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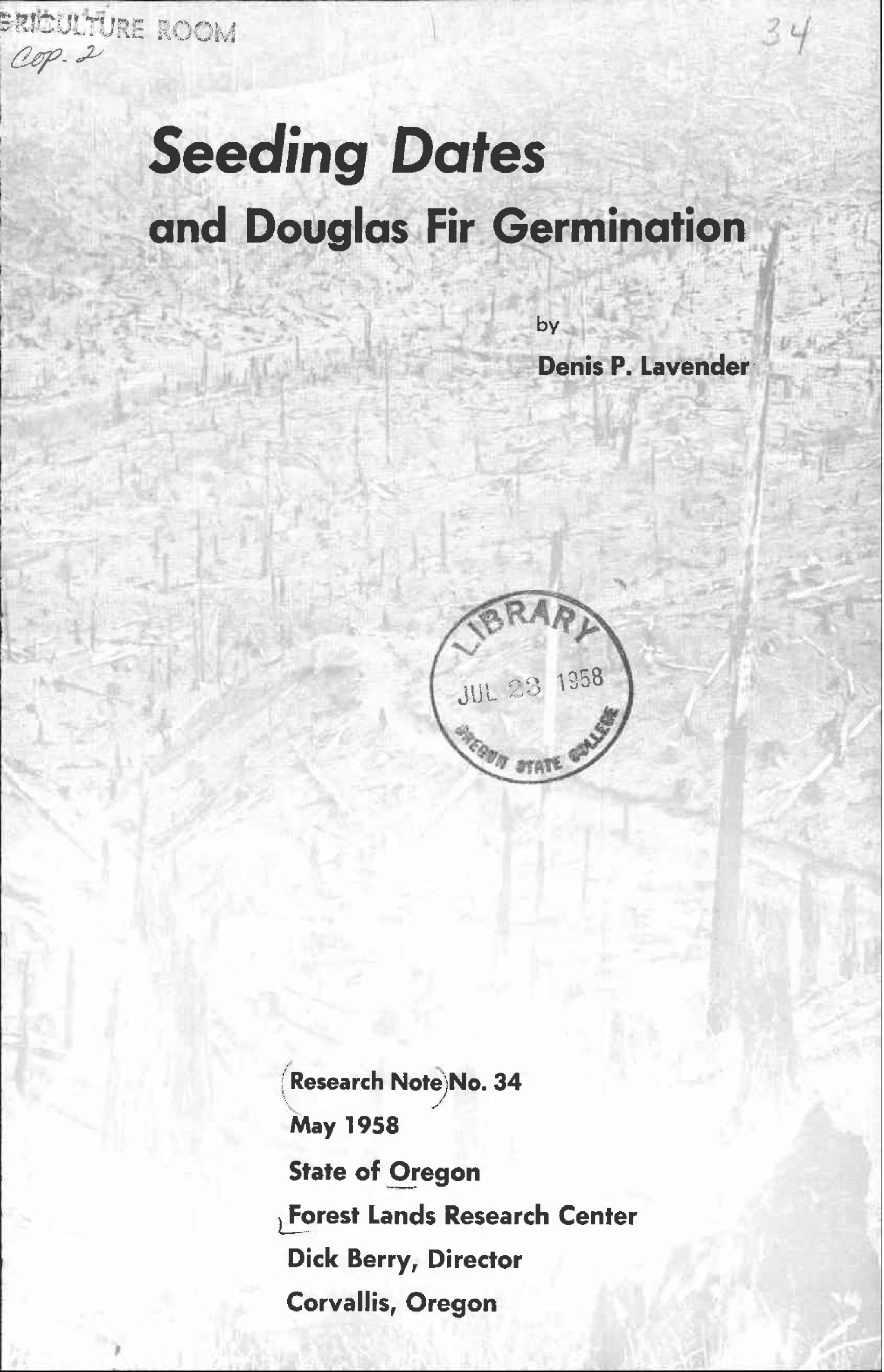

Seeding Dates
and Douglas Fir Germination

by

Denis P. Lavender

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Forest Lands Research Center

Dick Berry, Director

Corvallis, Oregon

Forest Lands Research Center

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Develop the full potential of Oregon's timber resource by:

increasing productiveness of forest lands with improved forest practices.

improving timber quality through intensified management and superior tree selection.

reducing losses from fire, insects, and diseases—thus saving timber for products and jobs.

