Tree
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Cone and Seed Improvement Program
BCMoF Tree Seed Centre

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A REVIEW OF COLLECTION, PROCESSING, TESTING AND STORAGE OF LODGEPOLE PINE SEED

ABSTRACT

The cone collection and extraction procedures for lodgepole pine (PL) are reviewed. The three pretreatments used for assessing seedlot quality: I) 28 day stratification followed by 24 hour soak; II) 24 hour soak and III) dry seed will be discussed with reference to germination capacity and germination value. Pretreatment (I) provided the greatest and most rapid germination, although differences between pretreatments were not as large for coastal (PLC) compared to interior lodgepole pine (PLI). The storability of PLI was examined and it was conclude that a 2% loss in germination could be expected, on average, for each year in storage. Initial germination of a seedlot was a much better predictor of present germination than storage time. An outline of the current research priorities of the Tree Seed Centre is given.

INTRODUCTION

Lodgepole pine (*Pinus contorta* Dougl.) is a wide ranging species occurring from southeastern Alaska to baja California and east to the Black Hills of South Dakota. In British Columbia two varieties are recognized : a coastal form (=PLC) var. *contorta* and an interior form (=PLI) var. *latifolia.* The coastal form is of minor importance to the nursery industry while the interior variety accounted for close to 90 000 000 seedlings planted in 1992. At the Tree Seed Centre (TSC) 1094 seedlots of lodgepole pine are currently in storage 96 % of which are PLI. This paper will therefore concentrate mainly on PLI. The cone collection, seed extraction and processing, testing and storability of Lodgepole pine will be covered in this paper. In view of my new position at the TSC I would also like to present our current research priorities and ways in which I will provide support to the nursery industry.

CONE COLLECTION

Interior lodgepole pine has serotinous cones which maintain viable seed on the tree for many years. The amount of viable seed can be expected to decrease with increased duration on the tree - seed reaches its highest viability at maturity and viability will then decrease with time! Guidelines have been given to subdivide PLI cones into four classes

- I - current years cones.
- II - partially weathered, closed cones.
- III - fully weathered, closed cones.
- IV - partially opened or opened cones.

Only those cones in classes I and II are recommended for collection, although up to 25% of class III and IV cones are acceptable in a shipment. Seedlot quality can be expected to be lowered by increasing proportions of class III and IV cones (Eremko *et. al*, 1989).

Cones mature during the period of August to October and this is the critical time for collection of non-serotinous lodgepole pine cones. To evaluate maturity embryos should be excised and measured in relation to the embryo cavity. Embryos should occupy 90% of the embryo cavity. The 'squish' test for filled seeds is not appropriate for PL due to the lack of colour differentiation between the megagametophyte and the embryo. For PLI cone collection can be done anytime, but picking is easier in cold weather due to the brittleness of the cone stalks.

Felling and picking is the usual means of cone collection due to the distribution of cones throughout the tree. Aerial collection is becoming more common and has a greater collection productivity/man-day, but it is expensive to perform. Squirrel cache collections are also increasing and for serotinous cones there should be no increase in pathogen infection, although problems may develop if non-serotinous PL is collected from squirrel caches (John Dennis, pers. comm.).

SEED EXTRACTION AND PROCESSING

Serotinous lodgepole pine cones are put into the kiln for 17 hours with a peak temperature of 60 degrees Celsius. The cones are currently not scorched or placed in boiling water before kilning. Lodgepole pine is a relatively easy species to clean (purities of seed in storage average 99.8 %)- the only problem is portions of the cone stalk are not always easy to separate out during processing.

The yield [viable seed/hl of cones] is very low for PLI as only the top third of the cone produces viable seed. The bottom two thirds of the cone have sterile ovules [only 25 of 120 ovuliferous scales produce seed] (Owens and Molder, 1984). For comparison the yield of PLI=70 000 seeds/hl of cones while PLC=180 000 seeds/hl of cones.

