CANADIAN TREE IMPROVEMENT ASSOCIATION/
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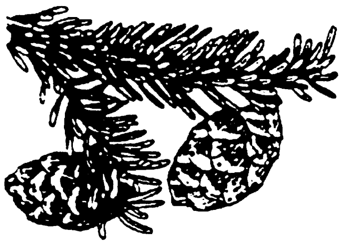

Tree Seed Working Group

NEWS BULLETIN

No. 44 December 2006

SEED DORMANCY

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CHAIR'S 'ARMCHAIR' REPORT

Happy New Year to all! Apologies for the News Bulletin not making it into your inbox in time to enjoy over the holidays. It has been a very busy year with our IUFRO Tree Seed Symposium, ISTA Forest Tree and Shrub Seed Committee Seminar, OECD meeting, and the CTIA meeting and associated TSWG workshop and CON**FOR**GEN Forum. The latter is an initiative to move us forward as a nation in the conservation of our tree genetic resources. Summaries of some of these meetings are enclosed. Locally in BC, the mountain pine beetle continues to not only destroy our forests, but our assumptions as well – this past year we have seen mountain pine beetles attack very young (< 8 cm dbh) trees, attack spruce, and attack our seed orchards in the North Okanogan. A year ago these were things we assumed would not occur, so keep an open mind to the occurrences you see or hear about – they may just be part of our changing 'climate'.

Thank you to everyone who contributed to this News Bulletin. We are currently making available all past News Bulletins in pdf format at the following site: http://www.for.gov.bc.ca/hti/treeseedcentre/tsc/tswg.htm . As of today, have gone back as far as News Bulletin Number 23 (March 1995) and more are going up all the time. I hope you enjoy them as they contain a lot of hidden jewels and innovative ideas for improving your practices.

Seed dormancy is an important physiological process in tree seeds and one that we have an incomplete understanding of. I often say that we are very fortunate with conifers as they store very well and in general they have dormancy mechanisms that are easily overcome with a moist pre-chilling treatment (= stratification). Baskin and Baskin (2004)[1] describe conifers and most angiosperms as having physiological dormancy (non-deep level) that is quite similar. A case is made by them towards the relevance of studies in *Arabidopsis thaliana* enabling elucidation of the basic mechanism(s) of physiological dormancy in seeds?

Seed dormancy extends back to Palaeozoic conifers in which fossilized embryos indicate that there was a significant delay between fertilization and seed germination. It is suggested that seed dormancy allowed conifers to colonize previously unforested habitats, notably arid or only periodically moist environments (Mapes et al. 1989). That is quite an amazing theory – without the evolution of seed dormancy we may never have seen the vast ranges of coniferous forests we now have in North America!

Seed dormancy issues can be far more complex among broad-leaved trees, although the few species we use operationally in BC have little or no dormancy (*Alnus rubra*, *Betula papyrifera*, and *Populus tremuloides*). Good examples of deeply dormant broad-leaved species in Canada include: *Acer pensylvanicum, Acer spicatum, Fagus grandifolia, Fraxinus nigra, Fraxinus amerericana, Juglans* spp., *Tilia americana,* and *Ostrya virginiana.* While conifers primarily have physiological embryo dormancy the broad-leaved species can have more complex mechanisms involving physical, mechanical, and morphological in addition to physiological dormancy.

A good overview of seed dormancy is provided by Peter and Shelagh. There are additional descriptive terms worth reviewing. Conditional or relative dormancy is also used to describe shallow dormancy. Testing for conditional dormancy and some types of vigour testing appear to be very closely associated concepts. The degree of conditional dormancy can be thought of as the result of the interaction between the genetic background, stratification duration, stratification moisture content, and germination temperature. Conditional dormancy quantification and the benefits of extended stratification offer the greatest gains where there is little control of germination conditions such as in a bareroot seedling production system. In a greenhouse environment, where germination temperatures can generally be controlled over 20ºC, conditional dormancy is not a production issue problem as long as stratification is properly applied. The other commonly encountered term is secondary or induced dormancy in which dormancy is induced in mature, non-dormant seeds as opposed to during seed development as is the case with the mechanisms of primary dormancy discussed so far. The best illustration I have found regarding the relationship between the various terms is Figure 1 in the review article by Foley (2001). Terminology can become a passionate issue for some and for those wishing to share a rare rant on the topic of ***stratification***, find a copy of page 8 of the 201st issue of the American Nurseryman ("Stratification" semantics).

I'd also like to draw readers' attention to a paper by Carole Leadem (Dormancy – Unlocking Seed Secrets) that can be downloaded from a web-link in the Suggested References section. It presents a general overview for investigating dormancy in a variety of species, especially when little is known about their dormancy-breaking requirements. I refer to several species in BC (yellow cedar, western white pine, whitebark pine, Amabilis fir, Noble fir, and subalpine fir[2]) as having deep dormancy. Our description is more in line with the time and effort involved in overcoming dormancy compared to a seed's inability to germinate at any temperature. Probably a bigger operational issue than the average degree of dormancy in a seedlot has been the variability in dormancy between seeds in a seedlot. Western white pine is a good example of a species that can contain, within a seedlot, deeply dormant seeds (requiring up to four months stratification) as well as seeds that possess no dormancy at all and will germinate readily given adequate moisture and subsequent warmth. Variability in degree of dormancy can be problematic if non-dormant seeds initiate radicle emergence prior to the seed being sown into its growing environment.

For the next News Bulletin the theme will be "Seed Storage" and unlike seed dormancy I hope it is something that many individuals can contribute to our current understanding on. At the BCMOFR Tree Seed Centre we use the basic "**Deterioration Rate**" statistic to quantify how well seed stores on a species basis as well as identifying individual seedlots that are deteriorating more rapidly than the species average. These deterioration rates are useful in helping to specify the germination retest frequencies we use operationally to maintain up-to-date estimates of seedlot germination. The deterioration rate is calculated quite simply as (original germination % minus the current or latest germination%) all divided by the time interval between the tests. We generally represent the deterioration rate as change in germination/year (DGC/ Dtime). The only limitations I place on this calculation are: a) the initial and current test are of the same test type and b) a minimum of 500 days

[1] References in the Armchair Report can be found in the Selected References section of this News Bulletin

[2] yellow cedar = *Chamaecyparis nootkatensis*, western white pine = *Pinus monticola*, whitebark pine = *Pinus albicaulis*, Amabilis fir = *Abies amabilis*, Noble fir = *Abies procera*, and subalpine fir = *Abies lasiocarpa*

between tests is required (otherwise one can get very large deterioration rate estimates based on small changes in germination). I would like to suggest/ request/challenge individuals to look at their seed inventories and present information on seed deterioration, using this simple variable for the next News Bulletin (June 2007). Thank you.

Again, all the best in 2007 to everyone. I look forward to your seedy contributions to the News Bulletin. Contributions do not need to be on the theme topic and all contributions dealing with tree seed are welcome. Suggestions for future News Bulletin themes are also welcome.

Dave Kolotelo
Chairperson

EDITOR'S NOTES

I first want to take this opportunity to wish you a Happy New Year and I hope you had a Joyous Holiday Season. It is incredible that another year has come and gone but then again it was a very busy, productive year for myself, being involved in the organization of the IUFRO Tree Seed Symposium held in Fredericton July 18–21 as well as the Canadian Tree Improvement Association meeting and associated Tree Seed Workshop and Gene Conservation Forum which took place in Charlottetown July 24–29. All events were well attended and a good time was had by all.

Seed Dormancy, the theme of this News Bulletin, is an interesting and challenging phenomenon. Ultimately, it is natures way of helping to ensure that a seed germinates when the environmental conditions are optimal for its survival. Dormancy is something we all accept when dealing with seed of those particular species. However, it is also a challenge for those species for which alleviation protocols have not been fully developed. Several articles in this issue address dormancy from a couple of different angles. In addition there are a number of articles on an array of other topics that I hope you will find interesting.

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

SEED DORMANCY IN A NUTSHELL!

