# Methods for Handling BLACK CHERRY SEED

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# Methods for Handling BLACK CHERRY SEED

THE METHODS used in handling black cherry (*Prunus serotina* Ehrh.) seed after it has been collected will affect the percentage of germination obtained. Studies made at our Laboratory at Warren, Pa., have shown that good germination can be obtained when the seed is properly handled and stratified.

This publication reports the results obtained from three separate seed-handling studies. The various operations involved in handling black cherry seed are also discussed.

## SEED-HANDLING STUDIES

The first study involved 21 combinations of methods for handling freshly collected seed. The second dealt with the effects of pre-stratification storage methods and chemical treatments on fresh seed. The third dealt with stratification time and chemical treatments on 1-year-old seed after storage at room temperature or in a household refrigerator. Germination was the dependent variable in all three studies.

Germination percentages, after transformation to the arc-sine, were subjected to analysis of variance. Orthogonal comparisons among treatments were then made. Germination values, based on speed of germination in conjunction with total germination, were determined by the method described by Czabator (*2*).

### Study 1

The first black cherry seed-handling study was made in 1963 to determine how germination is affected, if at all, by: (1) removal of pulp when the fruits were collected, (2) drying the seeds or fruits before stratification, (3) collecting fruits before fully ripe (still green), and (4) method of stratification.

Black cherry fruits were collected from standing mature forest trees and from trees felled on logging jobs. Some seed that had been depulped and dropped by birds was collected from the ground in the immediate vicinity of growing trees. Most of this seed had been regurgitated by the feeding birds, rather than voided in their droppings.

The fruits and seeds were handled by seven different methods, all but the last involving fully ripened seed:

- Pulp removed and seed stratified without drying (except evaporation of surface moisture).
- Pulp removed, seed spread and dried for 15 days in a ventilated garage left open to the varying outdoor temperatures of early autumn, then stratified.
- Pulp removed; seed dried 30 days then stratified.
- Pulp not removed; intact fruits stratified without drying.
- Pulp not removed; fruits dried 30 days then stratified.
- Bird-dropped seeds collected daily, held temporarily in sealed glass jar, then stratified.
- Green fruits, collected in late August, stratified intact without drying.

Several variations of the stratification treatment were compared: outdoor versus refrigerator, and sand versus peat media. Both media were used in the outdoor series but only peat in the refrigerated series. Four replicates of 100 seeds each were subjected to each of the 21 treatment combinations.

For the outdoor stratification, small wooden frames (12 by 12 by 4 inches) with screen wire tops and bottoms were used. Two layers of seed were placed between layers of the medium

in each frame. The loaded frames were placed in a shallow trench having a 6-inch gravel-sand base for drainage. The frame tops were about flush with the soil surface. After being placed in the trench, the frames were covered with hardwood leaves.

For the refrigerated stratification, a measure of seed was mixed with about four times its volume of peat in a small polyethylene bag. Bags were sealed with rubber bands. Temperatures ranged from 33° to 39° F.

Stratification periods ranged from 156 to 180 days for seeds or fruits that had undergone a drying treatment, and from 186 to 205 days for those that were stratified without predrying. Different starting dates accounted for some of the variation in stratification periods; another factor was that the refrigerator stratification was terminated earlier than the outdoor stratification.

Germination was determined in sand flats under day-night temperatures alternating between about 74° and 57° F. Seeds that germinated were tallied and removed twice a week for 4 weeks, and at weekly intervals thereafter. When no further germination was obtained for 7 days after the last count, the ungerminated seeds were cut and examined. These examinations showed that 95 percent of the 8,400 seeds used in the study were sound. Germination percentages and values for each of the seven seed-handling methods and each of the three stratification methods are shown in table 1.

Statistical analysis of the germination data showed significant differences at the 1-percent level among the 21 treatments. The main treatment effects were:

Stratification of ripe depulped seed without predrying (treatment 1) resulted in the most consistently high germination across all stratification regimes.

Leaving the pulp on the seed reduced germination. In treatment 4, which was identical with treatment 1 except for the pulp factor, germination after outdoor sand stratification was 67 percent, as compared with 91 percent for depulped seed. After outdoor peat stratification it was 82 percent, as compared with 86 percent. And after refrigerated peat stratification it was 8 percent, as compared with 88 percent.

