Forest Nursery Notes, July 1993."*

A new **deer repellent** has been developed by Plant Pro-Tect and is available for field trials. The garlic-based repellent is placed in biodegradable plastic stake dispensers

adjacent to individual seedlings or as a perimeter barrier. Plant Pro-Tect is actively seeking more efficacy data. Interested? Contact:

Jerry Walters  
Plant Pro-Tect, Inc.  
PO Box 902  
Palo Cedro, CA 96073  
Phone/Fax: (916) 547-5450

A new, copper-based systemic **fungicide/bactericide** is currently registered in the US for *Diplodia* blight on pines and fireblight on woody ornamental Rosaceae. Phyton 27® apparently also is effective against *Botrytis* but efficacy data is lacking for forestry crops. The producer is interested in obtaining such data. For information contact:

Andy Petersen  
Source Technology Biologicals, Inc.  
3355 Hiawatha Ave.  
Minneapolis, MN 55406  
Phone: (612) 724-7102  
Fax: (612) 724-1642

## Coastal BC Tree Seed

Pacific Forest Products Limited is interested in trades and/or sales of natural stand and orchard seed for coastal BC tree species. For information contact:

Gerry Fraser  
Saanich Forestry Centre  
Phone: (604) 652-4023  
Fax: (604) 652-2800





TECH TALK

Spruce Cone Maggot - Two Species in BC?

Two species of Canadian spruce cone maggots are now known to occur, at least in eastern Canada where one occurs on white spruce and the other on black and red spruces. Possibly, some specimens of what we in BC have traditionally identified as the spiral spruce cone borer, Strobilomyia neanthracina (or any one of its multitude of older names) may be S. appalachensis. Jean Turgeon and Jon Sweeney (Canadian Forest Service) are interested in answering this question.

This year produced bountiful spruce crops across BC but few spiral spruce cone borers. The Seed Pest Management Group of Silviculture Branch, with the help of Skimikin Seed Orchard staff were able to send Turgeon ordy a small sample of Strobilomyia from interior spruce. 1994 may show an increase in maggot populations in BC. The Seed Pest Management Group is interested in obtaining infested spruce cone samples from anywhere in the province in 1994 to aid in this research.

Ed. Note: the following abstract is reprinted from "Hosts and distribution of spruce cone maggots (Strobilomyia spp.) and first record of Strobilomyia appalachensis in Canada" (Jean Turgeon and loii Sweeney, 1993, Canadian Entomologist 125:637-642).

Two species of cone maggots, Strobilomyia spp., are known to attack seed cones of spruces in North America. Seed cones of black, red, and white spruce from Newfoundland to Alberta were collected to determine the number of host species and the distribution of these maggots. Strobilomyia appalachensis was obtained only from seed cones of black and red spruce, whereas S. neanthracina was obtained only from white spruce seed cones. Our observations represent the first record of S. appalachensis in Canada. We conclude that, like S. neanthracina, S. appalachensis has a transcontinental distribution, but exploits different hosts, namely black and red spruce. We also observed that S. appalachensis was capable of extended diapause.

Joint Annual Meeting of the Entomological Societies of Canada and Ontario

During the last week of September, 1993 about 250 entomologists from across Canada and the United States attended the joint Annual Meeting of the Entomological Society of Canada and the Entomological Society of Ontario in Sault Ste. Marie, Ontario. Participants included a number of British Columbia entomologists from the Ministry of Forests, Phero-Tech, the Universities (UBC, UVic and SFU), and the Pacific Forestry Centre. In addition to the presentation of a large number of 'scientific communications' on a wide range of topics, several symposia of interest to seed orchardists, nursery managers, and other forestry workers were held. Following is a list of the symposia and their contents. For more information on a particular symposium contact its organizer.

1. Improved Pesticide Applications

Organizer: Alarn Sundaram (Forest Pest Management Institute, 1219 Queen Street East, PO Box 490, Sault Ste. Marie, ON P6A 5M7). Thirteen papers presented including the following.

- Priorities for Forestry Insecticide Application Technology Research. Campbell, R. A. and C. A. Howard.