Summary

The seeds of many freshly collected or dry-stored tree species often fail to germinate when incubated under apparently favourable conditions for plant growth. Even in the presence of ample water, good aeration and a suitable temperature for growth, although the seeds fully hydrate, begin to metabolise and respire – they obstinately refuse to germinate. When there is a complete metabolic block to germination under all conditions, the seeds may be described as 'deeply dormant'. When the metabolic block to germination only occurs under some conditions, the seeds may be called 'shallowly dormant'. In nature, seeds with these two types of dormancy frequently acquire the ability to germinate by responding to the passage of one or more cold winters and emerge in a subsequent spring.

A third group of so-called 'hard-seeded' species possess an impermeable seed coat which prevents water uptake. Strictly speaking these seeds are not 'dormant' - because the embryo tissues have been prevented from hydrating and are therefore not respiring or metabolically active.

To stimulate the germination of ‘deeply dormant’, ‘shallowly dormant’, and ‘hard-seeded’ tree species requires the identification and application of a pre-(sowing) treatment usually abbreviated to ‘pretreatment’. Exposing tree seeds to artificial conditions which mimic seasonal changes can be used to pretreat dormant species. Using mechanical techniques that puncture, split or disrupt the seed-coat can be used to pretreat hard-seeded species.

Introduction

A dormant seed is one which is 'known ' to be alive, but does not germinate when provided with ample water, good aeration, and a suitable temperature (i.e., the normal requirements for plant growth).

In nature, dormant seeds possess many mechanisms for monitoring their environment and the passage of time. For example, they can perceive:

1) cycles of burial followed by re-exposure to light,
2) passage through a bird or animal gut,
3) transitions between one or more cold winters and warmer springs,
4) many combinations of these things.

The above environmental stimuli act as natural dormancy breakage agents. They overcome seed dormancy and often promote emergence at the beginning of the most favourable season for seedling growth and establishment. These natural environmental stimuli can frequently be mimicked by artificial techniques which can be applied before nursery sowing or direct seeding when they are often referred to as pre-(germination) treatments or 'pretreatments'.

There are almost as many methods of classifying seed dormancy as there are people working on the subject, and many of the systems are extremely complicated. The following three sections distill the plethora of seed dormancy types into two sorts of temperate tree seed dormancy – illustrated with one broadleaved species (*Fraxinus exelsior*) and one conifer species (*Picea sitchensis*). A tropical legume tree species (*Prosopis juliflora*) is used to make an important distinction between ‘dormancy’ and ‘hard-seededness’.

Deep Dormancy

Some seeds exhibit 'deep dormancy' - the embryo tissues absorb water, begin to metabolise and respire, but remain outwardly inactive at all temperatures. These seeds appear to have a complete metabolic block (or blocks) to cell elongation, growth, development, and differentiation under all conditions. Figure 1 shows that untreated 'deeply dormant' seeds do not germinate at any temperature (●) and that there is an absolute requirement for a relatively lengthy pretreatment to bring about any germination at all (■ , ▲). It is noteworthy that the first signs of pretreated seeds losing their dormancy occur with germination at the cooler temperatures (10–20°C). This is an important practical consideration when planning either when to initiate pretreatment, in relation to sowing date; or in deciding whether or not to extend a pretreatment duration in the spring - which would of course lead to a delay in sowing and hence warmer temperatures.

Shallow Dormancy

Some seeds exhibit 'shallow dormancy' - the embryo tissues absorb water, begin to metabolise and respire, but remain outwardly inactive at most temperatures. Shallowly dormant seeds also have a complete metabolic block (or blocks) to cell elongation, growth, development, and differentiation - but only under some conditions. Figure 2 shows that untreated 'shallowly dormant' seeds germinate at some temperatures but not all (●) - they demonstrate a pronounced temperature optimum in the laboratory with a sharp drop in germination either side. It is also interesting to note that a relatively short pretreatment begins to widen the range of temperatures over which germination occurs (■), and that lengthening the pretreatment can stimulate almost 100% germination irrespective of temperature (▲). Longer pretreatments are clearly beneficial in that they stimulate outdoor-sown seeds to emerge at the lower temperatures of a typical spring soil, and intensive-nursery sown seeds to emerge at the higher temperatures likely under cover.

Hard-seededness

Some seeds exhibit 'hard-seededness' - often the result of an impermeable seed coat acting as a barrier to water uptake so that the embryo tissues cannot hydrate. Figure 3 shows that a few untreated seeds may have permeable coats and germinate at most temperatures (●) and that although pretreated tropical legume trees are rarely able to germinate at lower temperatures (e.g., 10 or 15°C) a different sort of pretreatment (e.g., 'scarification'[1]) can stimulate virtually all seeds to germinate at higher temperatures even up

[1] Scarification - any ‘pretreatment’ that removes, abrades, splits, burns or softens the hard seed-coat without significantly damaging the embryo within, e.g., chipping, filing, boiling/hot water.

to and including a constant 40°C (■). It is not really surprising to discover that a tropical legume tree produces seeds with a better ability to germinate at higher temperatures than any temperate tree.

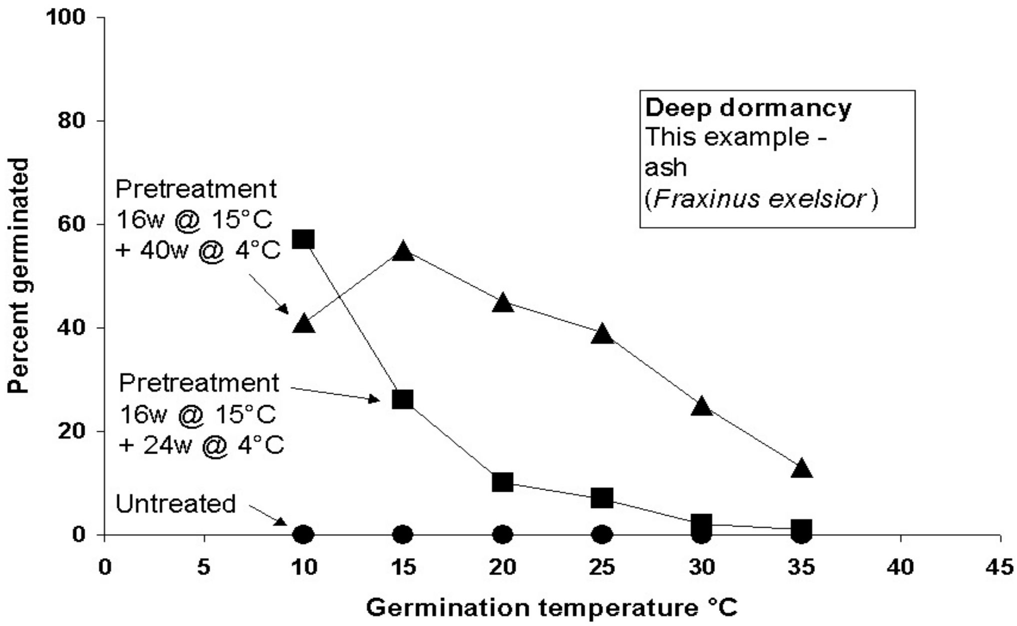

Fig. 1. Deep dormancy - the germination capacity of *Fraxinus excelsior* seeds at different temperatures following increasing pretreatment durations. Other examples: most temperate broadleaved species plus *Juniperus* spp. and *Taxus* spp.

