CANADIAN FOREST GENETICS ASSOCIATION
ASSOCIATION CANADIENNE DE GÉNÉTIQUE FORESTIÈRE

Tree Seed Working Group

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CHAIR'S 'ARMCHAIR' REPORT

It has been a time of significant change in the BC Forest Service since the last News Bulletin – we have had over 300 positions declared redundant since last September (about 9% of the Forest Service). Large hits were experienced by our Research Branch and the genetics program. The final outcome (who's left) of redundant and least senior positions is still ongoing and I ask for your sensitivity in interacting with BC colleagues. It certainly is a time of change within the BC Ministry of Forests and Range as we tighten our belts and focus on industry competiveness, revitalization of silvicultural investment past the free-to-grow stage, and developing a new relationship with First Nations.

You are all probably well aware that the Canadian Forest Genetics Association (CFGA) meeting was cancelled this summer and the executive is planning on rescheduling the meeting to the summer of 2011. Kathie Brosemere has left Forest Genetics Ontario and Paul Charrette is taking over the responsibility of chairperson for the CFGA. Further details are unavailable at this time, but check the Forest Genetics Ontario website (http://www.fgo.ca) or CFGA website (http://www.cfga-acgf.com) website for further information. I'd like to thank Kathie for all of her efforts associated with CFGA and wish her the very best in her new endeavours.

We will plan to have a Tree Seed Workshop associated with our 2011 CFGA meeting. Dale and I would appreciate feedback on topics of interest. I am always interested in feedback on whether individuals are interested in presentations on the most current advancements and developments in seed science and technology or a review of more basic principles and practices. I think the question is especially pertinent as most organizations face a great deal of planning for or are in the middle of succession. We would both greatly appreciate your feedback and suggestions.

I'm saddened to report that Dan Rudolf, one of our long-term seed orchard employees, passed away quite unexpectedly on March 28, 2010. Dan started his forestry career in 1973 at Cowichan Lake Research Station and retired from the BC Forest Service in 2007. Dan was involved in all of the essential duties in building a tree improvement program from parent tree selection through the multitude of activities involved in seed production. Dan's career spanned the critical period of tree improvement development in coastal BC and he played a vital role in the legacy we have today. Condolences are extended to Dan's family and friends. I think it is proper to honour the passing of those that have contributed to our very specialized business and invite others to contribute obituaries on those who have left us. Thank you.

To further add to this depressing Armchair Report here are some updated statistics regarding the status of our Mountain pine beetle outbreak in BC, primarily in relation to lodgepole pine:

➤ Approximately 630 million m^3 (47%) of the merchantable pine volume in the province has likely already been killed

➤ Approximately 65% of the pine volume in the province will be killed by 2016.

It isn't news for celebration, but current modeling efforts predict total kill to be about 67% of the pine volume by 2020 which is significantly less than the 80% kill that was previously predicted.

I hope that everyone has a good summer. It has been rather wet out west, but hopefully that will have a beneficial effect on reducing the extent of wildfires this summer on all the dead pine we have. On a more positive note I am suggesting that the theme of the next News Bulletin be "**Genetic Conservation**" as this is truly a positive step that we can take with seeds to ensure there is a legacy for future generations to work with. Lets keep the scope with tree seeds and yes, information regarding cryopreservation is of interest.

I'd like to thank everyone who contributed to this News Bulletin. I think our electronic sharing of information is even more important now as many of our organizations have imposed travel restrictions during these tough economic times. Your participation is greatly appreciated – Thank you.

Dave Kolotelo
TSWG Chairperson

EDITOR'S NOTES

If you look through previous summer issues of the News Bulletin you will note that they are usually less voluminous than the winter issues. This time of the year everybody is extremely busy. I appreciate those who took the time to prepare interesting articles. When I solicited articles for this issue I tried to impress upon everybody that it is a "news" bulletin. We are not necessarily looking for science-type articles but anything that is news. We all become wrapped up in our day to day activities and often consider what we are doing or have 'discovered' everybody else knows about it. This usually not the case. So consider writing about something, anything. Even if it has been said before, a refresher is always beneficial.

This News Bulletin does not have a theme and that is good from time to time. I think that Dave might want to start recycling some themes. There is a nice variety of articles that I think you will find interesting and newsy.

As a follow-up to the last News Bulletin on Seed Testing, there is an article in the recent issue of Seed Testing International on the evolution of seed testing. You can access this at the following web site https://www.seedtest.org/upload/cms/user/STI_139_Apr_2010.pdf .

I hope that everybody has a great summer and enjoys some vacation time.

Dale Simpson
Editor

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Comments, suggestions, and contributions for the News Bulletin are welcomed by the Chairperson and Editor.

