

# Sugar Pine Seedling Survival

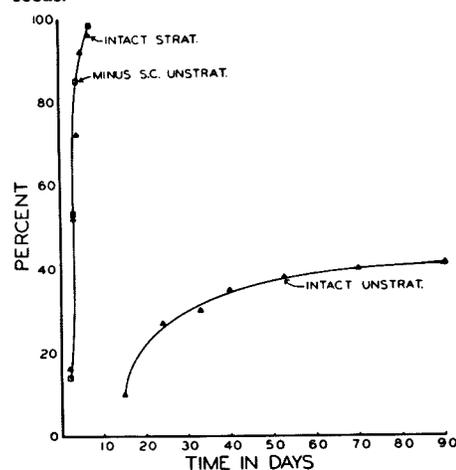
investigations indicate seed storage conditions important factor affecting vigor and subsequent survival of seedlings

Edward C. Stone

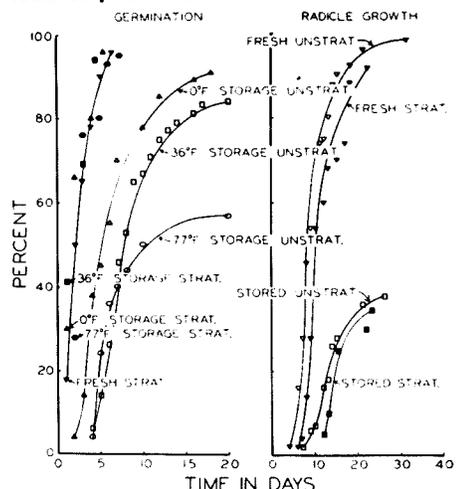
**Raising trees** in the forest from planted seed—direct seeding—depends upon several factors.

Varying results in experimental direct seeding operations—during the past several years—where rodents were eliminated, seed germination was good, and cutworms were controlled, but where the seed storage history was not the same—suggested that seedling vigor and survival were affected by seed storage.

The effect of stratification and the effect of seed coat removal on the germination of fresh seeds.



Below, left—Effect of storage temperature on germination and the effect of stratification on overcoming this effect. Seeds had been stored for two years and had their seed coats removed prior to use. Right—The effect of storage and stratification on the number of days, after germination, for the roots to reach 3". Seeds had been stored at 36°F and had their seed coats removed prior to use.



Consequently, a series of laboratory and greenhouse studies with sugar pine was initiated to study the germination and subsequent embryo growth of intact seeds, of seeds from which the inner and outer seed coats had been removed, and the seedling survival in the presence of different amounts of soil moisture.

Intact seeds were germinated in the bottom of small, shallow dishes filled with vermiculite. Water was added at regular intervals and the incubator—where the dishes were kept—was maintained at 77°F. Germination and subsequent root growth were observed.

When seed coats were removed, germination was carried out aseptically—to prevent seed decay—in screw top test tubes, partially filled with 1% agar, and placed in an incubator maintained at 77°F.

Seedling survival—in the presence of different amounts of soil moisture in 18" deep wooden flats filled with sandy loam—was determined in the greenhouse with a temperature range of up to 100°F in the daytime and down to 68°F at night.

Sugar pine cones were dried in a 120°F oven until the scales opened so the seeds could be knocked out of the cones. The seeds were dried at room temperature to an average moisture content of 10%, and stored until used at 77°F, 36°F, and 0°F, in desiccators containing a beaker of calcium chloride.

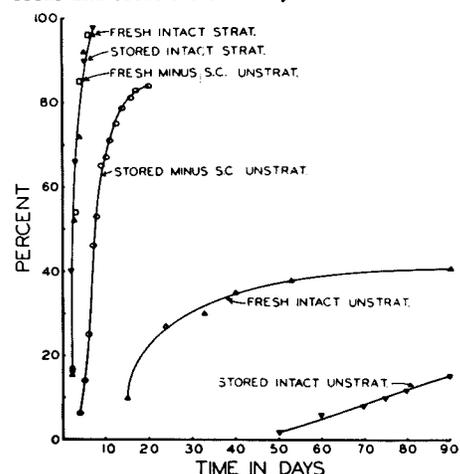
Seeds were stratified by storing them

at 36°F, for 90 days in moist vermiculite.