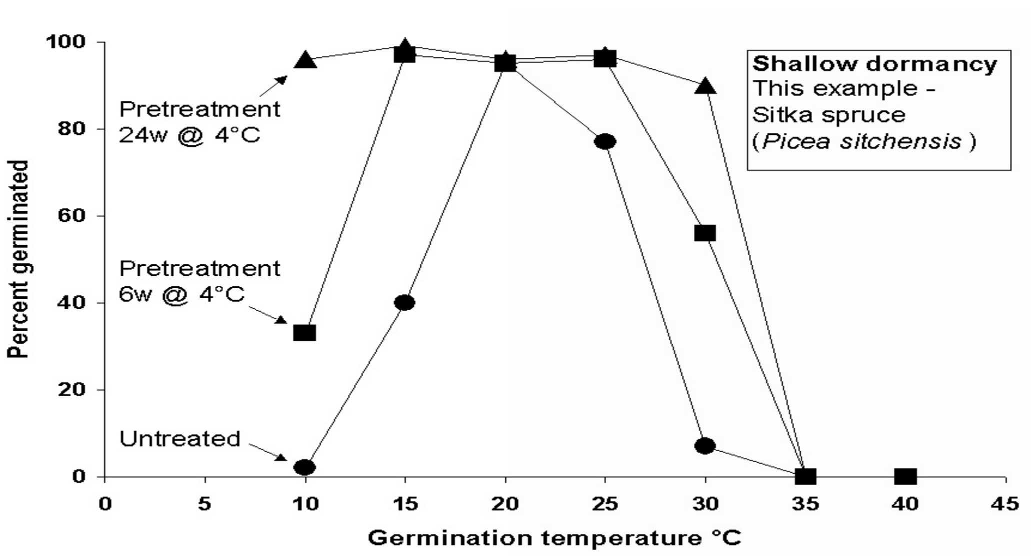

Fig. 2. Shallow dormancy - the germination capacity of *Picea sitchensis* seeds at different temperatures following increasing pretreatment durations. Other: most temperate conifer species plus *Alnus* spp. and *Betula* spp.

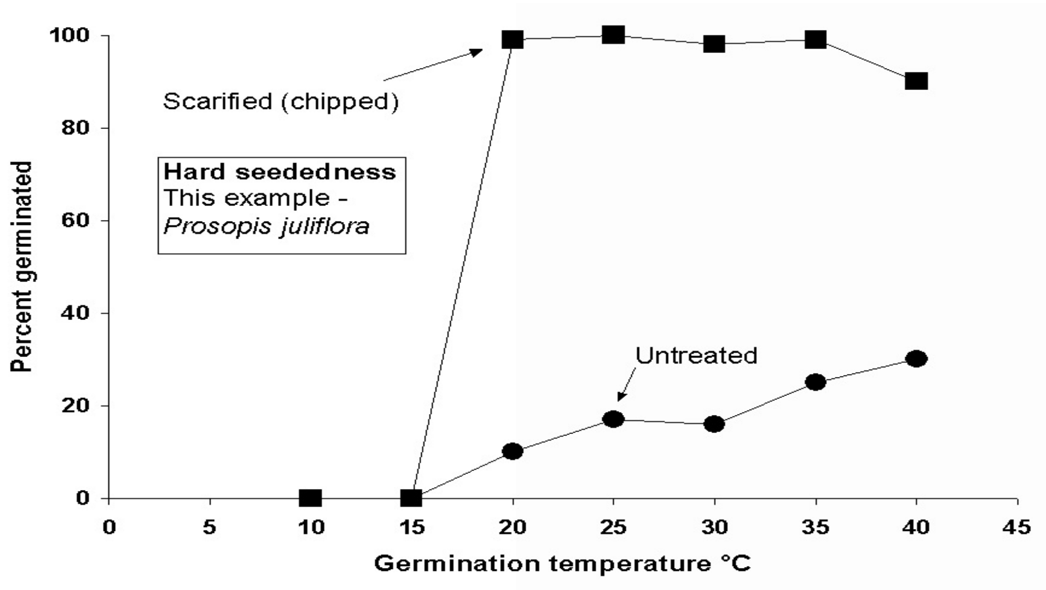

Fig. 3. Hard-seededness - the germination capacity of *Prosopis juliflora* seeds at different temperatures with and without 'scarification'[1]. Other examples: most temperate and tropical legume tree species.

Conclusions

Figures 1–3 illustrate the effects of different pretreatments and different pretreatment durations on seed germination over a range of temperatures for three different tree species. These pretreatment and germination characteristics are not only important when considering when and how long to pretreat seeds before nursery sowing or direct seeding, but also when debating the potential effects of climate change on the natural regeneration of different species. For example, if winters become warmer or shorter, or both, will seeds with deeply dormant characteristics need to migrate towards the poles?

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QUANTIFYING SEED DORMANCY?

Does the quantification of dormancy provide a useful operational tool? A useful research variable? Or just a plain waste of time and energy? **I'm not sure**, but I think it is worth pursuing and discussing further. In the context of ISTA 'double testing' Gosling and Peace (1990) and Gosling (2005) provide a good review of double testing, when they should be used, and their advantages but the results are not used to quantify the degree of dormancy which is the subject of this article. A similar discussion specific to AOSA was presented by Waibel (2005). There is not a great deal of literature on dormancy quantification for operational use. There are circumstances when information on the level of dormancy would help - such as when requests for seed are received after the date when full stratification can be supplied to meet a nurserys' sow date. If the seedlot has a high degree of dormancy we advise the client to obtain another seedlot, but if dormancy is low we would probably still use that seedlot and provide as much stratification as possible before sowing. The assumption in our BC (and much of Canada) situation is that the germination temperature (> 20 C) is above the level in which conditional dormancy would be present.

The most basic quantification of dormancy involves simply using the peak day of germination (Barnett 1972). The beauty of this is that no additional testing effort is required to estimate dormancy. I am inclined to think that dormancy is best quantified by comparing the results of stratified and unstratified test results. Richter and Switzer (1982) have done this and quantified degree of dormancy as the difference in area between the stratified and unstratified germination curves. I think that this is an excellent variable, but operationally it is not a variable that is easily calculated "on the run". I have suggested that Dormancy can be calculated simply by using the ratio of the of stratified and unstratified germination capacity [GC] (Kolotelo 2000) as illustrated below in equation 1:

(1) ~~Dormancy~~ = ((Stratified GC result / Unstratified GC result) -1)*100

This may be useful operationally and although the quantification by Richter and Switzer is far more precise I think operationally we need a variable we can calculate quickly for decision making. Based on some additional work I am inclined to offer an adjustment to dormancy as presented in equation 2:

(2) Dormancy = ((Stratified GC result - Unstratified GC result) / Stratified GC result)*100

This provides the ratio of the difference in GC relative to the stratified GC – a small value is indicative of similar results and a low level of dormancy, a high value indicates a large difference and a high degree of dormancy. Values will not exceed 100 and negative values are a quick indicator of a problem seedlot (unstratified GC > stratified GC). The assumption for calculating both of these variables is that we double-test our seedlots with stratified and unstratified germination tests. We have a long history of doing this for lodgepole pine and interior spruce in BC, but the utility of this is being seriously questioned by myself and I suspect I will recommend termination of our unstratified tests for seedlots behaving in a "normal" fashion. I simply believe we are more efficient putting our efforts into accelerating our retesting program or increasing our Quality Assurance program than double-testing our seedlots with low dormancy levels. I believe that the biggest advantage in quantifying dormancy would be for our deeply dormant species, but practicalities such as the minor yearly use of these species, large number of seedlots involved, and uncertainty regarding rate of dormancy breakage also make this an uncertain investment. The aim of this paper is to present available results on a few species in which we have comparisons of stratified and unstratified germination results and request feedback on the usefulness of suggested variables to quantify seed dormancy.

Results and Discussion

The results are presented separately for wild stand populations and seed orchard produced seed, if available, as differences were earlier noted for lodgepole pine (Kolotelo 2000). The variables presented are average and maximum Dormancy% as calculated in the equation above, peak day of stratified germination test, and peak day of unstratified germination test (Table 1).

The results confirm previous results (Kolotelo 2000) indicating that interior spruce is "shallowly" dormant and that seed orchard seed appears to have a greater degree of dormancy compared to wild stand seedlots. This trend is so consistent that it deserves additional attention. The most surprising result was how high the dormancy level is in western larch with values far exceeding those for the other species presented.

