TREE IMPROVEMENT

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Seed and Seedling Extension Topics

Extension Services Section - Editor, Don Summers

Welcome to Volume 3 Number 1! The way that the mailing list is growing, it would seem that you are enjoying the newsletter so far. Don't forget you are the people that are making it happen. With the number of interesting things that are going on out there, I think we can look forward to many more successful issues.

Speaking of the mailing list ... we are truly an international publication. I received a Christmas card from Mr. Jin Lin Shi, of the Peoples Republic of China. Thank you, Mr. Shi. I hope that if you can find the time you will send us a note telling us about your work. I'm sure there are many people who would like to hear about it.

And now a commercial plug in the interest of ecology. Mansonville Plastics (First Choice Manufacturing), in Langley, B.C., has indicated they are interested in the styroblocks people are discarding. For more information, contact Bob McKay or Mike Young at 1-800-663-8162.

As part of our continuing efforts to make this newsletter useful to you, we are considering starting a column that addresses specific questions submitted by readers. If you have a question about nutrients, growing conditions, pests, equipment, etc. send them along and we'll find an answer for you. If we can't answer the questions directly, we will find someone who can.

Growers Notes*

More on Gall Aphids

In the last newsletter (Vol. 2, No 2) 1 reported on a successful trial using dormant oil against spruce gall aphids. The oil was applied in April 1989, before bud flush, and appeared to control the aphids. The foliage changed colour slightly but appeared healthy.

Well, the plot thickens...!

While the trees looked fine through August, a survey during September showed that 23% of the trees in the sprayed block had developed yellow or red needles. This discolouration was not consistent within trees; sometimes 1988 needles were affected most, sometimes the older needles were affected as well and sometimes the damage was confined primarily to the interior of the tree.

Damage was scattered throughout the sprayed rows, with many trees not showing any symptoms at all. Similar symptoms were seen in the rest of the orchard, but at a very low level.

Some collections of dead and dying needles were made in September 1989 and sent to the CFS. A needlecast fungus, *Rhizosphaera* sp., was found in some of the samples.

The questions that arise are numerous. For example, if the oil was phytotoxic, why did the damage not show up on trees until September? Wouldn't one expect the dessication of the needles to occur during the heat of the summer? Is the effect clonal? We did not have clonal replication in this trial so this remains an unknown. If the needlecast was the cause, why was it not more prominent in the rest of the orchard? Did the spray somehow predispose the trees to infection? On a more global frame of reference, if the trees were predisposed to disease by the spray, might other sprays that we put on trees affect their susceptibility to disease.

We have not reached a consensus yet on what happened. We will be watching the condition of the trees and we have done some more sampling to check again for the needlecast.

The message right now is.... this tactic for controlling gall aphids is not idiot-proof yet. Use care if you are considering it.

Don Summers
Extension Services, Victoria

Grey Haired Seedlings?

As caliper demands increase and summer planting programs continue to be held up or sometimes can- celled, nurseries are increasingly faced with the problem of holding early sown 1-0

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

and finishing 2-0 crops in their nurseries. These crops invariably have budset very early in the season, and have to be held that way through a period of time which, in nature, would be their most active growth phase.

This year some nurseries found that these crops displayed pronounced yellowing of upper needles and, in some severe cases such as the earliest sown 1-0 spruce crops, actual browning and dropping of upper needles. Could it be that the post-budset cultural and climatic regimes on these early sown / early budset seedlings are encouraging premature leaf /needle senescence? Are nutrient, drought, heat, light, etc., stresses through the summer and early fall accelerating the natural aging process of the needles?

It is well documented that cytokinin, a phytohormone which delays leaf senescence, has less effect as the leaf ages. Abscisic acid, also called the "stress hormone", favours abscission and senescence of leaves and fruit is produced in rapid response to environmental factors such as deficiency of water or nitrogen. It is also produced by dormant buds, is antagonistic to the three growth hormones (cytokinins, gibberellins, auxins) and enhancer, membrane permeability, thereby disrupting the plant's source/sink relationships.

All in all, it would seem logical that soon after budset seedlings should either (1) be planted in the field; or (2) be held in a dormant, low stress condition until they can be. If neither of these is possible, then why are we producing these seedlings?

E. van Steenis
Extension Services, Surrey

Silicon

Silicon is one of the most common elements in the biosphere. In the plant kingdom it is found in greatest abundance in grasses, in the bark of trees and in common cereals. In soluble form, silicon is transported and distributed through the xylem. It is deposited in plant cell walls, favouring the outer walls of epidermal cells on both surfaces of the leaf, because these are the termini of the transpiration stream.

Some documented benefits to plants which take up silicon are:

1. Increased effectiveness of epidermal cell walls as barriers against water loss by cuticular transpiration and fungal infection.
2. Increased effectiveness of the root cell endodermis as a barrier against invasion of the stele by parasites and pathogens.
3. Decreased plant digestibility to herbivores, e.g., Equisetum arvense.
4. Reduced potential toxicity of heavy metals such as Mn.
5. Compression resistance of xylem vessels under conditions of high transpiration.

Saanich Test Station will be starting trial work with silicon on conifer seedlings in the spring of 1990.

E. van Steenis
Extension Services, Surrey

Western Redcedar Cone Midge

During the past three years, western redcedar cones have been examined for infestations and damage due to the western redcedar cone midge, *Mayetiola thuiae.*

Spring egg surveys and autumn damage assessments (larva and number of seeds destroyed) have been conducted during heavy, moderate and light crop years. Light, moderate and heavy damage levels, respectively, have been observed during this time. Two larval parasites have also been seen. These are wasps, probably from the genera *Torymus* and *Tetrastichus,* and they occur in about equal proportions. Together they can parasitize up to 40% of the larvae in any given year. These wasps do not prevent or arrest damage in the year of feeding because they attack cone midge larvae after the damage to seed has been done. However, they may be connected with reduced damage in subsequent years (up to two so far). The wasps were not found in cones during low infestation years.

A qualitative correlation has been determined between egg and midge populations and some trends have been observed. If a large number of eggs/cone is recorded in the spring survey then the damage to seed by feeding larvae will be heavy. Likewise, when few eggs are seen then damage will be slight. In a moderate infestation, the egg surveys tend to underestimate (slightly) the midge population. Also, there appears to be no method of predicting the rate of parasitism before the "treatment window" has passed for the midge.

Treatment trials to control damage to seed by M. *thujae* were initiated in high and moderate infestations. These were very successful and efficacy data are being submitted for registration. Egg surveys, damage assessments and parasite counts will be continued in 1990.

Bev McEntire and Don Summers
Extension Services, Victoria

Metasystox-R Against Spruce Cone and Seed Insects

Early season surveys of female flowers (conelets) for insect eggs are now used routinely in Douglas-fir seed orchards to determine spring infestation rates by cone and seed insects. If an

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infestation is above a certain threshold, a treatment with a systemic insecticide is recommended. As a result of this process, insecticides are used less than 50% of the time in Douglas-fir seed orchards to control cone and seed pests.

In order to provide a similar service to spruce seed orchards, trials have been conducted over the past several years to determine damage thresholds and to obtain efficacy data for registration of insecticides against spruce cone and seed insects.

