

GUIDELINES FOR SUCCESSFUL SEED STORAGE

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SHORT SUMMARY OF THE STEPS:

1. Determine whether the seeds can be stored. (Not all seeds can be stored successfully.)
2. Collect healthy, ripe seeds.
3. Separate and clean the seeds.
- 4a. Dry the seeds to the correct moisture level for storage.
- 4b. Meanwhile, germinate some of the seeds to make sure that they are good.
5. Pack the seeds for storage.
6. Store the seeds.
7. If you store the seeds for a long time, germinate a sample from time to time to make sure that they are still good.
8. Prepare the seeds for sowing: Seeds stored very dry need preparation before sowing.
9. Sow the seeds.

While going through all of these steps, keep good records.

Each step is described in more detail below. These instructions are for “orthodox” seeds. “Intermediate” and “recalcitrant seeds” require different measures. See the next paragraph.

1. DETERMINE WHETHER THE SEEDS CAN BE STORED

Not all seeds can be stored. If you are uncertain, try looking in the Royal Botanic Garden-Kew Seed Information Data Base (SID). First, find the scientific name of the plant. Then, connect to the Internet and go to:

<http://data.kew.org/sid>

Find the SID storage classification for your seeds. If the seeds are “orthodox”, you should be able to store the seeds for years by drying it as described below, then storing them refrigerated or frozen in airtight containers. If the seeds are “intermediate”, storage is trickier. You might be able to store them refrigerated. For advice, contact Alvin Yoshinaga at tel. # (808) 988-0469, fax

-0462, or e-mail, alviny@hawaii.edu. If the seeds are “recalcitrant”, it is not practical to store them for more than a short time. It is best to germinate them soon after collection.

If you cannot find the seeds in the SID, you may be able to guess whether the seeds can be stored. Small seeds that dry on the parent plant are usually “orthodox”. Large seeds that are moist when ripe (like mangos) are almost always “recalcitrant.”

2. COLLECT RIPE, HEALTHY SEEDS

Collect healthy, ripe seeds. Unripe seeds will not store well. Seeds are usually ripe when fruits are fully ripe or starting to dry. Ripe orthodox seeds are typically firm and dry, and are often darker than unripe seeds. (Some seeds may require additional ripening after collection.) Remember, viable seeds are alive. After collection, treat them like fresh produce. Keep them in a cool, ventilated place (if you keep them in plastic bags, leave the top unsealed so that the seeds/fruits can breathe). To prevent mold, they should not be wet. Try to process them as soon as practical after collection.

3. SEPARATE AND CLEAN THE SEEDS

If you process the seeds wet, air-dry them. Do not use heat to speed drying, as this will shorten storage life. Use moving air instead.

4a. DRY THE SEEDS TO THE CORRECT MOISTURE LEVEL FOR STORAGE

Under warm, humid conditions in Hawai'i, most stored seeds deteriorate rapidly. Air drying will not dry them enough for good storage life. For hints on how to dry seeds, see DRYING SEEDS FOR STORAGE below.

4b. MEANWHILE, GERMINATE SOME OF THE SEEDS

This is to make sure that the seeds are really viable. You may need to use special treatments to break dormancy. Seeds of some plants need a period of after harvest ripening before they will germinate. Ask other growers for advice.

5. PACK THE SEEDS FOR STORAGE

After you dry the seeds, you need to pack them in airtight containers. Otherwise, the seeds will absorb moisture from the air and undo the results of step 4a.

Many containers are not as airtight as you might think. For airtight storage, we recommend using containers with rubber gaskets. If you have many small containers of seeds, you can put the small containers into larger gasketed containers. (Exception: If you use a self defrosting refrigerator for both drying and storing the seeds, airtightness does not matter so much. See DRYING SEEDS FOR STORAGE below.) Note: If you are going to store the seeds for more than a few years, consider getting archival labels, or enclosing a piece of paper with the label in-

formation written in pencil inside the storage container. Ordinary stationery store labels may become brittle and fall off after a few years.

6. STORE THE SEEDS

Seeds of most garden and crop plants store best when dried and kept at low temperatures. In most national seed banks, the preferred method for long-term storage is freezing to near 0° F, which is the temperature in a home freezer or in the freezing compartment of a home refrigerator. For year to year storage, many store the seeds near 39° F, the temperature inside a home refrigerator. In developing countries, dried seeds are often stored at room temperature inside airtight containers, but cold storage is better if available.

If the freezer or refrigerator fails, it is not a disaster. Changing temperatures during storage will not harm the seeds, but when they are warm, they will age much faster than when they are cold. When the temperature drops, they will go back to aging slowly.

Our recommendations for storage conditions, once the seeds have been dried:

First choice: Freezing.

Second choice: Refrigeration. (Seeds of some wild plants store better refrigerated than frozen, but this is uncommon for cultivated plants.)

Third choice: Room temperature after proper drying, in airtight containers.