Table 1. Dormancy estimates (%) by seed origin (A=seed orchard; B=wild stand). Variables include: ~~Dormancy~~ as defined in Equation 1, Dormancy as defined in Equation 2 (and its maximum value), Peak day of stratified test, and peak day of unstratified test

Species[1]	Origin	Number seedlots	~~Dormancy~~	Dormancy	Maximum dormancy	Stratified peak day	Unstratified peak day
Pli	B	1368	11.2	9.3	43.2	7.0	9.7
Pli	A	57	30.0	20.8	44.3	7.1	10.3
Plc	B	47	5.4	4.5	26.9	7.3	10.0
Sx	B	662	3.0	2.2	70.5	8.8	10.2
Sx	A	110	6.7	6.0	21.5	9.7	11.2
SS	B	51	5.8	5.1	26.4	9.9	13.7
SS	A	10	11.8	9.2	28.9	11.6	14.7
Lw	B	12	116.0	52.6	63.2	10.2	20.3
Lw	A	10	677.5	77.8	94.4	8.8	19.4
Fdc	A	10	30.3	21.2	47.9	10.8	16.8

[1] Pli = interior lodgepole pine, Plc = coastal lodgepole pine, Sx = interior spruce, SS = Sitka spruce, Fdc = coastal Douglas-fir

The primary questions on my mind are:
1) Is dormancy quantification useful?
2) Can a useful quantification be based solely on the stratified germination test?

I view dormancy quantification using a stratified and non-stratified test as a good method for estimating dormancy. If data are available, equation 1 and 2 provide a practical estimate of dormancy with equation 2 providing a better variable, in my opinion. In correlations performed with the lodgepole pine dataset the dormancy variables had a very high r-squared of 0.96 indicating it probably does not matter which one you use as they are highly correlated. Dormancy (equation 1 or 2) was more highly correlated with unstratified germination capacity and peak day than with its stratified counterparts. Not surprising, but disappointing that stratified peak day did not appear to be a good descriptor of dormancy – as I visualize it.

This is more of an introduction to a discussion, so I hope my comments have encouraged some to respond. I currently believe that dormancy quantification offers minor benefits in an operational situation, but the methods of Richter and Switzer (1982) provide a good method to quantify dormancy in research projects where stratified and unstratified tests are performed.

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WESTERN REDCEDAR GERMINATION RESPONSE TO 21-DAY STRATIFICATION

Webster Nursery (Washington DNR, Olympia, WA) recently moved to operational pelletization of its western redcedar (*Thuja plicata*) seed, eliminating the possibility for stratification due to logistical constraints. While ISTA (1993) indicates a lack of dormancy in western redcedar, several container growers in Washington and Oregon feel that stratification is necessary to optimize germination (Westside Growers Meeting, Olympia, WA, June 2005). In 1996, the Tree Seed Centre of the BC Ministry of Forests and Range conducted a comparison of twenty-two seedlots of 21-day-stratified vs. non-stratified (dry) seed. They found that, on average, the germination capacity of stratified seed was unchanged from dry controls with only a slight improvement in germination speed associated with stratification (Dave Kolotelo 2006, pers. comm.).

Does western redcedar from Washington state exhibit a greater degree of seed dormancy than reported in BC? In May of 2006, tests comparing stratified and non-stratified seed were conducted on four seedlots of woods-run western redcedar representing the four main seed transfer zones in western Washington for this species.

1. Stratification treatment: Eight replicates of 50 seeds for each lot were separated into individual mesh bags and placed under a running water soak

for 24 hours. After 24 hours, seeds were surface dried at 21°C. Seeds were then placed on Petri dishes on #4 Whatcom blotting paper, pre-moistened with distilled water, and arranged so that no contact occurred between seeds. Petri dishes were inserted into plastic bags and placed in a stratification room at 2°C, where they remained for 21 days.

2. Control (non-stratified treatment): On day 21 of the stratification treatment, an additional eight replicates of 50 seeds for each of the four lots were plated out "dry" onto Petri dishes. Blotting paper was pre-moistened and seeds were evenly spaced as described above.

Tests were carried out using a germinator with alternating day/night temperatures of 30/20°C and a photoperiod of 16 hours light/8 hours dark. Blotter paper was moistened as necessary with a spray of distilled water. Germination counts were made on days 7, 14 and 21, with germinants removed at time of counting. Germination was defined as extension of the radicle to at least four times the length of the seed coat.

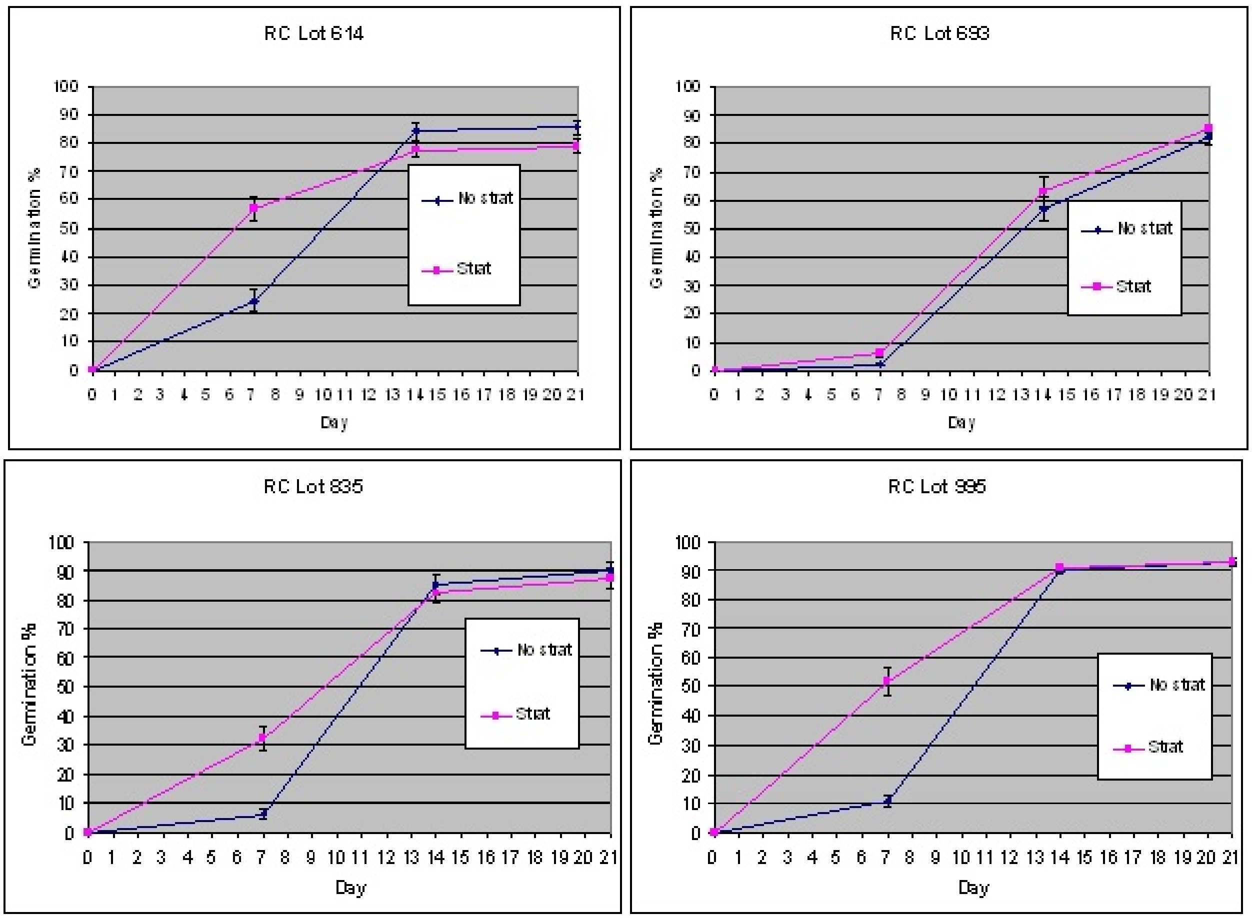

Fig. 1. Lab germination of stratified (21-day) vs. non-stratified (dry) seed for four lots of western redcedar. Error bars represent standard error of the mean.