During 1989 a trial was conducted at an interior spruce seed orchard in an attempt to obtain efficacy data for registration of the systemic insecticide Metasystox-R (MSR). A conelet survey had revealed a high infestation rate of a seed-destroying insect, the spruce cone maggot *(Strobilomyia neanthracinum).*

Two application methods were used in the trial: a conventional spray application using a backpack sprayer, and a direct injection using a drill and syringe. Three spray application rates were tested, 0.125, 0.25 and 0.5% a.i./litre. Injections were made at full product strength with the insecticide applied directly into holes at 10 and 15 cm intervals around the base of the test trees. Untreated trees were also included.

Treatments were all successful in controlling the cone maggot without adversely affecting seed germination rate. The data will now be submitted to support registration for MSR for use against spruce cone and seed insects.

Don Summers and Bev McEntire
Extension Services, Victoria

A Quick, Reliable Test for Determining the Species Composition of Spruce Seedlots

Spruce seedlots containing species mixes and hybrids of Sitka spruce and interior spruce cause problems in the nursery because of the different growing regimes of the species. The ability to determine the species composition of seedlots prior to growing is a valuable decision-making tool. A DNA probe derived from the chloroplast has been developed and tested in screening of pure and mixed seedlots of Sitka and interior spruce.

The results show that this probe can be used to screen total DNA samples to reliably identify and quantify the species composition of two-week-old germinants. A sample size of 0.5 g can be used and less than a 5% species contamination can be detected. Analysis of individual seedlings from a hybrid seedlot shows that both chloroplast types can be found in some individuals.

This result demonstrates the occurrence of hybrid individuals in seedlots and suggests that chloroplasts, which were thought to be derived from the pollen parent, can be inherited from both parents in spruce species. Seedlot identification obtained with the DNA probe agreed with the recommended growing regimes based on the nursery performance of the seedlings. This analysis is now available on a fee for service basis.

Ben Sutton
B.C. Research Corporation

Incidence and Pathogenicity of Seedborne *Fusarium* on Douglas-fir

Fusarium has caused an increase in disease problems during the last few years in British Columbia conifer nurseries (J. Dennis, pers. comm.). It is important to determine if *Fusarium* is introduced on conifer seed since this innoculum source could play a role in the epidemology of *Fusarium* diseases. Therefore, a study was initiated to evaluate the presence and pathogenicity of seedborne *Fusarium* on Douglas-fir.

Ten coastal B.C. Douglas-fir seedlots were assessed for the presence of seedborne Fusarium. The seedlots were chosen to provide a range of percent germination and age to determine if these factors correlate with the presence of the pathogen. Seed was rinsed for 5 minutes under running tap water to remove debris and any surface microorganisms not closely adhering to the seed. Seed was dried in a laminar flow hood to remove surface moisture and 400 seeds per seedlot were asceptically placed on Komada medium.

Fusarium was detected in 50% of the seedlots. Per cent of seeds from individual seedlots harboring *Fusarium* ranged from 0.25 to 10.75%. There was no correlation between the incidence of *Fusarium* and percent germination or seed age.

Seven species of *Fusarium* were isolated from Douglas-fir seed and included *Fusarium acuminatum, F. avenaceum, F. lateritium, F. moniliforme, F. oxysporum, F. poae* and *F. sambucinum.* Twelve Fusarium isolates, comprising 6 species, were assessed in pathogenicity assays. Disease symptoms were observed after four weeks of incubation and included pre- and post-emergence damping-off as well as fungal colonization of stem and needle tissues. Fusarium isolates ranged in virulence from low to high. *F. oxysporum* isolates were the most pathogenic and caused emergence failure or disease in 64-88% of seed that was inoculated. *F. moniliforme* isolates caused emergence failure or disease in 49-69% of seed that was inoculated. The remaining species caused lower levels of disease. A more complete study should be done to determine the extent of *Fusarium* seedborne contamination on Douglas-fir and other conifer species and deter- mine the role of this innoculum in disease development.

Paige Axelrood
B.C. Research Corporation

On the Premature Opening of Yellow Cypress cones on the Saanich Peninsula

A study was initiated to investigate possible cause(s) for premature cone and seed development observed on yellow cypress *(Chamaecyparis nootkatensis* (D. Donn) Spach) trees grown on the Saanich Peninsula. Systematic observations were carried out on 1987-1989 cone crops after the removal of any one and two-year-old cones. In February, seed and pollen cones were isolated and controlled crosses were made.

By late September (nine months from pollination), isolated and unisolated seed cones started to show signs of maturation (i.e., drying and cone shedding). Seed cone samples were then collected every month for anatomical investigation. In January, (11 months from pollination) cones were collected and seeds were extracted by hand on an individual tree basis.

Germination test results on the extracted seeds varied between 8 and 42% among the studied trees. Anatomical observations revealed that the 11-month-old embryos were similar to those collected from 18-month- old cones. It was concluded that the transplanting of these trees from their high-elevation sites to a warm, dry, low-elevation site provided suitable environmental conditions for seed cones to continue their development, without significant dormancy slow-downs due to cold temperatures. The observed reproductive cycle plasticity caused by transplanting trees to a warmer location reflects the dependence of development on environmental contingencies.

Debbie A. McLeod
Yousry A. El-Kassaby
Saanich Forestry Centre

Tech Talk

Nematodes May be the Answer to Several Problems

Entomogenous or insect parasitic nematodes have received much attention in the past few years.

Their potential as biological control agents against in- sect pests in agriculture, nurseries and horticulture has lead to considerable research on their biology and efficacy. Consequently, these nematodes have become commercially available and, under certain conditions, they have been more effective than chemical pesticides for insect control. In essence, they represent the perfect bio-control agent with exemption from registration, high virulence, ease of mass production and a broad host range. In addition, these nematodes have been shown to be harmless to mammals, many beneficial insects and plants.

These nematodes are generally from two families in the phylum Nematoda, namely Steinernematidae and Heterorhabditidae. They are basically bacterial feeders but differ from other rhabditid types of nematodes by having a mutualistic association with bacteria of the genus *Xenorhabdus.* Both steinernematids and heterorhabditids are found throughout the world but in the natural environment they occur in relatively low numbers. Like most nematodes, these two genera have a simple life cycle from egg, through four juvenile stages to a final adult stage. The infective or third-stage juvenile, which is the one commercially available, is particularly resistant to many adverse environmental conditions. The infectives are ensheathed in the cuticle of the previous juvenile stage that presumably provides the nematode with a greater ability to resist environmental stresses. The infectives are the only free-living form of these nematodes. They do not feed and are able to survive for long periods before finding a host. These juveniles contain live cells of the mutualistic bacteria in a special pouch adjacent to their intestines. This serves to carry the bacteria to a different host.

The infectives locate their targets by a variety of means, which include C02, excretory products and/or radiant heat pr by the hosts. They enter via natural body openings and then penetrate the mid-gut into the insect's haemocoel or body cavity. The nematodes then release their Xenorhabdus bacteria which rapidly multiply and kill the host within 48 hours. The infectives then feed on the bacteria and degenerating host tissues. Within a few days, the juveniles develop into adults which then cycle through 1 to 3 generations, depending on the host and environmental conditions. Unlike the steinernematids, which have both males and females through each generation, the heterorhabditic infectives all develop into hermaphroditic females. These females then pass through a sexual generation that is followed by a new production of hermaphroditic infective stage larvae. These new infectives then exit the dead host and begin the search for new hosts. Under favourable conditions the cycle takes approximately 2 to 3 weeks.

