SILVICULTURE

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Seed and Seedling Extension Topics

Eric van Steenis - Editor

Summer has come to a close and fall/winter is upon us. I think most of us are thankful for the many weeks of warin, clear weather at the end of the season to help put on those last few millimeters of stem diameter. Recent events included the Can-West Hort Trade show in- Vancouver (Sept 28/29), the Black-Out (Roots and Shoots) workshop in Prince George (Oct 14/15) and for the jet-setters the Canadian Greenhouse Conference in Ontario. Hopefully all of you were able to take in at least one of these.

A notable void is being created in the Ministry of Forests Seed Section by the retirement of Jenji Konishi after 33.5 years with the B.C. Forest Service. jenji has played a significant role in the development of B.C.'s tree improvement, seed orchard production, seed processing and seedling production programs. His insight and support will certainly be n-dssed.

Overall, 1994 has treated the industry well, with a fair bit of new greenhouse construction at several facilities, and the expansion into Alberta by at least three B.C. forest nurseries. Certainly never a dull moment, and lots of gossip on the "forest nursery grapevine' at all times! And yes, congratulations to Gemout and Linda at Roserim Nursery (100 Mile House) with the birth of their twin baby girls!!!

Eric van Steenis
Nursery Extension Services

Credit Where Credit Is Due...

You'll notice something new in the newsletter this time.... we have added a rider requesting that persons wishing to reprint information from Seed and Seedling Extension Topics obtain permission from the author(s) and credit the newsletter as their source. It is unfortunate that we have to be this blatant, but an article from the newsletter was recently edited and republished in a national trade magazine. This was
done without the authors' knowledge, and was accompanied by various erroneous editorial assumptions.

We hope that Seed and Seedling Extension topics can continue to be an open forum for discussion on technical issues in the nursery and seed production industries; a place where growers and others can freely report on their experiences - good and bad - with products and techniques new to them and/or the industry. We also hope that this new proviso requesting credit where credit is due will help give our authors a
say on how their information is used after it is published in this newsletter.

Don Summers,
Manager, Nursery Extension Services.

Province of British Columbia

Ministry of Forests

Roots and Shoots- A Reforestation Workshop

Through FRDA funding of research project FC-FRO12, Field Performance and Root Egress of Short Day Treated VVIiite Spruce Seedlings, a successful workshop was conducted in Prince George, B.C. on October 13 and 14, 1994. The workshop focused on short-day treatment of spruce in the nursery, field performance of treated stock in terms of root and shoot development, and finally root growth in general.

The workshop consisted of a one-day field trip followed by a day of presentations by approximately eight speakers. A booklet with information on each field trip stop and a submission from each presenter was compiled and handed out to attendees on the first morning. The field trip included stops at Hi-Gro Silva Nursery in Quesnel, the Ministry of Forests Red Rock Research Station, and a cutblock east of Prince George where the group got down and dirty digging up trees and making big holes in the ground. To entertain attendees on some of the long bus trips, videos on black bears and root rot were shown. The bear video, Bear Aware, turned out to be very appropriate as five black bears were sighted on the way to the cutblock. The long day ended with a terrific BBQ northern style!

The highlight of the two days was having Dr. Roy Sutton, scientist emeritus from CFS Sault Ste. Marie, lead us through the life and times of a root as it struggles against many obstacles below ground. Rob Scagel (Pacific Phytometrics) and Chuck Bulmer (CFS Prince George) helped make the cutblock session both lively and informative. Other speakers throughout the two days were Steve Grossnickle (B.C. Research Corp.), Eric van Steenis (BCMOF Nursery Extension Services), Mike von Hahn (1-li-Gro Silva Nursery), Chris Hawkins and Marek Krasowski (BCMOF Red Rock Research Station), and David Lloyd (Pelton Reforestation Ltd.). Short day treatment is being used in B.C. nurseries to induce dormancy with the end result in the nursery of uniform crops through height control. Development of seedlings and the field performance of -treated stock can vary due to the post-short day treatrnp-nt culture and handling. Differences in short day treatments applied, and the important cultural and handling regimes that follow, have resulted in varying reports of how treated sock develops post-planting.

Keith McClain (CFS Prince George) gave an excellent workshop synthesis to the forty folks from the nursery and titnber industry who attended. The workshop was organized by Andrea Easham (CFS Prince George) and a big thank you to all the people who helped out in the preparation and delivery.

Andrea Eastham,
Canadian Forest Service, Prince George.

Letters to the Editor

A new section!? Well, when someone sends a letter to the editor, why not let the readers in *m* it? So... here goes.

Dear Sir,

First of all, let me say that I have always found Seed and Seedling Extension Topics very informative and interesting. The technical articles are always topical, cover a wide range of information and cater to a diverse audience.

