X-RAY GOOD FOR ROUTINE TESTS OF SEED VIABILITY

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Forest tree seed has been analyzed by X-ray for a long time, mainly for research (9). Now the greater availability of X-ray facilities and increased demand for tree seed make their use in routine quick-tests practical (7). The method is fast, simple, and can be standardized. It is suited to mass-handling of many kinds of seed, including small, hard, or other special seed. Since the method is nondestructive, large samples can be used to improve test accuracy without wasting seed.

These benefits justify exploring every means of increasing test reliability. Currently the method resembles cutting tests for detecting physical damage in wormy, withered, or aborted seed and fruit (4, 8). A major problem of both X-rays and cutting tests is the uncertainty in relating soundness (percent of filled seed) 'to viability (percent of germination). This problem can be minimized by a stratification pretreatment, but because of variability among seed lots there is no general agreement (10). Therefore, specifying both pretreatment and germination conditions is important in testing seed quality.

A recent report recommended X-ray examination of fresh seed, but not of stored seed, in several species of conifers (2). It is not clear what the test conditions were, or how close an agreement was acceptable.. Lack of experience was blamed for the discrepancy between predicted and actual germination. But the following observations indicate how even fresh seed can be affected by slight mold.

Test Procedure

Fresh uncleaned seed from individual ponderos pines were used in tests of variability among trees Using special seed holders and industrial X-ray film:; negatives were prepared by the Entomology Depart ment, University of California (8). Soundness tallia from these films were compared with actual germina tion of the same seed (fig. 1). Germination generall fell below expectation, even though pretreatmes and germination should have given the best results Samples were stratified at 41' F. for 3 months an germinated at 70° F. for 3 weeks.

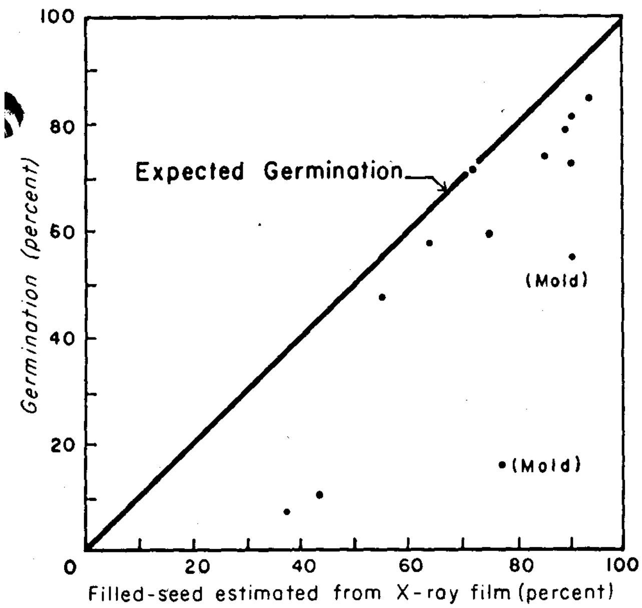

Figure 1.—Comparison of actual with expected germination of stratified ponderosa pine seed lots, based on filled seed tallies of X-ray negatives.

The greatest departure from predicted values occurred in two lots that developed mold. Only slight mold had been noted on the cones yielding this seed; this emphasizes the extreme care needed in cone handling (1). Less is known about fungi than insects in tree seed, but lowered viability (6) is closely associated with fungi, either directly or indirectly.

The poorer lots had a double loss, in that even their few filled seed germinated poorly. The reason is unknown but may be related to immaturity or faulty processing. To detect this invisible physiological damage, some tests use barium chloride, which penetrates dead parts of seed (2). The method is not consistent, being hard to measure. Moreover, the seed does not have to be dead to fail to germinate, while on the other hand, germination is possible in seed with up to 25 percent dead area (11).

Urografin, a medical compound that gives a sharper image, is especially useful in detecting seedcoats damaged in processing (5). Damage that might appear minor in fresh seed becomes aggravated in storage (10).

