TREE IMPROVEMENT
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Seed and Seedling Extension Topics

Extension Services Section - Editor, Gwen Shrimpton

This is the last issue of the newsletter I will be editing for awhile. At our last section meeting, we decided to transfer this function throughout the unit so the next editor will be Mike Pelchat. We apologize for missing the spring issue, but we were unable to obtain approval to publish at that time.

The Nursery and Seed Extension Services section welcomes Shirley Mah into the Seed Projects Officer position formerly held by Cam Bartram. Shirley's most recent work was in forest ecology but she has an extensive background in forestry.

Muriel Poirier, a long time employee of Green Timbers Nursery died of cancer in March 1991. Muriel's dedication and enthusiasm is greatly missed by all who knew and worked with her.

Grower's Notes

New Registrations/Novel Application Methods

Metasystox-R (MSR) is now registered for cone and seed insect control on Douglas-fir, spruce and western red cedar. On Douglas-fir and spruce, the material can be used as a foliar spray or as an injection into the stem of the tree. The use pattern specifies only a foliar spray on western red cedar.

MSR is an acceptable alternative to dimethoate. These materials are systemic and will translocate inside the tree to control larvae emerging inside the cones. This allows managers to conduct egg counts and assess insect populations in cones prior to applying control measures. The stem injection technique is particularly useful where drift from pesticide applications may present a problem.

Don Summers
Extension Services, Victoria

Anti-transpirants and Wetting Agents May Help Control Insects and Diseases

Several nurseries in Ontario have been using the tension reducing agent Basic H to get even wetting of their cavities which is similar to Soil Wet or Aquagrow. This product is available from Shaklee Product Distributors. At a recommended rate of one litre per formulated product to 10,000 parts of water, growers have found that it is effective at reducing damage from the Lygus bug. Basic H apparently kills several insect species especially true bugs, and may also discourage the establishment of fungi. To date, there have been no problems with phytotoxicity on conifer seedlings (Gim Reid, Inno Tec, personal communication).

Commercially available antitranspirants such as Wilt Pruf, Vapor-Gard, Cloud Cover and Folicote may control fungal leaf diseases, as well as protecting plants against water loss. The possibly function as extended cuticles serving as a physical and chemical barrier, to repel the film of water which is necessary for germination of fungal spores and provide an irregular surface to disorient the growing germ tubes. In china extensive investigations with GZM (high-quality lipid membrane) have shown that it controls diseases such as *Alternaria, Septoria, Pseudoperonospora, Colletotrichum, Rhizoctonia, Fusarium* and *Phytophthora* on several fruit, vegetable, grain and fiber crops. In Israel and the U.S. antitranspirants have controlled diseases such as anthracnose, leafblight, rust, powdery mildew and downy mildew on greenhouse and field crops. (Roger Lawson and M.M. Dienelt Greenhouse Manager Sept 1990).

Gwen Shrimpton
Extension Services, Surrey

British Columbia
Ministry of Forests

Northern Zone 1990 Fall Lift - Nursery Growers Awards of Excellence

Last February 26th, northern growers met at the Aspen Motor Inn in Smithers for one of their semi-annual Growers Meetings. The meeting was a success with over 40 people attending. Attendees represented a good cross section of the Northern Zone nurseries, MOF Nursery and Seed Extension Services, the nursery consulting industry, MOF Research Branch, Forestry Canada, MOF Regional Silviculture staff, BC Fisheries and Agriculture and even a lone licensee. At midday, with reporters from Skeena Broadcasting in attendance, presentations were made to two Northern Zone nurseries.

As promised last year, the criteria for judging nurseries was changed somewhat from the previous year. Rather than insisting that a nursery met or exceeded the request amount, as well as having all audits equal to or less than 6% for a given stock type combination, bulk nursery ratings were employed. It was felt that this provincially standardized system would be accurate in reflecting a nursery's cultural abilities. Given that every nursery sooner or later will produce a less than perfect crop, both the successes and failures for any one nursery were averaged.

Nevertheless, nurseries had to produce at least 500,000 seedlings in any given category if they were to be considered. Similar to last year, the awards only applied to the 1990 Fall Lift and were not species specific; hence the "bulk" nursery rating. As such, only three categories were identified for the Northern Nursery Administrative Zone: 1+0 Container; 2+0 Container; and 2+0 Bareroot. Finally, only the best nursery in each category was chosen and only if that nursery had a minimum of 90 points under the Nursery Rating System.

The 'Ministry of Forests, Northern Zone - Nursery Growers Award of Excellence" was presented to "Woodmere Nursery Ltd." for producing "Quality 1+0 Container Seedlings" and to "Telkwa Nursery Ltd." for producing "Quality 2+0 Bareroot Seedlings". Joe Wong and Norm Chadsey respectively accepted the awards on behalf of their nursery and staff. Coincidentally, both of these nurseries are based out of Telkwa, B.C., in the Bulkley Valley.

Hans Lussenberg
Northern Admin. Centre, Prince George

NAA Effects on Conifer Seedlings in British Columbia

NAA (1-napthaleneacetic acid), a synthetic auxin, is commonly employed to induce adventitious root formation in cuttings, and reduce fruit drop in commercial crops.

On conifer seedlings, it was found that:

- NAA affects the number of first order lateral roots initiated such that for container grown stock better formed root plugs are produced.
- 30 10 days from sowing seems to be the most effective application time for all species tested.
- Application rate as a soil drench to container stock varies between species. Recommended rates which minimize negative effects on shoot growth yet promote substantial root initiation are; 20 mg/l for interior Douglas fir; 10 mg/1 for Ponderosa pine and western larch, and 2 mg/l for lodgepole pine.
- Although the root form and vigour of container grown seedlings after outplanting may be enhanced by NAA treatment, early field performance results with interior Douglas-fir and western larch showed no difference compared to controls. Negative effects of NAA treatment on field growth have not been observed. After two field seasons, NAA treated container grown Douglas-fir and western larch seedlings grew as well as untreated seedlings.
- NAA treated (20 mg/1) bareroot Douglas-fir and Ponderosa pine seedlings had greater numbers of lateral roots than untreated seedlings. Further investigation of NAA application rate on bareroot stock at 30 days from sowing is required.

David G. Simpson
Kalamalka Research Station
abstracted from Target Seedling Symposium,
August 13-17, 1990,
Roesburg, Oregon

Fact or Fiction?
Some Non-Scientific Observations on the Production of Cottonwood Cuttings

In recent years, the demand for black cottonwood *(Populus balsamifera* L. ssp. *trichocarpa,* notably in the Prince Rupert Forest Region, has increased dramatically with its acceptability as a commercially viable species. This native northern species is being used to restock fluvial flood plains along the Skeena and Nass Rivers, as well as, the North Coast with remarkable success. Unfortunately, there are no proven hybrids available for these northern areas and nursery production has had to rely on completely wild stoolbed material, which has performed poorly compared to hybrid stoolbed - production. Common sense would lead us to expect this; however, no one expected the downfall in production to be so dramatic.

By wild stoolbed material, I am referring to black cottonwood whips that were harvested from a specific local area and processed into cuttings that formed the base stock for the nursery stoolbeds. As such, the identities of individual clones are not known, since the material is completely wild and represents a high degree of genetic diversity. This, as opposed to individual (plus tree) clones that could have been selected for their superior growth, has resulted in production levels that are 60 to 80 percent lower than hybrid stoolbed production levels. Even if superior clones had been selected, we would expect production levels to be below that of hybrid stoolbeds. In fact, in discussions with several cottonwood producers here in British Columbia, I have-reached the conclusion that even under ideal management, we can only expect to achieve 40 to 50 percent of hybrid production when completely wild stoolbed material is used. Similarly, I expect that plus tree (nonhybridized) clones would only achieve 80 percent of hybrid production levels. Clearly, this not only impacts the number of cuttings we can deliver to the planting crews, but it also increases the nursery costs.

I would be interested in hearing from any grower or scientist who might have more information on this issue.

Hans W. Lussenburg,
Northern Admin. Centre, Prince George

Nursery Administration and Planning Subsection Review

The Nursery Administration and Planning Subsection manages information regarding seedling production in the province. Our main function is maintaining and operating computerized information systems and ensuring that these systems interface smoothly with other Silviculture Branch Information Systems. The systems managed by this section include the Nursery Information System (NIS), the Sowing Request System (SRS) and various seedling shipping and transportation systems. Information from these systems is used to forecast trends in seedling production, which assists the Ministry in setting policy and managing programs relating to reforestation.

The Nursery Won-nation System manages information (such as inventory) on Crown responsible seedling production. The Sowing Request System processes orders for seedlings to be used in reforestation throughout the province. Both the Sowing Request and Tree Seed Registry (TSR) Systems are currently being rewritten to allow online access to seed inventories and sowing requests. The new systems are being developed to run in parallel with the existing SR and TSR systems for the 1992 sowing year (starting in fall 1991).

The section also administers contracts to commercial nurseries to fulfill those Crown seedling requirements in excess of Ministry nursery capacity. Other activities include developing new information management tools and providing technical support and advice to administer the Ministry reforestation program.

Current staff members are Michael Pelchat, Nursery Administrative and Planning Forester; Patti Kagawa, Seedling Production Forester; Cindy Haddow, Seedling Production Officer, and Remi Michelot, a programmer on contract to maintain the Nursery Information System.

Cindy, a recent addition to our staff, comes to us - from Dawson Creek Forest District where she was Range Officer. She has also worked as a lands officer, a project coordinator for the Ministry of Agriculture, a private consultant and owner and manager of a grain and beef farm. She moved to follow her husband's relocation to Duncan as District Agrologist. She started in November to maintain operation of the Sowing Request System while Patti was on maternity leave. Both Patti and Cindy are currently working part-time.

Mike Pelchat
Extension Services, Victoria

Seedlot Mapping Program

The Seed Extension group is currently involved in the development of a seedlot mapping program that will access information held in the Tree Seed Register and Inventory System. As a planning tool, the use of seedlot maps will assist field staff in identifying future cone collection areas and in selecting appropriate seedlots for reforestation purposes. The PC-based program will function as an easy to use, menu-driven system. Seedlots will be mapped according to specific selection criteria such as: species, seed planning zone, BGC unit, ownership, agency, and elevation range. In addition, a "zoom" function will enable free movement within provincial, regional and district level maps so that custom selected areas can be viewed or printed. Other features will include the ability to print colour-coded 8 1/2" x 11" maps on paintjet printers. The software is presently being developed by N.D. Systems, Ltd. of Victoria, B.C. and will be ready for pilot testing this spring.