The reason I am writing is to ask you and your readers what you think about trying to get a bit more 'news' in the newsletter. While the technical reporting to-date has been very good, there is seldom much information about the more 'social' aspects of the forest nursery industry in B.C. Is any one else interested in this? Why not a 'Profile" column that featured a different person or organization in each issue (this could be a nurseryman or a client); or an "About Town" column that focused on mergers, expansions, moves, etc; or a "People" column that reported on new faces in the industry, career moves or other personal accomplishments of our colleagues. A 'Letters" coluirm may also be a way to generate some discussion between readers on a variety of topics. These are just a few examples of 'newsy' information that I think may be of interest to many readers.

I would be interested in your thoughts on this. I realize that it could represent a lot of work, but if readers could contribute the occasional letter, fax, phone call or article as it happens, I'm sure that it wouldn't take long to fill a page or two in each issue.

Sincerely, Don Summers, Surrey, B.C.

Dear Mr. Summers,

I suppose upon reading this newsletter one might wonder if our industry is made up of a group of very independent andlor anti-social people. I don't think this is true on average and appreciate your ideas on how to draw out more participation from the readership. This publication is one of several vehicles for technology transfer and certainly could be expanded in some of the ways you have suggested. If anyone out there has more ideas or is willing to start the ball rolling we would welcome the 'challenge"!

Sincerely, Eric van Steenis

Province of British Columbia
Ministry of Forests

GROWERS NOTES

Crystallization - - Save Tax On Future Capital Gains

If you own assets that have appreciated in value, you may be interested in a new tax planning opportunity that arose out of the 1994 federal budget.

The "budget" (February 22, 1994), eliminated the basic $100,000 capital gains exemption for any capital gains realized on sales after February 22, 1994. However, the rules also include a mechanism allowing Taxpayers to easily use up their remaining exemption, if they had assets with accrued gains on that date. By simply 'electing' to have disposed of the asset, one can realize the accrued gain and use up any remaining exemption. Basically, you are then assumed to have reacquired the asset at the higher elected value, thereby "stepping up" its cost base. The higher cost base means lower capital gains in the future, when the asset is really sold.

Assets such as farmland, mutual funds, stock, or a partnership interest, etc. in the hands of someone who has not used up all of their $100,000 capital gains exemption are eligible. In the case of real estate, the property must have been acquired before March, 1992.

This is apparently a one-time opportunity. The election must be filed with your 1994 income tax return by April 30, 1995. Some complications can arise if you will be reporting Old Age Security or Unemployment Insurance income, etc. so the best thing to do is consult your accountants If you are eligible, the benefits will most likely outweigh the costs.

Eric van Steenis,
Nursery Extension Services.

Glossary of Some Plant Pathology Terms

This glossary is meant to improve communication between nursery managers, growers, stock adjudicators and researchers. The list of definitions in a previous edition of Seed and Seedling Extension notes (Volume 7, Number 1) dealt with the condition of disease and the mechanism involved, whereas this select glossary will introduce host-micro-organism interactions that represent other mechanisms for obtaining nutrients. The following publications were consulted during the preparation of the following select glossary; A Dictionary of Plant Pathology, 1989, by P. Halliday. Cambridge University Press, and Ainsworth and Bisby's Dictionary of the Fungi, 1983 (7th edition), by D.L. Hawksworht, B.C. Sutton and G.F. Ainsworth. Commonwealth Mycological Institute, Kew, Surrey, Great Britain.

Biotroph - (A Dictionary of Plant Pathology; 1989) an organism entirely dependent upon another living organism as a source of nutrients, applicable to mycorrhizae and obligate parasites.

Commensal - (A Dictionary of Plant Pathology;1989), an organism that can colonize the surface of healthy tissue without attacking the tissue or itself being damaged by any tissue response. Commensalism is a system of mutual convenience without apparent benefit or ifl effect to either organism.

Endophyte - (A Dictionary of Plant Pathology; 1989), an organism which completes its life cycle in a plant which shows no external sign of infection.

Epiphyte - (A Dictionary of Plant Pathology; 1989), a plant growing on another, not usually fed by it: a micro-organism living on plant surfaces in a non-parasitic relationship. (Dictionary of the Fungi, 1983), a plant living on another but not as a parasite.

Mycorrhiza(e) - (Dictionary of the Fungi, 1983) a symbiotic, non-pathogerdc association of fungi and the roots of plants.

Necrotroph - (A Dictionary of Plant Pathology; 1989), a flmgus that kills tissues as it grows through them such that it is always colonizing dead substrate. (Dictionary of the Fungi; 1983), a parasite that derives its energy from dead ceus of the host.

Symbiosis - (A Dictionary of Plant Pathology; 1989), the state of 2 different organisms, attached and living together, each contributing to the other's support or benefit. (Dictionary of the Fungi; 1983), the living together of unlike organisms.

Synergism - (A Dictionary of Plant Pathology; 1989), an association of 2 or more organisms acting at any one time and effecting a change which one of them alone does not make. (Dictionary of the Fungi, 1983), the association of two organisms acting at one t#ne and effecting a change which one only (alone) is not able to make.

Harty H. Kope
Applied Forest Science Ltd.

