Nursery Results

There are differences between lab and nursery germination worth discussing. Lab germination is carried out in a very controlled and sterile environment. A seed cover is not applied and temperatures are generally slightly higher and more rigidly controlled than those employed at the nursery. In the lab a seed is defined as germinated when the radicle has extended to four times the seed length. In the nursery a germinant is generally counted once it has emerged from the seed coat and its cotyledons are unfolding and photosynthesizing. By this time the radicle is approximately 10 times the seed length. Basically, at the nursery the judgement call for germination is made later in seedling/germinant development (Figure 101).

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One scenario, which is more common for some of the *Abies* species, is that a seed may be capable of producing a radicle but may not have the energy to shed its seed coat or it may grow abnormally once it does, perhaps not expressing positive **phototropism**. This can lead to significant reductions in yield at the nursery relative to predictions made based on lab germination.

Seedlots are tested for both germination capacity (GC) and germination speed at the BC Ministry of Forests Tree Seed Centre and retested at specific intervals (see Table 7, page 51). Every effort is made to provide accurate, up-to-date information, but it is not possible (or necessary) to test all stored seedlots each year. Results of the most recent test can be viewed on SPAR. They are also provided on request labels which accompany sowing requests.

Germination tests are based on a random sampling of seeds from a seedlot. Seeds for a particular sowing request are not randomly sampled since all seeds for a request may come from one box even though the seedlot may be 20 boxes in size. It is important to note then that variable germination can occur due to differences in sampling for testing and sowing request withdrawal procedures. All new seedlots are blended (mixed to reduce variability) prior to long-term storage, but this practice never eliminates all of the variability within a seedlot.

The Tree Seed Centre has been conducting a Quality Assurance (QA) program on sowing requests since 1992. This entails taking a seed sample from sowing requests just prior to shipping.[8] Each year approximately 200 sowing requests are sampled for moisture content (Table 8, page 56) and GC.

Nurseries are subsequently asked to provide the GC they attain operationally. Nursery results are then compared to laboratory and QA test results, and presented as falldowns relative to current laboratory germination (Table 14). In Table 14, falldowns are indicated as negative values, compared to lab germination, and increases in GC are presented as positive values. The positive values most likely arise from sampling or treatment differences.

The overall falldown of all sowing requests tested prior to shipping, sampled between 1992 and 2001, at the Tree Seed Centre is 2% below lab germination. The majority of this

[8] Quality assurance grams are added to selected requests prior to imbibition or pelletting.

Figure 101 Different criteria for quantifying germination exist between the nursery and the lab.

Table 14 Germination capacity (GC) falldowns relative to latest standard lab germination test, at time of shipping and at the nursery. Sample sizes (#), mean GC and estimate of falldown presented for each.

	Tree Seed Centre at shipping			Nursery information		
Species	**#**	**Mean GC (%)**	**Falldown (%)**	**#**	**Mean GC (%)**	**Falldown (%)**
Amabilis fir	138	66	2	48	72	-2
Grand fir	48	76	1	22	68	-7
Subalpine fir	106	62	-10	51	68	-6
Western redcedar	364	73	-7	126	75	-3
Coastal Douglas-fir	145	92	0	51	89	-3
Interior Douglas-fir	165	89	1	58	88	-2
Mountain hemlock	41	91	2	10	84	-3
Western hemlock	133	89	-2	56	82	-8
Western larch	183	76	-4	40	89	6
Coastal lodgepole pine	50	92	1	6	91	3
Interior lodgepole pine	323	93	0	102	86	-6
Western white pine	167	59	-22	73	73	-10
Ponderosa pine	113	86	-2	13	85	-7
Sitka spruce	73	93	-1	9	87	-7
Interior spruce	411	88	2	118	88	2
Sitka × interior spruce hybrid	42	90	2	0	0	0
	2502	82	-2	783	77	-3

difference can be attributed to subalpine fir and western white pine, which are high priority species for improvement in seed preparation techniques at the Tree Seed Centre. Western redcedar also displays large falldowns, but a component of this can be attributed to the pelletting process, which is estimated to delay germination by up to four days.

The falldown at the nursery is, on average, surprisingly low at 3% below lab germination. Western white pine showed the largest nursery falldown and is a high priority for improvements in operational stratification techniques. Western hemlock exhibited an 8% decline, followed by grand fir, ponderosa pine and Sitka spruce, which exhibited 7% declines in the nursery compared to SPAR GC. A falldown of 6% for interior lodgepole pine is surprising and considered high for a species which generally exhibits very rapid and high GC. A possible explanation is that, due to the excellent germination characteristics of lodgepole pine, it is sometimes sown outdoors under generally sub-optimal conditions. In general there are few complaints about poor germination of lodgepole pine crops, but it is very important to be as efficient as possible with this species due to significant shortages of available select (orchard produced) seeds.