Shirley Mah, Leslie McAuley
Extension Services, Victoria

Classical Biological Control of the Tarnished Plant Bug: A Breakthrough

Three species of European parasites have been released against tarnished plant bug (TPB) nymphs in the northeastern United States. Prior to 1988, only a few parasites, of one introduced species *(Peristenus digoneutis,* Loan), had been recovered from the field a year or more after release.

Fortunately, in 1988 we reared much larger numbers, and in addition, found this parasite in 5 fields as far as 6 n-dies from the release point. And, in 1989 we reared *P. digoneutis* from 20 miles (females) to 35 miles (males) away. The parasite is clearly established, and is dispersing well, though primarily downwind.

Total parasitism, by the European introduction and the two native parasites, was about 33% in both 1st and 2nd generation TPB nymphs, averaged over three years. This is about four times the rate by the native parasites alone, and is very encouraging. Research is continuing, to determine if parasitism rates will increase further and whether TPB numbers in alfalfa will decrease as a result.

W. H. Day,
USDA-Beneficial Insects Research Lab,
Newark, DE, U.S.
repainted from Biocontrol News Volume 3, April 1990

Rapid Information System - B.C. Ministry of Agriculture & Fisheries

The Rapid Information System or RIN is an electronic bulletin board for producers, technical representatives and government staff involved in horticulture. Primary areas are: floriculture, greenhouse vegetables and nursery crops. This is a free public board to encourage the exchange of information. The bulletin board operates 24 hours a day, 7 days a week.

The BCMAF - RIN provides information access to three main topics. The first is bulletins where timely updates on current issues, events and new system changes are provided. The second allows for mail and messages to be sent privately or publicly to other subscribers. Finally, the third component provides access to a database containing information files, production guides, management spreadsheets and software support programs.

Most microcomputers will be able to access the bulletin board via a modem and communications software package. The BCMAF-RIN supports baud rates from 300 - 9600. Your communication software should be set to the following parameters: 8 bit word length, I stop bit, No parity checking, ANSI terminal emulation. The phone number for BCMAF - RIN is: (604) 850-2980.

If you would like more information, please contact:

Gordon Grant
Provincial Floriculture Specialist

How Nutritious is Your Water?

Every cost conscious grower (all of us these days!) would like to be able to determine minimum fertilizer requirements for specific crop objectives. For this reason, when designing a fertilizer regime, it is prudent to take into account the nutrient value of the available water source.

Consider the water analysis below, which is not uncommon in certain areas of British Columbia (values are in ppm). Ca, Mg, and SO_4 are present in substantial, if not adequate, levels for conifer production. To match these levels using conventional fertilizers in "pure" water would require the addition of 360g $CaNO_3$/1000 litres and 254g $MgSO_4$/1000 litres. Hence if one is feeding these elements, a dollar saving is in order. Simply subtract the above rates from your desired nutrient feeding regime.

For example, if a grower desires a 100 ppm N, P, K regime and considers the Ca, Mg, and SO_4 levels in the water source adequate, he/she might decide to add 500g 20-8-20/1000 litres and 60 ml H_3PO_4 acid/1000 litres to give the final nutrient regime on the right.

The H_3PO_4 has effectively made the 20-8-20 regime into a 20-20-20 regime while at the same time reducing the buffering capacity (HCO_3 content) of the water.

Note: -NH_4/NO_3 ratio
-Nutrients supplied by the H_2O source are delivered during irrigation as well as fertigation.

	Water Analysis	Final Nutrient Regime
NO_3:	0.0	25.0
NH_4:	0.0	75.0
N(t):	0.0	100.0
P_2O_5:	0.0	104.7
K_2O:	2.0	102.0
Ca:	68.0	68.0
Mg:	25.0	25.8
SO_4:	23.0	23.0
Fe:	0.20	2.20
Mn:	0.30	0.55
Zn:	0.00	0.25
Cu:	0.00	0.25
B:	0.01	0.11
MO:	0.000	0.003
Si:	7.0	7.0
HCO_3:	132.0	80.6

Eric van Steenis
Extension Service, Surrey

Control Release Fertilizers May Help Reduce Fertilizer Run-off

Concerns about run-off from agricultural operations have been increasing. A recent survey of ornamental nurseries in the United Kingdom showed that overhead the irrigation is the highest consumer of water. Containers may take as much as 1.3 M. gallons of water/acre/season. This is equivalent to watering 1 acre and to a depth of 1.5 m. Anything from 60 to 90 percent of this water may be lost and not reach the surface of the container due to engineering limitations, wind, ventilation, variable crop canopy, and sloping sites (David Whalley, Grower April 4, 1991).

When the irrigation system is used to apply water soluble fertilizers (WSF), nitrogen and other nutrients will also be included in the nursery run-off. Control release fertilizers (CRF) can play a significant role in reducing fertilizer run-off in nurseries. When all fertilizer for the crop is placed inside the container, fertilizer waste can be reduced providing the containers are not leached excessively. A combination of WSF CRF can make fertilizer management very flexible. When choosing fertilizer regimes, growers may want to include the potential for run-off into their decision making process.

Gwen Shrimpton
Extension Services, Surrey

Tech Talk

Southern Vancouver Island Seed Orchards Beneficial Insect Survey: Introduction

In long term cropping systems such as seed orchards, pests and beneficial insects have a chance to develop complex interactions. These interactions often result in a delicate balance between restrained and outbreak pest populations.

Frequently, our management practices ran disturb that balance between pest and prey. As well, we often pay so much attention to the pests we encounter that we forget that there are many other insects in orchards that are quite helpful.

In order to better understand the dynamics of some of these insect interactions in provincial seed orchards, Silviculture Branch, B.C. Minis" of Forests has started a project to look at beneficial insects and to assess how they mesh with orchard management practices. The ultimate, and long term aim of the project is to attempt to incorporate these insects into an Integrated Pest Management (IPM) program.

The first phase of the project began in the spring of 1990. Michelle Schmidt, a coop student from Simon Fraser University, was brought on staff to do a survey for beneficial insects in coastal seed orchards. This part of the project was aimed at **1)** collecting base line information on the diversity of beneficial insects in the orchards, **2)** testing some methods for sampling and **3)** identifying predators/parasites that were found in this first year.

The survey aspect of the project will be continued and expanded as resources permit. The intention is to spend several years doing surveys in all of the orchards (coast and interior) so that the diversity and importance of the various beneficial insects can be assessed for each site. Other future project plans are: to develop extension aids that will help orchard managers recognize and protect these valuable pest management tools, to document the biology and ecology of the insects so that they might be enhanced as part of an IPM program, and to assess how current pest management activities in the seed orchards affect their populations. A partial outline of the results of this initial orchard survey is presented in the following article by Michelle.

Don Summers
Extension Services, Victoria

Southern Vancouver Island Seed Orchard Beneficial Insect Survey: Results

A survey was conducted to initiate a complete predator and parasite inventory for the seed orchards. In addition, an attempt was made to evaluate potential biological control candidates and to compare the populations across the summer and winter months.

With the help of Bob Duncan and Lee Humble at most Pacific Forestry Center (Forestry Canada), and the Biosystematics Institute in Ottawa, I was able to identify a number of potentially useful insects in the southern Vancouver Island seed orchards. They include in representatives from the following insect orders: Neuroptera (lacewings and dusty-wings), Coleoptera (beetles), Hemiptera (true bugs), Diptera (flies), and Hymenoptera (ants). Two arachnid orders, Acari (mites and ticks) and Aranae (spiders) were also identified. The table on the next page (Table 1) outlines the predators and their prey. Prey information was obtained through feeding trials and literature review.

In evaluating biological control potential, several factors must be considered. These include the degree of success of previous biological control attempts, rates of consumption, range of prey, reproductive capacities, search abilities, nature of feeding behaviour, habits, survivability and ease in rearing. Based on these factors, the following three biological control agents were selected from the list of predators. Brown and green lacewings and ladybird beetles were the most feasible because all rated very highly in each aspect biological control.

The brown lacewings rank highest overall. They are distinctive from the other two highly ranked insects their widespread abundance. This indicates that the seed orchard is an optimal environment, which increases the chances that they will successfully establish following a biological control release program.

The green lacewings are second in overall rank. They rate the same as the brown lacewings in each biological control factor and offer the advantages of established mass rearing techniques (likely adaptable to local species), and higher consumption rates.

(continued...)

Table 1: Insect and Archnid Predators of Southern Vancouver Island Seed Orchard Pests

PREDATORS	PREY		
	Aphids[1]	**Mites**	**Other Soft-bodied Insects**
Insectae:			
Neuroptera			
* Hemerobiidae (brown Lacewings)	+		+
Chrysopidae (green lacewings)	+	+	+
* Coniopterygidae (dusty-wings)	+	(spider mites)	+
Cleoptera			
Coccinellidae (ladybird beetles)			
Mulsantina picta minor	+	+	+
Neomysia subvitatta	+	+	+
Stethorus punctillum	+	+	+
Elateridae (click Beetles)			
Ctenicera suckleyi	(Cooley spruce gall aphids)		+
Hemiptera			
* Miridae (plant bugs)			
Deraeocoris brevi	+	(red mites)	
Anthocoridae (minute pirate bugs)			
Tetraphelps latipennis	+	+	+
Pentatomidae			
Podisus serieventris			+
Microphysidae (microphysids)			
Loricula bipunctata[2]		+	+
Diptera			
* Syrphidae (syrphid flies)	+		+
Hymenoptera			
* formicidae (ants)[3]			+
Arachnidae			
* ACARI (mites and ticks)			
Anystis agilis Banks		(spider mites)	(thrips & leafhoppers)
ARANAE (spiders)	+		+

1. refers to most species of aphids including Cooley spruce gall aphids, giant conifer aphids, and balsam wooly aphids
2. 2. a first sighting recorded in North America (Schwarts, Schmidt and Humble, In print)
3. only a few species are predators
* frequently occurring across a range of seed orchards

However, the overall ranking is lower than that of the brown lacewings because of lower reproductive rates and, more importantly, their infrequent occurrence. This may imply that the seed orchard is not the preferred environment.

