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AN INDEX OF RIPENESS FOR SUGAR PINE SEED[1]

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Immature or unripe seed may be one cause of the poor germination of sugar pine occasionally experienced in nursery practice or direct seeding projects. Ripeness of pine seed, or the time to harvest cones, is usually judged by a change from green to brown in the color of cones or by the development of a firm consistency in the endosperm. However accurately these criteria may be applied, they are subjective and cannot be described well enough to permit consistency in their use. More objective criteria have been proposed by Wakeley (2) and Maki (1). Wakeley suggested in 1938 that cones of the southern pines not be collected until they floated in water. Recently he has proposed floating in oil of specific gravity 0.88 as an index of ripeness (personal communication). Maki found that the germination of ponderosa pine seed was acceptable when the cones had a specific gravity of 0.86. This paper describes an index of ripeness for sugar pine seed.

1/ This study was conducted at Stanislaus Experimental Forest under the direction of Duncan Dunning, in charge of Forest Management Research.

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Methods

For the study, six sugar pine trees bearing abundant cones were selected in 1941. The trees were on north- and south-facing slopes, giving a range of environmental conditions which might affect ripening. Ten cones or more were picked from each tree on each of three sampling dates. The cones picked from any tree were selected throughout the length of the crown. Because of poor germination of seed from all the collections, another series of cones was picked in 1948, the first heavy seed crop year after 1941. On the collection dates the weight in grams and the volume in cubic centimeters (by displacement in water) were determined for ten undamaged cones from each tree.

Seed was extracted from the 1941 cones by air drying. Facilities for drying were inadequate, and some or all of the cones may have dried too slowly to yield good seed. Seed of the 1948 collection was removed from the cones by dissection within a day after collection and was immediately air dried. In each year the seed was stored for approximately two months at 41° F. and was then stratified at 41° F. for slightly more than two months. Samples for germination tests consisted of 50 seeds from each of five cones selected at random from the ten used for specific gravity determinations.

Results

Specific gravity of the cones

The specific gravity of the cones decreased from one period to another in the two years. The average specific gravities of the cones in 1941 and in 1948 are tabulated below by collection dates. A difference of 0.02 between the average specific gravities of collection dates was significant in both sets of data.

1941		1948	
August 28	0.88	September 9	0.92
September 9	0.87	September 24	0.87
September 29	0.81	October 7	0.78

The differences between means of trees for sampling dates were statistically significant. This variability makes it necessary to sample cones of each tree for which the average specific gravity is desired.

Germination of seed

The germination percent increased significantly from the first collecting date to the second and from the second to the third. In the 1941 tests germination was unaccountably low for the three collections, being only 1.4 percent for the first, 3.9 percent for the second, and 4.8 percent for the last. However, the proportion of seed having developed embryo and endosperm, as indicated by cutting tests, was 78 percent, 82 percent and 85 percent for the first, second and third collections respectively.

In 1948 the average germination by periods was 23 percent, 38 percent, and 88 percent (fig. 1). The forms of the germination curves suggest that delayed germination, which is occasionally experienced with immature seed, did not occur in the early collections. Either the period of stratification was long enough to avoid delay or the sample contained a small proportion of mature seed which germinated and a large proportion of immature seed which did not.

Relation between specific gravity and germination

The extent of relation between specific gravity of cones and seed germination in 1948 (fig. 2) is evident from the correlation coefficient of -0.75. Specific gravity alone explains 56 percent of the variation in the germination of the seeds. The relation of specific gravity to germination is shown also by covariance analysis. Thus the germination percents for the three collection dates would not have differed significantly if specific gravity had no effect on germination. In view of the many possible causes of variability in germination, a single-factor relationship this large is certainly important.

Change in weight of seed

The air-dry weight of the 1948 seed increased appreciably from one date to the next. The average weight of 50 air-dry seed was 9.40 grams in the first collection, 10.80 grams in the second, and 11.41 grams in the last. This increase in weight suggests at least that seed was not completely developed in the early collections.

Color of cones

Color of the cones before they opened naturally did not consistently indicate maturity of the seed. In the first 1948 collection, seed of the poorest germination came from cones which were brownest in color. Highest germination came from cones which had scarcely a tint of brown. In the last collection, seed of which germinated at the rate of 88 percent, cone color varied from greenish brown to brown.

Application in Cone Collection

The strong relation between specific gravity of the cone and germination of the seed offers an objective method of accepting or rejecting the cones on a particular tree. If, for example, 85 percent germination is desired, then cones should not be picked until the average specific gravity of the cones on a tree is 0.80. How to detect the average specific gravity of cones on a given tree with a reasonable certainty and with minimum equipment is obviously a sampling problem.

