TREE IMPROVEMENT

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Seed and Seedling Extension Topics

Extension Services Section - Editor, Glenn Matthews

It seems the only constant these days is change itself. Staff movements continue to occur, notably with Wayne Gates leaving the Ministry to join forces with Pacific Regeneration Technologies, and the shift in Rona Sturrock's duties from pathology research and extension to FRDA administration. The contributions of both to Extension Services will be greatly missed. On the side of stabilization, Drew Brazier, former North Zone Administrative Officer, has been named the new Manager of Nursery and Seed Orchard Services, and interviews are being held for the position of Greenhouse and Seed Orchard Specialist. Clare Kooistra returns to his position of South Zone Administrative Officer in Vernon, and Extension Services members thank him for his contributions and guidance over the past several months. Stewart Haywood-Farmer will be Acting North Zone Administrator until an appointment is made.

The first issue of "Seed and Seedling Extension Topics" was well received and thanks goes out to all those who supplied material. Please remember that contributions of new observations or techniques are needed to) make this a successful means of distributing information.

The joint meeting of the Forest Nursery Association of B.C., Western Forest Nursery Council, and Intermountain Forest Nursery Association in Vernon, August 8-1 1, was a great success, largely due to the organizational skills of Ralph Huber and the capable assistance of Elaine Hadath and Ilene Kudryk of Skimikin and Vernon nurseries, respectively. This joint meeting was quite large, with about 350 attending. We were pleased to see many of our U.S.A., European and out of province counterparts attend and contribute to the meeting's success. Many thanks to all those who organized the meeting, presented papers, prepared posters and n-tanned commercial booths. The USDA State and Private Forestry has undertaken publication of the proceedings. The 1989 meeting of the FNABC will be in Victoria in October and is being organized by Hans Stoffelsma of Arbutus Grove Nursery.

Grower's Notes*

Perhaps the unsatisfactory or inconsistent results nurseries have experienced in cleaning Styroblocks with bleach have been due to the pH of the solution used. Information on washing vegetables with chlorine solutions originating with the Florida Co-operative Extension Service and the Decco Tiltbelt Division of the Pennwalt Corporation indicates that the kill time for spores is much reduced when the pH is on the acid side of neutral. For example, a solution with a pH of 8.5 may take 8 times as long to effect a 99% spore kill as the approximately 2 1/2 minutes required at pH 6.5.

When household bleach (sodium hypochlorite) or solid calcium hypochlorite are dissolved in water, they form hypochlorous acid, which performs the sanitizing action by means of oxygen released in the breakdown of HOCI into HC1 and 0. The lower the pH, the more hypochlorous acid is formed. At very low pH, equipment will be corroded and free chlorine gas will be lost to the atmosphere. At high pH, hypochlorous acid (HOCL) dissociates to form hypochlorite ions (OCL-) and hydrogen ions (H+). Hypochlorite ions become dominant above pH 7.5 and have much less killing power than hypochlorous acid.

To be most effective as a sterilant without causing undue corrosion, the pH of the solution should be maintained between 6.0 and 7.5. A buffer is now available from Advance Chemicals which will maintain pH in the desirable range. It is used in a 1:1 ratio with the amount of 12% chlorine used (Advance 12), or 1:2 with household bleach, i.e., 20 parts water: I part buffer: 1 part 12% chlorine. Both products are available in 5 gal. or 45 gal. quantities. The buffer costs approximately $2.25 per gallon and the 12% bleach about $1.65. The effectiveness of chlorine in solution is reduced by the presence of organic matter, which ties it up and makes it unavailable as a sterilant. This need not be a problem as long as the amount of organic matter is "minimized and the concentration of the solution is monitored and adjusted.

Temperature also affects performance in that chlorine becomes more active as a disinfectant at higher temperatures, but higher temperatures also increase the ability of organic matter to tie up chlorine. Higher chlorine concentrations must therefore be used when more organic matter is present, when water is cold, or when exposure time is short.

It may be understandable if short-term chlorine dips have not worked well for us. Most nurseries have used household bleach, which is formulated to have a high pH (8.5), and many also have relatively high pH water. Added to this are: organic matter carried over on the blocks, cold washing conditions, short exposure times and an unknown solution concentration after the dip- ping of wet blocks commences. Less clear is what the chlorine concentration should be, or how to monitor it. Our longstanding chlorine recommendation for dipping blocks has been 0.5%, or 5000 ppm. The vegetable industry seems to use about 300 ppm at the appropriate pH, and sophisticated equipment is used in large operations which adds gaseous chlorine and buffer automatically. If chlorine proves to be more effective at regulated concentrations and pH levels, some nurseries may be interested in metering and control equipment available from Advance Chemicals for both chlorine and buffer, at about $900 each. Accurate chlorine levels can be determined by titration, but this is not very practical on a production line, and swimming pool tests may not handle the range of concentrations we require. While alternatives to expensive monitoring equipment are being developed, the best way to ensure an effective sterilant may be to replace it constantly or at least frequently with new supplies at the required concentration and pH.

Glenn Matthews

* Mention of commercial products in this newsletter does not constitute endorsement by the Ministry of Forests.

Sometimes a great notion has unexpected results. With the advent of May and June sown 2-0 container crops, nursery staff had difficulty controlling temperatures of dark colored sand cover. The germination of spruce, especially, falls off dramatically at both high and low temperatures, and high sand temperatures after germination can cause stem lesions. In unshaded outdoor compounds the only way to control sand temperatures is to water for cooling. Without accurate monitoring, the tendency is to err on the side of safety and cool too frequently.

Last year this resulted in a shift in wet-dry cycles to a higher percentage of "wet" Under these conditions the barrier effect of the sand was lost, and massive invasions of mosses and particularly liverworts became established.

With these results in mind, it seemed logical to use lighter colored material as a seed cover to reduce cooling requirements for late sown 2-0 crops. This meant a return to more expensive granite grit which has a somewhat lighter color and proved to be a few degrees cooler under full light. If grit was effective in reducing temperature, wouldn't a pure white material work even better? It may, under the conditions proposed, but trials in greenhouses with conventional crops were disastrous. In crops sown early in green- houses barely able to meet heating requirements, germination was badly suppressed under the white material because it was picking up little additional heat from solar radiation. In a later sown greenhouse crop, massive liverwort invasions occurred in white sand but not in dark colored sand. This happened because the blocks were mixed in the house and the crop was being managed to the requirements of the dark sand, resulting in cooler, wetter conditions in the white sand. It is apparent that different seed covers must be managed to their individual heating characteristics, maximizing the time the cover is kept dry consistent with other seedling requirements.

Glenn Matthews

Congratulations to Allan McDonald and Susan Zedel of Saanich Test Nursery for winning the 1988 Chief Forester's Award for their block of lodgepole pine seedlings, and thanks to all those who took part in this al- ways interesting competition. Following are the details of cultural methods used for the winning combination.

-Ed.

Because the Forest Nursery Association of B.C. annual meeting was held six weeks earlier than usual, the lodgepole pine grown at Saanich Test Nursery for the Chief Forester's Award competition was sown early and started inside. The sowing date was moved up to March 29 and the blocks were germinated in a heated greenhouse under supplemental photoperiod lighting. Greenhouse temperature was maintained at 19 degrees during germination and changed to 24-degree night and 19-degree day temperatures in the first week of May. Peters 10-30-20 "Blossom Booster" with STEM added was used as a starter at 75 ppm N and increased to 125 ppm N for growing. When the mean height reached 9 cm (June 10), the pine was moved outside and subjected to 3 successive "moderate" drought stress cycles to help induce bud set. Fertilizer for the remainder of the season was applied at 75 ppm N.

Allan McDonald

Media study: FRDA 1.45 Update

The preliminary survey of experimental media being used in Engelmann spruce crops in the nursery industry is nearing completion. Results of the initial survey of media physical and chemical properties have been summarized. Additional media have been prepared and are being studied. Crop attributes and media degradation results will be given in the next issue along with testing methods used.

The most important result is verification of the truism:

Variable peat quality and variable amendments yield, predictably, variable media. The variability of the media must be recognized in cultural management.

For those interested in obtaining screens to do your own profile of particle sizes in peat, the sieve sizes you might consider are: No. 5; No. 10; No. 20; No. 50; No. 100.

Sieves can be obtained locally from:

Hoskin Scientific Ltd.
239 E. 6th Ave.
Vancouver, B.C.
V5T IJ7
(604) 873-7894

or can be ordered directly from:

Soiltest Inc.
2205 Lee St.
Evanston, Illinois
USA 60202
(312) 869-5500

Another option is to build your own screens using stainless steel woven mesh that can be obtained from:

C & E Mesh Products
929 Tupper
Coquitiam, B.C.
V3K IA4
(604) 524-3606

I am planning budgets for fiscal 1989-90 and would like to know whether the nursery trade is interested in co-operating with three aspects of FRDA 1.45. The costs would be covered by FRDA but we need to develop a budget first - which means we need to know who would be interested in participating. Please contact me directly if you would like to be involved.