Growing in Copper Treated Containers Requires Greater Awareness

A substantial portion of the containerised forest seedling production in British Columbia is currently grown in copper treated containers. This includes almost all the lodgepole pine and some of the spruce, fir and cedar. Trial work done during development of the principle included some general reconunendations for associated nursery culture, and recent experience has brought to light a few points as well. Since copper treatment appears to be here to stay and most nurseries are or will be faced with this type of production it seems timely to review copper and its interactions with other aspects of nursery culture.

Loading Growing Media into *Cavities* - Copper treated cavities, especially those treated manually at the nursery, can have substantially more rough or 'sticky" cavity walls, ie. more friction or resistance to the flow of media. This can result in a 'caging" effect, where media adheres to the cavity walls before traveling all the way down, bridges across, and causes formation of air pockets. These in turn alter media volume available to the plant growing in that cavity, changing nutrient content, CEC, water holding capacity, etc. available to that individual. If these seedlings make it to final lift they often require culling due to reduced integrity of the root mass (plug). Media loading equipment can be adjusted to help alleviate this problem. Growing media moisture content and particle size distribution can also have an impact. Carefull attention needs to be paid to the container filling process because this is what the grower (and seedling) has to work with throughout the rest of the crop cycle.

Placement of Seed - Most conventional seeding equipment drops seed into the cavity from a short distance which results in a proportion being located near or against the cavity edge. This is generally not a problem but... it has been noticed that seeds situated very near or against a copper coated container wall can have their emerging radical chemically root pruned. If this happens in close proximity to the seed lateral roots cannot form and the gern-tinant dies (dessicates). If it happens a short distance (1-2 nun) from the seed and a lateral can and does form (be-tween the seed and the pruned tip) the gem-dnant may live if it can maintain its water status. The time it takes for the lateral root to initiate may leave these germinants behind (time wise) but also leaves them with only the top of the plug to exploit for water and nutrition for a much longer time, ie. drying of the top layer of growing media can result in dessication and death of these germinants while their weu-centered counterparts are already able to draw from the lower (inoist) regions of the plug. Hence placement of seed, especially when single sowing, and careful attention to germinant development and associated microclirnate/water management may be more critical when germinating in copper treated containers.

Irrigation Water Quality - Alkalinity and pH of the irrigation water source affect availability / solubility of most nutrients, copper being one of them. Its availability is reduced as pH and/or alkalinity levels rise. High alkalinity and high pH (or both) water sources can therefore reduce the efficacy of the copper treatment. This may render containers treated with lower concentrations or ones previously used almost ineffective, even though the treat-ment may wear off the container more slowly, making it last more crop cycles.

On the other hand, acidic water sources can make the treatment relatively more effective. However, by increasing the release of copper ions from the coating into the media solution an acidic water source may reduce the Iffespan of the copper treatment effect, ie. of crop cycles that will be effectively 'pruned".

Related to this point is Iining of the growing media, which basically effects an increase in alkalinity and pH

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of the root zone. Water quality and Iiining rate need to be considered in relation to the desired effectiveness of the copper treatment.

Competing and Complexing Ions - Copper competes with various other cations for uptake and may complex with certain anions to form precipitates. Dependmg on the cultural context, the above can result in a reduction of the copper effect, a copper induced deficiency (or reduced availability) of another nutrient, neither, or both. The most common observed competition effect is with iron (Fe). Iron (deficiency) chlorosis results from low availability of active ferrous (Fe,2) iron in newly fom-dng plant parts. Because copper competes with iron for uptake it reduces the relative availability of iron at any feeding rate. Hence, copper can 'enhance an - existing iron deficiency or bring on an impending one sooner. Copper treated crops mixed with regular treated crops often display pH induced iron chlorosis sooner under the same cultural regime.

Copper ions can also complex with phosphates, carbonates, hydroxides, low molecular weight organic complexes, and humic and fulvic acids, etc. This can occur in and/or outside the plant, again changing relative effectiveness of the treatment as well as availability of other nutrients. A readily visible complexing effect is the reddish/purple discoloration displayed by lodgepole pine in early spring and late fall. Non-copper treated crops usually don't "turn" as intensely and as early in fall or late in spring as treated crops.

Water Management - Water is the medium in which copper ions can dissolve and move. Without water the copper, and its effects, would be restricted to the treated cavity surface. Once irrigation takes place, copper ions can leave the treated surface and diffuse into the soil solution. There will be a concentration gradient from the surface (high) into the media (decreasing). Every irrigation, if leaching (drain through) is practiced, will replace the majority of dissolved copper ions with fresh water or fertilizer solution. This will drive the dissolution of the treatment coating but should also prevent the majority of the cavity volume from reaching toxic copper concentration levels, thus limiting "pruning" to a narrow zone near the cavity wall.

If leaching is not practiced, copper levels can slowly build to toxic levels (for root growth) throughout the plug. Eventually all the cation exchange sites may become saturated with copper as well as the soil solution, effectively preventing root growth anywhere in the plug. If watering (from above) is practiced to drive off only a small amount of copper each time, the toxic zone may be pushed down so that roots only grow in the upper half of the plug.