Two key environmental factors that greatly affect the efficacy of these nematodes are humidity and temperature.

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None of these nematodes are very resistant to rapid dessication. Thus, foliar applications for the most part have been unsuccessful. Temperature tolerances for survival, infection and reproduction vary greatly between species and strains. In general, the nematode's environmental origin tends to dictate its temperature range. Steinernematids show higher activity profiles at lower temperatures (4-14°C) compared to the heterorhabditids (10-16°C). Other physical factors include oxygen levels and the detrimental effects of solar radiation and UV light. Salinity, pH and photoperiods appear to have little or no effect on the nematode's ability to detect a potential host.

Both genera of nematodes have been observed to infect over 200 species of insects. The two major pests that would be targeted in forest nurseries are first, the black vine weevil *(Otiorhynchus sulcatus)* and second, the cranberry girdler *(Chrysoteuchia topiaria)*. Both larvae, particularly the black vine weevil, can cause significant damage to seedlings by girdling stems and/or stripping the entire root system. In general, the effects of an infestation are not usually noticeable until the end of the growing season or the next spring. Usually, there is only one weevil generation per year, but this may alter with changing cultural practices. With nurseries growing more stock for summer shipment, the potential for cycling generations of black vine weevil poses an even greater threat.

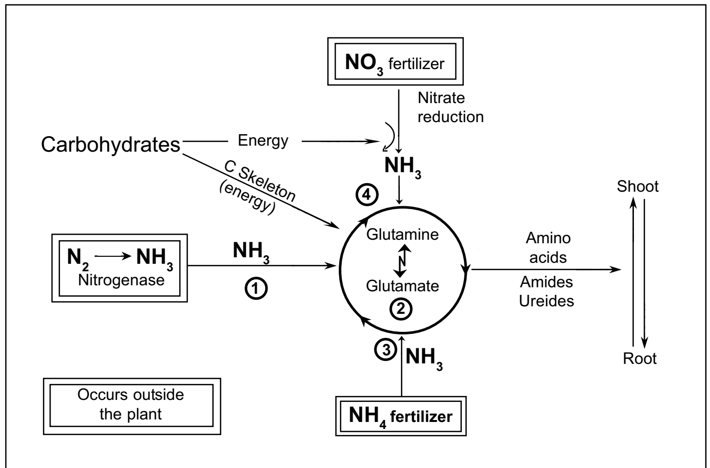
Traditionally, these nematodes have had good to excellent success in controlling infestations of these pests. Yet to date, this has not translated well to the forest nursery environment. Four principal factors have contributed to the lack of success, mainly the coarse peat mixture used for growing media, frequency of irrigation, low temperatures, and variable efficacy. The first 2 factors, especially at the height of the growing season, have probably washed the nematodes out of the root zone. The third is related in part to the decreased efficacy of the nematodes at low temperatures and that the most susceptible insect larval stages are found only in late fall or early spring. Variable efficacy is related to problems in mass production and strain differences.

There may be avenues to circumvent these problems. Incorporating nematodes into the irrigation cycles may maintain nematode levels, and provide a constant prophylactic treatment. Nematodes can easily be applied through any irrigation system with no significant equipment modifications. Temperature constraints may be decreased with testing of recently isolated cold-tolerant strains of steinernematids. Characterization of strain and efficacy differences is presently being addressed. As there are no completely effective chemical avenues currently available to forest nurseries, further trials are planned to increase nematode performance as a viable component of an integrated pest management program.

Dave Trotter
Extension Services, Surrey

Ammonia or Nitrate?

Nitrogen, because of its constituent role in proteins, nucleic acids chlorophyll and their synthesis, is one of the most important plant macronutrients. This importance also allows us to use it as a tool for the control of growth, i.e., nitrogen stress to reduce shoot length. Elimination of nitrogen from the fertilizer regime is one way of implementing control, but this leads to a severe nutrient imbalance and impairs plant physiological and biochemical processes. A more natural approach to partial control can be achieved through the application of nitrate based fertilizers instead of ammonium based fertilizers.



(after Marchner, 1989)

Nitrate and ammonium are the major sources or inorganic nitrogen taken up by the roots of higher plants. Ammonium and, in particular, its equilibrium partner ammonia (NH3 + H20 = NH4+ + OH-), are toxic at quite low concentrations. The main pathway of detoxification is the immediate formation of amino acids, amides, and related compounds upon entry into the root cells. Carbohydrates stored in the roots are used to supply the carbon skeletons for these amino acids, amides and related compounds, which are then translocated through the xylem to the shoots for further utilization. Because nitrogen assimilation in this way is such a fast process, plants grown solely on an ammonium based nitrogen source may at times deplete their carbohydrate resources to a dangerously low points, resulting in soft, succulent, very vegetative plants. What is happening, in effect, is that the ammonium is driving plant growth.

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Nitrate, on the other hand, is not as toxic and is mobile in the xylem on its own. This facilitates its transport to anywhere within the plant where nitrogen may be needed. In order for nitrate to be utilized, it must first be reduced to ammonia. This is a multi-step process requiring several enzymes, cofactors such as molybdenum, energy and time. The ammonia, as before, can then be utilized for amino acid, amide and related compound synthesis which are then further utilized.

What is important about nitrate is that it does not *have* to be reduced to ammonia and subsequently force amino acid synthesis, etc., and carbohydrate depletion. It can be utilized according to need instead of driving plant growth like ammonia would. Excess nitrate fed to plants is stored in roots and shoots in vacuoles and other storage organs. Release from these storage organs is in response to need and is gradual, governed basically by the maximum rate of translocation across the vacuolar membrane, as well as osmotic potential.

Also, even after release, nitrate has to go through the process of reduction to ammonia which further dam- pens the "nitrogen fertilizer response". Then, one last point would be that nitrate reduction takes place where nitrogen is needed. Therefore, carbohydrates in the roots are not preferentially depleted over those in the shoots.

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Eric van Steenis
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Effect of Controlled-Release Fertilizers on Formation of Mycorrhizae in Container-Grown Engelmann Spruce

INTRODUCTION

Soluble fertilizer nutrient regimes are often supplemented in container nurseries with controlled-release formulations. The level of fertilizer salts resulting from this practice may suppress mycorrhizal formation (Marx et al. 1977) resulting in a high percentage of non-mycorrhizal trees, or eliminating naturally occurring strains other than *Thelephora terrestris.* Nursery fertilization practices are important in growing seedlings of accept- able size that have abundant mycorrhizae.

Reducing fertility level may promote establishment of natural fungal strains which substantially improve root system quality compared to *Thelephora.* For example, E-strain fungi increase branching of mycorrhizal roots resulting in root plugs that withstand handling better than those colonized by *Thelephora.* E-strain is common in conifer nurseries when cultural practices are favourable for growth.

The objective of this study was to examine natural mycorrhizal colonization of Engelmann spruce under 6 fertility regimes incorporating Osmocote^R , Nutricote^R and Micromax^R as supplements to soluble fertilizer.

METHODS

Seeds of Engelmann spruce were sown at Balco Canfor Reforestation Centre Ltd. nursery in March 1987 in PSB 313A styroblocks (198 cavities per block, 947 cavities/m^2. The growing medium was composed of peat and vermiculite with dolomite lime. Osmocote (9- month release, 18-6-12), Nutricote (16-10-10), or Micromax Micronutrients were incorporates at rates of 4.7 kg/m for the former two and 385 g/m for Micromax.

