TREE IMPROVEMENT

Volume 2, Number 2 October 1989

Seed and Seedling Extension Topics

Extension Services Section - Editor, Don Summers

You may have noted a change of editor with this issue of the newsletter. Well... Glenn Matthews is now managing the recently privatized Koksilah Nursery (Odin Industries Ltd.) in Duncan, B.C. Hopefully, his many new duties will still allow time for him to continue his excellent contributions to this newsletter. We wish him well in his new endeavour.

We also wish Gwen Shrimpton well in her studies at U.B.C. and welcome Dave Trotter and Eric Van Steenis to the Extension Services Section, Silviculture Branch. Dave signed on last spring as the Nursery Pesticide Officer and Eric has recently joined our staff as a Culturist. Perhaps a who's who list would be in order after the dust settles a bit.

As editor, I want to thank all those who have contributed news, articles, updates, etc., to this newsletter ... keep those cards and letters coming, folks. We have another issue due early in the New Year, so as you reflect on the last season or plan for the next, please send along a few words - everyone will appreciate it.

The latest hot news item is that Green Timbers Nursery in Surrey is slated for rejuvenation this year as an ex- tension and demonstration centre. Plans call for a demonstration nursery, educational facilities, arboreta and a new home for the Extension Services Section - including a test nursery. The facility will be operated by the B.C. Forestry Association. What better place for a demonstration site than in the middle of a megalopolis!

Grower's Notes*

Gall Aphid Control

Dormant oil, applied early in the spring before bud burst, can control gall aphids in interior spruce seed orchards. The key to success seems to be to apply the spray before the adelgids start to feed in the spring.

In the spring of 1989, we flagged sample branches having (1) naked, dormant adelgids, and (2) woolly adelgids that had started to feed. Dormant oil was applied well prior to bud burst (April 14). Subsequent assessments showed that there were virtually no galls on those branches that originally had only bare adelgids (1). Where the insects were originally covered with wool (2), dormant oil was much less effective.

The foliage on trees changed in colour from light to dark green following the spray, however, the new foliage was fine and all of the needles remained green and fresh all summer. These trees will be monitored over winter and the trial will be repeated to confirm the results.

Dormant oil is a form of mineral oil that is mixed with water for application. According to Agriculture Canada, mineral oil is registered for use on spruce against gall aphids, however, check the product label before using it.

Don Summers

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

Irrigation Tips

I thought I would pass on a technique we have been using successfully for several years. When irrigating during cloudy weather add a Spreader-Activator to the water. While I can't endorse a specific product, we have used R11 mixed at the rate of ½ pint to 26 gallons of concentrate injected at the rate of 1:100. This treatment aids in foliar drying by breaking the surface tension of the water on the leaf. **A couple notes of caution:** Do not use during germination or if sunshine is expected during the day of application (we have observed some foliar spotting and burning when this occurs).

Joseph F. Myers

Coeur d'Alene Nursery

Cymbush Registered for Control of Lygus Bugs

The synthetic pyrethroid Cymbush (cypermethrin) is now registered for control of the tarnished plant bug *(Lygus* spp.) in conifer seedling nurseries. The new Cymbush 250 E.C. label P.C.P. #19170 reads as follows:

CONIFER SEEDLINGS (Nursery):
Tarnished Plant Bug *(Lygus* spp.) - Apply 280mL
Cymbush 250 E.C./ha in sufficient water for good coverage.

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BRITISH COLUMBIA
Ministry of Forests

Maximum of 3 applications per growing season.
NOT for greenhouse use.
Do not apply using backpack sprayers.
Do not apply before stock thinning.

Gwen Shrimpton

Sowing Rules for Class A Seed

MOF sowing rules for class A seed were modified in 1988 in order to conserve expensive seed orchard seed. Apparently nursery staff are not fully aware of this change. The modifications involve a reduction in seeds per cavity from 2 to 1 for germinative capacities over 90%, and an increase in oversow factors, as follows:

Class "A"	Germ. %	Seeds/Cavity	Oversow Factor
	100-96	1	1.35
	95-93	1	1.40
	92-90	1	1.45

These rules are current but, as usual, under review.

Mike Pelchat

Mites on Western Red Cedar

Two types of mites and the damage from a third type have been observed on Western Red Cedar during cone assessments for the cone midge *(Mayetiola thujae).*

The spruce spider mite, *Oligonychus ununguis* (Jacobi) is well known in B.C. This mite feeds indiscriminately on many coniferous species, spins a web and causes yellowing of needles in hot, dry weather. Only a few mites of this type were seen on the cedar samples and only from branch beatings, not on cones.

The second mite that was observed occurred in large numbers and has been identified as belonging to the family of false spider mites. This mite feeds primarily on foliage, but can also be found feeding between the bract-scales of the cones. Unlike the spruce spider mite, which has an oval transparent abdomen and takes up the colour of the material on which it feeds, this false spider mite has a blood-red body and a white fringe around a slightly flattened abdomen. This mite is also very small and cannot be seen without a microscope. The only evidence of damage is yellowing of the foliage associated with a powdery fungal growth.

Only the damage from the third type of mite was seen. It is probably an eriophyid mite like the pine needle mite, *Trisetacus,* (described in Vol. 1 No. 1), although the damage to the cedar cones is quite different from that in pine.

The saliva from feeding causes villi-like projections to appear on the cone scales. This type of damage is known as erinea and is a type of galling. After the erinea is formed, the mites live within this growth.

Damage to cone and seed by this last mite was minor but widespread. Most of the feeding occurs at the base of the cone and around the margins of the cone scales. Seed damage results when mite feeding is heavy enough to cause a scale to shrivel. The seed on affected scales can be distinguished from other immature seed by the dark-chocolate brown colour. These dark brown seeds were seen only in association with erinea.

Sometimes damage can be seen with the naked eye. Due to the note damage, the cone appears brown and dried up at the base and, since the damage usually occurs only on one side, the cone tends to bend over and form a right angle with the stem. Erinea is always present if this damage is examined under a microscope. The period of active feeding for this particular eriophyid mite has not been determined. The cones were picked in late August and the damage was evident at this time, but the mites were gone. The type of seed damage seen suggests that the feeding occurs after the cones have developed and probably occurs during the hot weather in June and July.

Like other mite populations these three have the potential to cause extensive damage and because of their small size they can be overlooked. However, when unexplained damage does occur, especially during hot and dry weather, keep an eye out for notes. Mites are a common problem in agriculture and we should keep them in mind as well.

Bev McEntire

Styroblock Sanitation

To address the problem of root rot fungi and algae build-up on styroblocks and their carryover from season to season, *Applied Forest Science Ltd.* is conducting experiments to identify materials and methods for sanitizing container-nursery styroblocks. Testing the efficacy of various materials and techniques for sanitizing styroblocks will hopefully prolong their use for several seasons.

Fungi found on containers during initial screening confirmed earlier work (personal communication, J. Dennis, Forestry Canada) and included *Phoma, Cylindrocarpon, Fusarium and Pythium spp.*

Preliminary work required establishing a source of styroblocks and identifying the fungal species on them. Once this was done, the styroblocks were then subjected to sanitizing treatments. Each treatment consisted of 10 replicate styroblocks, from each of which 20 pieces of styroblock material were taken from the bottom and top of 20 cavities. Thus, for each treatment, 200 cavities were sampled and pieces from each placed on selective culture media enabling any surviving fungi or algae to grow. Ten days to two weeks after the styroblock pieces

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were plated, they were assessed for fungal growth. The assessment of algae survival and growth takes about 30 days.

