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Coastal Douglas-fir Stratification

A significant proportion of coastal Douglas-fir (Fdc) regeneration in BC is accomplished using seed imported from the US. This is due to accelerated logging of Fdc and a lag in BC orchard production to meet this need. Weyerhaeuser Co. primarily supplies the seed and they recommend that the seed be stratified for a total of eight weeks prior to sowing, although their germination tests are performed using a three-week stratification treatment. The current stratification regime used in BC is three weeks, which is the direction given by the International Seed Testing Association (ISTA 2004). This study was intended to quantify the benefits (and/or risks) associated with eight weeks stratification versus our current methods for seed orchard produced seed. A brief review of pertinent literature is also included. I would like to thank everyone who supplied seed for this trial.

Materials and Methods

A total of ten seed orchard seedlots (5-BC and 5-US) were selected (Table 1) and germination tested using a 24-hour soak followed by either zero, three or eight weeks stratification at 2°C. Germination counts were conducted on Monday, Wednesday and Friday for 21-days allowing for calculation of the Germination Capacity (GC) and the Peak Value (PV) (Czabator 1962). Criteria for germination was that the radicle was at least 4X the length of the seed coat.

Table 1. Seedlots used in the Fdc stratification trial.

Origin	Seedlot	Orchard	SPZ[1]	GW
WA	60274	996	M	6
WA	60660	996	M	5
WA	61251	996	M	7
WA	61252	996	M	16
WA	61294	996	M	10
BC	60306	146	SM	2
BC	60583	149	M	7
BC	60643	154	M	5
BC	60684	120	SM	2
BC	61059	116	M	2

Results and Discussion

The seedlots from the US did appear to have slightly deeper dormancy as is indicated by their lower unstratified GC and PV (Table 1). After stratification for three weeks the differences between the two sources of seed were minimal (1.5% GC). Extending stratification to a total of

[1] **SPZ** = Seed Planning zone and **GW** = Genetic Worth estimates for volume growth

eight weeks increased GC by less than 2% for both sources of seed. The extension of stratification to eight weeks did consistently increase the GC (except 60660 and 61251) and the rate of germination (except 60660).

Table 2. Results for Germination capacity (GC - %) and Peak value (PV) of seedlots tested with zero, three and six weeks stratification.

Seedlot	GC-0	PV-0	GC-3	PV-3	GC-8	PV-8
60274	79.0	4.5	91.0	7.0	92.3	7.4
60660	72.3	3.5	93.5	8.3	92.5	7.5
61251	56.8	2.7	85.8	5.5	84.8	6.5
61252	43.0	2.0	82.5	5.2	86.8	7.2
61294	65.5	3.1	88.5	6.0	91.3	7.8
WA Mean	**63.3**	**3.2**	**88.3**	**6.4**	**89.5**	**7.3**
60306	74.5	4.1	87.5	7.6	91.5	8.4
60583	88.0	4.7	95.5	8.2	96.3	9.2
60643	78.0	4.0	92.0	7.1	93.8	8.8
60684	70.0	3.4	86.8	6.8	87.5	7.4
61059	77.5	4.0	87.0	7.8	88.8	8.2
BC Mean	**77.6**	**4.0**	**89.8**	**7.5**	**91.6**	**8.4**
Overall Mean	**70.5**	**3.6**	**89.0**	**7.0**	**90.6**	**7.8**

The germination tests were performed under optimal conditions, but it is well known that extended stratification will increase the '**vigour**' of seed or its ability to germinate under sub-optimal temperatures (Allen 1960, 1962; Gosling et al 2003; Poulsen 1996; Tanaka 1976; Sorensen 1991). The practical implication is that if you are not able to supply optimal, or close to optimal, conditions for germination then extended stratification will be beneficial. If you are able to supply optimum germination temperatures (considered the primary limiting factor once imbibition and some amount of stratification has occurred) then the benefit of extended stratification is limited. What is optimum? In testing we use an eight hour period with lights at 30°C followed by 16 hours at 20°C. This equates to 440 **degree hours** per day using a 5°C threshold temperature [(30-5) (8) + (20-5)(16)]. Degree-hours seems like a more reasonable way of looking at germination requirements vs. the much coarser degree-days. This would be equivalent to a nursery maintaining a constant temperature of 23.3°C which is certainly a realistic scenario for nurseries germinating Fdc in BC.

Are there any risks to extending stratification? In paper by Edwards and El-Kassaby (1995) they show that for 15 half-sib families a five-week stratification treatment was optimum, but a seven week treatment reduces the speed of germination in some families. Sorensen (1996) has also identified significant stratification length X family interactions. These observations suggest differential levels of dormancy among families. Gosling *et al.* (2003) also note decreased germination in a single seedlot, but it occurred after 48 weeks of stratification. Although extended stratification appears beneficial, at some point the decrease of seed reserves caused by the increased respiration (relative to dry seed) will negatively impact the germination characteristics.

In reviewing 'older' literature it is apparent that pre-germination was a much greater concern than it is today. It is unclear whether this is a genetic difference (or sampling difference) over time or whether our treatments today are different. Seed moisture content control through surface drying currently in use for Fdc and targeting of the moisture content are good methods of restricting pregermination.

In summary, extended stratification can be an effective tool to improve germination rate, especially when germination temperatures are sub-optimal. There is a point at which long stratification periods will be deleterious due to the decrease in seed reserves available for germination. From a genetic standpoint there is certainly evidence that dormancy can vary greatly between genetic entries and even a seven week stratification period may reduce the germination rate in some families. The decision on whether to extend stratification should first consider the germination conditions seed will be exposed to and whether there are currently concerns with crop uniformity (i.e. is germination synchronised and rapid or is there a noticeable lag within the crop).

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