The ladybird beetles are the third highest ranked. They rate higher than both of the lacewings in consumption rates and ease in rearing, but they are given a lower overall ranking because the beetles' most effective feeding period is not synchronized with peak aphid development (a target pest). It is possible that this could be manipulated by modifying development through rearing methods.

In the winter months of 1990-91, there was a significant reduction in diversity of insect species and life stages. The green lacewings, two of the three species of ladybird beetles *(Neomysia subvitatta* and *Stethorus punctillum),* the click beetles, plant bugs, microphysids, syrphid flies and red predator mites *(Anystis agilis,* Banks) were all absent. The third species of ladybird beetles *(Mulsantina picta minor)* and the minute pirate bugs were collected in the winter but only in the adult form. Both ants and spiders were collected commonly and abundantly throughout the winter. The absence of several species raises questions concerning hibernation, dormancy and overwintering locations.

Michelle Schmidt
Extension Services, Victoria

Copper-treated Styrofoam Blocks for Liverwort Control

At most coastal and some interior facilities in B.C., liverwort infestations of outdoor container-grown conifer seedlings has been a continual source of frustration for nursery personnel. Frequent irrigation and fertilizer applications, coupled with mild temperatures and high humidities provide a superb environment for liverwort establishment and growth. Over the years, a number of chemicals have been tested against liverworts with limited or variable success. In the September 1990 issue of this newsletter, articles by Gwen Shrimpton and Jim Kusisto reported on effective liverwort control measures using cultural techniques and a timed Simazine application, respectively.

In recent years, an increasing number of B.C. reforestation nurseries have been using copper to train the roots of a few conifer species, in particular, lodgepole pine. Simply, this process is accomplished by partially or completely coating the inside surface of the cavities in the styrofoam container with a formulation of copper carbonate. The idea is not new, the horticulture industry has used this technique for years, to discourage root bound plants. Alternatively, copper-based products have also been used extensively as a grounds-keeping method of killing moss and bryophytes. Therefore, based on a suggestion from one nursery manager and in an effort to provide alternatives to pesticide control measures, a trial was initiated last year to assess the effects of copper on liverwort establishment in container seedlings.

In 1990, four conifer nurseries, located in three different geographical zones of B.C., with histories of liverwort problems were selected as trial sites. Past experience has shown that seedlings grown for two seasons (2+0) in outdoor compounds are the most vulnerable to severe liverwort infestations. Based on each nursery's sowing requests, one of the styrofoam container manufacturers was asked to coat the upper surface of a number of blocks with the copper carbonate formulation currently used in the root training containers. Three block configurations currently used in B.C. were treated i.e. 313b, 415b and 415c. These were sent to the individual nurseries with their regular shipment of styrofoam blocks. The copper-treated blocks were then sown along with the regular blocks as per standard nursery practices and randomly placed in the outdoor compounds.

In all, one interior Douglas-fir (415b), two true fir (both 313b) and three spruce seedlots (313b, 415b and 415c) were sown. All but one spruce seedlot (415b) were assessed in 1990 for stem height, root collar diameter, dry stem and root weights, percent seedling germination and liverwort infestation. This year, all but the two true fir seedlots have been evaluated and these will be assessed this fall.

In general, the copper treatment had little or no effect on morphological characteristics and in all cases, the 2+0 seedlings surpassed the minimum operational standards set by the Ministry of Forests. The only exceptions were in the 415b Douglas-fir and 313b spruce. In its first year, the Douglas-fir seedlings in the copper blocks were significantly smaller than the controls but by the second year this difference had disappeared. The 313b copper block spruce was on average 2.0 cm shorter than the regular stock but this again was still well over the minimum height requirements for this block type.

In contrast, observations on seedling germination and liverwort infestation levels have been much more variable. Over both years, the 415b Douglas-fir, 415b and 415c spruce seedlots have shown no difference in germination levels between the copper-treated and control blocks. In comparison, the 313b spruce seedlot has shown a 16.6 and 21.1 % decrease in the number of seedlings per copper-treated block compared to the controls for last year and this year, respectively. The biggest surprise has been with both 313b true fir seedlots, i.e. noble and amabilis fir, which have shown to date a 39 and 50% reduction in germination, respectively.

As for liverwort infestations, copper was found to significantly reduce the number and size of liverworts in two of the four nurseries. At the nursery with the 415c spruce, liverwort numbers were reduced by 58% in 1990 and 81% in 1991 compared to the controls. In general, the few liverworts that did establish in the copper blocks, particularly in the first growing season, were very small and did not extend beyond the cavity lip. This year, some of the cavities were found to be covered with liverwort but this was in sharp contrast to the controls which had the entire block surface covered in liverwort.

In the second nursery, the 313b spruce had little or no liverworts in the first year but by this growing season, a 24% decrease in liverwort numbers was observed in the copper blocks compared to the controls. In part, this less dramatic decrease in liverwort numbers may be attributed to the decrease in seedling germination. With a greater proportion of cavities per block empty, this situation helps to facilitate their colonization by liverworts.

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Unfortunately or fortunately, depending on your perspective, the other two nurseries had extremely low liverwort numbers due to changes in their cultural regimes and so the liverwort assessments were inconclusive.

In general, it would seem that copper-treated blocks might be a method of reducing liverwort infestations while not compromising the vigour of established seedlings. On the other hand, some serious effects on seedling germination were observed, especially in true firs, and therefore more work is required to fine-tune this pest management option. This year, we are in the process of evaluating three copper-treated block scenarios which may help to resolve these questions. One involves blocks painted with a homemade formulation, the second and third are blocks coated by the manufacturer but one is at half the strength of the original copper carbonate formulation. It is hoped that these new conditions will provide additional information necessary to fully evaluate this alternative method to liverwort control.

David Trotter,
Nursery Extension Services, Surrey

Timing: A Critical Issue in the Chemical Control of insects

Chemical control of insects is more than a point-and-shoot scenario. The efficacy of an insecticide application is dependent on using the right chemical, at the right rates, under the right conditions, with the right application methods, at the right time. I would like to address the latter condition and illustrate the importance of applying chemicals at the right time. By 'right time, I mean in terms of the biology of the pest that the insecticide is meant to control.

The example that I will use is the spruce gall aphid *(Adelges cooleyi)*. These insects have a very complicated life cycle and I will only use highlights of it here to help illustrate my point. The insect lives on Douglas-fir and spruce. On Douglas-fir, it feeds openly on the needles and causes discoloration, distortion and/or needle drop. As feeding begins, a waxy, wool-like substance is secreted over the insects bodies. This covers them for most of the rest of their life and apparently protects them from predators and/or adverse environmental conditions.

On spruce, feeding by these insects causes abnormal growth of expanding needles and twigs in the spring. A chambered gall forms at the tip of infected branches and the young aphids feed in these chambers until they are mature.

The point to note about this 'bit of biology' is that the insects are protected by either plant tissue or a mass of waxy material which is hydrophilic (repels water) during much of their lives. This makes it very difficult to reach them with an insecticide. A 'systemic' insecticide is often touted as the answer to this problem; however, the effectiveness of these materials is dependent on a) uptake by the plant, b) if and how the material is translocated in the plant (xylem or phloem or both) c) how active the plant is translocating at the time of application, and d) which tissues the insect is feeding on (xylem or phloem or both). All of these factors may vary with time. In the case of the galls on spruce, the tissue disruption inside the galls may also affect the translocation of these materials. In the few trials that we have conducted with foliar applied systemic against the woolly stages of the spruce gall aphid, the results have been inconsistent.

When certain stages of the aphids are mature, they lay around 100 eggs under the woolly covering. When these hatch, the first thing they do is disperse. This stage is called the crawler stage and is one of the two stages in the life cycle where the insect is mobile and unprotected; the other stage is a flying adult stage (but not all adults fly). These crawlers move along the twigs and needles or are knocked or blown from spot to spot.

Once they settle and start to feed, they seldom move far and before long on Douglas-fir, they are covered with a woolly coat. In warm weather, this process from W to woolly coat may only take a week or so. On spruce, the process is complicated by the fact that the crawlers move to the base of the needles in the new growth as soon as the buds burst in the spring. This new growth is also quite waxy and repels moisture (spray materials).

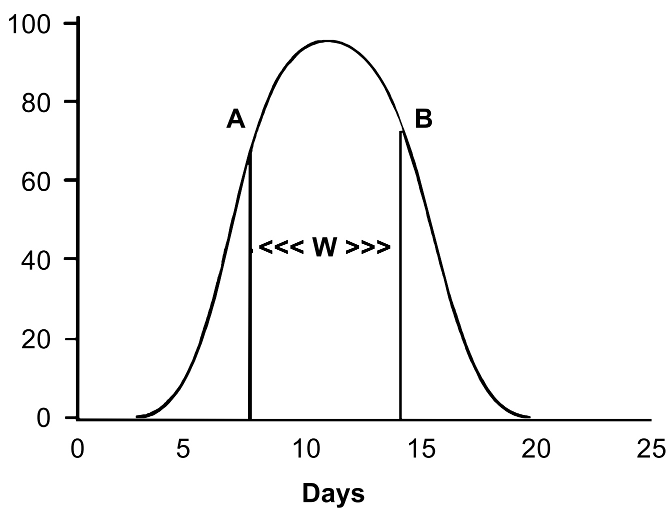
The 'right' time to control these insects is during the dispersing crawler stage. During this period, they are not protected by their secretions or by the galls that they cause. The hard part of this is that while a group of crawlers from one female's eggs may hatch, disperse and start to feed within the space of a few days or a week, it may take more than a couple of weeks for the bulk of an orchard population of crawlers to complete the cycle. This can be true for insects on an individual tree or in an entire orchard.