Demonstration blocks:

We will be modifying two different peat types with various amendments. It would help us to interpret the results of experimental trials if we could see how these media perform under a variety of cultural conditions. If nurseries would like to try some of these media in their operations we could fill blocks for the nurseries to sow with species of their choice.

Water management:

A large part of media performance is water management. We have been very surprised at the diversity of watering regimes applied to a single crop. We would like to know more about the range of watering regimes that are being used. If nurseries are interested in participating in gravimetric sampling, we would be prepared to help set up such a program.

Experimental media:

This past season we examined several experimental media that various nurseries were trying. We would like to continue to keep abreast of developments in the nursery trade and would welcome the opportunity to examine any other experimental media produced next year. If nurseries are planning on trying new media or amendment combinations, we would be interested in co-operating.

Rob Scagel

Seedling Sowing Requests 1989

The Chief Forester has announced that the seedlings sown in British Columbia will be the highest ever, total- ling 295 million.

The Ministry of Forests will plant 166 million seed- lings, the forest industry 124 million seedlings, and 5 million seedling will be planted on private land.

These sowing request levels indicate that both the Ministry and industry planting programs in British Columbia will beat the current approved 5-year plan levels.

For both the 1989 and 1990 planting years, 45 million trees will be planted on backlog sites under the $300 million Canada-British Columbia Forest Resource Development Agreement (FRDA).

Seedlings being sown now will be planted in the first year of a second FRDA, showing the Province's commitment to this second agreement.

Contact Drew Brazier, 387-8955; Peter Ackhurst, 387-8953, Silviculture Branch.

Tech Talk

Ministry Root Growth Capacity Testing

The current Root Growth Capacity (R.C.C.) test used by the Ministry has been very useful as one decision- making tool for assessing seedling quality following cold storage. The fundamental assumption of the test is that the more new roots a sample of seedlings exhibits after they have been grown under a standard set of conditions, the better the chance the associated population of seedlings have of surviving and growing after out- planting. The results of the R.C.C. tests are oft6n positively correlated to the associated seedling survival and growth in the field.

Recently, however, confusion has risen with the test procedures used and the interpretation of the results for the Ministry R.G.C. program. Consequently, the Director of Silviculture has modified the Ministry R.G.C. test. The modifications were recommended to the Director by a task group established especially to review the subject of assessing seedling quality.

Modifications

1. Temperature Regime for R.G.C. Test

The test temperature (day/night) and duration of the test will vary with species and stock type. Test durations given below are for container stock only.

All Bareroot Stock Must Be Tested For 14 Days

Species	Test Temperature (ºC) (Day/Night)	Duration of Test (Days)
Interior Spruce	25-20	7
Lodgepole Pine	30-25	7
Interior Douglas-Fir	25-20	7
Larch	25-20	7*
Ponderosa Pine	30-25	7*
White Pine	25-20	7*
Coastal Douglas-Fir	22-18	7
Abies Spp.	22-18	7
W. & Mtn. Hemlock	22-18	7
W. Redcedar	22-18	7
Yellow Cedar	22-18	7
Sitka Spruce	22-18	7

* There is little or no data available on test conditions for these species.

2. Test Duration

All bareroot seedlings are to be tested for 14 days instead of 7 days.

3. Interpretation of Test Results

Two recommendations have been inserted into the R.G.C. test to assist in the interpretation of the results:

i) Recommendations if the R.G.C. test is ≤ 2 (i.e., in the red or yellow zone of Table 1).

- If IRG (Burdett's table) is ≤ 2 and there are 3 or more "O" values for individual seedlings THE BATCH MUST BE RETESTED.
- THE RETEST SHOULD BE DONE IN A DIFFERENT ENVIRONMENT CHAMBER.
- For container stock the sample size should be in- creased to 32 seedlings, one half to be run for 7 days and the other half for 14 days. The 14 day test should also be assessed for other information such as bud flush and water potential, for example.
- BAREROOT STOCK MUST BE RETESTED FOR 14 DAYS.
- IRG RETEST INFORMATION SHOULD BE USED IN CONJUNCTION WITH OTHER INFORMATION KNOWN ABOUT, OR COLLECTED ON, THE STOCK AT THE TIME OF RETESTING TO MAKE THE APPROPRIATE DECISION ON THE STOCK, for example:
  - storage conditions
  - tissue analysis
  - morphological specification
  - seedling colour
  - cultural history
  - visual inspection of tested seedlings

ii) Table I - Decision-making recommendations concerning R.G.C. test results. Data are based on, 540 operational R.G.C. tests and nursery outplanting plot results. These results pool all species and stock types (After Binder *et al.* 1988b).

Table 1

Parameters	Automatic Rejection RedZone	DECISION Reserve Decision Consider Other Info Yellow Zone	Caution Green Zone
Mean IRG[1]	0	<2	>2
Change of accepting an unacceptable batch[2]	1%[4]	50%[4]	10%
Additional stock information required	Not usually	Required	Maybe
Type of information[3]			
Test conditions	+	+	+
Purpose	(+)	+	(+)
Pathology	(+)	+	(+)
Morphology	(+)	+	(+)
Storage History	(+)	+	(+)
Cultural History	(+)	+	(+)
Expected field planting conditions	(+)	+	(+)
Retest required	+	+	(+)
Visual inspection of seedlings	+	+	+

(1) IRG from Burdett (1979)
(2) "Unacceptable" is considered greater than 20% mortality in a nursery outplanting plot. Actual plantation conditions could require adjusting IRG limits.
(3) + collect other information; (+) other information optional
(4) Retest required

The modifications to the R.G.C. test are intended to improve the validity of the test and to remind users of the test that an R.G.C. result by itself cannot ultimately measure seedling quality, field survival and field performance. There are several other factors that must also be considered. For more information regarding the revised Ministry R.G.C. test, please contact a Nursery Administrative Officer.

Helmut Meuller	746-1453
Clare Kooistra	549-5591
Jim Sweeten	576-9161
Stewart Haywood-Farmer	963-9651

Stewart Haywood-Farmer

Manipulating Growth Rates and Tissue Nutrient Levels

It should be emphasized from the outset that nutrition cannot be controlled independent of other cultural factors in production nurseries, and tissue nutrient monitoring depends on establishing an experience base with a laboratory using consistent analysis procedures. The following observations are based on experience using 3:1 peat-vermiculite 1-3kg/m^3 coarse dolomite lime.

Recent trials and production methods have concentrated on manipulating tissue N or P levels to restrict height growth in fast growing species. Limitation of each of these two nutrients has worked well in producing balanced seedlings, except tissue levels are quite low by the time responses are observable, and there is concern expressed by field Foresters when they see pale coloured crops in mid-season. Trials just completed at Saanich Test Nursery have reduced N and P rates together to try to limit height nutritionally without having to use the very low rates with either N or P reduction alone. Following are observations and techniques used in the manipulation of growth and tissue nutrient levels.

Nitrogen

As a general guideline for conifers when no other indicators are available, nitrogen should be applied at about 75 ppm. The exact level should be determined by tissue N levels and by the response of height growth in relation to the target. There does not seem to be any favourable response to using all nitrate or all ammonium sources of nitrogen for conifers, although species from wetter sites such as spruce and western hemlock tend to have darker colour and perhaps better growth using higher percentages of ammonium, while species from drier sites may respond better to more nitrate in the balance (e.g., Douglas-fir and western red- cedar). Ammonium sources on lodgepole pine in the presence of sulphur or high P levels in the growing medium can produce sulphur based gases that some- times do no harm, and sometimes kill all the current foliage.

Some slow growing species may require nitrogen levels of 125 ppm or more. Others may ordinarily not need that much, but there are times when height development may be behind schedule. When it is desirable to stimulate height growth, higher balanced nutrient levels can be used, or the same level of balanced fertilizer can be alternated with a nitrogen source at about 100 ppm. An even more effective way to increase height is to use the same or slightly higher balanced nutrients, but fertilize the crop every day for 4 or 5 days. This technique should only be used when growing conditions are very good, and the growing medium must be allowed to dry down and aerate before it is repeated once more. This should not be done if the growing medium holds great amounts of water and is poorly aerated, due to the risk of promoting root rots.

In order not to raise tissue N levels too high and lose control of growth, fast growing species should be started at more modest levels, say 50 ppm. A western redcedar treatment in a nutrient trial grew well all season at 12 ppm after an initial start at about 50 ppm. Tissue N levels appear to have to be in the range of 1.8% in order to have any limiting effect on height. During early growth stages, tissue nutrient levels near or greater than 3% have little hope of being controlled with N, even if it is removed entirely from subsequent nutrient applications.

Although this technique is relatively new in production nurseries, so far there has been little difficulty in returning tissue N levels (and seedling colour) to more conventional levels later in the growing season.

