The Use of the IDS-Treatment on Southern Pine Seeds and its Effect on Seed Cost and Efficiency in the Seed Bed

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Abstract—The IDS-treatment (I = incubation, D = drying, S = separation) is a method to remove filled-dead seed from a seed lot. It is based upon the principle that, when incubated for some period of time and subsequently dried, seeds lose the absorbed water at different rates depending on their viability. Under tightly controlled drying conditions, dead seed and live seed lose water absorbed during the incubation period at different rates, creating the opportunity to make a separation. Contrasting seed lot qualities of loblolly, slash, and pines were submitted to the IDS-treatment. Untreated and treated seeds of the same lot were sown in a split-plot design in two (2) bareroot nurseries. A completely randomized study was established in a container nursery. This seed treatment process may prove helpful for those bareroot nurseries that use precision sowing techniques and most container seedling nurseries. For the seed inventory managers, improving the poor germinating lots of the high genetic value seed, is now a “viable” alternative.

Keywords: Pinus taeda L. , Pinus elliottii Engelm., IDS

INTRODUCTION

Nursery managers are always searching for new methods that will lead to improvements in their seedling crops. Experienced growers recognize the importance of seed bed density as it directly influences costs and most importantly seedling quality. In the southern USA, many bareroot nursery managers have employed precision vacuum sowers to accurately place the seed on the nursery beds. This equipment is expensive and consumes more time than drill-type seeders to operate, but the anticipated results appear to be justified as an increasing number of nurseries are employing this method of sowing seed. Integral to the success of using this equipment is the quality of the seed; specifically the percent of full live seed. This characteristic has always been a crucial part of the sowing plan, but now plays even a greater roll as vacuum sowers are designed to strategically place seed to the bed to maximize quality growth.

Container nursery growers have recognized this point for some time. They have observed that a single sown seed to each cavity is the most cost effective method to sow and grow a crop, if all seed germinates. In the northern latitudes where container seedling crops have become the norm, single sown seed (one per cavity) has become a reality with the development of a seed treatment technique called IDS. Virtually all the container seedlings in Sweden are grown from seed that have had all dead and damaged seed removed prior to sowing via IDS and other seed conditioning techniques (Bergsten, 1991).

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The IDS-treatment (I = incubation, D = drying, S = separation) is a method to remove filled-dead seed from a seed lot. It is based upon the principle that, when incubated for some period of time and subsequently dried, seeds lose the absorbed water at different rates depending on their viability. Under tightly controlled drying conditions, dead seed and live seed lose water absorbed during the incubation period at different rates, creating the opportunity to make a separation. The IDS technique was first developed for *Pinus contorta* by Simak (1983,1984) and considered a major breakthrough in seed treatment prior to sowing. Subsequent research by his colleagues at the Swedish University of Agricultural Sciences, Umea, Sweden has resulted in the use of IDS as a standard procedure for cleaning *Pinus sylvestris* (Bergsten, 1983), and *Picea abies* (Downie and Bergsten, 1990). Also based upon the work at Umea, Vozzo (1994) published successful separations of *Pinus roxburghii*.

However, the above mentioned species in relation to loblolly *(Pinus taeda* L.), slash *(P. elliottii* Engelm. var. *elliottii*) and longleaf *(P. palustris* Mill.) pines are all small seeded (70,000 to 120,000 + per pound). Until now, separation of commercial size quantities of these larger seeded pines has not been successful (personal communication with Dr. Robert Karrfalt and Dr. Frank Bonner, USDA Forest Service). Small samples of slash pine were successfully separated by Donald, (1985) when he employed the procedures published by Simak, 1983.

The objective of this research is two fold; 1) is it possible to successfully separate filled-dead seed from full live seed of loblolly, slash, and longleaf pine? 2) assuming IDS is successful, will nursery managers benefit from sowing the physically improved seed?

To answer these questions, it was necessary to treat good germinating lots (90% or better) and marginal germinating lots (approximately 80%) and sow them in operational bareroot nurseries and in a container nursery.

METHODS AND MATERIALS

Fifty pound lots of contrast-Ing seed lot qualities of loblolly, slash, and longleaf pines were submitted to the IDS-treatment according to the regimens described by Bergsten (1991). Prior to this treatment, germinations were completed according to ISTA standards to determine the seed quality from which a treatment program for each lot and species was developed. After the IDS treatment, germination tests were completed on all fractions (the flotant as well as the full live seed). Germination counts were made weekly through the fourth week.

Container Nursery Seedlings

Full live seed via IDS and untreated seed of loblolly and slash were sown to HIKO-93, (40, 5.6 cubic inch cavity) containers. The IDS treated seed (IDS seed) was single sown and the non-IDS treated seed (standard seed) was sown 2 per cavity, the standard sowing activity on April 25, 1994. Ten containers (replications) were randomized within the normal production operations of the respective species at International Forest Seed Company's Odenville, Alabama nursery. After germination was complete, the number of filled and empty cavities were recorded.