The trick is to get a feeling for what the insects in the whole orchard are doing by sampling and observing the condition of the

(continued...)

females and their eggs under the woolly tufts. This takes some patience, a hand lens, good judgment and some time for repeated sampling. The time aspect need not be too much of a burden, as the sampling is largely subjective and can be accomplished when doing other orchard tasks. The 'right' time to treat an orchard is when most of the orchard population of crawlers has hatched but before wool or galls protect them. This is called the treatment window or the period of time that the target is susceptible. Graphically, this might be represented by the top of the bell curve in Figure 1 or perhaps a spot just to the right of the top at point B. This assumes that it takes some time for the insects to disperse, settle, feed and become protected. Treatments applied too far to the left of point A, will not be effective because they have missed a large portion of the population not yet emerged. Treatments applied too far right of point B, miss the insects that have already hatched and settled. The idea is to find a balance that is compatible with the treatment that you want to use.

Figure 1 Pest Population
"The Treatment Window"



The treatment window for spruce gall aphid. The graph shows the proportion of insects emerging from eggs over time. A and B represent the earliest and latest times respectively for effective treatment with an insecticide. W represents the treatment window. Its width varies with biological and environmental factors as well as with the method of treatment.

How narrow or wide the window for effective treatment is, is dependent on the product that will be used and on the weather. Warm weather speeds up the processes of hatching and dispersal, while cool and cold weather can drag it out over several weeks. A product that has limited residual activity may have to be applied more than once if the weather is cool and egg hatch takes place over long period of time. Alternatively, a residual product may not be required if the weather is very warm and the hatch is short.

This idea of biological timing can be extended to other insects as well. B.t. (*Bacillus thuringiensis*) is a biologically based stomach poison that is very effective, so the best results are obtained when the insects are in the middle instars and consumption of foliage is high. Very young or very old larvae do not consume enough plant material to ingest a lethal dose. Timing must also be based on the average stage of development of the insects in the crop. The development of the individuals in an insect population is seldom simultaneous.

In summary, the biology of insects must be considered when a control measure is contemplated. There are biological 'windows of opportunity' that define the 'right' time for control measures to be effective. Outside of these 'windows of opportunity' any control measure will be less successful. As we move away from the more residual, broad-spectrum insecticides to more specific, non-residual materials, timing becomes more critical.

Don Summers
Extension Services, Victoria

Cone Scale Production After Fertilizer Application

Differences in seed yield from black spruce cones in the year following a heavy application of nitrogen were reported by Ben Wang at the 1989 CTIA meeting. He found that seed yield per cone after fertilization was 35-45 seeds compared to controls which produced 30 seeds/cone. This response may be explained by the fact that all cone scales are initiated in the induction year, therefore improved nutrition during this period could increase the number of scales initiated.

An increase in the number of cone scales results in more seed for a given cone production, therefore this effect could be useful in coastal orchards. However, seed orchards are kept well fertilized in conjunction with annual monitoring of foliar nutrients, therefore the number of scales per cone may not be limited by nutrients.

Methods

A pilot study was established to supplement a fertilizer induction study conducted by L. Ebell in Douglas-fir at Mt. Newton Seed Orchard 134. In the spring of 1989, these ramets had received either no fertilizer (control), 400 kg N /ha as ammonium nitrate or 400 kg N/ha as calcium nitrate.

After the cones had been picked in 1990, six sample cones were selected from the crop of each ramet. Not all ramets in the study produced cones, therefore the sample was limited. All three treatments were represented in 6 clones. In 5 clones, cones from the control and calcium nitrate were obtained, and in 1 clone, the control and ammonium nitrate were sampled. Only one tree or ramet was sampled per treatment, so a total of thirty trees were assessed.

Fertile scales were counted on each of the six cones per ramet. Data was analyzed using ANOVA. The experiment was a factorial with 12 clones and 3 treatments.

Results

The number of fertile scales per cone was generally consistent within a ramet. To estimate the mean scales per cone to within 10%, from 2 to 9 cones were required. The sample size of 6 cones was adequate for 26 out of the 30 ramets sampled.

From the ANOVA, the interaction between clones and treatments was highly significant. This indicates .that different clones reacted differently to the fertilizer treatments, and therefore definite conclusions cannot be drawn about the treatment effects. In 7 clones, the number of fertile cone scales was higher in the fertilized ramets than the control, while in 5 clones the control had more scales per cone. For the 6 clones where 2 treated ramets were sampled, calcium or ammonium nitrate sources either raised or lowered the number of scales per cone. In individual clones, differences of 10-40% in the number of cone scales were found between treatments.

The mean fertile scales per cone were 34.96 (control), 35.43 (ammonium nitrate) and 36.92 (Calcium nitrate). Operationally, this difference is not of great interest.

Because only 1 ramet per clone per treatment was available, the effect of environmental differences between trees, may have been more important than the effect of the treatment. Any future studies should either be carried out where nutrition is better controlled or includes a number of ramets per clone to quantify variation.

The possibility that cone scale numbers may be related to crop size on the ramet was examined. A regression of fertile scales per cone against cone production for each ramet showed no relationship between the two factors.

(R2 = .008).

Conclusion

In this pilot study, differences in the number of cone scales between fertilized and unfertilized ramets were variable. There appears to be clonal differences in the response which need to be quantified.

Joy Parkinson
Silviculture Branch, Duncan

Crop Diversification Leads to New Disease

Early this spring (1991) the Pacific Forestry Centre's Pest Clinic isolated a species of the pathogenic fungus, *Rhizoctonia,* from damped-off lodgepole pine container seedlings. This was significant because it is the first time *Rhizoctonia* has been isolated by the Clinic from British Columbia seedlings. The fungus has been isolated from bareroot damped-off seedlings from Manitoba and Saskatchewan. The fact that this fungus had not been isolated from B.C. bareroot seedlings was surprising because the fungus is ubiquitous and has caused problems in many agricultural crops. As it is primarily soil-born, damage by *Rhizoctonia* was not expected in container facilities.

In the present situation, approximately 37 containers were affected in a greenhouse. Severity ranged from a few seedlings to 90% of the seedlings killed in the styroblock. Seedling symptoms were classic for damping-off and included a collapsed, grey-green, mushy stem at the groundline with healthy stem and root tissue above and below the affected area. When cultured in the laboratory all of the seedlings showing these symptoms produced Rhizoctonia from the diseased tissue. Affected seedlings were killed rapidly but no spread has occurred since the initial observations.

Rhizoctonia can be introduced into a crop on seeds or by wind and windblown soil. *Rhizoctonia* is not known to produce asexual spores like *Fusarium* and Pythium. It does, however, produce sexual spores and sclerotia. Sexual spores can spread disease in agricultural crops and the fruiting bodies can form quickly. They are thin, greyish white crusts with the spores produced by cells identical to those on mushroom gills. Fruit bodies are formed on soil as well as on decayed plant tissues. The source of plant material can be cull piles or surrounding weeds. The sclerotia are much smaller but very similar to the black structures seen in *Botrytis* infected needles. They are resistant to cold and desiccation and can be windblown, especially with dry soil particles. Sclerotia of *Rhizoctonia* remain viable for many years.

The most likely source for the recent disease outbreak was a crop of poinsettias grown in the greenhouse before the affected conifer crop. A disease problem was noticed in the poinsettias but the causal fungus was not identified. *Rhizoctonia* causes a collar rot of poinsettia cuttings. It is likely that incomplete sanitation and a and a short time interval between the two crops, enabled the pathogen to survive and infect the conifer germinants. If susceptible host plants are grown which provide food material for building up of inoculum, a thorough cleaning of the greenhouses and equipment should be done before sowing subsequent crops.

Controls for *Rhizoctonia* disease are similar to those for other root and damping-off fungi. Sowing seed when the temperatures are war,, and misting just enough to keep the seed wet should reduce the chance of, having this disease. Preventing the pathogen from coming into the nursery is the best control. Hygiene is paramount. *Rhizoctonia* lives in soil and dust, so floors, tools, styroblocks and benches should be thoroughly cleaned. Bleach is recommended as an effective cleaning agent. If the disease is already present, removal of all infected plant material is mandatory. Plants and soil should not be put in the cull pile, but removed from the nursery site. No pesticides are registered for forest nursery use. Although pentachloronitrobenzene (trade names Quintozene or Terraclor) has been used, laboratory tests show Rhizoctonia quickly becomes resistant to this fungicide.

The Pacific Forestry Centre's Pest Clinic continues to operate on the basis of prevention and early detection of disease problems. Monitoring problems and confirming the causes of apparently minor diseases should be done to prevent new diseases such as *Rhizoctonia* from building up and causing much larger losses.

**Additional Note: As can be seen from the present disease case, new crops can introduce new diseases. It s important that plants coming from other nurseries are free from new pests. Recently, a pathologist from the United States indicated that *Cylindrocladium* had been isolated from azaleas in the Northwest U.S. This fungus s much more virulent than the *Cylindrocarpon* and *Fusarium* we have now. It causes a severe conifer root disease in Ontario. We have not identified *Cylindrocladium* in our nurseries and it is worth the effort to keep it out.

John Dennis
Pacific Forestry Centre, Victoria

Establishment of a Second Generation Orchard at Bowser

Establishment of the first phase of the B.C. Forest Service Orchard at Bowser will be completed in April 1991. (For those of you who don't know, Bowser is 25 miles south of Courtenay on Vancouver Island.) This orchard will produce Douglas-fir seed of outstanding quality for reforestation of crown lands in the Maritime Zone. By the year 2000, the orchard is expected to produce I 10 kg seed per annum, or more than 5.6 million plantable seedlings per annum.

With the support of Port Alberni District staff, approximately 15 hectares were logged in the summer of 1990. The site was then cleared and fenced. The pumphouse and irrigation systems for the first phase have been installed and a field office has been constructed.

Initial selections for phase I of the Bowser Orchard were established in a planned holding area at Duncan in 1987. Over the last 5 years, further genetic information has been gathered for these trees as well as growth and compatibility characteristics. Based on this data, 40 of the 100 initially selected clones were transplanted to the orchard site this spring. The ramets are 5 years old and 2-4 metres tall; therefore, seed production will begin earlier than if selections had just been grafted.

