Martin-Gatton
College of Agriculture, Food and Environment
Cooperative Extension Service

Plant Pathology Fact Sheet **PPFS-VG-09**

Disease Management Practices for Saved Vegetable Seeds

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Introduction

Saving non-hybrid (open-pollinated) vegetable seeds is a common practice in Kentucky. Homeowners and small-acreage producers may save seeds to preserve heritage and historically significant vegetable cultivars or as a money-saving strategy. However, infected seed can result in crop damage and losses in subsequent years. Disease-causing pathogens can be present on exterior surfaces or interior portions of seeds. A list of common diseases that can be managed through seed treatment is presented in Table 1. Multiple methods are available to eliminate or reduce pathogens in saved seeds.

Seed Selection & Preparation

Seeds should only be saved from healthy produce. Saving seeds from degraded or diseased fruit (Figure 1) predisposes seeds to low germination rates and a greater disease risk when planted.

Remove all juice and flesh from seeds to be saved; rinse thoroughly with clean water. Allow seeds to dry completely in a single layer. Once dry, examine seeds carefully and discard any that are discolored, mishappen, or otherwise appear unhealthy.

Tomato seed can be prepared by fermentation [See: Bill Best, D. A. (2017). *Kentucky Heirloom Seeds: Growing, Eating, Saving* (1st ed.) The University Press of Kentucky] or by washing in hydrogen peroxide or detergent (methods not detailed in this publication). Seeds are then dried for storage.

Table 1. Seed-borne diseases of common vegetable crops.
(Source: *Managing Pathogens Inside Seed with Hot Water*, Cornell University)

Crop	Common Seed-Borne Diseases
Crucifers (cole crops)	Alternaria leaf spot, Bacterial leaf spot, Black rot, Blackleg
Carrot	Alternaria leaf blight, Bacterial leaf blight, Cercospora leaf spot
Celery	Bacterial leaf spot, Cercospora leaf spot, Phoma crown and root rot, Septoria leaf spot
Eggplant	Anthracnose, Alternaria early blight, Phomopsis, Verticillium wilt
Lettuce	Anthracnose, Bacterial leaf spot, Lettuce mosaic virus, Septoria leaf spot, Verticillium wilt
Onion	Botrytis neck rot, Downy mildew, Purple blotch, Smut, Stemphylium leaf blight
Pepper	Anthracnose fruit rot, Bacterial leaf spot, Cucumber mosaic virus, Pepper mild mottle virus, Tobacco mosaic virus, Tomato mosaic virus
Spinach	Anthracnose, Cladosporium leaf spot, Cucumber mosaic virus, Downy mildew, Fusarium wilt, Stemphylium leaf spot, Verticillium wilt
Tomato	Alfalfa mosaic virus, Anthracnose, Bacterial canker, Bacterial leaf spot, Bacterial speck, Cucumber mosaic virus, Early blight, Fusarium wilt, Late blight, Leaf mold, Septoria leaf spot, Tomato mosaic virus, Verticillium wilt
Turnip, Radish	Alternaria leaf spot, Black rot, Blackleg

Figure 1. Diseased fruit, such as tomatoes with bacterial canker, should not be used for saving seeds.

Disease Treatment Methods

Pathogens affecting fruit in the field can carry over through seed to the next season, either on the seed coat or within seed. Seed treatments can reduce or eliminate seed-transmitted diseases by killing disease-causing pathogens within and on seed. However, treatments vary in efficacy; not all treatments can be used with all seeds. Common seed treatments appropriate for common vegetable crops are detailed in Table 2.

Table 2. Seed treatments appropriate for common vegetable crops.

Crop	Clean Field	Chlorine	Hot Water
Beans	√	√	
Cucumber	√	√	√
Cucurbits	√	√	√*
Peas	√	√	
Peppers	√		√
Tomatoes	√		√

*Large-seeded cucurbits are sensitive to hot water treatments.

Intentional Clean Seed Production

Utilizing management practices throughout the growing season reduces the likelihood that seeds will harbor pathogens. Producing "clean" or disease-free seed is recommended for all seed types and should be the first step in seed preservation. This method is particularly important for beans, most cucurbits (pumpkin, squash, watermelon, zucchini), peas, and potatoes, which have limited treatment options before planting.