Phosphorous

Phosphorous has routinely been applied at 50 ppm or more for many years, and at even higher levels after bud set in the fall. Recent trials on fast growing species have shown that growth is normal in all respects when P is applied at 25 ppm throughout the growing season. Treatments receiving as little as 5 ppm P appeared normal, although low P levels could be detected in tissue analyses. Phosphorous applications at lower levels are mainly attempts to achieve normal growth without overuse of expensive P fertilizers and having excessive nutrients run off the crop. P applications at very low levels may also be utilized to limit height of fast growing species, however, it appears that application rates as low as 2 ppm and tissue P levels of around I% are required in order to limit height development.

One advantage of manipulation with low P is that colour remains quite good, except that purpling may occur in spruce and pine if soil temperatures are cool. Phosphorous availability is temperature dependent, so lower rates will be necessary to control growth in a greenhouse compared to outdoor grown crops.

As with nitrogen, the strategy would be to return the crop to normal levels at the end of the growing season. This may be difficult to achieve with phosphorous if soil temperatures are low at that time.

Potassium

Potassium application rates have usually been in the 50- 80 ppm range, with little effect of different rates being observed during the growing season. Recent trials show growth to be quite normal in the range of 30 ppm K, however, applications of potassium sulphate beginning in August on spruce crops grown outside in coastal nurseries will prevent the observed decline of tissue K levels after September, and good colour will be retained all winter.

There is some evidence that potassium is involved in the transpiration process and that high K levels can enhance drought tolerance, but results do not seem to be consistent in all species.

Calcium and Magnesium

When acid peat is available and water pH is not too high, coarse dolomite lime can be used to modify pH and supply a source of calcium and magnesium. High pH water usually has sufficient supplies of calcium (50 ppm or more) and magnesium (15 ppm) and dolomite is not required. Calcium (and sulphur) can also be sup- plied by incorporating 1 or 2 kg/m^3 of gypsum ($CaSO4$) in the growing medium. If tissue levels are low during the growing season, soluble Ca in the form of calcium nitrate can be applied. $CaNO3$ must be applied separately from other fertilizers unless a dual head injector is available, due to the formation of insoluble precipitates if mixed in the concentrate form. Peters and Coast Agri have convenient new soluble fertilizer formulations (15-0-15) supplying N, K and calcium, but no phosphorous. These could be useful in situations where calcium is required in soluble form, allowing phosphorous levels to be manipulated by applications from a separate tank.

Magnesium is usually available in adequate amounts from dolomite lime and from water supplies. Prior to this past growing season, tissue Mg levels had always been in the acceptable range of 0.12 - 0.3%, however, marginal levels were reported in several nurseries in 1988. Repeated applications of magnesium sulphate did little to raise tissue levels, but growth appeared normal and no physical symptoms were reported.

Sulphur

In order to make sure all available nitrogen is metabolized, sulphur application levels should be maintained at about 25 ppm. Sulphur can be used to limit height development like N and P, but application levels of less than 1 or 2 ppm and tissue levels of about .04% will be necessary to be effective. Many nurseries have more than this level in their water supply. Osmocote contains enough sulphur to surpass control levels and large quantities of sulphur are available in ammonium and potassium sulphates, and from sulfuric acid, therefore sulphur is not a very practical tool for limiting height.

Trace Elements

Trace elements can be maintained within optimum ranges in tissue by controlling the sum of those available in water supplies, those added to the growing medium initially, quantities available in commercial fertilizers, and single element applications used to prevent deficiencies. Observations on the nutrient levels of many crops plus nutrient trials have resulted in target tissue nutrient levels and generalized application rates necessary to achieve them. If soluble fertilizers were utilized as the only source of trace elements, the following rates applied with each fertilization are thought to be adequate. Tissue analysis should be utilized to identify deficiencies or excesses, and rates modified accordingly.

If trace element requirements are partially supplied by slow release formulations in the soil mix or other sources, the soluble rates below should be reduced by 50% until tissue analysis results indicate the need for adjustment.

Glenn Matthews

PPM of Soluble Trace Element Applications - No Other Sources

Fe	Cu	Mn	B	Zn	Mo
2	2	0.5	0.5	2	.005

1988 Media Trial, Saanich Test Nursery

In an attempt to ameliorate root diseases associated with lack of aeration and excess water holding capacity in recent production crops, a media trial at Saanich Test Nursery was designed to investigate methods of improving soil aeration and to observe the effect on growth.

The trial consisted of 19 treatments in each of three species, coastal and interior Douglas-fir and white spruce. The first seven treatments were comprised of 1987 peat supplies that contained more than 10% dry weight of fine particles. The next seven treatments were the same except the peat used was 1988 supply, having about 1% finer than 100 mesh and a higher percentage coarser than 20 mesh. The range of media used was as follows:

1. 3 peat (1987): 1 vermiculite
2. 3 peat (1987): 1 sawdust
3. 1 peat (1987): 1 sawdust
4. 3 peat (1987): 1 hydrophobic flocked mineral wool
5. 4 peat (1987): 1 hydrophobic flocked mineral wool
6. 3 peat (1987): 1 hydrophobic granular mineral wool
7. 4 peat (1987): 1 hydrophobic granular mineral wool

Treatments 8-14 were duplicates of treatments 1-7 using 1988 peat supplies.

15. Sawdust with 0.5 kg/m3 Viterra 11 Hydrogel
16. 2 sawdust: 1 hydrophyllic flocked mineral wool
17. 2 sawdust: I hydrophyllic granular mineral wool
18. 3 Lakeland peat: I vermiculite
19. 2 composted sawdust: I hydrophyllic granular mineral wool

The flocked mineral wool we used was produced by CGC Industries and marketed as Capogro wool. The granular mineral wool was a Nichias Corporation product.

The trial has been sampled, measurements and weights have been taken, and although the data has yet to be analyzed, some trends are apparent. For the most part, the mean RCD's fall between cull standard and tar- get and only one treatment in the spruce (#16) had a mean root weight below cull standard. With the exception of Treatment 16 all the mean root weights for the coastal and interior firs were above target.

Comparing results according to Dickson's Quality Index:

$$QI = \frac{\textbf{Dry Weight}}{\dfrac{\textbf{Height}}{\textbf{RC Diam}} + \dfrac{\textbf{Top Weight}}{\textbf{Root Weight}}}$$

The peat-vermiculite and peat-hydrophobic mineral wool treatments produced the highest values in both Douglas-firs, with the 1987 peat and Lakeland peat doing as well as the 1988 peat. In the spruce, the best quality index was in the 1987 peat/vermiculite and the peat/sawdust mixes appeared to outperform the peat/mineral wool.

The peat moss/mineral wool combinations were generally quite similar in overall performance, but the flocked material isn't really practical in that the mix is extremely uneven and difficult to load, even by hand. This material was used in lieu of granulated mineral wool, which is now available from both Nichias and Capogro. Both granulated products load very readily and are physically well suited to our mixing and handling requirements.

The fresh sawdust mixes without peat moss did quite well, and formed fairly good plugs by the end of the growing season, although they were very difficult to ex- tract. The most successful of these mixes was sawdust with hydrophilic granular mineral wool, possibly be- cause it provides a mix in which the water is distributed more evenly than in the flocked mineral wool or hydrogel mixes.

The Lakeland peat and composted sawdust mixes performed as well as the control in both firs and did quite well in the spruce. Overall, the results, while not demonstrating dramatic differences among treatments, indicate some possible alternatives to the standard 3:1 peat-vermiculite mix. There were no apparent losses in growth or quality by using "poor" quality peat containing over 10% finer than 100 mesh particles, demonstrating that most materials can be managed successfully if their qualities are known in advance. Nor were there any signs of root rots in any treatment, although it should be emphasized that trials at Saanich Test Nursery utilize new blocks annually, so there would be no inoculum carry over due to contaminated blocks.

Media Trial Average Results

- Sown April 8/88, Sampled October 17-25, All 313A (198)
- Height (cm), Root Collar Diameter (mm), Root Weight (g), QI - Quality Index

	FDI 8149				FDC 7752				SW 4177			
Tr#	Ht	RCD	RtWt	OI	Ht	RCD	RtWt	OI	Ht	RCD	RtWt	OI
Min.	12	2.2	.4		12	2.5	.4		12	2.4	.5	
Target	18	3.0	.6		17	3.2	.6		17	3.0	.7	
1	17.5	2.6	.82	.23	20.5	2.7	.75	.21	15.5	2.4	.82	.26
2	16.0	2.4	.69	.19	21.1	2.5	.63	.17	15.1	2.4	.69	.23
3	14.2	2.4	.70	.21	17.7	2.5	.68	.19	14.6	2.3	.62	.20
4	18.3	2.6	.77	.22	20.5	2.6	.67	.19	17.8	2.6	.71	.24
5	18.1	2.6	.74	.21	19.9	2.7	.73	.21	16.8	2.3	.62	.19
6	18.2	2.7	.78	.23	21.0	2.8	.72	.21	17.5	2.4	.58	.19
7	17.9	2.6	.77	.22	21.6	2.7	.67	.20	17.6	2.4	.64	.20
8	17.7	2.6	.78	.23	22.6	2.6	.68	.18	16.2	2.4	.65	.22
9	16.5	2.4	.73	.20	20.9	2.6	.65	.18	14.5	2.2	.66	.21
10	14.8	2.3	.71	.20	20.0	2.4	.60	.16	14.1	2.4	.70	.24
11	18.8	2.5	.76	.21	20.9	2.6	.65	.19	15.4	2.4	.64	.22
12	18.3	2.6	.77	.22	22.2	2.7	.66	.19	16.7	2.5	.61	.21
13	18.9	2.7	.80	.23	21.5	2.7	.67	.20	18.6	2.5	.63	.20
14	17.4	2.7	.81	.25	23.3	2.8	.65	.19	17.7	2.5	.61	.20
15	13.5	2.1	.67	.18	20.9	2.2	.64	.15	18.1	2.3	.50	.17
16	11.0	2.1	.53	.17	18.8	2.0	.48	.11	13.1	2.1	.48	.16
17	16.3	2.3	.76	.20	16.5	2.4	.76	.20	15.7	2.0	.58	.18
18	19.2	2.9	.82	.26	23.9	2.8	.71	.20	19.1	2.6	.60	.21
19	17.4	2.7	.80	.24	19.0	2.7	.72	.21	16.0	2.4	.66	.23

