# STORAGE OF WHITE SPRUCE, JACK PINE, AND RED PINE SEED TREATED WITH ARASAN, ENDRIN, AND ALUMINUM FLAKES

J. H. Cayford and R. M. Waldron, Research Scientists
Department of Forestry of Canada
Winnipeg, Manitoba

## Introduction

Seed used in broadcast sowing is normally treated with chemical repellents to reduce losses by depredators; the most commonly used chemicals are Arasan and Endrin. Various studies have shown that these chemicals are somewhat toxic to tree seed (1-2, 6-7, 12-13). However, other studies have indicated that the benefits of protection often more than offset the detrimental effects to the seed (3, 9), (5, 8).

Freshly pelleted seed has been used inmost studies, and little information is available on the effects of the chemicals on seed that has been stored after treatment. However, in one study treated shortleaf pine (Pinus echinata Mill.) seed was stored for 17 weeks at 38$^0$ F. with no adverse effects on germination (10), and in another study treated loblolly pine (Pinus taeda L,) was stored for 38 to 40 days without loss in viability (11).

Since 1963 we have been investigating the effects of various chemicals on the germination of white spruce (Picea glauca (Moench) Voss), jack pine (Pinus banksiana Lamb.), and red pine (Pinus resinosa Ait.), and in one study we have been investigating the effects of storage on seed treated with Arasan, Endrin, and aluminium flakes. The results of this study, presented in this paper, indicate that treated white spruce, ' jack pine, and red pine

can be stored for at least 1 year at 35° F. with little reduction in germination.

## Methods

The white spruce seed used in the experiment was collected at the Riding Mountain National Park, Manitoba, in 1962; viability of untreated seed at the time of the experiment was 45 percent. Jack pine seed was collected in southeastern Manitoba in 1961; viability was 93 percent. Red pine seed was collected in Minnesota in 1962; viability was 76 percent.

A portion of each seed lot was treated in January 1964 by the Ontario Department of Lands and Forests with 2.6 pounds of Arasan75, 1.0 pound of Endrin-75W, and 1.0 pound of aluminum flakes per 100 pounds of seed. Dow 512-R latex was used as a sticker. Following treatment seed was stored in quart sealers at 35° F.

The study was conducted between December 1, 1964, and January 12, 1965, in a greenhouse in Winnipeg, Manitoba. Seed was surface-sown and sown at a depth of one-eighth inch. The experiment was established in a split-plot design using six replications, three species, and two sowing methods. Each plot consisted of a small waxed paper tub, 4 1/2 inches in diameter and 3 inches in depth, containing about 400 grams of medium-textured sand, filled to within one-half inch of the top. A thin layer of vermiculite was placed on the bottom of the tubs to permit rapid drainage of excess water. Fifty seeds were sown per plot.

Where possible, environmental conditions were maintained to provide maximum germination. Photoperiods averaged 15 hours; a battery of fluorescent lights provided supplemental light. Maximum and minimum air temperatures averaged 84° and 73° F., respectively, with extremes of 90° and 66°. Soil temperature at a depth of one-half to 1 inch averaged 78°. All plots were watered periodically to maintain a moist germinating surface.

Examinations were made weekly for 6 weeks, and all germinates were classified and recorded as normal or abnormal. All germinates were removed when the cotyledons had separated from the seedcoat. The data obtained in the study were subjected to standard analyses of variance (see appendix). Analyses were made of the total germinates per 100 seed sown, the percentage of abnormal germinates, and the total normal germinates per 100 seed sown. The number of normal germinates equals the total germinates less the number of abnormal germinates, all based on 100 seed sown.

## Results

### Total Germination

The method of sowing did not significantly affect germination; average germination of depth-sown seed was 64 percent and of surface-sown seed, 66 percent (table 1). There was a significant species-depth interaction; white spruce germination was higher when depth-sown, whereas pine germination was higher when surface-sown.

