TREE IMPROVEMENT

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Seed and Seedling Extension Topics

Diane Gertzen — Editor

2001 and we're still here! The "Y2K Bug" didn't materialize, but I'm sure some of us wonder if it did not metamorphose into the "Natural Gas Bug".

It appears energy costs will be higher from now on. This in itself is not insurmountable as long as prices stabilize and can at least be partially passed on to the consumer. Technology can help close the rest of the gap by reducing the number of energy "units" consumed per "unit" of crop produced. Currently prices are unstable due partly to the inability of existing pipeline capacity to satisfy peak demands. Even though expansion of pipeline capacity is planned the question remains whether it will be enough and in time for the next winter.

What is positive is the renewed interest in production efficiency, new technology, alternate crop cycles and production systems, etc. Perhaps this is a wake-up call we all needed. Certainly anything we do to increase our ability to operate in a more volatile energy pricing market will offset the negative impacts of future recurrences.

Recently, a number of greenhouse and energy industry meetings have presented a multitude of options ranging from fuel switching to co-generation to biomass and geothermal energy sources. The technology available is as impressive and overwhelming as the bureaucracy surrounding its implementation is stifling. Perhaps one of the most appealing alternatives is co-generation where the nursery installs a co-generation plant on its site and utilizes the heat while selling the electricity. Currently negotiations are underway between BC Hydro, BCUC (BC Utilities Commission), IPP's (Independent Power Producers), GVRD (Greater Vancouver Regional District) and the greenhouse industry, with other interested parties such as municipalities also offering input. Difficulties surround the issues of power generating stations on agricultural land, linking into and transporting electricity for export through BC Hydro lines, emissions, the possibility of selling electricity to BC customers, etc. I am sure that in the end we will have moved forward but in the meantime I would encourage anyone interested to stay in touch or better yet, get involved.

Eric van Steenis
Guest Editor

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GROWER'S NOTES

Greenhouse Energy Consumption

This topic needs little in the way of introduction. We have all felt the pinch. Depending on location and luck of the draw, natural gas rates have gone from less that \$3.00 to more than \$20.00 per gigajoule within a year, and now seem to be settling out just below \$10.00 per gigajoule. Industry "analysts" are predicting a possible \$13 to \$14 per gigajoule rate for the coming winter. A gigajoule is an energy unit equivalent to the energy released by the combustion of approximately 30 liters of gasoline. It is also equivalent to ~ 950,000 Btu, 0.165 barrels of oil, or 278 kilowatt-hours of electricity.

The long term is uncertain but one can assume that energy will make up a larger proportion of greenhouse crop production costs from now on. This has sparked renewed interest in energy conservation, alternate fuels, different growing facilities, new cropping systems, etc. This article briefly touches on energy conservation and provides a simple approach for evaluating alternate fuel sources.

Energy Conservation:
This requires first and foremost an awareness of what the energy is needed for, in what form(s), when, and where. Proximity of the source to its ultimate destination is key since a lot of efficiency can be lost during transfer. In a greenhouse there are basically two objectives for the heating system. One is to heat the growing plant so it can take advantage of available light during the day and process assimilates at night. The other is to heat the greenhouse environment thereby maintaining a favorable vapor pressure deficit, which facilitates plant transpiration and associated evaporative cooling as well as internal nutrient transport. Obviously humidity control is a major cost in terms of energy consumption. It will pay to investigate the sources of humidity and their management. Replenishing CO_2 can also be a major energy cost if it is done through venting due to the associated heat loss. Other options may be worth investigating.

During seed germination, humidity (reduction) and CO_2 injection are not issues but the proximity of the heat source to the seed is. Realize that germination speed can be approximated using a Q_{10} factor of 2 for plant respiration (between 5 and 25^0C germination speed [respiration rate] doubles for every 10^0C). This should be weighed against the cost of heating a growing facility. Starting with ambient outside temperatures, one can log heater-running time for each rise in set-point temperature. This is a very handy graph to have when deciding on heating set-points given various outside weather conditions (include both temperature and precipitation). Basically, if a 10-degree rise (between 5 and 25^0C) can be effected for less than a doubling in fuel consumption then it is economic (in terms of increased germination speed and subsequent reduced crop cycle time) to increase the growing temperature. The added bonus is a more uniform crop. In fact, the higher the price of fuel, the more economic it is!

Common sense heat conservation techniques abound. Sealing cracks, using IR trapping and/or anti-condensate polyethylene films, employing double poly roofs, raising heating pipes higher off the ground, skirting benches, keeping the heat off until a facility is full, pre-germinating, etc. are just a few. However, the biggest gain suggested in the literature is from the installation of energy curtains. These have to seal well! They then help by adding an insulating layer of air, reducing the total volume of air to heat, and limiting the loss of long wave radiation from the crop. They are more cost-effective when installed in gutter-connected greenhouses.

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Input Price Natural Gas per Gigajoule	Equivalent Input Price Propane per litre	Equivalent Input Price #1 fuel oil per litre	Equivalent Input Price Bituminous coal per tonne @ 3.3% mc	Equivalent Input Price Woodchips per tonne @ 35% mc	Equivalent Input Price Wood Pellets per tonne @ 2% mc	Equivalent Input Price Electricity per KWhr	Output Price Unit Heater Heat per Gigajoule (75% efficiency)	Output Price Boiler Heat per Gigajoule (85% efficiency)	Output Price Electric Heat per Gigajoule (100% efficiency)
$1.50	$0.04	$0.06	$49.50	$18.99	$27.00	$0.005	$2.00	$1.76	$1.50
$2.00	$0.05	$0.08	$66.00	$25.32	$36.00	$0.007	$2.67	$2.35	$2.00
$2.50	$0.06	$0.09	$82.50	$31.65	$45.00	$0.009	$3.33	$2.94	$2.50
$3.00	$0.08	$0.11	$99.00	$37.98	$54.00	$0.011	$4.00	$3.53	$3.00
$3.50	$0.09	$0.13	$115.50	$44.31	$63.00	$0.013	$4.67	$4.12	$3.50
$4.00	$0.10	$0.15	$132.00	$50.64	$72.00	$0.014	$5.33	$4.71	$4.00
$4.50	$0.11	$0.17	$148.50	$56.97	$81.00	$0.016	$6.00	$5.29	$4.50
$5.00	$0.13	$0.19	$165.00	$63.30	$90.00	$0.018	$6.67	$5.88	$5.00
$5.50	$0.14	$0.21	$181.50	$69.63	$99.00	$0.020	$7.33	$6.47	$5.50
$6.00	$0.15	$0.23	$198.00	$75.96	$108.00	$0.022	$8.00	$7.06	$6.00
$6.50	$0.16	$0.24	$214.50	$82.29	$117.00	$0.023	$8.67	$7.65	$6.50
$7.00	$0.18	$0.26	$231.00	$88.62	$126.00	$0.025	$9.33	$8.24	$7.00
$7.50	$0.19	$0.28	$247.50	$94.95	$135.00	$0.027	$10.00	$8.82	$7.50
$8.00	$0.20	$0.30	$264.00	$101.28	$144.00	$0.029	$10.67	$9.41	$8.00
$8.50	$0.21	$0.32	$280.50	$107.61	$153.00	$0.031	$11.33	$10.00	$8.50
$9.00	$0.23	$0.34	$297.00	$113.94	$162.00	$0.032	$12.00	$10.59	$9.00
$9.50	$0.24	$0.36	$313.50	$120.27	$171.00	$0.034	$12.67	$11.18	$9.50
$10.00	$0.25	$0.38	$330.00	$126.60	$180.00	$0.036	$13.33	$11.76	$10.00
$10.50	$0.26	$0.39	$346.50	$132.93	$189.00	$0.038	$14.00	$12.35	$10.50
$11.00	$0.28	$0.41	$363.00	$139.26	$198.00	$0.040	$14.67	$12.94	$11.00
$11.50	$0.29	$0.43	$379.50	$145.59	$207.00	$0.041	$15.33	$13.53	$11.50
$12.00	$0.30	$0.45	$396.00	$151.92	$216.00	$0.043	$16.00	$14.12	$12.00
$12.50	$0.31	$0.47	$412.50	$158.25	$225.00	$0.045	$16.67	$14.71	$12.50
$13.00	$0.33	$0.49	$429.00	$164.58	$234.00	$0.047	$17.33	$15.29	$13.00
$13.50	$0.34	$0.51	$445.50	$170.91	$243.00	$0.049	$18.00	$15.88	$13.50
$14.00	$0.35	$0.53	$462.00	$177.24	$252.00	$0.050	$18.67	$16.47	$14.00
$14.50	$0.36	$0.55	$478.50	$183.57	$261.00	$0.052	$19.33	$17.06	$14.50
$15.00	$0.38	$0.56	$495.00	$189.90	$270.00	$0.054	$20.00	$17.65	$15.00
$15.50	$0.39	$0.58	$511.50	$196.23	$279.00	$0.056	$20.67	$18.24	$15.50
$16.00	$0.40	$0.60	$528.00	$202.56	$288.00	$0.058	$21.33	$18.82	$16.00
$16.50	$0.41	$0.62	$544.50	$208.89	$297.00	$0.059	$22.00	$19.41	$16.50
$17.00	$0.43	$0.64	$561.00	$215.22	$306.00	$0.061	$22.67	$20.00	$17.00
$17.50	$0.44	$0.66	$577.50	$221.55	$315.00	$0.063	$23.33	$20.59	$17.50
$18.00	$0.45	$0.68	$594.00	$227.88	$324.00	$0.065	$24.00	$21.18	$18.00
$18.50	$0.46	$0.70	$610.50	$234.21	$333.00	$0.067	$24.67	$21.76	$18.50
$19.00	$0.48	$0.71	$627.00	$240.54	$342.00	$0.068	$25.33	$22.35	$19.00
$19.50	$0.49	$0.73	$643.50	$246.87	$351.00	$0.070	$26.00	$22.94	$19.50
$20.00	$0.50	$0.75	$660.00	$253.20	$360.00	$0.072	$26.67	$23.53	$20.00
$20.50	$0.51	$0.77	$676.50	$259.53	$369.00	$0.074	$27.33	$24.12	$20.50
$21.00	$0.53	$0.79	$693.00	$265.86	$378.00	$0.076	$28.00	$24.71	$21.00
$21.50	$0.54	$0.81	$709.50	$272.19	$387.00	$0.077	$28.67	$25.29	$21.50
$22.00	$0.55	$0.83	$726.00	$278.52	$396.00	$0.079	$29.33	$25.88	$22.00
$22.50	$0.57	$0.85	$742.50	$284.85	$405.00	$0.081	$30.00	$26.47	$22.50
$23.00	$0.58	$0.86	$759.00	$291.18	$414.00	$0.083	$30.67	$27.06	$23.00
$23.50	$0.59	$0.88	$775.50	$297.51	$423.00	$0.085	$31.33	$27.65	$23.50
$24.00	$0.60	$0.90	$792.00	$303.84	$432.00	$0.086	$32.00	$28.24	$24.00

Alternate Fuels:

This is intriguing. However, when attending workshops on the subject it quickly becomes obvious that in order to "easily" take advantage of the various options one needs to be working with a hot water heating system. Unit heaters only lend themselves to natural gas or propane, whereas any fuel can be used to heat a boiler. Some fuels require investment in extra storage, transport and delivery systems, as well as waste removal, etc. One interesting option is pellet fuel combustion technology, utilizing wood residues and agricultural fibers. Wood pellets in British Columbia and switchgrass pellets in Quebec are two examples.

When evaluating alternatives consider the capital investment associated with the system technology as well as the fuel price, how the biology of the growing system may change, and don't forget government regulations with respect to waste disposal and air quality. Since the difference in fuel prices determines the payback/economic feasibility it is imperative that fuels can be compared on a dollar per gigajoule basis (see attached table).

To use the table, select your current fuel source and price. Move to the left side of the table to obtain the equivalent price per gigajoule. Now choose a new fuel source and its current price to you. How does it compare on a $/gigajoule basis? Realize it currently takes about 2.5 gigajoules of energy per square meter of growing space to produce a forest seedling crop. Knowing your total greenhouse growing area quickly gives an indication of how much money the "switch" can "make or break" you. If comparing to electricity it is important to realize that its output (heat) cost equals its input (fuel) cost because it is 100% efficient. In other words, switching from a gas/wood/coal boiler to an electric boiler saves 15% in energy consumed regardless of its price.

An interesting example might be a grower with 2500 square meters of growing area on propane @ 36 cents/liter using unit heaters (75% efficiency). At 36 cents/liter = $14.50/gigajoule input cost which equals $14.50/.75 = $19.33/gigajoule (heat) output cost. Electricity is 5.8 cents/kWh or $16/gigajoule input <u>and</u> output cost. 2500sq m * 2.5Gj/sq m *$3.33 gives this grower $20,812.50 to work with in year one. If wood chips were available at $5.00/Gj delivered the difference in output cost would be $19.33 – $5.88 = $13.45/Gj or $84,062.50 in year one! Should he/she dig out the welder?

Eric van Steenis
Tree Improvement Branch
Ministry of Forests

The Effect of Hot Water Treatments on Pearlwort (*Sagina occidentalis*) and Snapweed (*Cardamine oligosperma*) Seeds

Introduction

Weed control in reforestation nurseries has always been a major concern to growers. In container crop production, water and nutrients are continually replenished so weeds compete for light, soil nutrients, and water thus limiting crop growth and quality (Leslie, 1994). If weeds are allowed to produce seeds the result may be a total crop failure (Ahrens, 1994; Elmore *et al.*, 1979). Control procedures with herbicides can be hazardous, while the process of hand weeding can be costly and inefficient. Prevention of weed establishment is the most effective means of managing weeds because individual survivors are eliminated. One method of weed prevention is by employing sanitary procedures such as heat or chemical treatments. Heat treatments involve radiant heat, steam, or hot water. Numerous studies have demonstrated its effectiveness in suppressing many plant pathogens as many species cannot survive temperatures above 80°C (Peterson, 1991). Weed studies have shown that high temperatures can reduce seed populations by breaking the dormancy of the heat susceptible seeds followed by a thermal kill of the seedlings (Egley, 1990). This prompted a preliminary trial to test the effects of hot water treatments on two weed species commonly found in container nurseries, snapweed and pearlwort.

Materials and Method

Twenty-five seeds of one year old and new (current season) pearlwort and snapweed were placed in 5mL vials and then soaked in 1mL of distilled water for 24 hours prior to treatment. A Pyrex™ dish (35x32x5 cm) was filled with tap water, and heated to 70°C, 75°C, 80°C, or 85°C with a hotplate/stirrer and monitored continuously. A 60mL syringe filled with water and a plastic vial holder were immersed in the dish. At the desired temperature, a vial filled with imbibed seeds (either pearlwort or snapweed) was placed into the vial holder and the contents of the syringe injected into the vial of weed seeds. The control group was treated with only tap water at room temperature (25°C). The contents of the vial were then quickly emptied into a germination box after 5, 10, or 15 seconds. The germination boxes had been lined with kimpac and filter paper and hydrated with 30mL of distilled water. The boxes were maintained at 25°C under ambient light conditions. Each treatment was replicated 4 times. The number of weed seed germinants/treatment was counted over a period of 2.5 weeks.

Results and Discussion

The results of the hot water treatments on new and one year old pearlwort and snapweed seeds are summarized in Figures 1-16. Hot water at a temperature of 75ºC applied for 15 seconds and 80ºC-85ºC at 10 and 15 seconds significantly decreased or eliminated the seed germination regardless of weed species or age. In contrast, temperatures at 75°C for 10 seconds or below had little effect or aided germination particularly with the snapweed. As well, temperatures at 80-85°C for 5 seconds resulted in both negative and positive effects on germination depending on the species and seed age. Inconsistent results were found with the new snapweed. The seeds may not have been fully mature at the time of collection.