Allan McDonald

Elevated Night Temperatures

In the first newsletter, warm night temperatures were discussed as a means of controlling growth. Results from last year's trial at Saanich Test Nursery are now available, and although they have not been statistically analyzed, certain trends are apparent.

The trial compared the effect of elevated night temperatures, the rationale being that if heights were not controlled, at least root collar diameters and root weights might be enhanced. The control and treatment greenhouse was maintained at 19ºC minimum through germination from a sowing date of March 24. After germination the control house was heated at 19ºC in the day and 13ºC at night. In midsummer, the control crop was moved outside. Upon return to the greenhouse in September, the controls were heated at 19º in the day and 8º at night.

The high night temperature house was heated at 19' in the day and at 23º for the first six hours of darkness, dropping to the day set point after that. In early summer it became increasingly difficult to maintain a night / day differential.

For a period of time the day set point was lowered and the night set point increased in an effort to maximize the number of hours that a differential was maintained. As this eventually became unmanageable, sidewalls were removed and ambient conditions prevailed for the duration of the summer. In the fall this treatment was heated at 19º day and night. The day cooling set point for both houses was 23º, although this temperature was exceeded on many occasions.

The results indicate that elevated night temperatures produced either nil or undesirable effects on all growth parameters measured. Heights of the three fastest growing species (western redcedar, Sitka spruce and coastal Douglas-fir) were increased with high night temperatures, but there was little or no effect on height in the other three species (interior Douglas-fir, Engelmann spruce, white spruce). There was no effect in any species on root collar diameter. The greatest and entirely consistent result in all species was the occurrence of substantially lower root weights under the high night temperature regime. Another trial, on nutritional regimes, was duplicated in the high night temperature greenhouse. Results were similar to the main trial, regardless of the various nutrient applications, except in cedar, where reduced P levels in combination with the two lower N rates and warm nights, did not produce lighter roots.

There is a complicating factor in these results in that the control treatments were moved outside at the time they were approaching target heights, and we know that higher light levels also result in increased root weights. Nevertheless there were no positive effects of high night temperature, and possibly some important negative influences. Future trials should attempt to determine optimum night temperatures that will maximize root development while not exacerbating problems with species that tend to excess height development.

Glenn Matthews

Pest Management

Balsam Woolly Aphid Regulations

All *Abies* spp. (Grand Fir, Noble Fir, Fraser Fir, etc.) must be grown under permit. Annual permits which expire December 31 of each year, can be obtained from the Nursery Crop Specialist, Abbotsford. When offered for sale or moved from the nursery, plants must be labeled with the appropriate tag verifying that they have been grown under permit. Tags can be obtained from the Entomologist, Cloverdale Office. Trees grown outside the infested zone have free movement within British Columbia. *Abies* spp. grown inside the Balsam Woolly Aphid infested zone are not permitted shipment to areas out- side the infested zone. The infested zone comprises the area south of the Parksville-Fort Alberni highway on Vancouver Island, and the coastal lower mainland. Maps outlining the zone are included in the Plant Protection Regulations, or are available from the source of permits.

When plants are moved within each zone, the following spray program is mandatory:

Plants must be dipped or sprayed to run-off with a registered commercial preparation of insecticidal soap (Safer's Insecticidal Soap 1-2%).

1. Trees (including seedlings) to be moved (or sold) be tween November 1 and March 31 must be sprayed once, just prior to movement.
2. Trees to be moved between April I and October 31, when reinfestation by mobile life stages is possible, must be sprayed twice, with a 14-day interval between treatments. The second treatment is to be done within 7 days of movement. CAUTION: It is suggested that treatments not be applied when trees are flushing and when light green tender growth is present because of possible phytotoxicity. From this point of view, treatmet under (1) above is suggested whenever possible.

Sale and movement of cut trees or foliage of *Abies* spp. grown in the infested zone is prohibited between January 31 and November I anywhere in British Columbia. However, cones and seeds of *Abies* spp. are exempt from this regulation. When moved between November 1 and January 31, cut Christmas trees, boughs for wreaths or decorations, and cones are exempt from treatment and tagging.

Permits:

Dr. Carol Barnett
Provincial Nursery Crop Specialist
Ministry of Agriculture and Fisheries
32916 Marshall Road
Abbotsford, B.C.
V2S lK2
Phone: 852-5350

Tags:

Dr. Henry Gerber
Entomologist
Ministry of Agriculture and Fisheries
17720 - 57th Avenue
Surrey, B.C.
V3S 4P9
Phone: 576-2911

Gwen Shrimpton

PESTICIDE CALL LINES

1. **U.S. Network** - The National Pesticide Tele-Communications Network (NPTN) is a toll free telephone service available to provide a variety of information about pesticides to anyone in the contiguous United States, Puerto Rico and the Virgin Islands.

The NPTN toll-free number is: **1-800-858-PEST**. NPTN operates 24 hours a day, 365 days a year. NPW provides:

1. Pesticide product information
2. Information on recognition and management of pesticide poisonings
3. Toxicology and symptomatic reviews
4. Referrals for laboratory analyses, investigation of pesticide incidents, and emergency treatment information
5. Safety information
6. Health & environment effects
7. Clean up and disposal procedures.

2. **Canadian Network** - The principle is quite similar to that of the National Pesticide Call-line operated in Canada by Agriculture Canada's

Pesticides Directorate. The Canadian pesticide Call-Line number is 1-800-267-6315. The Canadian service, although less ambitious in scope, is operated from Monday to Thursday and is available from anywhere in the country between 10:00 hrs. and 15:00 hrs. Please note that contrary to its U.S. counterpart, the Canadian call- line is not intended for handling emergency situations. Since its inception as a pilot project in 1985, over 5000 phone calls have been processed by Marie Josée de Saint-Victoria and her staff. They monitor complaints, as well as answer questions regarding the registration process, safety precautions, label instructions, and issues surrounding pesticide use. It is important to note, however, that questions pertaining to pesticide recommendation, spray calendars, and specific agricultural situations must be directed to provincial agricultural extension specialists.

Gwen Shrimpton

Benomyl Drenches Do Not Control *Fusarium* Or *Cylindrocarpon* Caused Root Rots (FRDA 1.47)

In Canada, benomyl (Benlate) is registered as a drench treatment on tobacco seedlings (125 grams product/ 230 litres/ l00n^2-Q) for control of root rot, but is not registered for use as a drench on conifer seedlings. As benomyl effectively inhibits conifer seedling derived cultures of both *Fusarium and* Cylindrocarpon when incorporated into agar media, trials were initiated in the hope of extending the benomyl registration to cover conifer seedling drench treatments.

Field trials were established at 3 mainland conifer seedling nurseries, testing various combinations of benomyl drench timing, volume, and concentration on 1 + 0 Douglas-fir seedlings. These trials included treatments of up to 3 times the amount of benomyl per area as that specified in the registration for tobacco. All trials were laid out in a complete randomized block design.

No treatment showed any reduction in the amount of *Fusarium* or *Cylindrocarpon* which could be cultured from the roots 2 weeks post-treatment. At the end of the growing season, samples from each treatment were measured for height, caliper, root dry weight, and shoot dry weight. No treatment showed any effect on these seedling characteristics, indicating that although benomyl is not phytotoxic to conifer seedlings, neither is it effective in control of root rot.

One problem with the above trials was a relatively low incidence of root rot in 2 of the 3 trials. Consequently, 2 further trials were established, one trial using some 1987 2 + 0 Douglas-fir seedlings known to be heavily infected with *Cylindrocarpon,* and the other trial using I + 0 Douglas-fir stock artificially inoculated with *Fusarium* spores. Benomyl drenches (2 grams product /litre of water, 800 nil /styroblock) were applied, and root samples were plated on selective media at 2 weeks post-treatment.