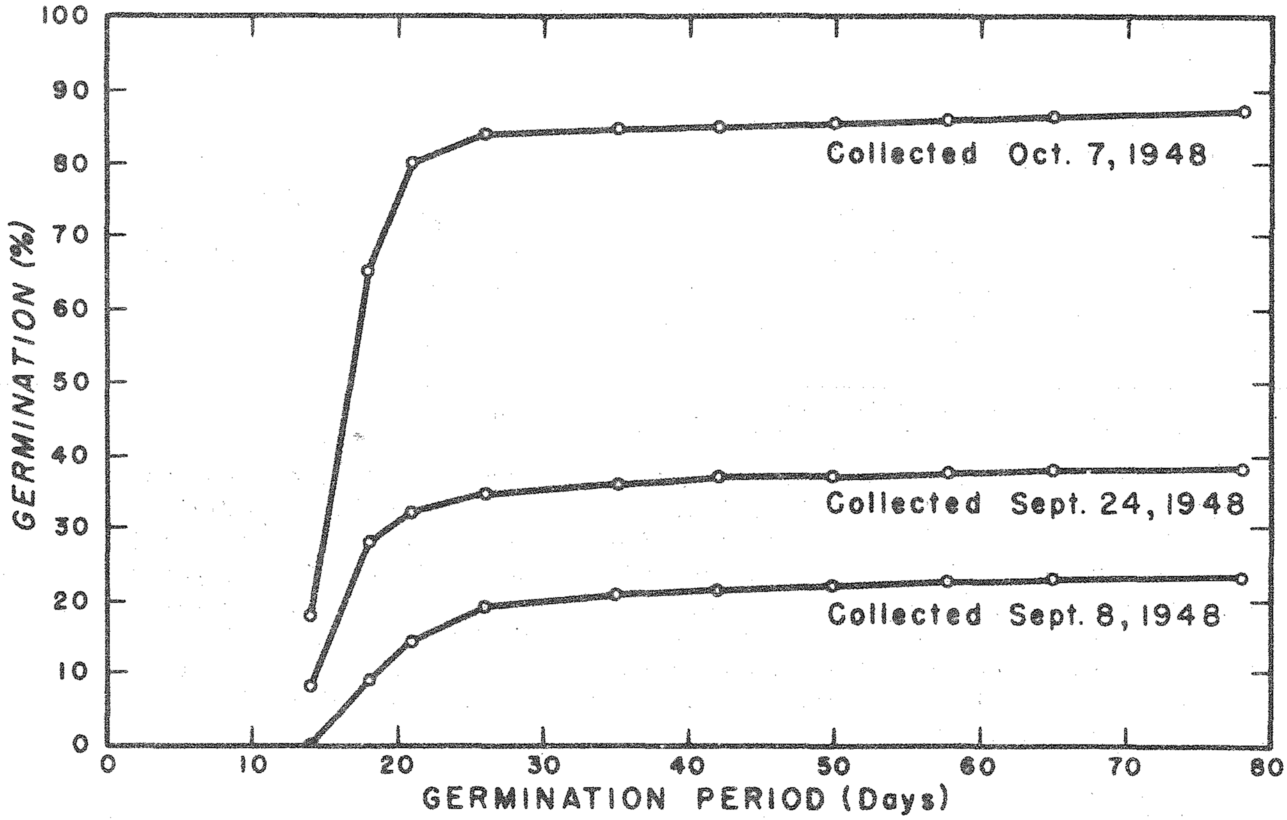

Figure 1. - Germination of seed.

