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Why It Is Important to Know When Cones Are Ripe

Reforestation has become one of the major conservation activities in the Lake States region and has been especially prominent since about 1933. To date, a total of approximately 1,000,000 acres have been planted to forest trees in this region, and there still remain about 15,000,000 acres which need planting.

Such large-scale reforestation programs must depend upon the collection of huge quantities of tree seed, and it is obviously important that the largest possible quantity of good seed be collected at the most reasonable cost attainable.

During the past 5 years the U. S. Forest Service has collected an average of 6,500 bushels of cones annually. In 1939 alone, there were collected the equivalent of 5,400 bushels of red pine cones, 1,700 bushels of jack pine cones, and 175 bushels of white pine cones. In addition, the State Conservation Departments and other agencies are estimated to have collected from 3,500 to 4,000 additional bushels of pine cones. At the prices usually paid, this means a potential annual income of about $15,000 for the local people in the cutover areas where cash income ordinarily is meager.

It can be seen quite readily that any general collecting of cones that are unripe or that have opened enough to shed much seed will result in increased cost of planting and reduction of acreage planted. In the case of private cone collectors it would doubtless mean loss of market. Since much of the cone collection work during the past seven years has been done by inexperienced people, such errors have not been unknown.

Past Methods of Determining Ripeness of Cones

Old experienced cone collectors usually determine the ripeness of pine cones by their general appearance, color, the degree of "milkiness" of the seed, their attractiveness to squirrels, or some combination of these factors. Inexperienced collectors, however, find considerable difficulty in determining cone ripeness, even though they attempt to follow the same procedure as do experienced collectors, since no one of the criteria already mentioned appears to be an infallible guide by itself.

It might be asked why there is any difficulty in determining cone ripeness, since it is Nature's method to open the cones and release seed after they have ripened. Although it is known that brown cones as a rule are ripe, it is an unfortunate fact that by the time cones are completely brown, they have also shed the greater part

[1] Maintained at University Farm, St. Paul, Minn., in cooperation with the University of Minnesota.

of their viable seed. Consequently, it may be stated that none of the old methods of determining cone ripeness is particularly suited as guides for inexperienced collectors.

Relation of Cone Ripeness and Specific Gravity

Some commercial cone collectors from the South many years ago followed the practice of testing some of their cones by dropping them in water. As long as the cones failed to float, they knew that they were too green to pick. If cones floated, it was assumed that they were sufficiently ripe for collecting. This method, however, did not seem to be widely adopted.

Recently there has been reported a study made on ponderosa pine (*Pinus ponderosa*, Lawson) in central Idaho.[2] This series of tests indicated a close relationship between cone ripeness, as shown by germinative ability of the seed, and the weight-volume relationship (specific gravity) of the cone. The essential findings of this study are shown in Table I.

TABLE I. RELATIONSHIP OF SPECIFIC GRAVITY OF PONDEROSA PINE CONES TO SEED GERMINATION CAPACITY

	Date (1936)						
	July 7	July 17	July 27	Aug. 6	Aug. 16	Aug. 26	Sept. 5
Mean germinative capacity of seed in per cent.....	-----	-----	0	4.5	50.6	64.8	74.1
Specific gravity of fresh cones	.948	.923	.922	.902	.860	.804	.740

The results showed that when freshly-picked cones reached a specific gravity of .860, there was a sufficiently high percentage of germinable seed to make collecting advisable. With higher specific gravities, germination of seed was very low or lacking entirely; with lower specific gravities, germination improved.

Tests similar to those made in Idaho were also conducted in the South, using the southern pines. Quite similar results were obtained, and it was concluded that cones were sufficiently ripe to collect when they had reached a specific gravity of .880.

To learn whether or not the pines native to the Lake States showed similar behavior, a study was inaugurated in 1938 near Roscommon, Mich., in which red pine (*Pinus resinosa*, Aiton) cones were collected at 10-day intervals from late July through September. Each collection consisted of 100 cones obtained in equal degree from the upper part of the crowns of 10 different seed trees. Each lot of cones was weighed shortly after collecting, the volume determined, and the seed extracted. During the winter the seed from

[2] T. E. Maki. Significance and applicability of seed maturity indices for ponderosa pine. Journal of Forestry, Vol. 38, pp. 55–60. January 1940.

each collection were tested for germination. This study showed the same general results for red pine as those already determined for ponderosa pine and southern pine, as shown in table II. There was a regular decrease in specific gravity from the beginning of collection (July 27) to the last collection (September 30). At the same time the germinative capacity of the seed showed a regular increase from 0 on July 27 to 83.0 per cent on September 19, after which it showed a slight drop. These results indicated that the specific gravity at which a reasonably high percentage of the seed germinated might be a little higher — .942 — than that found in the other species, but that the same criterion as for those species could be set up as a conservative measure of cone ripeness.