The number of fungal colonies recovered from the plated roots was uniformly high in both trials, with no difference between benomyl drenched and undrenched seedlings.

In a final investigation, planting media (3:1 peat: vermiculite) was inoculated with Fusarium spores and al- lowed to incubate for 2 weeks. At this time plug-size samples were removed and treated with the same volume and concentration of benomyl solution (2g/1) as they would receive in a drench. These samples, plus controls, were incubated for another week, and then plated out on *Fusarium* selective media. All samples produced *Fusarium* colonies, and the benomyl treatment made no difference to either the number or size of the colonies produced.

In summary, all available evidence suggests that benomyl drenches have no potential for either the control or prevention of *Fusarium* or *Cylindrocarpon* caused root rots in conifer seedlings. Because use of benomyl as a drench can be expected to select for benomyl resistance in all microorganisms contacted, it should be avoided if benomyl is to remain effective against foliar nursery pathogens. At present the only management option is to avoid getting the problem, often easier said than done. Block washing to remove pathogen spores, and the use of media with good drainage characteristics should help minimize the risk of root rot.

Frank Williams

They've Done It Again....

The spruce cone maggot, *Hylemyia anthracina* (Czerny) has had a name change and is now called *Strobilomyia neanthracinum* Michelson.

Also, the spruce seed moth, previously *Laspeyresia youngana* (Kearfott) is now called *Cydia strobilella* (L.) References to the spruce cone maggot and spruce seed moth in the literature will be under the new names in the future.

Current guidelines for the control of cooley spruce gall aphid *(Adelges cooleyi)* on spruce call for the application of sprays beginning at budburst, to protect the new growth. This is based on the idea that the galls are caused by the newly hatched nymphs as they start to feed on the new growth in the spring.

Unfortunately these control measures may not always work to prevent gall aphid damage. Overwintering female gall aphids - possibly *Pineus similis* - along with apparently unhatched eggs have been seen in the spring at the base of buds that have a) burst prematurely compared to the rest of the tree and b) started to form into galls. This did not happen in cases where overwintering female gall aphids - possibly *A. cooleyi* - were situated only along the twigs. In the latter case, egg hatch occurred coincidentally with bud burst and galls formed after some elongation had taken place. It could appear that some overwintering females may be able to initiate galls and that this may relate to adelgid species differences (i.e., *A. cooleyi* vs. *P. similis).*

Further evidence is seen with *Pineus pinifoliae.* Galls caused by this adelgid have been noted forming during the flowering period (conelet emergence). Mature P. *pinifoliae* emerged from these galls while galls being caused by the two former species were still forming.

Work is in progress to clarify what is happening, however this phenomenon may explain why spraying at budburst to control damage by spruce gall aphids can produce such erratic results

Don Summers

The Effects of *Adelges Cooleyi* Infestation of Douglas4ir in A Seed Orchard

Adelges cooleyi infestation in the Nootka Douglas-fir Seed Orchard was very heavy in 1988, including the controlled crosses on tree 3-19-AA, clone 220. When we harvested the cones from these crosses on August 23, we observed that the vegetative growth was damaged so severely that the needles and buds were dead. A similar observation was made on the other trees used for controlled crosses. Other branches had lost needles but the buds were healthy. A survey of Block 3, which was the most heavily infested, found the following:

a 24 trees had dead needles, some dead buds and poor elongation of the new growth.

b other trees (not counted) did not show the needle or bud damage but had poor elongation.

This problem is not severe enough to kill the trees, but in the seed orchard where we are looking for good vegetative elongation and increased flower sites, this is likely to reduce the cone crop potential the following year. If a heavy infestation causes this much damage, could it affect the developing seed?

Sheila Reynolds

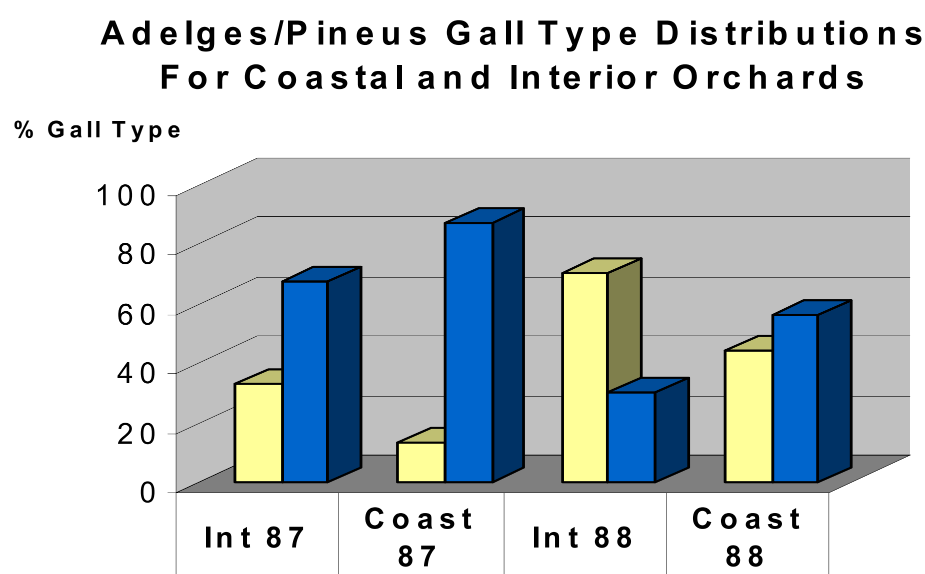
More On the Woolly Aphid Puzzle

For the past two seasons (1987-88), the relative proportions of two types of woolly aphid galls seen in spruce seed orchards have been recorded. Coastal and interior orchards have been monitored and each gall has been rated either *Adelges* (A) or *Pineus* (P). The adelgid galls are elongate and the pineus galls are pineapple shaped. Also keep in mind that this rating system is an over- simplification of the whole woolly aphid complex.

During the two years surveyed, the relative proportions of *Adelges to Pineus* fluctuated on an annual basis, similar to other types of pest populations. In 1987, *Pineus* galls were more abundant than *Adelges* galls in both interior and coast locations. The A/P proportions were 33%/67% in the interior and 13%/87% at the coast

By 1988 the relative proportion of *Adelges* galls had increased in both locations. The A/P proportions had changed to 70%/30% in the interior and to 44%/56% at the coast. Although the Pineus population was still higher at the coast, the percentile difference had dropped from 75 for 1987 data to 10 in 1988. In other words, the population proportions of *Adelges to Pineus* did a flip-flop in one location and showed a marked decrease in another. These annual population changes should be considered when devising control programs.

Bev McEntire



	Int 87	Coast 87	Int 88	Coast 88
Adelges	33	13	70	44
Pineus	67	87	30	56

Use Of Direct Injections Of Systemic Insecticides To Control Douglas-fir Cone Gall Midge

Foliar sprays of systemic insecticides are now used operationally to control cone and seed insects in Douglas-fir seed orchards in B.C. Dimethoate and oxydemeton-methyl (Metasystox-R) have been shown to be effective in reducing damage caused by the Douglas-fir cone gall midge *Contarinia oregonensis* (Foote. 1986).

However, in some locations and under certain conditions such as location near water supplies or during wet windy weather, foliar sprays are not recommended. An alternative to foliar sprays is injection of systemic insecticides, which are also effective against cone and seed insects. Premeasured amounts of Metasystox-R (MSR) can be purchased in plastic capsules containing 3 n-d of 50% a.i. at a cost of $1.75-2.00 per cap.

In 1987, a trial was conducted in a Douglas-fir seed orchard to compare a foliar spray of dimethoate to direct injections of MSR (insecticide only, no capsules). Two spacings (10 and 15 cm) were used. Trees selected for treatment had a large crop, were known to have a high infestation of cone gall midge eggs and were treated when most conelets were beginning to turn down. Twenty cones from 11 trees/treatment and controls were dissected. Seed condition and gall damage was recorded for a 1/2 cone slice.

All treated trees had a significant reduction in the number of galls and the 15 cm spacing had a significant reduction in the number of *Megastigmus* found (see TABLE 1). Controls had a mean of 2.3 galls per slice. Sprayed trees had a mean of I gall/ slice. Injected trees had a mean of 0.18 and 0.04 galls/slice for 10 and 15 cm spacing respectively. Filled seed was not increased in any treatment. This treatment method will be explored again in 1989. Please note that this method is not a registered use and a special use permit is required before such treatments are applied

Table 1: Cone Analysis Results For Insecticide Treatments In A Douglas-fir Seed Orchard Against Douglas-fir Cone Gall Midge. Means followed by the same letter in a column are not significantly different (p 0.5).

TREATMENT	N	Gall Mean	Megastigmus Mean
CONTROL	220	2.29a ± 0.20	0.28a ± 0.04
DIMETHOATE (spray)	200	1.04b ± 0.14	0.24ab ± 0.04
MSR INJECT (10cm)	220	0.04b ± 0.02	0.14bc ± 0.03
MSR INJECT (15cm)	200	0.18b ± 0.05	0.10c ± 0.03

Bev McEntire

Cylindrocarpon Study 1988 - Update

The Pacific Forestry Centre has been monitoring Douglas-fir seedlings at three nurseries for root colonization by *Cylindrocarpon* (Seed & Seedling Extension Topics, Vol. 1, No. 1, August 1988). This is an update on information obtained by culturing roots every two weeks.