Keep development of the forest resource in harmony with development of other Oregon resources.

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ABSTRACT

A single lot of Douglas fir, *Pseudotsuga taxifolia* (Poir), seed was used in two complementary seeding experiments designed to test effects of the following factors on Douglas fir seed viability. The seed was sown in the Tillamook Burn area of northwestern Oregon.

1) Time of seeding.
   Seed was placed in the field at intervals from November until late March.

2) Preseeding storage temperatures.
   In the winter of 1953-54 seed was stored at 0 F, 32 F, and 40-60 F for three months before seeding.

3) Stratification.
   Seed was stratified for three weeks before seeding in the winter of 1954-55.

Results of the experiments showed that:

1) Seed sown in November or December demonstrated greater field viability than that sown in later winter months.

2) Preseeding storage temperatures did not affect field viability.

3) Stratification increased the germination rate but not the total germination.

SEEDING DATES AND DOUGLAS FIR GERMINATION

The two studies described in this report were initiated in 1953 and 1954 respectively to determine what seeding dates would provide the best field germination when Douglas fir, *Pseudotsuga taxifolia* (Poir), was direct seeded.

The studies were designed to answer the following:

1) Will Douglas fir seed, placed in the field in the period from December to March, demonstrate the same germination capacity as that sown in the fall?

2) Will seed stored at 0 F prior to sowing in the field manifest a significantly higher germination percent than other lots stored at 32 F and "warehouse" conditions?

3) Will seed subjected to a cold, damp storage (stratification) for three weeks prior to seeding in January and February manifest equal, or higher, germination rates than seed sown immediately after removal from cold storage in the fall?

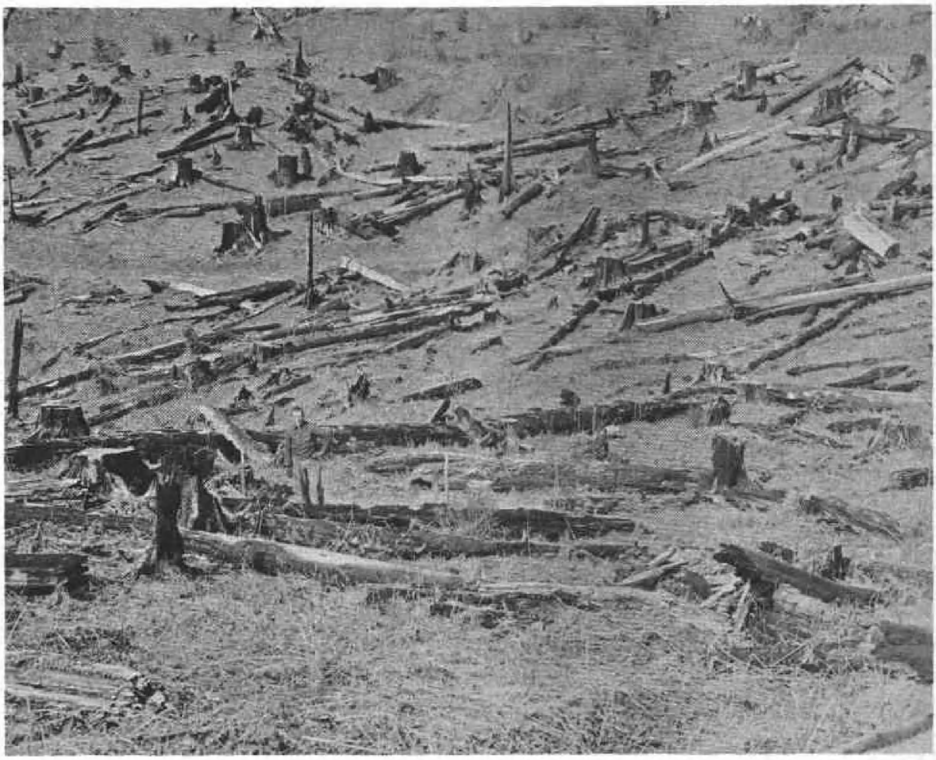

Plate 1. A view of the experimental area showing north exposure in foreground and west slope in left center background. (March 1954)