Deterioration in Storage

Storage deterioration was indicated in a series of tests using ordinary medical X-ray facilities on Douglas-fir seed. The resultant films were much less dis-tinct than those taken previously, but revealed empty seed effectively. The range in soundness was less than in the pine because cleaned seed was used. Even so, actual germination paralleled X-ray estimates for the seed stored 1 year (fig. 2). Seed stored 4 years showed high soundness but relatively poor germination. The stratification for 1 month at 41' F. may not have been long enough for maximum results. Also, more of the untreated seed germinated after the 3-week period at 70° F. But promptness can be as important as completeness of germination, both in the nursery and in the field.

As with the pine samples, fewer filled seed in poor lots seemed to germinate. This suggests the need for a nondestructive sampling method for viability estimates. X-ray examination of uncleaned seed samples shows the percent of soundness. This percent can be related to that of viability on the basis of conversion factors developed from the amount of empty seed and the length of storage. Hansen and Muelder (3) have shown the great detail obtainable from good film and experience. At present, equally valuable information seems available from large samples with less precise examination.

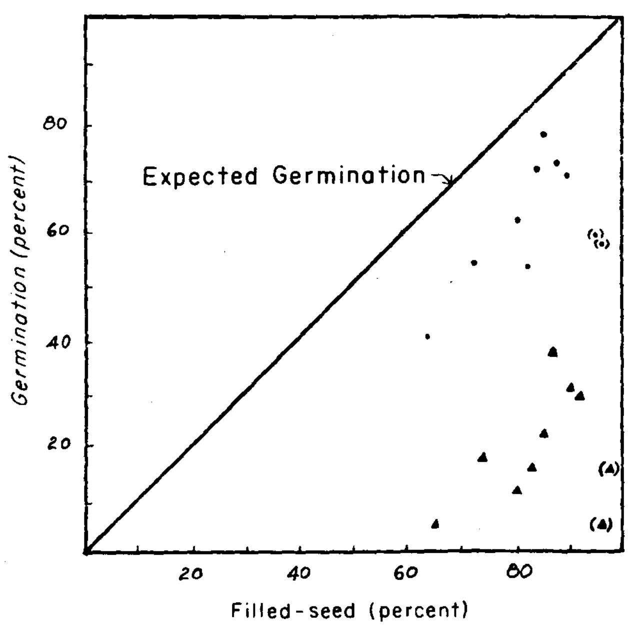

Figure 2.—Comparison of actual with expected germination of Douglas-fir seed lots, based on filled-seed tallies of X-ray negatives. Dots indicate samples stratified for 1 month at 41° F., and triangles indicate unstratified samples. All seeds were stored for 1 year except those indicated by parentheses, which were stored for 4 years.

Recommendations

These complications should not discourage the use of seed X-rays. On the contrary, experience justifies more use. No special equipment is needed, only the services of medical or dental X-ray units, purchased at hourly or piecework rates. Also, seed samples can be conveniently handled by fastening them in rows on blotting paper with gummed cellophane tape. Each seed is thus identified by position and can be returned to stock, if desired. Moreover, these tests showed that the "soft" X-ray dosage does not affect either the germination or seedling development, in line with other species *(3, 4, 8, 11).*

The "cost" of improving estimates of viability lies in improved cone and seed handling rather than in improved *X-ray* technology. In short, X-rays have emphasized the gaps in seed processing. Work with redwood (3) and with sugar pine *(1, 10)* demonstrates that seed of even sensitive species can be stored safely. Part of the problem for Scotch pine was invisible cracks in the seedcoat (5). Compounds like Urografin reveal this damage so that such seed can be used immediately rather than stored. Storing seed with wings, and dewinging them just before use (5), may even be feasible.

Keeping collections separate is highly desirable until soundness is determined, either by cutting or X-ray. Thus, the trees and localities producing poor seed and the collectors can be detected in time to prevent their complicating the testing of better seed. This attention to detail will require efficient, simplified records systems. The extra work is the price of improving X-ray diagnosis of tree seed.

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