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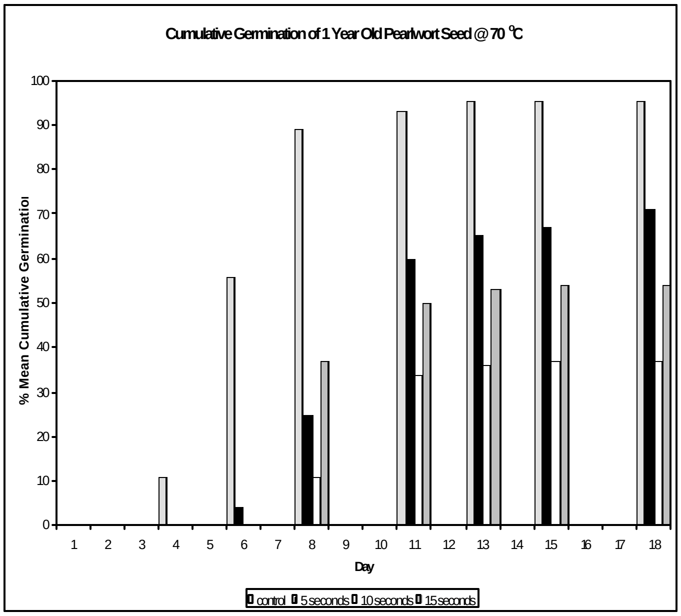
Figure 1



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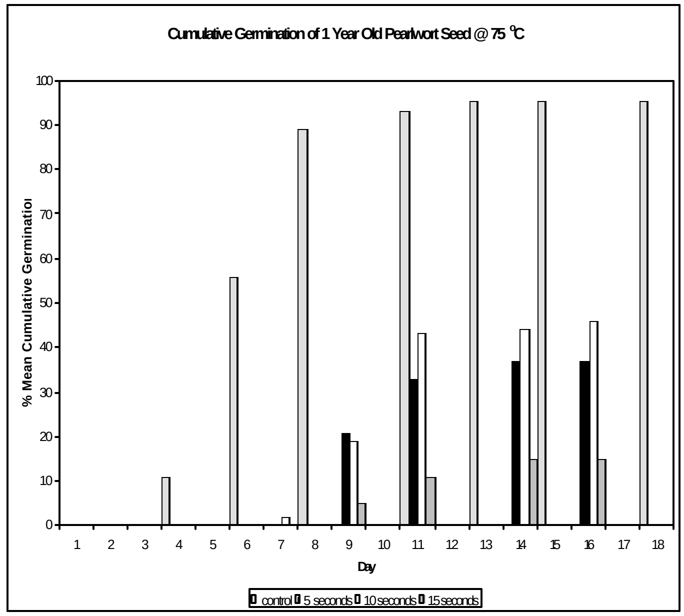

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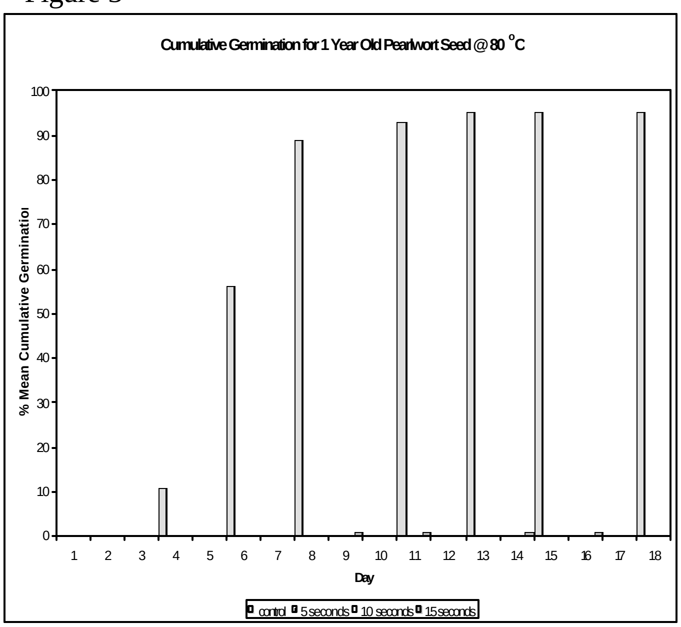

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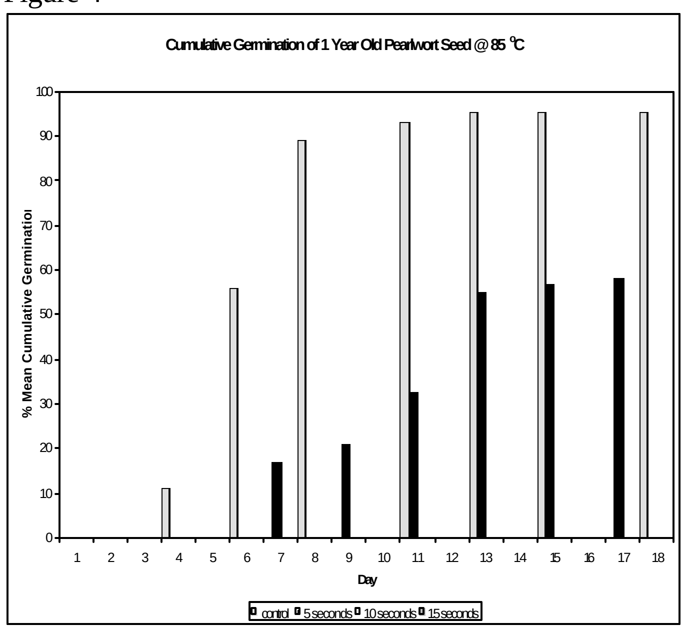

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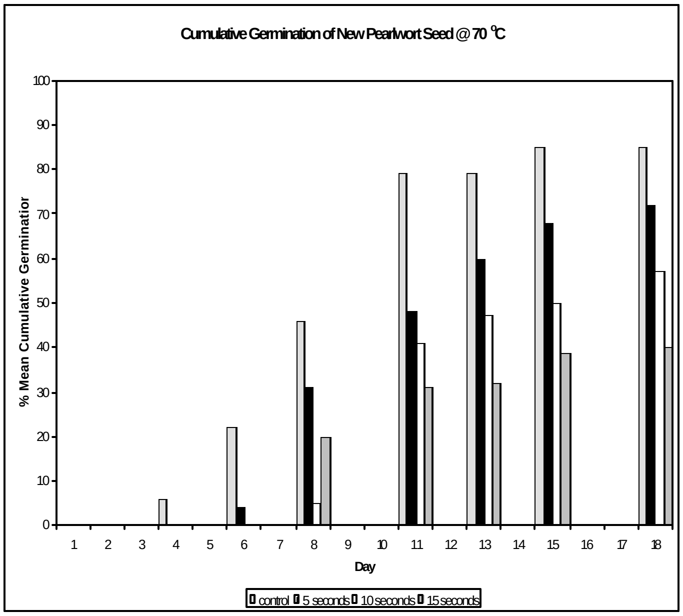

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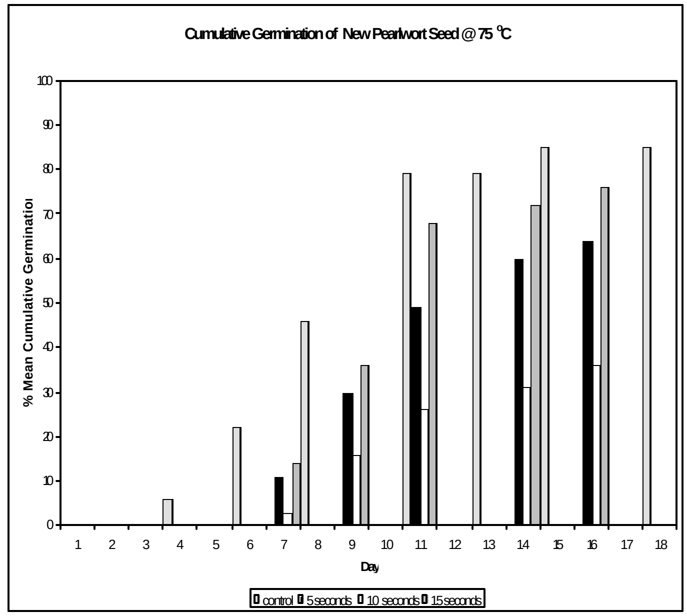

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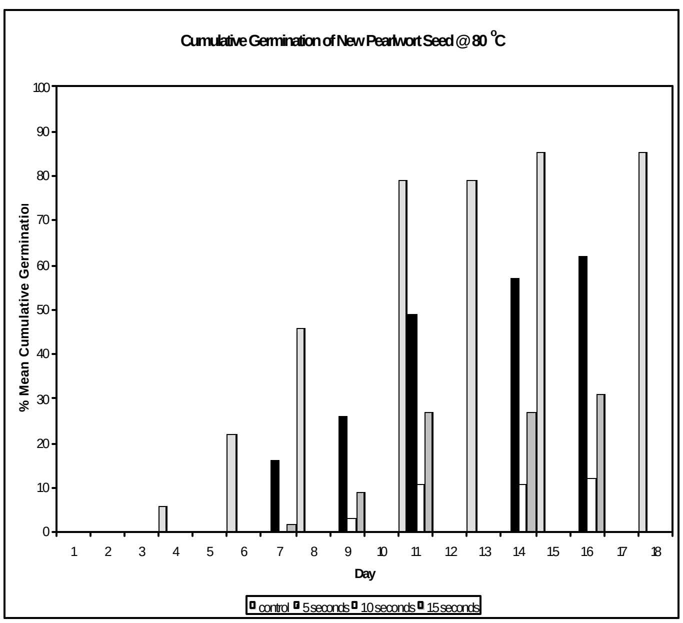

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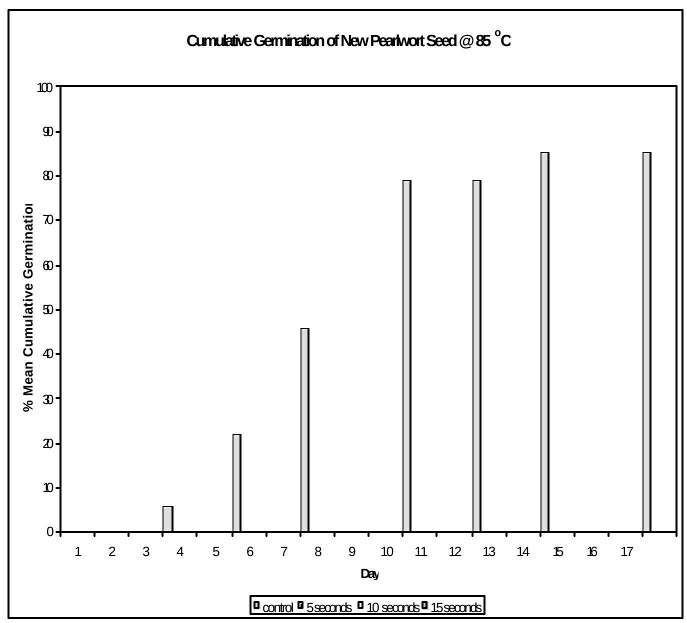

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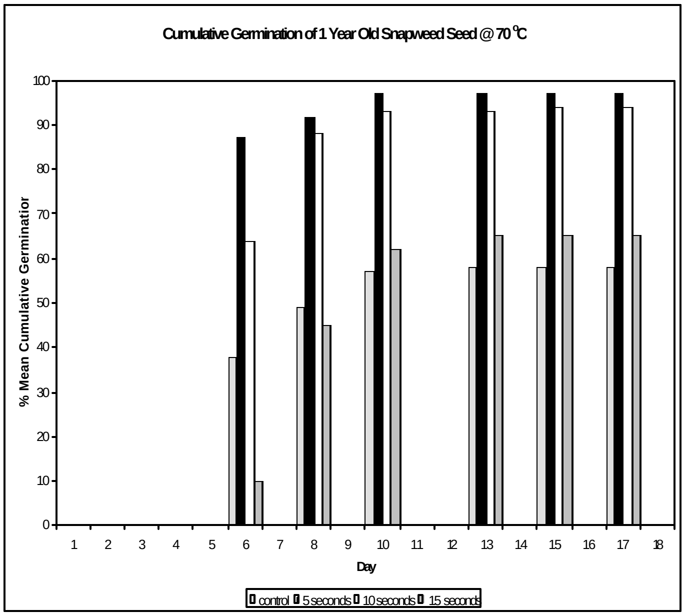
Figure 9



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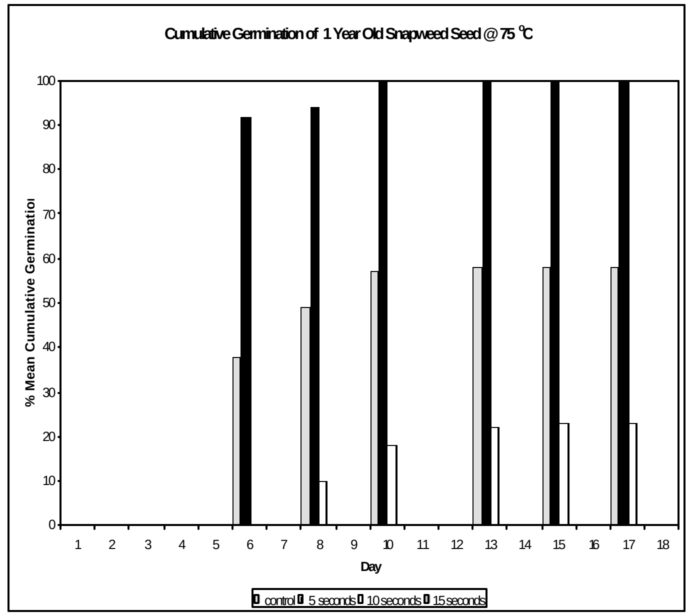

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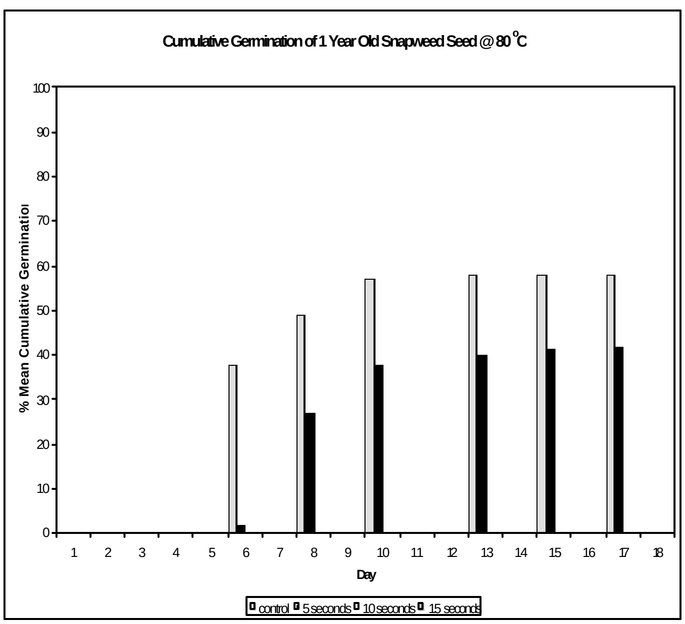

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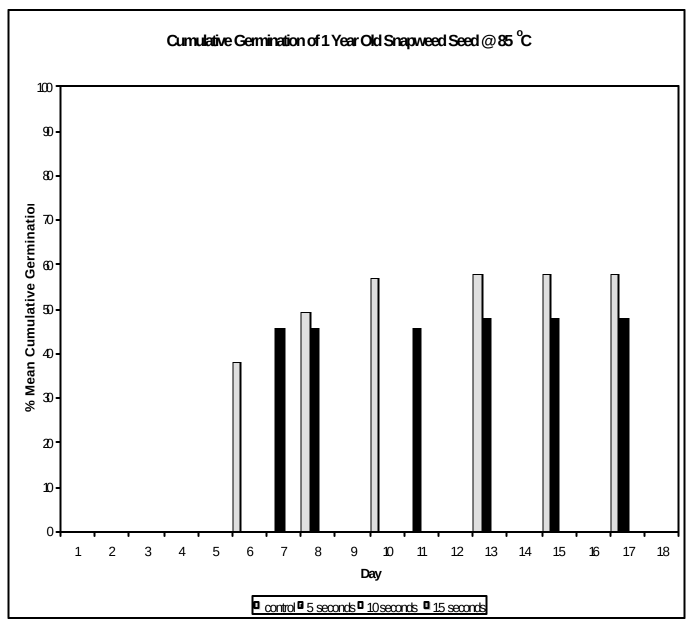

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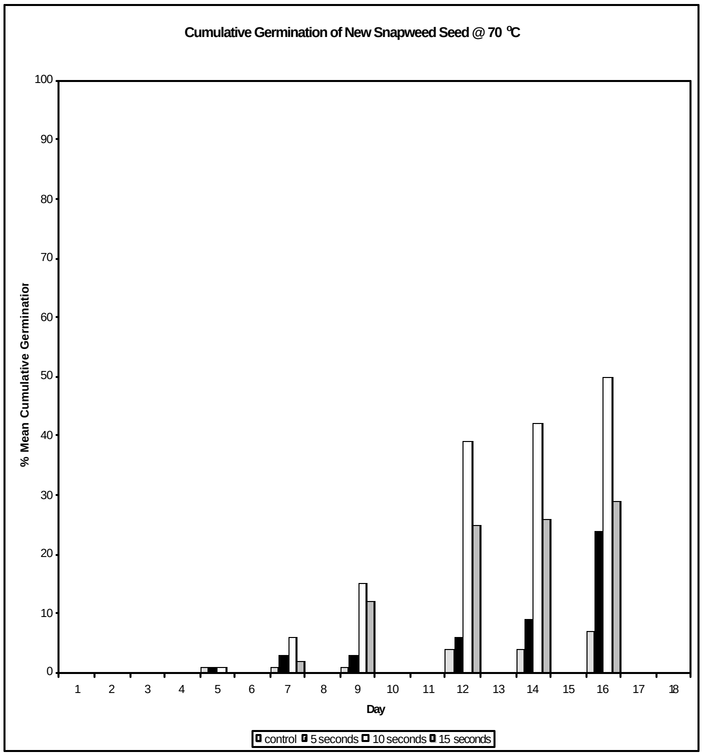
Figure 13



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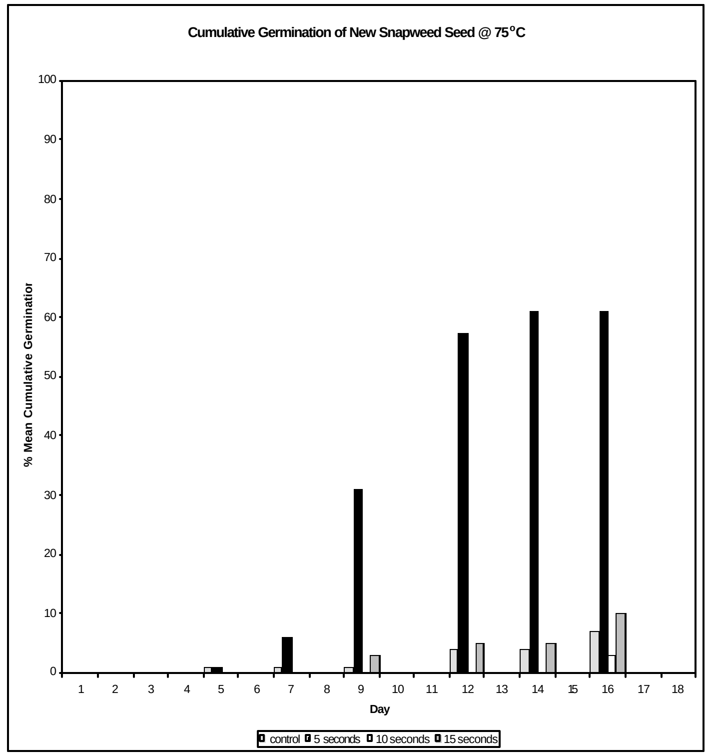