Perhaps wet/dry cycle water management with adequate "drain through" is more crucial with this stocktype than others.

Container Characteristics - Surface area to volume ratio is important considering the range of cavity sizes we are working with. Cavity surface area approximates the amount of treated surface and the associated 'toxic' zone (thin media volume adjacent to the treated boundary). The total container volume approximates media volume thus giving an indication of the amount of buffering capacity present. The higher the SA/VOL ratio, the lower the relative buffering capacity. Thus smaller cavities with higher SA/VOL ratios will require more careful management for most of the above mentioned *potential* problems.

Media coarseness affects aeration and drainage characteristics as well as available CEC or potential buffering capacity. Coarse media, with more aeration and better drainage characteristics can reduce diffusion rate of copper ions into the center of the cavity, thereby preventing a buildup to "toxic' levels there. Even though overall CEC (and hence buffering capacity) may be lower in a plug loaded with coarser media, the net effect can be positive since the need for high CEC (to adsorb free Cu ions) is less.

Container height affects perched water table depth relative to total container depth. In short containers, the perched water table will effect flooded conditions in a greater proportion of the total container volume (after irrigation/fertigation). Flooding increases acidity, reduces oxygenation, and allows more time for diffusion from the cavity wall into the center of the plug. Especially in cavities with very narrow bottoms (e.g. 211A) this may lead to overlap of the 'toxic" zones, making root growth near impossible in the lower portion of the plug.

Container shape also has an impact. For the same volume, round containers have a lower SA/VOL ratio than square containers. Hence *without* treatment, the degree of "rootbounding" will be less severe in a square container. *With* treatment, the square container contains more treated surface area for the same media volume, ie. less relative buffering capacity. Square containers may not need as much of the total surface area treated.

Eric van Steenis.
Nursery Extension Services.

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TECH TALK

Keithia Slight Assessment At Two Reforestation Sites

Keithia blight is currently the most important disease of Western redcedar seedlings in British columbia. Planting nursery grown seedlings in reforestation sites has given rise to concerns of the incidence and spread, throughout a plantation, of natural and nursery acquired Keithia blight. Evidence indicates that nursery acquired blight can severely affect survival of seedlings outplanted to reforestation sites. On august 16 and 17, 1994, in the company of Ian Leung of Reid, Collins Nurseries Ltd., two reforestation sites near Port Hardy were assessed for Keithia blight. All planted seedlings had evidence of Keithia blight damage, suggesting that an infection may have originated at the nursery.

Site one, 35 hectares, was planted with 1+0 (PSB 415B) and 2+0 (PSB 313B) container-grown Western redcedar seedlings, in 1991. Site two, 29 hectares, was completely planted with 1+0 (PSB 415B and PSB 313B) seedlings, in 1992. Keithia blight was noted on both the 1+0 and the 2+0 seedlings at the time of outplanting (both sites?). The sites were in the biogeochmatic zone **CWHvml** with **vhl** influence, an area of predominately Western redcedar - Hemlock forests and very high rainfall. The site series was classified as Ols and 06s, nutrient poor soils in the salal phase, on steeply sloping terrain. During the survey both planted and natural seedlings were assessed for presence of Keithia blight, the amount of foliage affected and the growth parameters of total seedling height and current leader length.

At both sites, signs of Keithia were visible on more than 95% of planted and natural seedlings, however, neither complete defohatim nor dead seedlings were noted. The amount of foliage affected ranged from 10 - 80% in both planted and natural seedlings, with most seedlings (80 - 90%) having 10 - 40% of the foliage affected. Heavily infected seedlings (500/o of the total foliage affected) had short (an) stem or branch intemodal elongation. Vigorously growing seedlings (2% of the foliage affected) had intemodal lengths of greater than 10 an. The morphology of a heavily infected seedling was short branches closely clustered around the stem. The resulting dense foliage reduces air movement, allowing water droplets to remain on Keithia affected foliage (a condition necessary for spore release and germination). The closeness of branches aids released spores to land on susceptible tissue. Disease cycling can readily occur on fl-ds type of seedling morphology.

Heavily infected seedlings constituted approximately 10 - 20% of the total number of seedhngs surveyed, and fell below “Free-to-Grow’ specifications for total seedling height and current leader length , whereas seedlings with low infection levels (10 - 40%) did achieve the criteria.

Heavily infected seedlings (50% of the foliage affected) were often localized to one area of a cut block, although site aspect, microcbmate and understorey vegetation did not differ from adjacent areas. The
reason for the differences in severity was related to an infection originating within the nursery, e.g., a localized infection occurring in only one area of the greenhouse, and boxed and outplanted together.