Phase I includes 1000 ramets representing 40 clones and replaces the production from the Koksilah first generation orchard at Duncan. Phase 11, which will be in place by 1996, includes 2000 trees representing 60 clones. It will replace the production from Quinsam first generation seed orchard at Campbell River, which will be phased out in 1995.

The Bowser Second Generation orchard is the result of years of tree breeding by Research Branch. Outstanding "plus" trees were chosen from natural stands in the late 1950's and early 1960's from across the coastal area. Controlled crosses were made between these trees so that their desirable characteristics of
vigour, form and adaptability could be accumulated in their progeny. The resulting seedlings were planted widely and their performance evaluated. The best seedlings from the best combinations of parents were identified and grafted for inclusion in the Bowser project.

In such a program, intensity of selection, which governs the gains, must be balanced against the need to maintain the diversity of the genetic base for future safety. In this way the first stage of the orchard, being planted in 1991, is based on selections amongst progeny from 156 of the original plus trees and sampling a total of 55 test sites and about 150,000 pedigreed trees. Progeny from 55 parents are represented in the orchard and a gain of about 12% in volume is projected based on progeny evaluations.

Higher levels of gain and diversity will be included in the main phase of the orchard to be planted in 1996. Trees will be selected from progeny of 372 parents tested across 88 sites. By using 12-year volumes and wood quality assessments with the wider base, gains will be increased to 15-18%.

The importance of good site selection for seed orchards cannot be overemphasized. Selection of the Bowser site was made after 18 months of evaluation of land parcels by a committee of Ministry and industry representatives. 55 candidate sites were evaluated, including existing orchard sites. To best realize the potential of the site, management practices will be initiated to maintain the genetic gain, diversity and adaptability developed through breeding and selection. In order to prevent contamination by local pollen, a 200 m buffer strip will be cleared of Douglas-fir. Nearby stands will be selectively thinned. Any surrounding land already cleared will be planted to pine. Overhead misting will be applied in the late winter for cooling. This delays the opening of reproductive strobili, thus making the orchard receptive period later than the local pollen flight.

The Bowser site was selected because of its droughty soils and excellent cone production potential. We would expect that limited selective cone induction work will be applied to those parents that are the poorest producers to ensure that we produce broadly adapted seedlots with a good parental balance. On the Bowser site, treatments that we would expect to use are withholding irrigation to create moisture stress early in the year, stem girdling and injection with GA 4/7.

We recognize that this orchard is in a potentially environmentally sensitive location. The sandy soils are ideal for cone production, but also could allow drainage of fertilizers and pesticides to the underlying aquifer. This aquifer supplies water to the Bowser area. The Forest Service has committed themselves to ensuring that our orchard management does not adversely affect this valuable resource. An Environmental Impact Assessment was carried out by Thurber & Assoc. before site selection was finalized. This EIA indicated that by using the following practices, we will eliminate any danger to the environment.

(continued...)

Weeds will be controlled manually rather than by herbicides. Cone and Seed insect control will be applied using stem injections to eliminate drift. These pesticides will be used only when populations warrant it and then only to crop trees. Metasystox R has been registered for stem injection and will eliminate drift problems. Slow release fertilizers will be used. Laboratory studies by Soilcon Inc. showed that little leaching of nutrients in the sandy soil occurs with slow release fertilizers.

The first cone crop from the Bowser orchard is expected to be harvested in 1991 with full production by 2000.

J. Parkinson, J.C. Heaman, G. Morrow
Silviculture Branch, Seed Orchard

Seed Sorting Trial

In February of 1990, some 680 grams of Mt. Newton Seed Orchard seed (S.L. 6576) was given to D. Pigott to sort by weight and volume. It was hoped that sorting would produce a more uniform nursery crop. Several nursery men had complained about the difficulty in raising seed orchard seed because of a great range in growth rates. One hypothesis was that, with booster pollination, more seeds were being produced per cone, and that several of the small ovules from the top of the cone, which normally do not amount to anything, were now being pollinated and were producing seed. Could this seed be adding to the variability in growth rates?

The seed was first sorted by size into three groupings:

1. Greater than a #10 mesh.
2. Greater than a #9 mesh.
3. Smaller than a #9 mesh.

These three groups were then sorted by weight using a pneumatic separator. Group 1 was separated into two parts (light and heavy). Group 2 was separated into three parts (light, medium, and heavy). Group 3 was separated into two parts (light and heavy). The seed was taken to MB's nursery, where it was stratified and sown.

There were large initial differences in germination and growth rates, with the larger and heavier seeds being first to germinate. By mid-summer, these differences were not noticeable, and by lifting date (December 1st), the treatments appeared visually the same. One styroblock (160 cavity) of each treatment was picked at random. Heights and diameters were measured for each tree in each block.

The following summarizes the data collected:

Sample Treatment		Seed Weight per 100 seeds	Avg. Diam. mm	Avg. Height	SD Dia.	SD Ht.	# empty cavities
A	control	1.23	2.99	21.9	0.63	4.3	4
B	large/heavy	1.49	2.88	22.8	0.85	6.0	9
C	large/light	1.42	2.51	21.2	0.84	6.3	11
D	medium/heavy	1.33	2.88	22.2	0.93	6.7	12
E	medium/medium	1.22	2.93	23.5	0.85	5.9	8
F	medium/light	1.19	2.80	22.6	0.81	5.8	8
G	small/heavy	1.02	2.65	20.3	0.87	6.1	12
H	small/light	0.92	2.74	19.0	0.97	6.5	14

The least variation was in the control. This treatment also had the least number of empty cavities. Based on this data, it can be concluded that seed sorting is not worthwhile.

The cull specifications for this crop were 2.5 mm diameter and 15 cm height. Based on these specifications, the recovery factors (# acceptable/ 160) of the treatments were as follows:

Sample Treatment		Avg. Diam. mm	Avg. Height cm	# below Spec. or Empty	Recovery factor %
A	control	2.99	21.9	13	91.9
B	large/heavy	2.99	22.8	21	56.9
C	large/light	2.51	21.2	45	71.9
D	medium/heavy	2.88	22.2	19	88.1
E	medium/medium	2.93	23.8	20	87.5
F	medium/light	2.80	22.6	29	81.9
G	small/heavy	2.65	20.3	30	81.3
H	small/light	2.74	19.0	27	83.1

The targets for the above crop were 3.2 mm diameter and a 20 cm top. The number of trees meeting target by treatment was:

Sample Treatment		# Making Target	% Making Target
A	control	68	42.5
B	large/heavy	63	39.4
C	large/light	27	16.9
D	medium/heavy	69	43.1
E	medium/medium	67	41.9
F	medium/light	53	33.1
G	small/heavy	33	20.6
H	small/light	51	31.9

Again, the control ranks near the top, indicating that further treatment is not necessary. In conclusion, seed sorting is not worthwhile.

Tim Crowder
Mt. Newton Seed Orchard, Saanichton

From Seed to Seedling: New Processing Techniques

Introduction

The Tree Seed Centre (TSC), 21 private and government nurseries and Pacific Phytometrics Consultants are cooperating in a trial to examine the effect of new seed cleaning and conditioning techniques on germination and early growth under nursery culture for a number of White/Engelmann spruce seedlots. The trial has been designed to address the following questions:

1) Can seedlots be upgraded to the point where the seeds/cavity and oversow factors currently require for the seedlots are reduced?
2) What are the seed preparation and seed handling regimes best suited to take advantage of seed prepared by both the new and older seed processing and preparation techniques?
3) How does the germination and early growth of processed seed compare to unprocessed controls from the same seedlot under a range of nursery culture regimes? Are seedlings from processed seedlots better seedlings?

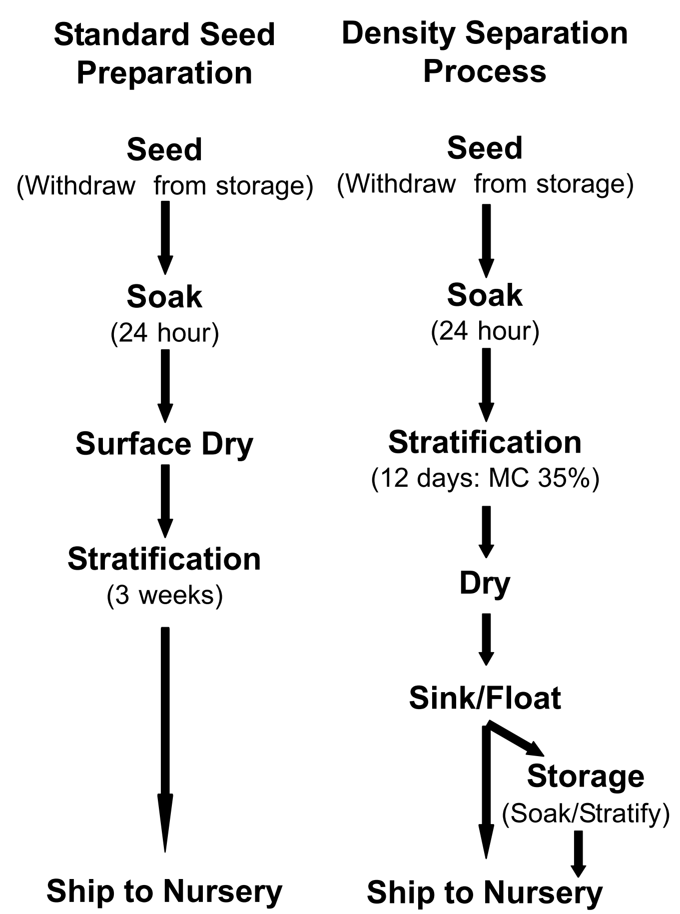
The nursery trials are ongoing (at the time of writing) and this article deals with the background behind the new seed processing techniques that are being evaluated in this nursery trial.