- Spray Cloud Behaviour and Off-Target Drift. Mickle, R. E.
  - The Ontario Ministry of Natural Resources' Insecticide Programme - Future Operations. Scarr, T.
  - Field Application of Bacillus thuringiensis. Dubois, N. R.
  - Rain-Washing of Fohar Deposits of Dimilin® WP-25 Formulated in Four Different Carrier Liquids. Sundaram, K. M. S. and A. Sundaram.
  - Spray Atomization Characteristics as a Function of Pesticide Formulation and Atomizer Design. Akesson, A. B. and W. E. Steinke.
  - Droplet Trajectories and Deposition with an Airblast Forestry Sprayer. Brown, R. B. and M. M. Sidahmed.
2. Natural Products for Insect Pest Management Strategies

Organizer: Blair Helson (Forest Pest Management Institute, 1219 Queen Street East, PO Box 490, Sault Ste. Marie, ON P6A 5M7). Ten papers and three posters presented including the following.

- Insect Toxins from Conifer Endophytes. Findlay, J.

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- Resistance in Sitka Spruce to *Pissodes strobi*: a New Theory and Developments. Sahota, T. *et al.*
- Neem and Beyond: the Next Generation of Botanical Insecticides. Isman, M.
- Aphid Control Properties of Depitched Tall Oil, a Botanical Insecticide. Xie, Y. and M. Isman.
- Effect of Neem Seed (*Azadirachta indica*) Extract on Oviposition by Noctuid Moths. Naumann, K. and M. Isman.
- Natural Products and Analogues as Potential Insect Control Agents. Strunz, G.
- Natural Products for Pine False Webworm Management. Lyons, D. B. *et al.*

### 3. Trends and Strategies in Insecticide Discovery

Organizer: Roger G. H. Downer (Dept. of Biology, University of Waterloo, Waterloo, ON N2L 3G1). Four papers were presented in this session.

- New Developments in Semiochemicals/Pheromones. McNeil, J. N.
- Natural Products and Insecticide Development. Amazon, J. T.
- Molecular Biology and Insecticide Development. Hutchinson, B.
- Biochemical and Physiological Targets for Insecticide development. Downer, R.

### 4. Application of Recombinant DNA Technology for Insect Control

Organizers: Arthur Retnakaran, Reddi Palli (Forest Pest Management Institute, 1219 Queen Street East, PO Box 490, Sault Ste. Marie, ON P6A 5M7). The following five papers were presented.

- Development of Neurotoxins as Pest Control Agents. Caveney, S

- Recombinant DNA Techniques for Developing Pest Control Agents. Palli, R.
- Developing Transgenic Viruses as Environmentally Benign and Effective Pest Control Agents. Thiem, S.
- Bt at the Crossroads: Improvement for Pest Control. van Frankenhyzen, K.
- Development of Transgenic Plants resistant to Pests. Sammons, D..

### 5. Insect Pest Management in Seed Orchards

Organizers: Jean Turgeon, Peter de Groot. (Forest Pest Management Institute, 1219 Queen Street East, PO Box 490, Sault Ste. Marie, ON P6A 5M7). The following nine papers were presented.

- Ontario's Seed Orchard Program: an Update. Nitschke, P.
- Cone and Seed Insect Problems of Pines, Spruces, and Larch. Bennett, R. G.
- Entomofauna of Pine, Spruce, and Larch Seed Cones: Patterns of Exploitation. Turgeon, J.
- Methods of Sampling Insects and Predicting Seed Loss. Sweeney, J.
- Monitoring Insect Pests in Coniferous Seed Orchards with Pheromones and Related Semiochemicals. Grant, G. G.
- Status and Future of Insect Pest Management in Seed Orchards. DeBarr, G.
- Monitoring Cone and Seed Losses in Jack Pine Seed Orchards: Why Bother? de Groot, P.
- Pest Damage to Ontario Seed Orchards. Hopkin, T.
- Responsibilities for Pest Management in Ontario Seed Orchards. Nitschke, P.