7. GERMINATE A SAMPLE FROM TIME TO TIME

If you store the seeds for more than a few years, you may want to take out some to test from time to time. Even under good storage conditions, seeds will eventually deteriorate. When the first signs of reduced germination appear, it is time to replenish the seed supply.

8. PREPARE THE SEEDS FOR SOWING

Seeds that have been dried for storage may become damaged if they absorb water too fast. This will lead to poor germination or unhealthy seedlings. To prevent this, allow the stored seeds to pick up moisture from the air slowly before sowing them. You can do this by putting them in a sealed plastic container with a damp paper towel for a day. (Do not let the damp towel contact the seeds.) In Hawai'i, we can just expose them to open air for a couple of days.

Note: If you have stored the seeds in a freezer or refrigerator, allow them to come to room temperature before opening the storage container. Otherwise, moisture will condense on the seeds. If you do not use all of the seeds, reseal the container immediately. You do not have to redry the remaining seeds unless the volume of air in the container is much greater (>100x) the volume of seeds.

9. SOW THE SEEDS

You can now sow the seeds normally.

DRYING SEEDS FOR STORAGE

For a home gardener who wants to store seeds on a small scale, we can suggest several simple methods:

1. Royal Botanic Gardens-Kew Mini Seed Bank

RBG-Kew in England produces an elegantly simple small seed bank intended for home users. It includes everything that you need, with instructions. The Mini Seed Bank's processing capacity is small, but you can easily triple its capacity with an expansion unit made from readily available materials. (If you want to expand it, we can send you instructions.) It is designed as a learning tool as well, so it may be worth considering for its educational value. You can see it at:

<http://shop.kew.org/kew-mini-seed-bank.html>

The main disadvantage of the RBG-Kew Mini Seed Bank is price. With the current weak U. S. \$, the price of UK £24.99 + air shipping comes to around \$60+/unit.

2. Drying in a Self-Defrosting (No-Frost) Home Refrigerator

This is an easy method if you have a self-defrosting refrigerator – if ice does not build up in your refrigerator, you probably have one. The self-defrosting unit naturally keeps the air inside the refrigerator dry. You can make use of this to dry seeds by using the following procedure:

Spread the seeds in a thin layer (1 seed deep is ideal, if possible) in a container with an airtight lid, but leave the lid off. Place the container into the refrigerator and leave it there for a month or so for the seeds to dry. (Large seeds with thick, hard coats such as beans may take longer.) When you are ready to store the seeds, open the door of the refrigerator and immediately put the lid on the container so that moisture does not condense on the seeds. Take the container out from the refrigerator and let it come to room temperature before opening it. Once it has come to room temperature, you can open it and pack the seeds for storage. Alternatively, you can just store the seeds inside the refrigerator in open storage, but this will take up more space.

3. Room Temperature Drying in Plastic Containers

If you do not have space inside of the refrigerator, you can dry seeds inside of airtight plastic containers. Spread the seeds into a shallow container in a thin layer (1 seed deep is ideal, if possible), then put the container into an airtight plastic container with drying agent. For seeds to be stored at room temperature, we recommend using silica gel as the drying agent. See the note below about sources of silica gel. For seeds to be refrigerated or frozen, we recommend calcium chloride, sold at Long's Drugstore and hardware stores under the brand name "Damp Rid". Mix

the calcium chloride with a little water until it is the texture of soggy shaved ice (it will get hot when you add the water). Fill a cup about ½ way with the slurry and put the cup into the airtight container. Do not let the slurry touch the seeds. The calcium chloride will remove moisture from the air inside the container.

Store the remaining calcium chloride in an airtight container – if you expose it to air, it will pick up water and dissolve. You can recharge the calcium chloride slurry to use again by heating it in a glass container until most of the water is driven off. You can dispose of the used calcium chloride solution by pouring it down the drain. Calcium chloride is not poisonous (it is an ingredient of canned tomatoes), but will corrode metals and cause skin irritation.

Whether you use silica gel or calcium chloride, place the drying container in a cool place, away from the sun. Check the container from time to time to see whether the silica gel or calcium chloride needs replenishing. If the silica gel becomes saturated, replace it with fresh silica gel. If the calcium chloride dissolves completely, add some more crystals, or recharge as described in the previous paragraph. Allow the seeds to dry for about a month (longer for large seeds with thick, hard coats), then pack them for storage.

Notes on Silica Gel

Silica gel for seed drying is available from various sources. Locally, it is sometimes available in craft stores, where it is sold for drying flowers. It can also be purchased from companies that sell archival storage products, scientific supplies, or from Southern Exposure Seed Exchange (see Item #1 below). For small quantities of seeds, the Eva-Dry Mini-dehumidifier is a convenient device with a built-in electric drier to recharge the silica gel. It is available locally from Longs Drugs for around \$20. For more information, see <http://www.eva-dry.com/E333.pdf>.