Concepts

Over the last two years, research at the TSC in collaboration with the Pacific Forestry Centre, has led to the development of protocols that are a hybrid of several seed processing techniques, and stress two concepts: DENSITY. SEPARATION PROCESSES and SEED CONDITIONING. Density Separation Processes have a long history in horticulture. Essentially, they are represented by any process that separates seed into two fractions based on the specific gravity of the seed. A number of seed cleaning devices, such as aspirators, gravity tables and the liquid separation tank, operate on this principle. One specific type of Density Separation Process - liquid separation of viable and non-viable seed via a sink-float sorting - has been used for a number of horticultural species (e.g. cotton, sorghum, lettuce, tomato, cabbage, onion, carrots), and was introduced into forestry under the name 'IDS' (Incubation, Drying, Separation). The method developed at the TSC is similar to "IDS", but replaces the Incubation stage, with a modified form of stratification ("prechilling") where moisture contents are strictly controlled. After the stratification stage, the seed are dried. The rate of drying of viable seed is slower, since viable seed actively retain moisture, which leads to a moisture content difference between viable and non-viable seed. During the sink-float sorting stage the heavier, viable seed sink, and the lighter, less viable seed float.

Seed Conditioning refers to those treatments that prepare a seed to germinate. This includes imbibition of water to activate biological processes, various forms of dormancy breakage, and osmoconditioning. The point of seed conditioning is to create conditions where the seed is brought up to, but not beyond the point where it is ready to germinate. In the horticultural industry this is often done via osmoconditioning, where chemical treatments are used to manipulate seed moisture. Germination is controlled by creating conditions where the embryo is capable of entering the rapid radical growth phase, but osmotic potential prevents elongation and growth.

Figure 1



To do this without chemical treatments a truncated 12 day stratification at 2°C was developed, where moisture contents were strictly controlled (with a target m.c. of 35%). The goal of the regime was to use a combination of cool temperature and moderately high moisture content to create conditions where the seeds were fully imbibed and biologically active, but under which the radical would not begin to elongate. While the methods developed at the TSC (see Figure 1) were designed to create a form of osmoconditioning without chemical treatment they are similar to the newly developed methods of "Target Moisture Content Prechill" by British researchers, and 'Invigoration"-by Swedish researchers. We have yet to determine suitable acronyms for our methods!

Monitoring Results and Modifying Recipes

One of the key steps to development of a successful protocol was the monitoring of our results throughout the development stage. The monitoring had two aspects. First, it served as a form of "quality control". Were target moisture content (m.c.) during stratification and the drydown step of processing being achieved? Would the processing and seed conditioning protocols developed give consistent results from one nursery request to the next in terms of germination performance? More importantly, monitoring was used as a "feedback loop", by which we could gain information to modify our protocols.

For example:

1. Results from the initial lab screening and processing stage were used to determine the suitability of a seedlot for processing.
2. Then when that seedlot was processed, the data gained during the lab trial was used to note features of the seedlot (for example, fungus problems; lack of separation into distinct fractions during the sink-float sorting stage) which might affect operational processing.
3. Next the germination performance of seedlots following lab processing (which used smaller amounts of seed and allowed better control of "seed environment") was compared to that of the operational processing. Figure 2 presents this comparison for three selected seedlots.

Figure 2

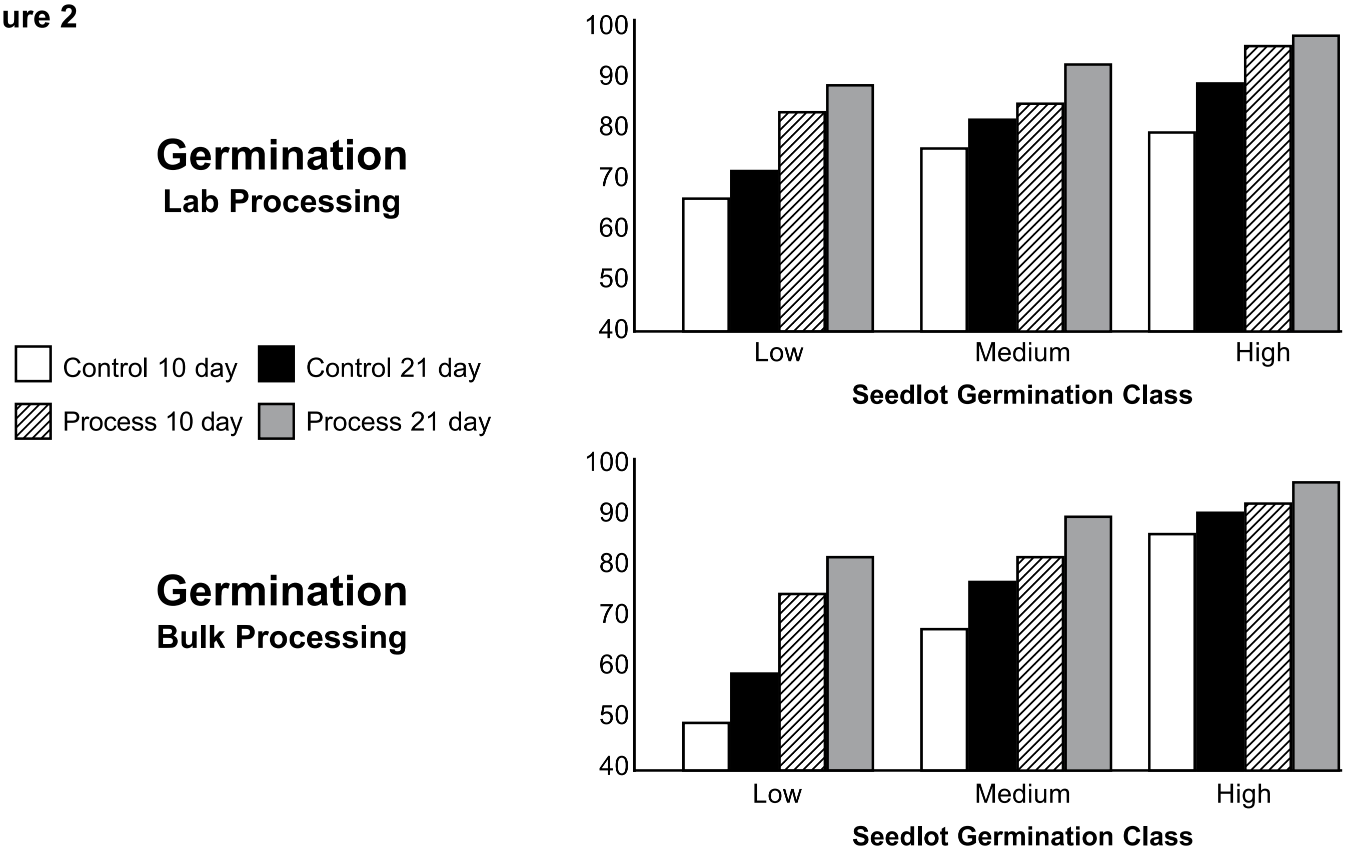
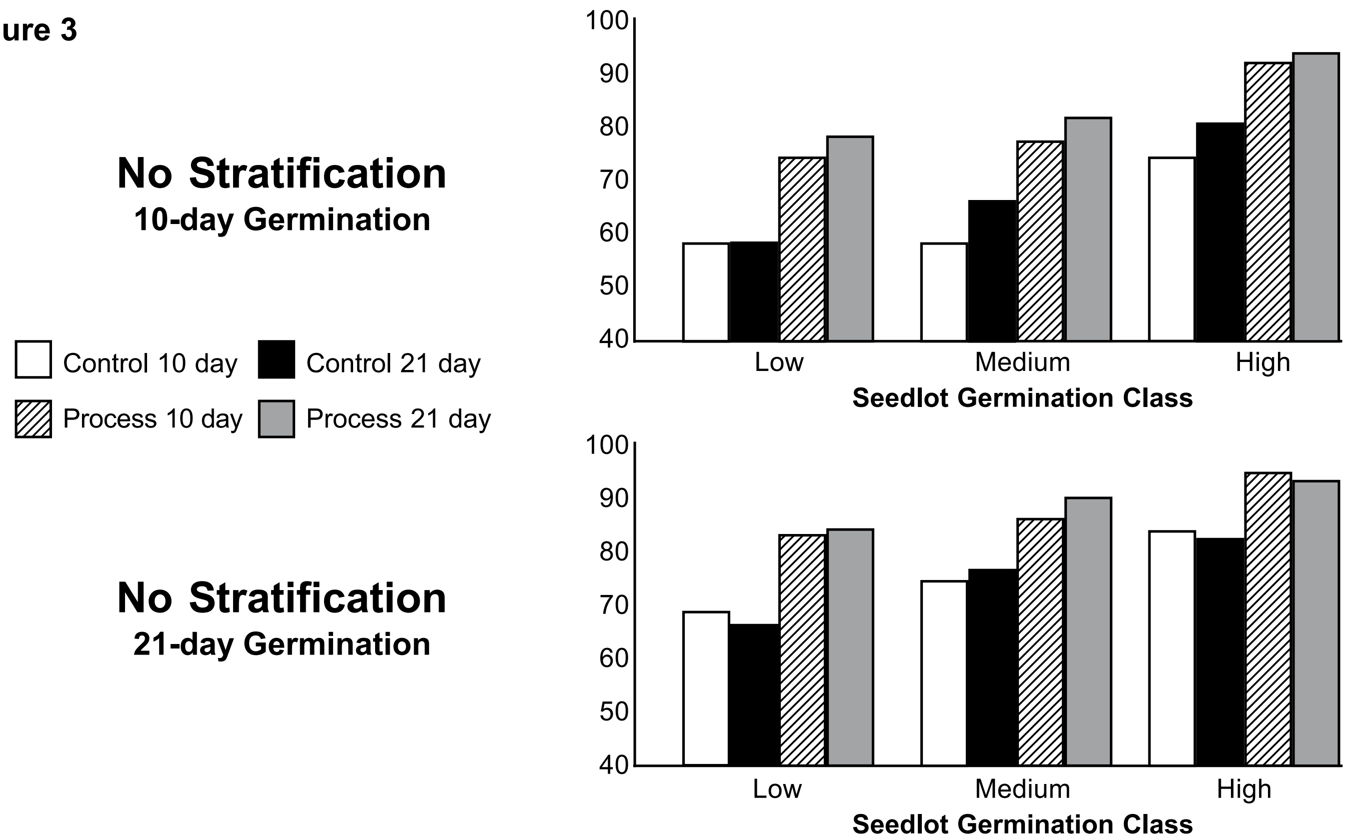


Figure 3



4. Finally, monitoring during operational processing led us to modify those procedures. During the course of the present trial, we noticed that germination performance for processed seed following a 12 day stratification prior to sowing was often a few percent less than germination processing immediately following the initial processing. This anomaly led to a small trial examining the need for stratification of processed seed following drydown and storage (for 6 months at -18°C). The results of this trial indicated that, for processed seed, stratification was not necessary, and good germination performance could be achieved following an extended soak of 48 hours (see Figure 3).