**Robb Bennett**

*Seed Pest Management Services, Victoria*

## Stratification of Western White Pine

### INTRODUCTION.

Western white pine (*Pinus monticola* Dougl.) is well known for its low and/or erratic germination (Larsen 1925; Advincula *et al.* 1983; Gansel 1986) due to the inherent dormancy of this species. The average germination of western white pine (Pw) seedlots presently in storage at the Tree Seed Centre (TSC) is 66%. Most of our conifers exhibit some degree of embryo dormancy (in which mature viable seeds are unable to germinate) which is generally overcome through stratification. Conunonly, embryo

dormancy is caused by the presence of inhibiting substances within the embryo. Some species specific dormancy is due to the seed coat which may restrict water or oxygen uptake, contain inhibitors, or may mechanically restrain the radicle from emerging. Some species may exhibit both types of dormancy. Embryo dormancy and mechanical restraint to emerging radicles may be the factors involved in the low germination of Pw (Pitel and Wang 1985).

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TREATMENT	PRESOAK	SOAK	WARM	COLD
Control	--	48 hours		60 days
T1	bleach	48 hours	24 days	60 days
T2	--	48 hours	24 days	90 days
T3	--	48 hours	32 days	120 days
T4	--	26 days	32 days	60 days
T5	clip radicle end	48 hours	NONE	30 days
T6	sulfuric acid	48 hours	24 days	60 days

Table 1. Treatments used in western white pine stratification trial.

Hoff (1987) looked at the effect of various tissues on Pw dormancy in 20 Pw families. He found that 93% of unstratified seed exhibited dormancy attributable to: embryo dormancy (50%), the seedcoat inner membrane (34%), and the outer seedcoat (9%). The remaining 7% exhibited no dormancy. Stratification of 21 days removed the inhibiting effect of the outer seedcoat but removal of embryo dormancy required between 42 and 90 days. Inner membrane induced dormancy (perhaps a barrier to water and/or oxygen absorption) was reduced with stratification, but even after 105 days of moist chilling 16% of the seeds still failed to germinate.

### MATERIALS AND METHODS.

In order to obtain the maximum potential germination of Pw seedlots, pre-sowing treatment methods must overcome all factors inhibiting germination. In this trial ten operational seedlots (8193, 10214, 27126, 28029, 30498, 30495, 31520, 31683, 31755, and 32565), which represent a large geographic range of both coastal and interior provenances, were subjected to seven treatments including a control (Table 1).

The control treatment is the warm-cold stratification treatment recommended by Edwards and Meagher in 1986 and is the current Pw treatment at the TSC. Although a 30 day warm period (20°C) is recommended, it may be abbreviated if appreciable pre-germination occurs. Differences in pre-germination were responsible for varying durations of warm treatment (14-32 days) for the various treatments. The temperature range of the operational warm treatment was 15-25°C.

**Presoak.** The addition of bleach (T1) may reduce surface-borne organisms and improve germination in Pw (Advincula et al. 1983). Radicle end clipping (T5) and sulfuric acid (T6) have been successful in removing physical barriers associated with the Pw seed coat (Pitel and Wang 1985).

**Soak.** For all treatments except T4, a 48 hour running water soak was used. This is the current operational method at the TSC for all requests greater than 60 grams in size. The T4 treatment involved a week of running water soak followed by 19 days in standing water (water changed periodically). A long soak can increase germination and/or reduce (perhaps even replace) the warm period prior to stratification (Pacific Forestry Centre (PFC) unpublished data). A 5 day soak is an effective treatment to replace part of the warm period prior to stratification (Edwards 1987). In a study on one seedlot an increase in germination was proportional to soak duration, up to a plateau of 14 days (PFC unpublished data). No detrimental effects were observed for soak durations up to 28 days. Ongoing lab trials at the TSC are comparing the standard pretreatment with a 14 day soak followed by various durations of stratification.

**Warm and Cold.** For all treatments, seeds were rinsed in water after the warm period just prior to being placed in stratification to minimize the effect of mold on the germination tests. Increased stratification time treatments (90 days - T2, 120 days - T3) were conducted to determine if gains could be obtained simply by prolonging techniques currently used at the TSC (60 days). Extended stratification promotes germination rate which will probably influence crop uniformity and widen the range of temperatures over which germination occurs (Wang 1987).