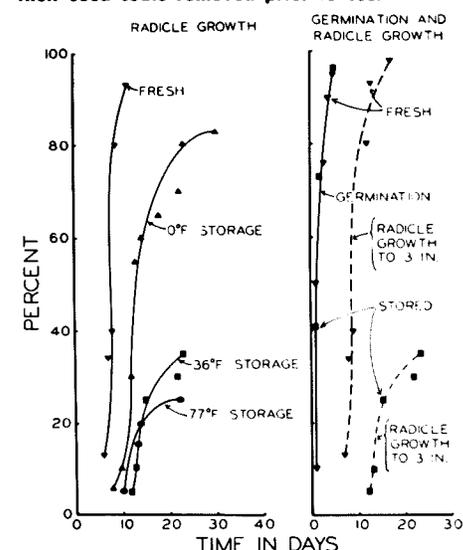
When the seeds were fresh and unstratified germination was slow, and—even after three months—less than 50% had germinated. When stratified, germination was rapid with 96% germinated

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The effect of stratification and the effect of seed coat removal on the germination of fresh seeds and seeds stored two years at 36°F.



Below, left—Effect of storage temperature on the number of days, after germination, for the roots to reach a length of 3". Seeds had been stored for two years and were stratified and had their seed coats removed prior to use. Right—The effect of storage on germination and the number of days after germination for the roots to reach 3". Seeds had been stored at 36°F for two years and were stratified and had their seed coats removed prior to use.



## Seedling Survival

Greenhouse survival, two months after planting, of fresh seeds and seeds stored two years at 36°F, when grown in flats watered only at the time the seeds were planted, and in flats watered three times each week. Both fresh and stored seeds had been stratified previous to planting.

| Flat No. | Watered initially |                    | Watered 3 times each week |                    |
|----------|-------------------|--------------------|---------------------------|--------------------|
|          | Fresh seed        | 2-year stored seed | Fresh seed                | 2-year stored seed |
|          | Survival %        | Survival %         | Survival %                | Survival %         |
| 1        | 86                | 8                  | 94                        | 78                 |
| 2        | 89                | 24                 | 86                        | 67                 |
| 3        | 88                | 19                 | 88                        | 74                 |
| 4        | 88                | 19                 | 88                        | 74                 |
| 5        | 88                | 19                 | 88                        | 74                 |
| 6        | 88                | 19                 | 88                        | 74                 |
| Ave.     | 88                | 17                 | 89                        | 73                 |

chemically treated plots where weed control was good and the flower stand was not reduced excessively.

The soil fumigants—methyl bromide and Vapam—increased growth and seed yields beyond that attributed to lack of competition from weeds. Apparently these materials control other pests—such as insects and fungi—and prevent those pests from feeding on the flower plants and reducing plant vigor.

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*William and Jim McDonald and Carl Deering of McDonald Seed Company and Marston H. Kimball, Extension Ornamental Horticulturist, University of California, Los Angeles, cooperated in the weed control tests.*

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## SUGAR PINE

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after seven days. When the seed coats were removed germination was the same as if the seeds had been stratified.

After two-year storage at 36°F germination of the intact unstratified seeds began later and fewer germinated than when the seeds were fresh. However, after stratification seeds germinated as if they were fresh. When the seed coats were removed, germination was improved but not to the same extent as with fresh seeds. Thus, unlike fresh seeds, the germination of stored seeds was differentially affected by stratification and removal of the seed coats.

The effect of the storage temperature on germination was not apparent when the seeds were stratified, but was apparent when the seeds were unstratified, and the seed coats removed. Germination of fresh seeds—with seed coats removed—was complete in seven days, with 96% germinated; stored at 0°F germination was 91% and complete in 18 days; stored at 36°F germination was complete in 20 days, with 85% germinated; and stored at 77°F germination was complete in 20 days, with 55% germinated.