Figure 15

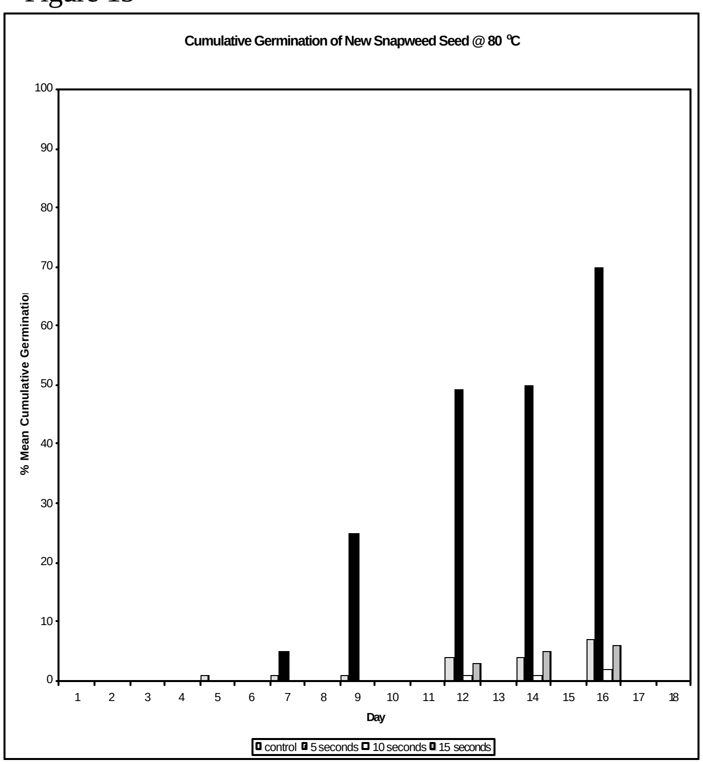
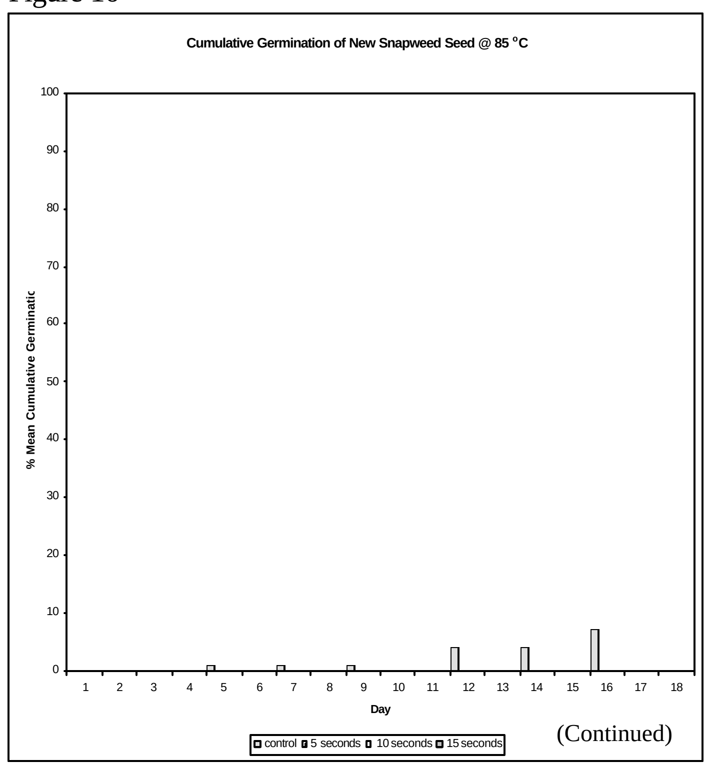


Figure 16



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In general, when applying hot water treatments to block washing methods, nursery operators should take into consideration the age and usage of their containers. Styrofoam blocks deteriorate over time, so cracks and holes will harbour increasing amounts of weed seeds (Sturrock and Dennis, 1988). Depending on the type of block washing method, nursery operators are advised to determine the costs of operating their equipment at these elevated temperatures. Some operators may find it more efficient to use 75ºC at 15 seconds, while washing less blocks in the given time, while others may prefer 80ºC or 85ºC at 10 or 15 seconds. However, at higher temperatures like 100ºC or 80ºC for 3 minutes, styrofoam blocks have a tendency to distort (Sturrock and Dennis, 1988).

Hot water treatments on pearlwort and snapweed seeds presents a possible method of decreasing or eliminating weed seed germination, but additional testing of this method under operational conditions is needed.

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Agnes Kwok
Co-op Student
Simon Fraser University

Dave Trotter
Tree Improvement Branch
Ministry of Forests

Seedlings without Surprises

So, you have a woodlot licence or other forest land where harvesting is planned (or already happened), and artificial regeneration is required. Unless you work in silviculture for the Ministry of Forests or for a major forest licensee, you may not have any idea how to go about obtaining forest seedlings for regeneration. This article is for those readers who need to obtain forest seedlings to meet their silviculture treatment obligations.

When planning artificial regeneration for a woodlot licence or similar area, licensees have two main options for obtaining tree seedlings. Each option has advantages and disadvantages.

Order seedlings to be grown at a commercial forest nursery.
By ordering seedlings specifically for your woodlot, you can ensure that you get the correct species and stocktypes for your site, and ensure that the seedlings have been produced from seed or vegetative lots that are suitable for your planting site. This will ensure that you are in compliance with the Forest Practices Code regulations and guidelines.

When ordering seedlings, lead-time is required to grow the seedlings in the nursery before they will be ready for planting. Typically, seedlings should be ordered in September/October of Year 0, sown at the nursery in February/March Year 1, and will be ready for planting in the spring of Year 2 (see Figure 1). Therefore, ordering seedlings and arranging a contract with a commercial forest nursery will require some time and planning to ensure that quality seedlings are produced from suitable seed. Ideally the ordering of seedlings should be planned so that the seedlings are available for planting shortly after harvesting or site preparation. On sites with competing vegetation, this is critical for optimum seedling survival and growth.

You will need to be prepared to make payments for: seed costs, seed services performed at the Tree Seed Centre, a seedling contract with a nursery, and cold storage and/or transportation costs for the seedlings once produced.

Purchase surplus seedlings from a major licensee or the Ministry of Forests, or seedling overruns from a commercial forest nursery.
By purchasing surplus or overrun seedlings, you may be able to obtain seedlings for your site within a shorter period of time. This can save you some time in meeting your regeneration obligations if you were not able to order seedlings prior to harvest.

However, there is a significant risk that the surplus seedlings you acquire and plant do not meet the Forest Practices Code regulations and standards. The seed or vegetative material used to grow the seedlings may not be suitable for your site, according to the requirements found in the Woodlot Licence Forest Management Regulation, Section 82. Surplus seedlings may not be a preferred or acceptable species or the best stocktype for your planting site.

With surplus seedlings, the costs for the seed, seed preparation, growing the seedlings at the nursery and cold storage may be rolled into one price. A single purchase price for surplus seedlings can be more straightforward than several payments associated with ordering seed and growing seedlings at a nursery. However, if the seed or seedlings that are planted do not comply with the Forest Practices Code regulations and guidelines, the requirement to produce a free-growing stand may not be met, which could mean costly re-planting.

The intention of this article is to explain how to order seedlings to be grown at a commercial forest nursery (option A). However, there are precautions you can take to ensure that you are in compliance with the Forest Practices Codes if you follow option B. These will be discussed later in this article.

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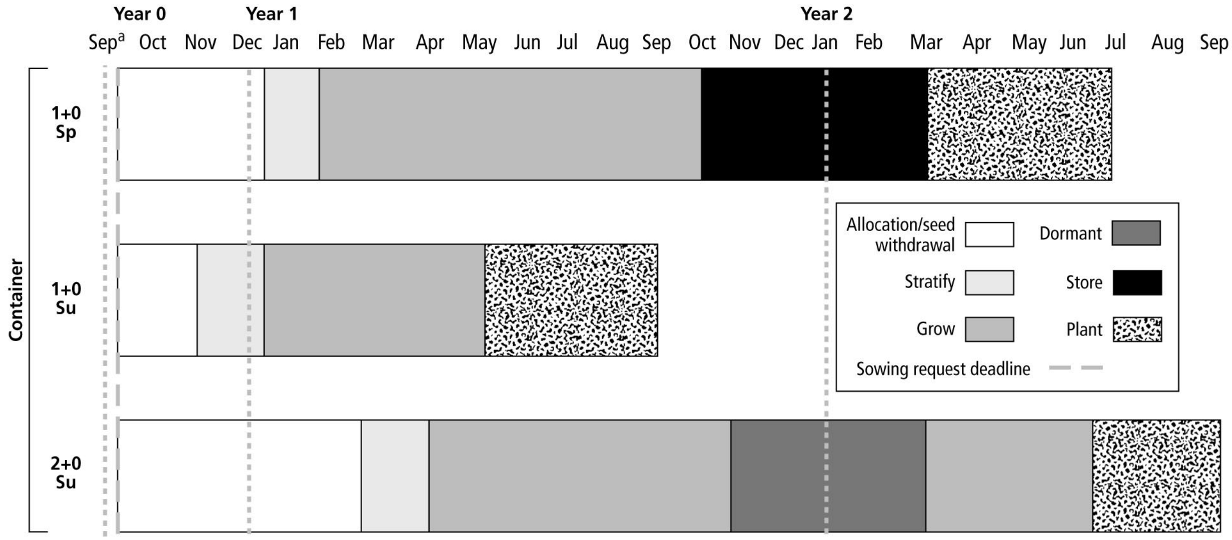

[a] Early sowing request deadline. Early sow requirements apply to: 1+0 Yc; 1+0 Pw; 1+0 Ba; 1+0 Bl; 1+0 Bn; all 1+0 summer plant and half-year transplant stock, and Cw.

Figure 1. Seedling request timelines for seed preparation and nursery production of 1+0 spring stock, 1+0 summer stock and 2+0 summer stock.

Seedling requests should be initiated in September/ October of Year 0. Exact timing of each phase will vary between nursery, species and container type. Use these timelines as a guide to determine the year that seedlings should be ordered to ensure that they will be ready for planting soon after harvest and site preparation of your woodlot.

Following are the steps for ordering seedlings.
Figure 1 shows the standard time frame for each of these steps.

Determine the species, stock type, container type, stock age, year and season of planting most appropriate for your site.
The publication *Provincial Seedling Stock Type Selection and Ordering Guidelines*[1] or a person with silviculture experience in your local area should provide you with the assistance you need to make these decisions.

Determine the quantity of seedlings of each species required.
If regeneration or leave trees are not present on the planting site, use the target stocking standards in the silviculture prescription or site plan for the area, to make your calculations. The number of tree seedlings to order per hectare may need to be reduced below the target stocking standard to take into consideration leave trees, existing planted trees or natural regeneration that may be present or anticipated. Alternately, the number of tree seedlings to order may need to be increased in areas where seedling survival problems are expected.

Contact Tree Improvement Branch[2],
with the following information:
- Name of Woodlot Licence holder
- Phone and fax numbers and email address if available
- Mailing Address
- Woodlot License Number
- Forest District
- Latitude and longitude of woodlot
- Mean elevation of planting site (from your site plan or silviculture prescription)
- Biogeoclimatic zone (from your site plan or silviculture prescription)
- Species of trees you would like to order
- Quantity of seedlings for each species to be ordered
- Stocktype and container type for each species
- Stock age, planting year and season
- Preferred seed lot numbers (where the woodlot licensee owns seed).

(Continued)

Note: The best time of year for ordering seedlings is September or October. If the ordering process is delayed until December, you will likely experience problems finding a nursery to grow your seedlings.

Review the suitable seed and/or vegetative lots available.
Tree Improvement Branch[2] will use the Seed Planning and Registration system (SPAR) to search for a list of suitable seedlots available for your planting site. Suitable seedlots are those that meet the regulations and guidelines specified in the *Seed and Vegetative Material Guidebook*[1]. You will be faxed a list of suitable lots with recommended choices highlighted. There may be situations where major licensees or seed dealers privately own all the suitable seed. If that is the case, you will be given contact names so that you can arrange to purchase the seed you require. Confirm your seedlot preferences with Susan Zedel[2].

Initiate entry of your seedling request(s).
Tree Improvement Branch[2] will enter a seedling request in SPAR for each species/ stocktype combination you require, pending arrangements with a nursery. You will be sent a SPAR report showing the pending seedling request ID codes.

Arrange a contract with a commercial forest nursery.
Contact commercial forest nurseries to obtain quotes for your seedling requests. A list of nurseries is available from Tree Improvement Branch[2]. Some B.C. forest nurseries have a standard contract that they can use for small orders. You will need to consider price per seedling, payment schedule and availability of cold storage facilities at the nursery if you have ordered spring plant stock. You should also consider the cost of shipping the seedlings if you can not arrange for pickup from the nursery. When negotiating the contract, ensure that you have an agreement regarding the quality of seedlings to be delivered (height, general health, etc.). To view the seedling specifications used for MOF seedling contracts, check out this website:
http://www.for.gov.bc.ca/nursery/branch.htm
Look for the link to *Seedling Stock Specifications*. This website also includes a list of typical seedling prices in the *Commercial Equivalent Rate* table.

Request approval of the seedling request(s).
Be sure to notify Tree Improvement Branch[2] with the nursery selected. Your seedling request(s) will then be approved. The Tree Seed Centre will withdraw the seed from storage at the appropriate time, prepare the seed with a pre-sowing treatment (stratification or pelletization), and ship the seed to the nursery in time for the nursery's sowing date.

Contact the Tree Seed Centre to check on status of seedling request(s).
To check on the status of your seedling request and the pre-sowing preparation of the seed, contact Dawn Stubley at 604-541-1683 (local 239) or
email: Dawn.Stubley@gems3.gov.bc.ca

More information on cone and seed services provided by the Tree Seed Centre is in the next article in the Newsletter.

Receive and pay invoices for seed costs (from the Ministry of Forests or private owner) and Tree Seed Centre services.
For more information on the Tree Seed Centre services, refer to the *Guide to Cone and Seed Services*[1].

Make contact with the nursery during the growing season.
You should contact the nursery some time during the growing season to ensure that your seedling requests are growing well, and that they expect to produce the amount of seedlings requested. If the nursery informs you that they may produce more seedlings than you ordered you are not obligated to purchase the surplus seedlings but there may be other woodlot licensees who want to purchase the seedlings.

(Continued)

Make arrangements for delivery or pickup of your seedlings from the nursery or the cold storage site… and plant your seedlings!

If you plan to use Option B, i.e. purchase surplus seedlings from the Ministry of Forests or a major forest licensee, or seedling overruns directly from a commercial forest nursery:

Follow steps 1 and 2 as described above.

Ensure that the seedlot(s) used to produce the seedlings are suitable for your planting site.
Suitable seedlots are those that meet the regulations and guidelines specified in the *Seed and Vegetative Material Guidebook*[1]. To check on suitability, contact Tree Improvement Branch[2]. You will need to provide the following information on your woodlot: planting site latitude, longitude and mean, minimum and maximum elevation.

Check on the quality of the seedlings and ensure that the price is fair.
If possible, go to the nursery to check on the quality of the seedlings in person, prior to making an agreement for purchase. Check the website links listed in item 6 above for seedling stock specifications used by the MOF.

Make arrangements for delivery or pickup of your seedlings from the nursery or the cold storage site.

Notes:
[1]The publications referred to in this article provide important information for woodlot licensees who are planning artificial regeneration:
Provincial Seedling Stock Type Selection and Ordering Guidelines
Woodlot Licence Forest Management Regulation
Seed and Vegetative Material Guidebook

These publications may be ordered from the Government PublicationsCentre Order by phone 1-800-663-6105 or via the internet: http://www.publications.gov.bc.ca/.
For those with internet access, they may also be viewed on-line at:
http://www.for.gov.bc.ca/hfp/pubs/stocktype/index.htm
http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcaregs/wlfm/wlfm6.htm
http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/veg/seedtoc.htm

The *Guide to Cone and Seed Services* is available at no charge directly from the Tree Seed Centre. Contact Dianne Wilson by phone: 604-541-1683 (local 236), or email: Dianne.Wilson@gems6.gov.bc.ca. More information on cone and seed services that are provided by the Tree Seed Centre will be included in the next newsletter.

Information on the Ministry of Forests Tree Seed Centre, Tree Improvement Branch, and the Seed Planning and Registry system is available on the internet: http://www.for.gov.bc.ca/tip/

[2]**For assistance and information, contact:**
Susan Zedel, SPAR Administrator / Seed Information Systems Officer
Tree Improvement Branch
Ministry of Forests
Phone: 250-356-1598 Fax: 250-356-8124
Email: Susan.Zedel@gems8.gov.bc.ca

Susan Zedel
Tree Improvement Branch
Ministry of Forests

How To Obtain Cone And Seed Services

As part of the Ministry of Forests, Tree Improvement Branch, the Tree Seed Centre (TSC) provides a variety of cone and seed services to the Ministry of Forests, forest companies and woodlot licences in British Columbia.

- Assistance with cone and seed evaluations before or during cone collections and post-collection storage.
- Cone conditioning and seed extraction from cones.
- Seed cleaning and upgrading.
- Seed testing and quality assurance monitoring of production and storage activities.
- Seedlot registration.
- Long-term seed storage and inventory management.
- Withdrawal, preparation and transport for seedling production.
- Feedback, information management and reporting services.
- Seed sales and transfers.
- Cone and seed forms management.
- Operational method improvement, training and extension.

Details about services provided by the TSC or forms required are available by visiting our web site at http://www.for.gov.bc.ca/tip/treeseedcenter. Alternately, phone the TSC (604-541-1683 extension 0) to request a copy of, *A Guide to Cone and Seed Services, Tree Seed Centre, Surrey*. Please call this number if you would like to inquire about, or order any forms or cone sack tags.

