

United States Forest Service. However in many areas it is outdated. The California Division of Forestry each year prepares a list of commercial seed dealers of plants native to California. This list is available from either the office of the State Forester, State Office Building No. 1, Sacramento, or the Davis Forest Nursery, California Division of Forestry, Route 1, Box 1410, Davis, California.

MODERATOR BATCHELLER: Thank you, Mr. Eden. We will now hear from our last speaker this evening, Mr. Dara Emery, who will discuss seed propagation of some of the native California plants. Mr. Emery.

SEED CULTURE OF CALIFORNIA NATIVE PLANTS

DARA E. EMERY

*Santa Barbara Botanic Garden
Santa Barbara, California*

This is a discussion of problems likely to be encountered in the seed propagation of California species of *Ceanothus*, *Fremontia*, and *Rhus*. Seed dormancy of one or more types is common to all these species. When the hot water treatment is used to break the seed coat dormancy, the seeds are added to about four times their volume of water at a temperature of 180° to 190° F., left to cool for 12 to 24 hours, and then sown before drying. Depending on the quality of the local tap water with its additives such as chlorine, iodine or fluorine, significantly better results may be obtained with the hot water treatment by using bottled drinking water, distilled water or rain water, and their use is recommended. The concentrated sulfuric acid treatment may also be used on hard seed. In this treatment it is important that the seeds be thoroughly and repeatedly washed in running water immediately following the prescribed soaking period in order to remove all the excess acid which may still be present in the charred part of the seed coats. For the type of internal dormancy that is sometimes present in seed of these species, the seeds should be put in a tightly sealed polyethylene bag with a small amount of moist peatmoss, placed in a refrigerator at a temperature of 35° to 41° F. for the prescribed period and then sown.

Ceanothus and *Fremontia* seedlings are particularly susceptible to damping-off, and it is extremely important that all soil mixes be sterilized and clean or sanitary cultural practices, such as those presented in the University of California Extension Service's Manual #23 on the U.C. System, be followed. No special soil mixes are required for these species but a very well-drained mix is desirable. The sequence in containers is from seed flat to liners to gallon cans. In some cases the seed flat is omitted and the seed is sown directly into liners.

Ceanothus Species, California Wild Lilac.

The seeds of most California species of *Ceanothus* are long-lived. Seeds ranging in age from seven to sixteen years have given good

results in germination tests at the Botanic Garden. Regardless of age, *Ceanothus* seed is quite variable as to the percentage of viable seed. Some species are also variable as to the presence or absence of internal dormancy. Seeds of nearly all the species have hard or impermeable seed coats which can be softened with the hot water treatment. Internal dormancy, when present, is of the type that is broken by cold stratification. See the accompanying chart for specific seed treatment recommendations.

Pre-treated seed starts to germinate in one to five weeks (average two and one half weeks) depending on the species. Eighty or ninety percent germination is not unusual.

Ceanothus seedlings are very subject to damping-off, and this is the most important single problem encountered in seed propagation of this genus. Seedlings seem to suffer less shock when spotted-off at the four- to six-leaf stage than at the two-leaf stage, even though this entails more root damage and often root pruning. Many species are very rapid growing and the use of some type of peat pots is recommended for liners to prevent coiled root systems. Rather severe losses among liners may be experienced two to four weeks after spotting-off, especially if the weather turns cool or if the plants are not kept on the dry side. Spotting-off losses can be avoided by sowing the seed in small peat pots at the rate of one or two seeds per pot.

In summer, during occasional hot spells, losses may occur among gallon can plants that are grown in full sun, even though they are kept adequately moist. Growing the plants under light shade helps to reduce this loss. Another loss may occur among container plants in the fall when summer temperatures drop. This is especially true when they are ready, or nearly ready, to plant out and are grown in full sun. Light shade also helps to reduce this loss.

A fungus disease that is a constant threat to *Ceanothus* of all ages is caused by a species of *Phoma*. This disease, common in the chaparral of certain areas, is spread by air-borne spores which require warmth and moisture to germinate. The disease is therefore most acute during spring and summer, in areas with lots of fog or early-morning dew. The first symptom of this non-systemic disease on container plants is usually the appearance of scattered necrotic leaves which do not drop. It may never go beyond this stage. However, infections that develop on the trunk near the soil-level soon girdle and kill the plant. The control is a preventive spray of parzate or fermate, two pounds per 100 gallons of water plus a little spreader, applied every seven to ten days. Among the *Ceanothus* species and hybrids growing in the Santa Barbara Botanic Garden, *Ceanothus griseus* and its clonal forms seem particularly susceptible to this disease, and the alternate-leaved *Ceanothus*, which are the most popular in cultivation, seem to be more susceptible than the opposite-leaved types.

Recommended Seed Treatment for *Ceanothus* Species

<i>Ceanothus arboreus</i> (Catalina <i>Ceanothus</i>)	Hot water. Two months stratification may further improve germination.
---	---