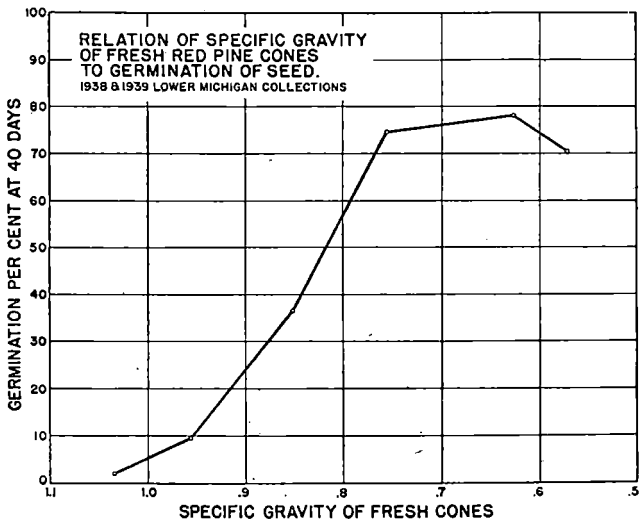
TABLE II. RELATIONSHIP OF SEED GERMINATION TO CONE CHARACTERISTICS. 1938 ROSCOMMON COLLECTION

Date of Collection	Specific Gravity (Average)	Average Cone Length (Mms.)	Average Cone Weight (Gms.)	Germination Per Cent	Description of Cones and Seed
July 27....	1.050	39.5	10.8	0	Cones green with brown-tipped scales
Aug. 11....	1.000	39.3	10.3	2.3	Cone color as above
Aug. 17....	.968	39.4	10.2	3.0	Cone color as before with hint of purplish tinge
Aug. 26....	.942	39.6	9.6	60.5	Cones definitely purple.
Sept. 8....	.854	40.5	8.6	72.0	Cones deep purple with brown top
Sept. 19....	.828	39.0	8.3	83.0	Cones as above with more reddish brown tinge.
Sept. 30....	.614	38.8	5.9	77.5	Cones mostly brown, scales opening

Mother trees: Age, 46–110; Height, 35–57; D.b.h., 8.5–14.5.

In 1939, similar tests were repeated at Roscommon, and also about 40 miles to the east on the Huron National Forest. Results during this year (See Table III) were similar in most respects to those of 1938, but were somewhat obscured by a rather general infestation of the cones by very small seed weevils. These insects, unlike the ordinary cone weevils, were not evident until after the seed had been extracted, and it was noted that many of them had tiny holes. Further investigation showed such seeds to be occupied by small larvae. Consequently the germination percentage of the seed was comparatively low. However, when a correction factor, based on the percentage of sound seed as determined by cutting tests, was applied, the germination values were more like those obtained in 1938. In both the 1939 collections, however, germination did not assume reasonable proportions until the cones had arrived at a lower specific gravity than was the case in 1938 (.855 and .811

as compared to .942). How much the difference may be due to season (the 1939 growing season was 10 days to two weeks behind that of 1938), and how much due to the weevil infestation is not known. Repetition of the tests in other years and in other localities is desirable, but present results are sufficient to set up some guides for the use of cone collectors. The average relationship between the specific gravity of freshly-picked red pine cones and germinative capacity of the seed is shown in Fig. 1. The reduced germination shown with the lowest specific gravity occurs after cone scales have begun to open (at about .600 specific gravity) and may be due to the loss of part of the most viable seed.



Since specific gravity has been shown to be a fairly good index of cone ripeness, it is of interest to note whether or not any other cone characteristics are similarly valuable guides. Length of cone remained fairly constant throughout the period of observation, so it is useless as a guide. Cone weight showed a regular decrease as the season advanced, but to use it, standards apparently would have to be set up for each locality and season, which puts this characteristic out of practical consideration. Number of seed per cone and the weight per 1,000 seed show more relationship to locality than to germinative capacity of the seed.