Two-year storage at 36°F had a pronounced effect upon root elongation, following germination. Of the embryos from the fresh seed that germinated, 98% developed roots 3" or longer in 30 days while only 38% of the embryos from stored seeds did so. Furthermore, unlike germination, root elongation was unaffected by stratification.

Storage temperatures had a pronounced effect upon subsequent root elongation, which was not altered by stratification. Roots 3" or longer were developed in 13 days by 98% of the

fresh seeds while 82% of the seeds stored at 0°F, 38% of the seeds stored at 36°F, and 25% of the seeds stored at 77°F developed roots of 3" or more in 30 days.

Thus the number of seeds that germinated was unaffected by two years of dry storage—provided the seeds had been stratified—but the number of seeds capable of subsequent root elongation was drastically reduced.

To measure potential field survival, fresh seeds and seeds that had been stored at 36°F for two years were planted—after stratification—in soil-filled flats in the greenhouse. Ten rows of 20 fresh seeds and 10 rows of 20 stored seeds were planted 1/2" deep in each of six flats. The flats were watered until the entire soil mass was saturated. Three of the flats were not watered again but the soil in the other three was brought to field capacity, three times each week, by watering with a sprinkling can.

After two months, approximately 90% of the seedlings from fresh seeds were alive in both the watered and nonwatered flats.

In sharp contrast, survival of seedlings from stored seeds in the flats watered three times each week was approximately 70% after two months and approximately 20% in the flats watered only once.

It is apparent—from these studies—that seed storage conditions can affect seedling survival subsequent to germination.

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## FUMIGATION

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evening or early in the morning in order to avoid temperatures that are injuriously high.

At night or on cloudy days the undertarp temperatures approximate the outside air temperatures, but on sunny days they are considerably higher. With clear tarps this increase is so pronounced that they are too dangerous to use for fumigation. Fortunately, temperatures under white opaque tarps are much lower, even though they are still somewhat higher than outside air temperatures.

Temperatures under the tarp are so important it is essential that they be known. Electrical equipment such as thermocouples could be used but the initial expense and care in handling make them undesirable. Temperatures inside a small airtight box—about 8" square—covered with a piece of the tarp plastic, approach temperatures under the tarp.

A thermometer inserted through a hole in the side of the box makes it possible to determine undertarp temperatures rather closely. Temperatures in a box will drop a little more rapidly in the evening than those under the tarp because of the heat given off by the ground.

Overdosage or overexposure to methyl bromide will cause plant injury, as will high temperatures.

Mild damage merely burns the mature leaves, and the plants soon recover, but in more serious cases the young leaves and fruit buds are burned, and in severe cases the plants are completely killed.

If unexpected high temperatures are encountered during fumigation the tarp should be removed before serious injury can be done. When not being used to actually fumigate, the tarp should be removed or extensive damage to the plants will result.

Methyl bromide—like ethylene dibromide—generally stimulates the growth of strawberry plants even when the cyclamen mite has not been present. This stimulation is, at times, attributed to the control of microorganisms in the soil, but it seems more likely that it is caused by a direct effect on the plants themselves. The stimulating effect—coupled with mite control—usually brings about a striking plant response soon after fields are fumigated. However, fumigation should not be undertaken when the cyclamen mite is not a problem, because stimulation—at certain times—may merely result in small leaves, flowers and fruit. This is least likely to happen when fumigation is done between crops.

Early spring—about January and February—seems to be the most suitable time for fumigation and should give cyclamen mite control well into the summer if not for the entire season. Early spring fumigation should also control the two-spotted mite and strawberry aphid for a reasonable length of time. As the plants are dormant and the weather cool at that time, it is generally possible to fumigate throughout the day. The exact time of fumigation will be determined by the distribution of the spring rains, because it is impractical to fumigate in the rain. The tarp soon fills with water and becomes unmanageable, and—probably—fumigation is less effective when the plants are thoroughly soaked, because water forms an impenetrable barrier against methyl bromide.

When fumigation is necessary during the growing season, an attempt should be made to fumigate between crops; however, if severe damage is encountered control should not be delayed.

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