Environmental conditions at both sites are ideal for Keithia blight occurrence and spread. Keithia blight is often found on cedar trees surrounding reforestation sites, rendering them perfect inoculum sources. However, site inoculum alone is not enough to compromise seedling performance in the field. This was best evidenced at these sites by the presence of disease on all natural seedlings, especially those older than the outplanted seedlings. It is interesting to note that none of these were in the heavily infected category.

Because no information was available on the level of Keithia blight on the nursery seedlings at the time of outplanting, it is difficult to assess the spread of nursery acquired blight. But, it is known that the extent of seedling infection when shipped from the nursery is a major factor influencing the growth and survival of outplanted seedlings. Thus, only stock that is visually free of any sign of Keithia, or seedlings that have been protected with fungicides, should be used for reforestation.

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British Columbia

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Harry H. Kope
Applied Forest Science Ltd.

A Presowing Treatment For Spruce -and Lodgepole Pine

Introduction

The intent of the following treatments is... to rapidly bring seed to the point of germination just prior to sowing, by ensuring the following:

1. The seed coat is weakened.
2. Light is available (can reach the embryo/emerging gern-dnant) to stimulate cholorophyll development.
3. Oxygen and moisture are available (to the embryo/ emerging germinant).

The objective is to bring seed to a point just prior to what is usually called “pre-germination’; that is before radide emergence actually occurs. The method used is one I have found to be useful over the last several years, however I’m sure improvements can be made. Try experimenting with the essential quantities: light, moisture, temperature, oxygen. Of course, in the process of activating seed, you *can* go too far. Therefore careful monitoring is required. Cutting testes monitor the changes within the seed and are usefull in setting targets for when seed is ‘ready to sow”. The environmental factors that seed will experience under this protocol are those that occur naturally in a seedbed, or in the nursery... temperature and moisture fluctuatuons, stimulation by light. We are simply trying to iinpart these conditions as uniformly as possible. Caution #1 before we begin... these treatments are for seed you are prepared to sow immediately - not for seed that may have to be held for a few weeks longer prior to sowing. Any technique that enhances germination can be a double-edged sword for the nursery. Before committing a crop to such a technique, I recommend trying it on a small scale to develop experience and finesse.

Protocol.

The protocol below is for Spruce & Lodgepole pine seedlots, and assumes they have recieved 10-21 days of stratification. Begin this treatment approximately a week before sowing. The protocol assumes (1) seed quality is high and (2) moisture content prior to treatment is in the 30-34% range, i.e. adequate. That is, this protocol is designed to condition high quality seed, it is not a method for uprgrading low quality seed. Acutally low quality seed is not likely to respond positively.

1. Gently dry-back seed. A fan and dehumidifier combination is quite efficient for large seedlots. Dry-back target is until seed is “flowable”. The internal contents of the seed should still be moist upon cutting. The seed, if spread thinly should take 1.5-3 hours to dry, depending on the relative humidity of the room and amount of air movement over the seed. As drying progresses n-dx seed so you do not have wet and dry patches.
2. Either during the dry-back, or following it, expose seed to light. A mixture of natural and fluorescent grow-lights will do (see step #4). Allow the seed to continue drying (without fan or dehumidifier) for another 3 hours (i.e. until close to the end of the day). At this point seed could be placed in a gern-dnator or green-house, but that is not necessary - any well lit area at approximately 20-23 degrees celsius will do.
3. At the end of the day place seed into an aerated soak. Use a nylon bubbler rather than ‘air-stones” so that the bubbles are very fine, avoiding the possibhhty of mechanical damage to the seed due to turbulence. Note: for both stratified Spruce & Pine - it is important that the soak be aerated to prevent damage from inadequate oxygen supply. Leave seed in the aerated soak overnight.

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4. If possible, light should be supplied during the dry-back and aerated soak period. 16 hours light, 8 hours dark is a guide, or expose seed to the light regime you plan to use in the greenhouse.

5. The next morning blot excess moisture from seed, then place back into stratification conditions - 2 to 5 degrees celsius. Because the seed is moist, there must be a large amount of surface area in the stratification bags. Don't fill bags more than a third full. Massage bags daily to move seed about.

6. After 1-2 days of further stratification, repeat treatment from steps 1-6. Perform this treatment 1-3 times in the week prior to sowing.

7. Adjustments. Cutting tests will determine effect of the treatment. Based on observations made you might want to modify treatments. In particular, warmth plus light may cause seed to germinate prior to sowing. If seed germination occurs prior to sowing - limit treatment to dry-back, or stop treatment and maintain seed under stratification conditions.

8. When treatments are complete, dry back until seed will flow easily (minimal drying necessary), then sow. Note: Because the seed is 'activated" it must be handled carefully, and watered immediately after sowing.

Observations

As treatment progresses, you should observe the following in cutting testes:

1. Seed coats be& to crack.
2. Cotyledons enlarge.
3. Cotyledons and hypocotyl turn green.
4. ***What you should not see is radicle extension. It is the sign to halt treatment.

The target with this treatment is to have over 60% of the cotyledons turn green, but no radicles extended prior to sowing.