Table 1.—*Percentages and germination values of fresh black cherry seed*

| Pre-stratification treatment number | Outdoor stratification | | | | Refrigerator stratification in peat | |
|---|---|---|---|---|---|---|
| | In sand | | In peat | | | |
| | Total germination, percent | Germination value[1] | Total germination, percent | Germination value | Total germination, percent | Germination value |
| 1 | 91 | 12.0 | 86 | 9.2 | 88 | 12.2 |
| 2 | 60 | 3.2 | 74 | 5.8 | 12 | .2 |
| 3 | 41 | 1.4 | 31 | .8 | 0 | — |
| 4 | 67 | 3.3 | 82 | 10.0 | 8 | .01 |
| 5 | 34 | .9 | 62 | 4.6 | 0 | — |
| 6 | 38 | 1.2 | 89 | 8.5 | 88 | 10.4 |
| 7 | 51 | 1.6 | 86 | 6.0 | 26 | .3 |

[1]Germination value determined by method described by Felix J. Czabator in *Forest Sci.* 8 (4): 386-396.

Drying the seed before stratification also reduced germination, and 30 days' drying caused greater reduction than 15 days' drying: compare treatments 2 and 3 (table 1) with each other and with treatment 1; also treatment 5 with treatment 4.

At the stage of immaturity exemplified by the green fruits used in this study, the seed compared favorably in germination with the seed of ripe fruits—treatment 7 versus treatment 4.

Peat was superior to sand as a medium for outdoor stratification. We cannot explain the erratic results with peat stratification in the refrigerator.

### Study II

In 1964, a study was made to determine the effects of prestratification temperature, moisture, and chemical treatments on seed germination. The effects were observed in stratification at weekly intervals from the 90th to the 120th day, and in germination flats after 120 days of stratification.

Fresh seed, collected in September 1963, was cleaned of pulp by mashing under a stream of cold water on October 4. After draining and thorough mixing, four samples of the seed were drawn for the prestratification or storage phase of the study. One sample was stored in a sealed polyethylene bag under each of these conditions: moist-cold, moist-warm, dry-cold, and dry-warm. For the moist storage, the seeds were thoroughly rewetted and then briefly drained before sealing in the bags; for the dry storage, the seeds were air-dried about 4 hours to remove all surface moisture before placing in the bags. All bags were sealed with rubber bands. An office cabinet in a room maintained at about 72° F. served for the warm storage; a refrigerator, which provided temperatures of 34° to 38° F., was used for cold storage.

On January 22, 4 months before sowing, the stored seed was treated by five different methods, stratified in peat, and placed in the refrigerator. The five treatments were:

- No chemical treatment.
- Soaked in a 3-percent hydrogen peroxide solution for 48 hours.

- Soaked in a 1-percent citric acid solution for 48 hours.
- Soaked in a 100-ppm. solution of gibberellin for 24 hours.
- Stratified untreated for 90 days, then (on April 21) soaked in a 100-ppm. solution of gibberellin for 2 hours, followed by 30 days' additional stratification.

After 90 days of stratification the seeds were examined weekly and a tally was made of the number of seeds that had broken dormancy (table 2). Seeds were considered to have broken dormancy when the radicle protruded beyond the seed coat. After 120 days of stratification the seeds were germinated in sand flats in the greenhouse. There were 4 replicates of 100 seeds for each treatment. Greenhouse temperatures were about 78° F. during the day and about 58° at night. Seeds that germinated were counted and removed from the flats each week for about 40 days until no more germinated (table 2). Seeds that erected a plumule above the surface of the sand were considered to have germinated.

An analysis of variance was made for the number of seeds *breaking dormancy* during stratification. There was a significant difference, at the 1-percent level, for chemical treatments, prestratification storage conditions, and their interactions.

For the basic conditions adopted for this study (fresh, cleaned seed stored 3½ months in sealed plastic bags), dry-warm storage without chemical treatment resulted in the highest germination value and the highest total germination—18 and 81.5 percent, respectively. No treatment combination involving chemicals closely approached those results.

However, after dry-cold storage, the hydrogen peroxide treatment did substantially improve germination over that for no chemical treatment (64.75 percent versus 25.50 percent). The germination value for this combination was 10. Also, after moist-warm storage, the citric acid treatment induced quicker germination than no treatment, but total germination was slightly less (54.75 percent versus 60.00 percent).