EXPERIMENTAL PROCEDURES

The experimental area was located at approximately a 2,200 foot elevation on a ridge between the drainages of Jordan Creek and the South Fork of the Wilson River in the Tillamook Burn. This site afforded an opportunity to study effects of four major exposures within an area of approximately $\frac{3}{4}$ acre (plate 1).

The seed used was collected by the investigator near Marion Forks (elevation 3,600 feet) in the drainage of the North Santiam River in the Oregon Cascades. The cones were dried at temperatures of from 85 to 110 F.[1] Seed was extracted in a screen-covered drum and cleaned on a small Clipper fanning mill. The seed was cleaned further with a South Dakota Blower until a cutting test, based on 800 seeds, showed it to be 98.8 percent sound.[2] A laboratory germination test involving a random sample of seed provided a standard for comparison with field germination results. The 1953 test evidenced 95 percent viability.

1953-54 STUDY

Individual seed spots consisted of approximately 350 Douglas fir seeds (eight seeds per square inch of soil surface). Exclosures provided protection against seed-eating mammals (figure 1). The exclosures or "cans" were approximately $7\frac{1}{2}$ inches in diameter and covered with $\frac{1}{4}$-inch-mesh hardware cloth. Each can was placed in a hole approximately $2\frac{1}{2}$ inches deep, from which the soil had been carefully removed. The soil was then replaced in the closest possible approximation to its original condition. The hardware cloth utilized for the bottom of the cans had the following advantages: 1) normal moisture movement through the soil was unimpeded; and 2) the cans could be removed after the conclusion of field examination and brought to the laboratory for inspection of the soil, herbaceous material, seedlings, and nongerminated seeds (plate 3). The Douglas fir seed, randomly selected with pneumatic seed counters from the mass of experimental seed, was scattered over the surface of the soil inside each can.

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[1] The author wishes to express his appreciation to the Woodseed Company of Salem, Oregon for their cooperation in making facilities available for this work.

[2] Cutting test: 100 seeds, selected at random, were bisected along the long axis and condition of embryo and endosperm noted. The percent seed classified as "sound" may be considered an estimation of the maximum possible germination percent.

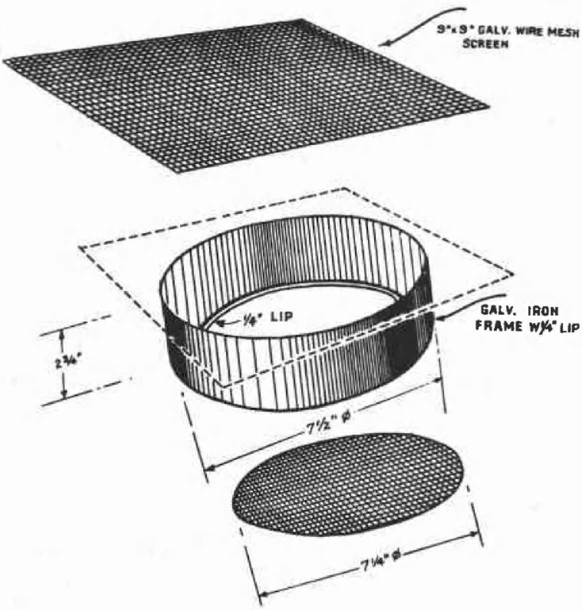

Figure 1.