**Germination Testing.** After treatments were complete, seeds were placed in plastic germination dishes on moist kimpak and filter paper. The dishes were placed in a germinator with eight hours of light at 30°C alternated with 16 hours of dark at 20°C. Each treatment and seedlot had four dishes with between 40 and 60 seeds per dish. The experiment was originally designed for 100 seeds/dish but the large number of

(continued..)





pre-germinants in some treatments reduced the number of seeds which could be used to test germination. Germinants were counted on Monday, Wednesday and Friday for 28 days.

### RESULTS

The average germination capacity of all seedlots and treatments ranged from 12% for seedlots with clipped radicles to 88% for seedlots receiving 120 days of stratification (Figure 1). In the clipped radicle treatment seedlots (T5), a large number of pre-germinated seeds (20%) and an obvious fungal problem resulting from opening the seed coat caused the poor results. The germination test results for T5 are an underestimate of the total number of seeds germinated but they do reflect the proportion of seeds which would germinate if sent to the nursery after clipping.

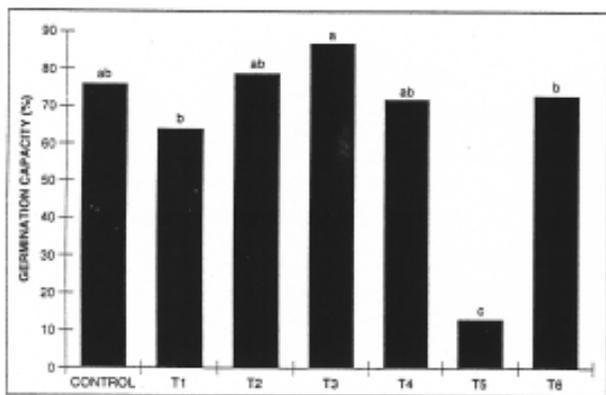


Figure 1. The average results of 10 western white pine seedlots pretreated using 7 different treatments (treatments with the same letter are not significantly different at =0.05).

In both cases where chemical treatments were used (T1, T6) the reduction in germination capacity was significantly different from the best treatment (T3). Both of these treatments produced equivalent levels of pre-germinated seed (T1=11%, T6=13%). Again, I believe it is reasonable to evaluate these treatments based on their post stratification performance (i.e., nursery performance) although the treatment may be more successful in terms of overcoming germination barriers than the results illustrate. The remainder of the treatments produced between 1 and 5% pre-germinated seed. Seedlots, averaged over all treatments, varied in pre-germination from 3 to 9%.

The 120 day stratification (T3) was the best treatment

in 8 of the 10 seedlots examined and for those seedlots the gain over the control ranged from 3 to 23%. The warm period differed from 24 days in the control to 32 days in the 90 (T2) and 120 day (T3) stratification treatments. The results suggest a limited effect of this difference as they are consistent with the expected increase in germination with increased stratification. Results for control, T2, and T3 treatments are not statistically different, although an average 12% increase in germination was found for T3 over the control (88% vs. 76%). Seedlot 28029 was slightly better (93% vs. 90%) with the 90 day stratification. Seedlot 30-495 had the best germination using the prolonged soaking treatment (80%), while it performed quite poorly under increasing levels of stratification (T2=27% and T3=52%).

The prolonged soak treatment (T4) was not significantly different from the control (4% decrease) and it appears that soaking may be used as a replacement for warm stratification. Seedlots which show lower levels of dormancy germinate more readily in the warm environment. The prolonged soak could insure against seed losses to pre-germination. Initial results from ongoing lab trials show that a prolonged soak followed by prolonged cold stratification benefit germination.