Cone color, on the other hand, appears to be closely related to ripeness. Although cones of definitely purplish color contained seed of good germinative capacity in 1938, and cones of the same color in 1939 showed a germinative capacity of 0 at Roscommon and only 8.9 per cent on the Huron National Forest, cones which were deep

TABLE III. RELATIONSHIP OF SEED GERMINATION TO CONE CHARACTERISTICS. 1939 COLLECTIONS

Date of Collection	Specific Gravity (Average)	Average Cone Length (Mms.)	Average Cone Weight (Gms.)	Number Seed per Cone	Weight of 1000 Seed (Gms.)	Germination Per Cent Actual	Germination Per Cent Corrected	Description of Cones and Seed
					Roscommon Collections			
Aug. 4.....	1.011	39.4	11.5	14.6	8.105	0	0	Cones green, scales tipped with brown
Aug. 14.....	1.006	39.9	12.1	15.5	9.335	0	0	Cone color as before
Aug. 24.....	.988	39.3	12.6	14.8	10.290	0	0	Cone color as above but little purplish cast evident
Sept. 5.....	.966	37.5	10.0	14.0	10.400	0	0	Cones definitely purplish
Sept. 14.....	.855	37.8	10.3	19.2	9.525	20.6	29.2	Cones deep purple and tinged reddish brown
Sept. 26.....	.735	36.6	6.9	15.8	9.695	57.1	90.9	Cones range from as above to complete brown
Oct. 4.....	.600	37.4	5.8	13.8	7.670	44.2	98.3	All cones brown, many scales opening
Mother Trees: Age, 32–98; Height, 23–65; D.B.H., 9.0–22.1; Total Number of Cones, 5–60								
					Huron Collections			
Aug. 4.....	.964	45.8	16.7	22.6	6.650	0	0	Same as for Roscommon
Aug. 16.....	1.136	46.8	17.0	22.7	8.130	0	0	As above except with faint purplish tinge
Aug. 26.....	1.149	46.4	16.2	21.3	8.535	0.1	0.1	Cones definitely purple; tips dark purple
Sept. 5.....	.876	48.0	15.9	22.7	9.095	5.6	8.9	Cones as for Roscommon
Sept. 15.....	.811	43.7	11.5	19.8	8.325	47.2	82.4	Cones as for Roscommon
Sept. 26.....	.777	45.6	12.1	21.6	8.930	54.2	76.2	Cones deep purple with more reddish brown than above
Oct. 6.....	.610	45.4	9.4	19.2	8.800	55.1	85.9	Cones as for Roscommon
Mother Trees: Age, 26–110; Height, 27–53; D.B.H., 6.9–18.3; Total Number of Cones, 5–70								

purple with reddish brown scale tips contained seed of good germinative capacity in both years. The latter color, then, can be used as a conservative guide to cone ripeness equally as well as a specific gravity of .850 with which it seems to correspond roughly. On the other hand, cone color can neither be defined nor measured so accurately as can specific gravity, so it is less desirable as a guide for inexperienced collectors.

The activity of squirrels, which were found to be cutting red pine cones 10 days to two weeks before the seed showed much germinative capacity, obviously is not a good index of cone ripeness.

During 1938, similar but less extensive tests were also made with jack pine (*Pinus banksiana*, Lambert) and white pine (*Pinus strobus*, L.) cones. (See Table IV.) Jack pine failed to show trends similar to those indicated by red, ponderosa, or southern pines. The specific gravity of the cones showed no regular trend and, in addition, remained above unity until cones two years old were collected, in which case the specific gravity dropped to .896. Consequently, such a test cannot be used for determining the ripeness of jack pine cones. However, from the practical standpoint, this is of no major importance, since the persistent cones of jack pine retain viable seed for several years after maturity and may be collected from the trees at any time of the year. In this instance, color of the cones seemed to give some hint as to the ripeness of the seed. It was found that when at least half of the cone was definitely brownish in color, a considerable percentage of viable seed could be recovered from it. As in the case of red pine, neither cone length, cone weight, nor the weight of 1,000 seed appeared to be a reliable index of cone maturity.

The tests with white pine showed trends similar to those indicated by red pine, although a high percentage of viable seed was obtained at a greater specific gravity, .973. This was the only species in which the activity of squirrels seemed to have a correlation with the ripeness of seed. The first activity of squirrels coincided with a relatively high germination value (87.0 per cent) of the seed, although a collection made 10 days previously also contained considerable good seed. Again, neither cone length, cone weight, or the weight of 1,000 seeds appears of any value as a guide to cone ripeness. Cones with the scales definitely tipped with brown appear to contain seed of high germinative capacity, and color therefore has some use as an index of ripeness.