Heather Rooke, Manager, (604-541-1683 extension 224, Heather.Rooke@gems9.gov.bc.ca) or Dawn Stubley, Operations Supervisor, (604-541-1683 extension 239, Dawn.Stubley@gems3.gov.bc.ca) would be pleased to provide assistance or answer any questions you might have about services offered by the TSC.

David Kolotelo, Cone and Seed Improvement Officer, (604-541-1683 extension 228, David.Kolotelo@gems7.gov.bc.ca) can provide information and answers to questions about cone and seed biology, method improvement, training and extension.

Some highlights of interest to our Woodlot Licensee clients:

Cone-Seed Evaluations and Cone and Seed Processing

Each year, the TSC provides assistance with cone crop monitoring and cone and seed extraction and processing services to a wide variety of ministry and private clients. TSC cone and seed processing involves a series of treatments: cone curing; extraction of seed from cones; cleaning to remove debris; removal of seed wings; and final cleaning and separation to remove empty or insect filled seed. The methods and procedures used at the TSC vary depending on the species or individual seedlot requirements.

Non-ministry clients may choose to have these services provided by one of four private facilities, located throughout the province. More information about private seed extraction and processing service providers can be obtained by contacting the BC Tree Seed Dealers Association, Lauchlan Glen, President at 604-826-4721.

Seedlot Registration, Testing and Long-term Storage

All seedlots destined for Crown land reforestation purposes, must be tested, registered and stored with the TSC. To ensure that the origin of tree seed identified as "suitable" for Crown land reforestation can be verified, each collection of cones is assigned a *seedlot* number. *The FPC Seed and Vegetative Material Guidebook* defines, *seedlot* as: "a quantity of cones or seeds having uniformity of species, source, quality and year of collection". Seedlot numbers originate on cone collection reports: Natural Stand (and Plantation) Cone Collection Report (FS721) or Seed Orchard Cone Collection Report (FS721A). These forms are completed by the orchard or agency collecting the cones then forwarded to the TSC, the information received is entered on the Seed Planning and Registry System (SPAR).

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A variety of laboratory tests are performed at the TSC: seedlot purity; seed moisture content, seed weight and germination. When testing of a new seedlot is completed, seedlot registration is confirmed.

Tree seed is stored in secure, monitored vaults at -18°C and can be safely stored for many years. During the period of time that a seedlot remains in storage, it is routinely inspected, tested and inventoried.

How to Acquire Tree Seed for a Seedling Request

Please refer to the previous article, *Seedlings without Surprises*, for more details and important information about seedling request timeline requirements.

The Seed Planning and Registry System (SPAR) can identify seedlots that are suitable for your planting site and meet the regulations and guidelines specified in the *Forest Practices Code Seed and Vegetative Material Guidebook*.

Seedlots registered on SPAR may have more than one owner. Each owner can identify quantities of seed as "surplus" and/or "reserved". For seedlots owned by the Ministry of Forests, a seedling request may be entered and APPROVED against some or the entire portion of a seedlot.

For "surplus" seed owned by a private forest company, a seedling request may be entered as PENDING in SPAR, after which you must contact Spencer Reitenbach, Inventory Management Technician, Tree Seed Centre at 604-541-1683 extension 229 to confirm your intent to purchase the seed. The TSC will then verify that the prospective purchaser and seller are in agreement and if so, the request is APPROVED. All parties are notified when the request has been moved to APPROVED status.

For seedlots that are designated as "reserved" only, the owner agency may be willing to sell a portion of their seedlot if contacted.

After a Seedling Request is Approved on SPAR What Happens?

When a seedling request is APPROVED on SPAR, the request is transferred, overnight to the TSC's Cone and Seed Processing System (CONSEP). As new APPROVED requests are received at the TSC, the seedlot withdrawals are scheduled for preparation and transport to meet species/seedlot biological requirements and growing instructions from the nursery that will be growing the seed. Each year, the TSC handles about 4,500 individual seedling requests. To improve seed germination at the nursery, most seedlot requests receive a running water soak and a period of chilling (stratification) prior to sowing. Eighty percent of seedling requests requiring stratification are treated at the TSC with the balance treated at the nursery. Exceptions are those species sown "dry" (not stratified) and western red cedar, which is pellet-coated to aid in precision seeding operations. SPAR can provide basic Request Status information but for more details, contact Dawn Stubley, Tree Seed Centre at 604-541-1683 extension 239.

How to Acquire Seed to Meet More Than One Years Needs

If you require a supply of seed to meet several years needs, you may wish to arrange for a seed purchase or cone collection.

Please note that before deciding to purchase or collect, it's important to confirm whether or not seed orchard seed is available or will be available in the near future before planning on a supply of natural stand seed. Unless you obtain written authorization to use natural stand seed from your district manager, the Woodlot Licence Forest Management Regulation requires the use of seed orchard seed if it is available.

Acquiring a 5-10 year supply of seed is no longer recommended because orchard production is expanding and new orchards are coming on-line; as a result, orchard produced seed will continue to displace natural stand seed. For more information on seed supply and planning please contact Susan Zedel, Tree Improvement Branch, (250-356-1598, Susan.Zedel@gems8.gov.bc.ca).

(Continued)

If a seedlot owner is willing to sell seed, they must advise the TSC of their approval to authorise a transfer of ownership. When the transfer of ownership occurs on SPAR, the TSC notifies both the purchaser and seller that the transaction is complete.

If there is insufficient or no orchard or natural stand seed available, you may wish to arrange for a cone collection. Please refer to the *FPC Seed and Vegetative Material Guidebook, Collection of cones, seed and vegetative material* for essential information. Woodlot licensees may be interested in collaborating with other woodlot licensees or agencies to reduce administration and costs of a cone collection. Please contact:
Susan Zedel, Tree Improvement Branch, (250-356-1598), Susan.Zedel@gems8.gov.bc.ca) if you would like a list of licensed seed dealers who provide cone crop monitoring and collection services.

Time Required to Provide Services
The time required will depend upon request type, species, cone or seed condition and time of year. Depending on the species or services required, the time required varies from a few weeks to several months. More information is available by referring to the *TSC Guide to TSC Operational Time Requirements*, at http://www.for.gov.bc.ca/tip/treeseedcenter/tsc/time.htm, by requesting a copy of our *Guide to Cone and Seed Services, Tree Seed Centre, Surrey* or contacting Dawn Stubley, Operations Supervisor at 604-541-1683 extension 239. Every effort will be made to expedite requests as a priority when necessary, provided sufficient time is available.

Fees for Service
Sales of ministry owned seed and some of the services provided by the TSC (i.e.) seed processing, new seedlot testing, seed withdrawal, preparation and transport, are provided on a fee for service basis. The TSC prepares and forwards invoices when all services for a given seedlot or request are complete.

The Ministry Surplus Seed Price Schedule:

http://www.for.gov.bc.ca/TIP/treeseedcenter/surplus_seeds/seeds.htm

The Fee Schedule for Cone/Seed Services:

http://www.for.gov.bc.ca/TIP/treeseedcenter/tsc/fees.htm

Dianne Wilson, Finance and Admin. Officer,

(604-541-1683) extension 236,
Dianne.Wilson@gems6.gov.bc.ca) can provide copies of these schedules and answer any questions you might have.

Heather Rooke
Tree Improvement Branch
Ministry of Forests

Seed Information Systems Development

The Seed Information Systems sub-program in the 2000/2001 fiscal year initiated the development of two web-based applications:

1. SeedMap, a new web-based mapping system, will provide tree improvement clients (ministry and non-ministry) with access to seed planning maps and associated spatial and attribute data summary reports.

2. SPAR (Seed Planning and Registry system) is being converted from the existing mainframe application and database to a web-based application and Oracle database.

SeedMap

SeedMap will provide tree improvement clients with the necessary tools for assessing current and projected seed needs, developing appropriate cone collection and seed supply access plans, identifying areas for orchard expansion and carrying out sound forest practices. SeedMap will also provide the ability to integrate seed planning and tree improvement information (spatially and otherwise) with other resource management initiatives such as land use planning, timber supply reviews, integrated silviculture planning, forest certification and gene conservation programs.

SeedMap will enable clients to select multiple reference map layers (e.g., seed planning zones/units, biogeoclimatic ecosystem classification (BEC), management unit (e.g., TSA, TFL[1]) boundaries, forest region/district boundaries, and TRIM[2] data) and view them on-line or as printed 8½" x 11" maps. Clients will be able to query spatial polygon information, search locations/features, and measure distances. Non-spatial summary reports (e.g., Species Plan[3] timelines, seed use, genetic gain, and inventory/production) based on current (SPAR/ISIS[4]) and projected (Species Plan) data will also be available through a report menu option or as a spatial query detail report.

SeedMap is being developed using ARC IMS, *ESRI Canada Limited* software, and client server-based technology. The SeedMap application will be accessed directly through a client's Internet browser without the need for additional desktop software or plug-ins. Clients will be granted access to SeedMap through their FSMASTER UserIDs. Non-ministry clients will access SeedMap using an Extranet User ID. A pilot of SeedMap will be available in spring 2001. A direct link to the new SPAR Web application is also planned (SPAR Web, July 2002).

[1] TSA = Timber Supply Area; TFL = Tree Farm License
[2] TRIM – Terrain Resource Inventory Mapping
[3] Species Plan timelines – projected orchard production and genetic gain over a specified planning period (i.e. 10 years)
[4] SPAR – Seed Planning and Registry system; ISIS – Integrated Silviculture Information System

(Continued)

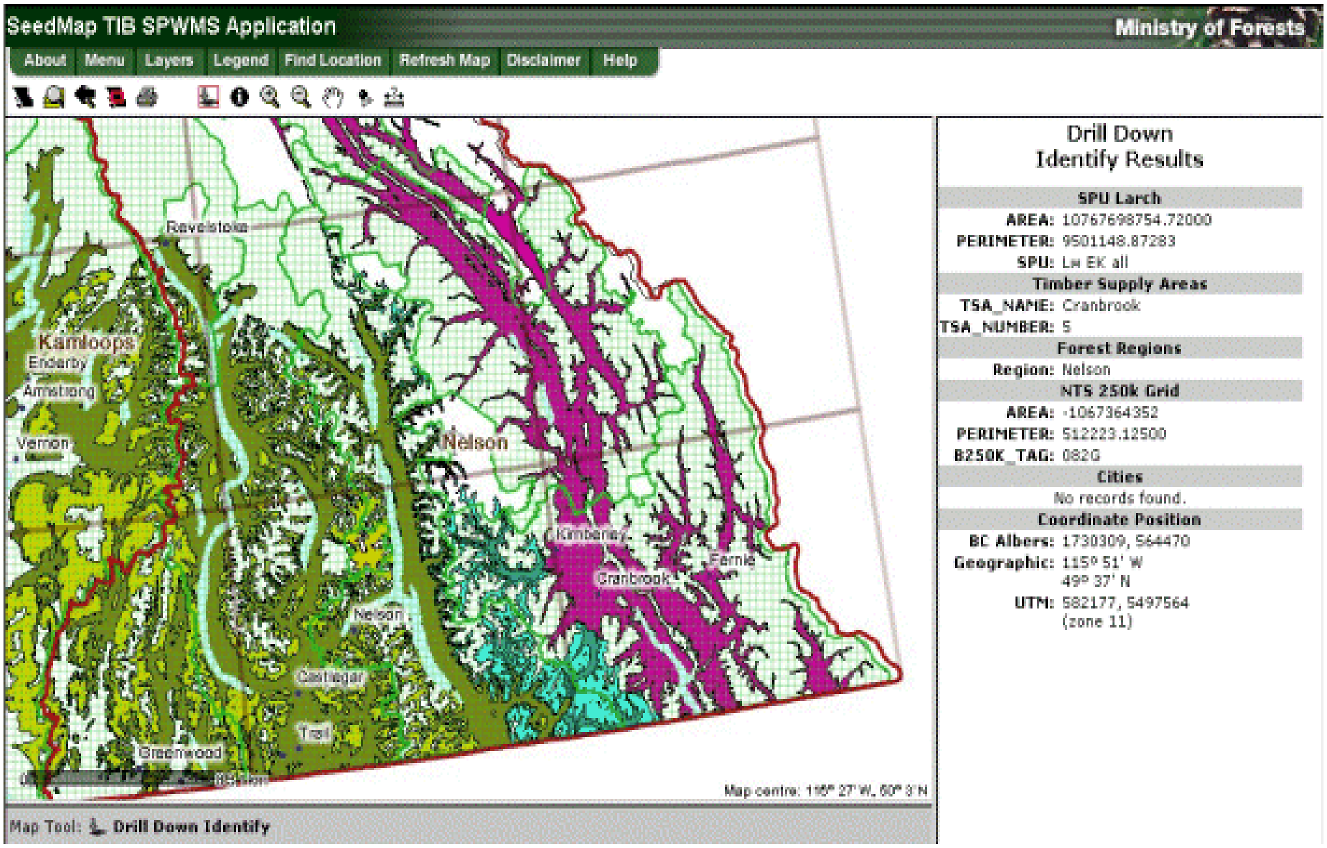

Fig. 1: Example of a SeedMap screen where the spatial layers for a specific map location are identified.

The BC Forest Genetics Council and the Ministry of Forests are sponsoring the SeedMap project. Forest Renewal BC is funding Phase 1 development. The ministry project lead is Leslie McAuley, Tree Improvement Branch. GDS & Associates Limited, Victoria, B.C., is developing the application.

SPAR Web Application

The purpose of the SPAR (Seed Planning and Registry system) web application development project is to convert the existing Ministry of Forests IBM VM mainframe application and database to a web-based application and Oracle database.

SPAR is an information management system that provides ministry and non-ministry tree-improvement clients with on-line access to current information on seed and vegetative lots and an on-line facility for entering seedling requests. SPAR incorporates the guidelines on selection of seed and vegetative lots detailed in the *Forest Practices Code of B.C. Seed and Vegetative Material Guidebook (April 1995)*

The new web-based application will provide a more intuitive and user-friendly interface to these SPAR functions than the existing SPAR application. SPAR users will access the system via their web browser software

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(eg. Internet Explorer). The reporting capability of the new system will also be significantly improved compared to the existing VM system. SPAR users will be able to submit reports to directly receive output in various reporting formats. A direct link to the new SeedMap application is also planned.

A Ministry of Forests SPAR Web Application Project Team has been established to review and prioritise any enhancements, and provide guidance on business issues regarding the redevelopment over the life of the project. Input will be sought from a range of stakeholders (Ministry of Forests and non-ministry SPAR users) at various stages throughout the project development.

The SPAR Web Application Development is a multiple phase project. The first phase, which commenced in September 2000 and is schedules for completion in spring 2001, includes:

- conversion of the SPAR data model from the existing format to an Oracle Designer format;
- conversion of the VM database to Oracle 8I; and
- conversion of all functionality related to seedlot and vegetative lot, including on-line screens and reports.

The core technology for the SPAR project will use the Java programming language, particularly Java servlets and Java Server Pages (JSP). Reporting development will use Crystal Reports, with various potential report output formats possible (eg. Adobe Acrobat pdf files). Security will be managed by Microsoft's challenge/response authentication process. SPAR users will continue to require a UserID and Password to access the system to ensure that access to seed owners' inventories is secure.

The second and third phases of the SPAR Web Application Development will handle conversion of the seedling request process, cone/seed service requests and all other functions until the mainframe system is completely converted. The final implementation of the project is scheduled for June 30, 2002.

The BC Forest Genetics Council and the Ministry of Forests are sponsoring the SPAR project. Forest Renewal BC is providing the funding for the contracted resources. The ministry project lead is Susan Zedel, Tree Improvement Branch, Ministry of Forests. The Information Management Group, Ministry of Forests, is providing the technical guidance required for the SPAR database conversion, the web application development, and the web security infrastructure. Pangaea Systems Inc., Victoria, B.C., is under contract for the systems development for the SPAR Web Development project.

Leslie McAuley
Susan Zedel
Tree Improvement Branch
Ministry of Forests

Volume of Cones Collected in BC - Orchard and Natural
(July, 2000 - May, 2001)

Seedlot	Species:	Genetic Class:	Collection Volume(Hl):	Original Seed Qty(g):	
	ALNUCRI Total	B	1.10	518	
	BA Total	A	3.00	8,960	
	BA Total	B	6.00	14,397	
	BL Total	B	102.45	136,652	
	CW Total	A	45.66	14,147	
	CW Total	B	13.55	23,170	
	FDC Total	A	99.90	32,320	
	FDI Total	B	136.30	86,856	
	HW Total	A	38.90	45,755	
	LW Total	A	56.40	60,793	
	LW Total	B	144.19	114,570	
	PLC Total	B	1.90	1,116	
	PLI Total	A	244.89	54,873	
	PLI Total	B	1,096.16	290,174	estimate
	PLI Total	B+	5.00	1,584	
	PW Total	A	58.22	25,553	
	PW Total	B	3.20	1,238	
	PY Total	B	319.40	664,965	
	SS Total	B	8.00	3,883	
	SX Total	A	10.00	1,707	
	SX Total	B	5.60	2,608	
	Grand Total		2,399.82	1,585,839	

This table includes all select and standard B.C. collections from 00/07/01 to 01/05/03 that we have received the FS721 / FS721A Cone Collection Reports for registration and storage.

All extractories are included and total grams extracted are estimated for Pli since we have some cones that are not yet extracted here at the Tree Seed Centre.

Spencer Reitenbeich
Tree Improvement Branch
Ministry of Forests

Forest Certification and Implications for Tree Improvement, and Seedling Production and Use

With increasing interest from environmental groups, retailers, and consumers for products from sustainably managed forests and "environmentally friendly" timber processing facilities, forest companies are pursuing various types of certification and eco-labelling for their forest land operations and mills.