### DISCUSSION

Extending the stratification portion of the pretreatment from 2 to 4 months produced an average 12% gain in germination. The probability of lowered germination, compared to the control, was about 10% as one seedlot showed substantially lower germination with extended stratification. Extended stratification also increased the rate of germination (information available upon request) and may lower the risk of temperature dependent non-germination. The decision to use extended stratification must be based on knowledge currently available and the seed owners' and nurseries' strategy of dealing with risks involved with procedural changes.

With extended stratification the critical limiting factor is the additional time required for seed pretreatment. Current methodology requires a total of 14 weeks and extension (to the best treatment tested) would require request approval 22 weeks in advance of the sow date. Sowing requests can be approved as early as July 1 of the year prior to sowing. I am recommending that seed owners request an extension to stratification for western white pine when time permits.

We would like to offer Pw nurseries an opportunity

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to operationally compare nursery performance of various pretreatments. The time available before sowing will determine the type of treatments which can be attempted at each nursery. I suggest that a comparison be made of three treatments: 1) standard, 2) extended stratification, and 3) extended stratification with warm period shortened and soak prolonged. The results would be reported without reference to nurseries involved and will help determine the most effective treatment to replace the current standard. If you would like to be involved in this type of operational trial or want more information, please contact me at 574-0461.

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**Dave Kolotelo**  
Tree Seed Centre, Surrey

## Summer Plant of Orchard and Natural Stand Spruce Seedlots

### INTRODUCTION.

Concerns about stock produced from seed orchard spruce seedlots have been expressed by field staff (Hawkins 1993, in press). The concerns primarily focus on morphology (all spindly stock) and logistics (failure to meet shipment and delivery dates for summer planting). A trial involving Silviculture Branch, Research Branch, and Forest Region staff was established this season at Red Rock Research Station (RRRS) to address these and other related issues (Hawkins 1993).

### METHODS.

Fifty seedlots from three seed sources (natural stand, seed orchard, and full sib controlled crosses) were sown into 415B styroblocs on 17 February 1993 at RRRS and germinated and grown under standard conditions. Short-day treatment (blackout) was applied to 28 of the 50 seedlots starting in late May (Hawkins in press, Hawkins and Krasowski in press). Each of the 28 blackout treated seedlots was paired with an untreated control and all were planted in a common garden at RRRS between 5 and 15 July 1993. This planting will be monitored for the next three to five seasons. Additional treatment pairs from each of the 28 seedlots (planted at the same time) will be

excavated in the late spring (May) of 1994 to compare effects of treatment on over winter health and stem and root growth during the season of establishment.

Six seedlots were selected from each of the three seed sources (Table 1) and the morphology (at planting in early July) of the treated and controlled seedlings grown from these seedlots was described (Table 2: height - HT, root collar diameter - RCD, coefficient of height variation - CV -HT, and "sturdiness" - HT:RCD). Two culling criteria were used at summer lift: the plug must hold together and the seedling must be at least 10 cm tall. A liberal grading approach was used because of the low number of cavities sown for each seedlot treatment.

### RESULTS.

At planting, the blackout treated stock had detectable buds and glaucous needles while the untreated stock, in many instances, did not have detectable buds and was still succulent. Blackout reduced height, had no impact on root collar diameter, and increased seedling sturdiness (indicated by reduced height to diameter

*(continued..)*





ratios) in all IS measured seedlots (Table 2). The effect of blackout on the mean height response by seedlot was quite variable. Seedlots with different growth rates prior to blackout had similar heights after treatment while seedlots with similar growth rates before treatment had different heights after treatment.

Seed orchard seedlot RCD was generally not as great as that observed from the other seed sources. An unchanging diameter coupled with the reduction in height resulted in a sturdier seedling (a smaller HT:RCD ratio). There also was no difference in root mass between blackout treated and untreated seedlings at planting (data not presented). CV - HT tended to be least in controlled cross seedlots while seed orchard seedlots were the most variable. Generally the CV-HT of orchard seedlots was similar to that observed for the natural stand seedlots (Table 2). The effect of nursery treatment on height CV was variable: blackout increased it, left it unchanged or decreased it. This held across seed source origins.

DISCUSSION.