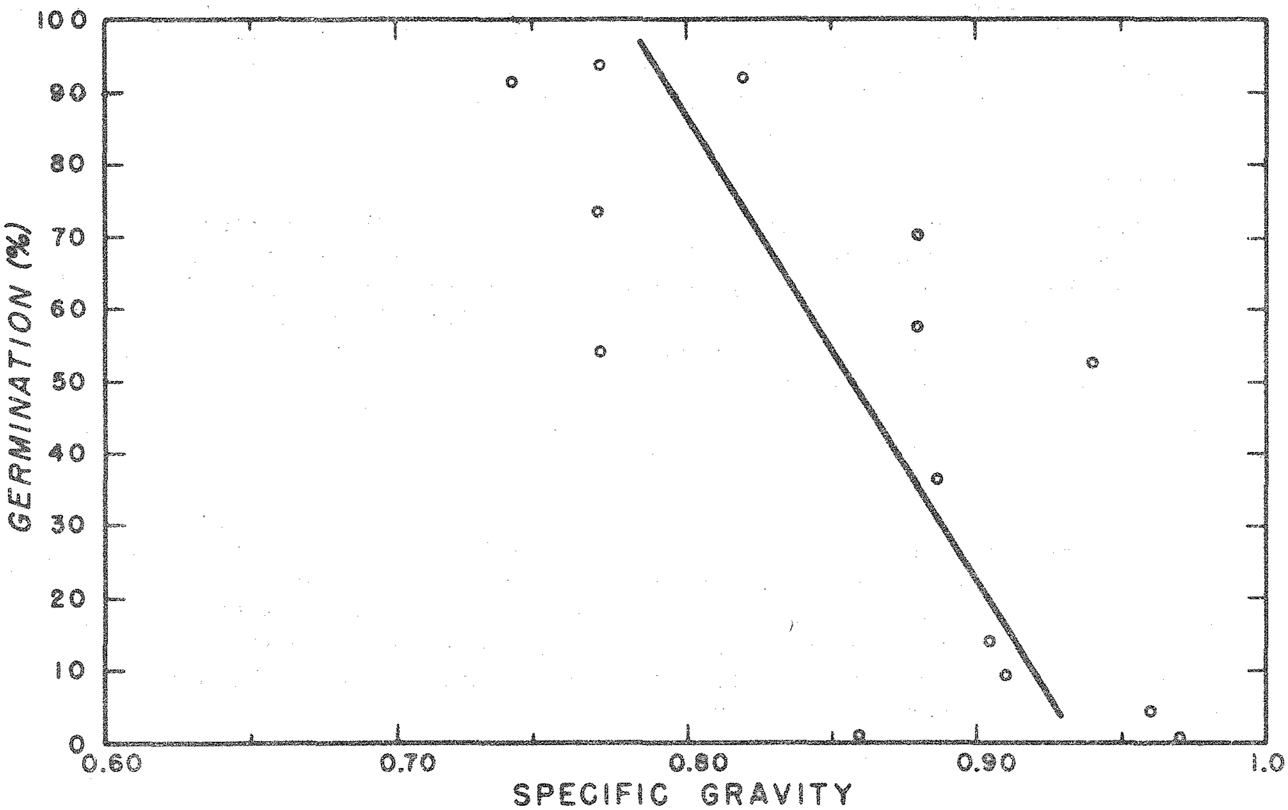

Figure 2.— Relation between specific gravity of the cone and germination of the seed, 1948.

A simple procedure might be based on the probability that cones would float or sink in some liquid, such as common kerosene, which has a specific gravity of 0.80 in the range 60° to 80° F. It is possible to compute how many cones from a population of assumed mean would float in kerosene. The probability is 0.50 that 3 or more cones of a sample of 5 will float when the mean specific gravity of cones in a tree is 0.80. Occasionally three or more cones will float when the mean is 0.81 (probability of occurrence is 0.20), and rarely when the mean is 0.82 (probability of occurrence is 0.04). If only 2 cones float, there is the possibility that the mean of the tree is as high as 0.84. The expected germination related to this average specific gravity is only 60 percent. To be reasonably sure of at least 80 percent germination, 3 or more cones of a sample of 5 should float.

Because of the variability between trees, each tree must be sampled to determine whether the specific gravity of the cones is low enough to give the desired germination percent.

There are some practical limitations in the use of such a procedure. The test applies only to freshly picked cones. It is therefore necessary to sample cones from the tree or to be sure that cones on the ground, as in a logging area, have lain there no more than a day or two. Obviously aborted cones or insect-riddled cones will not yield good seed even though their specific gravity is low, that is, many of them float in kerosene.

Proper cone collection, of course, must be accompanied by good seed extraction practice to avoid germination failure, such as that occurring in the 1941 seed.

Because sugar pine cones may be 20 inches long and 5 inches in diameter, a large container is needed for the floating test. The outside can of a standard rain gage is satisfactory; however, some method of catching the overflow is desirable to avoid carrying a large supply of kerosene. The small drums used for tractor lubricants might be satisfactory containers. Probably a better container could be fabricated from sheet metal to form a tank roughly 8 x 8 x 24 inches, in which cones could be placed horizontally.

In view of the costs of seed collection and the necessity to make the most of infrequent seed crops, an objective system of determining ripeness, such as this specific gravity index, appears worthwhile.

References

(1) Maki, T. E. 1940. Significance and applicability of seed maturity indices for ponderosa pine. Jour. Forestry 38: 55-60.

(2) Wakeley, P. B. 1938. Harvesting and selling seed of southern pines. U. S. Dept. Agr. Leaflet 156.