The 100-ppm. gibberellin treatments obviously were much too strong for use on black cherry seed; both treatments with

Table 2.—*Mean numbers of seed that broke dormancy and mean numbers that germinated, by periods and treatments*

| Chemical treatment[1] | Pre-stratification storage condition | Number breaking dormancy,[2] by days in stratification | | | Number germinating,[2] by days in germination flats | | |
|---|---|---|---|---|---|---|---|
| | | 90 | 104 | 118 | 7 | 22 | 40 |
| None | Dry-warm | 5.25 | 36.75 | 69.75 | 50.0 | 81.0 | 81.5 |
| | Dry-cold | .50 | 6.50 | 14.50 | 4.25 | 24.5 | 25.5 |
| | Moist-warm[3] | 12.00 | 25.00 | 52.00 | 23.0 | 58.3 | 60.0 |
| | Moist-cold | 0 | .25 | 1.25 | .25 | 2.25 | 2.5 |
| Hydrogen peroxide (3% solution for 48 hours) | Dry-warm | 2.50 | 12.50 | 43.50 | 15.75 | 46.25 | 46.50 |
| | Dry-cold | 7.00 | 29.25 | 58.00 | 39.00 | 63.50 | 64.75 |
| | Moist-warm | 9.00 | 13.75 | 37.50 | 17.75 | 57.25 | 59.75 |
| | Moist-cold | 2.00 | 4.25 | 6.75 | 1.25 | 9.0 | 10.50 |
| Citric acid (1% solution for 48 hours) | Dry-warm | .50 | 2.50 | 15.25 | 3.50 | 26.50 | 28.00 |
| | Dry-cold | .25 | 2.25 | 10.00 | 3.25 | 25.25 | 25.75 |
| | Moist-warm | 12.75 | 23.00 | 36.50 | 23.50 | 54.00 | 54.75 |
| | Moist-cold | 0 | .25 | 1.00 | .25 | 4.75 | 5.00 |
| Gibberellin (100 ppm soution for 24 hours on 90th day) | Dry-warm | .75 | .75 | .75 | 0 | 0 | 0 |
| | Dry-cold | .50 | .75 | 1.00 | 0 | 0 | 0 |
| | Moist-warm | 3.50 | 5.25 | 6.00 | 0 | 0 | 0 |
| | Moist-cold | 0 | 0 | 0 | 0 | 0 | 0 |

[1] No seeds treated with gibberellin before stratification broke dormancy.

[2] Mean of four replicates of 100 seeds each.

[3] Only three replicates for this treatment.

this solution completely inhibitied germination. However, results in the third study, noted later, indicate that much weaker gibberellin solutions may speed up germinations, although not without reducing total germination somewhat.

### Study III

In contrast to the preceding studies in which fresh seed was used, the third study dealt with seed stored for 15 months before stratification. The seed was part of the 1963 collection used in the second study. Hence, for certain treatments that otherwise were identical in the two studies, the effect of 15 months' storage on rate and total amount of germination could be ascertained by direct comparison.

The cleaned, surface-dry seed was placed in storage in early October 1963 and was removed for chemical treatments and stratification in January 1965. The experimental variables were:

*Three storage regimes.*—Dry-cold 15 months, dry-warm 15 months, and dry-cold 14 months followed by dry-warm 1 month.

*Four stratification periods.*—90, 105, 120, and 140 days.

*Four chemical treatments* (applied just before stratification).—(1) no treatment; (2) soaked 48 hours in 3-percent solution of hydrogen peroxide; (3) soaked 24 hours in 1-percent solution of citric acid; and (4) soaked 8 hours in a 10-ppm. solution of gibberellins.

All combinations of storage regime and stratification period were studied, but the three chemicals were applied only to seeds destined for 90 days' stratification. Hence there were 21 treatment combinations, as shown in table 3. Two replicates of 100 seeds each were assigned to each treatment.

The cold storage and stratification treatments were carried out in a refrigerator at 34°—38° F. The stratification medium was moist peat. Each replicate was stratified in a separate polyethylene bag. Seeds were removed from stratification at the end of the assigned periods and germination was determined in sand flats in a greenhouse. Seedlings were tallied and removed twice a week for 4 weeks, then once a week until no more seedlings

appeared. Ungerminated seeds were examined by cutting to determine whether they were (1) unsound (empty), or (2) sound but still dormant, or (3) originally sound but now rotted.

Analyses of variance run on both the total germination percentages (transformed) and on the germination values showed significant differences due to treatments in both sets of data.