Peters Conifer Starter^R (7-40-17), Grower R (20-17-19) and Plant-Prod Finisher^R (8-20-30) were applied to all treatments according to standard practices. All treatments received the same amount of soluble fertilizer over the growing season.

The Dickson Quality Index (Dickson et al. 1960), for which no standard is established, is a measure of seedling balance and is calculated as: dry weight/height- diameter ratio + shoot:root ratio.

RESULTS

Seedling Growth

Osmocote and Nutricote affected shoot length, stem caliper, seedling weight and shoot:root ratio (Table 1). Shoot length of treatments with either Osmocote or Nutricote exceeded target standard (17.0 cm) set by the B.C. Forest Service while treatments not NPK supplemented were below minimum standard (12.0 cm). Among treatments receiving Osmocote or Nutricote, few consequential effects were established. Shoot length was about 2 cm greater with Nutricote and Micromax compared to Nutricote alone. Root weight was significantly greater when Micromax alone was present compared to treatments receiving either Osmocote or Nutricote. However, root weight of all treatments exceeded minimum standards set by the B.C. Forest Service (0.5 g); only the Osmocote treatment had a mean root weight below the target standard of 0.7 g.

Mycorrhizal Colonization

Intensity and diversity of mycorrhizal colonization was affected by fertilizer NPK ratio and presence of Micromax (Table 2).

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Table 1. Effect of six fertility regimes on Growth of Engelmann spruce.

	Supplement					
Growth parameter	Osmocote	Nutricote	Osmocote+ Micromax	Nutricote+ Micromax	Micromax	Control
Shoot Length (cm)	18.6 ac	17.3 bc	16.4 b	19.6 a	11.0 d	11.1 d
Stem Caliper (mm)	2.59 a	2.67 a	2.52 a	2.57 a	2.13 b	2.12 b
Dry weight of roots (g)	0.65 c	0.73 bc	0.75 bc	0.72 bc	0.90 a	0.83 ab
Dry weight of seedlings (g)	2.28 a	2.32 a	2.22 a	2.34 a	1.75 b	1.72 b
Shoot: root ratio	2.55 a	2.26 bc	2.06 c	2.33 ab	0.97 d	1.13 d
Dickson Index	0.24 b	0.27 ab	0.26 ab	0.24 b	0.29 a	0.27 ab

Means within rows not sharing a common letter are significantly different by Turkey's test at P=0.05.

Table 2. Effect of six fertility regimes on percentage of micorrhizal and nonmycorrhizal feeder roots of Engelmann spruce.

	Supplement					
Root Colonization	Osmocote	Nutricote	Osmocote+ Micromax	Nutricote+ Micromax	Micromax	Control
Thelephora terrestris	83 a	17 a	75 a	96 a	54 b	21 b
Mycelium radicis atroviren	0 a	0 a	8 a	0 a	3 a	3 a
Amphinema byssoides	0 a	0 a	0 a	1 a	0 a	6 a
E-Strain	0 a	0 a	0 a	0 a	43 b	69 a
Unidentified	0 a	25 b	8 b	0 a	0 a	0 a
Nonmycorrhizal roots	17 a	3 b	11 b	2 b	0 b	0 b

Means within rows not sharing a common letter are significantly different by Turkey's test at P=0.05.

Table 3. Effect of Amphinema on growth of Engelmann spruce.

	Amphinema	Control	P
Caliper (mm)	3.12	3.15	0.69
Shoot Length (cm)	25.08	23.47	0.05
Root Weight (g)	0.85	0.74	0.04
Total Weight (g)	3.16	2.71	0.01
Shoot:Root Ratio	2.80	2.81	0.97
Dickson Index	0.29	0.27	0.15

Feeder roots of treatments with Osmocote or Nutricote were colonized by *Thelephora terrestris* at percentages ranging from 72 to 96. Intensity of *Thelephora* was substantially reduced when E-strain was a major component. Percentage of nonmycorrhizal roots was greater with Osmocote alone than in other treatments.

DISCUSSION

Increased root weight and smaller shoot:root ratio under reduced fertility (Table 1) demonstrates that nutrient application can be used to alter seedling morphology while maintaining a size adequate for planting. A shift in carbohydrate allocation to root systems under reduced fertility has been reported (Van Den Driessche 1988).

A higher Quality Index for the Micromax treatment compared to Osmocote suggests that the former is superior for planting. Clearly, the small shoots may be a disadvantage on some sites, particularly where competing vegetation is important. The Index was devised to predict field performance by selecting the best combination of morphological parameters (Dickson et al. 1960). It has been successfully related to field performance (Roller 1976, Ritchie 1984, Payandeh and Wood 1988).

The major impact of NPK supplements on mycorrhizal colonization was to change the types of fungi present (Table 2). Fungal colonization differed most between Osmocote and controls. Osmocote was detrimental to both density and diversity of colonization resulting in seedlings with 17% nonmycorrhizal root tips and only one fungal species. Controls had no non- mycorrhizal roots and four fungal types.

Inhibition of mycorrhizal colonization in conifers by high levels of NPK is well known (Crowley et al. 1986). This may be explained by the influence of nitrogen and phosphorus on levels of root sugars (Marx et al. 1977).

Growth hormones produced by mycorrhizal fungi induce branching of feeder roots; in spruce the branching pattern is pinnate. Because different species of mycorrhizal fungi (and even different strains of one species) produce varying amounts of growth regulators, the degree of root branching and number of root tips differ by fungus (Hunt, unpublished data). In addition, there is a significant relationship between percentage of feeder roots colonized and root branching with more branching at higher rates of colonization (Amaranthus and Perry 1987). Extensive root branching not only results in root plugs that hold together well and withstand handling better (Hunt, unpublished data), but greater numbers of root tips may improve field performance on droughty sites (Amaranthus and Perry 1987).

The reduction in percentage of mycorrhizal roots is probably significant in terms of overall seedling quality, but greater fungal diversity may contribute to seedling success after outplanting on some sites (Perry et al. 1987).

ADDITIONAL STUDIES

Subsequent studies conducted in Kamloops have demonstrated that a combination of modest fertility reduction and well-draining, coarse peat moss can significantly increase natural colonization by *Amphinema* on spruce. When present on greater than 50% of feeder roots, this fungus alters height, root weight and total weight (Table 3).