All issues of the News Bulletin are available at: http://www.for.gov.bc.ca/hti/treeseedcentre/tsc/tswg.htm

BC TREE SEED CENTRE FINALIST FOR PROVINCIAL SERVICE EXCELLENCE AWARD

This year's British Columbia Premier's Innovation and Excellence Awards finalists included the Tree Seed Centre (TSC). The nomination was submitted by Brian Barber and Lee Charleson, Tree Improvement Branch (TIB) and included letters of support and endorsement from colleagues and clients. Nominees included all full and part-time staff at the Tree Seed Centre and one TIB staff member as follows: Bryan Barker, Sherry Collins, Dave Cripps, Aggie Ellis, Nancy Elias, Nora Galdert, Christina Herman, Laura Klade, Dave Kolotelo, Ross Macdonnel, Debbie Picard, Kristen Picard, Michael Postma, Katherine Rapske, Anita Rebner, Spencer Reitenbach, Heather Rooke, Dawn Stubley, Diana Walker, Chuck Woodward, and Susan Zedel.

The following text was "extracted" from the nomination: "For many years, the TSC mission has been *Excellence in Cone and Seed Services*. The variety of forest stewardship services provided by the TSC is often referred to as the Seed Handling System, a vital chain of custody which ensures the identity, integrity, genetic diversity, physical quality and tracking of all seed used for Crown land reforestation in BC in accordance with the Chief Forester's Standards for Seed Use. The best scientific and technical information is used to guide these standards, decision-making and continuous improvement. The mountain pine beetle (MPB) outbreak lead to substantial demands for lodgepole pine cone and seed processing (15 138 hL in 2008 and 14 279 hL in 2009!). This and increasing seed orchard production levels placed significant pressures on the TSC and its staff. This critical MPB period along with the TSC staff's long-term dedication to client services was the impetus for the nomination of the Premier's Award in Service Excellence".

A total of 164 nominations from across the BC Public Service was received and ultimately the TSC was a finalist both regionally (lower mainland) and was one of two provincial finalists in the Service Excellence category. The 2009–2010 regional award ceremonies were webcast in April and in May the provincial award dinner and ceremony was held in Victoria. Though we ultimately didn't take the top prize in our category we felt that we had won! The nomination, letters of support and experience were a wonderful acknowledgment, and recognition of the scope and complexity of our very much people driven cone and seed service delivery system!

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ONTARIO TREE SEED PLANT NEWS

Over the last 8 months there have been significant organizational changes within the Ontario Ministry of Natural Resources (MNR). First the Forests Division, which the Tree Seed Plant was part of, left MNR and moved to the Ministry of Northern Development, Mines and Forestry leaving the Seed Plant with MNR. Then, in January 2010, the Deputy announced a "realignment" which has placed the Seed Plant in the Regional Operations Division under the guidance of the Southern Region Operations Manager. While we still stay in touch with our colleagues in the Forests Division, the move to Operations Division has already opened new opportunities for the program and staff.

The 2009/10 extraction season wrapped up in late April with a total of 2295 hL of cones received and processed. Our total volume remains down somewhat as a direct reflection of reduced silviculture activity with our forest industry clients however we were able to capitalize on a great red pine (*Pinus resinosa*) crop with 1332 hL collected in total (yes more than 50% of our total volume for 2009) with a resulting yield of approximately 53.6 million viable seeds. We were especially pleased to encourage our partners and clients to make significant collections. Their foresight and the funding support we received will pay huge seed dividends for us all in the years to come!

In the area of "product development" we have been working in two particular areas which have been of interest to many of our clients. The first is the long term storage of red oak (*Quercus rubra*). Traditionally, red oak is stored at 2°C for a maximum of one winter with a preference for having it fall sown (bareroot). The nursery and silviculture industries were prepared to accept that after good seed years there would be lots of stock available and after poorer seed years there might be a shortage of stock for a few years. This no longer seems to be the case. After some investigation we found that others were drying red oak to 30% moisture content and storing it at -2°C for up to 5 years with various success. Storage at -2°C had been a difficult temperature for us but we were lucky enough to acquire an additional walk-in freezer. So far anecdotal results suggest that seed from the bumper year that goes into longer term storage with high viability and vigour will store well for at least the first 2 years. However if the seed is marginal to begin with its viability drops quickly. We are currently waiting for a bumper year for red oak to do more work in this area. For more information contact Derk Sluiter (Derk.Sluiter@ontario.ca) at the Seed Plant.

The second area of interest has been with the processing of red maple (*Acer rubrum*) seed. As some of our nursery clients have been moving towards growing some hardwoods in containers the demand for "machine seed-able" maple seed has arisen. Our seed cleaning technician was up for the challenge and was successful at de-winging red maple and cleaning it to satisfy the mechanical sowing needs of our nursery clients. For more information, contact John White (John.P.White1@ontario.ca) at the Seed Plant.

As we look ahead there is much uncertainty as to what sort of crop year 2010 will be. So far we have experienced an extremely early spring followed by many hard frost events in between record breaking heat events. "It is not a crop until it is in our warehouse!"