SEED TESTING

From 1964 to 1990 lodgepole pine was tested *i)* with a 24 hour soak followed by 28 days stratification[test type 20) and also *ii)* dry [test type D1]. In March, 1990 a 24 hour soak test was also initiated [test type W1]. All lodgepole pine seedlots are currently triple tested to estimate the dormancy of a seedlot and offer an optional pretreatment if 4 weeks are not available for stratification. These 3 pretreatments will be discussed with reference to their effect on the following germination variables.

GERMINATION VARIABLES

The Ministry of Forests currently uses two variables to describe a seedlots germination characteristics: *germination capacity* and *germination value*. The germination capacity (GC) is the total number of germinants after a certain time period (21 days for lodgepole pine). This variable provides an estimate of the potential germination under 'ideal' conditions [30 degrees Celsius-8 hours light// 20 degrees Celsius-16 hours dark]. These are guidelines from the International Seed Testing Association (ISTA, 1985) and are fairly general to most conifers. The actual ideal germination conditions will have to be determined through testing procedures similar to those outlined by Carole Leadem in her presentation.

Germination value (GV) is an index combining speed and completeness of germination (Czabator, 1962). Figure 1 will be used to illustrate the concept of GV.

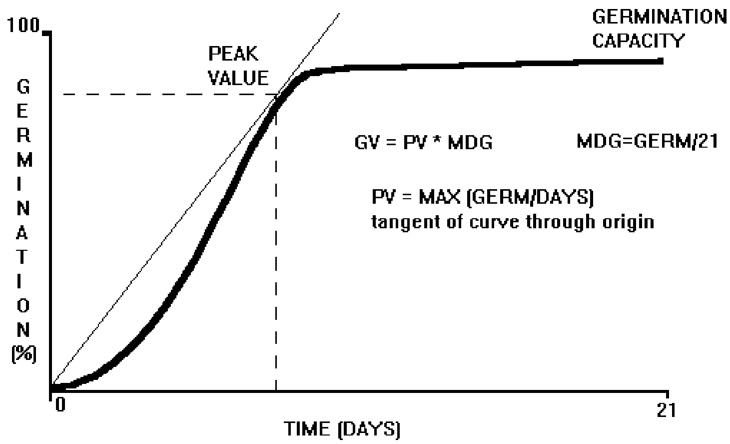

Figure 1. Illustration of the concept of germination value (GV).

The GV is a product of the mean daily germination [germination capacity/21 days]and the peak value [maximum value of cumulative germination divided by respective number of days]. The peak value is seen in Figure 1 as the point at which the dotted lines cross and is tangent to a line through the origin. The GV is useful in comparing seedlots in terms of both rate and speed of germination simultaneously. The GV is not useful to nurseries as it does not have realistic units that may aid in nursery culture and therefore it is better suited to more academic investigations.

Germination capacity is a variable which is familiar and 'here to stay' in the nursery industry and therefore a separate variable should be used to solely describe the rate of germination. Several variables such as germination after a certain number of days (7, 10 or 14) or the number of days to reach a certain germination percentage (R50, R80) may be more meaningful to nursery workers. I consider the peak value to be the most useful measure of rate of germination if presented properly. While a PV of 9 may be useful in comparison to a PV of 2 it I would be much better to know, for example, that the PV of 9 means that you can expect 90 % germination in 10 days and a PV of 2 could be 50% germination in 25 days. I believe that knowing that the PV is equivalent to the maximum germination rate (point of inflection on germination curve) this variable would be of benefit to nursery growers and certainly far more useful than the currently used GV. I would appreciate any comments the industry has on the direction the Ministry should take in regards to upgrading the information available for a seedlot.

RESULTS OF TESTING

The effect in which the three test types have on germination capacity and germination value will be illustrated and elaborated upon. Figures 2 and 3 illustrate the distribution of seedlots in 10 % classes, by test type, for germination and GV respectively.