Apparently seedlot response to blackout is not solely related to its growth rate prior to treatment as has been suggested within the nursery industry. In all likelihood, the

observed seedlot response to short-days is an interaction among the phytochrome system, dormancy induction processes, and inherent seedlot vigor. Such a mechanism could account for the observed responses.

It is commonly believed that short-day treatment reduces seedling RCD. This view could have arisen because of the severe blackout regimes used in the past. Analysis of variance for the 28 seedlot treatment pairs indicates RCD was affected not by blackout but by seedlot. Even with liberal grading criteria, blackout methodology produced morphologically suitable seedlings ready for planting in early July regardless of seed source. Control seedlings meeting specifications at the end of the growing season (Hawkins 1993, Tables 2 & 3) often did not have the sturdiness displayed by the blackout treated stock in July (Table 2). This "sturdy" morphotype is generally more desirable (Burdett et al. 1984). The general similarity of CV-HT of seed orchard and natural stand seedlot seedlings may indicate they respond similarly in the nursery.

From a nursery view, it is of interest to look at the effect of conventional, conservative grading on the seedlot treatment pairs. As with most parameters monitored in this project, the effect was variable (Table 3). The effect of blackout on recovery is almost seedlot specific. This suggests some seedlots may be more suitable for early summer plants than others. Most of the culling resulted because RCD was too small. Considering the timing of the hft, this is not as serious as it first appears because many of the culls were in the 2.5 to 2.6 mm range and would have made specifications after a few more days in the nursery. Another approach would have been to let the seedlots grow another one cm (about 3 days) before the blackout treatment was applied. This should increase height and RCD in the treated stock and improve recoveries. Generally the best recoveries were in the controlled crosses followed by the seed orchard and natural stand collection seedlots. This again suggests that seed orchard seedlots are not displaying unusual growth responses (compared to natural stand) and that blackout is a good way to manipulate a spruce crop, particularly the vigorous seedlots, to meet management objectives.

To date (October), mortality in the plantings is less than one percent. The first major tests of these seedlings will be to survive the coming winter and grow to expectations next growing season. These results will be reported in next fall's newsletter. Evidence collected at RRRS over the past seven cultural seasons suggests that blackout should have little effect on field performance.

Controlled cross				
SEEDLOT	NAME	ELEV(m)	LAT ('N)	LONG ('W)
cc-1	PG92 X PG27	-850	-53	-123
cc-2	PG117 X PG84	-850	-53	-123
cc-3	PG28 X PG129	-850	-53	-123
cc-4	PG100 X PG127	-850	-53	-123
cc-5	PG101 X PG143	-850	-53	-123
cc-6	PG143 X PG140	-850	-53	-123
Seed orchard				
SEEDLOT	NAME	ELEV(m)	LAT ('N)	LONG ('W)
6675	PG Breeding Arboretum	890	53:30	122:10
6863	Central Plateau, Low	740	54:57	124:54
6866	Central Plateau, High	960	54:56	124:39
6913	Shuswap Adams, Low	749	51:08	119:15
6914	Shuswap Adams, Mid	1270	51:03	119:18
691	5Shuswap Adams, High	1657	51:16	119:22
Natural stand				
SEEDLOT	NAME	ELEV(m)	LAT ('N)	LONG ('W)
4073	Hungary Creek	1190	53:46	121:30
8779	Alvin Creek	1067	55:44	122:02
30543	Duteau Creek	1800	50:04	119:00
30664	Birch Island	480	51:36	119:57
31460	Mt. Robson	1500	53:02	119:19
35075	Prophet River	450	58:25	122:55

Table I Description of IS spruce seedlots detailed in this report. Elevation above sea level, Lat - latitude, Long - longitude, cc - controlled cross.