Extension

The steps listed above are a basic protocol. You may wish to experiment with extension to the technique. In particular, what would be the effect of soaking seed in a light solution of fertilizer? If the seed is cracked, it is hypothetically capable of taking in nutrients. Could the aerated soak be replaced by misting or fogging the seed following dryback? Any similarities between the above treatments and hydroponic propagation methods are purely intential.

Caution # 2: Experiment with samples to develop finesse, do not experiment with your crop!

Mishtu Baneriee
Scientificals Consulting

Germination Comparisons: Tree Seed Centre Lab, Before Shipping and at the Nursery

For 1993 and 1994 sowing, germination information was received from nurseries on 196 requests tested at the Tree Seed Centre (TSC) prior to shipping. This allows a comparison of i) Lab germination [Lab] available on SPAR ii) germination on sowing requests prior to shipping [QAI and iii) germination experienced at the nursery [Nurs]. I would like to thank the 21 nurseries which provided information as these comparisons would not be possible without their co-operation. The overall relationship between Lab test results [Lab] and nursery germination [Nurs] produced a correlation of 0.83 [r=0.83; r2=0.681. This indicates that 68% of the variation in nursery germination can be explained by the Lab test results. The remaining variation can be attributed to the germination environment.

In Table I the comparisons of Lab, QA and nursery germination capacity (GC) are presented by species. The falldowns between Lab and nursery germination and between shipping and the nursery [QA] are also presented as estimates of expected nursery falldowns. The number of sowing requests sampled and the number of nurseries providing feedback on germination will influence the reliability of these estimates. I have eliminated data which nurseries indicated problems existed (i.e. bird damage, extreme temperatures) or those which received nursery upgrading and do not reflect the state of the seed tested.

Species showing a negative faudown (i.e. Plc & Py) actually achieved higher germination in the nursery compared to Lab and/or QA germination. The most likely explanations for higher nursery germination are i) extended stratification of requests before shipping and

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at the nursery before sowing ii) the extended count dates used by nurseries for many germination counts compared to 21 or 28 day counts used in testing and iii) the inclusion of abnormal gem-dnants in nursery counts.

The more important issue is wldch species germinate at the nursery below the level expected. In this category *Abies* sp. appear to predominate in addition to western larch and western white pine. Amabilis fir showed the highest decline, but only one nursery and two sowing requests from 1993 were included and I do not feel this reflects the average falldown in B.C. nurseries. It is difficult to obtain better estimates of nursery germination on Ba as most requests [57] are received after an abbreviated TSC stratification for nursery upgrading or dry [34%] based on 1993 and 1994 requested sowing services. For growers of *Abies* several references are enclosed. I would like to stress that extended stratification, beyond 12 weeks, in *Abies is* beneficial if sub-optimal conditions are expected to occur during germination. Nurseries wishing to extend stratification can do so by contacting the TSC {with consideration for the required timelines}, perform their own pretreatment or delay sowing and keep the seed in stratification at the nursery.

Western Larch also showed a large nursery falldown in germination. Information is limited on Lw culture,

Table 1. Comparison of Lab, Quality Assurante [QAI, and Nursery [Nurs] germination capacity [GCI with number of requests, number of nurseries and estimates of nursery falldowns in germinination % by species.

Sp	# Requests	Lab GC	QA GC	Nurs. GC	# Nurs	Lab/Nurs. falldown %	QA/Nurs. falldown %
Ba[1]	2	59.0	67.5	32.0	1	27.0	35.5
Bg	6	80.0	79.5	72.3	4	7.7	7.2
Bl	7	62.0	58.1	50.9	4	11.1	7.2
Cw	17	84.9	82.1	80.1	6	4.8	2.0
Fdc	11	92.3	94.5	90.1	5	2.2	4.4
Fdi	21	87.8	89.2	87.3	8	0.5	1.9
Hm	2	91.0	92.0	90.0	2	1.0	2.0
Hw	4	93.0	91.3	89.5	2	3.5	1.8
Lw	8	78.3	78.3	67.9	4	10.4	10.4
Plc	9	90.1	91.3	91.6	5	-1.5	-0.3
Pli	28	93.2	93.8	92.8	5	0.4	1.0
Pw	4	79.5	60.5	68.3	6	11.2	-7.8
Py	13	84.1	79.5	84.5	4	-0.4	-5.0
SS	6	96.8	97.3	93.2	1	3.6	4.1
Sx	55	85.3	87.9	85.8	12	-0.5	2.1
SxS	3	85.7	89.0	85.0	1	0.7	4.0
Total	196				21		
Mean		83.9	83.2	78.8		5.0	4.4

[1]Ba - amabilis fir; Bg - grand fir; Bl - subalpine fir; Cw - western red-cedar; Fdc - coastal Douglas-fir; Fdi - interior Douglas-fir; Hm - mountain hemlock; Hw - western hemlock; Lw - western larch; Plc - coastal lodgepole pine; Pli - interior lodgepole pine; Pw - white pine; SS - Sitka spruce; Sx - interiour spruce; SxS - Sitka X interior spruce hybrid.