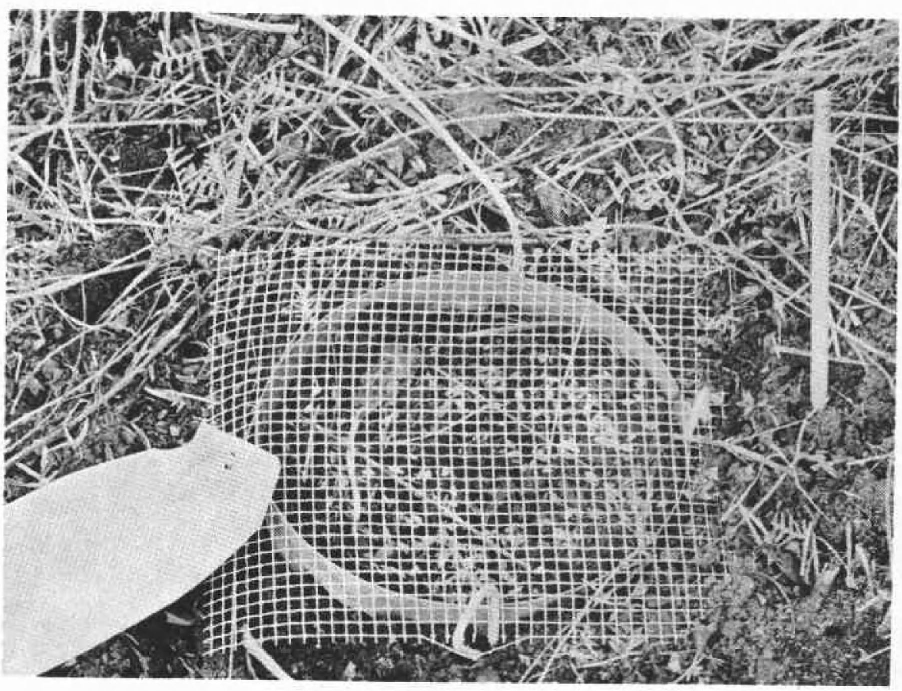

Plate 2. Closeup of "cans" in place. Westerly exposure, March 1954.

Each number in the table below indicates the number of cans on each slope seeded on a given date, and the storage history of the seed. A randomized split-block design was used, with each exposure treated as a block.

TABLE I

Storage treatment	Seeding dates			
	Fall—1953	Spring—1954		
	Nov. 27	Feb. 8	Mar. 2	Mar. 23
None	2	0	0	0
0 F	0	2	2	2
32 F	0	2	2	2
Warehouse	0	2	2	2

All seeds were randomly selected from the same lot. In November the spring-sown seed was divided into nine, approximately equal, sub-lots and stored in sealed glass containers at a moisture content of 6.4 percent. Three containers were placed in each of the following temperatures: 0 F (-17.7 C), 32 F (0 C), and warehouse or 40-60 F (5-23 C).

Plate 3. Typical cans after they were brought into the laboratory. The toothpicks mark seedlings germinated after September 1, 1954.

Field germination checks were made on approximately the first of each month from April through October, and the field germinants were tallied and removed. In October, all cans were brought into the laboratory and examined for seeds and seedlings. A laboratory test of the remaining nongerminated seed showed a viability of 70 percent (plate 4).