Germination of treated seed did not differ significantly from that of untreated seed; averages for the three species were 64 and 67 percent, respectively. However, several interactions were significant. Germination of treated white spruce seed was better than that of untreated seed, while the opposite was true for the pines. Germination of treated seed was better when surface-sown, whereas untreated seed germinated better when depthsown. A significant third-order interaction, treatment x sowing method x species, resulted from the low germination of untreated, surface-sown white spruce seed.

### Condition of Germinates

The proportion of abnormal germinates was not significantly affected by seed treatment. However, the sowing method had a significant effect; only 2 percent of the germinates from depth-sown seed were abnormal, as compared with 17 percent from surface-sown seed (table 2). None of the interactions involving either treatment or sowing method were significant.

TABLE 1.--Effect of storage on number of germinates per 100 seed sown from depth- and surface-sown, untreated and treated white spruce, jack pine, and red pine seed

| Species | Surface-sown | | Depth-sown | | Surface- and depth-sown | |
|---|---|---|---|---|---|---|
| | Control | Treated | Control | Treated | Control | Treated |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| White spruce..... | 28 | 57 | 53 | 42 | 40 | 50 |
| Jack pine..... | 84 | 84 | 90 | 71 | 87 | 78 |
| Red pine..... | 76 | 66 | 71 | 60 | 74 | 63 |
| All species..... | 63 | 69 | 71 | 58 | 67 | 64 |
| Average..... | 66 | | 64 | | 65 | |

TABLE 2.--Effect of storage on percent of abnormal germinates from depth- and surface-sown, untreated and treated white spruce, jack pine, and red pine seed

| Species | Surface-sown | | Depth-sown | | Surface- and depth-sown | |
|---|---|---|---|---|---|---|
| | Control | Treated | Control | Treated | Control | Treated |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| White spruce..... | 26 | 26 | 1 | 2 | 10 | 16 |
| Jack pine..... | 12 | 16 | 1 | 2 | 6 | 10 |
| Red pine..... | 14 | 29 | 4 | 2 | 10 | 16 |
| All species..... | 17 | 23 | 2 | 2 | 8 | 14 |
| Average..... | 20 | | 2 | | 11 | |

Number of Normal Germinates

The number of normal germinates per 100 seed sown was not significantly affected by treatment; treated seed produced an average of 55 normal germinates per 100 seed sown, compared to 62 for untreated seed (table 3). Depth sowing significantly increased the number of normal germinates, from 53 to 63 per 100 seed sown. The interaction between treatment, depth, and species was again significant.

TABLE 3.--Effect of storage on number of normal germinates per 100 seed sown from depth- and surface-sown, untreated and treated white spruce, jack pine, and red pine seed

| Species | Surface-sown | | Depth-sown | | Surface- and depth-sown | |
|---|---|---|---|---|---|---|
| | Control | Treated | Control | Treated | Control | Treated |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| White spruce..... | 21 | 43 | 53 | 41 | 37 | 42 |
| Jack pine..... | 74 | 70 | 89 | 69 | 82 | 70 |
| Red pine..... | 65 | 47 | 68 | 59 | 66 | 53 |
| All species..... | 53 | 53 | 70 | 56 | 62 | 55 |
| Average..... | 53 | | 63 | | 58 | |

## Discussion

There were no significant average differences in total germination, percent of abnormal germinates, or number of normal germinates per 100 seed sown between untreated and treated seed, both of which had been stored for 1 year at 35° F. However, results did differ by species and method of sowing. All treated seed, except surface-sown white spruce, produced fewer normal germinates per 100 seed sown, and the reductions were 5 to 22 percent.

A comparison of the number of normal germinates per 100 seed sown produced from surface-sown treated seed with no storage (13) and with storage for 1 year is shown in the following tabulation:

| Species | No storage | Storage for 1 year |
|---|---|---|
| White spruce | 24 | 43 |
| Jack pine | 83 | 70 |
| Red pine | 49 | 47 |

Thus, after 1 year of storage, there were somewhat fewer normal jack and red pine germinates but about 80 percent more normal white spruce germinates.

Thus, white spruce, jack pine, and red pine seed treated with Arasan, Endrin, and aluminum flakes can be stored for at least 1 year with little loss in germination. However, when sowing treated seed that has been stored for such a period, it would be advantageous to increase the sowing rate by about 20 percent to compensate for possible reductions in the number of normal germinates produced by treated seed.