(continued...)

but the results of Sorenson (1990) and some initial TSC lab results indicate that western larch responds to extended stratification. Sorenson (1990) indicates that if temperatures are below 55F [12.8C] that 40 days of stratification is required to obtain complete germination. If western larch is grown as an open compound crop growers should be aware that low temperatures may impact total germination and extended stratification may be worthwhile. The work of Sorenson was based on constant temperatures and the effect of temperatures intermittently falling below this level during germination are unknown. The TSC will be investigating extended stratification and its relationship to germination temperature of Lw in the near future.

In Pw, nursery germination was below lab test results, but nursery germination performed superior to seed sampled prior to shipping. The increased germination at the nursery is probably due to increased stratification before sowing. White pine germination has been problematic and we are currently in the process of changing our testing procedure to increase cold stratification and replace the warm stratification, which is conducive to mould and pregermination of non-dormant seeds, with an extended soak. Full implementation and test results will not be available for the 1995 sowing season. If you would like more information on Pw pretreatment please contact myself at the TSC.

I consider the remaining species to be within expected lab germination (nursery germination within 5% of Lab germination]. These are species averages and specific seedlots may deviate from these figures. In Cw, QA germination and germination at most nurseries includes the feature of pelletization. Lab test results are based on 'naked' seeds. Based on this data the process of pelletization accounts for a 2.8% decrease in germination and the impact of the nursery environment accounts for a further 2% reduction resulting in a total falldown of 4.8%.

The provided nursery falldowns are estimates based on available information. The sample size [1961 is small relative to the number of sowing requests shipped over the past two years [10 605]. The best information for your site is available at your site. I encourage all nurseries to compare lab germination with that realized in the nursery. A comparison with the presented provincial falldowns will indicate how your site performs and where you want to concentrate enhancement and monitoring efforts. We are always interested in hearing about seedlots which deviate from lab expectation and are continually working to try and improve the quality of seed you receive. Your feedback is always welcome.

References

Hansen, O.B. and T.G. Leivsson. 1989. Germination and seedling growth in *Abies lasciora?-pa* (Hook.) Nutt. as affected by provenance, seed pretreatment and temperature regime. Scand. J. For. Res. 5:337-345.

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Leadem, C.L. 1989. Stratification and quality assessment *of Abies lasciocarpa* seeds.FRDA Report 095. 18 pp.

Leadem, C.L. 1986. Stratification of *Abies a?nabilis* seeds. Can. J. For. Res. 16: 755-760.

Sorenson, V.C. 1990. stratification requirements for germination of western larch *(Larix occidentalis* Nutt.) seed. USDA Forest Service Res. Note PNW-RN-493. 11 pp.

Dave Kolotelo
Tree Seed Centre

Measuring Oxygen to Plant Roots

Roots need oxygen to function properly. The amount of air contained in the substrate (growing media) is currently taken as the measure of oxygen availability/supply. If the amount of air in the growing media is high then the overall oxygen supply is *assumed* to be good. However, the *amount of air* is actually a fairly rough measure.

A better measure of root system oxygen supply is the speed with which oxygen is transported to the roots. To facilitate this transport "large through-flowing air-canals" are required within the substrate. Further it is necessary to have a large surface area of roots in contact with air-fired pores. This is facilitated by 'small air-canals" that border on the film of water normally present on/around roots. Enclosed holes and isolated pores do not contribute to oxygen transport but... by measuring the air content of the substrate they are taken into consideration.

Thus current research at PTG (Proefstation vour Tuinbouw onder Glas in Naaldwyk, Holland... Research Station for Horticulture under Glass) is going to concentrate more on the speed of gaseous transport

(continued...)

through substrates. More attention will also be paid to pore size distribution and open(usefull) verses closed or isolated pores. From the root's perspective the substrate will thus be characterized more accurately.

Groenten + FruitlGlasgroenten 34-26 Augl94. Translated by Eric van Steenis.
Nursery Extension Services.

- Hydraulic continuity, as well as aeration continuity are important to all aspects of growing, they can in fact be looked upon as reciprocals. The critical part is the diffusion coefficient of the different gases in either water or air. Oxygen travels 10,000 X as fast in air as in water, the difference between a jet aircraft and a "speeding' turtle. In many plants, roots cease growing and functioning wiffiin minutes of oxygen deprivation.
- To maintain physiological balance, the rate of oxygen consumption must be matched by the rate of oxygen supply (diffusion dependent), which brings us back again to the interaction between irrigation practices and growing media, and everything that affects oxygen consumption rate (temperature, nutrition, micro-orgs, etc.).

Editor.