For seed stored 15 months, dry-cold storage for the full period consistently resulted in better germination than the other storage regimes. This is in marked contrast to the results after 3½ months' storage (second study) where germination was highest after dry-warm storage, and was only 25.5 percent after dry-cold storage (table 2). In the present study, the seed stored dry-cold germinated best—74 percent—after 120 days' stratification (table 3). However, this top figure was appreciably below

**Table 3.—*Total percentages and germination values of black cherry seed stored 15 months, by treatments***

| Seed storage | Stratification period | Chemical treatments | Total germination, percent | Germination Value |
|---|---|---|---|---|
| Dry-warm | 90 | None | 10.5 | 0.9 |
| | 105 | " | 22.5 | 2.5 |
| | 120 | " | 25.0 | 2.5 |
| | 140 | " | 17.0 | 1.1 |
| Dry-cold | 90 | $H_2O_2$ | 0 | 0 |
| | 90 | Citric acid | 24.0 | 3.9 |
| | 90 | Gibberellin | 24.0 | 3.6 |
| | 90 | None | 63.0 | 30.6 |
| | 105 | " | 51.0 | 15.7 |
| | 120 | " | 74.0 | 26.3 |
| | 140 | " | 62.5 | 15.5 |
| Dry-cold•plus 30 days warm | 90 | $H_2O_2$ | 61.5 | 28.0 |
| | 90 | Citric acid | 70.5 | 42.1 |
| | 90 | Gibberellin | 57.0 | 22.2 |
| | 90 | None | 52.5 | 19.7 |
| | 105 | " | 53.0 | 8.2 |
| | 120 | " | 50.5 | 12.1 |
| | 140 | " | 44.5 | 6.2 |
| | 90 | $H_2O_2$ | 9.0 | .6 |
| | 90 | Citric acid | 36.5 | 11.0 |
| | 90 | Gibberellin | 38.5 | 11.2 |

the top figure of 81.5 percent recorded for dry-warm storage in the second study, and may reflect some slight deterioration of the seed in storage.

Results in the present study show that dry-warm storage is detrimental when seeds are stored more than 1 year. Only 25 percent germination was obtained after 120 days' stratification; 50 percent or more of the seeds still remained dormant. Some additional treatment—perhaps warm-moist stratification before cold stratification—would be required to get more of the seed to break dormancy.

None of the chemical treatments increased total germination. However, the citric acid treatment did increase the rate of germination, and the total germination for seed stored dry-cold—70.5 percent—was not significantly lower than the top figure of 74 percent for seed given no chemical treatment. The germination value for this citric acid treatment was 42.1—the highest value obtained for any treatment in the three studies. The 10-ppm. gibberellin treatment also speeded up germination but tended to reduce total germination.

More of the seeds treated with chemicals rotted in the germination flats. Rotted or unsound seed among those chemically treated averaged 24.1 percent, as compared with 13.6 percent among those not so treated.

## DISCUSSION

In this section, each of the steps in handling black cherry seed—from seed collection to seed sowing—is treated separately. The discussions are based on both our own experience and relevant information in the literature.

### Seed Collection

Although open-grown, orchard-type black cherry trees produce abundant seed and offer easier opportunities for collecting seed than trees in well-stocked forest stands, collectors should avoid

orchard-type trees for genetic reasons if the seed is to be used to grow trees for timber production. The progeny of forest-grown trees can be expected to be somewhat similar to the parent in form and growth-rate, but there is little basis for judging these characteristics in orchard-type trees.

Most seed collected from standing forest trees has to be done by expert tree climbers. If trees of suitable quality are being cut at the right time on timber sales, seed can easily be collected from the felled trees. The ideal time is just before the fruits are fully ripe. At this stage the fruit clusters will cling to the branches when the tree is felled; later much of the fruit will drop when the tree is felled.

During the ripening season, the fruits at any given time will vary in ripeness from tree to tree, and even on the same tree. Fruit skins may range from green to red to black. When the skins are green, a few seeds should be cut open to see if the embryo fills the seed cavity. If the cavity is not filled (by the embryo), the seed is not ripe enough to pick. The *Woody-Plant Seed Manual* (*20*) states that if the seed coats within the stones are tan to brown, somewhat green fruits can probably be collected safely. When the cherry skin turns red, the embryo is usually mature; and when the skins become black, the fruit starts dropping from the trees. When the fruits have started to fall naturally, they can be collected from standing trees by spreading cloths under the crown and having a climber shake or beat the branches. In heavy seed years, ground cloths can be spread and left under selected trees to catch the natural fall. The catch should be removed frequently—perhaps daily—to minimize losses from rodents.