This article reviews the four major forest certification systems being pursued in British Columbia, and discusses their implications for tree improvement activities, and seedling production and use.

Certification Scheme Overview

Environmental non-government organizations (ENGOs), international and national standards associations, and forest industry associations are developing forest land and forest products certification systems. Under most schemes, accredited independent third parties, or verifiers, grant certification to ensure compliance with the certifying body's requirements. Certification schemes can be grouped into four broad categories:

1. **Process-based schemes** require a forest land or mill manager to design and implement an administrative environmental framework, and to set and meet specific standards. These standards can be developed internally or through public consultation.

2. **Performance-based schemes** require an applicant to meet environmental, social, and cultural standards defined by the certifying body and/or the applicant.

3. **Mixed schemes** have elements of both process- and performance-based systems.

4. **Chain of custody schemes** verify that manufacturers have used forest products derived from certified forests.

The certification schemes with direct consequence to tree improvement are the process- and performance-based schemes used to verify sustainable forest management.
To date, forest land managers in British Columbia have sought certification under four organizations:[1]

- International Organization for Standardization, 14001 Environmental Management Series (ISO 14001)
- Canadian Standards Association (CSA) Z809-96, Sustainable Forest Management System
- American Forest & Paper Association, Sustainable Forestry Initiative (SFI)
- Forest Stewardship Council (FSC).

ISO

ISO 14001, a process-based certification scheme, requires an applicant to abide by local laws and regulations, and internally developed environmental management system. For tree improvement, a forest land manager can meet these requirements by committing to use only tree seed and vegetative material that is collected, registered, and deployed in accordance with the *Forest Practices Code of British Columbia Act* and its regulations and guidebooks. Appropriate records must also be maintained.

CSA

The CSA scheme is both process- and performance-based. CSA standards require a forest land manager to develop, for a defined forest area (DFA), a set of values and goals that are consistent with the Canadian Council of Forest Minister's criteria and indicators for sustainable forest management (CCFM C&Is), and that are derived from a public consultation process.
Subsection 1.3 of the CCFM C&Is states that: "…genetic diversity is the ultimate source of biodiversity at all levels. It is the material upon which the agents of evolution act. Loss of variation may have negative consequences for fitness and prevent adaptive changes in populations."

The CCFM suggested indicator for maintaining genetic diversity is: "Implementation of an *in situ/ ex situ* genetic conservation strategy for commercial and endangered forest species."
In responding to public concerns about genetic diversity, the use of "improved" seedlings, non-local provenances, and exotic species, forest land managers may refer to provincial tree improvement activities and regulatory requirements, or may seek the assistance of tree improvement and other specialists.

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SFI

The SFI is a process- and performance-based scheme. A forest land manager may apply directly or seek second- or third-party verification under this system. Verifiers must demonstrate that the voluntary indicators established by the applicant are consistent with the principles, objectives, and performance measures of the SFI and the checklist of the certifying agency.

Under SFI's Sustainable Forestry Standard, Objective 4.1.2 states that members must: "Promptly reforest harvested areas to ensure long-term forest productivity and conservation of forest resources." Voluntary indicators suggested for this objective include:

- quality seed and seedlings that are locally adapted are readily available for reforestation
- genetically improved stock is appropriately deployed to achieve SFI reforestation requirements.

SFI applicants must describe how they intend to obtain and deploy seed and seedlings in a timely manner. These indicators could be satisfied by referencing seed procurement plans and inventories (including seed supply agreements), and seedling supply contracts. A commitment to using seed and vegetative materials in accordance with provincial regulations should also serve as a commitment to meet these indicators.

FSC

The FSC scheme is primarily a performance-based system. FSC regional standards are based on 10 pre-defined forest management principles. Principle 6 (Environmental Protection) and Principle 10 (Plantations) relate to specific aspects of tree seed and seedling production and use, including: maintaining genetic diversity, restricting use of chemicals, prohibiting use of genetically modified organisms (GMOs), controlling use of exotics, and ensuring ecological adaptation.

FSC regional standards are developed locally by chapters with representation from environmental groups, forestry-dependent communities, forest worker unions, and First Nations. Regional standards for British Columbia are under development.[2] MOF has been providing information on tree improvement and seedling production and use to this process to demonstrate that the province's regulations and practices are consistent with FSC principles. Once regional standards have been established, organizations accredited by the FSC can assess a forest land manager's ability to meet the standards.

While awaiting public review and approval of a B.C. standard, forest land managers can apply for certification through organizations with FSC-approved "checklists." Because applicants certified under checklists will have to re-apply for certification under the new standards, many B.C. forest land managers are awaiting approval of regional standards before seeking FSC certification.

Certification: Short- and Long-term Implications

Some forest lands in British Columbia have already been certified under the schemes described above. This suggests that tree breeding, seed production, seed registration, and seedling production practices in the province are acceptable to certifying agencies at this time.

Verification and monitoring of genetic diversity in seedlots, seedlings, and forests may become more comprehensive over time. As certification schemes evolve, scrutiny of tree improvement and seedling production activities may increase. Consequently, MOF Tree Improvement Branch is preparing a technical document on forest genetics and tree seed management in British Columbia.[3]

For further information regarding certification, visit the MOF Web site at: http://www.for.gov.bc.ca/HET/certification/. The author can be reached at (250) 356-0888 or brian.barber@gems4.for.gov.bc

[1]Refer to the MOF Web site for more information on these and other certification schemes, and a list of certified B.C. forest land managers. http://www.for.gov.bc.ca/het/certification/

[2]Release of first-draft FSC Regional Standards for B.C. was expected in April 2001.

[3]This document should be available in June 2001 at: http://www.for.gov.bc.ca/TIP/

Brian Barber
Tree Improvement Branch
Ministry of Forests

Three Year Results in Deer Browse Barrier Study

As reported in the June 1999 issue of the Leader, a field study is in progress on the Queen Charlottes to determine the economic effectiveness of four designs of deer browse barrier products. These include the Growcone® **Solid Tube**, the Sinocast® **Solid Cone**, the Sweetwood® **Metal Cage** and the Vexar® **Mesh Tube**. The report clearly states that: "the results and their discussion are offered only on general product designs".

This April 27, 2000 report discusses barrier performance three growing seasons after installation in 1997. Barrier effectiveness is ranked by the percent of crop trees after three growing seasons and the cost to achieve this performance.

Costs in Table 1 were determined for an assumed 10,000 unites of each barrier product. Maintenance costs carried out in the springs of 1998 and 1999 were discounted to 1997 using a 4.5% annually compounded interest rate.

Table 1: Barrier Performance and Cost Per Tree After Three Growing Seasons

Product	Barrier	Transport	Installation	Maintenance	Total Cost	Crop Trees
Mesh Tube	$1.05	$0.05	$1.87	$0.12	$3.09	98%
Solid Tube	$2.40	$0.43	$2.50	$0.42	$5.75	98%
Metal Cage	$3.39	$0.10	$3.75	$0.84	$8.08	90-95%
Solid Cone	$3.00	$0.09	$3.12	$2.56	$8.77	85%
Control Trees Without Barriers						32%

Costs to date **do not include** the cost of barrier removal, which is anticipated to substantially add to the net cost of some of the barriers. It is felt that some barriers will have to be removed to ensure free growing status of the seedlings. There is still much to learn about the timing and logistics of barrier removal. Remove them too early and run the risk of further browsing damage. Wait too long and you are faced with costly removal and possible destruction of the barrier.

Barrier performance is greatly enhanced with the use of quality stakes. Knotty or finger-jointed products are not recommended. Proper installation of the barrier is also an important factor and becomes even more critical in shallow rocky soils. Maintenance of the barriers is essential, with major damage on this study coming from the wind and deer.

Seedling growth is show in table 2. After three growing seasons none of the study trees have reached free growing minimum heights.

(Continued)

Table 2: Seedling Growth in cm After 3 Yrs.			
Product	**HT**	**RCD**	**H/D**
Solid Tube	106	1.34	79
Solid Cone	96	1.31	73
Metal Cage	93	1.49	62
Mesh Tube	84	1.34	63
Control	39	0.89	43

It will probably take several more growing seasons before we know the definitive cost of achieving a free growing crop on these study sites, subject to severe deer browsing. There is certainly an opportunity to refine the free growing criteria here, with respect to minimum heights (presently <browse height) and the impact of barriers on free growing seedling status.

From "Evaluation of Deer Browse Barrier Products to Minimize Mortality and Growth Loss in Western Redcedar", April 27, 2000 Contact John Henigman at 250-356-5886

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"The Leader" BC's Silviculture Digest, December 2000
Mike O'Neill
Pro-Forest Enterprises
708-6081 No 3 road
Richmond BC V6V 2B2
604-275-1858
profor@telus.net
Complimentary copy of the Leader is available upon request
Subscription 1 year for first time subscriber $20.00 + GST
Regular price per year is $24.00 + GST

John Henigman
Forest Practices Branch
Ministry of Forests

A summary of several “northern” site preparation trials

Bedford, L. and Sutton, R.F. 2000. Site preparation for establishing lodgepole pine in the sub-boreal spruce zone of interior British Columbia: the Bednesti trial, 10-year results. Forest Ecology and Management 126(2):227-238.

Abstract
Nine site preparation techniques for re-establishing productive lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) forest in the Stuart Dry Warm Sub-Zone of the Sub-Boreal Spruce Zone (SBSdw3) of interior British Columbia on “NSR backlog” (i.e., by provincial criteria, not-sufficiently-regenerated) sites are compared in a randomized block experiment, with one 48-tree, 750-m^2 plot of each treatment in each of 5 blocks. Low fertility, compact subsoil, and low water-holding capacity in a rooting zone as thin as 10 cm in lower slope and level positions are the main limiting factors. After 10 growing seasons, pine survival was 90-97%; mean stem volumes in 7 treatments were 41-235% higher than the control, and one treatment gave 29% less volume. Results from mounding and patch scarification were virtually identical. While site preparation can increase early growth of lodgepole pine, especially on the more poorly drained parts of sites such as Bednesti, planting directly into sheared, windrowed ground will give satisfactory survival and growth.

Bedford, L., Sutton, R.F., Stordeur, L., and Grismer, M. 2000. Establishing white spruce in the Boreal White and Black Spruce Zone: site preparation trials at Wonowon and Iron Creek, British Columbia. New Forests 20(3):213-233.

Abstract
Two trials (“Wonowon” and “Iron Creek”) in the Prince George Forest Region of interior British Columbia were begun in the mid 1980s to evaluate site preparation treatments for establishing white spruce (*Picea glauca* [Moench] Voss) in the Boreal White and Black Spruce biogeoclimatic zone. The 14 treatments (9 or 10 per trial) were: [B.C.] Ministry, Sinkkila, and Bracke mounds; Bracke mounds manually supplemented with 20-, 14-, or 6-cm cappings of mineral soil; fertilized Sinkkila mounds; Bracke patches; fertilized Bracke patches; bladed strips; plowed ground; herbicide; and untreated controls, separately with both standard and nominally superior “alternate” planting stock. With minor aberrations, each trial consists of 5 randomized complete blocks each with one 80-tree plot per treatment; planting was in spring, 1984 at Wonowon, 1987 at Iron Creek. All trees in mounding treatments and the inner 48 trees in other plots were monitored for performance through 1998 at Wonowon, 1996 at Iron Creek. The herbicide and plowing treatments, and mounds capped thickly enough with mineral soil to inhibit weed regrowth, were clearly superior to others. Survival rate increased with capping thickness at Wonowon, but while the 14 and 20 cm cappings were the best of the mounding treatments significant differences among them were few after 15 growing seasons. In both trials, patch scarification gave poorer results than did planting without site preparation.

Bedford, L. and Sutton, R.F. 2000. White spruce establishment after various mechanical site preparation treatments at Inga Lake, British Columbia: 12-year trial results. Submitted to Western Journal of Applied Forestry October 2000.

Abstract
A trial at Inga Lake in the Prince George Forest Region of British Columbia was initiated in 1987 to evaluate site preparation techniques for establishing white spruce (*Picea glauca* [Moench] Voss) on not-sufficiently-regenerated (“NSR”) sites in the BWBSmw1 biogeoclimatic subzone. After winter-shearing and piling in 1986/87, nine treatments were applied in 1987 in a randomized block design with five replications: untreated control, vegetation controlled (tending), burned windrow, disk trenching (with plantings in hinge, furrow, and mound-in-furrow positions as three separate treatments), breaking plow, bedding plow, and Madge Rotoclear mixing. Contemporary standard stock (2+0 PSB313) was spring-planted in 1988, 48 trees per plot, and annually monitored for performance and condition through 1999. On the basis of 12-year performance, neither

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high survival rates (> 90% in all treatments) nor mechanical site preparation (msp) guaranteed good growth; greatest growth occurred in the burned windrow and maintained-vegetation- control treatments, which did not involve msp, but the breaking plow and Madge Rotoclear treatments were not significantly inferior. The disk-trenching treatments facilitated browsing, did not control competition, and resulted in growth significantly poorer than did any treatment except the untreated control.

Boateng, J.O., Haeussler, S., and Bedford, L. 2000. Boreal plant community diversity ten years after glyphosate treatment. Western Journal of Applied Forestry 15(1):15-26.

Abstract
This study examined 10-year and 12-year post-treatment effects of broadcast and spot application of glyphosate for site preparation on structural diversity, species richness and diversity, and crop tree growth in two boreal forest plant communities in north-eastern British Columbia. At the broadcast-sprayed site, reduced dominance of the tall shrub layer was associated with increased structural diversity and increased richness of the herb layer 10 years after treatment. At the spot-sprayed site, no significant differences in plant community structure or diversity could be detected after 12 years. At both sites, glyphosate application increased the growth of planted white spruce (*Picea glauca*) seedlings without eliminating deciduous trees and shrubs. The results indicate that a single application of glyphosate to prepare sites for reforestation can improve crop tree performance without adversely affecting vascular plant community diversity.

Burton, P., Bedford, L., Goldstein, M., and Osberg, M. 2000. Effects of disk trench orientation and planting spot position on the ten-year performance of lodgepole pine. New Forests 20(1):23-44.

Abstract
A disk-trenching experiment in the sub-boreal spruce zone of British Columbia, Canada, established three plots (0.12 to 0.26 ha each) with trenches running east-west, and another three plots with north-south trenches. Approximately 200 *Pinus contorta* Dougl. seedlings were planted in each of 13 microsites: berm, hinge, and trench positions in each of north, south, east, and west aspects, and in untreated locations between furrows. Soil temperature and soil moisture of representative microsites were monitored for 3 years; seedling diameter, height, and vigour were monitored annually for ten growing seasons. Based on tenth-year stem volumes, performance on south-, east-, and west-facing microsites was significantly greater than on north-facing or untreated microsites. Superior growth was noted on all berm and hinge positions other than those facing north. Microsites identified as best in year 5 were also best in year 10. On east-, south-, or west-facing berm positions, stem volume averaged 47% to 54% greater than that of control seedlings in year 5, but had suffered greater mortality. Seedlings on east-, south-, or west-facing hinges were 46% to 61% (year 5), or 36% to 47% (year 10) larger than control seedlings. Both east-west and north-south disk-trenching treatments are useful for increasing seedling growth, with planting spot selection being more important overall than trench orientation. The stand-level effectiveness of north-south disk trenching was greatest, because the creation of cool north-facing microsites was avoided.

Hauessler, S., Bedford, L., Boateng, J.O., and MacKinnon, A. 1999. Plant community responses to mechanical site preparation in northern interior British Columbia. Can. J. For. Res. 29:1084-1100.

Abstract
Ten-year response of plant communities to disk trenching, plowing, rotoclearing and windrow burning was studied on two contrasting sites to address concerns that mechanical site preparation reduces structural and species diversity. Cover and height of all species on randomly located subplots within 0.05- to 0.075-ha treatment plots were used to develop indices of volume, structural diversity, and species diversity; to ordinate the plots; and to correlate species diversity with crop-tree performance. At both sites, community response was strongly influenced by the severity of site preparation. On a boreal site dominated by willow (*Salix* L. spp.), green alder (*Alnus crispa*(Ait.) Pursh ssp. *crispa*) and trembling aspen (*Populus*

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tremuloides Michx.), sitepreparation increased structural diversity and had little effect on species diversity. High-severity treatments increased non-native species abundance 10-to 16-fold while only marginally enhancing growth of planted white spruce(*Picea glauca* (Moench) Voss) over medium-severity treatments. On a nutrient-poor sub-boreal site, species diversity declined with increasing treatment severity and with increasing lodgepole pine (*Pinus contorta* var.*latifolia* Engelm.) stem volume. Velvet-leaved blueberry (*Vaccinium myrtilloides*Michx.) was highly sensitive to mechanical disturbance. Moderate mechanical treatments appear to improve conifer performance while causing little change to plant communities, but high severity treatments can cause substantial change.

Heineman, J.L., Bedford, L., and Sword, D. 1999. Root system development of 12-year-old white spruce (*Picea glauca* [Moench] Voss) on a mounded subhygric-mesic site in northern interior British Columbia. For. Ecol. Manage. 123(2/3):167-177.

Abstract
On a silt-loam soil in the boreal white and black spruce (BWBS) zone in northern interior B.C., 50 root systems of 12-year-old planted white spruce *(Picea glauca* [Moench] Voss) seedlings were excavated; 25 from mounds (14 cm of mineral soil over inverted organic matter) and 25 from untreated ground. Diameter, depth, and substrate of main structural roots were assessed at 10 cm intervals from the stem. The total number of roots and the aggregate cross-sectional root area (CSA) exiting the mound or a 50-cm control radius in untreated ground were also determined. Seedlings on mounds had well-developed root systems that were equally as symmetric as those in untreated ground. Roots extended well beyond the mound, excepting those few that were surrounded by saturated soil conditions. Mound seedlings had more, and thicker, main lateral roots than seedlings in untreated ground. CSA of mound seedlings was approximately five times greater than for seedlings in untreated ground, and the total number of roots was 2.5 times greater. Beyond the mound, depth and substrate of main lateral roots was similar to that of seedlings in untreated ground. It was concluded that the potential for long-term mechanical stability of white spruce on such mounds would be no less than that of seedlings planted without site preparation.