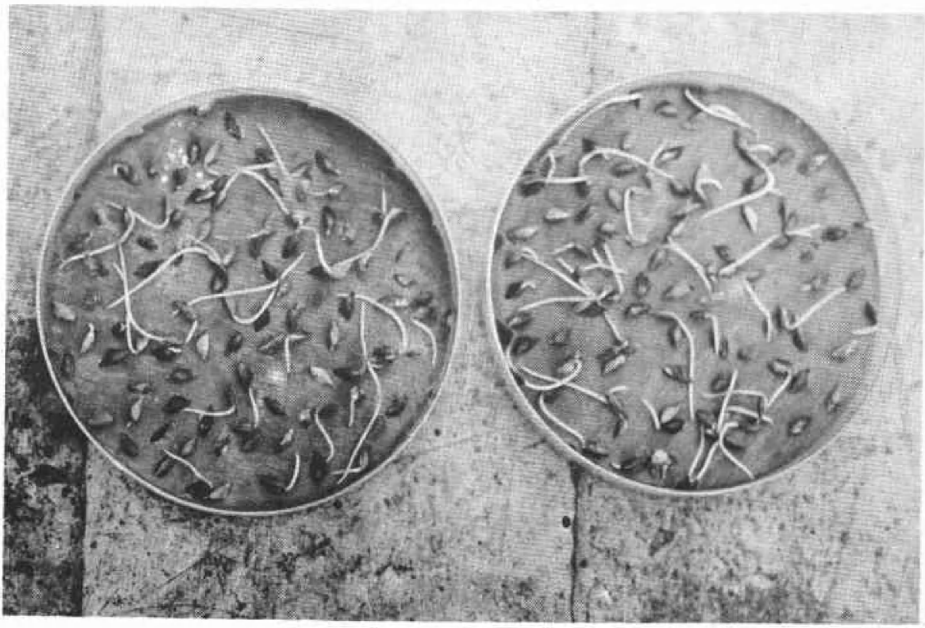

Plate 4. Typical germinants tallied during a laboratory germination test.

1954-55 STUDY

Results of the 1953-54 study (page 3) indicated that seeding untreated Douglas fir seed in the late winter produced poor, and late germination. An earlier study, Gartz (2), produced similar data for stratified[1] seed sown in the spring. The 1954-55 study was designed as a continuation of the previous year's work to investigate effects on field germination of a 3-week cold, damp treatment followed by late winter seeding.

Each number in the table below indicates the number of cans on each slope seeded on a given date, and the pretreatment given the seed. A randomized block design was used, with each exposure treated as a block.

[1] Storage in a moist medium at 34-39 F for six weeks.

TABLE II

Pre-treatment	Seeding dates			
	16 Nov 1954	14 Dec 1954	19 Jan 1955	16 Feb 1955
Non-strat	3	3	3	3
Stratified	0	0	3	3

The seed spots were similar in design to those in the 1953-54 study with the following modifications:

1) The cans were placed in the field during late spring of 1954 to allow the soil to settle before seeding.

2) Hoods of hardware cloth (plates 7 and 9) approximately 8 inches high and 8 inches in diameter were placed over the cans to prevent depredations by seed-eating mammals. These hoods permitted much more normal development of herbaceous cover than did the flat hardware cloth.

3) Two hundred seeds were placed in each can instead of 350.

Seed for the 1954-55 study was of the same lot used in the previous year's work. It was stored at 0 F until late fall in 1954. At this time it was removed from the cold room and all sub-lots required for the 1954-55 project were randomly selected with a pneumatic seed counter. The seed was then placed in cold storage until the projected seeding dates (see table II) or for initiation of the prechill treatment. In addition, a sample of seed was selected for the cutting and germination tests. These tests showed the seed 98.25 percent sound and having a viability of 91 percent (Douglas fir commonly suffers some reduction in viability each year, even when stored at 0 F).

The prechill treatment consisted of mixing seed with pumice that had been saturated with water. The mixture was stored at 39 F for 3 weeks prior to placing in the field.

The seeds were placed in the specified cans on the dates listed in the chart on page 7. A soil-air thermograph was installed on the south exposure with the soil bulb placed inside the can designated for December 1 seeding (plates 8 and 9). In addition, maximum thermometers and Coleman fiberglas soil-moisture blocks (soil mosture measuring apparatus based on varying electrical resistance with varying soil moisture) were placed on all exposures.

Field germination checks were initiated on April 13, 1955. Experience from the previous year indicated that weekly counts should be made to insure accuracy because it appeared that in 1954 some seeds had probably germinated, died, and withered away *between* germination checks and consequently were never tallied. Germinated seedlings were tallied and removed in 1955. The number of seed caps removed was also recorded. This step was another modification suggested by the 1953-54 study since distinguishing between empty seeds and discarded seed caps in the laboratory proved difficult.

Plate 5. Westerly plot, March 1954.

Plate 6. Westerly plot, October 1954. Note difference in herbaceous plant cover.

