College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

Soil and Crop Management
October 2014
SCM-32

Saving Seed

Sharon A. Motomura[1], Theodore J. K. Radovich[2], & Russell T. Nagata[1]
Komohana Research & Extension Center[1], Department of Tropical Plant and Soil Sciences[2]

Farmers and gardeners have saved their own fruit and vegetable seed for millennia. Saving seed from desirable plants is a fundamental act of agriculture and has resulted in thousands of the fruit and vegetable varieties we have today. Seed-saving takes time and other resources away from growing crops, and most commercial farmers prefer to purchase seed from companies that specialize in producing it. Still, many farmers and gardeners will save at least some of their own seed to select and preserve well-adapted varieties that may not be available in the commercial market. Several vegetable varieties selected and saved by Hawai'i farmers are available from the University of Hawai'i Seed Program (Figure 1). This article highlights key points to be aware of when saving seed in order to produce high-quality seeds and to retain variety characteristics. For more details regarding seed-saving, please see the resources at the end of this article.

Figure 1. Organic seed production at the CTAHR Waimanalo Research Station. Foreground: 'Kewalo' tomato and 'Koba' green onion. Background: 'Hirayama' mustard cabbage.

Pollination

Seeds in nearly all cases involve the sexual union of the ovule, located within ovary, and the pollen, in a process called pollination. Understanding the basics of pollination biology of plants is an important part of seed-saving. There are two general modes of pollination: cross-pollination and self-pollination (Table 1). Plants that are cross-pollinated receive pollen from different flowers. Cross-pollination can occur randomly, as is the case of wind-directed pollen, or by targeted means such as insects, birds, and mammals. Cross-pollination increases the genetic diversity of a population, which increases the potential for adaption of the variety to future changes in the environment. Many vegetable crops naturally cross-pollinate, including sweet corn, pumpkins, and cucumbers. Different mechanisms have evolved to maximize the chance of cross-pollination. For example, male and female parts may be on separate flowers, as they are in corn and cucumber (Figure 2), or even on separate plants (papaya and asparagus). In flowers with male and female parts, pollen shed may occur before or after the stigma is

Published by the College of Tropical Agriculture and Human Resources (CTAHR) and issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, under the Director/Dean, Cooperative Extension Service/CTAHR, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822.

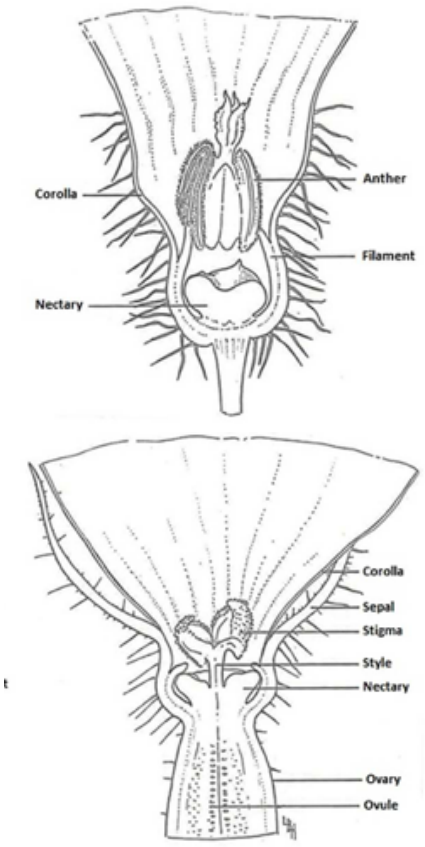

Figure 2. Longitudinal sections of cucumber flowers: male flower (top); female flower (above). Adapted from ARS (1976).

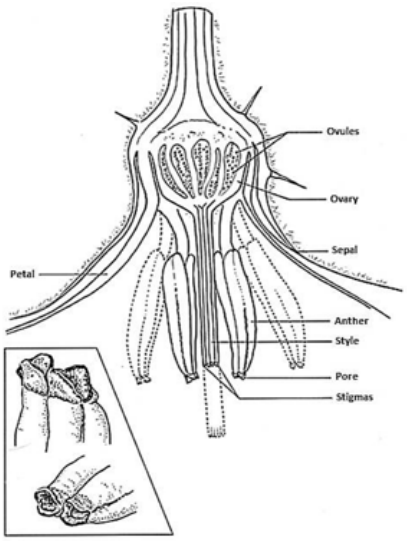

Figure 3. Longitudinal section of eggplant flower. Dotted areas indicate variation in length of style and position of stamens. Inset shows pores of anther tubes enlarged. From ARS (1976).

receptive (avocado) or the style may be protrude beyond the anthers (runner beans), increasing the potential for insect-mediated cross-pollination (Figure 3). Another mechanism for cross-pollination is self-incompatibility, where the pollen from the same plant or mating type will fail to pollinate itself due to physiological–chemical interaction (cabbage and radish).