At the end of August, an initial trial of 34 treatments subdivided by concentration or time of exposure, was completed and assessed for fungal survival.

The treatments examined to August 31, in order of increasing effectiveness, were:

Treatment Agent	Subdivision Within Treatment
Ozonated water	2 minute dip
RX44 Quaternary Ammonium	10 second dip
Ozonated water	1 minute dip
Ozonated water	3 minute dip
Borax 40 g/1	10 second dip
Ozone gas	1 minute exposure
Bleach	10 second dip in straight 0.5% solution
UV light	3 minute exposure
Control	Unwashed
Bactrex Quaternary Ammonium 450 mL/1	10 second dip
Methyl Bromide 70 cc/ 100 ft^3	24 hour exposure
Bleach	10 second dip in Tween 20 prior to 10 second dip in 0.5% solution
Microwave radiation	2 minute exposure
Control	Washed
Roccal 8 mL/1	10 second dip
Lysoquat Quaternary Annomium 4 mL/1 followed by Lysofume 8 mL/1	10 second dip
UV light	5 minute exposure
Lysofume 8 mL/1	10 second dip
Lysoquat Quaternary Ammonium 4 mL/1	10 second dip
UV light	2 minute exposure
Ivory soap	15198C 10 second dip
Bleach Styroblock	dip in glucose and incubation for 4 days followed by 10 second dip in 0.5% solution
Bleach	10 second dip in 0.5% solution buffered to pH 7
UV light	1 minute exposure
Ivory soap	30198C 10 second dip
Ivory soap	50198C 10 second dip
UV light	4 minute exposure
Demoss	15198C 10 second exposure
Ivory soap	75198C 10 second dip
Demoss	30198C 10 second dip
Demoss	50198C 10 second dip
Sodium Metabisulphite	10 second dip in 2% solution
Hydrogen Peroxid	10 second dip in 30% solution
Sodium Metabisulphite	10 second dip in 5% solution

It must be stressed that these results are preliminary and have not been subjected to any statistical analysis. However, sodium metabisulphute and the heated soaps appear to offer promise as does the UV light and buffered bleach. Further work is being done in the form of a second trial where the most promising treatments are being examined more closely. For any additional information, contact Michael Peterson, *Applied Forest Science* Ltd., Sidney, B.C.

Michael Peterson

Overwinter Protection Using Tildenet

During the winter of 1987/88 temperature was monitored on various stock treatments designed to protect overwintering seedlings at the Thornhill Nursery. Some of the more interesting results are presented here.

The test location was in one of the open compound production areas protected by windfencing. Each treatment consisted of 6 blocks of one year old interior spruce with treatments separated from one another by about 10 feet. Treatments were as follows:

1. 1C - Control I (blocks on pallet 2 ft. off ground).
2. 2C - Control 2 (blocks on ground under pallet).
3. 4T - Tildenet (netting placed over pallet with blocks on ground).

The Tildenet cover is a high density, stitched black polyethylene netting (#90 EC) which provides 90% shade. In previous tests it was found to be the best avail- able material in terms of strength, resistance to extreme weather conditions, and handling.

The monitoring equipment consisted of a Campbell Scientific Inc. 21X datalogger, thermister temperature probes and #WM680 anemometers supplied by Forest Technology Systems. One probe was suspended in a Stevenson weather screen placed on top of a pallet while others were placed in the center area of each treatment approximately halfway down the plug.

A graph of minimum temperatures summarizing data every six hours is shown on page 4. In this first cold spell of winter there was no snow cover. Ambient air temperatures reached an extreme low of -13.0ºC on January 6, 1988. The three treatments reached -13.6(IC), -10.4 (2C) and -9.6ºC (4T).

From this graph it is apparent that blocks on the ground on January I were initially 5ºC warmer than those on the pallet. Five days later the difference shrunk to 3.2ºC. Interestingly, the Tildenet cover (4T) provided a further level of protection of 0.7 - 0.8ºC over exposed blocks on the ground (2C).

The mean wind measurements during the coldest weather (not shown) were 0.8 km/hr or less under the cover compared to 8-9 km/hr at seedling height on thepallet. Maximum winds were 2.3 km/hr under cover compared to 12-14 km/hr on the pallet.

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Of particular interest is the temperature of blocks on pallets (1C). After the outbreak of arctic air on Dec. 29 there was about a 24 hour period during which time the plugs froze; then temperatures plummeted at nearly 1° per hour until midday on Dec. 30. At that point the plug temperatures were lower than air temperature minimums by up to 1° for the duration of cold spell.

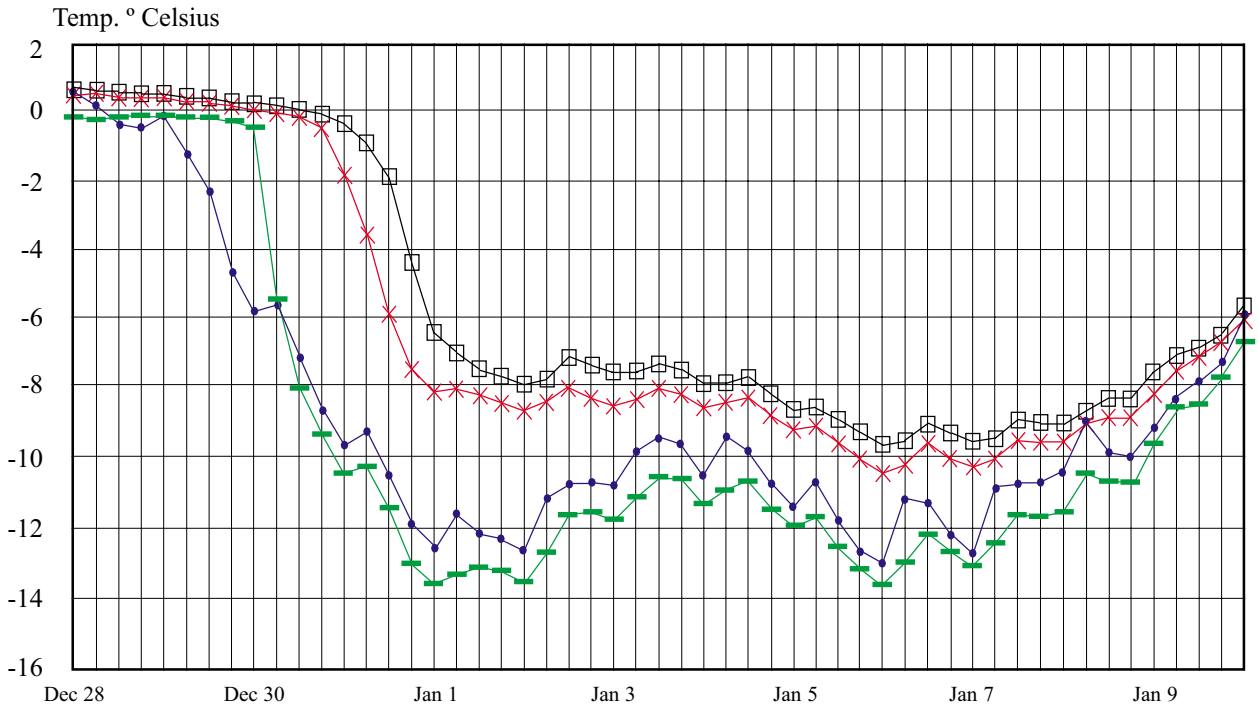
This phenomenon has been observed on other occasions at the Thornhill Nursery. It seems to be related to winds and is something other nurseries should be aware of whenever stock is left above ground during periods of cold weather risk.