These germination counts were continued until June 28. The cans were then returned to the laboratory and numbers of seeds and seedlings recorded. A test of nongerminated seeds indicated a mean viability of 74 percent for all sound seeds failing to germinate in the field. Only 6 percent of all placed seeds were found to be blank at time of examination. Inasmuch as nearly 2 percent of the seeds placed in the field were known to be blank, this represents an increase of only 4 percent for the period of field exposure. This confirms previous work, Lavender (3), indicating that fungi and insects do little damage to Douglas fir seed in the field.

TABLE III
Relationship Between Germination and Seeding Dates
(1954 Data)

Month*	Seeds placed**	Seeds found	Seeds found	Field germination	
				Seeds placed	Seeds found
			percent	*percent*	*percent*
Fall	2,728	2,032	74.5	68.1	91.5
Feb. 8	6,235	4,895	78.5	37.9	48.3
Mar. 2	6,378	5,045	79.1	30.2	38.1
Mar. 23	6,697	5,265	78.6	27.6	35.2

* It was originally planned to seed on Jan. 15, Feb. 15, and Mar. 15, but inclement weather forced a revision of the seeding dates.

** It was originally planned to place 350 seeds in each can. Sufficient weights (for average sized seeds) were placed in storage to produce 350 seeds per can, but the experimental seeds were heavier than average and therefore each can received a few less than 350.

RESULTS

Results of the 1953-54 study are summarized in tables III-V. Analysis of the data indicates that the greater number of seedlings produced by the fall seeding as opposed to the spring is significant at the 1 percent level. Further, the greater number of seedlings produced by the seeding on February 8 when compared to those in March is significant at the 5 percent level. Preseeding storage treatments had no effect on seed viability in the field.

The effect of exposure is most significant of all, with highest germination percents occurring on north slopes, and the lowest, on south slopes. It is interesting to note that the effect of exposure is much less on seed sown in the fall. Germination of fall-sown seed varied from a high of 76 percent on the west slope to a low of 58 percent on the east slope, based on the number of seeds placed. On the basis of number of seeds found, the west slope produced 99 percent and the east slope 78 percent.

These data demonstrate that rapid germination when temperatures are favorable is essential if seedlings are to be established on drier slopes. Other experience by the author, wherein vigorous seed (characterized by rapid, high, laboratory germination tests) has produced substantially more seedlings than other, only slightly less vigorous lots of seed, lends further weight to this conclusion.

Plate 7. South exposure, May 1955, showing the hoods employed to protect the seeds, and the shelter protecting the soil-air thermograph.

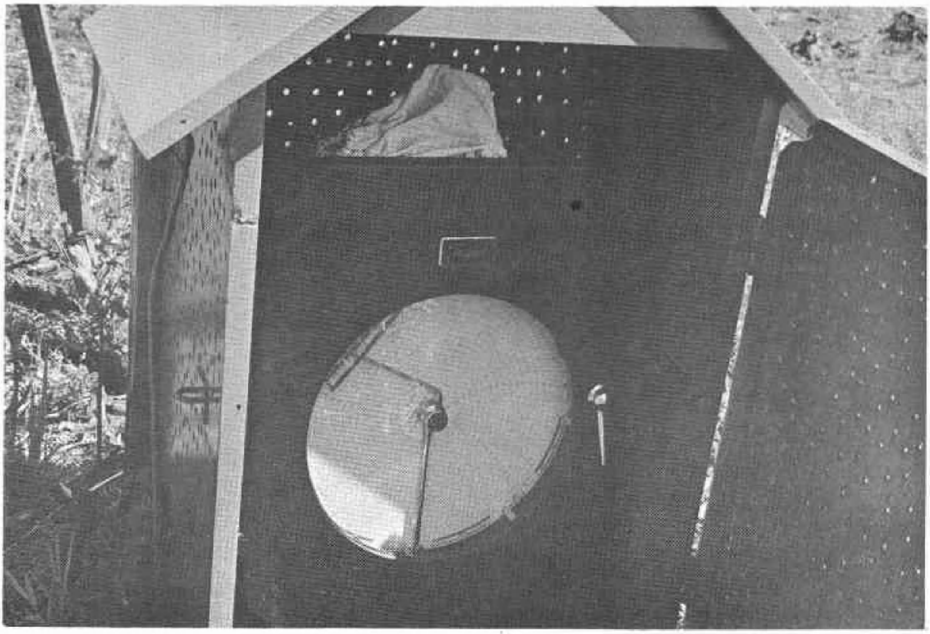

Plate 8. Closeup of shelter and soil-air thermograph. The holes in the shelter are to facilitate free air movement.