For the four lots tested, germination capacity at day 21, was for practical purposes, the same whether seed was stratified or not stratified (Figure 1). Germination capacity of non-stratified seed averaged 87.6% compared to an average of 86.1% for stratified seed. Germination speed can be defined as days to 50% germination (G50). Averaged across the four lots, stratifying seed increased germination speed an average of 2.5 days.

While the tested western redcedar lots do not appear to exhibit dormancy, the slight improvement of germination speed associated with the 21-day stratification for lots 614, 835 and 995 might amplify in sub-optimal germination conditions. Since western redcedar seed has particularly limited storage reserves, any delays in germination should be avoided (Kolotelo 1997). As with other Pacific North West conifers, and in particular with western redcedar seed that is sown dry and pelletized, growers should supply an ideal water and temperature environment to expedite germination.

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IPGRI CHANGES NAME

Since 1 Dec 2006, the International Plant Genetic Resources Institute (IPGRI) now operates under the name 'Bioversity International'. Please find more details from our new website at www.bioversityinternational.org .

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STORING SEED AFTER STRATIFICATION

Many nurseries and tree seed storage facilities are faced with the question of what to do (and when) with seed that has been stratified, but was not sown to produce seedlings. This literature review intends to provide a condensed summary of information available on the subject with reference to north temperate conifers (Table 1). It is a first attempt at providing a useful bibliography that includes relevant details allowing readers to more readily evaluate the wealth and relevance of studies on a specific issue. Comments are greatly appreciated on the amount of detail presented and the format. Thank you.

An introduction to the subject with several broadleaved genera can be found in DeAtrip and O'Reilly (2006) [*Alnus* and *Betula*] and Muller et al. (1999) [*Fagus*], but it is beyond the scope of this review. The wealth of literature on stratification techniques that involve moisture content adjustments (stratification-redry or stratification followed by storage), particularly in the genus *Abies,* is not included due to time constraints (having too much fun with quantifying dormancy ☺). These treatments differ little from many of the references included that have a period of cold treatment at close to maximal moisture content (≈ 40–50%) and then a drying step to bring the moisture to a lower (≈ 30–35%) range. An excellent review of these procedures is provided in George Edwards' "*Abies*" chapter (starting on page 24) for the Woody Plant Seed Manual and readers are asked to refer there for further information on *Abies* spp. (http://www.nsl.fs.fed.us/wpsm/Abies.pdf).

Some of the papers reviewed contain additional information, but only the common thread of stratification followed by some amount of drying is reviewed – either as part of the pre-treatment or as a response to trying to maintain seed quality for future sowing. The shaded references are slightly off topic as they look at the effect of dry storage on dormancy, but I thought that they were worthwhile including. If you know of additional topical references, please forward them to me. The references are grouped by species to assist in assessing appropriate actions based on available background for your species of interest. In the next News Bulletin I will present our experience at the BCMOF with returned seed and review the impact of drying stratified seed to storage moisture content and freezing the seed on subsequent germination capacity.

Table 1. A review of literature on the storage of previously stratified seed. Sample includes species as well as number of genetic entries tested.

Authors	Year	Sample	Methods	Findings / Discussion
Allen	1962	Douglas-fir (2)	✶ 1 dormant & 1 less dormant lot ✶ stratified seed [20,40,80,120 days] ✶ seed subsequently dried to 40 or 70% moisture content [mc] and then a) stored open at 0-2ºC or b) dried for 24-hr at room temperature; and then stored for up to 100 days ✶germination tests {2X25} ✶mc on oven-dry basis *vs* usual fresh wt basis ✶ Cutting tests determined viable seeds and then added to obtain GC	✶after open-storage at 0-2ºC, mc decreased with duration and rate of germination decreased *"indicating a loss of stratification effect"* ✶ for 24-hour room dried seed the low mc seed decreased germination rate, but higher mc increased germination rate ✶ both seedlots responded similarly
Belcher	1982	Douglas-fir (1)	✶ Stratified seed [30 days] dried to 23.6% mc ✶germination tests {4X100}	Dried seed could be stored for 10 months without loss in GC
Danielson and Tanaka	1978	Douglas-fir (3)	✶ Stratified seed [30-60 days] dried back to 3% mc ✶germination tests {4X50}	Oven-dried (15.2%) → 9 mos. OK Air-dried (37.1%) → 3 mos. OK Not dried (50.1%) → 3 wks. OK
De Matos Malavasi, Stafford and Lavender	1985	Douglas-fir (2)	✶ Stratified seed [28 days] at 45% mc – samples dried to 35%, 25% and control (45%) ✶germination tests {4X100}	**45.7 % Strat**: Embryo → 51.8%; Mega → 35.0%; Seed coat → 55.5% **35.8 % Dried**: Embryo → 51.7%; Mega → 35.7%; Seed coat → 31.2% **23.8% Dried**: Embryo → 32.3%; Mega → 22.6%; Seed coat → 18.7% ✶undried seed reduced GC after 3 mos. storage – dried seed was generally not affected up to 3 mos. in storage ✶illustrate gains in seedling length and dry weight with dried seeds
Hedderwick	1968	Douglas-fir (1)	✶Stratified seed [42 days] then air-dried for three weeks ✶germination tests {3X100}	✶no loss in GC, but germinative energy *(speed)* diminished
Muller, Falleri, Laroppe and Bonnet-Masimbert	1999	Douglas-fir (1)	✶ fresh seeds – stratified for 20, 28 and 34 weeks @32% mc then redried to 6.7% mc ✶germination tests {4X50}	**20 weeks**: GC and MGT reduction after drying/ no subsequent reduction up to 6 mos. storage in either **28 weeks**: GC not reduced by drying or storage up to 6 mos. / MGT progressively reduced after drying, 4 and 6 mos. storage **34 weeks**: GC not reduced by drying or storage up to 4 mos. / MGT progressively reduced after 4 mos. storage
Sorenson	1999	Douglas-fir (12 families)	✶ fresh seeds – **1**✶ stored @ -12ºC and 3 ºC for 2 –32 weeks and **2**✶ stored @ -12ºC and 3 ºC for 0.5 to 2 years ✶germination tests {3X100}	✶ Mean Germination Rate used as an indicator of dormancy **1**✶ dry, cold storage 'very' slightly reduced dormancy (0.15 days) **2**✶ @ 3 ºC seed deteriorated in storage; @ -12ºC there was no impact on MGR [max effect =3.6 hrs] or GC ✶ dormancy increases in storage may be due to deterioration under suboptimal conditions

Jones, Gosling and Ellis	1998	Sitka Spruce (5/1/1))	**1** (5)✶ stratified seed [84 days] and then dried to 6–8% mc and stored at 3 ºC for up to one year **2** (1)✶ stratified seed [98 days] and then dried to 6–7% mc and stored at 3 ºC for up over 3.5 years ✶ at 847 days storage [2.3 years] a sample was restratified [98 days], dried + stored for one year **3** (1)✶ stratified seed [84 days] and samples dried to 25, 20,15, 10, 7 and 4% mc and sampled at 0,6, 12, 18, 24, 30, 36, 42, and 52 weeks ✶ germinations tests at 10 ºC (to test removal of conditional dormancy) ✶germination tests {4X100}	**1**✶ redrying reduced GC in 4/5 lots by 5%; the other by 22% immediately ✶ continued storage resulted in decreasing GC, but not to level of unstratified seed (i.e., reimposition of conditional dormancy occurs = 2º dormancy) ✶developed equation to predict GC based on storage time, GC, + **2**✶ GC continued to decline to 3.5 yrs storage, but not to unstratified level ✶ after re-stratifying the seed and placing in storage GC decreased in a similar pattern, but conditional dormancy almost completely reversed **3**✶ extended 'storage' at 25 and 30% mc continued to overcome conditional dormancy ✶ at lower seed mc extended storage, conditional dormancy is reimposed
Gosling	2000	Sitka spruce	Seed stratified @30% or dry @ 7% for 3,6,12, and 24 weeks ✶ germinations tests at 10 ºC (to test removal of conditional dormancy) ✶germination tests {4X100}	✶ No seed at 7% mc was induced to germinate at 10 ºC ✶ Dry after-ripening absent in shallowly dormant Sitka spruce
Danielson and Tanaka	1978	Ponderosa pine (2)	✶ Stratified seed [75 days] dried back to 3% mc ✶germination tests {4X50}	Oven-dried (8.9%) → 3 mos. OK Air-dried (26.5%) → 9 mos. OK Not dried (32.7%) → 4 wks. OK
Barnett	1972	Loblolly pine(6)	✶ Stratified seed [147 days] then a sample dried to 10% mc and tested at 6 & 12 mos. ✶germination tests {2X100}	✶after 6 mos. storage there was little GC loss, but Peak Day decreased ✶ after 12 mos. storage there was a GC drop (12% vs. 6 mos) and a maintenance of same peak day as 6 mos. storage ✶ seedlots stored for periods up to 12 mos. after stratification lose the benefit of the treatment
Hall and Olson	1986	Noble fir (4) Amabilis fir (2)	✶ Stratified seed [28 days] then dried to 5-9% mc and dried for up to 1 year ✶germination tests {3X100}	✶ seeds stratified and dried could be held up to 1 year without loss in GC ✶ cold storage periods had a positive effect on GC and it was concluded 28 days is insufficient stratification for these species