Sampling began May 13,1988 and consisted of 20 seedlings per nursery. By October 14, eleven samplings had been completed at each of the three nurseries. *Cylindrocarpon* was isolated from roots of Douglas-fir seedlings at all three nurseries in the first sampling. This indicated that an infection source may be present right from sowing. The levels of isolation from root pieces at the three nurseries were 40% (Nursery A), 12% (Nursery B) and 6% (Nursery C). Over the growing season, the level of infection increased at the three nurseries. By mid-October the levels of isolation were 68% (Nursery A), 45% (Nursery B) and 61% (Nursery C). All 20 seedlings at Nursery A had some *Cylindrocarpon* by June 2, and at Nursery B by July 18. By September 27, 19 out of 20 seedlings at Nursery C had some *Cylindrocarpon.*

Root rot has been present in both Nursery A and Nursery B sample trees. There were some necrotic roots and some living roots with dark cortical tissues in the bottom half of the plug. These dark roots were still producing short roots. Shoots of these trees do not show any indication of a disease and are considered by the nursery personnel to be excellent stock. *Cylindrocarpon* is easily isolated from the dark material. There has been no apparent root rot or root blackening in the stock from Nursery C. This stock has shown a slow increase in the presence of *Cylindrocarpon;*

now all three nurseries have approximately 70% of their roots producing this fungus. All cultural practices of the three nurseries will be compared to determine what possible differences would produce the three levels of root colonization by this fungus.

Sampling of the roots at various levels in the cavities showed that *Cylindrocarpon* was initially found mostly in the middle of the cavity. This has since changed; it is now found more in the bottom third of the cavity. This indicates the importance of moisture and aeration to the disease.

The monitoring is continuing into the lifting and storage phases to determine whether or not root rot intensifies before outplanting. Also, several smaller trials are being conducted to improve detection methods, find the sources of inoculum, and better understand *Cylindrocarpon* in forest nurseries.

John Dennis &
Jack Sutherland

Keithia Blight

Keithia blight caused by the fungus *Didymascella thujina* is a disease of western redcedar. It is a native of British Columbia and is found on redcedar wherever it grows. It was introduced to Europe from North America, and has caused serious losses in nurseries in southern Britain and France.

Keithia was first noted in B.C. nurseries in July 1988 on 2-0 container-grown western redcedar. The blight was probably present in past years, but a cool, moist spring combined with high-density planting encouraged rapid spread of the disease. Despite improved aeration around the styroblocks and application of recommended fungicides (fixed copper and benomyl), the disease progressed throughout the stock. This spread was encouraged by unusually wet fall weather.

Several researchers have examined the life history of this disease. Damage first appears in spring on lower foliage, and is encouraged by low light and high humidity. Experimentation has shown that spores and latent infections from the previous fall determine the early extent of the disease. The fungus is not systemic (i.e., it does not travel into the stem), but kills an individual leaflet, then produces spores which blow to healthy leaflets and infect new tissues. Heavily affected plants can be killed, possibly by toxins produced by the fungus. Inoculated plants have symptoms and produce fresh spores after two weeks at approximately 200 C. When weather conditions are favorable, the disease can cycle and spread quickly. The process is slower at lower temperatures and ceases at 5'. The spores are unique in that they have thick walls and are covered with a thick, gelatinous covering. These characteristics prevent desiccation and allow the spores to be blown great distances and still remain viable. Also, once the spores stick to something, they are stuck permanently. This means that spores stuck to greenhouse walls and other structures should not provide inoculum for future crops. It appears that fresh spores must be produced each year on eastern redcedar foliage if the disease problem is to recur.

Control of Keithia blight begins at sowing and continues throughout the growing season. Conditions of low density, low succulence, high light intensity and low humidity discourage infection and spread. Cedar seedlings carried over from one year to the next are prime sources of the disease. Fungicides are usually effective in controlling foliage pathogens but penetration of the canopy is necessary to contact as much of the fungus as possible. If you grow redcedar and feel that you may have a low-grade infection of Keithia, send samples to John Dennis at the Pacific Forestry Centre. Gwen Shrimpton at Surrey Nursery should be contacted regarding current control measures.

John Dennis &
Jack Sutherland

Overwintering Cutworm Larvae

During the winter (1988) lift of container stock several nurseries have found large numbers of cutworm larvae. The species present has been identified as *Diarisia pseudorosaria.* Populations of this cutworm overwinter as larvae and have been collected through the fall and winter at coastal and interior nurseries. The larvae mature in March and the adults fly in mid May. There is one generation a year. The habits of this cutworm are not well known but it apparently feeds on grasses. In conifer seedling nurseries damage appears to be minimal. Larvae could however be a problem if they accompany stock to the planting sites. In some newly prepared sites there are few weeds present to serve as alternate hosts so larvae will feed on the conifer seedlings. Further, emerging adult moths would increase the population if they chose to oviposite in the reforested site.

In nurseries the nocturnal larvae are usually found in the top 5 cm of the plug during the day. They are often dislodged when seedlings are lifted, sorted and bundled. One of the best forms of control is to educate nursery staff to watch for and remove them during the lift.

Some nurseries have been successful in controlling these cutworm populations using applications of a baitmixture. Mix I kg of Sevin 50 WP into 4 L of water and stir it into 4 kg of bran until it is uniformly moistened and free of lumps. Place the bait in small mounds of about 4 gms each directly on the surface of the styroblocks, use about 8 mounds per pallet of 24 blocks. This application leaves no residues on the foliage so bait can be applied immediately before the lift. There is also no problem with bird kills because they usually can't find the bait.

Gwen Shrimpton

Conifer Root Aphid

This last growing season, significant infestations of the conifer root aphid *Pachypappa tremulae* occurred on container spruce at several nurseries in the Prince George area. In B.C. this aphid was first identified from container grown white spruce in 1973, and has since been collected from several nurseries in the Interior and around Prince George. Most infestations have been on spruce but the aphid can also infest pine, larch and Douglas-fir.

In Quebec, *P. tremulae* appears to be widely distributed in conifer seedling nurseries. It has been collected from white spruce, *(Picea glauca),* black spruce (P. *Mariana),* and jack pine *(Pinus banksiana).* At some facilities up to 80% of the seedlings can be affected. In Alberta, there have been chronic infestations of P. *tremulae* at conifer nurseries for years. The aphids have been found on container spruce and spruce potted for grafting stock.

The life history of *P. tremulae* is not well known, however, it appears to have two stages. One is on the roots of conifers where it secretes a white waxy substance. In nurseries it is most often found on spruce container stock, and there are few records from bare root. The aphids are usually found on the surface of the plug between the roots and the container wall. They also occur either at the top of the plug or at the bottom around the drainage hole. Their distribution on the roots appears to be limited by oxygen demands. The preference for container over bare root stock may be explained by the aphids intolerance to a soil that retains water. It would appear that the peat - vermiculite media used in containers provides an ideal environment for this root aphid.

Infestations of *P. tremulae* in natural stands are usually confined to mycorrhizal surfaces, and suberized roots are unaffected. However, mycorrhizae are not always prevalent on conifer seedlings in nurseries because high levels of nitrogen inhibit their growth. On nursery seedlings the aphids have been observed feeding directly on root tissue, however, there is rarely noticeable damage to the root system. The other stage in the life cycle of *P. tremulae* occurs on the leaves of trembling aspen *Populus tremuloides* where it forms structures known as leaf nests. These were described by Kock (1856-57) as "an elongate reddish swelling situated along the leaf midrib and bounded below by a slit between the hypertrophied and appressed margins of the galled tissue". The fact that this aphid has an alternate cycle on aspen would explain its more frequent occurrence at nurseries in the Prince George area. However, there is some evidence to suggest that the leaf nest phase is not necessary and it can survive all year on conifer roots.

Most nurseries that have had populations of this conifer root aphid have not reported any damage. The infested seedlings do not appear chlorotic or undersized when compared with uninfested stock. In Quebec and Alberta no control measures for root aphids have been applied to date and they do not consider this insect to be an important pest.

Damage from this insect will probably be minimal when the seedlings are growing in nurseries under ideal conditions with ample nutrients and moisture. How- ever, problems could arise in planting sites if seedlings are stressed. It is possible that soil mites and other predators would control root aphids present on seedlings in planting sites. There may also be some mortality during lifting and storage of the stock when seedling roots are exposed, and the fragile aphids are subject to desiccation. A trial to determine the effect of *P. tremulae* on outplanted seedlings has been initiated by Drew Brazier. Initial results are anticipated by the end of next summer.

Gwen Shrimpton

Current Projects

Following are profiles of research agencies, with a view to making the efforts of their staff more widely known. Note that the Forest Biotechnology Centre and BC Research are now an independent industrial research corporation, under the name British Columbia Research Corporation. -Ed.

