Tree Improvement Branch

Cone and Seed Improvement Program
BCMoF Tree Seed Centre

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Western white pine shatters a basic assumption![1]

I'd like to discuss a very basic assumption in seed technology: that **the results of lab testing are a good predictor of results with larger quantities of seed.** At the BC Ministry of Forests Tree seed Centre we have been struggling with the duplication of lab results in operational seed preparation (OSP) for several years. The most significant pretreatment difference is the sample size. In the Lab 100 seeds are used per replicate and up to a maximum of 1000 grams (approximately 50 000 seeds) are used in OSP. Lab methodology for western white pine (Pw) is somewhat different from other species as seeds are placed on top of an accelerated ageing (AA) tray with moistened kimpack beneath during stratification as opposed to be placed directly on filter paper. The current methodology for Pw in both the LAB and OSP includes a 14-day running water soak followed by 98 days of cold stratification (germination test type=G55).

A total of nineteen western white pine (Pw) 2001 sowing requests (SRQ) had grams added to allow for a direct comparison in germination capacity (GC) (effectiveness in breaking dormancy) between the OSP and LAB methods sampled and pretreated at the same time. The moisture content of seed was also monitored, by weight a) after draining, just prior to surface drying; b) after surface drying; c) after 7 weeks of stratification and d) at end of stratification = 14 weeks. The LAB samples also had similar moisture content estimates performed, but since surface drying does not occur in the lab only a, c and d was quantified for the lab.

Results

Germination

Even with our efforts to mimic the Lab procedures in OSP, the results indicate that our OSP techniques are inferior in breaking dormancy to lab procedures. The germination capacity (GC) of the OSP requests averaged 58%, while the Lab averaged 91% based on 19 samples. The falldown in germination ranged from 6 % to 60% indicating that **the individual seedlot may have a large impact on the way white pine responds to OSP techniques** (Figure 1).

[1] A full 10- page report can be obtained by contacting the author

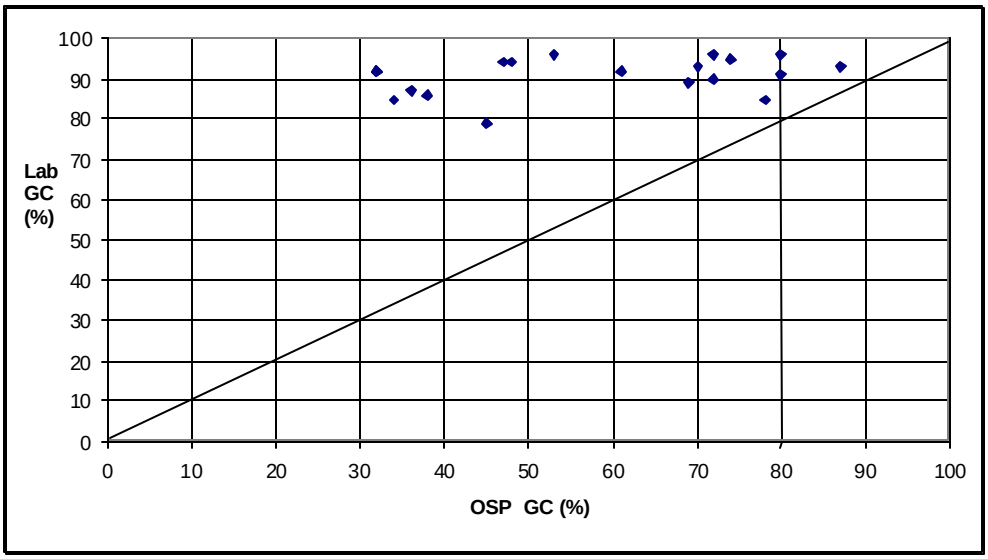

Figure 1. Plot of operational seed preparation (OSP) germination capacity (GC) versus the lab.

Extended Stratification

For three sowing requests, the nursery requested that we hold the seed for an additional two weeks of stratification. Sampling and germination testing were performed after 14 weeks stratification (pretreatment completion) and after 16 weeks stratification. The additional two weeks stratification resulted in a 5% average increase in GC (71 to 76%). An additional request was tested after 15 and 16 weeks stratification with a 3% gain in GC. These results indicate that **stratification may not have been of a sufficient duration (or moisture content – *covered later*) to totally overcome dormancy**.

Stratification Unit Size

For white pine, sowing requests are divided into stratification units of 1000 grams or less (i.e. a 3200 g request is divided into 4 units of 800 grams each). It has been suggested that smaller 'requests' may have higher moisture contents and this may result in greater germination. The coefficient of determination (r^2) between seed quantity (g) and the moisture content i) after draining and ii) after surface drying both was 0.60. The moisture contents during stratification were not as well correlated with bag size [≈ 0.10 at 7 and 14 weeks] indicating that bag size has much less influence on stratification moisture content (at least after 7 weeks). The relationship between bag size and nursery germination falldown (Lab minus Nursery GC) was weak (r^2 =0.25), but it did indicate that smaller bag sizes are experiencing smaller falldowns in GC (Figure 2).