Bareroot Nursery Seedlings

The IDS seed and standard seed of loblolly and slash were sown at International Forest Seed Company nurseries in Buena Vista, Georgia on April 20, 1994 and

Statesboro, Georgia on April 28, 1994. The study design was a split-plot with five replications; the main plots were IDS and standard seed, which were sown at target seed bed densities of 26 and 18 per square foot. All seed was sown with vacuum precision sowers (a LOVE at Buena Vista and a SILVER MOUNTAIN at Statesboro) adjusting the machines for total germination as determined by germination tests and assuming 15% percent cull rate for all plots during lifting. All seedlings were grown via standard growing procedures. After 60 days, the distance between 100 seedlings in one line of a drill in each plot was measured to determine bed density. Plot means and standard deviations were calculated.

Table 1. Percent total germination and vigor of seed prior to and after IDS Treatment expressed as Peak Value[1].

	PRE IDS		POST IDS	
	GERM.[2]		GERM.[2]	
SPECIES	(%)	PV	(%)	PV
Lob 1	92	6.0	97	6.7
Lob 2	83	3.87	97	6.5
Slash 1	80	5.73	94	6.5
Slash 2[4]	95	6.21	NA	NA

[1] Czabator (1962)

[2] Results of one germination test.

[3] Average germination of the seed that separated into the first two chambers of the sedimentation flume.

[4] The germination prior to the IDS Treatment was high and based on this particular seed lot no IDS Treatment was recommended.

RESULTS AND DISCUSSION

IDS Treated Seed

The IDS treatment method employed was successful in separating filled-dead seed of loblolly and slash pines (Table 1). Addition of glycerol, n-hexane, and ethanol in varying amounts to water created solutions with specific gravities equal to that of the filled-dead seed. The high viability full live seed sank and the filled-dead seed (including some weak viable live seed) floated in the solution (Table 2). The seed that

Table 2. Pounds of seed and mean percent germination of the flotant.

SPECIES	WEIGHT (LBS)	GERM. (%)
Lob 1	1.5	27
Lob 2	2.8	40
Slash 1	4.8	32
Slash 2	NA	NA

Laboratory size samples of longleaf seed submitted to a preliminary IDS treatment resulted in a successful separation.

floated is referred to as "flotant" since it is primarily filled-dead seed but contains a small portion of live seed.

But to apply the IDS treatment the wing was removed from each seed by hand. The commercial size lots were much too large to do this work; consequently, the longleaf seed was not separated. Additional research should be continued to find a cost efficient method to remove the wing using a "PREVAC" separator (Bergsten and Wiklund, 1987).

When comparing seed tests prior to and after IDS treatment, the total percent germination and seed vigor, when expressed as Peak Value (PV) (Czabator, 1962), increased dramatically (Table 1). The PV is the percent germination rate divided by the number of days the seed has been in the germinator at that count. In all but one germination test, the PV was highest after 14 days. The PV moved up (the vigor improved) from 21 to 14 days on the Lob2 seed lot after the IDS Treatment (Table 1). This is an important fact and implies that the IDS treatment process does not negatively influence the vigor of the healthy seed and, in fact, has improved the seed lot as a whole resulting in greater uniformity in the speed of germination (Table 1).

In the sedimentation flume used for the separation step, filled, live seed from Lob2 and Slash1 were separated into all ten chambers and seed from Lob1 settled into the first two chambers of the sedimentation flume. Seed that settled in the third through tenth chamber resulted in germinations of 85% (slash) and 81% (loblolly). Each resultant lot was 100% full, but all the seed did not germinate after the standard 30 day stratification followed by a 28 day germination period. The PV for each, 5.8 (slash) and 5.1 (loblolly), occurred after 14 days in the germinator, just as the seed that settled into the first two chambers. But the PV is noticeably lower. Examining the radiographs revealed a higher proportion of insect damaged and abnormal seeds, 7% (slash) 14% (loblolly) in this seed, relative to the seed separated into the first two chambers (maximum 2% for each species). This is explained as the heavier more vigorous seed sinking immediately and the lighter less vigorous seed sinking more slowly, settling into the last seven chambers. It is reasonable to say that this IDS treatment using the sedimentation flume can separate low vigor seed from higher vigor seed. These results are pioneering for loblolly and slash pine. The less vigorous seed of *P. sylvestris, P. contorta* and *A. picea* are separated via similar methods (personal communications, Birger Erikson, Swedish University. Umea, 1994).

Container Nursery Seedlings

Seed treated with IDS was single sown and untreated (standard) seed was double sown (two per cavity). The number of seedlings per 40 cavity container and the percent full cavities is shown in Table 3. Filled cavities resulting from IDS treated seed were nearly as high as those sown with two standard seed per cavity. However, this result is somewhat disappointing since nearly 95% full cavities was expected based upon the seed test results (Table 1.) of the IDS seed. However, the percentage of seedlings of sown seed is higher for both species. This fact illustrates the potential seed efficiencies that can be gained from sowing 100% full live seed.

Reasons for this downfall in germination are not obvious. A

Table 3. Seedlings per 40-cavity tray.