Forest Biotechnology Centre - Head, Dr. Ben Sutton

Tissue Culture Section

Dr. David Webb	Fiona Webster
Dr. Dane Roberts	Wayne Lazarof
Barry Flinn	Stephanie McInnis

Tissue culture provides a rapid method for clonal propagation of superior genotypes. This technology enhances traditional tree improvement programs by facilitating mass production of desirable genotypes and by providing plant tissues for genetic engineering of conifers.

Embryo culture will help solve seed dormancy and germination problems with rare and valuable seeds. Micrografting can be used to rejuvenate tested superior trees. Micropropagation via organ and embryo regeneration will be important for genetic engineering and for developing cost effective mass propagation techniques.

Genetic Engineering

Dr. Gary Powell

Dermot Flanagan

The genetic transformation of commercial tree species offers many advantaged for tree improvement, which may enhance and accelerate tree breeding. The possibility exists to introduce desirable traits such as disease, insect and herbicide resistance into tree species by the integration of foreign genes from other organisms. Natural DNA transfer by Agrobacterium is one method used successfully to transfer genes into agricultural plants. The Forest Biotechnology Centre is extending its use to conifers. Another important aspect f this research will be to isolate novel genes which have the potential to enhance the value of forestry species.

Biofertilizers and Biological Control:

Dr. Paige Axelrod

Reed Radley

Biofertilizers and Biological Control involves identifying beneficial microorganisms indigenous to the root region of conifers that enhances plant growth and provide control of fungal pathogens. Inoculants containing these beneficial microorganisms will be developed to improve seeding health in consider nurseries and enhance seedling survival and establishment on reforestation sites. The mechanisms by which these beneficial microorganisms exert their effects will also be investigated.

Ecophysiology:

Dr. Steven Grossnickle

Greg Wiggins

John Major

Ecophysiology research provides performance assessment of superior stocktypes produced by the combination of tissue culture, genetic engineering and microbial inoculants. Researchers monitor the physiological and morphological attributes of operational and improved stocktypes to identify stock quality characteristics required for improved forest regeneration. This approach bridges the gap between basic biotechnology research and its application in forestry, forest nurseries and reforestation sites. Emphasis is placed on ensuring that the developed technologies are transferred to forestry operation.

Cowichan Lake Research Station - Ministry of Forests Research Branch - Forest Renewal Group

Jack Woods

Jack's main emphasis is in projects relating to seed orchards and general tree improvement planning, especially relating to advanced generation breeding for coastal Douglas-fir. His research involves Douglas-fir breeding but he also supervises western hemlock and Sitka spruce breeding programs. Other projects include nursery and field testing for the identification and culture of Sitka and interior spruce hybrids.

John Russell

John is involved in yellow cedar stock quality improvement (FRDA 2.4) in a co-operative effort with Steve Grossnickle of the Forest Biotechnology Centre, and Glenn Dunsworth of MacMillan Bloedel. This study involves improving quality of yellow cedar rooted cuttings through cultural methods and donor stock maturation, and assessing physiological results in nursery and field planting trials. He is also working on methods of improving techniques for rooting cuttings of genetically improved interior spruce and coastal Douglas-fir (FRDA 1.14) to provide genetically improved stock for reforestation before seed orchards are in full production.

John is also investigating the extent and distribution of genetic variability of western redcedar and yellow cedar, to guide future breeding and seed orchard requirements. Initial work will involve provenance testing to guide seed use, and progeny testing from established seed orchards.

Ian Cairns

Ian is involved in the production of seedlings and rootstock for use in research and breeding programs, and in the computer inventory control of grafted stock for seed orchards and clonebanks. In his efforts to improve stock quality, he has conducted several trials of interest to others including different media and lime rates for potted root stock, a fungicide trial comparing the effectiveness of Rovral to Captan/Benlate, and cultural methods to improve height growth in *Abies lasiocarpa*. Blackout trials on Douglas-fir and Sitka spruce have included daylengths of 8, 10 and 12 hours, duration times from 21-35 days and other factors including drought stress, nutrients and shading.

John Ogg

Part of John's function is to produce vegetatively propagated material in support of the Coastal Tree Improvement Program. He also improves methods and produces rooted cuttings of other conifer species used directly for operational planting, and is investigating the feasibility of using cuttings of *Abies lasiocarpa* for similar purposes. John has also assisted Dr. Bob van den Driessche in studies to determine nutrient deficiency symptoms in conifer seedling crops.

Don Carson

Besides his function of station superintendent, Don has several interesting projects comparing the rooting ability of conifer cuttings, the effects of pruning rootstock, grafting in the field compared to container stock, and the influence of containers, media and IBA applications on the production of cuttings. Other trials include the grafting of *Abies amabalis* onto four other species.

Literature Review

Fungi associated with seeds of eastern white pine and white spruce during cone processing and seed extraction
Mittal, R.K. and Wang, B.S.P. 1987. Fungi associated with seeds of eastern white pine and white spruce during cone processing and seed extraction. Can. J. For. Res. 17:1026-1034.

Using standard moist-blotter and potato-dextrose-agar tests, 13 species of fungi were isolated from seeds and cone scales of *Pinus strobus* and 17 species from *Picea glauca.* Most fungi were common to both hosts but varied considerably in prevalence on seeds during cone processing and seed extraction. *Alternaria alternate, Aureobasidium pullulans, Cladosporium cladosporoides,* C. *herbarum, Fusarium sporotrichoides, Mucor hiemalis, Penicillium aurantiogriseum,* and *Rhizopus nigricans* were associated with more seeds than other species identified. In closed cones on trees the seeds were usually free from fungi that developed and spread during cone processing and seed extraction. Seeds extracted from cones that were kept on the forest floor showed more fungal contamination than those brought to the laboratory immediately after collection. Seed moisture content gradually decreased, while germination increased between cone collection and final seed conditioning.

LYGUS LINEOLARIS (HETEROPTERA: MIRIDAE) POPULATION DYNAMICS: NYMPHAL DEVELOPMENT, LIFE TABLES, AND LESLIE MATRICES ON SELECTED WEEDS AND COTTON

S.J. Fleischer and M.J. Gaylor. Environ, Entomol. 17(2): 246-253 (1988)

ABSTRACT

The influence of hosts upon the demography of *Lygus lineolaris* (Palisot de Beauvois) was examined by comparing vital rates among hosts, and with life tables, and Leslie age-class models. Nymphal development, survivorship, and sex ratio data were obtained from cohorts on cotton, green beans, and up to 12 weed hosts implicated as sources of immigration into cotton. Adult survivorship and fecundity data were obtained from cohorts on cotton and *Erigeron annuus* (L.) Persoon. Linear models for total or stage-specific nymphal development were not different among nine weed hosts and cotton; they extrapolate to a lower threshold of about 10ºC. A truncated normal model from green

beans resulted in an upper threshold of about 34ºC and a curve breadth that suggests a temperature-generalist life strategy. The percentage of time per instar was influenced by the host. Nymphal survivorship was high on weed hosts but poor on cotton. The sex ratio was 1:1 and was not influenced by host. Adult survivorship and total fecundity was higher on cotton than *E. annuus,* but the cohorts on cotton had a higher death rate and longer generation time. Thus, the intrinsic rate of in- crease on cotton was about half that on *E. annuus.* The stable-stage distribution was unaffected by host and was about 0.50, 0.40, and 0. IO for eggs, nymphs, and, adults, respectively. Host influenced the time of convergence. These analyses suggest an r-selected life strategy.

RECOMMENDATIONS AND ALTERNATIVE GROWING MEDIA FOR USE IN CONTAINERIZED NURSERY PRODUCTION OF CONIFERS: SOME PHYSICAL AND CHEMICAL PROPERTIES OF MEDIA AND AMENDMENTS[1]

R.K. Scagel, G.A. Davis

ABSTRACT

Physical and chemical properties of various nursery media were examined at the start of the crop cycle of containerized Englemann spruce. Preliminary results showed physical and chemical properties of the peat and amendments are highly variable. Combined, these ingredients produce variable media. The results highlight the need for monitoring the media physical and chemical properties and altering nursery culture to accommodate media properties.

[1]Poster session presented at the Combined Western Forest Nursery Council, Forest Nursery Association of British Columbia, and Intermountain Forest Nursery Association meeting; 1988 August 8-11; Vernon, BC. (To be published in the proceedings. - Ed.)

EFFECTS OF CARBON DIOXIDE ENRICHMENT AND NITROGEN SUPPLY ON GROWTH OF BOREAL TREE SEEDLINGS

Kevin Brown and K.O. Higginbotham

SUMMARY

The effects of two levels of atmospheric carbon dioxide (350 ul 1^{-1}, 750 ul 1^{-1}) and three levels of nitrogen 15.5 mM, 1.55 mM, 0.155 mM N) on biomass accumulation and partitioning were examined in aspen *(Populus tremuloides* Michx.) and white spruce *(Picea glauca* (Moench) Voss) seedlings grown in controlled environment rooms for 100 days after germination.