### Seed Cleaning

The pulp can be removed from the seed more easily if the fruit is spread out in a cool place for a few days for further ripening. The time required will vary with the degree of ripeness of the fruit when picked. Fruits with green-colored flesh seldom become red or black; usually they turn brown, then the pulp starts to dry and soon becomes almost impossible to

remove. When seed is picked in this condition, it should be stratified immediately in peat outdoors over winter with the pulp on. Good germination (86 percent) was obtained with seed handled in this manner (table 1, treatment 7).

In studies at the Eastern Tree Seed Laboratory involving different techniques for removing the pulp from black cherry seeds, Leroy Jones found that soaking the fruits in running tap water for 10 days was detrimental: no seeds germinated. He also found that germination was decreased when water was added to a mass of freshly picked fruit and the pulp was allowed to ferment (*11*).

Large quantities of seed can be cleaned by running the fruits in water through a macerator or hammer mill and floating or skimming off the pulp (*20*). Seeds at the Warren Laboratory have been cleaned by mashing the fruits in a potato ricer while in a small stream or under a stream of tap water. The cherry skins, being lighter than the seeds, will rise and can be floated off with the help of the water current.

### Is Pulp Removal Necessary?

When the pulp is removed from ripe cherry seeds, germination is increased. In seed studies at the Saratoga, New York, nursery, Heit (*5, 6*) found that seeds without pulp germinated better than seeds with pulp. Hough (*8*) also reported that removal of the pulp increased germination; in fact, his seeds sown with pulp intact did not germinate at all.

Patton (*17*) studied several preplanting treatments of black cherry seed at the Wooster, Ohio, nursery. He found that fall-sown seed that was practically free of pulp began germinating earlier and faster than seed that had been sown with the pulp intact, or seed that was mashed free of pulp but not washed, or seed that had been soaking in water to which lye had been added. However, within about a month after the beginning of germination, differences among the test beds had largely disappeared. He concluded that it was unnecessary to treat black cherry seed in any way to get adequate germination, and that the earlier germination gained by cleaning the seed probably

does not justify the labor involved. However, we feel that early germination is desirable because a period of dry weather later in the spring might prevent germination of the tardy seeds.

Kain and McQuesten (*12*) have reported that rosaceous seeds germinate best when freed from the ripe, fleshy parts, washed clean, and dried before storage and subsequent stratification.

In our studies at the Warren Laboratory, cleaned black cherry seed that was kept moist germinated better than moist seed with the pulp left on (given the same stratification treatment). However, when dried 30 days before outdoor stratification, seeds with pulp germinated about as well, or better, than cleaned seed (table 1).

In an exploratory study in 1963, apart from the three studies previously discussed, Cleaned seed and seed with pulp was stored dry in open containers at room temperatures for 10 months, then stratified in sand for 9 months. Germination after this treatment was somewhat better for the seed with pulp (72 percent versus 57 percent).

Hartman and Kester (*4*) report that "the fruit or seed coverings of stone fruits, or the juices from them, contain substances that rather strongly inhibit germination. In nature the decomposition of the seed coverings takes place by various agencies of the environment". Consequently, to obtain good germination of seed that has not had the pulp removed, the seed must be handled by methods that will bring about decomposition of the inhibitory pulp and its juices.

Hartman and Kester suggest a period of warm stratification (68° to 86° F.) before the usual cold stratification. The warmer temperatures favor the micro-organisms that break down the pulpy coverings, whereas the temperatures of 32° to 50° F. needed for after-ripening inhibit micro-organism activity. A constant intermediate temperature near 50° F. may sometimes be effective, because this is within the lower temperature range for micro-organism activity and also is within the upper range for after-ripening. However, the period of time needed would usually be somewhat greater than when warm and cold treatments are used consecutively. In any event, the seeds should never be

allowed to dry out if maximum germination is desired during the first year after seed collection.

### Seed Storage

Storage conditions are an important consideration for black cherry seed that is not to be fall-sown immediately after collection. The main essentials are access to oxygen to promote after-ripening, prevention of heating, prevention of excessive drying, and, for storage periods of 1 year or more, temperature ranges of 33° to 40° F.