- Isolate plants grown for seed production from other crops whenever possible.
- Maintain proper planting practices, plant spacing, irrigation, and fertilization to promote plant health.
- Apply fungicides and bactericides to prevent infection; make applications on a regular schedule.
- Prevent viral infections by managing vectors and/or preventing mechanical transmission.
- Certified Organic growers should use only OMRI-approved products for managing diseases.

Heirloom and rare cultivars may warrant extra caution and more intensive management to assure disease-free seed production. In some cases, intensive disease management can help "clean up" a seed collection known to be infected with bacteria or fungi; virus diseases cannot be treated or cured.

Fungicide Seed Treatments

Many types of vegetable seeds can be treated with a fungicide coating prior to planting. This method is often used to protect seeds and seedlings from soilborne pathogens; it is ineffective for managing seedborne diseases (seeds already infected).

[1] Select a fungicide product labeled for the crop and method of application. Read all label directions before treatment. In general, fungicides labeled for treating seeds are expensive and are only available in large quantities that are not feasible for residential gardeners and small acreage growers. Captan, the only seed treatment product available for small acreage growers, is often ineffective against pathogens that threaten seeds and seedlings. Some non-heritage cultivars may be available from suppliers as pre-treated seed.

[2] Place the fungicide product and seeds into a zippered plastic bag or a plastic container with a tight-fitting lid.

[3] Shake the container until seeds appear thoroughly coated with fungicide.

[4] Use caution when handling treated seeds; see label for personal protective equipment requirements.

Chlorine (Bleach) Treatment

Chlorine treatment can be used on any type of seed. This method helps remove bacteria and fungi from the seed surface (but not from seed interior). Chlorine treatment should not be used on fungicide-treated seed or hot water-treated seed. In most cases, bleach treatments should be delayed until time of planting. Some seeds can be stored after treatment, but many have poor germination if stored for long periods. Growers treating seed for the first time should begin with a small number of seeds and then test seeds for germination before treating large batches. Use caution when handling bleach solutions. Chlorine treatment is not OMRI-approved.

[1] Combine one part household bleach (5% to 7.5%) hypochlorite) with four parts water; add two drops of dish detergent for each quart of solution (Figure 2a). One gallon of solution will treat approximately one pound of seed. Use a new solution for each batch. For detailed information on preparing seeds for treatment, see Step 2 in "Hot Water Treatment" section (page 4).

[2] Add seed to the bleach solution, stirring occasionally. Small seeds can be folded into paper towels or coffee filters or placed into a tea strainer for easier retrieval.

Chlorine (Bleach) Treatment (cont'd)

[3] Submerge seeds and soak for 1 minute (FIGURE 2B).

[4] Rinse seeds with clear water for 5 minutes.

[5] Air dry in a single layer before storing.