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RED OAK SEED COLLECTION

When Dale Simpson indicated they were looking for articles, we considered what area of information needed some highlight or even a revisit. We decided that Northern red oak (*Quercus rubra*), always a topic of interest and especially these days with numerous insect and diseases problems being a prominent factor in declining forest health over a wide range of species, merited an article. Note that the leaves and acorns of red oak are poisonous to cattle and sheep!

In approaching this subject area we need to examine what to collect and what constitutes proper handling and storage. Important also are the steps involved in floating the acorns and sorting the acorns that sink. Unfortunately, not all acorns that sink are viable. Also, what mechanisms should be in place to properly hold the acorns?

Collection

Seed collection in a good year confers a number of advantages: 1) higher intensity of selection of seed bearers, 2) the cost of collection is lower, due to the concentration of the seed crop, 3) seed will be of higher quality, higher germination capacity, and will retain viability longer than seed collected in a poor year (Seal et al. 1965 , Turnbull 1975), and 4) a heavy seed crop usually reflects previous heavy pollen production, to which all or most trees in the stand have contributed, thereby increasing genettic variation. Genetic variation alleviates the disadvantages associated with collections from isolated trees, as seeds can be few, of low viability and any seedlings produced are frequently weaker or malformed (Stein et al. 1974).

There are a few other points to consider:

1) **Phenotypic characteristics** of the parent tree relating to branch arrangement, crown form, and stem form. In oak as in other species, most offspring will emulate the characteristics of the parent. Therefore avoid collecting from trees exhibiting poor form.
2) **Acorn maturity and freshness**. Visual and physical characteristics provide simple yet dependable maturity indices. Therefore collections should be timed to when the pericarp has lost its green colour or is in the process of changing to a brown colour and exhibits a cup scar that is bright yellow. This normally occurs in late September to mid October.
3) **Predators and defects**. Acorn quality is frequently poor in light crop years due to attacks by weevil and other insect predators and pathogens that occur in a high proportion. Acorns which still have caps attached after drop are essentially defective. Mature, sound acorns slip easily from their caps. Acorns should be floated to remove under-developed acorns, leaves, caps, and other floatable debris. Healthy sound acorns will sink as will those that are damaged. Sorting should be conducted after to separate the undesirable acorns. If conditions are dry at the time of collection, full acorns may float. Therefore allow adequate time to maximize collection yield. The most significant fungus which infects acorn crops and causes black rot is known as *Ciboria batschiana*. This appears as a black spot on the pericarp and is accentuated if the acorns are to be stored for extended periods of time. Not all external indices are an indication of internal damage. To prevent germination, the embryo axis must be destroyed.
4) **Size**. Sizing has not been fully investigated but I think it is important to make mention of it. Studies have indicated that the initial leaf areas of seedlings are correlated with acorn size which makes sense when we consider that the food stores available during seedling development are substantially different. Other studies have shown a correlation between acorn weight and height growth at three years of age.

Seed Handling and Storage

Let's again put a few things in perspective. Interactions between various factors involved are complex, however, it is possible to make some generalizations about seed storage.
1) Mature, fully ripened seed maintains viability longer than seed collected when immature.
2) Seed damaged at the time of collection does not retain viability as well as undamaged seed.
3) Fluctuations in environmental temperature and fluctuations in seed moisture content are more detrimental than constant conditions.
4) Slowing respiration in seed adds to longevity.

Protection against high or rapidly fluctuating environmental temperatures can be very difficult to control and care should be taken to avoid placing the acorns into such situations. This applies not only during the storage of the acorns prior to shipping, but also at the time of shipping. Methods of storing the acorns should provide an environment that optimizes both cool conditions, high humidity, and protection from rodents.

Storage

Acorns should be surface dried after floating then stored in darkened areas employing any one of the following methods.
1) Store in cool ventilated sheds in dampened cone bags, or
2) Store in 4 mil plastic bags held in a cool area, or
3) Store in oxygenated water.
All serve to prevent the acorns from losing moisture. Because starch is more hygroscopic than fat, moisture content can be more easily maintained in red oak acorns.

Acorns of the red oak group can be stored for three to five years under special conditions although quality will decrease each year. The best storage method documented to date, is maintaining acorn moisture content between 30 to 35% at a temperature of 1 – 3°C. Because of a high respiration rate, gas exchange is necessary, therefore acorns are stored in 4 mil polyethylene bags contained within fibre drums or cans without lids or cardboard boxes. These bags are permeable to gaseous exchange without loss of moisture. Viability will be completely lost if acorn moisture content drops to about 25% (Bonner and Vozzo 1987).

Short-term storage methods include storing acorns submerged in water. This is strictly an overwinter procedure and does prevent radicle emergence. One option is to utilize 45 gallon drums filled with water. A ratio of twice the volume of water to that of the acorns is required. This method is in use at a nursery located in Stoneville, Mississippi. Another alternative, is to simply place the bags of acorns into moving water, ensuring that they will be under the ice layer at the time of freeze up. They are left submerged until required for spring sowing.

