# Low Temperatures Reduce Storability of Loblolly Pine Seeds at High Moisture Contents

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*Loblolly pine seeds with high moisture contents (2.5-.30 percent) should not he stored at temperatures near 23°C or chore freezing, and careful handling is necessary even at intermediate temperatures of -15 and - 7°. It is generally preferable to dry the seeds to 8-10 percent moisture and store at temperatures below freezing.*

Particulars in direct-seeding; operations, it sometimes become. necessary to return pine seed to storage after it has been stratified. Drying, however. usually reinduces dormancy (1) and may he difficult without special equipment. The study reported here was made to determine the effects of storing stratified loblolly pine seed at very low temperatures for a year.

## Methods

Three single-tree lots of fresh seed were collected and processed, after which their moisture content averaged about 10 percent. All empty seeds were removed by water flotation. The lots were then subdivided and subjected to all I6 possible combinations of storage at moisture Contents of 5. 15. 25. and 30 percent and at temperatures of 2. -7. -15. and -23°C.

Since pre-storage tests had indicated that stratification improved germination, all evaluations after the I-year storage period were conducted with seeds stratified for 28 days. Duplicate 100-seed samples were tested for each treatment-replication under standardized laboratory conditions. Germination percentages and germination values (GV), which take into account both speed and completeness of germination (2). were computed and analyzed. Differences due to treatment were tested for significance at the 0.05 level.

After the seed lots had been brought to assigned moisture contents, but before they were placed in storage, germination percentages and values averaged 95 and 31.9. with no differences among moisture treatments.

### Results and Discussion

Storage temperature, moisture content, and the interaction of these factors significantly affected both speed and completeness of germination after 1 year's storage (table 1.) In seeds held at moisture contents of 25 and 3O percent. storage at -23°C lowered viability to 70 and 18 percent. The low germination values reflect slower response as well as reduced viability. The combination of very low temperature and high moisture content probably caused ice crystals to form iii the seed.

Seeds with high moisture contents were also expected to deteriorate rapidly when stored at temperatures alms e freezing. This was. iii fact, the case with lots hell at 2°C and 25 percent moisture, which had only 60 percent viability. At 30 percent moisture (fully imbibed), however. sects retained 95 percent viability and germinated rapidly (GV 74.8). Apparently these conditions were equivalent to stratification. But seeds with GV near 70 may begin to germinate in cold storage, and so it is risky to let them reach this stage.

Unexpected results also occurred at intermediate temperatures. At -15°. seeds with 30 percent moisture maintained 91 percent viability, but again speed of germination increased so much that the GV was 71.0). At 25 percent moisture and -15°, viability dropped to 77 percent: GV was 30.5. A temperature of -7° and moisture content of 30 per-



TABLE 1.—*Germination of loblolly pine seeds after 1 year of storage at four moisture contents and four temperatures*

| Storage temperature (°C) | Moisture contents (percent) 5 | 15 | 25 | 30 |
|---|---|---|---|---|
| | *Germination percentages* | | | |
| -23 | 93 | 97 | 70 | 48 |
| -15 | 94 | 96 | 77 | 94 |
| - 7 | 96 | 83 | 90 | 82 |
| 2 | 82 | 86 | 60 | 95 |
| | *Germination values* | | | |
| -23 | 38.6 | 40.9 | 20.3 | 6.8 |
| -15 | 38.9 | 31.2 | 30.5 | 71.0 |
| - 7 | 34.1 | 27.3 | 40.9 | 29.1 |
| 2 | 28.5 | 22.3 | 19.6 | 74.8 |

cent resulted in 82 percent germinability and GV of 29.1, but a moisture level of 25 percent at the same temperature in maintained 90 percent viability with GV of 40.9. It is obvious, then, that imbibed seeds are sensitive to variations in storage conditions.