These results, if they hold true for a larger sampling of seedlots and longer storage times, could go some way toward simplifying the logistics of seed preparation.

In short, monitoring is an ongoing process. As more background information on each seedlot is gathered, our ability to "customize" treatments to individual seedlots will increase. Monitoring throughout development of the processing techniques, and on the outgoing product, indicate we have developed reliable and repeatable techniques, and can produce consistent results. Current questions that need to be determined, and can only be determined in the context of such a monitoring program are:

1) What are the soak regimes necessary to reach full imbibition of the seed coat?
2) Which seedlots require full stratification, and which seedlots demonstrate good germination with a shorter stratification regime?
3) What are the effects of prolonged storage on processed seed.

Our initial results demonstrate that after 6 months storage, processed seed are not dormant, and will germinate vigorously after an extended soak treatment. With longer storage times, will dormancy be re-initiated?

In going from seed processing to seedling culture, more information is required on the role of seed in the context of nursery culture. For example, what criteria should be used to evaluate seed upon arrival and during any extended storage prior to sowing at the nursery? As our trial progresses, some of these questions on the interaction between seed processing/preparation and nursery culture will be addressed. These answers will feedback to, and may modify, how seed is processed and handled.

Mishtu Banerjee, Murugi K. Larsen, Rob Scagel
Pacific Phytometric Consultants, Surrey

SX 90 2040 Nijssen LED Photoperiod Light Evaluation

Introduction

New technology in photoperiod lighting for plants has been developed by Nijssen B.V. in Holland. It relies upon lighten-emitting diodes, manufactured specifically to produce a 660 nm frequency light source. Claims are, that in addition to lower power requirements and ease of installation, the system is more effective in influencing bud development, stimulating germination, and rooting cuttings. This trial was initiated to provide a comparison of these new lights with the high-pressure sodium vapour lights which are currently the standard photoperiod light source in the container conifer industry.

Methods and Materials

Experimental Design

The treatments received supplemental photoperiod light to provide a 20-hour day length. Each treatment consisted of 5 replicates loaded with the standard 3 peat:l vermiculite media, incorporating 2 kg/m³ 12 mesh and finer dolomite lime, and 0.75 kg/m³ Micromax. All treatments were double-sown in PSB 313A's. Fertilization was according to standard Green Valley Regime with STEM applied throughout the season at 0.5% of the fertilizer weight.

Seedlots

The seedlots used were:

Sw	04177 (MRB)	93Hl1/B3/04177/0.91	- 95% 436 s/g
Fdi	08149 (2030)	82Ll2/B2/08149/1.13	- 89% 106 s/g
Bi	05107 (EK)	82Jl1/B3/05107/1.53	- 76% l00 s/g

Treatments

1. Control: Sodium Vapour Photoperiod Extension
   Standard Green Valley Regime
   Grower - 20-20-20 at 100 ppm N
   Finisher- 20-20-20 at 50 ppm N
   Photoperiod supplemented with HPSV light source

2. Nijssen Light Photoperiod Extension
   Standard Green Valley Regime
   Grower - 20-20-20 at 100 ppm N
   Finisher- 20-20-20 at 50 ppm N
   Photoperiod supplemented with LED light source

Light treatments were separated from each other by black polyethylene curtains, which were drawn at the end of each day and opened in the mornings.

Evaluation

Frequent observations were recorded throughout the season with regard to growth and bud formation and ease of dormancy induction after seedlings reached optimum height. Static samples measured during the season have been used to generate growth curves.

Random samples collected at the time of bud-set and at the end of the year were processed for morphological comparison. Soil samples were collected and pH and conductivity measured. Frequent observations were recorded regarding incidence of disease and general appearance (colour differences, growth).

Results

In all three species, few differences in morphological development were observed over the course of the growing season. The *Abies lasiocarpa* treatments were abandoned after they set bud in both treatments within six weeks of germination. Growth curves generated from static sample measurements (Figures *1 and 2)* demonstrate little difference in growth under the two light sources. In both species, bud set was delayed until the photoperiod lights were removed. The interior Douglas fir growth *(Figure 1)* is identical under both light sources. The interior spruce growth appears to be similar under both lights but the spruce does seem to have set bud earlier after being removed from under the Nijssen lights *(Figure 2)*. Random samples collected at the end of the season were processed for height and root collar diameter measurements as well as shoot and root dry weights. The results are tabulated in *Table I* and depicted as bar graphs in *Figures 3 - 6*.

In random samples collected at the end of the season both the interior Douglas fir and the interior spruce demonstrated slightly less height growth under the Nijssen light. RCD was significantly lower under the Nijssen lights in the interior fir, but not in the interior spruce *(Figures 3 & 4)*. In both species, the top dry weights were reduced under the Nijssen light treatment, while root dry weight appeared unaffected. Height and RCD measurements were tested using three ANOVA procedures; T-tests, Duncan's multiple range test, and Student-Newman-Keuls test.

Discussion and Recommendations

The Nijssen lights appeared to provide an effective light source for photoperiod extension, no less effective than the high-pressure sodium vapour lights, which are currently being used in most conifer seedling nurseries throughout the province. The lights themselves are relatively expensive when set up in a stationary configuration to cover an entire greenhouse.

(continued...)

Ten lights and one power source cost about $2500 and a 30 by 200 foot greenhouse would require approximately 50 lights, costing about $12,000. On the other hand installation and wiring are extremely easy and inexpensive. Ten Nijssen lights can be strung together in series, powered by one twelve volt transformer unit and the lights can be mounted on any steel frame by their magnetic bases. Wiring is by patch chords with phone connectors which plug into jacks on each light. These are provided in lengths which provide proper spacing between lights. Their portability might make them appealing to nursery growers who could take advantage of it. A possible application of this lighting system which might help offset the high cost would be to try the lights on an irrigation boom to interrupt the dark period rather than to extend the day length.

As far as their performance goes, the fir didn't loose enough in top growth or RCD to be of concern under production conditions, and the reduced height in both species may well be a point in their favour considering root mass doesn't appear to have suffered. It appears that this light source might allow more controlled height prior to budset, which would provide a definite advantage.

Allan McDonald
Extension Service, Victoria

Table 1 SX90204q - Nijssen Light Comparison

Averages of random measurements taken at 38 weeks

Seedlot: FDI 8149

Treat	Height	RCD	Top Wt	Root Wt	Tot Wt	T/R	QI
1	18.9	2.8	1.21	1.07	2.29	1.1	0.29
2	16.1	2.6	1.00	1.00	2.10	1.0	0.28

Seedlot: Si 4177

Treat	Height	RCD	Top Wt	Root Wt	Tot Wt	T/R	QI
1	15.3	2.4	1.20	0.74	1.91	1.6	0.2
2	14.3	2.5	1.1	0.78	1.85	1.4	0.3

Note: From each treatment, 75 seedlings were sampled randomly (15 from each of 5 replicate blocks) for the morphological assessment