All temperature and wind data relate to conditions with no protection from snow cover. Later that winter (data not shown), there was about 20 cm snowpack which gave considerably more protection to stock on the ground. For example, on February 1, 1988 air temperatures reached -16.5°C while treatments 1C, 2C and 4T were -16.5, -6.5 and -7.3°C, respectively. The best protected treatment was the blocks on the ground (2C) where the seedlings were totally covered in snow.

Seedling survival was checked the following spring and losses were reported to be negligible.

Minimum Temperatures

Thornhill Nursery - Winter 1987/88



- WS (air) = air temperature in a Stevenson weather screen located on top of a pallet at seedling height.
- 1C = plug temperature in blocks on a pallet.
- 2C = plug temperature in blocks on the ground under a pallet.
- 4T = plug temperature in blocks on the ground under a pallet covered with Tildenet.

Kim Bartlett

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Automated Seedling Extraction Line

Testing of the new prototype automated pin-extraction line has already shown substantial gains in nursery productivity.

At present, the line consists of a pre-loosening machine for loosening seedlings and a pin extractor that ejects them onto a conveyor belt.

In February 1989 the pre-loosening machine was tested at Surrey nursery on two-year old interior spruce. Almost 4,000 PSB 415 (112) blocks were successfully loosened to permit easy extraction.

Tony Willingdon, Surrey Nursery Superintendent, estimated there was a 25% savings in labour costs with this machine, not to mention the savings in worker claims for sore hands, wrists and tendonitis problems that are frequently associated with seedling extraction.

In July 1989, both the pre-loosener and the pin extraction machines were tested in operational trials during the summer lift of one and a half year old spruce at Green Timbers. Short production trials were run from 13 minutes up to I hour to evaluate the equipment and to compare nursery worker productivity between a totally manual line and the automated one.

Despite a wide range of liverwort infestation which complicated the extraction process, production gains of 4 to 62% (mean 33%) per nursery worker were measured with the automated line. The best gains occurred with fairly large stock and low incidence of liver-worts while the lowest improvements occurred with smaller stock and lots of liverworts.

Comments from workers on the automated line were favourable. Even though seedlings were not always pushed out individually (seedlings with heavy liver- worts came out in clumps due to root growth from cavity to cavity), they were easily lifted off the sorting belt for grading and counting. In some of the tests the pressure of a continuous seedling supply seemed to en- courage productivity in order to keep up with the seedling flow.

Pre-loosening is the key to successful extraction. The variable root pressures required to extract individual seedlings without pre-loosening resulted in them drop- ping onto the belt in different positions. This complicated further handling.

Two year old stock in particular, requires pre-loosening in 4 stages, i.e., lifting no more than one quarter of the cavities at a time in order to prevent breaking blocks. Less root bound stock can be loosened in two or possibly one lift.

After passing through the pre-loosener the blocks are turned on edge and fed into the extractor. Before ejection, each row on the block is centered automatically using “centering cones”. This step is essential due to minimal clearances between the pins and drainholes. Once in position, the rows are ejected at a rate of up to one per second, equivalent to 16 cavities per second for PSB 313 (160) blocks.

Maximum production speed during July tests were one block in 15 seconds - equivalent to just over 10 cavities/second for a PSB 313 (160). Improvements to the block indexing and in-feed setup could increase this rate by another 20%.

Some nursery growers have expressed concern over the potential for root damage through pin-extraction. Our experience from tests last winter indicates that despite some root plug distortion, root growth is unaffected. In fact, spreading the root mass apart on root bound plugs may have some positive effect on root growth after planting.

Another concern is the potential spread of root disease between crops. We believe that proper monitoring and sanitation practices will make this equipment no more of a liability than the extraction belts and tables in current use.

Development of this equipment is only part of a totally automated seedling extraction line. Requests for proposals have now been advertised for an “Automated Seedling Grading System” and an “Automated Seedling Wrapping Machine”. We are hopeful that by October we will be working with two companies to develop this additional equipment.

Based upon the recent testing, work is now under- way to further upgrade both the pre-loosener and pin extraction machines in time for the winter lift. The consulting firm of Sandwell Swan Wooster Inc. has been retained to provide engineering services for the upgrading and integration of new components to the extraction line.

We are in the process of filing a patent application for the new equipment. It is anticipated that the new extraction line equipment will be built under license by one manufacturer who will then be able to market and sell it throughout the industry.

Kim Bartlett

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Tech Talk

Use of Fog Misting to Reduce Water Loss from Container-Grown Seedlings

ABSTRACT.

Repeated, short duration misting of Engelmann spruce and interior Douglas-fir during hot weather can be used to reduce water loss by up to 36% from styroblock containers. When applied properly, misting does not increase the risk of foliar disease.

High summer temperatures in the southern Interior of British Columbia necessitate frequent watering of container-grown conifer crops. Repeated saturation watering may result in poor aeration and inadequate oxygen supply in the root zone. Indications of poor root system aeration are not uncommon in southern Interior nurseries. Varying degrees of root swelling ("water roots"), root lenticel swelling, apical foliage spiralling and suppression of feeder root development have been noted (G. Hunt, unpublished data). Growth of mycorrhizal fungi in container root plugs, whether inoculated intentionally or naturally, is strongly inhibited by inadequate oxygen supply. These fungi are important to vigorous development of feeder roots by virtue of hormones they produce which substantially increase root branching. The objective of this study was to determine if misting can be used to reduce the rate of water loss from containers.

Short duration applications of fine-droplet water mist were applied at frequencies of 20 or 30 minutes to container-grown Engelmann spruce and interior Douglas-fir when maximum daily temperature exceeded 30ºC. Water loss based on container weight changes was recorded.

Analysis of data within each misting frequency (Table 1) showed that weight loss among misting treatments in spruce did not differ at a misting frequency of 30 minutes. Average loss of misted Douglas-fir was greater compared to nonmisted trees during the 30 minute frequency period. Water loss from misted containers, relative to nonmisted, was highly significant at the 20 minute frequency for both species. Figure 1 shows an example of weight loss over two days comparing misted and nonmisted spruce.

Temperature affects the rate of transpiration and was likely a major factor influencing water loss in this study. A temperature of 30º was established arbitrarily as the minimum for applying mist. This ensured rapid evaporation of mist droplets from needles and minimized risk of moisture induced disease. Thirty-year records for Kamloops indicate an average of 29 days annually when maximum daily temperature is greater than or equal to 30º. Last summer (1988) was near normal with 32 days in this temperature range.

Comparison of maximum daily air temperature with water loss showed no significant correlation. Although more data may have revealed a relationship, it is likely that other factors influencing transpiration would preclude using temperature to predict water loss. Light level, humidity, air currents, and available soil water interact with air temperature to determine transpiration rate.

