Upgrading Seeds With IDS: A Review of Successes and Failures

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INTRODUCTION

The IDS procedure has become widely known and discussed among nursery managers. It is reported to have potential to upgrade seed lots to high quality levels. This is especially attractive to container growers who desire to single sow seeds to save seeds and labor. This paper reviews some of the literature and reports on trials made at the National Tree Seed Laboratory to help nursery managers determine if the procedure has potential to assist them in their operations.

BACKGROUND

Incubate-Dry-Separate, or IDS, is a fluid separation technique that exploits the principle that dead seeds take up and lose water faster than viable seeds do.

Figure 1 is a graph adapted from Downie and Wang (1992) that shows how living and dead seeds of white spruce (*Picea glauca* [Moench] Voss) dry at differential rates. The best separations on weight and specific gravity are possible when the moisture content difference is the greatest. Both live and dead seed start at the same place and dry to the same moisture content but in between there is a point when they are very different.

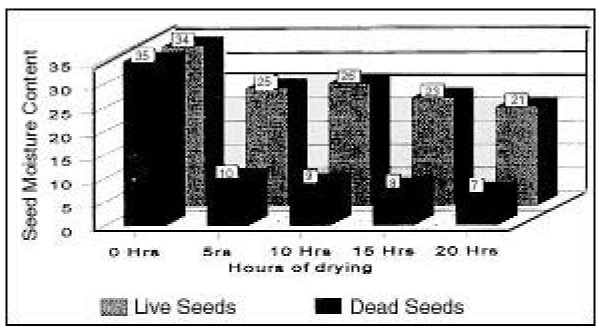

Figure 1. The moisture content of live and killed seeds dried in relative humidity of 50%.

In this data, the maximum weight difference was observed between 5 and 20 hours. This would be the point when a weight separation could be most effected. The steps in this procedure are to imbibe or incubate the seed to full imbibition, rapidly dry it and then separate it by floatation in water or other suitable fluid. The technique was developed by Simak (1984) in Sweden.

LITERATURE REPORTS

Is a species a candidate for IDS? Will it work? The literature lists several species on which the procedure has been tried. Some have been successful, others not, and still others the results are mixed. Species that have been improved include lodgepole pine (*Pinus contorta* Dougl.) (Simak 1984) (Downie and Wang 1992), Scots pine (*Pinus sylvestris* L) and Norway spruce (*Picea abies* (L) Karst.) (Bergsten 1993), jack pine (*Pinus banksiana* Lamb) (Downie and Wang 1992), *Pinus roxburghii* (Vozzo 1990) and Douglas fir (*Pseudotsuga menziessii* Mirb.) (Sweeney et al. 199 1). Attempts to improve eastern white pine (*Pinus strobus* L.) (Downie and Bergsten 1991) and western white pine (*Pinus monticola* Dougl.) (Kolotelo 1993) have not given satisfactory results. Downie and Bergsten (1991) found white spruce to be improved by the procedure but Downie and Wang (1992) got disappointing results with this species.

IDS TRIALS AT THE NTSL

Experience with the procedure at the National Tree Seed Laboratory is mixed. A lot of Scots pine was successfully upgraded from 43% germination to 85% by removing dead filled seeds. One lot of *Acer grisium* was improved from about 40% filled seed to over 80% filled seed by removing the empties. Empties could not be removed with air separaters or the specific gravity table. This was probably due to the very thick seed coat and the light weight of the embryo. A combination that made the filled and empty seeds weigh about the same. Following an overnight water soak, the embryo became heavy enough to create a specific gravity difference with timed drying. The empty seeds could be floated off and the filled seeds sank. An attempt to remove fungus damaged seeds from slash pine (*Pinus elliottii* var. *elliottii* Engelm.) seed lots failed completely. Table 1 shows the germination of the sinking and floating fractions from 5 white spruce and 2 Sitka spruce (*Picea sitchensis* (Bong.) Carr.) seed lots. Although the germination of the sinking seeds was always higher than the floating seeds, the results were not totally satisfactory.

Table 1. Germination after 14 day prechill of Alaskan spruce after IDS.

Species	Lot number	Floating seed	Sinking seeds
White spruce	1	69	86
	2	33	89
	3	76	88
	4	58	79
	5	79	91
Sitka spruce	1	72	96
	2	34	88

This was because the objective was to improve the seed to the point where it could be single sown in containers, and only the one lot of Sitka spruce approached this quality. Additionally, the germination of the sinking seeds was often too high to discard. One lot of ponderosa pine (*Pinus ponderosa* var *scopulorum* Engelm.) with many immature seeds was separated also with mixed success. The seeds were judged to be immature by radiographs because the gametophyte tissue did not fill the seed coat. In the overnight water soak, a fraction never sank and this is was expected to be the poorest. However, the germination of this fraction was actually the very best (Table 2.).

Table 2. Germination of one lot of ponderosa pine after IDS.