Figure 1 SX90204q - Nijssen Light Trial

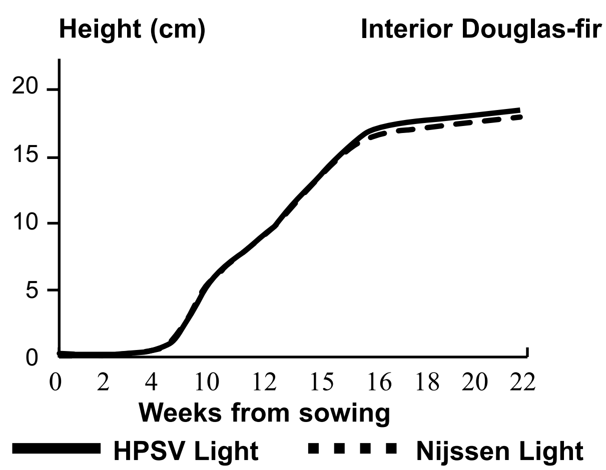


Figure 2 SX90204q - Nijssen Light Trial

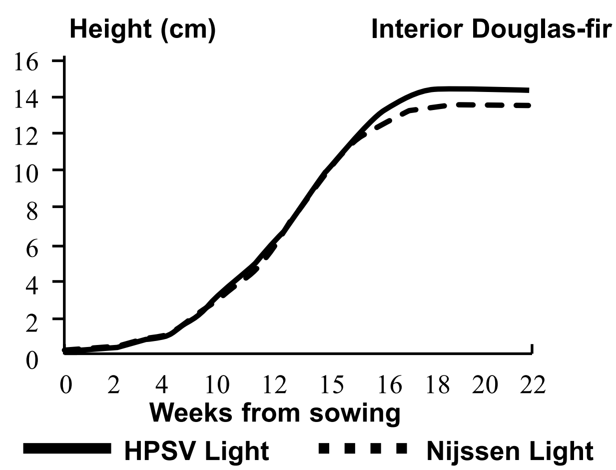


**Figure 3 SQ90204q - Nijssen Light Trial
Height and RCED at 38 weeks
Fdi 8149 - Treatments 1 & 2**

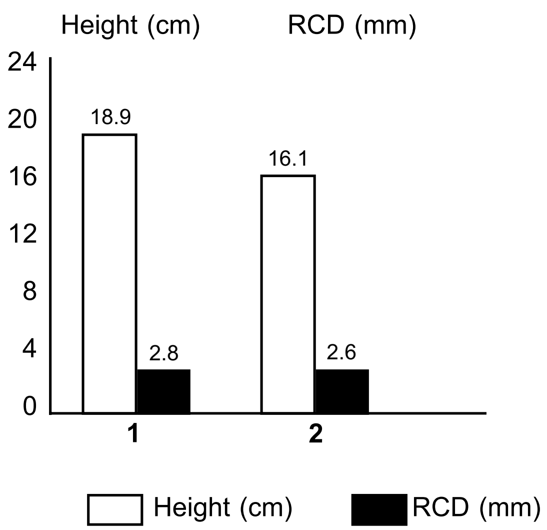


**Figure 4 SQ90204q - Nijssen Light Trial
Height and RCED at 38 weeks
SW 4177 - Treatments 1 & 2**

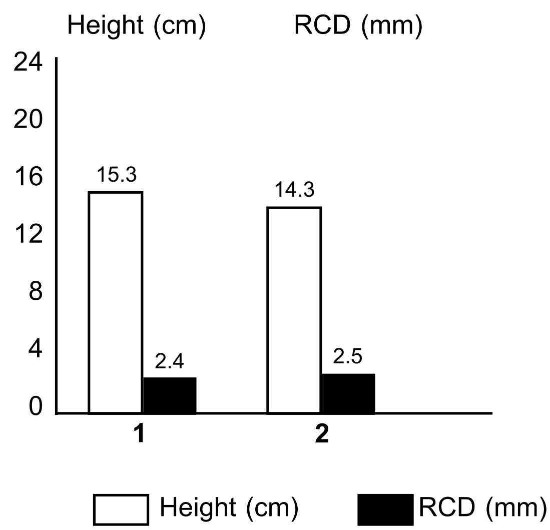


**Figure 5 SQ90204q - Nijssen Light Trial
Dry Weights at 38 weeks
Fdi 8149 - Treatments 1 & 2**

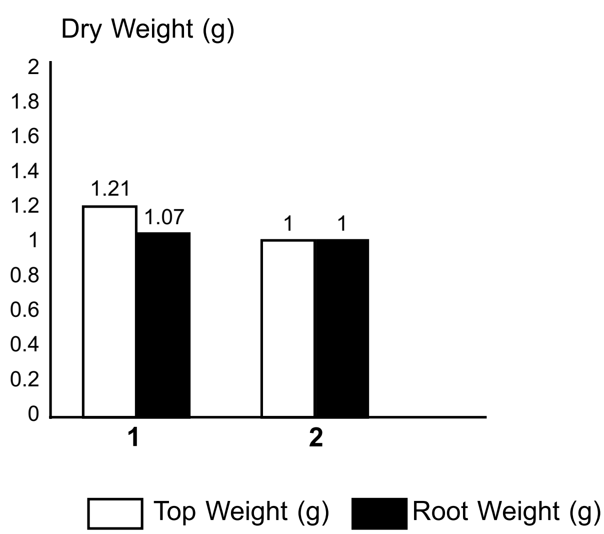
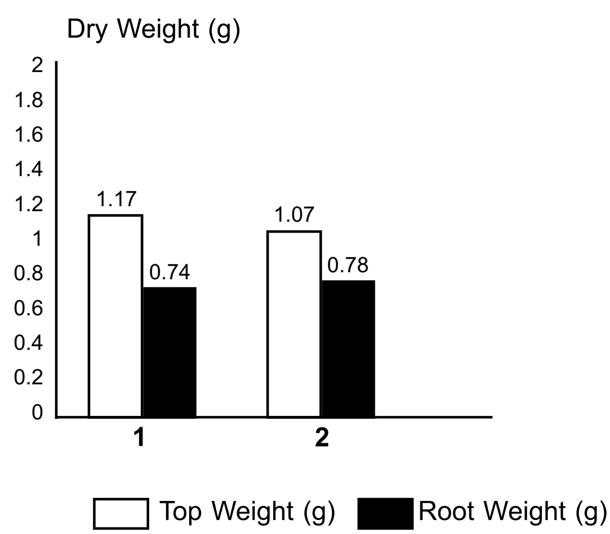


**Figure 6 SQ90204q - Nijssen Light Trial
Dry Weights at 38 weeks
Sw 4177 - Treatments 1 & 2**



LITERATURE REVIEW

Growing Healthy Seedlings
Identification and management of pests
In northwest forest nurseries.

by Philip B. Hamm, Sally J. Campbell, Everett M. Hansen.

This book provides an illustrated guide to the identification and management of fungi, insects, and abiotic conditions that cause problems in Northwest bareroot conifer nurseries. A key to nursery pests offers initial guidance in identification. Separate chapters address individual pests with details on recognition, damage cycle, and management practices to reduce losses. A final chapter discusses the integration of pest-management practices into the entire nursery operation. Tables of pesticides and pests controlled, a check-list of control activities keyed to the seedling growth cycle, and a glossary of terms included in the book.
Copies can be requested from:

Jerry Beatty, Forest Pest Management,
P.O. Box 3623
Portland, OR 97208
Phone 503-326-2727

Farm Chemicals Handbook 91

This annual publication provides an up-to-date-quick and easy reference to the chemicals used in the Farm Industry. It includes a guide to micronutrients with manufacturer, trade name and product description, as well as a listing of fertilizer brand names and descriptions cross referenced by companies. A pesticide dictionary lists compounds available in the U.S., with a technical description of the material, the name of the producer and the common, scientific and brand name. There is also a buyer's guide and a listing of the names, main office addresses and telephone numbers of all farm chemicals manufacturers and suppliers.

It is available from:

Meister Publishing Co.
37841 Euclid Avenue,
Willoughby, OH 44094
Phone 216-942-2000

The cost is $67.00 U.S. for the 1991 edition. Make cheques payable to Meister Publishing Co. It can be ordered by fax or mail.

Nursery Pest Management
Final Environmental Impact Statement (FEIS)

This 86 page document which has a separate summary report as well as 2 appendices is available at no cost from:

Sally J. Campbell
Nursery E.I.S. Team Leader
USDA Forest Service
319 S.W. Pine Street
P.O. Box 3623
Portland, Oregon 97208

It describes the purpose and need, the nurseries, the issues, the alternatives, and the environmental consequences of pest management at Forest Service tree nurseries in Washington and Oregon.

Guidelines for the Sanitation
of Nursery Seedling Containers

by Michael Peterson

This guide describes step-by-step procedures for washing seedling blocks. Several products that proved effective in trials are recommended. Copies are available at no charge from:

Silviculture Branch
Ministry of Forests
3rd Floor, #31 Bastion Square
Victoria, B.C. V8W 3E7
Phone 604-387-1191
Fax 604-387-1467

Container Tree Nursery Manual, Agricultural Handbook 674
This manual is being published as a series of seven volumes. Two volumes of the Manual are already available: Volume Four - Seedling Nutrition and Irrigation, and Volume Five - Nursery Pests and Mycorrhizae, Volume Two - Containers and Growing Media has just been published. The remaining volumes are in various stages of completion, and will be published over the next couple of years.

Single copies of these Agricultural Handbooks will be provided by the USDA-Forest Service, Cooperative Forestry at no charge - contact:

(continued...)

Tom D. Landis
USDA-Forest Service, CF
P.O. Box 3623
Portland, OR 97208-3623
Phone 503-326-2727

Additional copies of the latest publication can be ordered from the U.S. Government Printing Office using the following stock numbers:

Vol. Two	Containers and Growing Media	1990 001-001-00644-1 $9.50 U.S.

A simple staining technique for assessing feeding damage by *Leptoglossus occidentalis* Heidemann (Hemiptera: Coreidae) on cones.

Campbell, B.C. and P.J. Shea. 1990. Can. Entomol. 122:963-968.

This paper outlines a technique to identify feeding punctures made by the western conifer seed bug on cones. A dye (ruthenium red) is used to stain the residues of digestive enzyme activity left on the punctures when the insects feed. This could be a useful too for seed orchard managers wanting to sample seed bug damage on cones during the growing season.

Bibliographical Review of *Pachypappa tremulae* (L): a root aphid of conifer seedlings in containers

by R. Lavallee

Copies are available free of charge from:

Laurentian Forestry Centre
Canadian Forestry Service
1055 du P.E.P.S., Box 3800,
Sainte-Foy, Quebec
G1V 4C7

This booklet describes the taxonomy, distribution and hosts, biological cycle, damage and control of the conifer root aphid in reforestation nurseries in Quebec.

ERRATUM:

Please note the following correction in 'Container Seedling Inventories', Volume 3, Number 2, under 'Empty Cavity Count', the second sentence should read; 'After germination, count and record the empty cavities in 1.0% of the blocks to a minimum of 10 blocks and a maximum of 25 blocks.'

NOTE:

Sources

Gwen Shrimpton
David Trotter
Eric Van Steenis
Nursery Extension Services,
3605 192nd St.,
Surrey, B.C. V3S 4N8.
Tel. (604) 576-9161

Mishtu Banerjee
Pacific Phytometric Consultants,
1531 - 133B Street,
Surrey, B.C. V4A 6A5
Tel. (604) 531-1948

Joy Parkinson
Coastal Seed Orchard Admin.,
Box 816,
Duncan, B.C. V9L 3Y2
Tel. (604) 746-1225

Tim Crowder
Mt. Newton Seed Orchards
1450 Mt. Newton Crossroad,
R.R. #2, Saanichton, B.C.
V0S 1M0
Tel. (604) 652-4211

Allan McDonald
Saanich Test Station
Ministry of Forests, R.R. #2,
7380A Puckle Rd.,
Saanichton, B.C. V0S 1M0
Tel. (604) 652-5413

John Dennis
Pacific Forestry Center
506 W. Burnside Rd.,
Victoria, B.C. V8Z 1M5
Tel. (604) 388-0655

Hans Lussenburg
Northern Admin. Center
Ministry of Forests
R.R. #7, R.M.D. #6,
Prince George, B.C. V2N 4T5
Tel. (604) 963-9651

Don Summers
Mike Pelchat
Shirley Mah
Michelle Schmidt
Silviculture Branch
Ministry of Forests
3rd Floor, 31 Bastion Sq.,
Victoria, B.C., V8W 3E7
Tel. (604) 387-1191

Dave Simpson
Kalamalka Research Station
and Seed Orchard,
3401 Reservoir Rd.,
Vernon, B.C. V1B 2C7
Tel. (604) 549-5577

Gordon Grant
B.C. Min. of Agriculture & Fisheries
32916 Marshall Rd.,
Abbotsford, B.C. V2S 1K2
Telephone: (604) 852-5350

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