Seed shipment

The benefits of exemplary seed collection and storage methods may be largely lost if care is not taken when shipping to the nursery. It is seed viability at the time of sowing, rather than at the time of shipping from the storage facility, that determines the number of healthy plants produced from a particular quantity of seed. It is therefore essential to provide shipment methods that will ensure minimal loss of viability in the time interval between shipping and sowing.

The selection of appropriate methods of transportation will depend on: 1) characteristics of the species, 2) the quantity to be shipped, 3) expected length of time in transit in relation to the destination, 4) mode of transportation, and 5) conditions to which the shipment is exposed to.

Provided that the initial moisture content of the acorns is adequate when initially shipped, it can be easily maintained during transit by the use of appropriate packaging and rapid transit. It is necessary to take precautions against the possibility of mechanical damage to the acorns through careless handling while in transit. Use a method that will separate the acorns and prevent stacking of other goods atop the acorns.

In summation, by revisiting this material, it was our intention to emphasize some of the things to be aware of at the time of collection or when purchasing acorns and highlight techniques in place that scope out the proper handling and storage of acorns. Always be reminded that good quality stock begins with good quality seed.

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HOW TO ACHIEVE SUSTAINABLE CONSERVATION OF ORTHODOX SEEDS OF FOREST TREE SPECIES

Quebec's strategy for the conservation of biological diversity is based upon two major concepts: the creation of protected areas and the implementation of ecosystem-based management. Since 2000, actions have been taken for the conservation of species and ecosystems in Quebec, but genetic diversity is conserved through a coarse filter only, with no conservation strategy targeted to specific requirements of each species.

To overcome this gap, a new research project was initiated at the Direction de la recherche forestière (DRF, Research Branch) comprising two objectives: develop a strategy for the conservation of forest genetic resources, based on gap analysis, and identify optimal conditions for *ex situ* conservation of forest genetic resources in seed banks. The last objective will be briefly presented here.

Since 2007, the DRF uses the measurement of water activity (a_w) to evaluate quality of orthodox seed. This method was developed by Cemagref in France. Its main advantage is that it is non destructive. With the hydric characterization of the main species used for reforestation in Quebec (Baldet et al. 2007, 2009), we determined the optimal a_w (a_w of best stability) for their conservation.

The main objective of the actual DRF seed bank is to provide material for the establishment of genetic tests in tree improvement programs. While some seedlots have been stored for more than 40 years we thought of using a_w to evaluate their quality. A representative sample of the seed bank was identified (different species and periods of storage) resulting in more than 900 seedlots being tested. Water activity values were quite high, illustrating a high moisture content. Containers used by the DRF are made of different plastics and are quite variable as regards to their form and volume, depending on the collection year and number of seeds comprising each seedlot.

Seedlots are kept in freezers at -18°C, where relative humidity is high (between 70 and 80%). The a_w obtained confirms the importance of the container for seed conservation (for an exhaustive analysis of containers see Gomez-Campo (2002)).

Collaboration was initiated with the Centre de technologie minérale et de plasturgie Inc. (Center of mineral technology and plastics processing industry) in Thetford Mines, Quebec, (www.ctmp.ca), for the development of a polymer that would limit gas exchange between the seed and the atmosphere in the freezer. This polymer would serve as base material for new containers. We also know that repetitive openings of the containers induce changes in the container's atmosphere and possibly an a_w increase of the seed (Colas et al. 2009). Another objective of the project is to design a new lid for the containers. It will combine two properties: the possibility of visually monitoring the internal atmosphere, thanks to a coloured indicator (if humidity rises in the container, the colour changes) and the presence of an opening which will allow the insertion of an a_w probe without affecting the internal atmosphere. With this new lid, conservation quality of the seed will be maximised. If a change in a_w is detected, the seed will be dried to the optimal a_w for continued conservation.

The development of a new container limiting the interaction between seed and the atmosphere in cold chambers will give us a reliable tool for long-term conservation of quality seed, a minimum required standard when conservation of forest genetic resources in seed banks is at stakes. Moreover, operational seedlots used for reforestation purposes, stored as big volumes at the Centre de semences forestières de Berthier, will also be stored in containers made with this new polymer.

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SEED YIELDS: TRENDS WE HAVE FOUND

Seed yields have been calculated over the past 22 years for all the species extracted at the Atlantic Forest Seed Centre located just outside of Fredericton, New Brunswick. For the purpose of this report we thought it would be of interest to summarize the yields from wild stands vs first-generation orchards vs second-generation orchards. The summary is restricted to black spruce (*Picea mariana*), white spruce (*P. glauca*), and jack pine (*Pinus banksiana*) as these species make up the bulk of reforestation efforts in Atlantic Canada.