Average weight loss of nonmisted Engelmann spruce was greater than misted trees regardless of the misting frequency (Table 1). The difference was significant, how- ever, only for the 20 minute misting frequency. This suggests that longer exposure to moisture with alternating dry periods decreased stomatal opening and suppressed transpiration. Greater weight loss of misted Douglas-fir suggests that the degree of stomatal opening and transpiration were increased by misting every 30 minutes. For both tree species, transpiration was clearly inhibited by misting every 20 minutes.

Table 1 indicates that misting can either increase or decrease transpiration. The ultimate driving force responsible for transpiration is the vapour pressure gradient between the interior and exterior of the needle. This gradient is determined by a combination of canopy microclimate factors (see above). Without measurement of these factors, definitive explanations of water loss recorded in this study cannot be made.

No visible signs of disease appeared in either misted or nonmisted trees. Because mist droplets were allowed to completely evaporate before the next mist application, there is no reason to suspect that canopy fungal disease would increase, even if misting were carried out for a month or longer. It is critical that careful attention be given to proper application of mist. Penetration into the canopy must be limited to the upper two-thirds to three- quarters to allow complete evaporation prior to the next misting pass. Droplets must not drip into the canopy base or growing medium. *Botrytis* is the only notable foliar disease at the BCRC nursery. It generally starts growth at the canopy base late in the growing season as day length shortens, air temperature decreases, and dew

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settles on the shoots. The development of this disease is not concurrent with "sting during hot weather.

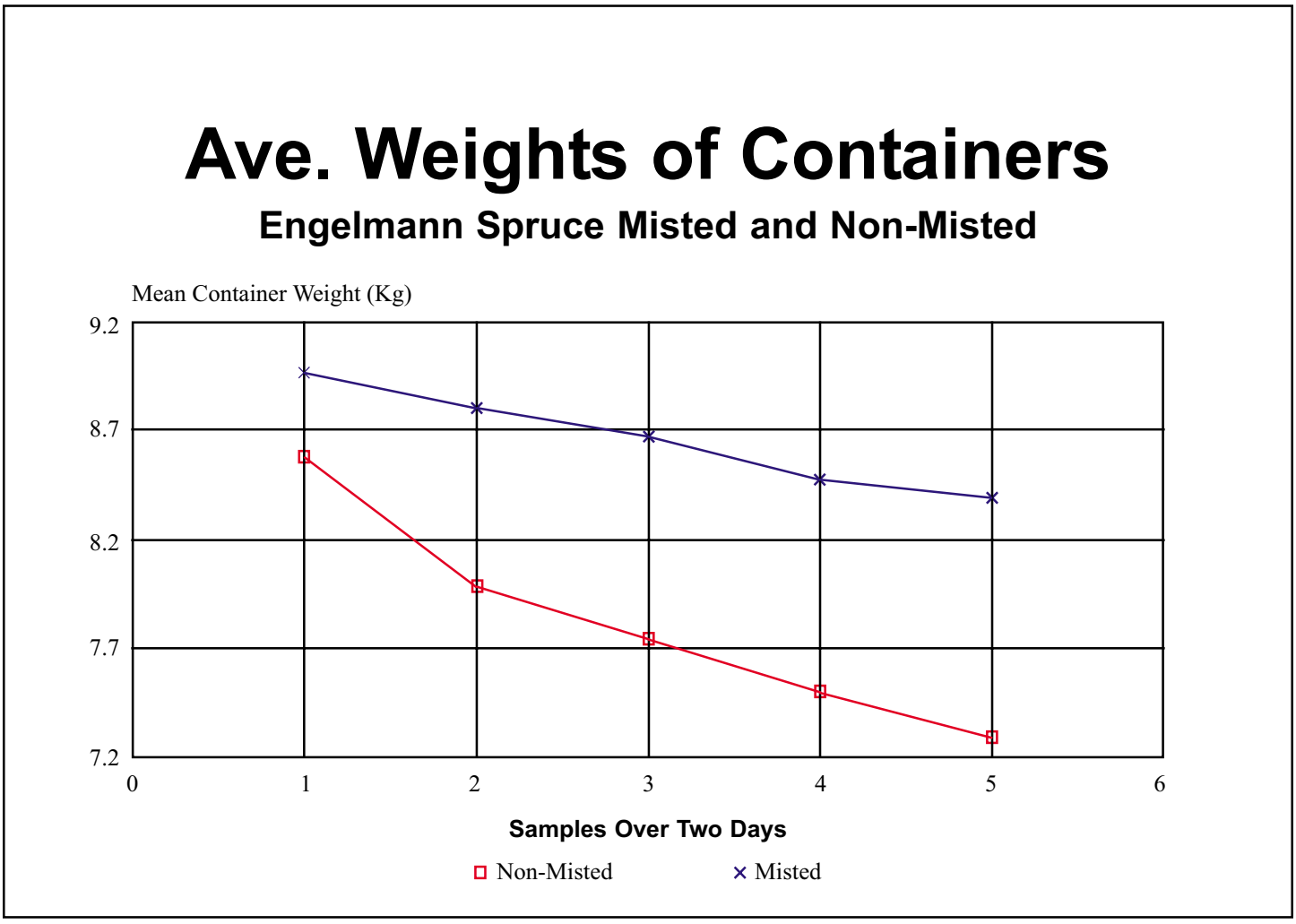
With demonstration that water loss is affected by misting it would be desirable to gather additional information in succeeding studies. Data on effects of misting on canopy temperature and humidity would help explain reasons for difference in water loss recorded in this study. In addition, measurement of needle conductance would indicate the effect of misting on stomatal function.

Table I

An average weight loss of containers for misted and nonmisted Engelmann spruce and Douglas-fir at two misting frequencies.

	Misting Frequency	Mean Hourly Weight Loss (g)		
Tree	(minutes)	Misted	Nonmisted	P
Spruce	30	178	194	0.470
	20	65	88	0.004
Douglas-fir	30	101	83	0.060
	20	92	143	0.000

Figure 1



Gary Hunt

Sporotrichosis

Over the past few issues of Western Forest Nursery Notes, Tom Landis has written a series of articles on sporotrichosis. As this information may be of interest to nurserymen in B.C. it has been abstracted with Tom's permission.

Sporotrichosis is a skin disease caused by the fungus *Sporothrix schenckii* that usually affects hands and arms. Infection of the skin may occur through cuts, abrasions or puncture wounds. After several weeks, small painless skin blisters may develop that are persistent and fail to respond to normal therapy. These lesions may turn into a firm moveable subcutaneous nodule, and skin colour often becomes pink or purplish. If left untreated the disease can spread through the lymph system causing glands in the elbow or armpit to become swollen and sore.

Sporotrichosis is not a serious disease if promptly diagnosed and treated. The problem is that many physicians are unfamiliar with the disease and may misdiagnose it. The lesions symptomatic of sporotrichosis skin infections do not respond to standard antibiotics or surgical drainage, but can be cured with orally administered potassium iodide. Although cheap and effective, this treatment may cause stomach disorders in some people. Treatment must be continued for several months, or until all symptoms have disappeared.

