USE OF X-RAY TECHNIQUE FOR DETERMINING SOUND SEED

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The California Division of Forestry became involved with the use of radiographs for seed evaluation through a cooperative study with Dr. R. W. Stark, Associate Professor of Entomology, Department of Entomology and Parasitology, University of California at Berkeley. Dr. Stark's work (2) was on "bad seed" detection methods based on the use of X-rays in seed examination that had been developed by Simak (1) and others.

The studies of the Division of Forestry have been only exploratory. Evaluations of individual seeds on radiographic prints have been compared with actual germination of the same seed. Work has been done on ponderosa pine (Pinus ponderosa), Douglas-fir (Pseudotsuga menziesii), white fir (Abies concolor), Monterey pine (Pinus radiata), and Sierra redwood (Sequoia gigantea). White fir seed is quite troublesome because of pitch pockets. Sierra, redwood seed is extremely difficult to work with because of its small size.

In the spring of 1962 studies were made on fresh seed. Agreement between radiographic print evaluations and germination results obtained in the germination chamber was obtained with 74 of 97 seeds (table 1). Although a greater correlation is necessary 76-percent

TABLE 1.--Number of times, by species, radiographic print evaluation for germination agreed with results obtained in a germination chamber, fresh seed

Species	No. of evaluations	No. of times agreement was obtained
Pinus ponderosa..	25	19
Pseudotsuga menziesii.....	24	18
Abies concolor...	42	34
Pinus radiata....	6	3
Total.....	97	74

agreement by an evaluator without experience in reading radiographic prints indicates high accuracy can be obtained.

In the spring of 1963 some work was done with stored seed. In Simak's work with Scots or Scotch pine (Pinus sylvestris), it was found that barium chloride ($BaC12$) was absorbed by dead tissue of the seed. After being X-rayed, this tissue appeared as dark coloration on the radiographic print; in contrast, live tissue was light. Even when $BaC\ 12$ was used as an impregnating chemical, satisfactory results were not obtained. Simak has pointed out ".. $BaC12$ is no universal agent for an X-ray contrast analysis. Seed of different species react differently to the same chemical substance." With no treatment of seed, agreement between evaluations and germination tests was obtained with only 54 of 98 seeds. The use of $BaC\ 12$ increased agreement slightly; it was obtained for 183 of 297 seeds (table 2). $BaC12$ did not materially improve evaluation results with ponderosa pine and Douglas-fir stored seed. Impregnation of the dead tissue in the seed of these two species did not occur. Therefore, an adequate contrast between dark (dead) and light (live) colored tissue was not obtained on the radiographic print. Many seeds which looked anatomically viable on the radiographic print proved nonviable when tested in a germination chamber (table 3).

The rather meager work in radiographic evaluations for the germination potential of

TABLE 2.--Number of times, by species and type of treatment, radiographic print evaluation for germination agreed with results in a germination chamber, stored seed

Species	Type of treatment	No. of evaluations	No. of times agreement was obtained
Pinus ponderosa.	None.....	48	28
	$BaCl_2$, 10 percent, 1-hour soak.	50	34
	$BaCl_2$, 10 percent, 2-hour soak.	50	34
	$BaCl_2$, 20 percent, 2-hour soak.	50	31
Pseudotsuga menziesii.	None.....	50	26
	$BaCl_2$, 10 percent, 1-hour soak.	49	25
	$BaCl_2$, 10 percent, 2-hour soak.	49	30
	$BaCl_2$, 20 percent, 2-hour soak.	49	29
Total.....	.....	395	237

seeds (figs. 1-3) has given two primary conclusions.

1. With increased skill one should be able to evaluate radiographic prints of fresh seed and obtain a germination percentage very close to that obtained by use of a germination chamber.

2. Work with stored seed does not yet give satisfactory results because of inability to distinguish between live and dead tissue.

Even if radiographs cannot be used effectively for viable seed counting, they should be of use in insect detection, in detection of damage caused by the various extracting and cleaning methods, and in evaluating percentages of anatomically unsound seed. Stages of maturity also can possibly be determined by evaluating embryo development.