Supplemental Mass Pollination

Until there is good pollen production, seed yields are low. This can be alleviated by using supplemental mass pollination which has worked very well for us over the years. It is easy and efficient to do, particularly for spruce. Jack pine requires an applicator that injects the pollen over the flowers using a nitrogen cylinder and a cone at the end of a wand (Fig. 1). This method requires much more pollen in order to treat flowers over the entire tree. With the spruces, applying pollen by hand with an insufflator (Fig. 2) works well.

Figure 1. Supplemental mass pollination of jack pine.

Figure 2. Powder insufflators used for controlled pollination.

GA $_{4/7}$ Injections

The application of $GA_{4/7}$ either by foliar spray or stem injection works very well for inducing female cone production. One thing we have noticed, however, is that the cones are smaller, very prolific, and the seed yields aren't quite as good. The flip side, though, is without a $GA_{4/7}$ application, an orchard may not produce a crop. We use a rate of 1 g $GA_{4/7}$ per 10 ml alcohol (95% or 100%). We inject 1/10th ml/tree, so 1 g will treat 100 trees.

Fertilizer

This is important to ensure the trees have sufficient nutrition to produce big, healthy cones with filled seed. There are many other factors that come into play, but a dry summer will ensure the trees are under enough 'stress" to induce flower production for the following spring. It is important the trees are well nourished so they aren't seriously compromised from their efforts. We focus our fertilizing efforts on newly established orchards. We are fortunate enough to have very fertile farm soil on site, so trees grow very well. For fertilizer, we have been using ammonium nitrate (34-0-0) mixed with 10-10-10 at a 1:2 ratio although we are now using only 10-10-10. Table 1 shows the rates of fertilizer used.

Table 1. Rates of fertilizer applied to trees in seed orchards.

Amount/tree	Tree height
30 g	< 1 m
50 g	1 – 2 m
100 g	> 2 m

Seed Yields

Jack pine orchards tend to produce lots of pollen and we do not apply $GA_{4/7}$ as the orchards produce a regular cone crop. Yields from second-generation orchards (Table 2) are lower and may reflect the initial juvenile age of the first few years as this is an average over time. The older second-generation orchard was consistently producing 1.0 kg of seed per hL of cones

Yields in second-generation black spruce clonal orchards are lower than those from first-generation seedling seed orchards. We have used $GA_{4/7}$ operationally in these orchards and have found the cones tend to be prolific and smaller with more hollow seed. This, in turn, results in a lower overall yield, but, as previously noted, we get a consistent crop we can depend on.

The second-generation white spruce clonal orchard has just started producing which would explain the lower yield (Table 4). We supplementaly mass pollinated the crop harvested in 2009.

Table 2. Seed yield from various sources of jack pine cones.

Seed source	Age of crop trees (years)	Kg seed/hL cones	Range
Natural stands	Mature	0.802	0.46–1.65
Seedling orchard (F1)	7–15	0.833	0.49–1.20
Clonal orchard (F2)	7–15	0.622	0.53–0.77

Table 3. Seed yield from various sources of black spruce cones.

Seed source	Age of crop trees (years)	Kg seed/hL cones	Range
Natural stands	Mature	0.735	0.43–0.95
Seedling orchard (F1)	10–22	0.646	0.32–0.95
Clonal orchard (F2)	6–15	0.454	0.35–0.53

Table 4. Seed yield from various sources of white spruce cones.

Seed source	Age of crop trees (years)	Kg seed/hL cones	Range
Natural stands	Mature	1.44	1.36–1.53
Clonal orchard (F1)	9–27	1.55	1.03–2.55
Clonal orchard (F2)	7–11	1.29	1.22–1.36

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LENGTHENING STRATIFICATION TIME INCREASES GERMINATION SPEED OF COASTAL DOUGLAS-FIR IN LAB AND GREENHOUSE TRIALS

Introduction

At Washington Department of Natural Resources's Webster Nursery (Olympia, WA), we routinely stratify coastal Douglas-fir (Fdc) (*Pseudotsuga menziesii* var. *menziesii*) seed, destined for the cool soils of bareroot fields, for 60 to 90 days. Seed handling practices have been refined to reduce disease and premature germination that lead some growers to avoid these long stratification times. These practices include seed-surface sterilization, running water rinse for further cleanliness and aerated imbibition, targeted seed-surface drying, and moisture monitoring during stratification. In our judgment, the benefits of rapid germination in the sometimes harsh conditions of an outdoor growing environment far outweigh risks associated with extended periods the seed spend in a moist and cool stratification environment before sowing.

In greenhouse sowing, our Fdc stratification lengths are relatively short, from 30 to 45 days. While wild Fdc seed almost always germinate rapidly, general observations over the past several years indicate that improved seed is more prone to delayed germination when treated with these reduced-length stratifications, even in considerably warmer greenhouse conditions. Since the large majority of our greenhouse-sown seed is improved, we examined the effect of a series of stratification lengths on germination speed and capacity, both in lab and greenhouse settings. We did not test wild vs. improved seed, but intend to examine such a comparison in the future.