ACKNOWLEDGEMENT

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Gary Hunt
Heffley Reforestation

Manipulation of N & P Levels to Modify Growth Rate

In a follow-up to previous nutrient trial work at Saanich Test Nursery, various levels of nitrogen and phosphorus were used to control the growth rates of interior spruce, coastal Douglas-fir and western redcedar. Past trial results have indicated that lower levels might provide a means of arresting growth in fast growing species. In this trial, levels were dropped below previous trial levels, resulting in the following treatments:

1. Control - Standard Green Valley Regime
2. Nitrogen Level I - Phosphorus Level 1
3. Nitrogen Level I - Phosphorus Level 2
4. Nitrogen Level I - Phosphorus Level 3
5. Nitrogen Level 2 - Phosphorus Level I
6. Nitrogen Level 2 - Phosphorus Level 2
7. Nitrogen Level 2 - Phosphorus Level 3
8. Nitrogen Level 3 - Phosphorus Level 1
9. Nitrogen Level 3 - Phosphorus Level 2
10. Nitrogen Level 3 - Phosphorus Level 3
11. Plant Prod Regime R

Level 1 Nitrogen - Sw 100 ppm Fdc, Cwr 75 ppm
Level 2 Nitrogen - 50 ppm
Level 3 Nitrogen - 25 ppm
Level 1 Phosphorus - 50 ppm
Level 2 Phosphorus - Sw, Fdc 10 ppm, Cwr 5 ppm
Level 3 Phosphorus - Sw, Fdc 5 ppm, Cwr 2 ppm

In all treatments, micronutrients were supplied through Micromax^{R} incorporated in the mix at 0.75 kg/m^{3} in addition to a STEM^{R} supplement at 0.5% of the control fertilizer weight with each application of fertilizer. Dolomite at 2 kg/m^{3} was included in the mix.

Static samples were collected throughout the season to generate growth curves and random samples were taken at 18 weeks and 32 weeks for height, RCD (root collar diameter) and dry weight measurement. Foliar samples were sent for analysis at the change from grower to finisher, after 4 weeks on finisher, and at the end of the season.

The tissue N and P levels in the foliar analysis samples collected before switching from grower to finisher reflected the fertilizer levels. This correlation was gradually lost during the remainder of the season, and in the final sample, the only correlation appeared to be in the lowest N application rates on western redcedar.

(continued...)

MANIPULATION OF N AND P LEVELS TO MODIFY GROWTH RATE

Nutrient Trial Average Results - 33 Weeks from Sowing
- Sown March 16,1989 All PSB313A (198)
- Height (cm), Root Collar Diameter (mm), Root Weight (g)

- QI - Quality Index = $\dfrac{\text{Dry Weight}}{\dfrac{\text{Height}}{\text{RC Diam}} + \dfrac{\text{Top Weight}}{\text{Root Weight}}}$

	Sw	4177	Fdc	16501	Cwr	20202						
Tr#	**Ht**	**RCD**	**RtWt**	**QI**	**Ht**	**RCD**	**RtWt**	**QI**	**Ht**	**RCD**	**RtWt**	**QI**
Min.	12.0	2.4	0.5		12.0	2.2	0.4		15.0	2.0	0.3	
Target	17.0	3.0	0.7		18.0	3.0	0.6		20.0	2.5	0.4	
1	17.9	2.5	0.82	0.26	20.3	2.7	0.91	0.25	27.7	2.6	0.55	0.16
2	22.4	2.7	0.73	0.24	25.2	2.9	0.87	0.24	28.6	2.5	0.44	0.13
3	21.3	2.6	0.66	0.22	24.6	2.9	0.80	0.23	26.1	2.4	0.53	0.14
4	20.5	2.6	0.76	0.25	21.1	2.6	0.78	0.21	24.2	2.3	0.48	0.13
5	20.3	2.7	0.80	0.26	23.7	2.8	0.71	0.21	28.8	2.6	0.57	0.16
6	15.9	2.3	0.79	0.25	21.7	2.7	0.80	0.22	28.7	2.5	0.52	0.14
7	17.8	2.4	0.73	0.23	21.0	2.7	0.86	0.23	23.7	2.2	0.52	0.13
8	16.6	2.2	0.69	0.21	20.7	2.6	0.83	0.22	27.4	2.5	0.61	0.15
9	16.0	2.3	0.81	0.24	22.8	2.8	0.88	0.24	24.4	2.3	0.59	0.14
10	13.8	2.2	0.70	0.22	15.4	2.2	0.83	0.22	22.0	2.2	0.55	0.13
11	16.0	2.4	0.62	0.22	22.6	2.9	0.76	0.24	27.8	2.7	0.47	0.15
RR11	20.0	2.7	0.42	0.17	33.1	2.8	0.47	0.15	30.7	2.5	0.22	0.09
SM11	15.6	2.6	0.52	0.21	21.5	2.4	0.51	0.15	26.7	2.2	0.27	0.09

In the mid-season random samples, the coastal Douglas-fir appeared to be the least affected by the diminished nutrient levels. The only treatment with abnormal appearance was treatment #10 with stunted tops and apparently normal roots. Similarly, the RCD's were lowest in treatment #10. Root weights were slightly higher at lower nitrogen levels.

The western redcedar at 25 ppm N (treatments #8-10), had purple foliage, and at 2 ppm P, poor lateral root development. Treatment #7 had stunted tops with purple tips and treatment #3 had purple foliage and reduced root development. With the exception of treatment #10, root weights were all similar.

In the white spruce treatments, all treatments showed normal root development, but other than treatments #1-3, all had purple foliage. In treatments #5, 6 and 10, the tops were stunted. Root dry weights showed little variation.

In all species, comparison using Dickson's Quality Index showed little difference between treatments.

The accompanying table summarizes the measurements taken from the final random samples, collected in October and November. By the time this sample was collected, the colour of the foliage had returned to normal in everything except treatments #4 and 7 in the cedar and treatment #10 in the fir. The final evaluation of the roots will take place when stock is lifted and pack- aged. At that time, the ratio of plantable seedlings to seedlings culled for lack of root development will be determined.

Allan McDonald
Saanich Test Nursery

Saanich Test Nursery Vented Block Comparison

Following recent work by Mike Peterson (AFS, Applied Forest Science), indicating that the use of vented blocks might help to minimize *Botrytis* infection, an operational trial was carried out with red cedar, white spruce and coastal Douglas-fir using various vented styroblocks.

Three container configurations (PSB 198, PSB 160 and PSB 112) were investigated using blocks manufactured by Beaver Plastics (Ventblocks) and First Choice Manufacturing (Airflow blocks). All treatments were grown in 3:1 peat-vermiculite mix containing 2 kg/m3 dolomite lime and 0.75 kg/m^3 Micromax. Fertilizer regime was Peters 10-20-30 R at 100 ppm during active growth, followed by 10-20-30 at 50 ppm as a finisher. STEM[R] was added throughout at 0.5% of the fertilizer weight and ammonium sulphate was used periodically to raise N levels to 125 ppm. Some of the vented block treatments

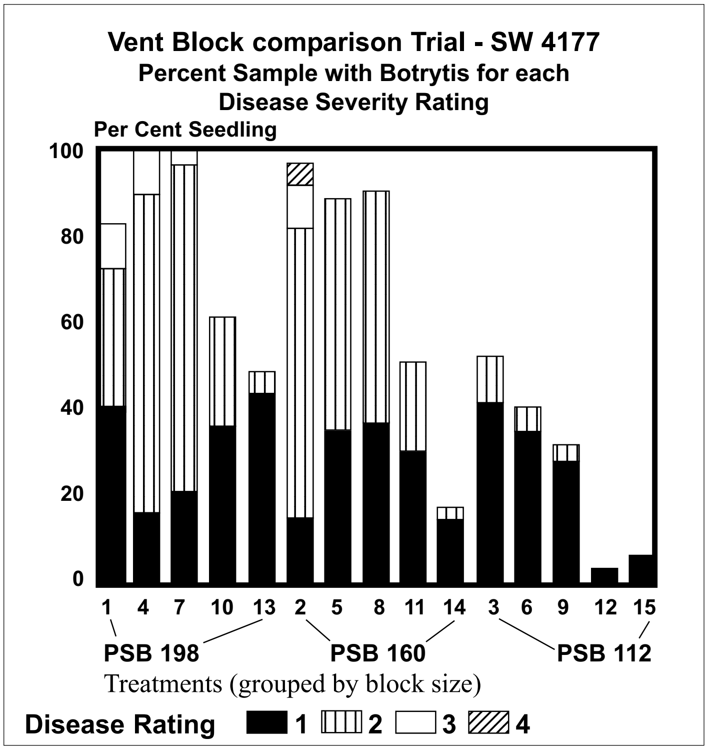
(continued...pg 12)