Macadam, A. and Bedford, L. 1998. Mounding in the Sub-boreal Spruce Zone of west-central British Columbia: 8-year results. Forestry Chronicle 74(3):421-427.

Abstract
Results are presented from two site preparation trials involving mounding on a moist to wet site with a medium soil nutrient regime (5-6/C) located in a lower slope to toe of slope position and on a near-level area upslope from the first site with medium soil moisture and nutrient regimes (4/C). Both trials compared the performance of long-rooted hybrid white spruce (*Picea glauca ? P. engelmannii* [Parry ex Engelm.]) (Sxw) container stock (PSB 323) to that of a standard-sized stock (PSB 313) planted in inverted mounds and untreated spots. The trial on the first site also tested the effectiveness of two mound capping depths and of planting the 313 stock to two different depths in mounded spots. After eight seasons, there were no significant differences between 313s and 323s in terms of height growth or proportions of free growing trees. Although diameter growth was significantly greater among 323s in mounds compared to 313s this relatively small difference is unlikely to justify the higher cost of the larger stock. Height and diameter growth among 313s were 17 and 22% greater, respectively, for trees planted in mounds with 20 cm of capping compared to 12 cm of capping. Deep-planting in mounds consistently resulted in slight increases in height growth and survival relative to planting to the standard depth, though differences were not statistically significant. Rates of growth were substantially greater among trees planted in mounds compared with those in untreated spots. The greatest relative differences were noted on the first site where height growth among 313s was 43 to 74% greater in mounded treatments depending on planting depth and capping thickness, with similar improvements in diameter growth.

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Macadam, A., Sutton, R.F and. Bedford, L 2001. Site Preparation for Establishing Lodgepole Pine on Backlog Sites in the Sub-Boreal Spruce Zone [the Doris Lake and Kluskus trials] B.C. Min. For. Note 27. Jan. 2001 (available at: http://www.for.gov.bc.ca/hfp/pubssilvnotes.htm

Abstract
At Kluskus, a fertilizer treatment applied to the soil surface at the time of planting had no effect on the survival or growth of lodgepole pine.
While mounding treatments resulted in superior tree height and diameter during the early years of plantation establishment, the high cost of the treatment and relatively low rates of survival make it a poor choice on these sites with average and drier moisture regimes. Newly planted seedlings are particularly vulnerable to moisture stress until roots have become established, and since both Kluskus and Doris Lake are seasonally rather dry sites and mounding tends to aggravate existing soil moisture deficits, the high rates of mortality were not surprising.
Though seasonal moisture deficits occur at both sites, there are important ecological differences between them that affected response to treatments. While soils at Doris Lake are relatively porous and well drained, at Kluskus soil drainage and rooting are severely restricted by a dense layer of basal till close to the soil surface. Consequently, although treatments that created depressed microsites (Bräcke patch and V-blade) consistently improved survival and growth at Doris Lake, this was not the case at Kluskus. The Sinkkilä patch treatment improved tree survival at Kluskus, but it failed to improve growth significantly relative to untreated controls. While the depressed microsite created by the patch scarifier mitigated drought conditions, and thereby decreased mortality during the first growing season, it also aggravated seasonal flooding, particularly during snowmelt. The placement of tree roots closer to dense root-restricting layers in the soil would also have contributed to slower growth relative to other mechanical treatments. The shallow, intermittent disk trenched furrows and very light blading treatments at Kluskus resulted in some degree of mineral soil exposure without creating significant depressions. Both treatments resulted in superior growth relative to either patch scarification or untreated controls.
At Doris Lake, site preparation significantly improved survival for bareroot stock. However, the survival of plug stock on untreated ground was greater than for any site preparation treatment planted with bareroot stock. By year 14, the annual height growth of bareroot and plug stock planted in the control was equal to the annual height growth on the 14 cm mound (the best treatment at year 10). If this trend persists, the difference in height growth between the bareroot stock planted on the untreated ground and the bareroot stock planted on the best site prepared ground will be approximately 1 m. The absolute gain in growth from site preparation on drier ecosystems such as Doris Lake, where the vegetation competition poses no serious threat, is generally less than on sites with a vegetation problem. On such sites, the manager needs to weigh the benefits of accelerated early growth against treatment costs.

MacKenzie, D.M. 1999. The Effect of Mechanical Site Preparation On Soil Properties, Nutrient Dynamics And Tree Growth: Tenth Year Results for Two Sites in Northern British Columbia. M.Sc. Thesis, Simon Fraser University, 117 p.

Abstract
Tenth year comparisons of soil physical and chemical properties were made between eight MSP treatments at two study sites in the northern interior of British Columbia. The Bednesti site, located in the SBS, was planted to lodgepole Pine. The Inga Lake site, located in the BWBS, was planted to Spruce. The bedding plow, breaking plow, fire and madge all had statistically higher crop tree growth compared to control treatments. In many cases the bedding plow had significantly higher concentrations of soil nutrients than the control, while the breaking plow, fire and madge treatments were not significantly different from the control indicating that chemical fertility had not been effected.
Foliar analysis did not show many significant differences between the foliar element concentrations and when compared to acceptable foliar nutrient levels for these species, treatments had either adequate supplies or slight deficiencies. In many cases, the bedding plow, madge and fire treatments increased foliar nutrients and needle weight

(Continued)

relative to the control. This may be related to better soil climate, nutrient availability and nutrient uptake on these treatments.

Sutton, R.F., Bedford, L., Stordeur, Linda, and Grismer, Marvin. 2001. Site preparation for establishing interior spruce in British Columbia: trials at Upper Coalmine and Mackenzie. Western Journal of Applied Forestry *in press* "ready for Jan 2001 issue".

Abstract
Two trials ("Upper Coalmine" and "Mackenzie") were begun in the 1980s in the Prince George Forest Region, B.C., to evaluate a total of 13 site preparation treatments for establishing interior spruce (*Picea glauca ? engelmannii*) in the Engelmann Spruce-Subalpine Fir and Sub-Boreal Spruce biogeoclimatic zones. Treatments included mounding (with various thicknesses of mineral soil "capping"), patch scarification, blading, disk trenching, and herbiciding. In each trial, five blocks each contained one 48- or 80-tree plot/treatment. Trees were monitored for 10 yr at Mackenzie and 15 yr at Upper Coalmine. Large mounds have had consistent biological success. Tree seedling response to blading was site specific; blading at Mackenzie was not significantly inferior to the best (Ministry mound) treatment, but at Upper Coalmine was no better than the untreated control.

von der Gönna, M.A. 1989. First year performance and root egress of white spruce (*Picea glauca* [Moench] Voss) and lodgepole pine (*Pinus contorta* Dougl.) seedlings in mechanically prepared and untreated planting spots in north central British Columbia. M.Sc. Thesis, Univ. B.C., 130 p.

Abstract
Root zone temperature and root egress were studied during the first growing season on white spruce and lodgepole pine seedlings planted in various forms of mechanically prepared microsites. Mounded microsites had higher summer soil temperatures and greater diurnal ranges, at a depth of 10 cm, than the patch and control treatments. Mounded microsites, however, showed the greatest response to changes in weather and decreasing solar radiation inputs in the fall, being the first to record soil temperatures below freezing. Seedlings planted in the deep mineral soil over inverted humus mounds created by the Ministry Mounder had significantly greater numbers of new roots greater than 1 cm long than did seedlings planted in patch and control treatments at 45 and 70 days after planting. Seedlings planted in other mound and plowing treatments had high to intermediate numbers of new roots. At 95 days after planting, seedlings planted on all mounded treatments generally had higher root area indices, root dry weights and total dry weights than did seedlings on other treatments. Variation in treatment results over the three spruce sites studied reflect differences in site conditions, primarily soil moisture regimes. High and fluctuating water tables negatively effected seedlings planted in patch and control treatments.

UPDATES

CHANGES IN SEED PEST MANAGEMENT GROUP

After nine years as the BC Ministry of Forests' Seed Pest Management Officer, Robb Bennett is taking a break. He has accepted a six month temporary appointment (beginning 5 February 2001) to one of a series of new Ministry of Environment, Lands, and Parks positions dealing with endangered species and habitats issues. He may come back to haunt the province's conifer seed production community upon the completion of the temporary period but both Bennett and MoELP hope the new positions will become permanent.

In Bennett's absence, Ward Strong will be handling administration of the Seed Pest Management program as well as his regular duties of providing services to the Interior BC community. Michelle Hall will continue to handle pest management services on the Coast.

Seed Pest Management administration and Interior operations can be reached by contacting

Dr. Ward Strong at:
Kalamalka Forestry Centre
3401 Reservoir Road
Vernon BC V1B 2C7

phone: 250- 549-5696
fax: 250 -542-2230
e-mail: Ward.Strong@gems7.gov.bc.ca

Coastal operations can be reached by contacting Michelle Hall at:
Saanich Seed Orchards
7380 Puckle Road
Saanichton BC V8M 1W4

phone: 250 -652-7613
fax: 250 -652-4204
e-mail: Michelle.Hall@Gems7.gov.bc.ca

Seed Pest Management Group Launches New Cone and Seed Insect Information Website

In March 2000, the Seed Pest Management group (BC Ministry of Forests, Tree Improvement Branch) launched a new website devoted to insects of importance to conifer seed production in British Columbia. Photos and information on hosts, distribution, damage, life history, and management are presented for over 60 insects.

The opening page contains a very simple search engine and links to the four main components of the website. "ABOUT" links to instructions on using the site (including the search engine) and acknowledgements (foremost among these is Loyal Chow of the University of Victoria who did all the programming, coding, and file construction). "INSECTS" provides a listing by tree species of all insects included in the website as well as an entomological classification of them. "INFO" includes an overview of the importance and ecology of cone and seed insects and how to deal with them. "LINKS" gives access to other sites of interest, some more useful than others.

Please visit this site at:

http://www.for.gov.bc.ca/tip/iig/

Robb Bennett
Tree Improvement Branch
Ministry of Forests

Forest Health Clinic Closes

In the early 1970's there was an increased need for tree seedlings for reforestation. The small number of nurseries present at the time increased in size and new nurseries came into being. There was a commitment by both the provincial and federal governments to reforest a backlog of harvested sites and promote a sustainable forest industry. Growing tree crops intensively caused an increase in disease and pest problems. The Canadian Forest Service (CFS) with its forest health specialists, appointed a scientist (Dr. Bill Bloomberg) and a technician (Mr. Walter Locke) to study disease problems of Douglas-fir and find solutions to high losses of seedlings in bareroot fields. Meanwhile, researchers in both governments were developing a new method of growing trees; the styroblock container system. After doing some excellent work on *Fusarium*, Dr. Bloomberg was replaced by Dr. Jack Sutherland.

The Canadian Forest Service's Pest Clinic rapidly became an integral part of the "nursery system", suggesting modifications to disease promoting cultural growing practices and preventing large losses of seedlings due to spread of chronic diseases. In 1984, Walter Locke retired and John Dennis took over the Pest Clinic. The BCMOF, recognising the contribution of the Clinic, started providing annual support by hiring students for the summer. This allowed John to make visits to nursery sites and educate nursery personnel on pest prevention techniques. Students also helped Jack with his research projects aimed at problems appearing in the rapidly developing container seedling system. CFS funding was A-Base while BCMOF funding came through branch base as well as FRBC backlog reforestation programs.

In the late 70's, the BCMOF created an Extension Services group to help forest nurseries solve critical problems appearing under the constantly improving seedling growing system. Over the next decade, seedling culture and pest management specialists in concert with nursery growers developed recommendations on how to grow excellent trees. Along with John Dennis, Gary Roke and a backdrop of pathologists and entomologists at the Pacific Forestry Centre, they provided a holistic, team approach to integrated pest management. The Pest Clinic established a database on nursery problems, identifying new problems as well as long-term needs. The team augmented nursery trends of lowering pesticide use, improving stock quality, reducing large seedling losses, increasing survival in the field and raising the level of education and expertise of personnel in the nursery industry.

With recent budget reductions and a focus on forest research, the service sections of both provincial and federal governments have been cut. Support for an industry that appears healthy and sustainable is becoming hard to justify in terms of tax dollars. Despite a fee structure incorporating an industry charge per sample, sufficient funds were not obtained in 2001 to keep the service going. The team regrets the loss of the Pest Clinic but all associated with the Clinic should be proud of its legacy of providing excellence in service to the reforestation industry.

Dave Trotter
Tree Improvement Branch
Ministry of Forests

TECH TALK

How Long Should We Soak Ponderosa Pine Seed?

The current soak duration for ponderosa pine (*Pinus ponderosa* P. Laws. exC. Laws.) [**Py**] of 24 hours was questioned. A relatively low value of 27.8 ± 0.5% moisture content was estimated from Quality Assurance testing for 84 – Py sowing requests and this value fell below the average of 31.7% for all species (see 'Stratification Moisture Content' in Volume 12 #1 of this Newsletter). Due to their large seed size and thick seed coat it was hypothesized that **Py may not be achieving optimal hydration in 24 hours and a longer soak may be required for this species**.

To investigate moisture content in Py after soaking it was decided to assess moisture content under lab conditions and under operational seed preparation conditions. The methods and results will be presented separately for these two investigations followed by a common discussion.

Materials and Methods

Lab Testing

A total of ten seedlots were selected representing a variety of sources and seed qualities (germination capacity [GC] ranging from 78 to 92%) (Table 1). For each seedlot a total of eight replicates of 100 seeds were counted and weighed to obtain the weight before soaking. Four replicates, of each seedlot, were soaked for 24 hours and four replicates were soaked for 48 hours. After soaking the replicates were again weighed (without surface drying) before placing seeds into germination dishes[1] for 28-days stratification at 2°C. After stratification was completed the seed was again weighed and the germination dishes transferred to a germinator set at 30°C for eight hours with lights and 20°C for 16 hours in the dark. Seed was considered germinated once the radicle was 4X the length of the seed coat. Germination capacity was assessed after 21 days.

Table 1[2] Seed sources of Ponderosa pine (Py) used to evaluate moisture uptake.

Seedlot	Location	Coll Yr	Lat.	Long.	Elev.	SPZ	GC
3001	OK Falls	1976	49 00	119 00	579	TOD	91
5747	OatScott	1988	49 58	118 00	800	WK	80
5752	Arrow Pk	1988	50 07	117 53	610	WK	88
31257	Premier Lk	1991	49 57	115 42	850	EK	92
31825	Kerr Cr	1991	49 03	119 15	825	TOD	78
31845	West Kettle	1992	49 05	118 58	820	TOD	86
31906	D'Arcy	1991	50 33	122 29	380	SM	89
32000	Camoo Jct	1989	50 50	122 07	480	TOA	89
39301	Hat Cr	1993	50 48	121 34	900	TOA	85
42569	Clapperton Cr	1991	50 12	120 40	870	TOA	83

(Continued)

Estimates of moisture content were obtained non-destructively by knowing the storage moisture content of each seedlot and the fresh weight before and after soaking and after stratification. The first step was to determine the oven-dry weight of each replicate by solving the following:

(1) Oven-dry weight = fresh weight * (1-moisture content)

Once the oven-dry weight is obtained one can calculate the moisture content at any other fresh weight using this formula:

$$\textbf{Moisture content} = \frac{\textbf{fresh weight} - \textbf{oven-dry weight}}{\textbf{fresh weight}}$$

To present the results as a percentage multiply by 100.

Seed Preparation Testing

Four of the seedlots in Table 1 (previous page) had larger quantities of seed available for testing (**3001**-1400 g; **5747** – 300 g; **5752** – 120 g and **32000**- 1400 g). The average sowing request size for Py is 1941 grams since 1995, but can range from 29 to 3000 grams. This larger scale testing was performed to determine the 'operational' impact of the treatments. The high value and scarcity of Py seed limited the size and number of seedlots that could be used in this part of the trial. The amount of seed indicated above was divided into four fractions, weighed and two fractions were soaked for 24 hours and the other two for 48 hours. Within each soak duration one fraction was surface dried and the other fraction was not surface dried. The four fractions therefore represent a simple factorial experiment (without replication) looking at the effect of soak duration and surface drying. Each fraction was weighed after soaking (with or without surface drying) and then put in plastic bags and placed into cold stratification at 2°C for 28 days. Seed was weighed again after stratification was complete. This allowed for an estimate of the moisture content of the entire 'request'. Seed was then sampled and germination testing conducted the same as in Lab testing, outlined above.

Results

Lab Testing

The average moisture content of all ten seedlots was estimated at 35.2% after a 24-hour soak and 36.8% after a 48-hour soak. The two treatment became more similar during stratification and differed by only 0.4% at the end of stratification. Moisture content differences were not statistically significant between the 24- and 48-hour soak after imbibition or after stratification. From Analysis of Variance, seedlots were a statistically significant source of variation in moisture content after imbibition and after stratification. For example, variation between seedlots ranged from 32.4% to 39.9% following the 24-hour soak.

Differences in GC were slight (not statistically significant) between the two treatments with the 24-hour soak (79.6%) having slightly higher germination than the 48-hour soak (78.3%). Seedlots were a statistically significant source of variation for GC. The response did vary by seedlot as only half of the seedlots had a higher GC with the 24-hour soak. In three seedlots, falldowns of 8, 9 and 10% were experienced by extending the soak to 48 hours.

Seed Preparation

The four seedlots all followed the same pattern for moisture content progressing from 24-hour soak + surface dry (**28.9%**); to 24-hour soak (**30.7%**); to 48-hour soak + surface dry **(31.8%)**; and finally the 48-hour soak **(33.9**%). This is the pattern one would logically expect for moisture content. During stratification the surface dry samples gained a small amount of moisture (0.3%), but the non-surface dry samples lost about 0.6% moisture.