Lab and Greenhouse Trial Set-up

We selected four distinct lower-elevation, western Washington lots of first-generation improved seed, collected from DNR's Meridian Seed Orchard in 2005 and 2006. Seed had previously been stored at -18°C and a moisture content of 7–8% prior to seed withdrawal in fall of 2009.

Seed treatment

After withdrawal, the seed was surface-treated with two parts household bleach (sodium hypochlorite 5.25%) to three parts water for 10 minutes in a volume of solution at least 3 times that of the treated seed. Seed was removed from bleach and thoroughly rinsed until the strong bleach smell was no longer detectable. Next, seed was soaked for 48 hours in running water at a trickle but fast enough to exchange several water volumes and to maintain an oxygen-rich environment.

After the 48-hour running water rinse, the seed was surface-dried to moisture contents of between 33–35%. Seed remained in mesh bags within 4-mil polyethylene bags that were opened wide enough at the top to allow for gas exchange, but closed tight enough to avoid over-drying the seed. The seed was placed in a cooler at 2°C and relative humidity averaging 50%. The seed was turned or "massaged" once weekly, and monitored visually and quantitatively for excess or low moisture until sowing.

Lab trial

For the lab trial, eight 50-seed replicates were plated on pre-moistened blotter paper in enclosed Petri dishes. The Petri dishes were placed in a germinator set for Association of Official Seed Analysts standard Fdc lab-test temperature regimes of 8-hour periods at 30°C followed by 16-hour periods at 20°C. Actual average temperature was 22.2°C over the course of the 21-day germination period. Germination was measured weekly and defined as extension of the radicle to at least four times the length of the seed coat. A small number of abnormal germinants was noted and recorded as non-germinated seed.

Greenhouse trial

For the greenhouse trial four 60-seed replicates were sown into 515A styroblocks, with each tray considered a replicate. Temperature of the germination environment was measured by placing an ibutton just below the surface of the top-dressing grit at seed level. Average temperature over the 32-day germination period was 20.7°C. Germination was measured twice weekly and defined as extension of the growing point (whether seed coat had been shed or not) above the surface of the grit top-dressing.

Results

Results from the four seed lots were combined for each trial. The distinguishing trend in the lab trial was the rapid germination of the 84-day treated seeds, with germination at day 7 more than 30% higher than the 28- and 56-day treatments (Fig. 1). This advantage disappeared by day 14.

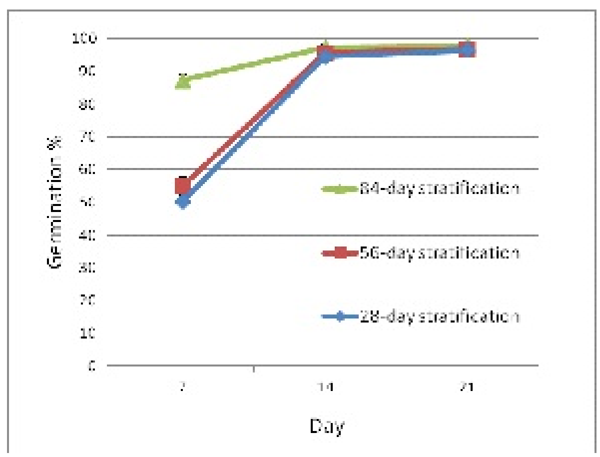

Figure 1. Douglas-fir lab trial showing cumulative germination percentage for 28-, 56-, and 84-day stratification treatments. Error bars represent standard error of the mean.

For the greenhouse trial, germination rate differentiated between the 38- and 66-day treatments, with germination of the shortest stratification time lagging behind the longer treatments through the first 21 days (Fig. 2).

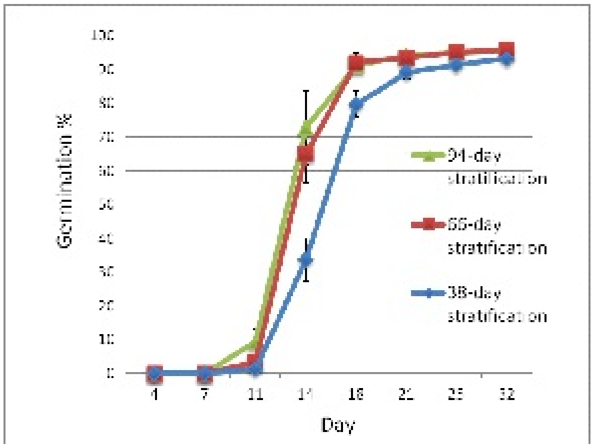

Figure 2. Douglas-fir greenhouse trial showing cumulative germination percentage for 38-, 66- and 94-day stratification treatments. Error bars represent standard error of the mean.

Across all treatments, seed germinated more quickly in the lab trial, completing germination roughly a week faster than in the greenhouse. Two factors may explain this: the 1.5°C average warmer temperature in the lab and the different criteria used to define germination for each trial.