Recently, a diagnostic service for sporotrichosis has been established in the United States through Dr. Michael W. Rytel at the Medical College of Wisconsin in Milwaukee. The laboratory will analyze blood serum samples for $35.00 and can provide patient information sheets and mailing containers. If desired, the results can be confidentially reported to a personal physician. For more information on this service, contact:

Dr. Michael W. Rytel
Department of Medicine
Division of Infectious Diseases
8700 West Wisconsin Ave.
Milwaukee, WI 52336
Phone (414) 257-6151

S. schenckii can be found on many different organic materials such as nursery soil, flowers, shrubs and lumber, but it is most commonly found in peat moss. The fungus appears to develop after the moss has been processed. It has never been isolated directly from a peat bog, and workers who harvest peat in bogs do not contact the disease. The fungus stays dormant in peat moss until it has been wetted for an extended period of time and storage of moss under warm moist conditions allows the fungus to proliferate.

Apparently, this fungus is most common in peat moss from the Lake States, especially the state of Wisconsin. Peat moss from Wisconsin has caused disease problems in other geographical areas. Epidemics of sporotrichosis have been documented in several states including Mississippi, Florida, Vermont and Oregon, although clinical cases are relatively uncommon considering the number of people that are regularly exposed to sphagnum moss.

Sporotrichosis is not a frequent problem in forest nursery workers. There have been a few cases at bareroot nurseries in the past, but it doesn't seem to be a serious problem at the present time. Further, the disease can be traced to seedlings from relatively few nurseries and the nurseries in question all used peat moss from Wisconsin. Interestingly, no case of sporotrichosis has been confirmed from a container nursery to date, even though peat moss based media is routinely handled. Most cases of the disease have come from people who handle seedlings during tree planting activities especially when the seedling roots have been wrapped in peat moss.

Although it is highly unlikely that reforestation nursery workers in B.C. would become infected with sporotrichosis, it is important to be aware of the existence of the disease and report any suspicious skin infections as soon as detected. If any cases are positively identified, the recommended control procedures include wearing protective gloves and clothing, and disinfecting wounds and work areas.

Gwen Shrimpton

Tissue Analysis

The monitoring of tissue nutrient levels is essential for determining the overall effect of nutrition and environment, and as a diagnostic tool which can be used to prevent and correct nutritional imbalances. Tissue analysis can also be used as part of an overall cropping strategy in which nutrients are maintained within predetermined levels to optimize growth relationships.

The interpretation of tissue analysis results requires consideration of species, stage of development, environmental conditions and former analyses from the nursery. A few examples of reasons to modify expectations are as follows:

- There are differences in species abilities to obtain some or all nutrients; e.g., western red cedar is very efficient in obtaining almost all nutrients from relatively low source levels. The relative growth rates of species seem to reflect their efficiency in obtaining nutrients, especially nitrogen. Depending on other factors, especially temperature and with no other nutrients limiting, w. red cedar can be grown optimally at about 15 ppm N, coastal Douglas-fir and Sitka spruce at 60-75, interior spruce and Douglas-fir 75-100, and slow growing *Abies amabilis* and A. *lasiocarpa* 125-200. Lodgepole pine has probably one of the most temperature dependent responses. Grown outside, N levels of 125 ppm may be required, but in a greenhouse the heat units also promote height development and N levels of 75 ppm might be more appropriate.
- It is difficult to obtain target levels of calcium in Douglas-fir until after bud set. Nurseries with high Ca levels in the water source (65 ppm+) get better results than low Ca water sources, even with additional calcium nitrate. Tissue levels of calcium and most trace elements will be lowest during the most active growth period and will increase after bud set. Some like manganese and boron can then become quite high. Nutrient strategies for trace elements should anticipate the use of lower rates after bud set.
- Douglas-fir is very efficient in obtaining phosphorous, i.e.; levels in tissue will be higher than in other species given identical feeding rates.
- Lodgepole pine may show increasing zinc levels after mid-summer.
- The interior spruces and Sitka spruce are poor at obtaining copper. Readings for these species will usually be at the low end of the range.
- Manganese levels will increase in the spruces late in the growing season and continue to be high in year 2, especially if soil pH is low (4-5). This can result in a ring of golden tipped needles close to the apical bud in both container and bare-root crops.
- High soil pH can result in lime induced iron chlorosis in interior and coastal Douglas-fir and lodgepole pine. Under these conditions tissue levels of iron will appear to be normal and adequate. TMs is a basic problem with total iron analysis in that it will show in the analysis but it can be in a form the plant cannot metabolize, hence the chlorosis. Perhaps analysis for “active” iron would be a better diagnostic tool.
- Low soil temperatures can inhibit the uptake of phosphorous, and possibly potassium.
- It is suspected that potassium can be leached directly from foliage under conditions of heavy rain.
- Some nutrients like calcium and boron are taken up and moved through the plant in the transportation flow. If conditions are hot enough to close the stomata, or if water stress conditions exist, or if humidity is high enough to block egress of water from the tissue to the atmosphere, then the uptake of these nutrients may be greatly suppressed. This may explain why there is sometimes no tissue level in- crease when nutrients are theoretically being supplied at adequate levels.
- Nutritional imbalances can result in chlorosis in lodgepole pine caused by overwatering. The relation- ship is not understood but the only cure seems to come from warmer temperatures and presumably in- creased soil aeration and transpirational flow.
- Some elements like calcium and boron are immobile within the plant tissues, therefore deficiencies usually affect new growth or buds. A crop might show classic deficiency symptoms for calcium (dark green, hard older needles, stunted apical needles with dead or inactive meristem tissues, and black roots) and yet if the whole seedling were analyzed it may show adequate calcium levels. To confirm diagnoses in these cases it would be necessary to analyze tissue near the growing tips only. The opposite situation can occur with manganese when golden tipped apical spruce needles might suggest manganese toxicity. An analysis of the whole plant might show normal levels, but very high Mn levels would be evident if only the upper needles were analyzed. Mobile elements within the plant include nitrogen, phosphorous, potassium, manganese and molybdenum, with magnesium being mobile or intermediate. Other intermediate elements are copper, zinc and iron. Calcium, boron and sulfur must be regarded as immobile within plant tissues.
- For convenience sake, the target and ranges established for tissue nutrient levels presented in the first newsletter are repeated here. The 0.15% minimum listed for sulfur may be optimistic for a large part of the growing season. These guidelines are the distillation of a large information base, but are based mainly on the methodology of one laboratory.

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Element		Target %	Range %
N	Nitrogen	2.0	1.5 - 3.5
P	Phosphorous	0.25	0.2 - 0.4
K	Potassium	1.0	0.8 - 2.0
Ca	Calcium	0.35	0.2 - 1.0
Mg	Magnesium	0.15	0.12 - 0.30
S	Sulphur	10% of N level	0.15 minimum

		ppm	ppm
Fe	Iron	100	80 - 600
Cu	Copper	8	4 - 20
Zn	Zinc	30	25 - 80
Mn	Manganese	100	80 and up
B	Boron	30	20 - 50

Glenn Matthews

Small Fly Populations In Greenhouses

Many conifer seedling nurseries in B.C., especially older established greenhouse facilities, can have large populations of small dark coloured flies. In 1980 and 1981, due to concerns from several nurserymen, a survey for larvae in the seedling plugs, and adults in the greenhouses was conducted at 7 nurseries located across the province. The results of the survey appear below.

Families of small flies collected in container facilities.

Agromyzidae
Anthomyiidae
Cecidomyiidae
Chironomidae
Dolichopodidae
Empididae
Ephydridae
Muscidae
Psychodidae
Sciaridae
Sphaeroceridae

Eleven different families were identified and of these the shore flies family Ephydridae were the most common, followed by the dark winged fungus gnats, family Sciaridae.

