Tree Improvement Branch

Cone and Seed Improvement Program
BCMoF Tree Seed Centre

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Conifer Seed Longevity

There are over 5500 conifer seedlots in the BC seed inventory. This is the backbone of the BC reforestation program on crown land. Maintaining up-to-date germination information is critical to ensure that seed is being used efficiently to produce seedlings and that seed owners have accurate inventories of the quality and quantity of seed they own. Repeated germination tests allow for an assessment of how quickly and to what degree germination changes over time – the deterioration rate. The average deterioration rate of species has been a key factor in assigning a germination retesting frequency, but it is not the only factor. Consideration of individual seedlot deterioration rate, historic use, seedlot size, feedback on past nursery and lab performance and total number of tests able to be performed in a given year all influence if and when a seedlot is retested. This note provides an update on our calculated average seed deterioration rate estimates for BC conifer species in relation to values calculated in 2002[1].

The deterioration rate was calculated as the initial germination capacity (GC) minus the current GC all divided by the time between tests. It is presented as the change in germination percent per year. The only limitations are 1) that the initial and current germination test types are the same and 2) that the storage duration is greater than 500 days[2]. If test types change, the deterioration rate will be calculated based on a subset of the entire life of a seedlot in long-term storage. The deterioration rate provides a basic linear estimate of deterioration and a simple method of comparing species and seedlots within species. Non-linear estimates, providing a more realistic description of deterioration, are problematic to construct due to the limited number of germination tests available per seedlot. A comparison of average species deterioration rate estimates for BC conifers performed in 2002 and 2007 is presented in Table 1.

Only three species exhibited deterioration rates greater than 1%/year: *Thuja plicata* (Cw), *Tsuga heterophylla* (Hw) and *Abies procera* (Bp). The first two species have consistently shown the highest deterioration rate since 1997 and are prioritized for germination retesting. These are also considered the conifers with the lowest level of seed dormancy in British Columbia. There is much less data on Bp deterioration with only 18 seedlots and an average of only seven years of storage history. In general, *Abies* spp. display relatively erratic germination, especially *Abies amabilis* and *A. lasiocarpa*, and this is reflected in the relatively large changes in deterioration rate estimates between 2002 and 2007. The species exhibiting the largest estimate change was *Chamaecyparis nootkatensis* which had a rather large -2.16 %/year estimate in 2002, but a gain of 0.37 was estimated in 2007. Although test procedures (soak, warm stratification and cold stratification duration) have not changed, there has been increased emphasis on monitoring and maintaining a high (about 44%) moisture content during the warm stratification phase of the pre-treatment. This has generally

[1] The 2002 article can be found at http://www.for.gov.bc.ca/hti/publications/misc/RTS%20TSWG36.pdf
[2] A total of 660 seedlot were not included in the deterioration rate estimates as they had only one germination test performed or they were not in long-term storage for a minimum of 500 days between initial and current germination tests.

resulted in improved germination and the prime factor explaining this large change in the deterioration rate estimate.

Table 1. A comparison conifer seed deterioration rate (DetRate = Δgermination / year) estimates performed in 2002 and 2007 at the BCMOFR Tree Seed Centre.

	2002			2007		
Species	**# Seedlots**	**DetRate**	**Mean Age**	**# Seedlots**	**DetRate**	**Mean Age**
		%/year	**years**		**%/year**	**years**
Abies amabilis	165	0.06	7.8	159	-0.69	10.1
Abies grandis	49	-0.72	11.3	51	-0.99	13.4
Abies lasiocarpa	107	0.17	8.9	132	-0.93	9.7
Abies procera				18	**-1.52**	7.1
Thuja plicata	370	-1.24	8.5	268	**-1.02**	11.0
Pseudotsuga menziesii var. menziesii	349	-0.1	11.7	194	**-0.08**	16.5
Pseudotsuga menziesii var. glauca	609	-0.21	13.2	525	-0.22	16.6
Tsuga heterophylla	366	-1.13	12.1	292	**-1.03**	15.6
Tsuga mertensiana	47	-0.46	14.1	47	-0.49	16.3
Larix occidentalis	173	-0.67	7.8	165	-0.49	11.2
Pinus contorta var latifolia	1495	-0.08	8.5	1342	**-0.05**	11.7
Pinus contorta var contorta	49	-0.15	8.5	52	**0.01**	11.3
Pinus monticola	95	-0.19	8.6	114	-0.21	7.8
Pinus ponderosa	150	-0.46	6.6	184	-0.34	8.2
Picea sitchensis	194	0.03	14.7	163	**-0.03**	20.4
Picea glauca/ engelmannii complex	1233	-0.22	13.3	1004	-0.26	16.6
Picea lutzii	50	-0.28	11.5	43	-0.23	15.0
Chamaecyparis nootkatensis	35	-2.16	4.6	42	0.37	7.4
Total	5610			4795		