EVENTS

Forest Seedling Grower Course - Module III
December 5-9 '1994
Edmonton, Alberta, Canada.
For More Infor?nation Contact:
Al Nanka, Forestry Canada,
Northern Forestry Centre
5320-122 St. Edmonton, Alberta,
Canada. T6H 3S5
Ph: 403-435-7261/Fax: 403-435-7274

lack Pine Budworm Symposium
January 23-26, 1995.
Winnipeg, Manitoba, Canada. -
For More Infornmtion Contact:
Mike Grandmaison, Forestry Canada,
200-180 Main Street
Winnipeg, Manitoba, Canada R3C IA6
Ph: 204-983-7027
Fax: 204-983-8792

Professional Pest Management Association of B.C. Annual General Mtg.
February 16, 1995.
Vancouver, B.C.
For More Information Contact:
Jim Matteoni @? Kwantlen Coflege, P.O. Box 9030
Surrey, B.C. V3T 5H8 Ph: 604-599-3247

Pesticide Applicator's Course for Forest Seedling Nurseries
Early in 1995
For More Infornmtion Contact:
Dave Trotter, Nursery Extension Services
14275-96th Ave. Surrey, B.C.
V3V 7Z2
Ph: 604-930-3302
Fax: 604-772-1288

Science of Trees and Their Treatments by Dr. Alex L. Shigo
March 9-10,1995
Vancouver Convention Centre,
Vancouver, B.C. Canada.
Ordy $241.- Can. for the two days!!
For More Information Contact:
John Kirkland at Ph: 503-254-0482

4th National Symposium on Stand Establishment of Horticultural Crops
April 23-26, 1995
Monterey, California
For More Information Contact:
Tim Hartz at UC Davis, 916-752-1738.

(continued ..)

Advanced Forest Pest Management Training Program (AFPM)
Spring, 1995. The Integrated Forest Vegetation Management Course, Prince George, B.C.
June 17-25, 1995. Integrated Pest Management for Forest Nurseries, Kernptville, Ontario.
Fall, 1995. The Forest Insect Management Course, Sault Ste Marie, Ontario.
December 5-7,1995. Forest Pest Management Decision Support. Petawawa, Ontario.
For A4ore Information Contact:
Eileen Harvey
Ph: 705-949-9461 Fax: 705-759-5700

Principles and Procedures of Plant Tissue Culture
February 14-15, 1995
Edmonton, Alberta
For More Information Contact:
Dr. Mohyuddin Mirza
Alberta Tree Nursery and Horticulture Centre
RR #6, 17507 Fort Rd. Edmonton T5B 4K3
Ph: 403-422-1789

Seed Orchard Management and Cultural Options for Quality Seed Production
A Tree Seed Working Group Workshop,
held in conjunction with...
25th Annual Meeting of the Canadian Tree Improvement Association
August 28, 1995.
Victoria, B.C. Canada
For More Information Contact:
David Kolotelo at 604-541-1683
or by EMAIL at DKOLOTEL@mfor0l.gov.bc.can.

Forest Nursery Association of B.C. Annual Meeting.
September 19 & 20, 1995
Harrison, B.C., Canada.
For More Information Contact:
Bruce Morton, Hybrid Nurseries Ltd.
12682 Woohidge Road,
Pitt Meadows, B.C. VOM 1PO
Ph: 604-465-6276
Fax: 604-465-9829

Can-West Hort Trade Show
September 20-22, 1995
Canada Place, Vancouver, B.C.
For More Information Conact:
BCNTA Office @ 604-574-7772

MARKETPLACE

This new section is being trialed because all of us in the nursery business have a traditional "boneyard' of material which may be of use to someone else!? So this is your chance to buy/sell/trade or give-away!

Send your requests marked "Marketplace" to the editor at the address below.

Wanted: 2 Cubic yard ribbon mixer in good working order. Phone Mike von Hahn at 604-992-8631.

For Sale: Old Mill double row seeder in good - working order, 4 yrs old. Phone Bill or Arnold Boerboom at 604-494-9467.

For Sale: 1000 Capilino (198 cavities, white) blocks, like new. Contact Serena Wood at 604-468-5731

Wanted: Complete seeding line in working order. Contact Dave or N4ilt Pancoast at 403-527-8942.

For Sale: *As new* Vandana seeder with PSB410(112 cavities) and 180 plates. Contact Dave or NUt Pancoast at 403-527-8942.

Wanted: Old NEII seeder in working order. Contact Les Shurtliff at 604-789-3363.

Wanted: Conveyers, dead or live, and other lift line equipment; used **propane** forklift **in** working order; dumptruck or manure spreader for farm use. Contact Iola Wedman or Siriol Paquet at 604-337-8487

For Sale:- Gravity Oven/Dehydrator made by Blue-M Electric Co., 120 volts, 38 to 288 degrees Celcius range, approximately 4+ cubic foot capacity, in working order. Contact Gemout Zemanek or Linda Brown at 604-395-7108 or 604-395-4934. $ 850.- obo.

Wanted: - 14 Greenhouse Circulation Fans. Contact Gemout Zernanek or Linda Brown at 604-395-7108 or 604-395-4934

For Sale: - 4 Smith R-8 Fertilizer Injectors in working order. Contact Steve Pelton at 604-465-541 1 -

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