The adults of shore flies are found in moist places such as marshes, the shores of ponds and streams and the sea shore where they often occur in large numbers. The larvae are aquatic and many species occur in brackish or even strongly saline water, and some live in mud. In conifer seedling nurseries large populations can leave noticeable green fly specks (excretions) on the styroblocks. These are particularly evident around plugs containing a lot of algae. The larvae breed harmlessly in moist places on the floors of the facilities, or in algae on pots, benches, walls and floors. There is some evidence that adults of both shore flies and fungus gnats can mechanically vector spores of plant pathogens. How- ever, populations of shore flies are mainly a problem be- cause of their nuisance value.

The dark winged fungus gnats are potential pests of conifer seedlings. The adults generally occur in moist shady places and are fairly common. The larvae of most species live on fungi, and some occasionally become pests in mushroom cellars. The larvae of *Bradysia spp* which have been frequently collected on the nurseries are common in plant pots and will feed on plant roots. Since the introduction of a number of different artificial growing media such as peat and composted hardwood bark, fungus gnats have become problems in several different horticultural crops.

Adult flies feed on decaying organic matter and algae. They can often be seen resting on the surface of the growing media and appear to be attracted to moist media, especially media that contain peat moss to lay their eggs.

In conifer seedling nurseries fungus gnat larvae infest container plugs, preferring to feed on the upper roots consuming the root hairs and small rootlets of most conifer species. In heavy infestations they will strip the main roots leaving only the vascular tissue, and will sometimes girdle the sterns just below soil line. Seedling wilt and sudden loss of vigour results. However, infestations of fungus gnats are not common, and the seedlings attacked have usually been predisposed, often by an infection of *Fusarium.* Once the seedlings are well established and vigorously growing, these insects are generally not pests.

Populations of these small flies can be monitored using yellow coloured sticky traps. Yellow is a colour that attracts many insects including aphids, shore flies, fungus gnats, thrips and whiteflies. The more intense the yellow the better. Some growers request that greenhouse personnel avoid yellow clothing because it can attract outdoor insects into greenhouses. Red and darker colours will not attract pests to workers' clothing.

These traps can take many forms. In B.C. they are available commercially through biological control companies such as:

Applied Bio-Nomics Ltd.
P.O. Box 2637
Sidney, B.C.
Phone: 656-2123

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They can also be homemade by draping and stapling a yellow ribbon around a wooden stick and soaking it in heavy motor oil, or by smearing both sides of plastic picnic plates (solo brand) with vaseline petroleum jelly and suspending them in the greenhouse with wire. These traps can be used to monitor populations of flies present and determine whether they are the innocuous shore flies or potentially damaging fungus gnats. These two families can be distinguished using the characteristics listed in the table below.

Characteristics used to differentiate shore flies and fungus gnats

	Shore Flies	Fungus Gnats
Family	Ephydridae	Sciaridae
Body	Size and shape of fruit flies	Resemble tiny mosquitoes
Size	2 - 4 mm	2 - 4 mm
Wings	Have pale spots	Grey with "Y" shaped vein
Antennae	Short with a bristle	Long bead-like
Flight	Tend not to fly but are strong fliers when they do	Easily excited into flight but are poor fliers
Larvae	Maggots have no distinct head	Maggots are slender with dark shiny heads

In order to monitor fly populations, yaps should be placed at approximately one per 900 m^2 in the greenhouse. With a density of one every 1 m^2 they can also be used to actually reduce the number of flies present.

Fungus gnats can be difficult to control because they have overlapping generations. They complete their life cycles in about 3 weeks so populations can build up rapidly under favorable conditions. Keeping a clean, neat, weedless greenhouse is the first step in managing both fungus gnats and shore flies. Because these insects thrive in moist areas, there should be good drainage under the greenhouse and overwatering and collection of water in low places should be avoided. Eliminating weeds and algae both inside and outside the green- house is a good practice. A slurry of 0.7 kg of hydrated lime per 4 litres of water or 0.5 kg of copper sulphate per 4 litres of water under the benches should control both weeds and algae for up to three months. However, both these mixtures can be damaging to heating or water pipes.

After the stock has been lifted, the styroblocks should be washed and greenhouses cleaned out well. Good cultural practices that produce vigorous healthy stock and proper irrigation to avoid overwatering will make the seedlings less attractive to fungus gnats. If larvae be- come established in the seedling plugs and damage is evident, a drench of Diazinon 50 WP at 100-150g/100 L is recommended. Larvae are legless, semitransparent, milky white worms with black heads that range up to 0.5 cm in length.

Gwen Shrimpton

Cone Induction In Coastal Seed Orchards

Over the last 10 years, the use of cone induction in Coastal Seed Orchards has changed as our objectives shifted and as new information became available from research.

Our present objectives are to produce crops annually from orchards over 9 years old, and to improve the clonal balance of these crops. Fortunately these two objectives are compatible as we have found that larger crops will involve pollen and cone production from a large proportion of the clones.

Prescriptions for cone induction vary with species, site conditions and orchard age, but usually include more than one of the available cone induction techniques.

Moisture stress continues to be the base for cone induction, but is limited by the climate and soil type of the orchard. At Dewdney, soil mounding has been effective at overcoming the poor drainage to provide moisture stress.

High Nitrogen fertilizers (400 kg N/ha) applied just at vegetative budburst are used in most of our orchards, either on individual trees or broadcast on whole sectors.

Root pruning was used in the Campbell River orchards where moisture stressing is difficult because of the high rainfall. This method proved to be hard on the equipment and has been replaced by girdling.

Girdling with a pruning saw is used in many orchards as it appears to intensify the action of other induction techniques and improves pollen production in Douglas-fir.

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Gibberellic Acid, either as a foliar spray or injected directly into the stem, produces dramatic increases in cone production in several species. GA is used operationally in Hw, Fdc and Cwr to promote early cone production and to push non-productive trees into production.

Treatment schedules may vary, but an individual tree is treated no more than every 2 years. The highly stressful treatments (GA and girdling) are not applied to small or sick trees or trees carrying a cone crop.

Usually orchards are divided in half with induction alternating annually between the two halves. In addition to the moisture stress applied throughout the induction sector, individual trees which have not produced cones in the past 2 years receive high N fertilizer, girdling and/or GA.

After the cone buds have been initiated (around July for all species but cedar), trees are provided with optimal nutrients and water to produce the largest, healthiest cones.

Up to 1988, 1.5 Tonnes of Douglas-fir seed has been produced from orchards. Using the above techniques, it appears that our Fdc, Hw and Se orchards will surpass their expected targets.

Joy Parkinson

Cone Induction In Interior Spruce Seed Orchards

Preliminary results indicate that simple withholding of irrigation can induce dramatic increases in cone production in interior spruce orchards at Kalamalka

The trial involved approximately 560 trees of an or- chard established in 1981. Drip irrigation lines were not turned on until mid-July in alternate rows vs. control rows where irrigation began on April 14. In the spring of 1988 cone production was estimated on a per tree basis: Trees receiving the drought treatment were over three times more likely to carry significant cone crops than control trees.

During cone collection this year, cones will be counted by tree and the data analyzed. However, on the strength of this spring's results, the withholding of irrigation as a cone induction treatment has been extended to two other spruce orchards at Kalamalka. At this point, the plan is to treat one half of an orchard at a time, reversing treatment and control areas each year. Smaller trees within drought rows will receive water. The end of the withholding period will be timed to coincide with the reaching of 95% elongation by the growing shoots.