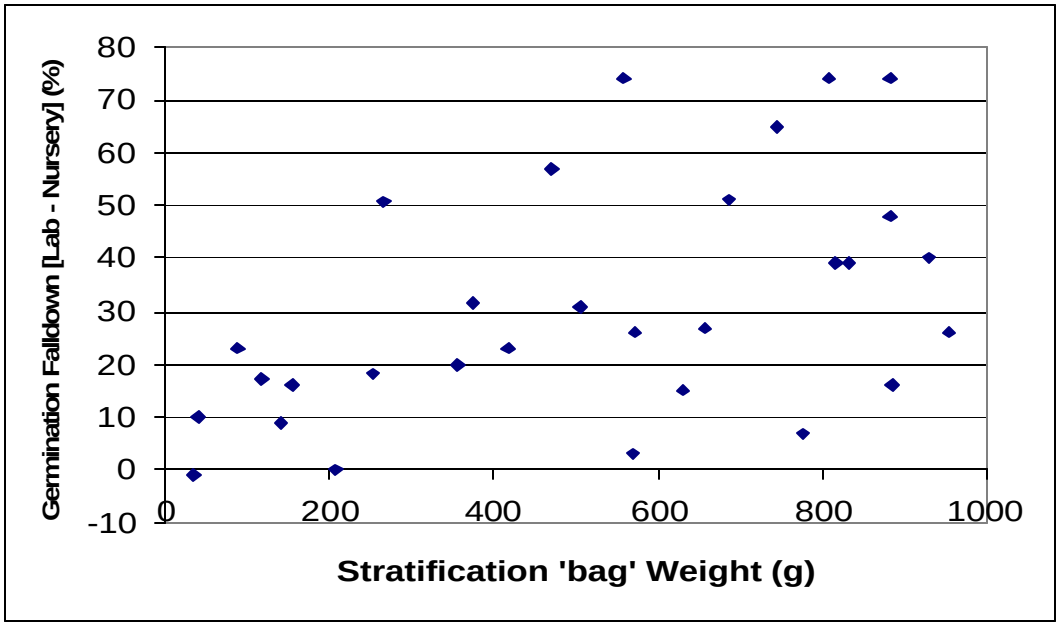

Figure 2. The relationship between sowing request bag size and germination falldown.

Moisture Content

For OSP the average moisture of the seed following a 14-day soak and drainage of excess moisture was 40.6%. After surface drying the moisture content was reduced to 35.5% indicating that surface drying removes 5.1% moisture from the seed. This was fairly consistent across seedlots and the r-squared value between drained and surface dry moisture content was 0.89. The OSP samples appear to lose moisture during stratification in comparison to lab samples (Figure 3). This appears to be a significant difference in the two treatments: **lab samples are maintained in stratification at a moisture content approximately 3.4% greater than in OSP!**

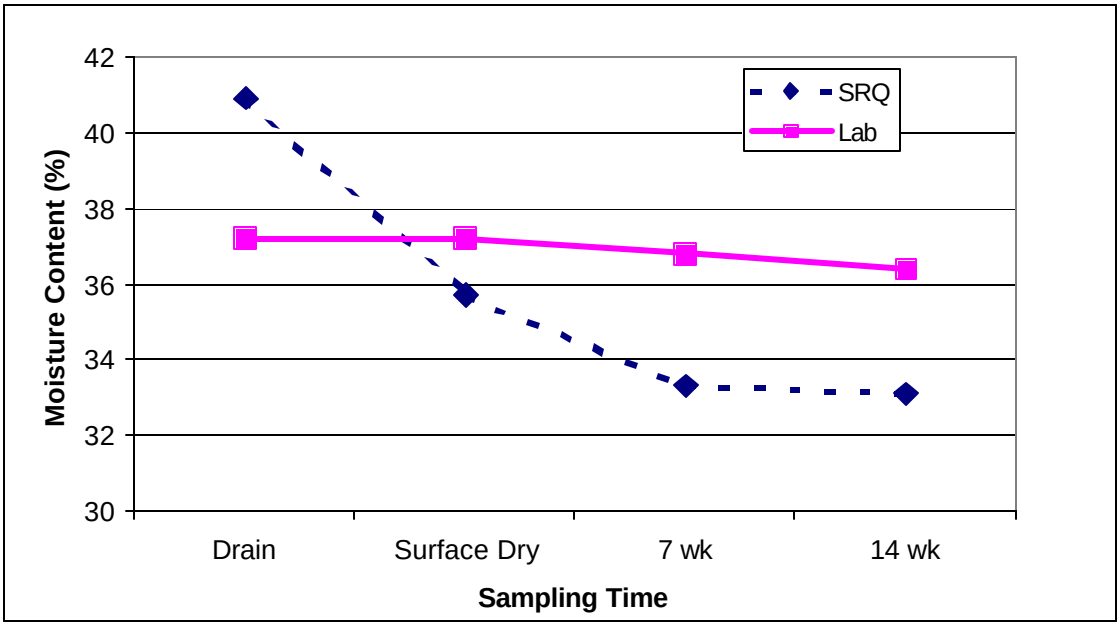

Figure 3. Comparison between moisture content after Drain, Surface Drying and 7 & 14 weeks of stratification for lab samples and operational sowing requests (SRQ) [n=19].