Saanich Test Nursery Vented Block Comparison

Vented Block Trial Average Results - 33 Weeks from Sowing
- Sown April 5,1989 415 (112), 313 (160), 313A (198)
- Height (cm), Root Collar Diameter (mm), Root Weight (g)

$$\text{- QI - Quality Index} = \frac{\text{Dry Weight}}{\frac{\text{Height}}{\text{RC Diam}} + \frac{\text{Top Weight}}{\text{Root Weight}}}$$

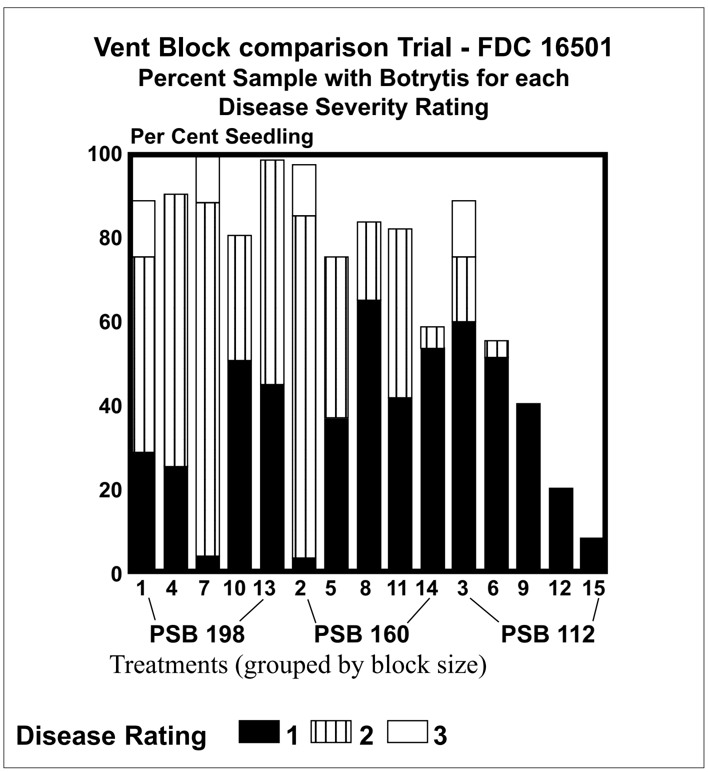
	Sw	4177	Fdc	16501	Cwr	20202						
Tr#	**Ht**	**RCD**	**RtWt**	**QI**	**Ht**	**RCD**	**RtWt**	**QI**	**Ht**	**RCD**	**RtWt**	**QI**
1	19.9	2.5	0.54	0.20	24.7	2.6	0.82	0.20	37.7	2.5	0.33	0.10
2	19.5	2.6	0.50	0.20	29.4	2.7	0.73	0.18	38.2	2.2	0.29	0.09
3	19.6	2.9	0.71	0.29	29.1	3.3	1.17	0.31	40.3	2.7	0.47	0.14
4	19.7	2.5	0.41	0.17	25.0	2.5	0.66	0.16	34.8	2.2	0.25	0.08
5	19.2	2.6	0.49	0.20	24.4	2.8	0.94	0.24	34.3	2.3	0.36	0.10
6	20.4	3.0	0.78	0.32	26.6	3.3	1.43	0.37	40.0	2.9	0.56	0.17
7	19.9	2.4	0.34	0.15	28.8	2.5	0.62	0.15	36.1	2.2	0.27	0.08
8	20.5	2.6	0.50	0.20	25.0	2.6	0.76	0.19	35.8	2.2	0.30	0.09
9	20.1	3.1	0.89	0.36	24.0	3.2	1.56	0.41	35.3	2.7	0.62	0.17
10	18.8	2.5	0.46	0.18	23.9	2.6	0.81	0.19	32.7	2.4	0.36	0.10
11	18.4	2.6	0.53	0.22	25.1	2.7	0.86	0.21	37.3	2.4	0.35	0.11
12	19.3	3.0	1.06	0.39	23.0	3.2	1.65	0.43	39.1	2.7	0.49	0.15
13	19.0	2.5	0.46	0.18	24.5	2.6	0.78	0.19	34.8	2.5	0.38	0.11
14	17.1	2.5	0.65	0.24	20.6	2.7	0.95	0.24	35.0	2.4	0.38	0.11
15	18.0	2.9	1.14	0.41	21.5	3.1	1.63	0.42	37.6	2.8	0.67	0.19

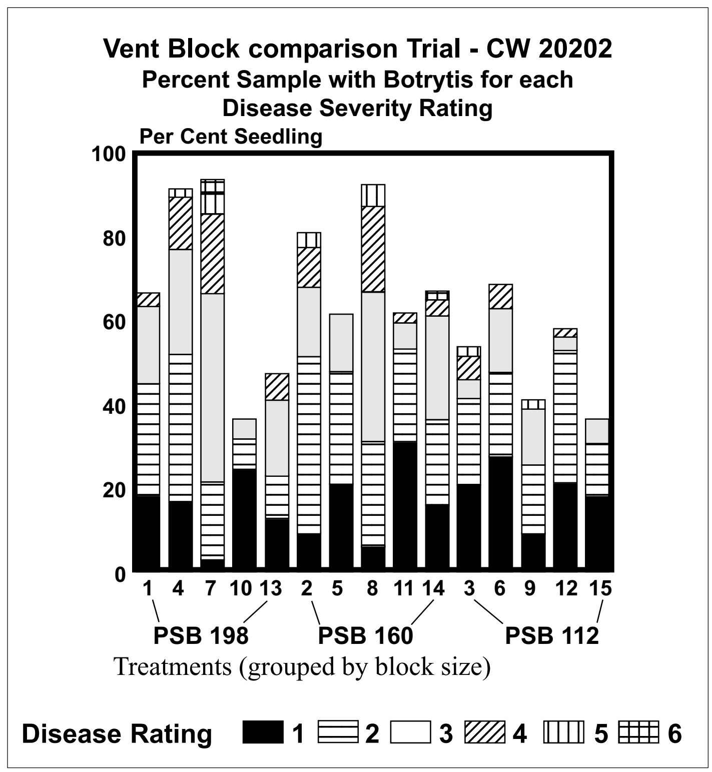


The following treatments were tried:

1. Control - PSB 198 standard blocks
2. Control - PSB 160 standard blocks
3. Control - PSB 112 standard blocks
4. Ventilated blocks - PSB 198 Beaver Ventblock
5. Ventilated blocks -PSB 160 Beaver Ventblock
6. Ventilated blocks - PSB 112 Beaver Ventblock
7. Ventilated blocks - PSB 198 F/Choice Airflow
8. Ventilated blocks - PSB 160 F/Choice Airflow
9. Ventilated blocks - PSB 112 F/Choice Airflow
10. Induced air flow - PSB 198 Beaver Ventblock
11. Induced air flow - PSB 160 Beaver Ventblock
12. Induced air flow - PSB 112 Beaver Ventblock
13. Induced air flow - PSB 198 F/Choice Airflow
14. Induced air flow - PSB 160 F/Choice Airflow
15. Induced air flow - PSB 112 F/Choice Airflow

Random samples were collected at 34 weeks from sowing and height and root collar diameter measurements and dry weights were taken. In addition, seedlings were rated according to the *Botrytis* Rating Scale devised by Mike Peterson and the percentages of the samples falling into the various rating categories were recorded. The height, root collar diameter and root weight data are contained in the accompanying table, along with the Dickson Quality Index ratings.





were provided with an induced airflow after the canopy closed, using skirting around the benches and greenhouse inflator fans. There was little improvement in the PSB 198 configuration, except where air flow was induced through the vents in the spruce and fir. Generally, in the PSB 160's and the PSB 112's there were fewer infected individuals and/or reduced severity of infection in all three species. The most dramatic improvements showed up in the PSB 112 fir and spruce. The lack of improvement without forced airflow might be due to the increased seedling density and the heavier canopy over the block.

Allan McDonald
Saanich Test Nursery

Weed Control

Weed control is the most persistent production problem which growers must solve to produce a quality plant in a reasonable period of time. Weeds not only compete for light, water and nutrients, but also act as hosts of potentially injurious insects and diseases and shelter for rodents. A heavy weed population can increase handling, and therefore cost, during shipping season, and can reduce plant size and quality.

There are many methods that reduce a weed population. Cultivation, burying or hand pulling weeds prevents annual weeds from flowering and spreading seed, but must be done consistently to be effective. Chemical weed control is used by many nurserymen as part of the program to reduce labour costs. However, it is necessary that the applicator understand the behaviour of the herbicide and the influences of water, sunlight and the state of growth of the crop to ensure that the application is effective for a reasonable period of time and the crop is not injured.

Herbicides are applied either to the foliage of growing weeds (postemergence) or to the soil to prevent germination (preemergence). Foliar herbicides are either contact chemicals that weaken and disorganize the plant cell membranes causing leakage and subsequent localized death (GRAMOXONE), or translocated chemicals that move throughout the plant and slowly disrupt chemical processes that kill the entire plant (ROUNDUP).

Entrance of the herbicide into the plant is reduced by many physical factors. To be effective all foliar applied herbicides must cross a waxy water-repellent membrane called the cuticle which covers all of the non-woody above-ground surfaces of plants. A thick cuticle encourages the formation of large droplets that run off the foliage. A hairy leaf results in droplets sitting on top of the hairs and not reaching the leaf surface. Grass leaves are positioned at an angle that encourages runoff. Many herbicides must be applied to grasses before the 5 leaf stage in order to be effective.

Stomata, the tiny pores in leaves which allow $C0_2$ to enter and water vapour to exit the leaf, provide an entrance for a foliar applied herbicide. However, most stomata are on the underside of the leaf, which is difficult to coat with herbicide, and the chemical must still cross the cuticle covering the internal cells. The cuticle is thinner in younger leaves and stems which explains why control is much more effective on young weeds early in the season. However, translocated herbicide must be applied to leaves that are actively exporting carbohydrates, manufactured in the photosynthetic process, out of the leaf. The herbicide travels with this outward flow to the root. Very young leaves are net importers and the herbicide will stay in the leaf reducing the effectiveness of the application.

Many herbicides used are applied either to the soil or growing medium surface to prevent seed germination. The chemical must be dissolved in the soil/medium solution in order to be effective. In the soil or media, small negatively charged clay or humus particles called colloids absorb or hold onto positively charged herbicides. There is a balance between the concentration of herbicide in the soil/media solution and the amount held by the colloids. As the concentration decreases in the soil solution, the herbicide held by the colloids is released to maintain this balance. This explains why some herbicides are retained in the top few centimeters at the soil/media surface and remain effective for long periods of time despite the heavy leaching activity from irrigation or rainfall. Porous soilless mixes and sandy soils may retain herbicide for a shorter period of time.

The amount of herbicide that is required for effective control is small which is good as losses are usually quite high. Volatilizaton or the evaporation of the chemical into the atmosphere is one type of loss. As a result, certain herbicides must be applied when temperatures are cool and incorporated mechanically or via irrigation immediately after application in order to prevent excessive losses (CASORON). Sunlight can also break down some chemicals in a process called photodecomposition (TREFLAN).

A major area of herbicide loss is the activity of microorganisms, such as bacteria, algae, fungi and actinomycetes, inhabiting any soil or container growing medium. The microbes use the herbicide as a carbon- rich food source, multiplying rapidly after application. Soil temperature, moisture, pH, aeration and high organic matter content favourable for plant growth also favour microbe activity. Multiple applications of the same chemical can result in high populations of microbes and subsequent high decomposition rate.

Many herbicides are selective. This means that the chemical can kill one plant or a group of plants without

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Many herbicides are selective. This means that the chemical can kill one plant or a group of plants without harming another (the crop). In some cases the selectivity is based on a physical separation. Soil applied herbicides stay in the surface layer of the soil or growing medium. The plant roots are below this layer. Obviously, there is a potential for crop injury if a large concentration of herbicide moves down to the crop root zone. Some herbicides are taken up by the plant, but a biochemical process detoxifies the chemical. In other cases herbicides, especially ones with postemergence control, can only be used when the crop is dormant. The cuticle layer is completely formed and thick enough at this time to reduce the amount of herbicide entering the plant.

Each nursery has its own unique soil types, container growing media, crop mix, planting techniques, soil cultivation practices and grower preferences. Herbicides are usually only a part of a full weed control program. If used incorrectly, the costs can be quite high. Your chemical weed control program deserves some thought and planning each year. There are many books published on this subject and the Nursery Crops Production Recommendations outlines many of the facts needed to make good decisions. However, the pesticide label is really the most valuable source of information

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Adams, R.W. Ed. 1988. Handbook for Pesticide Applicators and Dispensers. 5th Ed. British Columbia Ministry of Environment and Parks.

Gwynne, D.C. and R.B. Murray. 1985. Weed Biology and Control in Agriculture and Horticulture. Batsford Academic and Educational, 4 Fitzhardinge Street, London, UK WIH OAH.

Rice, R.P. Jr. 1986. Nursery and Landscape Weed Control Manual. Thomson Publications, P.O. Box 9335, Fresno, CA 93791.

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Literature Review

INFLUENCE OF SEED-BORNE FUNGI ON NUTRIENT COMPOSITION AND GROWTH OF CONIFER SEEDLINGS

P. Singh and R.K. Mittal (1989)
European Journal of Forest Pathology
19: 65-77

Nutrient levels, height and biomass were affected by the presence of inoculated seed-borne fungi on eastern white pine and white spruce. Variable responses of the above parameters in both species to each fungus resulted in no clear relationship when compared to measured growth in- dices. It is suggested that the fungi may interfere with seed germination and development by affecting the absorption and/or translocation of nutrients.