It remains to be seen how well this will work in years of wet weather or at less dry sites. Having a drip irrigation system and the ability to turn water on and off individual trees allows for the flexibility needed. An additional benefit of the drought treatment has been that the treated trees showed reduced height growth (by 33%), thereby reducing cone collection costs in the long run.

Chris Walsh

Current Projects

Fusarium on Douglas-fir Seeds

Damping off is an important problem in container stock in conifer seedling nurseries. Seed-borne inoculum may be the cause of these phenomena or of later root disease by *Fusarium* species. In cooperation with the Seed Centre, Pacific Forestry Centre and B.C. Research, an extensive trial is being conducted to evaluate the efficacy and toxicity of seed cleaning treatments to reduce levels of seed-borne *Fusarium* on Douglas-fir. The treatments involve ethanol, bleach and running water in combination with standing and running water imbibition.

Dave Trotter

Ridomil Fungicide Trial

Root rots, particularly *Pythium* and *Phytophora* have increasingly become a problem in container and bareroot stock in B.C. Ridomil is used extensively in U.S. conifer seedling nurseries to control these pathogens. A large trial is being conducted at 5 conifer nurseries in B.C. to assess the efficacy and phyotoxicity of the fungicide on a variety of conifer species and stock types. Data from this trial will be submitted to support a registration for use in conifer seedling nurseries.

Dave Trotter

Cobra Herbicide Trial

A pesticide trial with the herbicide Cobra (lactofen) is being conducted at Surrey Nursery. The trial is to evaluate the performance of pre-emergence applications of lactofen for plant tolerance and weed control in 1+0 bareroot Douglas-fir and Lodgepole pine.

Dave Trotter

Bird Damage Assessments In Seed Orchards

Red crossbills *(Loxia curvirostra)* are migrant finches that travel in small flocks and cat conifer seed. Periodically these birds have caused significant losses in seed orchards. They feed by picking cones off the tree and extracting individual seeds. Not all of the seeds in each cone are eaten and an individual bird may pick several cones before moving on.

Through the University of Victoria co-op student program, Industry seed orchards and Silviculture Branch hired Wayne Osborne to do a problem analysis and some field work to investigate the problem. Wayne's report should be available in the fall of 1989.

Other pest projects include: efficacy tests for. Metasystox-R* (sprays and tree injections) on spruce against cone and seed insects and for Bayleton on spruce against spruce cone rust; damage prediction studies for red cedar cone midge and spruce gall aphids, disease surveys for *Rhabdocline* and Swiss needlecast on Douglas-fir and for stem rusts on Lodgepole pine.

Don Summers, Bev McEntire

* Mention of commercial products does not constitute an endorsement by the Ministry of Forests

Seed Administration

The following outlines some of the current activities of the Seed Administration and Planning Section of Extension Services, Silviculture Branch:

1. Seed Transfer Guidelines
   The Interior Seed Transfer Guidelines have been reviewed and modified. A comprehensive pamphlet outlining seed transfer from natural stands, superior provenances, and seed orchards is now available from Silviculture Branch, 3rd Floor - 31 Bastion Square, Victoria, B.C., V8W3E7. The Coastal Seed Transfer Guidelines are currently under review. Upon completion of the review process a pamphlet will be released.

2. A Guide to Collecting Cones of B.C. Conifers
   This FRDA Report (055) is available from Crown Publications Inc., 546Yates Street, Victoria, B.C., V8W IK8 (386-4636) at a cost of $20. This document is a must for anyone involved in cone collecting.

3. Tree Improvement in B.C.
   This document outlines the B.C. Tree Improvement Program. This FRDA report is available from Forestry Canada, 506 West Burnside Road, Victoria, B.C. V8Z IM5.

4. Cone Collections - Natural Stands
   The 1988 Cone Collection resulted in 10,000 hectolitres of cones being collected provincially. Reports from the regions indicated that the 1989 cone crop will be considerably smaller.

5. Seed Orchard Agreements
   Coastal and Interior Seed Orchards Agreements are in the process of being renegotiated. The Province, City of Vernon and the Vernon Seed Orchard Company (Northwood, Weldwood, West Fraser and the Pas Lumber) entered into an agreement pertaining to the development of a 78 hectare seed orchard facility. 66.7hectares of advanced generation lodgepole pine, interior spruce, and interior Douglas-fir orchards will be developed. In the spring of 1990, the first orchards of spruce will be planted.

6. Bowser is Best!
   A coastal task force evaluating second generation orchard sites have identified Bowser, a small town on Vancouver Island, north of Qualicum Beach and south of Courtenay, as a superb location for second generation seed orchards.

7. Greenhouse effect
   Our Provincial seed transfer program encourages seed movement northward as well as upward so if there is a warming trend, we will not be too badly off.

8. White Pine
   A stand of white pine on Texada Island is believed to be exhibiting some rust resistance characteristics. This area has been reserved as a seed production area.

9. Tree Seed Register and Inventory System (TSR)
   Based on input from system users, a new release of the TSR is now available which provides detailed information on all seedlots registered with the Ministry. Enhancements include the addition of new fields (e.g., latitude/longitude, forest district) and new provisions for multi-agency collections, superior provenance seedlots and surplus seedlots. Omissions and errors in the database have also been corrected. TSR reports can be obtained at Regional Offices and will soon be available at District Offices also.

10. Cone Analysis Service
    A cone analysis service was, for the first time this year, offered to all cooperative orchard managers with a producing

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orchard. Response has been positive and cones from about fifteen orchards (six different species) will be examined. The information generated will be used to quantify seed production levels, determine when and why seed losses occur and monitor the effectiveness of pest control measures.

Paul Birzins, Cam Sailram, Leslie McAuley

LITERATURE REVIEW

DISEASES AND INSECTS IN BRITISH COLUMBIA FOREST SEEDLING NURSERIES

J.R. Sutherland, G.M. Shrimpton, and R.N. Sturrock 1989. FROA Report No. 065. Victoria, B.C.: Forestry Canada British Columbia Ministry of Forests. 85 p.

This report is a revision of "Diseases and insect pests in British Columbia forest nurseries"(1980). It contains numerous colour photographs, and colour-coded keys which make pest identification much easier. Other notable additions include diagrams of life histories, and expansion of the insect pest section. Because many nursery pests seemingly ignore regional boundaries, nursery managers from all geographic regions will find this publication useful.

COLLEMBOLA IN FOREST NURSERIES OF BRITISH COLUMBIA WITH NOTES ON SPECIES OF ECONOMIC IMPORTANCE

Valin G. Marshall, Gwen M. Shrimpton, and Jeffrey P. Battigelli

A survey of 24 forest nurseries in British Columbia yielded 22 collembolan taxa, half of which is reported for the first time for the province. The species most frequently encountered was *Sminthurinus quadrimaculatus.* Only one of the species collected, *Bourletiella hortensis is* a recognized pest of conifer seedlings. The presence of the predatory collembolan, *Isotoma viridis,* and of predacous actinedid notes suggest that pest collembola species might be controlled naturally by these predators and that only under exceptionally high collembolan populations would artificial control measures be necessarily.