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SOMETHING IS A BIT OFF

There was a song written not so long ago "*If you Could Only Imagine*" that puts one in a place and time that implies an association to something that has occurred, is about to occur or something that relative thinking would suggest that to us, that yes we know what you're talking about.

What I want to do is tweak your memory, to a space in time, to a rainy, damp, foggy day in a community where a pulp mill is actively processing it's product. The winds are almost non-existent. The day is dreary and overcast and as you step out the door and greet the day by taking that first very deep breath you almost gag. The taste and smell of sulphur is everywhere. Not that pleasant fresh air you anticipated, but rather, something totally unexpected and totally awful. So...... are you transported to that dimension of time?

The above depicts what we have experienced in our lab during the IDS treatment on several occasions, when drying back the seed in preparation for the separation part of the process. It's something that we haven't seen frequently but often enough to know that the seedlot's poor germination capacity has been compromised due to sulphur dioxide pollution. The sulphur dioxide could be an active part of the demographics in the growing zone at the time of flowering and initial seed development or an aspect of nutrient uptake from the soil by the parent tree. In retrospect, it seems that problems begin where seed collection areas have been located northeast of where the sulphur dioxide is being emitted. Prevailing winds during this time are generally from the southwest. This isn't just another acid rain tale but rather a subtle occurrence that has gone unnoticed for the most part.

It is our observation, when examining the seed anatomically, that the megagametophyte appears grey in colour. This visual assessment is observed after the seed has completed its full imbibitional process. The affected seedlot has an odour that can be detected after completing the imbibitional step and during the incubation phase. It's not that fresh, resiny smell that a pine or spruce seed normally emanates but rather a smell that's "a bit off". As the seed respires duringincubation (stratification) that faint smell still prevails, again leading you to think that "something is a bit off".

The real confirmation for us has come when we begin the "Dryback" part of the IDS treatment. At this point in time we have begun drying the seedlot. The water vapour released from the seed has a heavy sulphur odour, which fills our lab space.

These contaminated seedlots tend to clean up relatively well as the sulphur affected seed within the seedlot are dead and the tissues easily release their water. The whole principle of the IDS treatment is based on the premise that dead tissue does not retain water under dehydrational conditions.

Here are just a few of examples of seedlots we have worked with having a distinct sulphur odour.

Up-Grading Results - Winter 99/00

Species	SSN & SLOT	Crop Yr.	Size	Original Germ. (%)	Prevac Germ. (%)	Frac.	Rtn Germ. (%)	Germ. (days)
Red pine	002-09-135-00 98002236135	98	na	37.0 16 days	39.0	B1 Fltrs	87.5 5.5	20

Up-Grading Results - Winter 05/06

Species	SSN & SLOT	Crop Yr.	Size	Original Germ. (%)	Prevac Germ. (%)	Frac.	Rtn Germ. (%)	Germ. (days)
White spruce	012-17-367-00 80-012-A00-367	80	na	69.0 28 days	n/a	B1 B2 Fltrs	85.0 75.5 11.0	18
White spruce	012-17-367-00 80-012-A00-367	80	na	48.0 28 days	n/a	B1 B2 Fltrs	73.5 75.0 18.5	21

Gains made by the above examples are two fold: 1) germination capacity and 2) germination energy - the vigour of seed - two sets of enhancements.

There have been studies too numerous to mention that involve the effect and impact sulphur has had relative to environmental aspects. Simply put, what we wanted to acknowledge, is how this intruder has stealthed its way into our seed inventories virtually undetected.

There are many reasons why germination and vigour are compromised. Is this yet another to add to that list? If something is suspect to you, have your seedlot sampled and retested, assessed or upgraded to ascertain the problem and resolve the question. It could leave you with a solution to pollution ! and an abiding confidence of your seed in storage.

If there is something causing you concern, please don't hesitate contact us.

Merry Christmas to all and enjoy the ***Peace of the Season*** ☺☺☺☺ ‼

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ISTA FTSSC SEMINAR, VERONA, ITALY

The Forest Tree and Shrub Seed Committee (FTSSC) of the International Seed Testing Association (ISTA) held its latest meeting, a Seminar, in the beautiful World Heritage City of Verona, Italy, during the week of September 12–15, 2006. Three days of intense indoor conference presentations, plus two field trips, filled out the program attended by 30 participants representing 12 countries. Local organization was courtesy of Corpo Forestale dello Stato, Ufficio Territoriale per la Biodiversità, Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale (CNBF), Peri (VR). Our local organizer was Fabio Gorian, Deputy Chief of the National Forestry Corps, and Laboratory Manager of the CNBF seed processing centre and seed testing laboratory in Peri. Chairing the Seminar was Zdenka Prochazkova, Czech Republic, Chair of the FTSSC.

The week began with a visit to Bosco della Fontana MN approximately 90 minutes by tour bus south of Verona. Bosco della Fontana, all 160 ha or so, is the last piece of native forest in the entire Veneto plain. The rest of the countryside has been deforested for agriculture, and much viniculture (hic!). A team of eight or so scientists and foresters are dedicated not only to maintaining the woodland, but are working to bring it back to its original natural state, that is, eradicating introduced species including the American red oak, and returning it to the species that used to grow there some 300–400 years ago. By species, think birds, butterflies, reptiles as well as plants. It was occupied by the Germans during WWII as a field artillery base, but damage was not significant. We visited the ancient palazzo, in the centre of the forest, that was the home of the original owners, and still very largely intact with major portions of its interior decorative frescoes visible on the walls. Our return journey was via Mantua, to visit the Palazzo Te built by Giulio Romano, Raphael's best pupil, between 1525 and 1535, and which became the residence of the marquis Federico Gonzaga. Many paintings and frescoes survive. Andrea Mantegna, the famous Veronese painter, lived and produced much of his best loved work in Mantua.

The indoor program was held in Castelvecchio (literally, "Old Castle", dating to the 12th century) in the old part of Verona, still very much the city centre. Tuesday was devoted to discussions of the germination test and included a presentation by Fabio Gorian entitled "Qualitative testing on particle sizes of *Larix decidua* Mill. seeds". This study showed that over its geographic range, using 7 widely distributed sources, European larch seeds vary more than 2-fold in length, almost 3-fold in width, and 2-fold in thickness. Seeds were graded into four mass classes, and tests showed that despite variations among seed sources, in all cases the largest mass class with a 1000-seed weight more than triple that of the smallest mass class, germinated twice as well as the smallest seeds, before and after prechilling. The need to represent all particle (i.e., seed) sizes in a commercial collection was emphasized to ensure conservation of biodiversity.