Discussion

The results clearly show that the conditions provided to pretreat LAB samples is not being replicated for OSP. The LAB prepared samples had an average GC 33% greater (91% vs. 58%) than that achieved with OSP. The most significant pretreatment difference is the size of the sample pretreated. In the Lab 100 seeds are used per replicate and up to a maximum of 1000 grams (approximately 50 000 seeds) are used in OSP. In the lab, seeds are not touching during stratification and there is a large air: seed ratio. The container is closed during stratification in the lab. In OSP adjacent seeds are touching (from all directions) within the one Kilogram seed mass and the air:seed ratio and the kimpack:seed ratio is reduced relative to the lab. To provide an equivalent air: seed ratio in OSP one would need an air volume of 60 to 75 litres within the stratification unit for one Kg of seed [totally impractical

The most obvious physiological difference between the Lab and OSP is the moisture content of the seeds during stratification. The average OSP moisture content of 33.1% appears insufficient to efficiently overcome dormancy compared to the 36.5% level experienced in the Lab. This relatively high moisture requirement is considered to be critical and will be the focus for improvements in OSP. For other species (i.e. interior lodgepole pine and spruce) the optimal moisture content for stratification is 30%.

The strategy adopted has been to try and mimic the accelerated ageing tray system used in the lab. This may not be appropriate as a container to precisely mimic this environment is probably too large to be practical. The tray system is also problematic as it occupies a large area and makes it difficult to monitor and 'manipulate' seeds. The tray system in OSP has not provided improved germination in the two years in which it was implemented (2000 and 2001).
Feedback from some nurseries stratifying their own requests indicates that our problems are not unique, but some growers are quite successful at stratifying Pw. They emphasize that the seeds must be kept "moist" during stratification and that seed "manipulation" or the movement of seed within the stratification unit is required and is performed by some on a daily basis.

It appears that Pw does violate the basic assumption of "the results of lab testing are a good predictor of results with larger quantities of seed". For most species we are not faced with having large germination differences between LAB and OSP procedures. Problems with achieving consistent and high GC with Pw are well documented and may partly be explained by this lack of agreement between lab test results and the results of OSP using much larger quantities of seed. It is possible that there is no one pretreatment that will produce equivalent results with small (100 seeds) and large (up to 50 000 seeds) quantities of seed in Pw!

Other than documenting our experience with Pw, the main message I'd like to send is that **we would not have had the information to adequately address this issue without good quality assurance monitoring**. In competitive times a quality assurance program will keep you ahead – it should not be the first thing you drop. It may need to be prioritized to your local problems, but monitoring of seed quality at the nursery is important to maintain a feedback loop to testing procedures allowing us to ask the question "Why are we not meeting lab results". There are many explanations and in the case of white pine the most obvious reason appears to be associated with the moisture content of seeds in stratification. Stay tuned and see how our 2002 sowing requests perform with the following recommendations.

Recommendations

Several changes are being recommended for 2002 sowing of western white pine. The testing of recommendations is problematic due to the need to have operational quantities of seed available (≈ 1 Kg) for trial purposes and the time required to obtain results with Pw pretreatments (approximately 5 months). These recommendations are directed specifically at OSP and no changes are being recommended for the lab testing of Pw.

1. Operational stratification of **Pw requests should revert to being performed in polyethylene bags**. Smaller sized stratification units (500 g) will be tested on a limited scale in 2002 to evaluate potential benefits.

2. The **moisture content of Pw requests stratified in OSP should be increased** to better correspond to the moisture content experienced in the lab. The increased moisture content can be accomplished by instituting the following:
    a) Eliminate surface drying performed on Pw sowing requests.
    b) Monitor moisture content during stratification. All sowing requests stratified at the TSC should have fresh weights recorded following draining and after one month of stratification.
    c) I am recommending that the target moisture content range of Pw should be between 35 and 38% during stratification. Moisture content adjustment should occur if the moisture content is less than 34% or greater than 40%.

3. All **Pw sowing requests should be monitored and 'handling' during stratification every Monday, Wednesday and Friday**. This involves a visual inspection for fungal growth and moisture status (excessively wet or dry), and handling of the seed within the bag to break up any fungal colonies and redistribute moisture within the stratification unit.

4. **We should volunteer to extend stratification to our clients up to a maximum of 120 days**. All OSP results indicate that increased stratification will increase GC and 120 days is the standard duration used in the US to stratify Pw.

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