EFFECT OF DIFFERENT INBREEDING LEVELS ON FILLED SEED PRODUCTION IN DOUGLAS-FIR

J.H. Woods and J. C. Heaman 1989. Can. J. For. Res. 19:54-59.

Matings of Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco) were performed to develop inbreeding levels with inbreeding coefficient (F) values from 0.0 to 0.75. A strong inverse linear relationship was found between filled seed per cone and F at values lesser than or equal to 0.5. The following mean filled seed per cone values were obtained: outcross (F = 0.0), 31.6; half-sib cross (F = 0.1 25), 21.3; full-sib cross (F = 0.25), 16.7; parent-off- spring backcross (F = 0.25), 15.5; self (F = 0.5), 1.2; second generation self (F = 0.75), 0.03. Parental effects on filled seed per cone were large, accounting for about 50% of the total variation. The use of related clones in a seed orchard will result in less inbred seed than expected under total panmixia, owing to decreased filled seed production at all inbred levels. Also, breeding programs will require increased effort to obtain seed when mating designs include crosses between related trees.

APPLICATION OF PORTABLE DATA RECORDERS IN NURSERY MANAGEMENT AND RESEARCH

W.J. Rietveld and Russell A. Ryker Tree Planters' Notes 40:3-10; 1989

A portable data recorder is a specialized electronic device for recording and storing data in the field, then transmitting the data directly to a computer, thus eliminating the time and errors associated with manual data transcription. Use of a data recorder allows errors and completeness to be checked in the field, data to be collected directly from instruments, and turnaround time between collection and completed analysis of data to be kept to **a** minimum. Considerations for selecting a data recorder to meet individual needs, and some of the drawbacks of these instruments are discussed. Specific applications in nursery management and research are presented.

ESTIMATION OF SEED ORCHARD EFFICIENCIES BY MEANS OF MULTISTAGE VARIABLE PROBABILITY SAMPLING

(continued...)

C. Bartram and G. Miller 1988. Can. J. For. Res. 18:1397-1404

This paper describes two frameworks for developing effective multistage variable probability sampling methods to estimate seed orchard efficiencies. In both cases a standard multistage approach is implemented initially in multiple orchards and years. The effectiveness of this approach is then evaluated against several alternative methods, using the initial efficiency data collected, and subsequent survey procedures are prescribed on the basis of this analysis. An example illustrating the application of this methodology in coastal Douglas-fir *(Pseudotsuga mesa* (Mirb.) Franco) seed orchards in British Columbia is presented.

EFFECTS OF ROOT SEVERING TREATMENTS ON LOBLOLLY PINE

W. C. Carlson, C.A. Harrington, P. Farnum, and S.W. Hallgren 1988. Can. J. For. Res. 18:1376-1385

Six-year-old loblolly pine seedlings were subjected to root severing treatments varying from 0 to 100% of first-order lateral roots. Separate treatments severed surface-oriented or deep-oriented roots. Plant water status was monitored periodically for several months. After all measurements were taken, gross root system structure was determined by excavation. Treatment responses were evident on all dates of measurement. Relationships between percentage of root system cut and leaf conductance or water potential were stronger when surface-oriented roots were cut than when deep-oriented roots were cut. Severing surface-oriented first-order lateral (SOFOL) roots probably resulted in greater impact on plant water status than severing deep-oriented first- order lateral (DOFOL) roots because (1) SOFOL roots had both surface-oriented and deep-oriented second-order lateral roots that could tap both surface and subsurface soil horizons for soil moisture, and (2) the deep-oriented second-order roots (originating from the SOFOL roots) were spatially distributed over a much larger area than the DOFOL roots and thus would have access to soil water in a larger volume of soil. For SOFOL roots the relationship between percentage cut and leaf conductance or transpiration was strongly negative; for DOFOL roots, no relationship between these variables was observed. Initially water potential decreased with the percentage of roots cut in both groups; in later measurements, water potential was affected more by severing SOFOL than DOFOL roots. Calculation of soil moisture depletion by depth indicated that both surface- and deep-oriented second-order lateral roots were important for water uptake. Severing SOFOL roots significantly decreased nitrogen, phosphorus, and potassium levels in needles of the first growth flush of the year. Levels of these elements in terminal buds were not affected by severing SOFOL roots, but were significantly reduced by severing DOFOL roots. Secondary xylem production was reduced proportionately to the amount of root system cross-sectional area severed.

DEVELOPMENT TIMES OF THE PACIFIC SPIDER MITE (ACARI: TETRANYCHIDAE) ON WATER-STRESSED ALMOND TREES

David H. 01, John P. Sanderson, Roger R. Youngman, and Martin M. Barnes Environ. EntomoL 18(2):208-212 (1989)

Greenhouse and field studies were conducted to assess the effects of water stress on almond leaf temperatures and Pacific spider mite, *Tetranychus pacificus* McGregor, development times. Egg-to-egg developmental times on water-stressed almond trees were 11% faster than developmental times on nonstressed trees. Leaf surface temperatures on the stressed trees averaged 2.1ºC higher than those on the nonstressed trees. Accumulated degree-hours for egg-to-egg development were not significantly different among the mites from the stress and nonstress treatments. Thus, the faster developmental times for the notes on the stressed trees were the result of the higher leaf surface temperatures. Mean daily leaf canopy temperatures from 4-yr-old water- stressed almond trees were 2.0ºC higher than control trees under field conditions. Leaf canopy temperature differences were significantly correlated with differences in predawn leaf water potentials between the water- stressed and control trees. Mature almond trees under an irrigation regime of 55% evapotranspiration (ET) had significantly higher afternoon leaf canopy temperatures than trees under regimes of 85 and 100% ET. Increased leaf surface temperature in water-stressed almond trees have the potential for accelerating increases in spider mite populations.

SUSCEPTIBILITY OF PACIFIC NORTHWEST CONIFERS TO PHYTOPHTHORA ROOT ROT

Sally J. Campbell and Philip B. Hamm Tree Planters' Notes 40(l):15-18; 1989

Seedlings of 11 conifer species were inoculated with 5 species of *Phytophthora - P. cactorum* (Lebert & Cohn) Shcroet, *P. Cryptogea* Pethbr. & Lafferty, *P.drechsleri* Tucker, *P. megasperma* Drechsler, and *P. pseudotsugae* Hamm & E.M. Hansen - to determine suscep-

(continued...)

tibility to phytophthora root rot. Pine, cedar, larch, and spruce species showed tolerance to the disease whereas some true fir and hen-dock species were quite susceptible. Other species showed intermediate susceptibility. Management of phytophthora root rot is discussed, utilizing this information on relative susceptibility on various conifers grown in the Pacific Northwest.

IMPROVING FIELD PERFORMANCE OF SOUTHERN PINE SEEDLINGS BY TREATING WITH FUNGICIDES BEFORE STORAGE

James P. Barnett, John C. Brissette, Albert G. Kais and J.P. Jones South. J. Appl. For. 12(4).281-285

Field survival of longleaf, shortleaf, slash and loblolly pine seedlings that had benomyl incorporated into the packing medium was markedly improved over that of clay-slurry controls. The more difficult to store seedlings of longleaf and shortleaf pine had greater magnitudes of response than more easily stored loblolly and slash pines. The decrease in seedling survival with storage time is related to a rapid increase in pathogenic microorganisms in cold storage. Although BenlateR 5OWP is now registered for this use, the most effective fungicide dosage rates for routine use with different southern pine species must still be determined.

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