When saving seed from cross-pollinating varieties there are several important things to keep in mind. Remove (rogue) off-types from the population before pollination occurs if at all possible to prevent the perpetuation of these types. Isolate varieties of the same crop from each other. Isolation can be done by means of distance, by means of time (by planting varieties so they flower at different times), or by bagging flowers and hand-pollinating if necessary (Figure 4). Save seed from as many individuals as possible. The minimum number of individuals recommended for most cross-pollinating species is 80, although seed from as many as 200 individuals is recommended for corn to minimize inbreeding.

Self-pollinated species include tomato, pepper, peas, beans, and lettuce. The anthers on the flowers of self-pollinated crops typically surround the pistil, and pollen shed often occurs before flowers open, ensuring self-pollination. Isolation in self-pollinated varieties is less of a concern than in open-pollinated varieties, but outcrossing can still occur, especially if plants are touching or pollinator populations are high and diverse in species, or if plants are stressed. Recommended distances between self-pollinated varieties of the same species range from 10 to 15 feet. Seed should be saved from 15 to 50 individuals in self-pollinating populations.

Hybridization refers to the controlled cross between individuals from two distinct varieties. Reasons for hybridization include hybrid vigor (increased yield), uniformity, disease resistance, and variety protection. Many commercial varieties are hybrids. Seed saved from hybrid vegetables will likely not produce uniform populations of individuals resembling the parent plants from which they were selected. For those interested in making their own hybrids and developing their own cultivars, see the references by Allard (1999) and Deppe (2000).

Special Needs

Special considerations need to be made when growing plants for seed. Planting should be timed so that seed maturation occurs during dry weather if possible. Using

Figure 4. Bagged flowers on papaya tree.

Figure 5. Winnowing is done by using wind or a fan to remove chaff from seeds.

a protective structure such as a greenhouse or temporary cover is also very useful to produce high-quality seeds. Plants will be in the field much longer when grown for seed than for food (e.g., 30 days vs. 120 days in lettuce). Spacing of seed crops should be wider than when crops are grown for food to accommodate larger plant size and to maximize airflow to reduce chances of disease.

Seed Harvesting and Cleaning

Seed should be allowed to mature as fully as possible on the plant, but mature seed should be harvested as soon as possible to avoid losses to birds, rain, insects, and disease. In the case of dry seeds like lettuce and beans, plants may be cut from the field when mostly dry and allowed to complete drying on benches in a well-ventilated covered structure like a greenhouse, garage, or barn. Seed matures sequentially (from the bottom up) on an inflorescence or flower stalk, so some growers will walk through a field periodically to remove mature seed pods or shake inflorescences into a bucket or garbage can to collect the mature seeds, and allow the rest to remain on the plant. Growers may also place woven weed mats around the base of plants to collect dropped seed.

Once dried, the seed will need to be freed from its protective material. For small-scale cleaning of dry seeds, hand-shelling of seeds in pods is an effective method. Pods can also be put in a cloth bag or pillowcase and physically manipulated by gentle stepping or threshing to break them open. Seeds from dried inflorescences such as lettuce can be shaken loose by gently tapping on the side of a bucket to catch the seeds. Screens of various widths can be used initially to separate seeds from trash. Wind or fans may then be used to separate the lighter chaff from the seeds. Winnowing, or the use of wind to separate seeds from chaff, is a simple procedure. Gently pour the processed material from a shallow pan or basket into another, controlling the position and distance between the two pans so the wind or a fan will carry the lighter chaff past the lower pan but allow the heavier seeds to fall into the lower pan (Figure 5). It is important to remember that seeds are living organisms and are susceptible to damage when abused. As a general rule, the lower the seed moisture content, the greater the possibility of damage from physical contact.