Nitrogen supply had pronounced effects on biomass accumulation, height, and leaf area of both species. Root weight ratio (RWR) of white spruce was significantly increased at the lowest level of nitrogen, whereas RWR of aspen did not change much with in- creasing levels of nitrogen.

Carbon dioxide enrichment significantly increased (1) the leaf and total biomass of spruce seedlings grown in the high-N regime, (2) the RWR of seedlings in the medium-N regime, and (3) the root biomass of seedlings in the low-N regime after 100 days. Carbon dioxide enrichment of aspen temporarily increased biomass and height in all three nitrogen regimes. Root, stem, and leaf mass, height, and leaf area of aspen were increased only at the 30-day harvest in the high-N treatment and at 50 and 60 days in the low-N treatment. Height, stem biomass, and leaf biomass of aspen seedlings were significantly increased by C02 enrichment after 40 days in the medium-N treatment. These effects did not persist, possibly because of the onset of mineral nutrient supply limitations with increasing plant size. Tree Physiology 2, 223-232 (1986). 1986 Heron Publishing-Victoria, Canada

GREENHOUSE ENVIRONMENT AND EPIDEMIOLOGY OF GREY MOULD OF CONTAINER-GROWN DOUGLAS-FIR SEEDLINGS

Peterson, M.J., Sutherland, J.R., and Tuller, S.E. 1988. Greenhouse environment and epidemiology of grey mould of container-grown Douglas-fir seedlings. Can. J. For. Res. 18:974-980.

The environmental parameters associated with grey mould, *Botrytis cinerea* Fr.: Nocca & Balbis, on container-grown Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, were studied in a plastic-covered greenhouse and a fibreglass-covered greenhouse near Victoria, British Columbia. Disease losses and numbers of *B. cinerea* spores were much higher in the fibreglass-covered house, where seedlings were taller and more succulent because the fibreglass reduced light intensities. From July to October the length of time when the combination of temperature and relative humidity that favours *B. cinerea* spore germination and infection was 14.5 times greater in the fibreglass-covered than in the plastic-covered house. Conditions beneath the seedling canopy that enhance the disease were more prevalent in July and August than in the autumn when the disease becomes evident, suggesting that earlier application of preventive fungicides may benefit disease control. Grey mould inoculum originated from outside the greenhouses, but once the disease was established on the seedlings, numbers of spores within the houses exceeded those outside. Airborne spore numbers both outside and within the greenhouses were highest during the day. Numbers of spores within the houses peaked when the irrigation system was on; this is ascribed to the mechanical effect of the irrigation water on spore dispersal rather than to changes in greenhouse environmental parameters.

CHANGES IN LOBLOLLY PINE SEEDLING ROOT GROWTH POTENTIAL, DRY WEIGHT, AND DORMANCY DURING COLD STORAGE

Laura E. DeWald and Peter P. Feret

ABSTRACT

Loblolly pine *(Pinus taeda* L.) seedlings from a Virginia nursery were lifted once per month between October and February during the 1983 and 1984 lifting seasons and held in cold storage at 2"C for 3, 6, 9, and 12 weeks. Following cold storage, root growth potential (RGP) and root and shoot characteristics were compared to freshly lifted seedlings. New root growth was similar despite significant differences in dry weight and shoot activity between cold-stored and freshly lifted seedlings. Seedlings placed in cold storage prior to the accumulation of 500 chilling hours in the nursery stored poorly. Cold storage success of seedlings in the spring was variable. FOR. SCI. 34(l): 41-54.

FIELD PERFORMANCE OF DOUGLAS-FIR SEEDLINGS AFTER TREATMENT WITH FUNGICIDES

Owston, P. W., W. G. Thies, and W. Fender. 1986. Field performance of Douglas-fir seedlings after treatment with fungicides. Can. 1. For. Res. 16:1369-1371.

Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco) seedlings grown in containers with pasteurized or nonpasteurized potting mixture and treated with benomyl, captan, fenaminosulf, or ethazol, or left untreated were outplanted in the Cascade Range of western Oregon. The seedlings from all treatments appeared to have been in similar condition at time of planting, so neither nursery managers nor silviculturists would have suspected effects of the treatments to carry over to field performance. After 7 years, however, seedlings grown in pasteurized potting medium survived better than those grown in nonpasteurized medium.

Furthermore, survival of benomyl-treated seedlings in pasteurized potting mixture was higher than survival of those grown in pasteurized mixture without any fungicide treatment and survival of ethazol-treated seedlings in unpasteurized mixture was lower than those in unpasteurized mixture without fungicide treatment. There was no evidence that the nursery treatments adversely affected seedling height or mycorrhizal development.

NURSERY SEEDBED DENSITY IS DETERMINED BY SHORT-TERM OR LONG-TERM OBJECTIVES

Jon P. Caulfield, David B. South, and James N. Boyer.

ABSTRACT

Lowering nursery seedbed density can increase the proportion of high quality (grade 1 and 2) seedlings relative to cull (grade 3) seedlings. Outplanting higher grade seedlings can increase survival and volume production. Lowering seedbed density from present levels may therefore increase stand value at rotation age. The relationship between four seedbed density levels (60,90,120, and 150 seedlings/ lineal bed foot) is evaluated for slash *(Pinus elliottii* Engelm.) and loblolly *(Pinus taeda* L.) pine, and the impact of grade on growth performance is projected. An economic analysis demonstrates how to determine the present value of the expenditure justified to alter seedbed density to obtain a projected future change in outplanting performance. Potential economic gains ranging from - $4.13 to $27.58 per thousand seedlings were derived by altering seedbed density from a base-level density of 120 seedlings/lineal bed foot. Positive values were associated with decreases in density and negative values with density increases. Site quality of outplanted areas plays a major role in determining the amount of the justifiable expenditure. South. J. Appl. For. 11(l): 9-14.

USE OF MYCELIAL SLURRIES OF MYCORRHIZAL FUNGI AS INOCULUM FOR COMMERCIAL TREE SEEDLING NURSERIES

Boyle, C.D., Robertson, W.J. and Salonius, P.O. 1987.
Use of mycelial slurries of mycorrhizal fungi as inoculum for commercial tree seedling nurseries.
Can. J. For. Res. 17:1480-1487.

Blended mycelial slurries of a variety of ectomycorrhizal fungi were assessed for their suitability as inoculum for containerized tree seedlings. Mycelium of most fungi tested, with the exceptions of *Pisolithus tinctorius* (Pers.) Coker & Couch and *Paxillus involutus* (Batsch:Fr.) Fr., withstood blending well. Viability remained high after storage in modified Melin-Norkrans agar medium, water, or dilute saline at either 40C or room temperature, indicating that slurries are robust enough to tolerate conditions that would be en- countered in a commercial setting. Experiments investigating methods for applying slurries to containerized seedlings were conducted using *Hebeloma longicaudum* (Pers.: Fr.) Kummer. Slurry infectivity dropped after it was mixed into a peat-vemiculite growing medium, particularly in the presence of high levels of fertilizer. This indicated that inoculum should not be added to multipots until short roots capable of becoming mycorrhizal are present and that contact of the inoculum with fertilizer should be avoided. Injection of slurry into the root zone resulted in the most consistently high colonization, but application of the slurry to the surface of the growing medium was also effective, the latter being more feasible in a commercial setting.

Mycorrhizae developed with as little as I mg mycelium per seedling, although 100 mg gave more consistent results. In inoculation trials in which slurries of nine representative fungi were injected into the root zones of 8-week-old black spruce or jack pine seedlings, five of the fungi consistently formed mycorrhizae. For these fungi, slurries could be an effective inoculum.

Nursery Production Guide

The Nursery Production Guide for 1988-89 has been amalgamated with several other crops into the “Nursery, Greenhouse Vegetable and Ornamental 1988/89 Production Guide for Commercial Growers”. It was produced commercially and is available at an advertised cost of $9.00 from most agricultural supply companies who are members of the Crop Protection Institute of Canada.

Unfortunately, the section specific to forest seedling nursery pest control was omitted from this guide.

Therefore, this section will be produced and distributed to the growers separately again this year. Although the 1988/89 guide does not contain control recommendations specific to forest nurseries, many of the sections such as pesticide application and safety, plant protection regulations, common greenhouse pests, general production information and behaviour of herbicides would be most useful to growers.

Vented Styroblocks

The use of the new vented Styroblocks should be approached with caution and extra vigilance. In his trials on *Botrytis* levels using vented blocks, Michael Peterson forced air up through the blocks, but this air was heated for only the first 24 hours after watering. The use of underbench heating in combination with vented blocks should be monitored closely. Effects that might be anticipated include:

1. Lower humidity during germination might cause sticking of seed coats.
2. More frequent watering may be required and salinity levels may be higher.
3. Perimeter cavities may dry more rapidly in relation to interior rows.
4. Elevated soil temperatures may not be conducive to maximizing root weights

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REMEMBER:
October 16 – 19, 1989

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