While silica gel itself is inert, some forms raise safety issues. The main concern is over indicator silica gel that uses blue/pink cobalt chloride as a moisture indicator. Cobalt chloride is under investigation as a potential carcinogen when inhaled over long periods. This is most likely to be a problem with the fine dusty forms of silica gel sold for flower drying. In bead forms of indicator silica gel, the cobalt chloride is tightly bound to the beads. An alternative is to use plain silica gel, and use a hygrometer to show when it needs recharging, or to use other indicators. Silica gel is also manufactured using non-toxic yellow iron or methyl violet-based indicators. These are harder to find.

After silica gel has absorbed moisture, it can be redried for use again by baking or microwaving. For instructions, www.southernexposure.com/library/drying-seed-silica-gel.html.

Other Drying Agents

Charcoal, powdered milk, and rice are effective drying agents when baked. None are as efficient as silica gel, so larger quantities are necessary. If you use these, you can get inexpensive humidity indicators from www.gaylord.com as Standard Humidity Card, item # 62031.

TECHNICAL NOTES ON SEED DRYING

Operators of central seed banks and others who need to maximize seed storage life can improve seed longevity by controlling the moisture level of the stored seeds. Current theory suggests that seed storage life is maximized by drying seeds so that they are in equilibrium with 20% relative humidity at storage temperature. On the Gaylord humidity card, this is when the topmost block is in a transition from pink to blue. If you dry the seeds at one temperature, but store them at a different temperature, some adjustment needs to be made:

Drying temperature	Storage temperature		
	25°C/77°F (room)	5°C/41°F (refrigerator)	-18°C/0°F° (freezer)
25°C/77°F (room temperature)	20%	33%	46%
5°C/41°F (refrigerator)	14%	20%	32%

At 32-33% relative humidity, the top block of the Gaylord humidity card is pink, and the second block is in transition from pink to blue. At 46% relative humidity, the top two blocks are pink and the third is in transition.

The relative humidity of the air inside a typical self-defrosting refrigerator in Hawai`i is about 20% if no moist items are kept inside, about 30% if there are moist items. The relative humidity inside the freezer is much higher.

WHERE TO FIND MORE INFORMATION:

1. General Information for Heirloom Seed Savers

For guidance on how to produce and harvest seeds from many common, and some not so common, vegetables and herbs, see the book by Suzanne Ashworth, *SEED TO SEED: Saving Our Vegetable Heritage*. (\$24.95 + shipping from the seed catalogs listed below.) The instructions for seed storage, though sound, are outdated.

For information about conservation of heirloom plants and landraces, consult the following sources:

In 1994, John de Graaf and Vivian Boe produced the 50 minute program *THE GENETIC TIME BOMB* for Oregon Public Broadcasting. It is available on video from several sources. See http://www.goenc.com/records/record_generator.asp?encnum=006234 or <http://store.videoproject.com/gen-191-v.html>. While the overall subject is erosion of genetic resources in crops, there is extensive coverage of heirloom plant conservation.

There are national organizations of people who actively maintain heirloom plants. For crop plants, there is Seed Savers Exchange, tel. # (563) 382-5990, web site, www.seedsavers.org.

For horticultural plants, Flower and Herb Exchange uses the same contact information, although it is an independent organization. Both are at 3076 N. Winn Rd., Decorah, IA 52101.

Private nurseries specializing in heirloom plants are becoming more common. One example is Seeds of Change, P. O. Box 15700, Santa Fe, NM 87592-1500, www.seedsofchange.com, tel. # (888) 762-7333, e-mail, gardener@seedsofchange.com. Another is Southern Exposure Seed Exchange, P. O. Box 460, Mineral, VA 23117, www.southernexposure.com, tel. # (540) 894-9480, e-mail, gardens@southernexposure.com.

For an example of a regional landrace conservation program in the Southwest, see the SEARCH website at www.nativeseeds.org. There are links to other heirloom plant web sites. One organizer of the SEARCH program, Gary Nabhan, published a book in 2004, WHY SOME LIKE IT HOT, that has a chapter about the effects of post-European contact diet on native Hawaiian health.

In 1998, Suzanne DeMuth of United States Department of Agriculture produced a 3 volume GUIDE TO HEIRLOOM VARIETIES. An on-line edition is available to view at: www.nal.usda.gov/afsic/AFSIC_pubs/heirloom/heirloom.htm. There is also a print edition. This fine handbook on heirloom varieties contains extensive contact information for sources of propagation material and organizations that promote heirloom varieties.

2. A Seed Storage Web Site with Links to Other Sites

The Hawai'i Conservation Alliance maintains a seed storage manual for native Hawaiian plants at <http://www.hawaiiconservation.org/conservationresources.asp>. While the manual is intended for seeds of native plants, it applies to seeds of cultivated plants as well. There are links to other web sites.

3. Seed Conservation Laboratory Contact Information

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