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Controlled cross						
SEEDLOT	TRT	RCD (mm)	HT (cm)	CV HT (%)	HT:RCD	
cc-1	C	2.69	26.2	13.5	97.4	
	SD	2.74	18.0	18.7	65.7	
cc-2	C	2.84	22.7	10.4	79.9	
	SD	2.89	16.9	10.1	58.5	
cc-3	C	3.01	24.0	11.8	79.7	
	SD	3.13	18.0	12.5	57.5	
cc-4	C	3.06	20.7	15.8	67.6	
	SD	2.98	16.4	18.7	55.0	
cc-5	C	2.96	21.7	17.2	73.3	
	SD	2.51	13.6	20.5	54.2	
cc-6	C	3.02	24.3	9.3	80.5	
	SD	2.88	17.3	9.3	60.1	
Seed orchard						
SEEDLOT	TRT	RCD (mm)	HT (cm)	CV HT (%)	HT:RCD	
6675	C	2.93	22.1	12.0	75.4	
	SD	2.96	20.0	13.2	67.6	
6863	C	2.82	20.8	18.2	73.8	
	SD	2.96	17.3	20.1	58.4	
6866	C	2.78	21.4	32.1	77.0	
	SD	2.91	16.8	16.2	57.7	
6913	C	2.88	22.1	17.0	76.7	
	SD	2.86	15.2	18.3	53.1	
6914	C	2.81	20.5	17.8	73.0	
	SD	2.93	15.4	20.1	52.6	
6915	C	2.90	21.3	24.1	73.4	
	SD	2.79	14.6	16.9	52.3	
Natural stand						
SEEDLOT	TRT	RCD (mm)	HT (cm)	CV HT (%)	HT:RCD	
4073	C	3.01	17.5	22.2	58.1	
	SD	2.75	14.9	23.3	54.2	
8779	C	3.07	19.1	12.7	62.2	
	SD	2.96	15.9	16.9	53.7	
30643	C	3.13	18.7	17.9	59.7	
	SD	2.82	15.1	22.4	53.5	
30664	C	2.95	23.7	10.4	80.3	
	SD	2.94	19.6	12.7	66.7	
31460	C	3.05	18.6	18.0	61.0	
	SD	2.87	14.6	23.8	50.9	
35075	C	2.98	22.1	16.8	74.2	
	SD	2.67	15.9	15.9	59.6	

Controlled cross							
SEEDLOT	TRT	REC (%)	RCD (mm)	HT (cm)	CV HT (%)	HT:RCD	
cc-1	C	53	2.78	26.2	5.0	94.2	
	SD	80	2.86	18.7	14.3	65.4	
cc-2	C	80	2.96	23.3	8.4	78.7	
	SD	93	2.91	17.1	9.3	50.8	
cc-3	C	93	3.00	23.6	10.2	78.7	
	SD	87	3.22	18.4	11.6	57.1	
cc-4	C	94	3.11	21.0	14.5	67.5	
	SD	83	3.11	17.4	11.0	56.0	
cc-5	C	80	3.09	22.7	14.2	73.5	
	SD	40	2.90	15.9	6.3	54.8	
cc-6	C	87	3.11	24.6	8.8	79.1	
	SD	87	2.93	17.6	8.9	60.1	
Seed Orchard							
SEEDLOT	TRT	REC (%)	RCD (mm)	HT (cm)	CV HT (%)	HT:RCD	
6675	C	89	3.01	22.4	11.8	74.4	
	SD	95	2.98	20.1	12.9	67.5	
6863	C	83	2.95	21.8	14.1	73.9	
	SD	72	3.06	18.7	15.5	61.1	
6866	C	56	3.15	23.1	9.9	73.3	
	SD	67	3.21	18.2	9.8	56.7	
6913	C	89	2.99	22.4	13.4	74.9	
	SD	67	2.98	16.7	8.8	56.0	
6914	C	72	3.03	21.8	10.2	72.0	
	SD	61	3.17	17.3	12.4	54.6	
6915	C	67	3.22	22.6	15.2	70.2	
	SD	67	2.98	16.0	8.5	53.7	
Natural stand							
SEEDLOT	TRT	REC (%)	RCD (mm)	HT (cm)	CV HT (%)	HT:RCD	
4073	C	78	3.20	18.9	15.5	59.1	
	SD	50	3.05	17.4	16.1	57.0	
8779	C	83	3.18	19.6	10.9	61.6	
	SD	72	3.09	17.2	9.2	55.7	
30643	C	83	3.27	19.8	11.8	60.6	
	SD	61	3.04	17.2	12.2	56.6	
30664	C	83	3.02	23.4	9.8	77.5	
	SD	83	3.06	20.4	7.9	66.7	
31460	C	78	3.17	19.9	13.1	62.8	
	SD	56	3.16	16.5	12.4	52.2	
35075	C	78	3.05	21.5	9.9	70.5	
	SD	61	2.91	17.3	13.0	59.5	