Zdenka Prochazkova then continued with a discussion of testing very tiny seeds by weighed replicates, followed by a discussion of the Seedling Evaluation Handbook that is undergoing revision. In a detailed examination of normal versus abnormal germinants in seeds of dicotyledonous plants, as well as in coniferous seeds, Zdenka showed how numerous abnormalities tend to be overlooked. Then followed a practical session of evaluating germination in *Abies*, *Larix*, *Robinia* and *Betula* – the latter genus being something of a current 'cause celebre' in revising testing weighed replicates.

The afternoon was spent preparing seeds of these same four genera for tetrazolium (TTZ) testing, under the guidance of Steffi Kraemer (LUFA Augustemberg, Karlsruhe, Germany) for evaluation the following day. The previously controversial vacuum treatment, used to draw the TTZ solution into dry (not pre-soaked) seeds was demonstrated.

The following day (Wednesday) was given over entirely to TTZ. The early hours were spent evaluating and discussing the results of the *Abies* and *Robinia* seeds set up the day before, then a lecture by Dr. Norbert Leist (also LUFA Augustemberg, Karlsruhe, Germany) on the theoretical aspects of TTZ testing. For some time there has appeared to be an emphasis to "introduce" the dry method of TTZ testing into the ISTA Rules. In fact, the dry method was the first method to be used in the Rules and was supplanted by the wet method (in which seeds are presoaked for several hours before being placed in TTZ solution, without vacuum treatment). Dr. Leist made it clear that he and his colleagues were attempting to reintroduce the dry method which, in conjunction with vacuum treatment, gives results in far less time than the wet method. Dr. Leist emphasized that both dry and wet methods would be listed as alternatives in the revised Rules, and that analysts would be able to use either method according to their experience in obtaining reproducible results. The day wound up with an evaluation of the staining patterns in the *Larix* and *Betula* seeds prepared the day before, together with further discussions with Dr. Leist. The official dinner was held that evening in the restaurant "Re Teodorico" situated high on the hillside to the north of Verona, overlooking the River Adige (pronounced A-di-gee) and the rooftops of the old city. This afforded many photo opportunities (if more were needed!).

Thursday saw our second field trip to the Seed Centre at Peri. We saw seed processing and production, the nursery in which are grown many ground-cover native plants as well as tree seedlings, the cold storage facilities, and the seed testing and genetics laboratories. These facilities lack very little in modern equipment and anyone who has experience in a Canadian seed centre would feel quite at home in Peri. The main piece of equipment still not on inventory is an x-ray machine. When the writer suggested to the Director of the Centre that it was essential that funds be found for one at the earliest opportunity, he offered his wallet to Sergio Pasquini, the seed Quality Manager. Our return from Peri took us to the Armani vineyard and wine shop, local to Peri, where tasting, accompanied by dinner, was very much in order.

We returned to Castelvecchio for the final day (Friday) that was devoted to discussions of tree seed purity, and the proposed revisions to Pure Seed Definitions (PSDs). The session began with a review of the purity test by Rita Zecchinelli, Seed Purity Head at ENSE – Laboratorio Analisi Sementi Tavazzano (LO), in Milan. This was a perfect lead-in to the presentation by this writer on the "Reasons for revising PSDs for coniferous species, with special attention to the Pinaceae and Cupressaceae, as well as the Taxaceae and Taxodiaceae". Most of the discussion concerned PSDs 47 and 51, but also 10 and 50. [As an aside, many of the proposals have been accepted by the ISTA Purity Committee, but there remain some basic issues to be resolved, the main one being "pieces of seed" as this applies to coniferous seeds.] The afternoon wound up with a poster session prepared by various attendees before the seminar was officially closed.

The conference facilities were excellent, despite being in the "Old Castle" which is a glorious edifice. Our hosts were most generous and helpful and, despite the cancellation of the Accompanying Persons program, everything went very well. For anyone contemplating a trip to Italy, Verona comes very highly recommended. The people are friendly, the food and wine – delicious. There are many Roman artifacts, including an almost complete arena right in the middle of the city, and (for the ladies) the shopping is out of this world. There is far too much to see in two weeks: from Verona you can make side day trips to Mantua, Padua, Venizia, as well as Lake Garda (the Riviera of Italy) only an hour away, so give yourself plenty of time. Venice is glorious, but Verona is better value for your buck!

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OECD TREE SEED SCHEME MEETING

The biennial meeting of designated authorities of the OECD Scheme for the Certification of Forest Reproductive Material Moving in International Trade was held in Siófok, Hungary October 4–6. The meeting was attended by delegates from 15 of the 22 member countries. In addition, delegates attended from 5 countries as observers as well as 6 international organizations. Burkino Faso and Uganda have applied to join the Scheme and delegates from these countries gave presentations on the current status of their programs. Brazil is a member of the Agriculture Seed Scheme and may join the Forest Seed Scheme after completing the updating of its forestry legislation.

In the Scheme, reproductive material (seeds or vegetative propagules) can be certified in four categories: source identified, selected, untested seed orchards, and tested. Over 90% of the seed that is traded internationally is certified as source identified or selected.

The significant accomplishment of this meeting was agreement on wording to update the text of the current Scheme which has been in effect since 1974. Work started in the early 1990s to rewrite the Scheme to take into account new types of reproductive material that could be produced. This revised Scheme was not unanimously accepted by the member countries due to the inclusion of text whereby genetically modified reproductive material would be labeled as such.

At the 2004 meeting of country delegates, it was proposed that text from the new Scheme of 1997 be used to replace text of the 1974 Scheme for "source-identified" and "selected" categories while text for "untested seed orchards" and "tested" remained essentially unchanged. The European Commission (EC) recommended that text be inserted to ensure that the reproductive material (seed) did not contain genetically modified material (GMO). Following circulation of this draft, comments were received from a number of countries and the United States rejected the text proposed by the EC and suggested alternate text. The draft document was revised taking into account these suggestions and circulated in March 2006. Comments were received and the EC proposed an alternate text regarding the adventitious presence of GMO. At the meeting in Siófok, all countries agreed there is a need for the Scheme and that there must be an agreement on the current revised text. After further discussion, it was agreed that: 1) text from the new Scheme will replace text of the 1974 Scheme for "source-identified" and "selected" categories, 2) the new text proposed by the EC on adventitious presence of GMO will be inserted, 3) text for "untested seed orchards" and "tested" categories will be deleted, 4) a short paragraph added stating that the text for the 2 categories removed is under discussion and will be inserted when consensus is reached. This proposal was agreed upon by all member countries present. A revised draft, taking into account these changes, was prepared and circulated. Following final editing and careful cross-checking of the text, the Scheme will be submitted to the OECD Committee for Agriculture for their approval in May 2007 and if approved then forwarded to OECD Council for final decision. Everybody was extremely pleased with this accomplishment!

A one day field tour was conducted with stops that included two nurseries and a seed stand. All nurseries in Hungary have been privatized since 1991 and although it was fiscally challenging the first number of years the situation is stable now. The first nursery visited had black locust and black poplar seed orchards. Both seedlings and rooted cuttings (whips) are produced primarily for hardwood species. The group next visited a beech seed stand. Seed collected from the stand is certified as "selected". The stand was certified following evaluation of a number of phenotypic traits (stem straightness, stem twistedness, crown size and quality, and forking). Poor quality trees were removed and more will be gradually removed over time. The second nursery we stopped at produces conifer and hardwood seedling planting stock. Before planting stock can be sold it must be certified by an inspector from the Ministry. The inspector estimates the number of seedlings in the nursery and evaluates this against the quantity of seed sown, ensures all seed certificates are in order and all seed lots are properly identified in the nursery. Only after the inspection has been completed and a certificate issued and signed by the inspector and nursery owner can the nursery owner ship the seedlings for planting.

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NATURE'S COMMON ELEMENTS UNDER NEW MANAGEMENT

Nature's Common Elements has passed a torch ..... From now on your IDS seed upgrading will be handled by Karen and Mike Long. We will be working alongside them for the next couple of seasons to allow for a seamless transition in the technology applications.