The four treatments all produced relatively good germination ranging from 82 to 86%. The 48-hour no surface drying treatment produced the highest GC (86%); followed by the 48-hour soak + surface dry (85%); 24-hour + surface dry (84%) and the 24-hour non-surface dried treatment (82%). Analysis of Variance indicated that the effect of surface drying was not statistically significant, while seedlot and soak duration were statistically significant sources of variation. All of the interaction terms were not statistically significant[3].

(Continued)

Discussion

The results do not indicate that a substantial consistent gain can be achieved by extending the soak duration in Ponderosa pine to 48 hours. In lab testing the moisture content can be increased with a 48-hour soak from 35.2 to 36.8%, but it is not expected that this difference will affect dormancy breakage, germination capacity or rate. The average GC was greater with the 24-hour soak (80 *vs*. 78%), but not significantly different from the 48-hour soak. The greatest source of variation was between seedlots that showed statistically significant differences in moisture content (before and after stratification) and in GC. The results are based on a sample of ten seedlots distributed throughout the BC range of the species (Table 1).

With the operational-sized samples the 48-hour soak without surface drying was the best treatment. Analysis of variance indicated that the 48-hour soak was superior (significantly different), but that the effect of surface drying was not statistically significant. The average advantage of the 48-hour soak was an increase in GC of 2.2% for four seedlots of Py.

These results possibly reflect one of the greatest fears in seed technology – the disagreement between lab testing and operational testing in the statistical significance of a term in the model (i.e. Soak Duration). In this case lab results indicate no advantage to increasing soak duration to 48 hours, while operational results indicate an advantage. The experimental design was not identical between the two areas, but they both did consider soak duration in Py.

I am recommending that we retain the current 24-hour soak for Ponderosa pine at this point in time. The lab studies were based on a larger sample of seedlots (which could not be practically replicated with operational quantities of seed), large falldowns occurred with a 48-hour soak in lab testing and the fact that the operational germination gain was rather small at 2.2% have influenced this decision. Surface drying is not performed in lab testing, but it was thought that this practice in seed preparation might have been excessive causing the relatively low stratification moisture contents found in Quality Assurance Py monitoring. Rather than change the soak duration – more emphasis will be placed on limiting the amount of surface drying occurring on the request prior to stratification. I believe that the differences exhibited between the lab and seed preparation are operationally quite small, although they are statistically significant. A larger more consistent difference would need to appear before a change in methods is justified.

Nurseries stratifying there own seed may want to extend soak to 48 hours and clients can request this service of the Tree Seed Centre at the beginning of the sowing season. Ponderosa pine can also have relatively high levels of *Fusarium* sp. contamination [56% of seedlots infected with an average infection rate of 2.1%] and a running water soak or other seed sanitation treatment should be incorporated to limit losses from this pathogen. The results clearly indicate the significance of seedlot differences – we should all become more familiar with individual seedlots. Check the fungal assay results included on the sowing request label and available on SPAR[4]. If anyone would like detailed results of seedlots used in this trial, please contact me.

[1] Germination dishes consist of one piece of kimpack (22-ply wadding paper) , 50 ml of water and one filter paper onto which the seeds are placed.

[2] Coll Yr = Collection year; Lat.= latitude; Long. = longitude; Elev.= elevation in m.; SPZ= seed planning zone and GC= germination capacity (%)

[3] the interaction terms include – Seedlot* Soak; Seedlot* Surface Dry; Soak*Surface Dry and Seedlot*Soak*Surface Dry. The full Analysis of Variance models and statistical tables have not been included for brevity, but will be made available by the author on request.

[4] **SPAR** = **S**eed **P**lanning **A**nd **R**egistry system.

Dave Kolotelo
Tree Improvement Branch
Ministry of Forests

Foliar applied Admire 240F™(imidacloprid) is less effective than insecticidal soap in managing hemlock woolly adelgid, *Adelges tsugae*

Hemlock woolly adelgid (HWA), *Adelges tsugae*, is an important pest in coastal western hemlock (*Tsuga heterophylla)* seed orchards, occasionally causing tree mortality following continued attacks. In eastern United States this insect has devastated entire eastern hemlock (*T. canadensis*) forests in certain areas.

For the past several years Seed Pest Management has advocated monitoring of HWA and control, when necessary, through the application of insecticidal soap (2%) accurately timed to target the crawler stage. This approach is effective, but the timing of sprays is critical and the monitoring required to ensure proper timing is labour intensive.

In an effort to produce a simpler protocol, we tested the systemic insecticide Admire 240F ™ against HWA. It blocks acetylcholine receptors causing insect paralysis and death. Although it is more toxic (moderate, with acute oral LD50 for rats: 450 mg/kg, mice: 150 mg/kg) than insecticidal soap, it has the advantages of selective activity, less harm to natural enemies, and systemic action. Therefore, it is able to target many life stages in a less critical timing window than insecticidal soap.

With the support of Western Forest Products Ltd. (WFP) we began preliminary testing in June 1998. A single spray of Admire 240F ™ was applied at label rate (6.2 mL in 80 L) or half-rate (3.1 mL in 80 L) to the foliage of 30 trees in each of two WFP orchards using a tractor-driven hydraulic tank and a handheld wand. Numbers were assessed prior to spraying, and at 2 weeks, 4 weeks, 2 months and 4 months after spraying. Percent mortality was calculated using the following formula: % Mortality = (no. dead HWA / total no. alive + dead HWA) x 100%. The performance of Admire 240F ™ was compared with insecticidal soap efficacy data from previous operational records.

Label and half-rate Admire 240F ™ HWA populations were reduced by 60% and 46%, respectively, at 2 weeks post-treatment, compared to the controls which increased by 31% (Fig. 1).

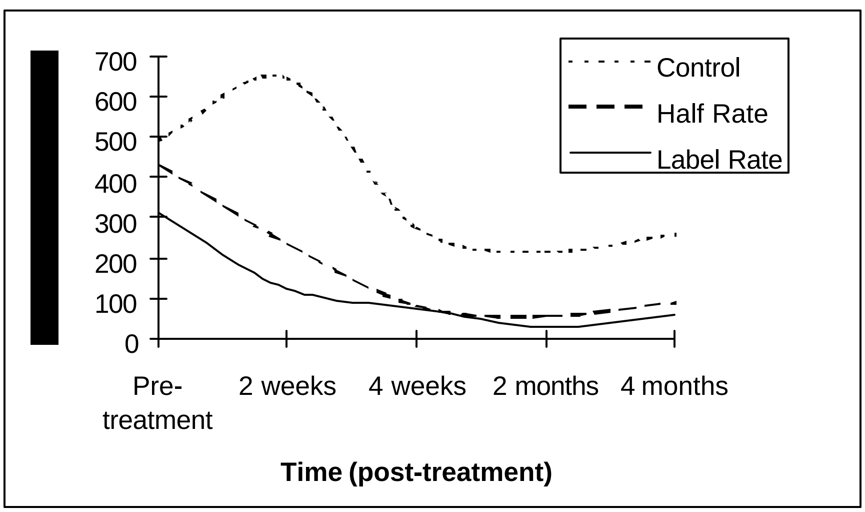

Figure 1. Treatment effect of Admire 240F ™ on HWA numbers.

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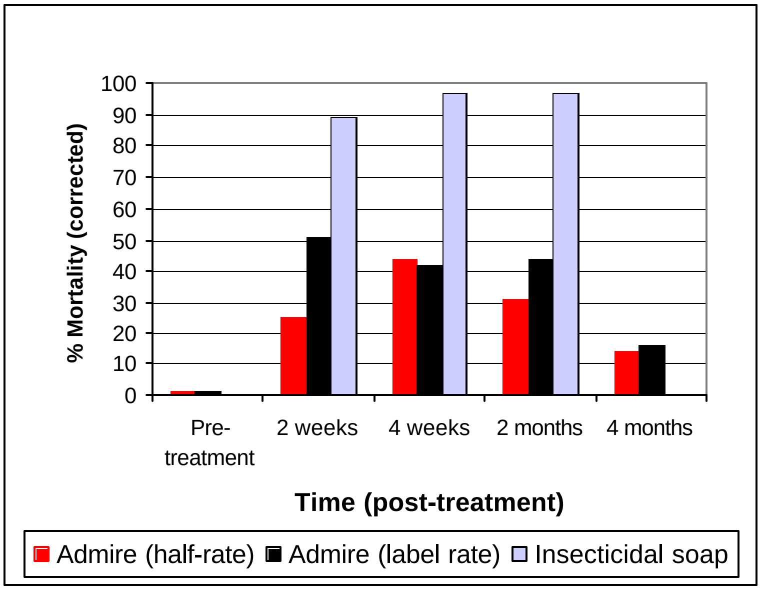

Figure 2. Percent mortality of HWA population treated with Admire 240F ™ compared to insecticidal soap efficacy data (from previous operational records).

Label rate Admire 240F ™ achieved 51% mortality at 2 weeks post-treatment dropping to 14% after 4 months. Half-rate achieved 25% mortality at 2 weeks but similar levels to label rate subsequently. Insecticidal soap averaged 89% mortality at 2 weeks post-treatment and 97% mortality at 1 and 2 months post-treatment (Fig. 2).

Admire 240F ™ applied as a foliar spray in late June did not perform well compared to past applications of insecticidal soap. It may prove to be more effective as a soil drench or stem injection. Earlier application may also improve performance (treatment is recommended in early to mid-May, but a permit delay postponed our trial until the end of June).

Natural enemies keep HWA below the economic injury level in its native Asia. Researchers in eastern United States have imported several species (including a Japanese ladybird beetle, *Pseudoscymnus tsugae*, two Chinese ladybird beetles, *Scymnus sinuanodulus* and *S. ningshanensis*, and a derodontid beetle, *Laricobius nigrinus*) and are currently rearing and evaluating them for biological control potential. *P. tsugae* is particularly promising given its strong prey preference for HWA over other aphids. Mass rearing has been successful and beetles have been released in 10 states including New Jersey, Connecticut and Virginia. These natural enemies are all susceptible to insecticidal soap, though not necessarily at the time of application (HWA crawler stage). Admire is more selective, possibly reducing the effect on natural enemies, though there is some activity against ladybird beetles.

At this time we continue to recommend the following guidelines for management of HWA:

1. DO NOT USE NITROGEN FERTILIZER on infested trees. Nitrogen fertilizer has NO BENEFICIAL EFFECT on such trees and actually boosts survival and reproduction of HWA even in the presence of pesticides. Nitrogen fertilizers may increase susceptibility of hemlock to attack.
2. Monitor HWA populations in the late winter/early spring watching for appearance of egg masses under the wool. Accurate monitoring is critical.
3. THOROUGHLY DRENCH infested trees with Safer's Insecticidal Soap (2L/100L) when eggs are hatching and crawlers begin to appear outside wool. Phytotoxicity has not been observed with Safer's on

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hemlock and this product is as effective or more so than other products. Our trial work has also shown that Diazinon, Cymbush, Ambush, and Trounce are also effective but Dimethoate is not (BCFS, unpublished data). An early start to your spray program (early to mid May) may give better control than a late start.

Seed Pest Management will analyze your hemlocks for woolly adelgid infestation and advise you in the development of a control program. Please direct enquiries to Michelle Hall at 652-6593 or 652-7613 (fax 652-4204).

The following references have important detailed information on the management of HWA:

1. McClure, Mark S. 1992. Hemlock woolly adelgid. American Nurseryman, March 15: 82-89.
2. McClure, Mark S. 1991. Nitrogen fertilization of hemlock increases susceptibility to hemlock woolly adelgid. Journal of Arboriculture 17(8): 227-230.

We thank Paul Bertorelli (WFP) for suggesting this project.

Michelle Hall
Robb Bennett
Tree Improvement Branch
Ministry of Forests

Monitoring and Control of Douglas-fir Cone Gall Midge (*Contarinia oregonensis*: Diptera, Cecidomyiidae) Using Its Sex Pheromone.

Since 1995, the BC Ministry of Forests' Seed Pest Management group has been collaborating with researchers at Simon Fraser University to develop and refine a monitoring and control program for Douglas-fir cone gall midge (DFCGM) using the male-attracting sex pheromone produced by female DFCGM. This midge is the single most serious cone and seed pest in coastal Douglas-fir seed orchards. After hatching, DFCGM larvae tunnel into cone scales and form galls near developing ovules. Gall formation results in seed fusion to the scale (preventing seed extraction at harvest) or, when populations are high, destruction of seeds. Severe infestations may destroy 100% of the seed.

In seed orchards in British Columbia, DFCGM populations are monitored using counts of egg-infested scales in samples of 50-100 conelets per orchard collected towards the end of the early spring pollination period. This method is labour intensive, requires specialized skills, and must be precisely timed and done rapidly to ensure accurate population estimates. When mean egg-infested scale counts reach a critical threshold of $\geq$ 2.6 per conelet, population control is indicated. The "control option" of choice is a foliar spray of dimethoate or Metasytox-R ™(both of which are highly toxic systemic insecticides). Stem injection of these chemicals is also registered for control of DFCGM in BC but most orchardists find this approach unwieldy.

In the United States, no effective DFCGM population monitoring program is used. Populations are routinely controlled through annual foliar sprays of the contact insecticide esfenvalerate against flying adults and of dimethoate against DFCGM larvae in conelets.

Technically difficult and labour-intensive monitoring, location of orchards in suburban residential areas, increasing public opposition to insecticide use against cone and seed insects, build up of insecticide resistance in DFCGM, and the probable deregistration of dimethoate in the United States in the near future all indicate a need for a new approach to monitoring and control of DFCGM.

Female DFCGM release a sex pheromone to attract males. In our lab and field trials in 1995, 1996, and 1997 we successfully 1) isolated and identified this pheromone (termed "bennettin") and subsequently 2) produced and field-tested a synthetic version of it. With our demonstration that bennettin is as effective as virgin female DFCGM in attracting males, monitoring and control of DFCGM populations with synthetic pheromone became feasible. Monitoring and control trials were run in 1998 and 2000. These are planned to be completed in the spring 2001 field season. Results from the 2000 field season are presented below.

Monitoring of DFCGM:

Twenty-seven operational monitoring blocks in coastal Douglas-fir seed orchards in Washington and Oregon were established between 20 and 30 March 2000. In each block, 20 bennettin-baited traps were hung from 20 trees at heights of 1.5-2 m. Numbers of male DFCGM captured were recorded from 17-28 April, after completion of the Douglas-fir pollination period. At this time, 50 conelets were randomly collected from each block and dissected to determine the number of DFCGM egg infested scales per conelet. At each block, an estimate of percentage crop trees was made by counting all trees with at least 5 conelets each. From 30 July to 3 August, 50 mature cones were collected from each block that had remained insecticide free during the growing season. These cones were dissected to determine the number of DFCGM gall infested scales per half cone.

From these data, relationships between DFCGM adult populations, egg infestation of conelets, cone damage, and potential crop size were determined through regression analysis.

Results

Crop sizes varied widely between sites with percentage of crop trees ranging from 8-90%. The majority of orchard blocks (18 of 27) had $\geq$ 50% crop trees. There was a

(Continued)

highly significant relationship between mean numbers of egg infested scales and galled scales (Fig. 1) and both showed highly significant relationships with mean numbers of trapped DFCGM males (Fig. 2). These relationships were much stronger when percentage of crop trees within blocks were incorporated into the analysis (Fig. 3). In seed orchard blocks with ≥ 50% crop trees, egg infested and galled scales were strongly related to male trap catches without multiplying numbers of egg infested or galled scales by the percentage of crop trees (Fig. 4).

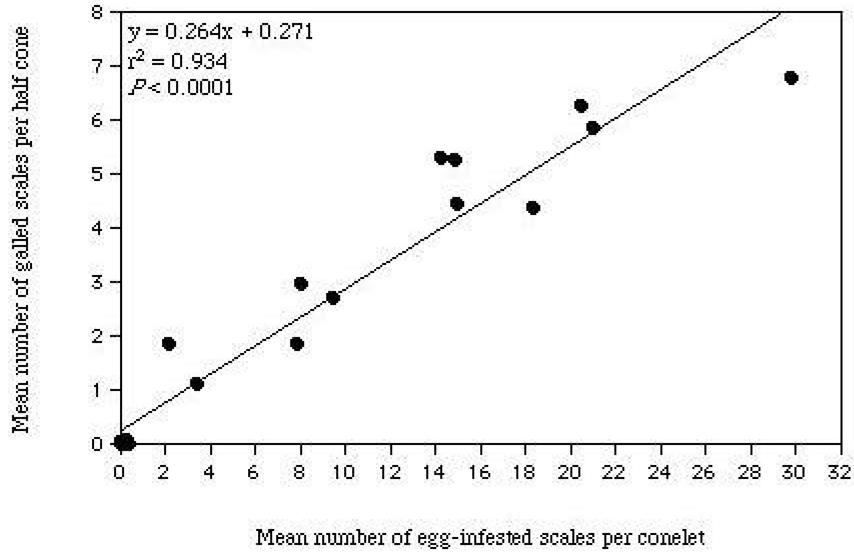

Figure 1. Relationship between mean numbers of DFCGM egg-infested and galled scales. Each data point represents the result from one orchard block.