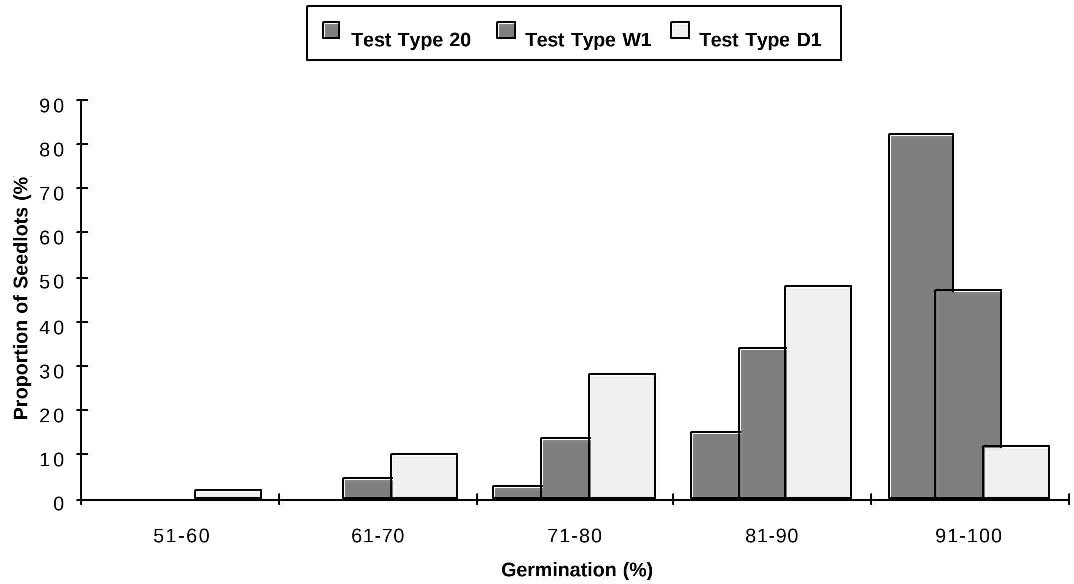

Figure 2. The distribution of coastal lodgepole pine seedlots in storage by test type and germination capacity class.

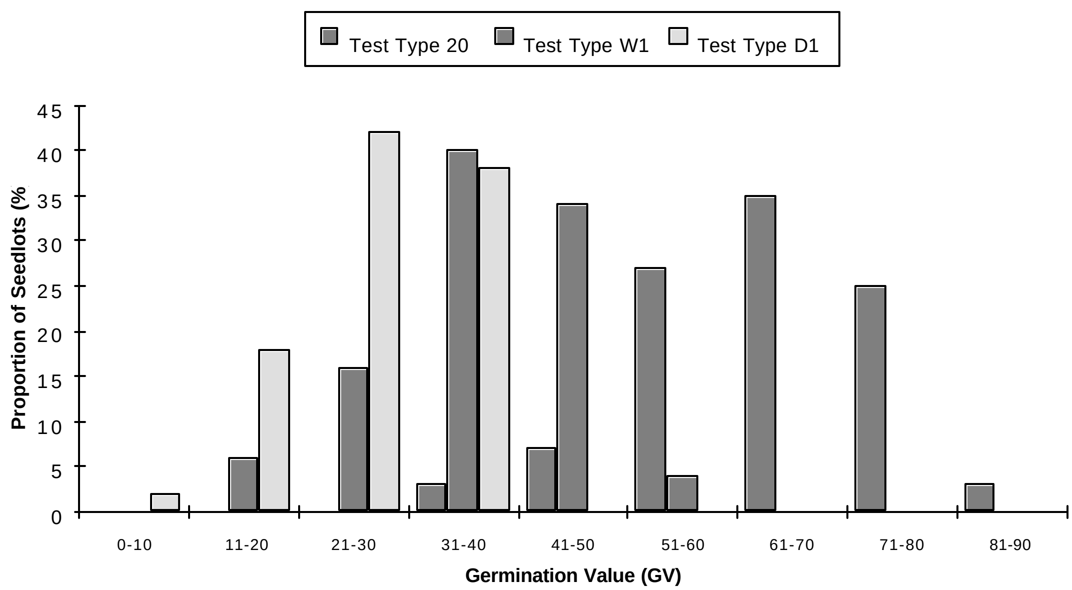

Figure 3. The distribution of coastal lodgepole pine seedlots in storage by test type and germination value class.