Therefore, to make arrangements for your seed upgrading needs, contact:

Seedtek Innovations
681 Enders Rd.
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Attention: Karen and Mike Long

Tel: (807) 933-0359
Email: seedtek@mac.com
Website: www.seedtek.ca

Nature's Common Elements is simply shifting gears over to the creative side of seed technology pursuing some new and different elements such as:

- training - customized seed handling workshops
- developing specialized seed equipment, e.g., seed dryers
- consulting services and native plant interests.

So as in the past we welcome your inquiries relating to your needs and concerns to provide services for you, other than seed upgrading.

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TREE SEED WORKING GROUP WORKSHOP

At the 30th Biennial Canadian Tree Improvement Association (CTIA) meeting we hosted a Tree Seed Workshop entitled "*Appreciating, Quantifying and Utilizing Family Differences*". The full agenda is present below and most abstracts will be included in the CTIA Proceedings. The workshop was generally well received and a big thank you is extended to all the presenters who took the time and effort to address the topic. Here are the presentation titles, speakers and some highlights of the session, from my perspective.

Introduction	Dave Kolotelo
25+ years of family-block planting in the Southern US - from novelty to standard operating procedure	Steve McKeand
Quantifying genetic differences in Newfoundland's breeding population of white spruce seeds and cones	Barry Linehan
Processing family seedlots	Al Foley
Parental contribution estimate methods for orchard seedlots in British Columbia: why, how, and does it work?	Jack Woods
Family variation in white spruce seed and seedling characteristics	Jean Beaulieu
BC experience of processing by family	David Kolotelo
Tree Improvement Delivery System: critical evaluation with emphasis on seed and seedling production	Yousry El-Kassaby

The theme was intended to address the incredible variation we have in our seed orchards, firstly appreciating this, then dealing with its quantification, and finally how do we make the most efficient use of this variation. The theme isn't a call for intensive family forestry (= family block planting), but a suggestion that by paying attention to family differences one can gain efficiencies in the activities spanning from cone collection to sowing the seed in the nursery. The idea is not that we perform each activity by family, but the decision to bulk families should be questioned as there are efficiencies to be gained at each step. I suggest that extension is an area that has lagged behind our gains, that statistical expertise needs to be available to operational facilities (seed orchards, processing facilities, nurseries), and that path analysis can be a useful tool to identifying the largest sources of variability in the Seed Handling System.

Steve McKeand provided the Lexus model of family forestry in which family block planting has been occurring for over 25 years and is now a standard operating procedure! Estimates of genetic gain in volume are approximately 35% over two breeding generations of loblolly pine compared to wild seed. The philosophy is simply to plant the best seed on the best sites and I believe it is an area of efficiency we should be looking closely at throughout Canada.

Barry provided some interesting results on variation in cone and seed characteristics for the first bumper crop from Newfoundland's white spruce clonal seed orchard. Six ramets from each of 10 clones were sampled. Clones accounted for over 60% of the variation in cone dry weight and seed per cone. Seed weight ranged from 305 to 436 seed/g.

Al provided a good overview of the Ontario Tree Seed Plant's processing of small lots, defined as being a volume less than 5 l. Cone drying is divided into two phases. First there is air drying and then subsequent kiln drying. With these small lots the cones remain in cloth bags throughout the process. Small tumblers have been developed and probably the most exciting development was the construction of a line of 28 small-scale de-wingers! The small lots are generally then put over a miniature fanning mill, but sometimes hand cleaning is required. Testing is often not performed due to the value of the seed, but it is dried to storage moisture content.

Jack outlined how seedlot genetic worth (GW) values are incorporated into timber supply analyses in BC. An important aspect is the estimation of the relative contribution of the orchard genotypes (through pollen and ovule gametes) to the seedlot. This allows for adjustment of the seedlot GW values based on gametic contribution and the calculation of a seedlot's effective population size (Ne).

Jean presented the work of Sylvie Carles who was on maternity leave and unable to present the results of her doctoral thesis. A total of 75 families was studied for a variety of traits including: seed – length, width, area, and volume; germination %; height, diameter, and shoot and root dry mass of seedlings. Significant differences between families for all traits, except diameter, were found. The traits were intercorrelated and seed width showed the strongest correlation with seedling morphology. No significant correlations were found between germination variables and seedling morphology.

I discussed some of our research into family processing of lodgepole pine, interior spruce and coastal Douglas-fir conducted in the late 1990's. Large variability in characters such as seed size, yield, and dormancy were noted between clones and between collection years. Families were consistent across years for trends in seed size and dormancy (i.e., one year lower or higher for all clones), but dormancy did not follow the same trend. Comparisons between family and bulk processing indicated that efficiencies may be gained in spruce and Douglas-fir, but no advantage was seen in lodgepole pine.

Yousry reviewed and discussed the tree improvement delivery system with emphasis on the connectivity of the system and avoidance of compartmentalization. An alternative to the tree improvement delivery system emphasizing vertical management concepts was presented as a means of surpassing the goals of our current system.

Look forward to 2008, when Québec will be the host province for the CTIA and our next Tree Seed Workshop.

Dave Kolotelo

NATIONAL TREE SEED CENTRE

The fruit and seed crop was moderate to heavy in eastern Canada (Ontario to the Maritimes) although it was spotty and more variable in the Maritimes. Single-tree collections were made from populations in the Maritimes of the following species: trembling aspen (*Populus tremuloides*), large-tooth aspen (*P. grandidentata*), beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), choke cherry (*Prunus virginiana* var. *virginiana*), white birch (*Betula papyrifera*), yellow birch (*B. alleghaniensis*), northern red ash (*Fraxinus pennsylvanica* var. *austini*), black ash (*F. nigra*), eastern white cedar (*Thuja occidentalis*), white pine (*Pinus strobus*), and red spruce (*Picea rubens*). Three populations of hemlock (*Tsuga canadensis*) were sampled in Québec. Seed was obtained from eastern white cedar, hemlock, white ash (*F. americana*), red ash (*F. pennsylvanica*), eastern flowering dogwood (*Cornus florida*) and pitch pine (*Pinus rigida*) in Ontario.

Tamarack Germination Testing

During 2006, 211 tamarack (*Larix laricina*) seedlots were germination tested. These seedlots were the result of collections made between 1970 and 1984 to establish provenance trials. Germination tests were not carried out on freshly collected seed. In 1986, these seedlots which had been stored at 4°C were conditioned (dried) and stored at -20°C. Eleven seedlots collected in 1970 were tested in 1976, 1993, and 2006. These same 11 seedlots were also a part of the 211 that were tested in 1993 and 2006.

Although the viability of the fresh seed is not known, results from the germination tests carried out in 1976 of the 11 seedlots collected in 1970 indicated that they were of good quality (mean germination 85.7%). Tests carried out in 1993 showed a marked decrease in germination (26.8%). This represents an annual average loss of 3.46%/yr. Average germination in 2006 was 17.1%. Although this is low, it represents an annual average loss of 0.75%/yr between 1993 and 2006 which is considerably lower than the 3.46% annual loss which occurred between 1976 and 1993.

In 1993 and 2006, 211 seedlots were tested yielding an average germination of 42.0 and 33.7%, respectively. The mean germination loss during this 13 year period was 0.64%/yr which is slightly less than that of the 11 seedlots reported above during the same time period. It appears that the conditioning treatment applied to the seed in

1986 along with moving the seed to a more favorable storage temperature of -20°C helped to stabilize the seed and reduced the rate of deterioration.

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UPCOMING MEETINGS

28th ISTA Congress
May 5-11, 2007 Iguassu Falls, Brazil
www.seedtest.org

Seed Ecology II
Sep 9–13, 2007 Perth, Western Australia
www.seedecology2007.com.au

Carrefour de la recherche forestière
Sep 19–20, 2007 Québec City, QC
http://www.mrn.gouv.qc.ca/carrefour/

IUFRO Larix Symposium
Sep 16–21, 2007 Québec City, QC
http://www.mrn.gouv.qc.ca/carrefour/larix.asp

Canadian Poplar Council
Sep 16–21, 2007 Québec City, QC
http://www.mrn.gouv.qc.ca/carrefour/populus.asp

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