Fraction	Unstratified	Stratified
Original lot	90	68
Floaters from overnight soak	94	89
IDS sinking seeds	80	68
IDS floating seeds	81	56

The floating and the sinking seed from the completed IDS procedure germinated the same without stratification, but the sinking seed did better after stratification, 68% versus 56%. However, both germinations would not be acceptable in most nurseries for efficient seedling production. The fact that the sinking seeds did do better, however, was an indication that the stronger seeds were segregated into the sinking fraction, just not as completely as desired. An average weight of seedlings at 10 days also showed that the more vigorous seeds were found in the sinking portion of the IDS separation. The seedlings from the sinking fraction in the stratified germination test were the heaviest and were 12% heavier than the seedlings from the floating fraction. Compared to the seeds that never sank during the imbibition step, this most vigorous fraction had seedlings almost 17% heavier (Table 3). It should also be noted that stratification also gave heavier seedlings with all fractions of the seed lot. Although the stratification stressed and killed many weak seeds, those that remained were invigorated.

Table 3. Weight in grams of 10-day old ponderosa pine seedlings from seed treated with IDS.

Fraction	Unstratified	Stratified
Original lot	0.22	
Floaters from overnight soak	0.20	0.24
IDS sinking seeds	0.23	0.28
IDS floating seeds	0.21	0.25

VARIATIONS ON THE TECHNIQUE

The basic criterion for a species to qualify for improvement with IDS are that the seeds need to float in the separation fluid (usually water) when dry and sink when fully imbibed. If this condition cannot be met, then the separation fluid needs to be modified or replaced for IDS to work with that species. For example, seeds with stoney seed coats will sink in water unless completely empty. Therefore, the separation of filled living seeds from filled dead seeds could not occur with water. A more dense solution is needed. In the other direction a seed that is very buoyant and not able to sink in water would require using a solution that is less dense than water such as an organic solvent. Organic solvents would require quick and careful work as they can be harmful to the seed and the worker. A good example of a modified separation fluid was reported by Vozzo (1990) where the best separations of *Pinus roxburghii* were made with sucrose solutions of 1.04 specific gravity.

The imbibitional step has been done in different ways. Simak (1984) imbibed the seed on blotters at 15^{o}C. Sweeney (1991) soaked the seed in water overnight and then held it as for normal cold naked stratification at 15^{o}C for 3 days. The trials at the NTSL all were done using the overnight water soak at ambient temperature or the naked stratification procedure at 3^{o}C to imbibe the seed.

The relative humidity of the drying air is another factor that can be regulated to improve separations. Downie and Wang (1992) used air at 50% relative humidity and got the same drying rate as with 20% relative humidity. In contrast, drying with air below 20% relative humidity can in some cases speed the drying process and accentuate the difference in the drying curves (Bergsten 1993). Table 3. Weight in grams of 10-day old ponderosa pine seedlings from seed treated with IDS. The final step of separation can be done in a plain pale, in a column separator (Figure 2) or in a flume which is similar to a fractionating air aspirator (Figure 3). The pale and column separator give vertical separation while the flume gives both vertical and horizontal density gradients.

A detailed discussion of the variables in IDS separation are given by Bergsten (1993).

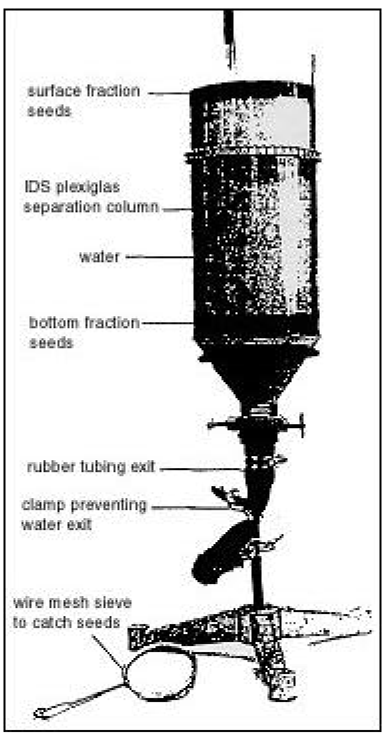

Figure 2. IDS column separator (Downie 1992).

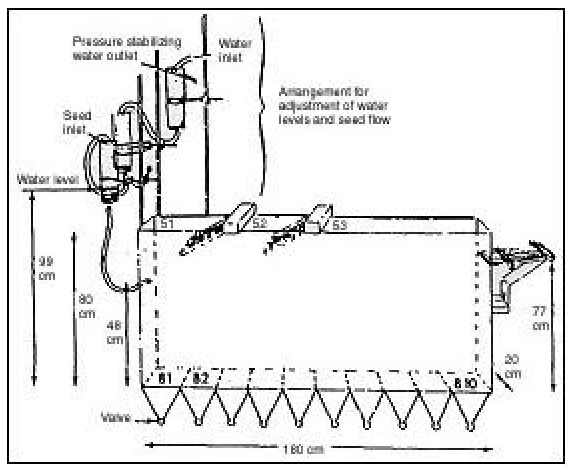

Figure 3. Sedimentation flume (Bergsten1993).

SUMMARY

The incubation-dry-separate procedure has been used successfully to upgrade many species and is used operationally in Sweden on a large scale. It can be very technical and requires research on the specifics of the seeds to successfully use it.

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