Practical Application of These Tests

The practical value of the specific gravity tests for cone ripeness lies in their ease of application and their simpleness, which makes them of considerable value for inexperienced collectors. For instance, it is necessary only to collect 5 or 6 cones from a tree, since it has been noted that all the cones from an individual tree are quite uniform in degree of ripeness, although a different tree, only a short distance away, may be 10 or more days further advanced or re-

TABLE IV. RELATIONSHIP OF SEED GERMINATION TO CONE CHARACTERISTICS OF JACK AND WHITE PINES, 1938 ROSCOMMON COLLECTION

Date of Collection	Specific Gravity (Average)	Average Cone Length (Mms.)	Average Cone Weight (Gms.)	Weight of 1000 Seed (Gms.)	Germination Per Cent	Description of Cones and Seed
					Jack Pine	
July 5.....	1.031	40.4	7.8	—	0	Cones green with brown-tipped scales; did not open.
July 15.....	1.092	38.3	7.4	2.45	0	Cones same color as above, scales pliable. Seed light gray, not filled. 8–10 hours to open cones.
July 25.....	1.102	40.3	8.4	3.38	0	Cones same color as above, scales a little more rigid. Seed partly filled, similar in color to above.
Aug. 4.....	1.138	40.1	8.5	3.490	54.5	Cones about half green and half brown. Seeds light in color, well filled.
Aug. 16.....	1.196	38.8	8.1	3.065	75.2	Cones mostly brown.
Aug. 24.....	1.150	40.7	8.3	3.91	71.6	Each cone nearly all brown or yellowish.
Sept. 3.....	1.120	38.0	6.9	3.96	1*	Cone color as above.
Sept. 16.....	1.148	37.9	7.1	3.57	68.5	Cones brown with slight yellowish cast on lighter colored portion.
Sept. 23.....	1.081	37.9	6.5	3.69	74.0	Cones brown to light brown.
Oct. 5.....	1.040	38.8	7.2	3.94	61.2	Cones grayish brown. 5 per cent floated in water.
1937 Crop ...	1.032	37.9	5.1	3.84	51.8	25 per cent of cones floated in water.
1936 and earlier	.896	39.3	5.2	3.17	38.5	All cones floated in water.
Mother Trees: Age, 30–50; Height, 37–48; D.B.H., 8.5–11.0.						
					White Pine	
July 28.....	.995	113.0	24.2	—	0	Cones green with tinge of brown on scale tips. Some floated. Did not open under heat. Seed not filled.
Aug. 12.....	.983	116.8	25.7	—	0	Cone color as above; cones floated in water.
Aug. 18.....	.973	119.2	26.7	16.2	80.8	Cone scales tipped with brown, some center scales tinged with brown.
Aug. 29.....	.922	131.8	25.3	20.6	87.0	Edges of scales brown, cones yellowing, a few brown. Squirrels beginning to cut.
Sept. 9.....	.840	104.5	19.3	25.2	89.4	Cones dark greenish brown; some beginning to open. Squirrels cutting heavily.
Sept. 21.....	.711	120.4	11.0	19.7	90.0	Cones brown, mostly open. Large part of crop cut down by squirrels.
Mother Trees: Age, 45–110; Height, 38–88; D.B.H., 13–30.						

* Seed injured in extraction.

tarded in ripeness. These few cones may be dropped in a test liquid of known specific gravity, and if half or more float, cone collection can be made reasonably safely from that particular tree. Kerosene, with a specific gravity of about .80, is a suitable and easily obtainable test liquid for use with red pine and gives a conservative test. A mixture of half kerosene and half linseed oil gives a less conservative, but probably suitable test. Linseed oil, which has a specific gravity of about .93, appears to be a suitable liquid for use with white pine cones. Various combinations of kerosene and linseed oil can be used to obtain specific gravities between these ranges.

Of further interest to cone collectors is the fact brought out by these studies that there is a safe period of from 20 to 30 days over which suitably ripe cones can be collected. There is also described the cone coloration for each of the three pines which coincides with good germination capacity of the seed.

Summary

Reforestation, which has become a major conservation activity in the Lake States, is dependent upon an adequate supply of tree seed. Large-scale seed collection has made it necessary to use inexperienced collectors to a large degree, and some losses have been experienced through the gathering of unripe or overripe cones. Older methods of determining cone ripeness, such as activity of squirrels, natural opening of the cones, and milkiness of the seed, all have been found to be unreliable tests in the hands of inexperienced collectors. Recent studies in central Idaho, the South, and the present studies in the Lake States, show a close relationship between specific gravity of the cones and ripeness of the seed. These tests may be applied in practice by collecting 5 or 6 cones from an individual tree and dropping them into the test liquid (kerosene for red pine and linseed oil for white pine), and if half or more of them float, cones can be collected from the tree with reasonable assurance of good seed-germination. Cone color also appeared to be a fairly good index of ripeness of red pine, white pine, and jack pine cones in Lower Michigan, but it is not so easily defined or accurately measured as is specific gravity, and hence is not so good a guide for inexperienced collectors.