Table 2. Mean seedling morphology (assessed at planting) by seedlot and nursery treatment. TRT - treatment, C - control, SD short-day, other abbreviations in text.

Table 3. Mean seedling morphology culled to Forest Service specifications (415B summer shipment) by seedlot and nursery treatment. REC - estimated recovery by TRT based on minimum RCD of 2.6 mm and HT between 14.0 and 28.0 cm, other abbreviations in text.

In summary, blackout resulted in less spindly seedlings regardless of seed source, blackout allowed early summer plant dates to be met even though the stock was grown in a high latitude facility, and seed orchard seed does not result in unusual seedlings for summer plant.

The efforts of the staff at Red Rock have made this project possible. K. Thomas is thanked for criticism of the article.

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**Photoperiod and Night Frost Influence the Frost Hardiness of *Chamaecyparis nootkatensis* Clones.**

*Ed. note: the following abstract is reprinted from the article of the same name by B. I. Hawkins in the Canadian Journal of Forestry Research 23:1408-1414 (1993).*

Frost hardiness in yellow cypress (*Chamaecyparis nootkatensis*) was studied over the winter to determine the relative influence of photoperiod and subzero temperatures on the hardening and dehardening processes. Stecklings (rooted cuttings) of five clones from each of the three provenances were grown outdoors and in two controlled-environment-chambers at 10:5°C day:night temperatures and 12- or 6-h photoperiods. Half of the plants in each photoperiod treatment were subject to a 4-h night frost, three times per week from December through to March. Frost hardiness was assessed at intervals using the freeze-induced electrolyte leakage method. Variability in frost hardiness was greater among clones within

provenances than among provenances. Significant differences in hardiness among clones existed throughout the experiment; however, the ranking of clones by hardiness was not consistent. Stecklings in the 6-h photoperiod were consistently more hardy than their counterparts subjected to 12-h photoperiods. Stecklings placed outdoors had equivalent hardiness to those in the 6-h photoperiod until the advent of natural frosts in January. At this time, the outdoor trees were the most hardy. Night frost also significantly increased frost hardiness in stecklings in controlled environments. Stecklings in all treatments began to dehardened between January and March. The outdoor plants dehardened most rapidly. Stecklings in the controlled environments dehardened slowly until the night-frost treatment ended, whereupon previously frozen plants dehardened more rapidly than their unfrozen counterparts.

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**Variation in *Picea glauca* Seed Germination Associated with the Year of Cone Collection**

*Ed. note: the following abstract is reprinted from the article of the same name by G. E. Caron, B. S. P. Wang, and H. O. Schooley in the Canadian Journal of Forestry Research 23:1306-1313 (1993).*

The effects of cone storage period and pre-germination treatment on seed maturity and dormancy were compared for cones of white spruce (*Picea glauca*) collected from individual trees in 1984 and 1988. Seeds were extracted from cones and germinated after 2 or 6 weeks of cone storage in 1984 and after 2, 4, 6, 10, or 14 weeks in 1988. Based on cumulative degree-days, seeds were more mature at collection time in 1988 than in 1984. Seeds from 1984

cones stored for 6 weeks matured during storage, and both germination percentage (GP) and rate of germination (GR) were significantly improved. In contrast, storage up to 14 weeks in 1988 did not increase GP and GR, as seed had attained maturity prior to cone collection. Seed dormancy was present in both 1984 and 1988. Significant improvements in GP and GR were achieved in 1984 with a pre-germination treatment even before seed maturity was attained. Prechilling of seed after 6 weeks of cone storage increased GP from 60 to 95% in 1984 and 64 to 89% in 1988.



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