At 5 percent moisture content, only the 2° temperature, and at 15 percent moisture only the 2° and -7° temperatures resulted in reduced germ inability (table 1). At these moisture contents temperatures of -15 and -23° maintained both speed and completeness of termination equal to that in the initial tests. The poorer performance at 2° and negative 7° is probably related to the development of secondary dormancy. This phenomenon occurs in loblolly pine seed held under certain conditions of moisture and storage temperature (3).

These data indicate that loblolly pine seeds with high moisture contents, as attained during stratification, must be handled carefully if stored without drying. Care should he taken to avoid extremely low temperatures (near -23°C) and those above freezing. Even in a range of -15° to -7°, seeds may he promoted to the extent that they begin to germinate in storage or that dormancy is reinduced. For this reason, large lots representing a considerable investment should be dried before storage. Some reinduced dormancy must be expected, particularly if seeds are dried only to 10 to 18 percent moisture and stored at temperatures near freezing (1). Therefore, drying to 7 to 10 percent moisture and staring at subfreezing temperatures are recommended.

## Literature Cited


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## News & Reviews

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## *Dying Forest Helps in Radiation Probe*

For the past 12 years an isolated forest area at New Turk's Brookhayen National Laboratory has brew dying a slow, deliberate death, The forest, an experimental victim of the atomic age, is bring devastated by lethal gamma rays. much the same as might happen during fallout from a nuclear holocaust.

But the *Irradiated Forest,* as it is called, is offering Brookhayen scientists more than just a chilling look at the long-teen effects of radiation. It also is giving them a better understanding of how a forest grows and what happens to it under stress.

*There is some evidence that the pat*terns of destruction are similar. whether the stress comes from radiation or from air pollution, pesticides or other toxic substances.

Within 6 months after a radiation source was placed at the center of the forest, all higher plant life within 20 yards of the source was killed. Since those first months, distinct zones of destruction have been radiating slowly outward from tile source.

In the zone closest to the source, where radiation intensity is highest• only the most primitive lichens survive. In the zone at the perimeter of the 50-acre forest all forest species survive. but not without some ill effects.

"You see the changes in the forest telescoped here in a relatively short period of time," George M. Woodwell. the project's senior ecologist. said recently as he prepared to enter the forest. "If you disturb vegetation chronically (even by means other than radiation) you will find patterns similar to this,"

On a recent afternoon, Woodwell entered the well-fenced forest arid started walking down a narrow dirt path toward the forest's center. Through a small clearing at the end of the pat li. the bleached remains of trees were already visible.

But at the forest's perimeter, there were no visible signs of radiation damage. The five major types of vegetation common to Long Island forests were present-pines, oaks, hushes, grasses and flosses.

Only Woodwell's practiced eve could pick out the first subtle effects of the radiation. Alter he had walked only a short distance, he paused. "Even here," he said, "I'm sure I can measure effects on the pine trees ,,.the needles are shorter, the diameter of the trees is reduced."

He was about 160 yards from the radiation source, as measured by small stones placed along the pathway. At this point, less than one roentgen a day of radiation was reaching the vegetation. As wood well continued his walk he started clicking off an increasing inventory of death and destruction.

"At 130 yards, there are definitely measurable effects-I to 2 roentgens' exposure per day," Woodwell said, lie pointed to scraggly, Blunted pine trees with many of their branches hart' of needles. But the oak trees looked healthy and the ground cover of shrubs and grasses was abundant. The forest still looked pretty healthy.

Yet just 10 yards later, Woodwell said simply, "We've now lost the pine trees." At 125 yards from the radiation source• we had entered another vegetation zone, a zone in which no trine trees survived. "We now have just an oak forest." Woodwell "aid.

"As we keep walking, we'll start In take out the scarlet oak and the white oak,"

Woodwell now was into the devastated clearing at the forest's center, an area in which the destruction hooks as if it could have been caused by a 750-pound bomb. At about 100 yards from the source (about 1o roentgens' exposure a day), the oaks have disappeared. Only small seedlings survive closer in, and they soon die off.

At 80 yards (between 10 and 20 roentgens' exposure a day), the blueberry arid huckberry bushes have disappeared. At 22 yards (about 160