TABLE 3.--Effectiveness of treatments in improving the reliability of radiographic print evaluations of stored seed

Species				Type of seed	Treatment
Pinus ponderosa		Pseudotsuga menziesii			
Column 1[1]	Column 2[2]	Column 1[1]	Column 2[2]		
Percent	*Percent*	*Percent*	*Percent*		
0.....	16	4	8	Fresh.....	None
25.....	8	22	20	Stored.....	None
4.....	18	14	27	....do.....	$BaCl_2$, 10 percent, 1-hour soak
8.....	26	16	24	....do.....	$BaCl_2$, 10 percent, 2-hour soak
26.....	16	16	22	....do.....	$BaCl_2$, 20 percent, 2-hour soak

[1] Column 1 is the percentage of seed evaluated as nonviable which later germinated in a chamber.

[2] Column 2 is the percentage of seed evaluated as viable which later did not germinate in a chamber.

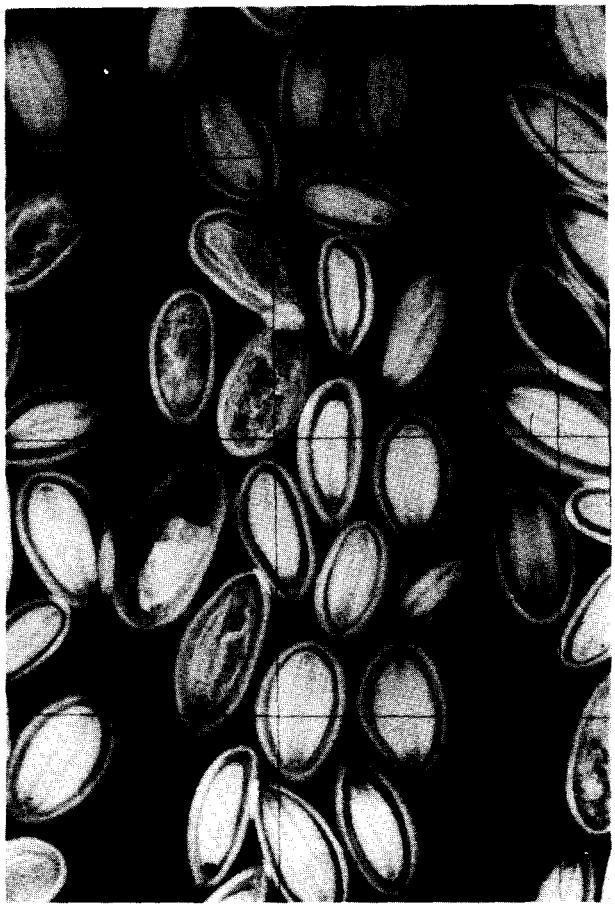

Figure 1.--Ponderosa pine showing many empty seeds, many seeds not filled completely, and some seeds with malformed embroyos.

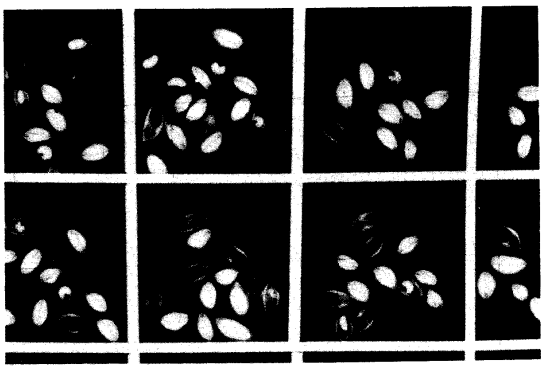

Figure 2.--Douglas-fir showing full and empty seeds with some insect infestation.

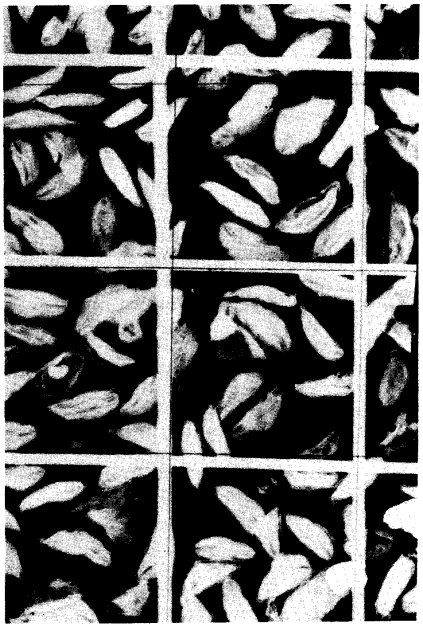

Figure 3.--White fir showing full and empty seeds with some insect infestation.

Literature Cited

(1) Simak, Milan

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(2) Stark, R W., and Adams, R S.

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