TABLE IV
Relationship Between Germination and Storage Temperatures
(1954 Data)

Temperature	Seeds placed*	Seeds found	Seeds found	Field germination	
				Seeds placed	Seeds found
			percent	*percent*	*percent*
0 F	6,417	5,051	78.7	31.8	40.4
32 F	6,199	4,957	80.0	32.8	41.1
Warehouse	6,694	5,197	77.6	30.8	39.7

* It was originally planned to place 350 seeds in each can. Sufficient weights (for average sized seeds) were placed in storage to produce 350 seeds per can, but the experimental seeds were heavier than average and therefore each can received a few less than 350.

Seed sown on March 22 produced the highest percent germination of any of the west slope spring seedings. It is the author's opinion that while this is a valid data variation, the trend in the bulk of the data is sufficiently pronounced that the germination count on the west slope in March may be safely ignored.

The 1954-55 seeding showed a much smaller reduction in germination percent with later dates of seeding than did the 1954 study. Statistical analyses, however, show this difference to be significant at the 1 percent level. Furthermore, the spring of 1955 was the coldest of the decade in the Tillamook Burn area, and these low temperatures produced abnormally late (over a month later than 1954) germination dates. Therefore it is presumed that 1955 was as favorable a year as can reasonably be expected for late winter or spring seeding. The analyses further show that the differences in germination percents of treated and untreated seed are nonsignificant and that the effect of exposure on seed germination was also nonsignificant.

TABLE V
Relationship Between Germination and Exposures
(1954 Data)

Exposure	Seeds placed	Seeds found	Seeds found	Field germination	
				Seeds placed	Seeds found
			percent	*percent*	*percent*
North	5,947	4,631	77.9	49.5	63.5
South	5,947	4,319	72.6	23.8	32.8
East	4,195	3,434	81.9	30.9	37.8
West	5,949	4,853	81.6	39.4	48.3

Even though the total germination differences by seeding date are not as great as those shown in the 1954 data, the earlier seeding dates and pretreatments clearly produced more rapid germination. Figure 2 illustrates this trend. Had 1955 been a normal year, it is probable that the May 31 germination percentages would more nearly approximate total germination than do the percentages on June 13 (final 1955 germination date).

Using this hypothesis, it is recommended that direct seeding be done before the first of the year in areas with climates similar to the Tillamook Burn area of northwest Oregon. Or, if inclement weather should force postponement of seeding beyond this date, stratification of the seed until weather conditions are favorable would probably produce greater germination. It would be unwise, however, to stratify seed unless the normal weather pattern would permit seeding the chosen area well before spring, as spring seeding of either stratified or nonstratified seed has proved unsatisfactory.

TABLE VI
Relationship Between Germination and Seeding Dates
(1955 Data)

Month	Seeds placed	Seeds found	Seeds found	Field germination	
				Seeds placed	Seeds found
			percent	*percent*	*percent*
Nov.	2,400	2,213	92.2	81.1	87.9
Dec.	2,400	2,275	94.3	77.8	82.1
Jan. (Strat)	2,400	2,259	94.1	80.1	85.1
Jan. (N. S.)	2,400	2,315	96.4	79.2	82.2
Feb. (Strat)	2,400	2,356	98.2	69.3	70.6
Feb. (N.S.)	2,400	2,298	95.8	63.1	65.9