Table 1. The mean, standard deviation (s) and range of germination capacity (germ) and germination value (GV) for 100 randomly selected interior lodgepole pine seedlots tested under the three pretreatments.

VARIABLE	TEST = 20	TEST = W1	TEST = D1
GERM % (MEAN)	94.0	86.8	81.3
GERM % (s)	5.0	7.5	8.4
GERM % (range)	71 to 99	63 to 96	54 to 94
CZABATOR GV (MEAN)	63.7	37.1	27.4
CZABATOR GV (s)	10.7	9.1	7.0
CZABATOR GV (range)	33 to 90	11 to 54	8 to 40

Table 2. The mean, standard deviation (s) and range of germination capacity (germ) and germination value (GV) for 17 coastal lodgepole pine seedlots tested under the three pretreatments.

VARIABLE	TEST = 20	TEST = W1	TEST = D1
GERM % (MEAN)	93.3	91.5	91.0
GERM % (s)	5.3	4.9	4.9
GERM % (range)	81 to 99	80 to 99	83 to 99
CZABATOR GV (MEAN)	57.1	40.7	35.1
CZABATOR GV (s)	12.9	10.3	7.6
CZABATOR GV (range)	40 to 79	27 to 61	25 to 49

From Figure 2 it is obvious that PLI generally has good germination and that stratification increases the proportion of seedlots in the higher germination classes (all stratified seed is above 70 % germination). In Figure 3 the distribution for GV shows a similar pattern with the stratified seed having the highest values. These figures illustrate all testing records at the TSC and will have a relatively small sample size for the 24 hour soak treatment which was only initiated in 1990.

In Table 1 the mean, variability and range of 100 randomly selected PLI seedlots, having all three test types, is presented. Again, stratification improved GC and GV. The range and standard deviation of germination capacity was decreased in stratified seed due to the improvement of germination at the low end. This represents seedlots which required stratification to overcome embryo dormancy. Several seedlots in the upper end of the range performed well with or without stratification suggesting that these seedlots are not dormant. While not having adequate time to stratify may not greatly affect germination capacity, due to low or no embryo dormancy, the rate of germination will be much slower for unstratified seed. This may have more of an impact on nursery culture and is a good reason to provide information on rate of germination.

In comparison to germination capacity, the range and standard deviation for GV is larger for stratified seed. One explanation is that GV is a compound variable and is a product of mean daily germination and peak value and their associated variability. The GV is increased at both ends of the spectrum due to the increases in rate of germination with stratification and with no upper limit to GV, as with germination, the stratification tends to increase the variability.

In Table 2 the effect of the 3 pretreatments on germination and GV is illustrated for coastal lodgepole pine. The trends are similar, but the differences between treatments are greatly reduced in comparison with PLI. This can be attributed to the lower expected embryo dormancy associated with coastal lodgepole pine.

STORABILITY

The storability of interior lodgepole pine was investigated by use of regression analysis using data on hand from the seedlot retesting program for germination capacity, initial germination and storage time. Storage time was calculated from the time seed was initially placed in cold storage, but data on germination tests were only used after 1975. At this time the TSC obtained its second germinator and all tests can be considered to have been performed under controlled conditions. For investigations into the storability of PLI only the stratified pretreatment was investigated since it gives the best germination and is the usual pretreatment for PLI.

The parameter we wish to estimate is the current germination of a seedlot based on its past performance and/or time in storage. Can this be determined on a species basis (do all seedlots follow the same pattern, but start at different points or are their very different patterns for deterioration of seeds in storage?).