Polyethylene bags are useful both for storing and for stratifying seed because this material permits diffusion of oxygen and carbon dioxide between the inside and outside air with only minimal loss of moisture. Polyethylene is light, tough, flexible even when cold, and transparent—seeds in stratification, for instance, can be observed for sprouting without opening the bags. Small to medium-size bags are preferable to larger ones, not only because of easier handling, but, more important, because aeration is better and the likelihood of heating is less when the volume of seed is relatively small. Although we have not determined an optimum size of bag for storing black cherry seed, tests with loblolly pine and slash pine seed provide some guidelines: seed of these species germinated better after storage in 5- and 10-pound bags than after storage in 25-pound bags (*15*).

Black cherry seed should not be permitted to dry out during the period between cleaning and stratification. If the seed is to be stored briefly before placing it in stratification, only the surface moisture should be removed to prevent molding. Shumilina (*19*) found that drying the seeds of sour cherry (*Prunus cerasus* L.) for only 10 days before stratification reduced germination. With each increase in length of drying period there was a further reduction in germination. Shumilina referred to several other Russian reports on sour cherry that, in general, are in accord with his observations of the adverse effects of drying the seed. One of these reports recommended that cherry seeds be sown or stratified only in a fresh condition immediately after picking. Another said that cherry seeds could be dried before sowing or

stratification, but only for a short period. Another said that cherry seeds will not germinate the next spring if stratification is delayed 1½ months.

In our first study at the Warren Laboratory, germination was reduced when cleaned seed was permitted to dry 15 or 30 days at summer temperatures under a roof. Germination for fresh seed stratified in peat immediately after cleaning was 86 percent; when 15 or 30 days' drying preceded stratification, germination was 74 and 31 percent, respectively (table 1). In other experiments, seeds dried 2 months and 3 months at warm temperatures and then sown in field beds germinated very poorly the following spring. Most of these seeds laid over and germinated the second spring.

We have not yet determined the best combination of temperature and moisture content of seed for storage periods of 1 year or more. A long-term storage study started in 1965 is expected eventually to provide a basis for prescribing storage conditions.

We know that fresh, cleaned black cherry seed, after having been spread out about 4 hours at 72° to 78° F. to dry off the surface moisture, will have a moisture content of 20 to 30 percent (based on dry weight). And we know that the moisture content of such seed will decrease in storage unless the seed is sealed in air-tight containers. In one of our experiments, the seed moisture content dropped to 11 percent after 2½ months' storage at room temperature in a large polyethylene bag that had been closed by twisting the top and fastening tightly with a rubber band. Seed from the same batch stored at the same temperature in a screw-capped but not completely sealed glass container had a moisture content of 14 percent after 1 year. In another experiment, surface-dried seed stored in a refrigerator at 33° to 38° F. still retained 30 percent moisture after 6 months in a sealed glass container, but in a paper box the moisture had dropped to 14.5 percent.

First-year results in the long-term storage study point to a seed moisture of 12 to 15 percent and a temperature of 33° to 41° F. as effective conditions for maintaining seed viability.

## Pre-Stratification Treatments

Several chemicals have been used successfuly to overcome seed dormancy and to stimulate seed germination of various conifer and hardwood tree seeds (*1, 3, 10, 14 16, 17, 18*). In studies on black cherry seed at the Eastern Tree Seed Laboratory, Leroy Jones (*11*) found that a 48-hour soak in a 0.1 percent citric acid solution preceding 120 days' stratification increased germination from 57 percent for untreated seed up to 89 percent for treated seed. He reported that a 30-minute soak in sulfuric acid before stratification reduced germination. Hood and LaVoie used the sulfuric acid treatment followed by 120 days of moist-cold stratification at 39° to 41° F. and obtained only 8 percent germination, as compared to 52 percent germination by seeds that were not acid-treated.[1]

However, E. I. Roe treated black cherry seed with sulfuric acid and obtained 76 percent germination versus 64 percent by untreated controls. In his study Roe found that sulfuric acid was harmful to seed that had passed through a captive robin; germination was reduced from 87 percent to 59 percent. He believed these seeds were damaged by the acid because the seed coats had been reduced in thickness or otherwise altered by passage through the bird's digestive tract. As further evidence of seed-coat changes, Roe stated that, after 120 days of cold stratification, the robin-passed seed germinated much better and more rapidly than control seeds.[2] This subject is discussed also in an article by Krefting and Roe (*14*). They found that many kinds of seed, after passage through the digestive tracts of animals or birds, after-ripen in less time and germinate earlier in seedbeds than seeds not subjected to such digestive action.