<i>Ceanothus cordulatus</i> (Hoaryleaf Ceanothus; Whitethorn)	Hot water and 3½ months stratification
<i>Ceanothus crassifolius</i> (Hoaryleaf Ceanothus)	Hot water. Three months stratification may further improve germination.
<i>Ceanothus cuneatus</i> (Buckbrush)	Hot water.
<i>Ceanothus cyaneus</i> (San Diego Ceanothus)	Hot water. Three months stratification may further improve germination.
<i>Ceanothus dentatus</i> (Cropleaf Ceanothus)	Hot water and 3 months stratification.
<i>Ceanothus divaricatus</i> (Whitebark Ceanothus)	ditto
<i>Ceanothus diversifolius</i> (Trailing Ceanothus)	ditto
<i>Ceanothus foliosus</i> (Wavyleaf Ceanothus)	Hot water. Three months stratification may further improve germination.
<i>Ceanothus fresnensis</i> (Fresno Mat)	Three months stratification.
<i>Ceanothus greggii</i> var. perplexans (Cupleaf Ceanothus)	Hot water and 3 months stratification.
<i>Ceanothus griseus</i> (Carmel Ceanothus)	Boil in water 1 minute, then cool immedi- ately to room temperature.
<i>Ceanothus impressus</i> (Santa Barbara Ceanothus)	Hot water and 3 months stratification.
<i>Ceanothus incanus</i> (Coast Whitethorn)	Hot water and 2 to 3 months stratification.
<i>Ceanothus integerrimus</i> (Deerbrush)	Hot water and 3 months stratification.
<i>Ceanothus jepsonii</i> (Jepson Ceanothus)	Hot water.
<i>Ceanothus lemmonii</i> (Lemmon Ceanothus)	Hot water and 3 months stratification.
<i>Ceanothus leucodermis</i> (Chaparral Whitehorn)	ditto
<i>Ceanothus megacarpus</i> (Bigpod Ceanothus)	Hot water.
<i>Ceanothus oliganthus</i> (Hairy Ceanothus)	Hot water. Three months stratification may further improve germination.
<i>Ceanothus palmeri</i> (Palmer Ceanothus)	Hot water and 3 months stratification.
<i>Ceanothus papillosus</i> (Wartleaf Ceanothus)	ditto
<i>Ceanothus papillosus</i> var. roweanus (Rowe Ceanothus)	ditto
<i>Ceanothus parryi</i> (Parry Ceanothus)	ditto

<i>Ceanothus parvifolius</i> (Littleleaf Ceanothus)	ditto
<i>Ceanothus prostratus</i> (Squaw carpet)	ditto
<i>Ceanothus purpureus</i> (Hollyleaf Ceanothus)	Hot water and 2 to 3 months stratification.
<i>Ceanothus ramulosus</i> var. <i>fascicularis</i> (Coast Ceanothus)	Hot water. Three months stratification may further improve germination.
<i>Ceanothus rigidus</i> & var. <i>alba</i> (Monterey Ceanothus)	Hot water.
<i>Ceanothus sorediatus</i> (Jim Brush)	Hot water. Three months stratification may further improve germination.
<i>Ceanothus spinosus</i> (Greenbark Ceanothus)	ditto
<i>Ceanothus thyrsiflorus</i> (Blue Blossom)	Hot water.
<i>Ceanothus tomentosus</i> var. <i>olivaceus</i> (Woollyleaf Ceanothus)	Hot water. Two to 3 months stratification may further improve germination.
<i>Ceanothus velutinus</i> (Tobacco Brush)	Hot water and 3 months stratification.
<i>Ceanothus verrucosus</i> (Wartystem Ceanothus)	Hot water. Three months stratification may further improve germination.

Fremontia Mexicana, Southern Fremontia and
F. Californica, Flannel Bush.

The problems most apt to occur in seed propagation of *Fremontia mexicana* and *F. californica* are seed dormancy, spotting-off losses, and damping-off of gallon can stock in the early fall. The seeds of both species have hard or impermeable seed coats which yield to the hot water treatment. Pre-treated seeds of *F. mexicana* start to germinate about two weeks after sowing. *F. californica* seeds may also have internal dormancy which can be broken by 30 to 60 days of cold stratification. This seed, pre-treated for hard seed coat but not for possible internal dormancy, starts to germinate six to seven weeks after sowing, and germination may be sporadic. Total germination of 65 to 100 percent may be expected for both species. The easiest way to avoid possible spotting-off losses is to sow the seeds singly in 2¼" or 3" peat pots. Using a sterilized, well-drained soil mix, following clean cultural practices, keeping the plants on the dry side, and growing gallon stock in light shade helps to avoid possible root rot losses as the weather turns cool in the fall.

Rhus integrifolia, Lemonade Berry and *R. ovata*, Sugar Bush.

Seed dormancy is a problem in *Rhus ovata* and *R. integrifolia*. Both species have tough, impermeable seed coats. This dormancy condition may yield satisfactorily to the hot water treatment, but at the Santa Barbara Botanic Garden the sulfuric acid treatment is preferred. *R. ovata* seed requires soaking in concentrated sulfuric acid

for a period of one to several hours. One germination test on freshly-collected garden seed using replicates of 100 seeds each and soaking periods of 1, 2, 3 and 4 hours gave total germination of 35%, 62%, 60% and 24% respectively, with the first germination occurring in eight days on all replicates. In another case, using one-year-old garden seed, 250 seeds soaked 3½ hours gave a total germination of 67%.

Rhus integrifolia seed requires soaking in concentrated sulfuric acid for four hours or longer, depending on the age of the seed. No germination test, such as was made on *R. ovata* seed, has been made on this species at the Garden, and our germination results over the past five years as seen below have not been consistent.

Botanic Garden seed - Year collected —	Date Sown	Treatment period in Conc. Sulfuric Acid	Total germination	Days before first germination
1957	July, 1958	5 hrs.	40%	14
" (same seed lot)	Feb., 1962	4 hrs.	72%	11
1959	June, 1959	4 hrs.	81%	9
" (Same seed lot)	Sept. 3, 1960	4 hrs.	34%	9
" (Same seed lot)	Sept. 24, 1960	5 hrs.	12%	12

To obtain optimum germination with any particular lot of seed, a germination test similar to that mentioned above for *R. ovata* is suggested.

Spotting-off for both species is best done at the two plus leaf stage, and even then the tap roots may be four to six inches long or more. Root pruning does not seem to be detrimental to the seedlings.