Looking at a simple linear regression of storage time on present germination should give us an indication of the average deterioration of seed in storage. In Figure 4 the regression line of germination as a function of storage time is shown with a r-squared value of 0.37. Although this regression is statistically significant at the 99.9% confidence limit it is not acceptable for prediction purposes as it only explains 37% of the variation in present germination. Inverse and polynomial forms of the regression were also examined, but the linear form best described the relationship between storage time and present germination. The 2% average deterioration rate presents a 'ballpark' figure on what can be expected of lodgepole pine in storage. It can be considered a conservative estimate as it includes all seedlots, some of which have been the mistakes which we have learned from in terms of collection timing and extraction in the past 30 years.

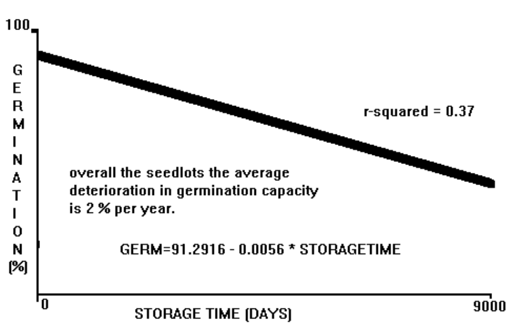

Figure 4. The regression line of storage time and germination % for PLI.

In looking at the effect of initial germination (which may have been conducted prior to the TSC obtaining germination chambers) on the present germination (Figure 5), it is apparent that it is a good variable for prediction purposes. The linear regression explains 91% of the variation in present germination using the seedlots initial germination. Other polynomial forms of the initial germination investigated did not greatly improve the equation. Initial seedlot quality will therefore have a large impact on the future viability of the seedlot.

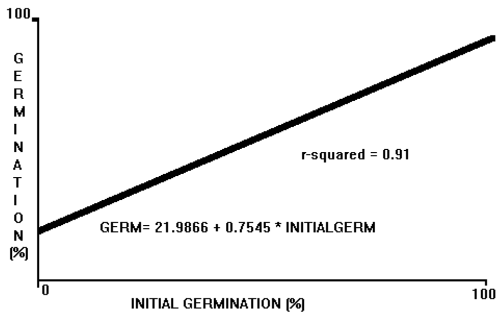

Figure 5. The regression line of initial germination and present germination.

Investigations into storability of our species is an evolving exercise and this is the first attempt at developing methods for looking at storability. Similar exercises will be conducted for all of our major conifers in order to i) provide basic information on species storability ii) determine an updated retest schedule for our major species and iii) refine our testing protocols by removing unnecessary testing such as the dry testing of PL since it provides little practical information for a 50% increase in effort (from 2 to 3 tests).

TREE SEED CENTRE - CURRENT RESEARCH PRIORITIES

1. Investigate the storability of species in storage at the TSC. Update the current retest schedule to increase the efficiency of our retesting program. Try and correlate storability data with collection timing and origin of the seedlot.

2. Test the upgrades to our drying facilities at the TSC - determine efficiency of drying and continue research into a closed cabinet/less labour intensive dryer. Research in this area will be associated with improvements in MC monitoring of seed in stratification.

3. Aid in the implementation of Enhanced Separation Techniques. Update information on suitable seedlots, efficiency of separation and further develop techniques specific to various categories of seed [species, seedcoat type, etc..,]

4. Improve the current stratification regimes of several 'problem' species [yellow cypress and western white pine] and complement other work by MOF and FORCAN staff on <u>Abies</u> sp.

5 Improve the transfer of information from the TSC to nurseries and owners and vice versa.[TECHNOLOGY TRANSFER]

- any research results or procedural changes at the TSC through [*Seed and Seedling Extension Topics* Newsletter, Reports, memos, workshops and meetings] *DSP memos, Quality Assurance Monitoring.*
- need for information from nurseries (feedback) on seedlot performance - to correlate with current testing procedures and quantify the difference in germination between the TSC and nurseries.
- provide the most informative seedlot information to the grower and seed owner in order to assist with initial crop establishment (Germ. at specific day, Germ. curves etc..,)

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