These falldown figures are intended as guidelines and provincial averages. They help establish priorities for the cone and seed improvement program for the Tree Seed Centre and its clients. Best estimates for a particular nursery are based on the values calculated as part of its QA program. All nurseries are encouraged to perform at least some germination counts following sowing to determine their actual falldowns, if any. Seed owners are becoming more frugal with seeds and a proper QA program will help determine what can and cannot be done to meet their expectations.

The falldown at the nursery is, on average, 3% below lab germination

Seeds sown at the nursery may be subjected to a longer stratification period as sowing requests are shipped after the appropriate stratification duration, but seeds are generally placed in a cooler at the nursery until sowing, thereby extending the stratification period. This may improve germination characteristics if a seedlot is more dormant than average for the species. However, it may decrease germination if the seedlot is of poor quality and extended stratification causes deterioration or

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fungal build-up. Germination in the lab is based on a 21 or 28 day test, but nursery counts often extend much longer. Part of this is due to the difference in classification of a germinant, but it may also include late germinants that were not included in the lab test results. Nurseries also may perform additional treatments on their seeds such as density separation, soaking, priming, or sanitation soaks (H_2O_2). These practices can change the quality of a sowing request (positively or negatively), confounding the comparison with lab test results.

Conditions in a nursery are generally more variable and can be more extreme than in a germination cabinet. Because the nursery environment is more variable and less sterile, weaknesses that might go unnoticed in the lab can be expressed and lead to losses in the nursery. The fact that high vigour seeds generally achieve higher GC under a wider range of temperatures than low vigour seeds is a classic example. Temperature is an obvious factor and will generally be more stable under lab conditions. However, one has to take into account the humidity and light intensity conditions in order to assess the full impact of various temperature regimes.

Once completely stratified and fully imbibed, temperature (heat) sum becomes one of the most important factors governing germination speed. The distribution of this temperature (day/night) is not critical to the germination process (Edwards and Leadem 2000). However, to accurately compare germination strategies, temperature regimes should be converted to heat sums.

Germination Counting in the Nursery

There is no standard method for performing nursery germination counts. Nurseries vary on the use of half- or full-block counts. Also, the criteria for sampling, defining germination, count duration, and number of blocks/half-blocks used to provide a reasonable estimate of GC varies by nursery.

It is recommended that full blocks are used since seeding machinery, if it displays a problem that results in empties, will do so with a pattern that repeats itself on a block-by-block basis. For some equipment, counting half-blocks can result in missing a seeder problem (it depends on how many drops or rolls a seeder makes per block). Another reason for sampling whole blocks is that the trend to larger cavities reduces the number of seedlings to be counted. Also, some of the larger containers, such as the 77 cavity container, cannot be equally split to allow counting half the cavities.

It is difficult to come up with firm guidelines, as a database that looks at this level of sowing detail does not exist. However, very general recommendations are that germination counts in the nursery should be based on at the very least two blocks and a maximum of 2% of the blocks, depending on request size, species and crop uniformity.

Extra Seed

Nurseries can have seeds left over after sowing and may wonder what to do with them. All extra seeds should be returned to the BC Ministry of Forests Tree Seed Centre. Storage of seeds destined for Crown land reforestation must be stored at the Ministry's Tree Seed Centre. To increase the probability of salvaging seeds, as a customer service nurseries should dry them down to a lower moisture content and return them to the Tree Seed Centre. Seeds should be redried and sent in a timely manner, in an appropriate container, with seedlot identification (sowing request labels) included.

At the Tree Seed Centre, returned seeds are promptly evaluated for condition (obvious deterioration, mould, physical damage, pre-germination, or high moisture content), amount returned, class of seed, time since stratification was completed, and seedlot balance. Seeds that are obviously deteriorated are discarded. It should be emphasized that the main cause of deterioration in returned seeds is the maintenance of a very high (30%+) moisture content for prolonged periods. In general, the moister the seeds, the more rapidly they deteriorate.

If seeds are considered salvageable they are sampled for GC and moisture content and dried back to a storage moisture content (4.9–9.9%). If GC is poor the seeds are discarded. If GC is relatively unchanged, the seeds are placed into freezer storage for an additional six months and then retested for GC. If GC is still comparable to the parent seedlot, the seeds may be blended into the parent seedlot or stored as a separate seedlot for use in future sowing requests.

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