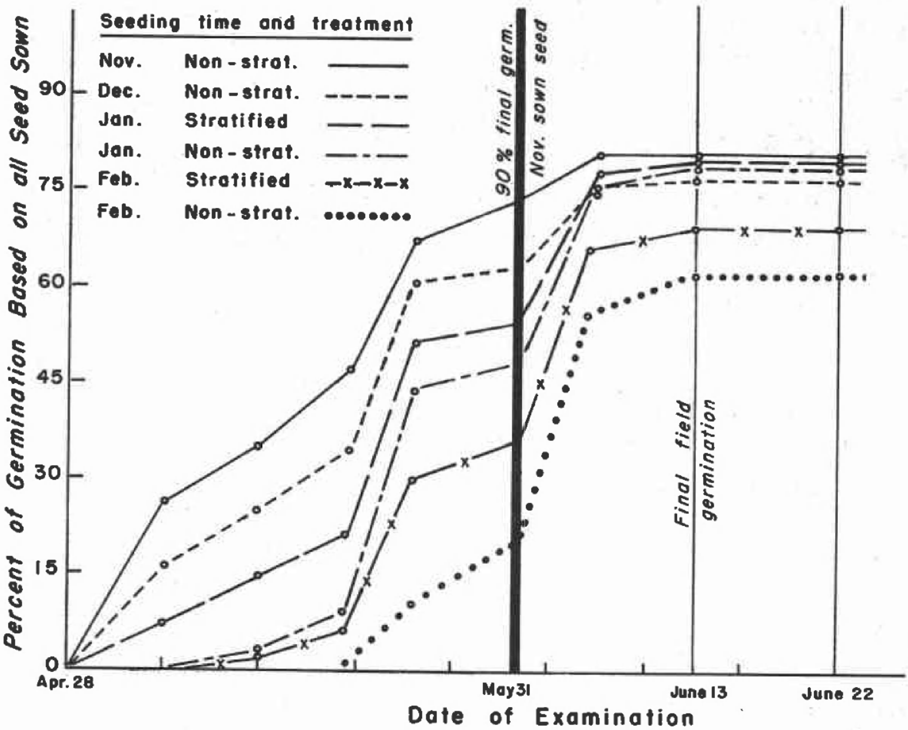

Figure 2. Relationship of seeding time and other seed treatments to rate of germination and to total germination. The heavy unbroken vertical line represents the date (May 31) when germination of the fall sown seed was 90 percent complete.

Plate 9. A closeup of December 1 seed spot showing bulb of soil-air thermograph inside the can.

TABLE VII
Relationship Between Germination and Exposures
(1955 Data)

Exposure	Seeds placed	Seeds found	Seeds found	Field germination	
				Seeds placed	Seeds found
			percent	*percent*	*percent*
North	3,600	3,463	96.2	68.4	71.1
South	3,600	3,366	93.5	72.3	77.3
East	3,600	3,478	96.6	76.0	78.7
West	3,600	3,409	94.7	83.7	88.4

CONCLUSIONS

Analyses showed the effect of exposure to be significant for the 1954 project, but nonsignificant for the 1955 experiment. It is believed that the cold spring of 1955 modified the effect of exposure, and that the results of the 1954 work are more typical of exposure effect, i.e., northerly exposures are generally favorable, with southerly exposures unfavorable.

Short term storage (up to three months) under temperature conditions existing in a dry, unheated warehouse during the winter months in the Pacific Northwest does not reduce field viability of Douglas fir seed.

Pretreatment (stratification) of seed increases speed of germination, but for this experiment did not increase the total field viability of the seed.

Seed sown in areas with a climate similar to the Tillamook Burn area of northwestern Oregon should probably be sown before January, and definitely before February, to achieve maximum field germination.

BIBLIOGRAPHY

1. Carmichael, Ralph L. Relation of seeding date to germination of Douglas fir seed. Northwest Science. Vol. 31 No. 4. November 1957.
2. Gartz, Jack S. Stratified Douglas fir seed sown in April, May, and June. Oregon State Board of Forestry Research Note No. 19. January 1955.
3. Lavender, Denis P. Effect of field stratification on Douglas fir seed germination. Oregon Forest Lands Research Note No. 33. February 1958.

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