Several chemicals were tried by Defler[3] to hasten germination. He found that concentrated sulfuric acid was detrimental to germination and that acid-treated seeds were more susceptible to attack by molds. He concluded that stratification in peat moss below frost line for 90 days at about 36° F. induced better germination than any chemical treatment.

[1] Hood, G. A. and K. LaVoie. Personal communication, 1963.
[2] Roe, E. I. Personal communication, 1962.
[3] Defler, Samuel E. BLACK CHERRY: CHARACTERISTICS, GERMINATION, GROWTH, AND YIELD. Thesis, N. Y. State Col. Forestry. 1937.

The usual purpose of acid scarification is to modify hard or impermeable seed coverings (*4*). Black cherry seed coats are not impermeable because the micropyle is open, thus permitting air and moisture to reach the embryo during after-ripening and germination. However, the seed coats are relatively hard, and their physical resistance to expansion of the embryo may vary considerably with method of seed storage. Defler[3] observed that seeds stored under moist conditions split readily, whereas seeds stored air-dry exhibited much resistance to pressure before cracking.

The chemical seed treatments tried at the Warren Laboratory, and reported in this publication, did not stimulate seed germination enough to warrant their use. Seed that was properly handled and stored germinated better without treatment than with any of the chemical treatments.

### Seed Stratification

The period of stratification needed to prepare black cherry seed for germination varies with the age of the seed and its environment from the time of collection. Fresh seed will need less stratification to break dormancy than seed that has been stored a year or longer. Cleaned seed will need less stratification than seed with pulp.

Dale E. Kester (*13*) discussed the environmental influences of water, aeration, and temperature on stratification of Mahaleb and Mazzard cherry seed. After-ripening does not take place in a dry seed. After-ripening requires air—presumably oxygen—and cool temperatures: from 32° F. or slightly below to around 55° or 60° F. It ceases and, in some cases is reversed, at higher temperatures. Stone fruits properly stratified and then sown when unseasonably high temperatures prevail may fail to germinate the first year; instead, they may lay over and germinate the following year. Kester says that length of time required for stratification is closely related to temperature. The shortest time is required at optimum temperatures. As the temperature deviates from optimum, the stratification requirements become longer and longer.

The proper soil environment for stratification of seeds was studied by Shumilina (*19*). He used sand, humus, and peat as stratification media for sour cherry seed (*Prunus cerasus* L.) and found that peat provided the most favorable combination of moisture and aeration. He determined the field capacity and maximum capillary capacity of these media for water. The field capacity was 24 percent for forest sand, 169 percent for humus, and 322 percent for peat. Sixty percent of field capacity was considered the optimum moisture condition. The distribution of moisture was more nearly uniform in peat. Shumilina found that aeration in peat was twice as high as in sand. He states that Krocker and Belokhonov also concluded that peat was the best stratification medium, and further, that Krocker had shown the excessive acidity of peat to have no adverse effect on the seeds. In his study with sour cherry seeds, Shumilina obtained 85 percent germination with peat stratification, 64 percent with humus, and 65 percent with sand.

Shumilina found that fresh cherry seeds could be prepared for spring sowing by stratification in trenches immediately after harvest. Thus the seeds would have 4 to 5 months' time to be prepared for germination before freezing of the trench. Dried seeds require more time and therefore should be stratified in "warm trenches"—trenches covered with enough straw and snow to protect the seed from freezing during the winter.

Defler[3] reported that black cherry seed stratified in peat moss at 40° F. from time of cleaning until spring sowing produced about four times as much germination as cleaned seed sown immediately in the fall. Height growth after one season also was greater for the spring-sown seed.

In our black cherry seed studies at the Warren Laboratory, we found that uncleaned seed stratified immediately after collection needed a warm period of 3 to 4 months to decompose the pulp and bring about certain essential internal changes before beginning the 120-day cold stratification. Also, cleaned seed that was to be sown the next spring after collection, needed a period of warm storage before cold stratification. As shown in our second study, seed held in cold storage before stratification ger-

minated poorly (table 2). Yet, when seed was stored dry-cold 15 months and then stratified 120 days, 74 percent germinated (table 3). Obviously the internal changes that prepare the seed for germination proceed much more slowly at 34° to 38° than at room temperature.