Discussion

Are longer stratification times worthwhile for greenhouse culture of Fdc? Day 7 germination of the 84-day stratification length in the lab trial was impressive, especially to those who might see a potential savings in heating costs. In the greenhouse trial, speed of germination, as defined by G50 (days to 50% germination), was only 3 days faster when comparing the 38- and 94-day treatments. Still, large operations in cold climates expend considerable money each day to heat a greenhouse. A physiological benefit of reaching near-complete germination as quickly as possible is the ability to reduce nighttime temperatures and burn fewer carbohydrates in artificially warm dark periods.

A labor-savings benefit of rapid and complete germination is avoiding the need for re-thin call backs, assuming more than one seed per cell is sown. Quicker germination also reduces the pest window at this extremely susceptible, succulent stage. A final argument in favor of longer stratification lengths may be apparent in seedling uniformity at pack out. This trial will conclude with end-of-season morphological measurements to evaluate whether small improvements in germination speed lead to improvements in seedling size leaving the nursery.

For these four seed lots, we encourage a 60-day+ stratification time to facilitate optimal culturing of Fdc. In the future, under the above-described seed handling practices, we intend to implement these longer stratification times as regular practice in greenhouse culture.

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SEED EXTACTING AND CLEANING AT J.D. IRVING, LIMITED

The large quantities of cones we collected in 2009 made for a lot of work during the winter. We collected 628 hL of cones and received an additional 40 hL from the Prince Edward Island Provincial Nursery.

Two hourly employees worked on seed extracting and cleaning from late November until late April. We are still cleaning the last Norway spruce seed via liquid and gravity separation. Our seed cleaning equipment came from Sweden 22 years ago. We had some equipment problems in February with the Tumbler/Dewinger. It took 3 weeks to get the replacement part from Sweden. The entire processing operation came to ahalt. It was the first problem we had in 22 years.

We also had a large amount of Norway spruce seed sink in the liquid separator this year. The seeds were abnormally large (very healthy) and heavy. A significant amount of hand cleaning was required. The table below summarizes the seed processing work.

Table 1. Summary of seed processing conducted by J.D. Irving, Limited.

Species	Location	Volume of cones (hL)	No. seed/g	Wt. seed (Kg)	MC (%)	Germ. (%)	Purity (%)
Red spruce	Breeding garden	38.7	334–402	47.76	5.3–5.7	98	99.98
Black spruce	Seed orchard	18.4	685	8.755	6	99	99.98
White spruce	Seed orchard	155.4	360–458	220.05	5.0–5.6	96	99.99
Norway spruce	Seed orchard	382.9	-	-	-	-	-
White pine	Seed orchard	32.6	47–55	22.735	5.6	85*	98.26

* unchilled seed

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MOISTURE CONTENT CHANGES DURING FREEZER STORAGE

This article discusses the quantification of changes in moisture content (MC) during long-term freezer (-18° C) storage and its impact on our retesting policy at the BC Ministry of Forests and Range Tree Seed Centre. The actual changes, generally gains in MC, are the result of absorption of moisture from the atmosphere during seed withdrawal for sowing requests, testing purposes, or research requests. The MC changes are most probably during the short period in which seeds are exposed to air of higher relative humidity and/or temperature when they are being sampled. The seedlots investigated all initially had MCs between 4.9 and 9.9%. Testing for MC is based on the oven-dry method as prescribed by the International Seed Testing Association (ISTA 2009). Although retesting of all seedlots for MC is not a standard procedure, for a variety of reasons we had a reasonably good dataset that may be useful in comparing species and determining if retesting MC is justified for any of our species. The results could also then be used to prioritize seedlots for drying to try and extend longevity in long-term storage.

In 1994, a co-op student looked into this question and reviewed existing records to identify seedlots above 9% MC and estimate an average change in MC per year for each species (Prabhu 1994). Based on this analysis, *Abies amabilis* and *Larix occidentalis* were identified as having much higher average changes in MC and retesting frequencies of 10 years were applied to these species. A common reason for retesting MC was when seedlot characteristics were changed by drying the seedlot to a lower level to increase longevity or upgrading the seedlot through the removal of non-viable seed to increase quality. Since these tests involved a change in the seed characteristics above what would normally occur during general use, these data points were removed from the data set.

This year I am reviewing all of our retesting frequencies and MC seemed like a good place to start. In this analysis further effort was extended in: a) identifying upgraded or dried-back seedlots from older paper records and b) increasing the sample size for species for which we had very little information. As with the initial 1994 analysis, the primary variable estimated for comparative purposes was the average change in MC per year, by species. This was calculated as the change in MC divided by the time difference, in years, between the two tests. In Table 1, the results of these latest changes in MC per year, by species, are presented as well as the results from the 1994 analysis. The average gains in moisture are much lower than estimated in 1994 with all species falling below a moisture gain of 0.1 % per year. From my perspective **this justifies the discontinuation of our retesting program for**

MC. I also believe that these results are quite conservative as some of the averages appear biased upwards for a few seedlots tested in a specific year, but I did not feel justified removing these values from the dataset.