	LOB		SLASH	
	IDS	NO-IDS	IDS	NO-IDS
Average number per tray	34	67	34	54
Percent full cavities	85	95	85	89
Percent seedlings of sown seed	85	84	85	68

review of all our seed handling and nursery procedures did not reveal any clues as to why we only had 85% of the IDS seed germinate (Table 3). Examining adjacent containers of production run seedlings (containers of test seedlings were completely randomized among the regular crop seedlings) revealed germinations that were also lower than expected for the slash pine lot and one of three loblolly lots. Subsequent inventory reports indicated that only 85% of the cavities were full for both species. Two other isolated lots of loblolly resulted in 93% and 94% full. It may well have been a disease or some local environmental condition affecting germination.

Based on our costs for extra seed and labor to thin the double germinates (two seedlings germinating from the two standard seed sown to a cavity), we determined that the extra revenue gain from the additional seedlings (9% loblolly and 3% slash Table 3.) would justify the added expense to submit seed to an IDS treatment. Seedling quality will be measured once the crop matures to determine if a difference exists between the seedlings grown from IDS seed and standard seed.

Bareroot Nursery Seedlings

At each nursery the IDS and standard seed of loblolly and slash were sown with vacuum sowers at two targeted seed bed densities; A low density (18/ft ^{2}) and the standard production density of 26/ft ^{2}. The objective was to evaluate differences between seed treatments and relate them to seedling quality at lifting. It was thought that the best possibility for significant seedling quality differences would be found in those grown at low densities where they had the space to maximize growth. Seed grown at higher densities tend to produce more cull seedlings, which may interfere with maximizing growth potential.

To make statistically valid evaluations, the actual bed densities should not be different between seed treatments within a targeted sowing density. For all plots, calibrated sowing machines were adjusted to expect a 15% cull rate at lifting for each specific germination rate and seed size. Theoretically, then, the seedling bed densities are expected to be equal between treatments (IDS seed compared to standard seed) within a targeted density. The actual bed densities 60 days after sowing are presented for each treatment in Table 4. In none of the treatment plots did the actual seedling bed density equal the targeted seedling bed density. The mean density of each plot was determined by measuring the distance between 100 seedlings in one line of a drill in each replication, and mathematically converted to the number of seedlings per square foot. In 1 plot (standard loblolly sown at the Statesboro Nursery) the actual density was only 0.5 feet off the target.

These early results are not surprising to the experienced nursery manager. Due to the many environmental and human management influence upon the seed and the germinates, expected targets are seldom met. However, the actual mean densities in five of eight possible comparisons (two per species at each nursery location) are equal

Table 4. Number of seedlings per square feet at the two nurseries.

Buena Vista Nursery

	----Loblolly----		----Slash----	
	Low Density	High Density	Low Density	High Density
IDS	16.5	27.7	14.2	20.3
No IDS	16.3	29.0	11.6	21.8

Statesboro Nursery

	----Loblolly----		----Slash----	
	Low Density	High Density	Low Density	High Density
IDS	15.2	21.8	11.7	18.8
No IDS	18.5	21.4	10.6	14.7

(P = 0.05) even though they did not equal the targeted density. This implies that although the targeted density was not met, the sowing and germination was still consistent. In most cases, the actual density was much lower than expected. The loblolly sown at 26/ft^2) at the Buena Vista nursery was slightly higher (average of 2.3 ft^2) than expected.

Reasons for lower than targeted seedling bed densities are many, including heavy rains killing seedlings at the Statesboro nursery very soon after sowing. But in general, it seemed that germination of the IDS seed or the standard seed was not as high as expected. Also, the time required for complete germination of all the viable seed was much longer this year. This affect may well have been due to lower than normal nighttime and daytime temperatures experienced during much of the spring.
Bed densities were operation-ally checked to insure an adequate job of sowing, but extensive data collection was not practical. Since the bed densities were not accurately (collecting statistically ample data) measured to allow statistical comparisons of densities at time of sowing and after germination, the effects of lower seedling bed densities are confounded. Seed quality would have certainly suffered if we had taken hours worth of data prior to mulching the seed.

The seedlings to date are healthy and plans are to continue to evaluate each treatment at harvest. Several linear feet of each plot in each replication will be lifted and precisely counted and evaluated using a computer aided analysis referred to as "machine vision" developed at Auburn University (Wilhoit et.al., 1993). This will enable us to accurately determine bed densities at lifting, as well as the physical qualities of every seedling lifted.

CONCLUSIONS

1. The IDS treatment employed to separate filled-dead seed from full-live seed of loblolly and slash pines was successful. Increasing the germination percentage as well as removing low viability seed was pioneering work for both species.

2. Physical qualities and seedling growth is inconclusive at this time. The number of filled cavities in the container nursery and bed densities at the bareroot nurseries have not provided accurate information to determine if an economic advantage is to be expected from this first crop grown from IDS treated seed. However, the authors anticipate this seed treatment process will prove beneficial for those bareroot nurseries that use precision sowing techniques and all container seedling nurseries. For the seed inventory managers, improving the poor germinating lots of the high genetic value seed, is now a "viable" alternative.

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