A method of stratification that has given satisfactory results for us is refrigerator stratification in peat in small polyethylene bags. About four times as much peat as seed, by volume, was used in our experiments. The peat was left in water overnight; then the free water was drained off and the seed was mixed with the wet peat. Outdoor stratification in peat or sand in shallow wooden frames with screen tops and bottoms, as described under the first study, also gave good results. Peat was somewhat the better of the two media in our outdoor experiments (table 1).

### Seed Germination

Black cherry seed has a hard seed coat. Water can penetrate the seed coat through a single micropylar channel that starts at the point of attachment of the stone to the fruit stalk and opens near the radicle of the embryo (*19*). Hough states that germination does not depend on the partial decomposition of the bony seed coat by soil organisms, or by passing through birds, or upon splitting of the seed coat by frost. Before germination will take place, the seed requires a period of after-ripening that, under natural conditions, occurs over winter in the forest floor (9).

At the time of germination in the spring, the embryo swells and splits the shell of the stone into two halves. The radicle emerges and may grow an inch or two in length while temperatures are still below 40° F. Plumule growth does not usually occur at these temperatures.

In our second study, seeds that had been stored moist-warm began breaking dormancy after about 90 days in stratification, and after 120 days many of the radicles were ½ inch or more long. In the first study, seeds stratified in peat in the refrigerator similarly broke dormancy after about 120 days and began radicle growth. Seeds with a protruding radicle of ½ inch or more are

hard to handle for sowing because the radicles are easily broken. A broken radicle often results in failure of the little plant to survive, even though a plumule may appear.

Some surplus seed from the first study was left in the refrigerator for about a year after it began to break dormancy. The radicles continued to grow slowly during this time, attaining lengths of 1.5 inches or more, but plumule growth was evident in only a few seeds and then did not exceed 1/4 inch. When these held-over seeds were sown in sand flats in a cool greenhouse (44° to 60° F.) the plumules began to grow and developed in a normal manner. Some seedlings were 10 inches tall in May and up to 20 inches by mid-June.

Under natural conditions cherry seeds drop to the forest floor in late summer and are covered later by the annual leaf fall. Germination begins in late March, and occasionally earlier, in northwest Pennsylvania. On one occasion we found seeds sprouting under a 34-inch snow cover on March 8. Mean daily temperature for the preceding February had been 13° F., and −30° F. was recorded on February 27. However, the forest floor under the snow was not frozen. The radicle of germinating black cherry seeds easily penetrates the duff and soil of the forest floor, and numerous seedlings become established in the vicinity of seed trees after good seed years.

### Fall Sowing

Fresh black cherry seed may be fall-sown where there is no rodent problem. This eliminates the storage and stratification handling that is necessary for spring sowing. Seed that has not been cleaned of pulp should be sown as soon as possible after collection to assure a period in moist soil at moderate temperatures long enough for the pulp to completely decompose. The winter period in the soil will then satisfy the chilling requirement. Heit (7) found that if fall sowing is delayed beyond October 15, reduced germination will result. Seed with pulp that has been stored dry for a year or more probably should be sown or stratified by late summer because decomposition of the dried pulp will take longer than with fresh fruit.

In studies at the Saratoga nursery, Heit (6) found that black cherry seed sown by September 20 gave considerably better germination than that sown October 23. Cleaned seed germinated better than seed with pulp. Seed with pulp, sown October 23, did not germinate the following spring in beds that were not mulched to prevent freezing. Mulching increased germination in both early and late sowing.

## RECOMMENDATIONS

Fresh seed that is to be sown the following spring should have the pulp removed, be surface-dried,[4] and then be stored in sealed polyethylene bags at room temperature until stratified. The seed should be stratified at 32° to 38° F. for 120 days before the planned sowing date. Peat is recommended as the stratification medium.

If removal of the pulp is not feasible, the seed should be stratified in moist peat or sand at 68° to 78° F. during September, October, and November, and then it should be stratified cold for 120 days before spring sowing.

If seed with pulp is to be fall-sown, the sowing should be done no later than October 15, and the beds should be mulched to prevent freezing.

When seed is to be held in storage for a year or more, it should first be cleaned of pulp and surface-dried,[4] then placed in small polyethylene bags sealed to prevent excessive drying, and stored at 32° to 38° F.

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[4] Time required for surface drying varies; it might require only a few hours in a heated room, or it might take a day or two under less favorable drying conditions.

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