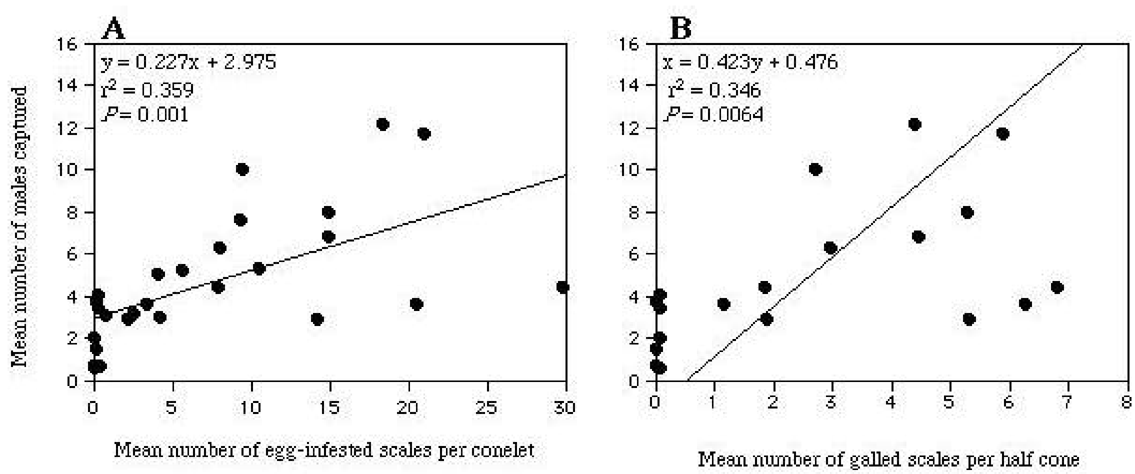

Figure 2. Relationships between mean number of male DFCGM captured in pheromone-baited traps and mean numbers of both egg-infested scales (A) and galled scales (B).

Figure 2

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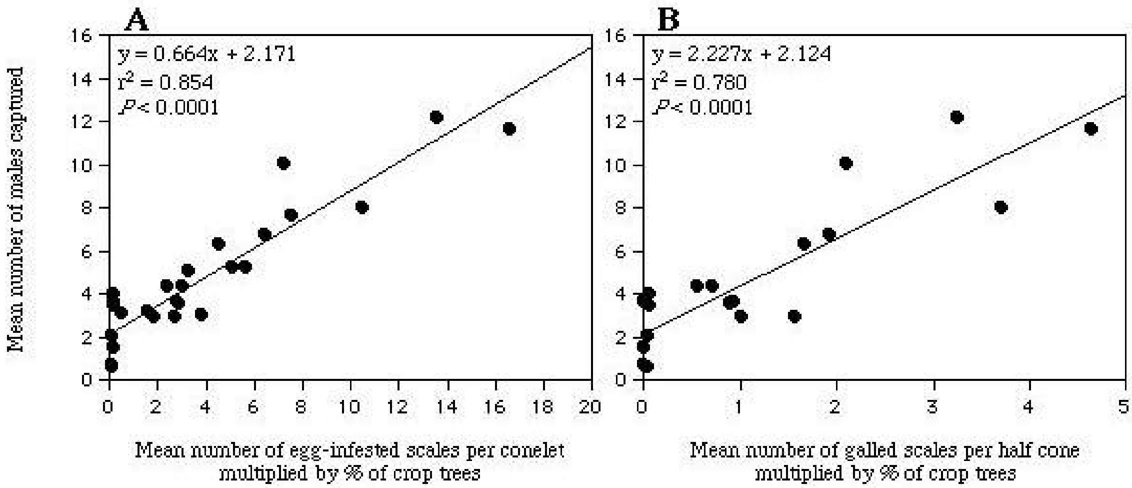

Figure 3. Relationships between mean number of male DFCGM captured in pheromone-baited traps and mean numbers of both egg-infested scales (A) and galled scales (B) each multiplied by the percentage of crop trees.

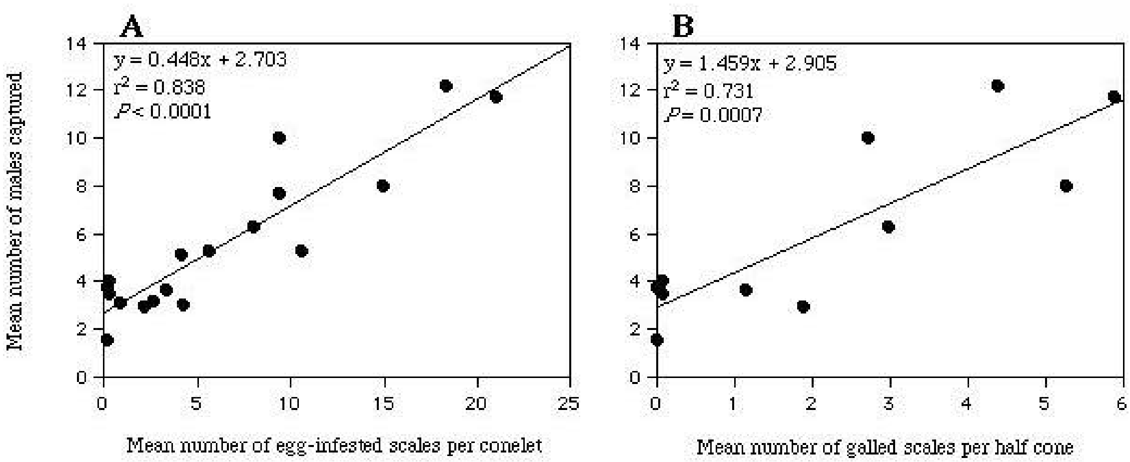

Figure 4. Relationships between mean number of male DFCGM captured in pheromone-baited traps in orchard blocks with ≤50% crop trees and mean numbers of both egg-infested scales (A) and galled scales (B).

(Continued)

"Attract & Kill" For Control Of DFCGM

Tiny amounts of DFCGM "Attract & Kill" formulation (bennettin-impregnated pyrethroid paste) were applied to trunks and branches of all trees in selected blocks in Saanichton area and Bowser Douglas-fir seed orchards in late March 2000. Trees in adjacent blocks were left untreated as controls. Bennettin-baited insect traps were placed in treatment and control trees to assess numbers of male DFCGM in each block. Trap catches and egg infested scale counts (50 conelet samples) were assessed in mid-April after completion of DFCGM adult flight and the Douglas-fir pollination period.

Results

Results were variable but at at least one site there was a very highly significant reduction of DFCGM numbers in the treatment block (Fig. 5). Essentially all male midges were killed in treatment block (treatment traps accounted for 0.8% of total trap captures) although control traps averaged over 26.3 male DFCGM each (99.2% of trap captures).

Fig. 5

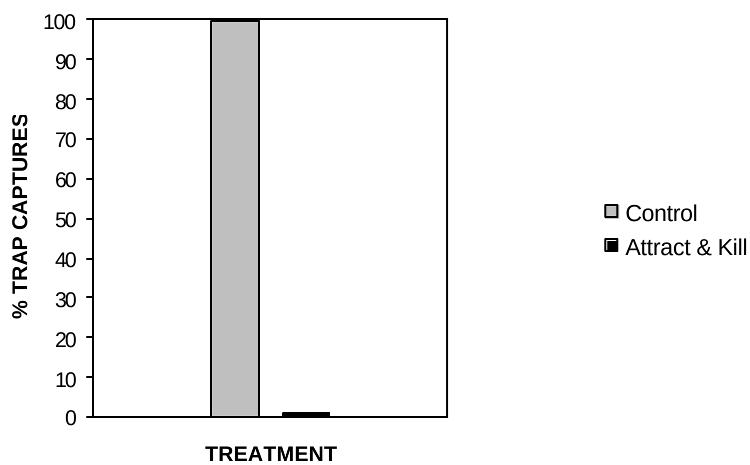

Figure 5. Percent of DFCGM males caught in pheromone-baited traps in untreated and "Attract & Kill"-treated orchard blocks.

Discussion and Conclusions

Our data indicate that catches of male DFCGM in bennettin-baited traps can be used to predict the numbers of both egg-infested scales in conelets (Figs. 3A and 4A) and galled scales in mature cones (Figs. 3B and 4B). Pheromone-based monitoring, therefore, could replace counting of egg-infested scales as a means to decide whether control of DFCGM is warranted. This decision, however, must take the size of the current cone crop into account (Fig. 3) because numbers of conelets in seed orchards affect the level of egg infestation, regardless of numbers of males captured in pheromone-baited traps.

In orchard blocks with 50-100% of the trees induced for crop production, numbers of crop trees and abundance of cones on trees usually are high. In such orchards accurate estimates of conelet abundance may not be necessary to obtain a strong correlation between captured DFCGM males and egg-infested scales (Fig. 4A).

According to our correlations, an average of 3.0 to 3.9 (Figs. 3A, 4A) or 3.2 to 4.4 (Figs. 3B, 4B) males per trap produce respective equivalent predictions of 2.6 **egg-infested scales per conelet** and one **galled scale per mature half cone** (Fig. 1). We conclude from this that control of DFCGM should be considered when an average

(Continued)

of ≥3.0 males are captured per trap. This critical value may be revised as the monitoring system is fine-tuned and more data are gathered in future field seasons.

The monitoring trial results provide the foundation for a highly accurate and successful DFCGM monitoring program using bennettin-baited insect traps. The 2001 field season will refine the trap type to eliminate non-target insect bycatch and provide the final data needed to consolidate the monitoring program for user delivery. For the 2002 field season, we expect that Douglas-fir seed orchard managers will have a very simple, cheap, and effective tool for pinpointing the flight period of DFCGM adults, accurately estimating population sizes, and predicting potential damage.

The "Attract & Kill" formulation virtually eliminated male DFCGM at one test site even though midges were abundant in an immediately adjacent untreated site. This result indicates good potential for the "A&K" approach to provide successful control of DFCGM populations. Whole site treatments using the "Attract & Kill" formulation are planned for the 2001 field season. These should show whether or not elimination of most of the males in a DFCGM population results in significant reduction of developing larvae and consequent cone damage.

Acknowledgements

For providing Washington and Oregon field sites and information on cone development, we thank Beaver Creek Seed Orchard, Cascade Timber Consulting Inc., Horning Tree Seed Orchard, Meridian Seed Orchard, Provolt Tree Seed Orchard, Rayonier Seed Orchard, Roseburg Forest Products (Lebanon), J.E. Schroeder Forest Tree Seed Orchard, The Timber Company, Travis Tyrell Seed Orchard, and Weyerhaeuser Company (Medford & Rochester). We thank Phero Tech Inc. (Delta, British Columbia) for preparation of the pheromone baits. We thank the managers at Timberwest, Western Forest Products, and BC Ministry of Forests sites for permission to test DFCGM "Attract & Kill" in their Douglas-fir seed orchards. The research was financially supported by the British Columbia Ministry of Forests and the Operational Tree Improvement Program of Forest Renewal British Columbia.

Robb Bennett
Tree Improvement Branch
Ministry of Forests

Petra Morewood
W. Dean Morewood
Gerhard Gries
Regine Gries
G. Khaskin
S. King
K. N. Slessor
D. Holden
Simon Fraser University

PUBLICATIONS

Opportunities for Improvements to Reforestation Success

Marek J. Krasowski, Ph.D. & Ronald J. F. Elder, R. P. F.

Abstract

Various issues pertaining to artificial reforestation using coniferous planting stock are presented in the question/ answer format. The discussed topics include: planting into organic soil substrates, microsite selection, planting depth, and closing the planting hole. These topics are viewed in the context of different site-related or climate-associated factors that may limit the successful establishment and growth of planted seedlings. A brief discussion of the literature on basic requirements for seedling growth and survival is also presented.

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Research Branch Extension Note (EN) 43
Published 2000
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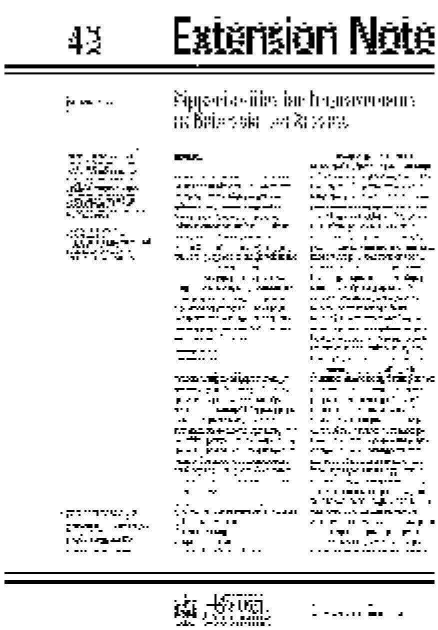
43 Extension Note

Forest Practices Branch Silviculture Notes
BC Ministry of Forests

#23 – Root development of 12 year old white spruce growing on mineral-capped inverted mounds and untreated ground in the BWBS Zone of Northern B. C. (pdf, 498k, posted February 22, 2000)

#27 – Site preparation for establishing lodgepole pine on backlog sites in the sub-boreal spruce zone (pdf, 177k, posted Jan. 10, 2001)

www.for.gov.bc.ca/hfp/PubSilvNotes.htm

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EVENTS

Coastal Silviculture Committee
Summer Workshop
Mixedwood & Riparian Management
June 12 & 13, 2001
UBC Malcolm Knapp Research Forest
Maple Ridge, BC

For more information contact:
Tom Hedekar
ph. 250-741-2597
fax 250-741-2190
Tom.Hedekar@mala.bc.ca

Susan Farrant
ph. 250-741-2628
farrants@mala.bc.ca
www.mala.bc.ca/www/ForestEx/CSCS2001.htm

British Columbia Seed Orchard Association
Northwest Seed Orchard Managers Association
Joint Annual Meeting
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Coast Bastion Hotel
Nanaimo BC

For more information contact:
Gord Morrow
ph. 250-757-2015
fax 250-757-2019
Gord.Morrow@gems2.gov.bc.ca

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Northern Interior Vegetation Management Association
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Stand Management in the Wetter SBS & ESSF Subzones
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Rob Bryce UNBC
ph. 250-960-5982
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Tree Improvement/Forest Genetics Tour
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Anna Monetta
ph. 250-565-6322
Anna.Monetta@gems3.gov.bc.ca

Diane Gertzen
604-930-3309
Diane.Gertzen@gems3.gov.bc.ca

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42nd Annual Meeting
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For more information contact:
Lynne Caton
ph. 360-352-5405
lynnecaton@briggsnursery.com
Steve McCulloch
ph. 360-459-4116
mtshadwnsy@aol.com
www.ipps.org/WesternNA/Index.htm

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For more information contact:
Tony Ramirez
Wa State Dept of Natural Resourses
PO Box 47017
9805 Bloomberg Road SW
Olympia WA 98504-7017
ph. 360-664-2884
fax 360-664-0963
tram490@wadnr.gov

CONTRIBUTORS TO THIS ISSUE

Brian Barber
Technical Advisor
Tree Improvement Branch
BC Ministry of Forests
712 Yates St. 3rd floor
Victoria BC V8W 1L4
ph 250-356-0888
fax 250-356-8124
Brian.Barber@gems4.gov.bc.ca

Robb B. Bennett
Invertebrates-At-Risk Specialist
BC Ministry of Environment, Lands & Parks
PO Box 9374 Stn Prov Gov
Victoria BC V8W 9M4
ph. 250-387-6978
fax 250-356-9145
Robb.Bennett@gems6.gov.bc.ca

Michelle Hall
Seed Pest Management
Tree Improvement Branch
BC Ministry of Forests
7380 Puckle Road
Saanichton BC V8M 1W4
ph 250-652-7613
fax 250-652-4204
Michelle.Hall@gems7.gov.bc.ca

John Henigman
Lorne Bedford
John McClarnon
Forest Site Management Section
Forest Practices Branch
BC Ministry of Forests
PO Box 9513 Stn Prov Govt
Victoria BC V8W 9C2
ph. 250-387-6656
fax 250-387-1467
John.Henigman@gems1.gov.bc.ca
Lorne.Bedford@gems2.gov.bc.ca
John.McClarnon@gems1.gov.bc.ca

Dave Kolotelo
Cone & Seed Improvement Officer
Tree Seed Centre
Tree Improvement Branch
BC Ministry of Forests
18793- 32nd Avenue
Surrey, BC V4P 1M5
ph. 604-541-1683 ext 228
fax 604-1685
Dave.Kolotelo@gems7.gov.bc.ca

Leslie McAuley
Seed Information Analyst
Tree Improvement Branch
BC Ministry of Forests
712 Yates St. 3rd floor
Victoria BC V8W 1L4
ph. 250-356-6208
fax 250-356-8124
Leslie.McAuley@gems8.gov.bc.ca

Petra Morewood
W. Dean Morewood
Gerhard Gries
Regine Gries
G. Khaskin
S. King
K. N. Slessor
D. Holden
Dept of Biological Sciences
Simon Fraser University
Burnaby, BC V5A 1S6
ph. 604-291-4392
fax 604-291-3496
gries@sfu.ca

Spencer Reitenbach
Tree Seed Centre
Tree Improvement Branch
BC Ministry of Forests
18793 - 32nd Avenue
Surrey, BC V4P 1M5
ph. 604-541-1683 ext 229
fax 604-541-1685
Spencer.Reitenbach@gems5.gov.bc.ca

Heather Rooke
Manager Tree Seed Centre
BC Ministry of Forests
Tree Improvement Branch
18793 - 32nd Avenue
Surrey, BC V4P 1M5
ph. 604-541-1683 ext 228
fax 604-541-1685
Heather.Rooke@gems9.gov.bc.ca

Dave Trotter
Agnes Kwok
Nursery Pest Management Specialist
Tree Improvement Branch
BC Ministry of Forests
14275-96th Avenue
Surrey BC V3V 7Z2
ph. 604-930-3302
fax 604-775-1288
Dave.Trotter@gems4.gov.bc.ca

Eric van Steenis
Culturist
Tree Improvement Branch
BC Ministry of Forests
14275-96th Avenue
Surrey BC V3V 7Z2
ph. 604-930-3303
fax 604-775-1288
Eric.vanSteenis@gems5.gov.bc.ca

Susan Zedel
SPAR Administrator/Seed Information Systems Officer
Tree Improvement Branch
BCMinistry of Forests
712 Yates St. 3rd Floor
Victoria BC V8W 1L4
ph. 250-356-1598
fax 250-356-8124
Susan.Zedel@gems8.gov.bc.ca

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Diane.Gertzen@gems3.gov.bc.ca
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