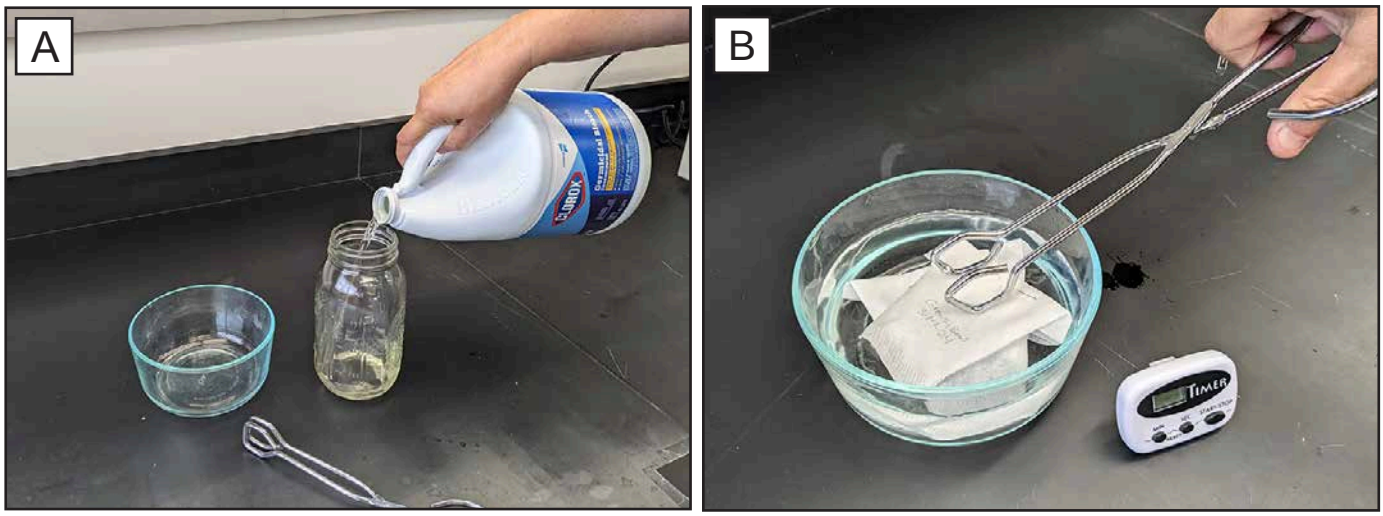

FIGURE 2. A SOLUTION OF CHLORINE, WATER, AND DISH DETERGENT MAY BE USED TO DISINFEST THE EXTERIOR OF SEEDS (**A**). SEED PACKETS SHOULD BE SUBMERGED IN THE SOLUTION FOR ONE MINUTE (**B**).

Hot Water Treatment

Hot water treatments can kill disease-causing pathogens on both the exterior and interior of seeds. This process can take more time and specialized equipment than other treatments, but it is the most effective.

Hot water treatment can be used for popular vegetable crops such as cucumber, peppers, and tomatoes. However, this method should not be used to treat beans, many cucurbits, peas, and potatoes. A complete list of crops compatible with hot water treatment is provided in TABLE 3.

This method, which uses two hot water baths (sous vides, FIGURE 3), begins by priming seeds in warm water, and then transferring them to hot water to eliminate pathogens. The materials and steps for hot water treatment are detailed in the section on the next page).

Hot water seed treatment should be completed one to two months before planting. Growers treating seed for the first time should begin with a small number of seeds and then test seeds for germination before treating large batches. Several University of Kentucky Coopertive Extension offices can facilitate or assist growers with hot water seed treatment; contact your county agent for more information.

FIGURE 3. FREE-STANDING SOUS VIDES (A) OR SUBMERSIBLE MODELS (B) CIRCULATE WATER AND MAINTAIN CONSISTENT TEMPERATURES, MAKING THEM IDEAL FOR HOT WATER SEED TREATMENT.

Hot Water Treatment: Step By Step

Materials

The following materials are needed for hot water treatment of saved seeds.

- Sous vides (2)
  - A sous vide is either a free-standing machine (Figure 3A), or submersible device (Figure 3B) used to heat water for food preparation. A sous vide circulates water and maintains a consistent temperature.
  - Stove top and slow cooker heating methods make regulating temperatures difficult, and they are not recommended.
- Stapler
- Pencil
- Tongs
- Thermometer (2)
- Coffee filters or cheesecloth
- Timer
- Paper towels
- Plates

Hot Water Treatment Process

[1] Warm one sous vide or water container to 100°F and a second to the target treatment temperature (see Table 3). Use clean water for each batch of seeds being treated.

- Verify that temperatures are accurate using a thermometer. Temperatures need to be within 0.1 to 0.5 degrees of the target treatment temperatures.
- If temperatures are too low, pathogens in or on seeds may not be killed. If temperatures are too high, seeds may be killed and fail to germinate.

[2] Distribute seeds in a single layer onto coffee filters. Do not overfill. Depending on the size of seed, 15 to 30 seeds per packet is appropriate (Figure 4).

- Fold each packet and secure with staples. When working with small seeds, use extra folds and staples to ensure that seeds do not escape during treatment.
- Label packets with the seed type, cultivar, and date treated. Use a pencil; do not use ink or marker when labeling packets, as it will wash off or smear during treatment.
- Place packets into the first water bath set at 100°F.

[3] Do not overfill the water bath; typically, 5 to 8 packets per bath are appropriate. Seed packets should be completely saturated. Push down with tongs to ensure submersion (Figure 5); a coin or other small weight may be added to the packet to aid in submersion.

[4] Set a timer for 5 minutes.

[5] Using tongs, remove seed packets from the first water bath and transfer them to the second water bath, which should be set to the target treatment temperature (Table 3).

[6] Set a timer for the required treatment time (Table 3). Different types of seeds can be treated together if they require the same treatment temperature. If treatment time varies between the type of seeds, set multiple timers.

[7] Once the hot water treatment is complete, remove seed packets and place onto plates or mesh screen.

[8] Use paper towels to remove as much moisture from packets as possible. Do not twist packets to remove water (packets may tear).