This information may be of marginal value to other agencies as it reflects our storage environment, our sampling environment (which is influenced by a humid climate during most of the year), and the number of times each seedlot was withdrawn for sampling. Certainly a more useful measure would be to have these results in addition to the number of times a seedlot is withdrawn, but an accurate quantification of that is not possible. We could obtain a reasonable number of withdrawals per seedlot since 1994 (when our current electronic data management system, CONSEP was introduced), but even with that there are several problems trying to use this information. I'm convinced that the data indicated in Table 1 are the worst-case scenario for changes in seedlot MC (i.e., some of the data should have been eliminated from the dataset, but I couldn't find written documentation indicating that dryback or upgrading practices actually occurred). I'm quite comfortable with all of our species having a gain below 0.1% per year indicating that with 'normal' use it would take 10 years for a seedlot to increase by 1%. This may or may not be a useful guide for other facilities, but it impacts our TSC policy and I thought I'd share our perspective.

Table 1. Change in moisture content of seed for various species stored at the BC Tree Seed Centre.

Species	BC Species Code	Number of Samples	Average Δ MC/year 2010	Average Δ MC/year 1994
Abies amabilis	BA	123	0.031	**0.230**
Abies grandis	BG	7	0.082	0.105
Abies lasiocarpa	BL	15	0.063	0.126
Thuja plicata	CW	15	0.079	0.158
Pseudotsuga menziesii var. *menziesii*	FDC	14	0.044	0.076
Pseudotsuga menziesii var. *glauca*	FDI	34	0.061	0.078
Tsuga mertensiana	HM	5	0.022	0.116
Tsuga heterophylla	HW	15	0.046	0.103
Larix occidentalis	LW	104	0.027	**0.197**
Pinus contorta var. *contorta*	PLC	10	0.064	0.151
Pinus contorta var. *latifolia*	PLI	32	0.062	0.058
Pinus monticola	PW	40	0.096	0.156
Pinus ponderosa	PY	10	0.004	0.161
Picea sitchensis	SS	10	0.016	0.051
Picea glauca X *engelmannii*	SX	84	0.086	0.086
Picea lutzii	SXS	3	0.049	0.095
TOTAL / Average		516	0.051	0.122

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Dave Kolotelo

WHITEBARK PINE ECOSYSTEM FOUNDATION OF CANADA

Whitebark pine (*Pinus albicaulis*) is a Provincially blue-listed species in both British Columbia (BC)and Alberta, and was recently elevated to endangered status by the Committee on the Status of Endangered Wildlife in Canada. The decline of whitebark pine is due to a number of threats including white pine blister rust, mountain pine beetle, fire suppression, and climate change. In light of these threats, a small group of individuals recently collaborated to form the Whitebark Pine Ecosystem Foundation of Canada, a registered non-profit society in BC. The purpose of this society is to promote the conservation of whitebark pine ecosystems by supporting restoration, education, management, and research projects that enhance knowledge and stewardship of these valuable ecosystems. This society is a chapter of the Missoula, Montana based Whitebark Pine Ecosystem Foundation (www.whitebarkfound.org). The intent of the Canadian group is to work closely with the parent organization to share resources while working to raise the awareness and increase the amount of work dedicated to whitebark pine in Canada.

The Tree Seed Working Group may be interested in this subject area, as not only is whitebark pine an interesting subject for it's conservation concerns, but it is also highly valued for its seeds. The large, nutritious seeds, are highly valued by wildlife as an important food source. For species such as the Clark's nutcracker and the Grizzly Bear, the decline in available seed may greatly impact the viability of these species in some areas.
Individuals interested in joining the society should become a member of the parent organization, which publishes a small journal dedicated to whitebark pine conservation and research and often contains a number of Canadian submissions. For further information or to get involved contact Randy Moody.

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UPCOMING MEETINGS

IUFRO Recent Advances in Seed Research and *ex situ* Conservation
Aug 15–21, 2010 Taipei, Taiwan
Contact: Tannis Beardmore
tbeardmo@nrcam.gc.ca

ISF Tree and Shrub Seed Group Meeting
Aug 22–24, 2010 Ithaca, New York

International Conference of the European Seed Kilns
"Climate Changing and Tree Seed Production"
Sep 9–12, 2010 Verona, Italy
http://www.iskc.eu/

ISTA Workhop: Water Activity Measurement Applied to Seed Testing
Oct 13–15, 2010 Montargis, France
Contact: Patrick Baldet
patrick.baldet@cemagref.fr

10th Conference of the International Society for Seed Science
"Seed Science in the 21st Century"
April 10–15, 2011 Salvador - Costa do Sauipe, Brazil

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