## References


(1) Anonymous,
1964a. Annual report 1963. Northeast. Forest Expt. Sta., Forest Serv., USDA, Upper Darby, Pa., p. 11.

(2)
1964b. Exploratory direct seeding trials in the Interior wet belt. In Forest Res. Rev., year ended March 1964. British Columbia Forest Serv., pp. 48-49.

(3) Croker, Thomas C., Jr.
1959. Direct seeding longleaf pine in south Alabama and northwest Florida. Alabama Conserv. 30(5): 18-19.

(4) Derr, Harold J.
1961a. New bird repellents for direct seeding. Foreign Agr. Organ., Forestry Equip. Notes A-25-61, 2 pp.

(5) _____
1961. Guidelines for direct seeding loblolly pine. South. Forest Expt. Sta. Occas. Paper 188, Forest Serv., USDA, New Orleans, La., 23 pp.

(6) Dimock, Edward J., II.
1957. A comparison of two rodent repellents in broadcast seeding Douglas-fir, Pacific Northwest Forest and Range Expt. Sta. Res. Paper 20, Forest Serv., USDA, Portland, Oreg., 17 pp.
(7) Jones, LeRoy.
1963. Germination of repellent-treated southern pine seed before and after storage. Southeast. Forest Expt. Sta. Res. Note SE-15, Forest Serv., USDA, Asheville, N.C., 4 pp.
(8) Mann, William F., Jr.
1957. Direct-seeding the southern pines. Forest Farmer 17(2): 8-9, 12, 16-18.
(9) . _____
1959. Guidelines for direct seeding longleaf pine. South. Forest Expt. Sta. Occas. Paper 171, Forest Serv., USDA, New Orleans, La., 22 pp.
(10) Maple, William R.
1961. Treated shortleaf pine seed can be stored. South. Forest Expt. Sta. South. Forestry Note 136, Forest Serv., USDA, New Orleans, La., 4 pp.
(11) Meade, F. M.
1963. Storage of repellent-treated pine seeds. Ark. Farm Res. 12(6): 5.
(12) Shea, Keith R.
1961. Field survival of thiram-treated Douglas-fir seed. Weyerhaeuser Co., Forest Res. Note 38, 8 pp.
(13) Waldron, R. M., and Cayford, J. H.
1964. Effects of seed treatment with fungicides and repellents on the germination of white spruce, jack and red pine. Dept. of Forestry of Canada, Mimeograph 65-MS-4, 30 pp.

## Appendix

Analyses of variance for total germination, percent of abnormal germinates, and number of normal germinates[1]

| Source of variation | Degrees of freedom | Total germination | Percent of abnormal germinates[2] | Number of normal germinates |
|---|---|---|---|---|
| Total..... | 71 | | | |
| Blocks (B)..... | 5 | 1.00 | 2.98 | 1.37 |
| Species (S)..... | 2 | 119.08** | 7.95** | 88.80** |
| Error 1..... | 10 | | | |
| Depth (D)..... | 1 | 2.09 | 124.06** | 52.30** |
| D x B..... | 5 | 5.86** | 1.20 | 4.25* |
| D x S..... | 2 | 9.77** | 1.67 | 3.39 |
| Error 2..... | 10 | | | |
| Treatment (T)..... | 1 | 1.92 | 2.26 | 4.92 |
| T x B..... | 5 | .34 | .97 | .33 |
| T x S..... | 2 | 5.83* | .29 | 3.89 |
| T x D..... | 1 | 14.50** | 1.20 | 4.77 |
| T x B x S..... | 10 | .53 | .95 | .40 |
| T x D x S..... | 2 | 4.74* | 2.50 | 4.13* |
| T x D x B..... | 5 | 1.22 | .39 | 1.20 |
| Error 3..... | 10 | | | |

[1] F values:
* Significant at the 5 percent level.
** Significant at the 1 percent level.

[2] Percentages changed to angles using Arasin transformation.