Several species show very slow (< -0.1%/year) deterioration: *Pseudotsuga menziesii* var. *menziesii; Pinus contorta* var *latifolia; Pinus contorta* var *contorta; and Picea sitchensis* with these species requiring less frequent germination retesting to provide up-to-date information. The remaining species' estimated deterioration rates fall within the range of -0.21 to -0.49% germination per year and show relatively little change from the 2002 estimates of deterioration rate.

Calculation of average species deterioration rates is the first step in the review and improvement of our germination retesting program at the Tree Seed Centre. Actual changes to retesting frequencies have not been finalized as I expect to restructure our retesting program to optimize the use of testing resources. Some of the possible changes being considered are described below:

1) **Seedlot Deterioration –** A key to this exercise was to move from a species specific deterioration rate to a seedlot specific deterioration rate in specifying the retest frequency of an individual seedlot. This will require some software enhancements and will likely chronologically follow an initial general adjustment to the species retest frequency. Complications include seedlots in which only one test is available or that the storage duration is less than 500 days. The species retest frequency will probably default for these seedlots. The emphasis will be on identifying those seedlots which deteriorate faster than the species average, and are being actively used, for more frequent retesting.

2) **Historic Use –** Seedlots are currently prioritized for retesting if they were used in the previous sowing year and consideration is then given to when seedlots were last used. This prioritization will continue, but it will probably be automated with system improvements in the coming year. Initial thoughts are to look at seedlot use in three categories:
    a. Used in the last five sowing seasons
    b. Used in the last five to ten sowing seasons
    c. Not used in the last ten sowing seasons

    Other options include the number of times a seedlot has been used or the number of trees produced over a given time frame. Different retest frequencies may be employed for each category with the possibility that seedlots not used in the last ten years will not receive germination updates until seed is expected to be used for sowing. The intent is to not use testing resources for seedlots that have a very low probability of being used in the upcoming sowing year.

3) **Seedlot Size –** Currently very small seedlots may not be retested as their impact on maintaining current information is limited and resources are better spent on other seedlots. Minimum size varies by species, but generally if seedlots do not have sufficient seeds to produce 10 000 seedlings a germination retest is generally not initiated.

4) **Genetic Class –** Seed orchard produced seed is a high priority for germination retesting. An initial look at deterioration rate by genetic class indicates lower levels of deterioration for seed orchard seed, but the comparison is confounded with seedlot age. Seed orchard seedlots are generally younger and are generally used faster than the inventory of natural stand seed, so this is the most likely explanation for these differences. Genetic class is also considered in relation to the proportion of seedlings requested for that class. For example, in interior spruce where 82% of the seedlings are produced from orchard seed, it is less important to test **all** natural stand seedlots than in a species like lodgepole pine where only 12% of the seedlings are derived from orchard seedlots. Genetic class useage by species is used to prioritize which species obtain the greatest investments in updating natural stand seedlots germination information.

5) **Germination Test Precision –** The deterioration of a seedlot over time is one parameter affecting the ability to provide an accurate estimate of the germination capacity. The other parameter affecting the germination precision is the variability present in a germination tests between the four replicates. This has previously been presented as the precision of germination tests (see http://www.for.gov.bc.ca/hti/publications/misc/GCTSWG36.pdf) and can vary greatly between species and between seedlots within a species. This variability is easily quantified and should also be considered in assigning retest frequencies to individual seedlots.

The deterioration rate (of species and individual seedlots) is an important attribute for determining when seedlots should be retested. The linear deterioration rate is a simple statistic allowing for prioritization of species and seedlots, but it does not increase our knowledge concerning seed deterioration in the biological sense as germination is expected to be non-linear as seeds age. Retesting programs will also provide the data to develop these non-linear functions in the future with additional long-term data. The rate of deterioration is just one of the elements to be considered in determining what frequency seedlots should be retested for germination.

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