BOTRYTIS: A HAZARD TO REFORESTATION

R.K. Mittal, P. Singh and B.S.P. Wang
(1987) European Journal of Forest
Pathology 17., 369-384

This is a review article on the effects of *Botrytis* on conifer seeds and seedlings for reforestation. Seed-borne *Botrytis* results in decay, reduction of germination and affects both seed appearance and indexing. A summary *of* Botrytis infestations on seedlings is discussed in reference to field and storage performance. A variety of factors that affect the establishment of *Botrytis* in seedlings are temperature, light, relative humidity, nutrition, oxygen, air movement and pollution, and interactions with other organisms. Avenues for prevention are reviewed for both seeds and seedlings.

HOW TO AVOID GREENHOUSE CONDITIONS THAT COULD BE OPTIMUM FOR DEVELOPMENT OF BOTRYTIS

R.H. Lawson and M.M. Dienelt (1989)
Greenhouse Manager 8 (2): 139-140

The article suggests that low temperatures, high relative humidity and low light conditions provide the optimal conditions for the development of *Botrytis.* Infestations may be reduced with increasing airflow through the foliar canopy and reducing humidity. In storage, lower humidity and constant temperatures helped to decrease condensation and subsequent Botrytis infestations. Postharvest control was improved with Phyton 27 (not registered in Canada) or bio-control agents like *Exophiala jeanselmei.*

POPULATION OF ADULT FUNGUS GNATS AND SHORE FLIES IN BRITISH COLUMBIA CONTAINER NURSERIES AS RELATED TO NURSERY ENVIRONMENT AND INCIDENCE OF FUNGI ON THE INSECTS

S.E. Keats, R.N. Sturrock and J.R. Sutherland (1989) New Forests 3: 1-9

The authors found that shore flies and fungus gnats were more abundant in nurseries where moisture accumulation encouraged the buildup of mosses, liver- worts and algae. The pathogens *Fusarium, Phoma* and *Botrytis cinerea,* as well as other non-pathogenic fungi, were associated with the flies. The interactions of the insect pests, sanitation and diseases are discussed.

PROCEEDINGS OF THE THIRD CONE AND SEED INSECTS WORKING PARTY CONFERENCE

G. E. Miller (ed.)/IFURO, FOR CAN, B.C. Ministry of Forests Pacific Forestry Centre, Victoria, B.C. 1989

Proceeding of the third cone and seed insects working party conference.

INSECTS AFFECTING REFORESTATION: BIOLOGY AND DAMAGE

R.I. Alfaro and S.G. Glover (eds.)

Proceedings: IUFRO working group on insects affecting reforestation.
Vancouver, B.C., Canada, July 3-9,1988
Forestry Canada, Pacific Forestry Centre
Victoria, B.C. 1989

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 mesa* (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 0.5. The following mean filled seed per cone values were obtained: out- cross (F = 0.0), 31.6; half-sib cross (F = 0.125), 21.3; full- sib cross (F = 0.25), 16.7; parent-offspring 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.

DISTRIBUTION OF *BARBARA COLFAXIANA* (KEARFOTT) (LEPIDOPTERA: TORTRICIDAE) EGGS WITHIN AND AMONG DOUGLAS-FIR CROWNS AND METHODS FOR ESTIMATING EGG DENSITIES

J.D. Sweeney and G.E. Miller. 1989 Can. Ent. 121:569-578

The spatial and frequency distributions of Douglas-fir cone moth, *Barbara colfaxiana* (Kearfott) eggs in Douglas-fir trees and stands were determined by dissecting 13 262 conelets collected from 81 trees in 3 sites and 2 years. There were no consistent trends in egg density associated with crown level or aspect. The frequency distribution of eggs per conelet fitted the negative binomial in 3 of 5 site-years but a common k for the negative binomial could not be calculated. Green's index of aggregation suggested that the cone moth egg distribution was significantly aggregated in each site-year.

The optimal number of conelets per tree to sample was determined to be 4 in forest stands and 3 in seed orchards. The number of sample trees required for estimating mean egg density with 10% and 20% precision and 90% confidence was calculated for a range of mean egg densities using the method of Kuno. The sample sizes required to estimate a control threshold density of 0.6 eggs per conelet with 10% precision and 90% confidence were very large and would be impractical for operational use. Therefore, a sequential sampling plan was developed for use in seed orchards that would classify cone moth egg densities as either above or below a critical density at which 10% seed loss would be expected.

(continued...)

THE EFFECT OF CAVITY SIZE AND COOLED STORAGE TEMPERATURE AND DURATION ON SURVIVAL AND EARLY GROWTH OF WESTERN RED CEDAR SEEDLINGS

TA. Hale, J. Halusiak
and Y.A. El-Kassaby

Forest Nursery Association of B.C. 9th Annual Meeting Notes A study was conducted to investigate the effect of three cavity sizes, 313B (160 seedlings/ block; 4 in^3), 415B (112 seedling block; 6 in3), 415A (80 seedlings/block/8 in^3), two cold storage temperatures (-1°C and +1°C) and six storage period (1-6 months), on the survival and early growth characteristics of western redcedar *(Thuja plicata)* seedlings.

Following every storage period, seedlings were examined for the presence of gray mold *(Botrytis cinerea),* and root growth capacity was determined. Survival and early growth characteristics (height, diameter, shoot and root dry weights) were assessed from a replicated complete randomized farm field trial that accommodated the three studied factors in a factorial arrangement. At the end of the growing season the seedlings were destructively sampled and, as expected, classical significant differences were observed for height, diameter and shoot and root dry weight for the three factors studied. However, all of the second degree interactions (cavity size x storage temperature x storage time) and most of the first degree interactions (cavity size x storage temperature, cavity size x storage time, etc.), were also significant. Cavity size produced expected significant differences in all studied traits when data from every storage period were analyzed separately, and the +1°C storage temperature showed higher means for growth characteristics when significant differences were observed. Survival was consistently high, and ranged between 100% (415A after 5 months storage) and 86% (415B after 6 months storage). Root growth capacity showed increased activities after two months of cooled storage and a steady decline was observed with the length of storage period. The seedlings grown at +l°C gave higher root growth capacity for all cavity sizes than the ones grown at -l°C for the first two storage times and the reverse was observed for the remaining four months. Botrytis incidence was only observed after six months of cooled storage.

It was concluded that storing at l°C for a period of two months produced the best early growth and root growth capacity results. Differences among cavity sizes, although highly significant, are influenced more by the initial size of the stock and uniformity of the test site. Therefore, actual planting site conditions should dictate which stock size is to be used.

Events

The combined meeting of the Western Forest Nursery Council and Intermountain Forest Nursery Association will be held at Umpqua Community College in Roseburg, Oregon, on August 13-17,1990. This meeting will include a special symposium on “Target Seedlings” as well as the usual technical presentations. An all-day field trip is scheduled to visit two bareroot nurseries (the Oregon State D.L. Phipps Nursery and the International Paper Kellogg Nursery), and one container facility (Rex Timber Greenhouse Nursery). The initial response to this meeting has been excellent and we are expecting several hundred nursery managers and reforestation foresters.

Contact Paul Morgan for the latest information:

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Elkton, Oregon
USA 97355
Phone: (503) 584-2214
Fax: (503) 584-2326

The Forest Nursery Association of B.C. will hold its 10th Annual Meeting September 24 - 27, 1990 at the Whistler Conference Center.

Contact Dave Trotter for more information:

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