Seed-saving from fleshy fruits requires wet-processing of the seeds. It is important when collecting seeds from fleshy fruits that the seeds are physiologically mature and will be able to be dried and stored and will germinate when planted. Ripe tomatoes, colored peppers, and winter squashes harvested for eating contain mature seeds and are okay for saving seed. Vegetables like green beans, cucumber, summer squashes, and eggplant must be left on the plant for much longer than when used for eating to ensure that seeds are fully developed. Seeds scooped out of fleshy fruits are best processed by fermenting in water to remove closely associated material and germination inhibitors. The most common process for small-scale producers is to soak the seed in water

Figure 6. Seed may be stored for several years in sealable plastic containers (A), glass jars (B), or self-sealing foil-lined packets (C).

for 2–3 days, stirring twice daily. In some cases (e.g., papaya), fairly intense agitation with a blender and rubber blade may be used (for more information, see the video on "Producing Organic Papaya Seed" at http://youtu.be/y_CNS0yawCU). For larger seed-cleaning operations, commercial enzymes are available to speed up the fermentation process. After the fermentation step, seeds are drained, rinsed, and dried on paper towels or screen. Seeds may then be air-dried or dried using a fan on low speed. The details of seed processing vary with species. See the References section for more details.

Seed Storage

Most growers are content to store seed from year to year or for a few years at most. These growers follow the "Rule of 100." The rule of 100 states that the sum of the temperature (°F) and the relative humidity (%) should equal 100. For example, refrigeration at 50°F and 50% relative humidity fits these criteria. Seed dried to 2–5% seed moisture and stored in the refrigerator in an airtight container can maintain viability for decades (Figure 6). Exceptions to this rule are "recalcitrant" seeds, those that cannot be dried down. These include very large-seeded species (e.g., avocado and mountain apple), as well as seeds from many other tropical fruit crops. Seeds that can be dried to a low moisture content and maintain viability are called "orthodox" seeds. For more details regarding seed-saving, especially long-term storage and "seed-banking," see Yoshinaga (2010), and cited references therein.

References

Allard, R.W. 1999. Principles of Plant Breeding. 2nd ed. John Wiley & Sons, Inc.

ARS. 1976. Insect Pollination of Cultivated Crop Plants. Agriculture Research Service, USDA. Agriculture Handbook #496.

Ashworth, S. 2002. Seed to Seed: Seed Saving and Growing Techniques for Vegetable Gardeners. Decorah, IA. Seed Savers Exchange.

Deppe, C. 2000. Breed Your Own Vegetable Varieties: The Gardener's & Farmer's Guide to Plant Breeding & Seed Saving. Chelsea Green Publishing.

Fanton, J., and Immig, J. 2007. Seed to Seed: Food Gardens in Schools. Seed Savers Network. http://www.seedsavers.net/local-seed-networks.

Nagata, R. 2011. Saving seeds from cross-pollinated crops. *West Hawaii Today*. May 7 2011. http://www.westhawaiitoday.com/sections/news/local-features/saving-seeds-cross-pollinated-crops.html

Navazio, J., and Colley, M. 2010. Seed Saving Basics. Video presentation. Hua ka Hua Seed Symposium. Kona Hawaii. April 17 2010. http://www.kohalacenter.org/publicseedinitiative/presentations.html.

OSA. 2010. A Seed Saving Guide for Farmers and Gardeners. The Organic Seed Alliance. http://www.seedalliance.org/uploads/publications/seed_saving_guide.pdf

Radovich, T.J.K. 2011. Biology and classification of vegetables. In Handbook of Vegetables and Vegetable Processing (pp.-). Wiley Publishers.

Sutevee,S., Sunanta, J.,Huang, R., and Kalb, T. 2005. Saving Your Own Vegetable Seeds: A Guide for Farmers. AVRDC The World Vegetable Center. April 17 2010. http://www.avrdc.org/pdf/PROD6saving_your_ own_vegetable_seeds.pdf

Yoshinaga, A. 2010. Seed Storage. Video presentation. Hua Ka Hua Seed Symposium. Kona Hawaii. April 17 2010. http://www.kohalacenter.org/publicseedinitiative/presentations.html.

Acknowledgements

The authors would like to thank Mr. Glenn Teves and Ms. Kiersten Akahoshi, who served on the peer-review committee.

Table 1. Examples of Orthodox Seeds That Are Easy to Grow and Save.

Crop	Pollination Biology	Processing
Beans	Self	Dry
Peas	Self	Dry
Tomato	Self	Wet
Eggplant	Self	Wet
Pepper (bell, chili)	Self	Dry
Carrots	Cross	Dry
Okra	Cross	Dry
Corn	Cross	Dry
Mustard	Self/Cross	Dry
Pak Choi	Self/Cross	Dry
Choi Sum	Self/Cross	Dry
Lettuce	Self	Dry
Cucumbers	Cross	Wet
Squash	Cross	Wet
Pumpkin	Cross	Wet