[9] Air dry seeds completely. A single layer will facilitate rapid drying and prevent mold or decay. Packets can also be torn open for drying; however, use care so as not to scatter or lose seeds.

[10] Package dry seeds in airtight bags, bottles, or vials. Store in appropriate conditions until ready for planting.

Figure 4. Seeds to be treated should be placed in labeled coffee filters and secured with staples.

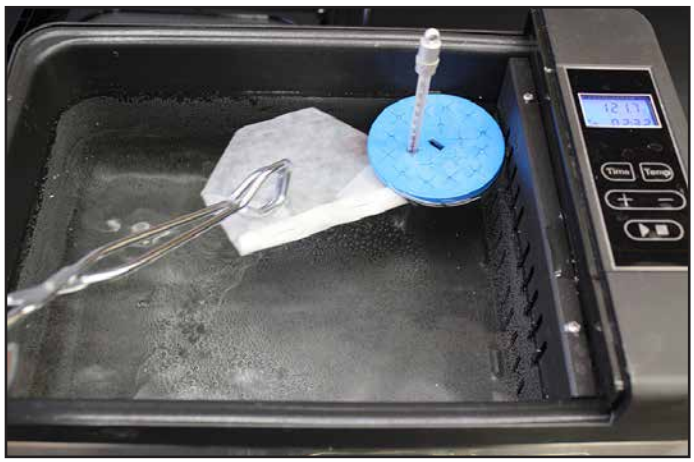

Figure 5. Place prepared seed packets into hot water baths and use tongs to ensure submersion.

Table 3. Hot water treatment guidelines for treatable crops, temperatures, and treatment duration. (Credit: *Managing Pathogens Inside Seed with Hot Water*, Cornell University)

Crop	Treatment Temperature (degrees F)	Treatment Duration (minutes)
Broccoli	122	20
Brussels sprouts	122	25
Cabbage	122	25
Carrot	122	20
Cauliflower	122	20
Celeriac	118	30
Celery	118	30
Chinese cabbage	122	20
Collards	122	20
Coriander	127	30
Cress	122	15
Cucumber	122	20
Eggplant	122	25
Kale	122	20
Kohlrabi	122	20
Lettuce	118	30
Mint	112	10
Mustard	122	15
New Zealand Spinach	120	60-120
Onion (sets)	115	60
Parsley	122	30
Pepper	125	30
Radish	122	15
Rutabaga	122	20
Shallot	115	60
Spinach	122	25
Sweet potato (cuttings, sprouts)	120	10
Sweet potato (roots)	115	65
Tomato	122	25
Turnip	122	20
Yam (tubers)	112	30

Success After Seed Treatment

While seed treatments can reduce pathogens on or within seeds, plants may become diseased once planted in the garden or field. Integrated pest management (IPM) practices should be used to prevent disease throughout the growing season. Common practices include:

- Use new or sanitized containers and new or pasteurized soil when starting seeds in trays.
- Rotate crops throughout the growing space. Rotations of 2 to 3 years are recommended.
- Increase plant spacing to improve air circulation.
- Prune, stake, or trellis plants to improve airflow.
- Avoid overhead watering to prevent leaf moisture and reduce humidity.
- Remove weedy plant species which can reduce air circulation and/or harbor pests and diseases.
- Scout plants regularly for the presence of diseases and insect vectors.
- Remove diseased plants and plant parts to reduce spread.
- Clean pick produce. Never leave diseased produce in fields.
- Remove all plant material at the end of the season. Do not compost diseased plant materials.

Additional Resources

- Managing Pathogens Inside Seed With Hot Water (Cornell University)
https://www.vegetables.cornell.edu/pest-management/disease-factsheets/managing-pathogens-inside-seed-with-hot-water/
- Kentucky Heirloom Seeds: Growing, Eating, Saving, Bill Best and Dobree Adams (University Press of Kentucky, 2017)
https://www.kentuckypress.com/9780813168876/kentucky-heirloom-seeds/
- University of Kentucky Extension Plant Pathology Publications
https://plantpathology.ca.uky.edu/extension/publications

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Photos: University of Kentucky—Kim Leonberger (2A, 2B, 3A, 4, 5); Bugwood.org—Heinz USA (1); Cornell University-Margaret Tuttle McGrath, *Managing Pathogens Inside Seed with Hot Water* (https://www.vegetables.cornell.edu/pest-management/disease-factsheets/managing-pathogens-inside-seed-with-hot-water/) (3B)