

# Controlling Diseases of Vegetable Transplants in The Greenhouse

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When a plant disease starts to develop in the greenhouse, the result can be dead plants, since young plants are very vulnerable, or a season-long battle in the field after transplanting. In addition to the importance of starting with healthy transplants, disease management steps such as sanitation and environment modification can be easier to implement in the greenhouse compared to the field, and more successful. Damping-off and gray mold are the most common diseases of greenhouse transplants.

*Pathogen-free seed.* Ensuring seed is not a source of pathogens causing diseases is an important first step in management. Some pathogens can be on or in seed. Fortunately, not all are capable of becoming associated with seed, but some important pathogens can. Seed-borne fungi include pathogens causing Septoria leaf spot of tomato and Alternaria leaf spot of crucifers. Diseases caused by seed-borne bacterial pathogens include black rot of crucifers, bacterial leaf spot of pepper, and bacterial canker of tomato. Contaminated seed can be an important first source of a pathogen on a farm or even a larger area (most notable example is the new downy mildew of basil in the USA). Additionally, a severe disease outbreak can result when a pathogen is present at the start of plant growth. Pathogens able to get inside seed are especially difficult to manage because a surface treatment won't affect them. Only heat treatment can get in to these pathogens.

Inquire about the seed's history before purchase. What measures were taken to minimize the opportunity for seed to become contaminated during production. Producing seed where seed-borne pathogens do not occur and/or where environmental conditions are not favorable, such as in a greenhouse, are ways to obtain clean seed. Also ask if the seed was tested and/or treated for seed-borne pathogens. This information is often on the seed package.

If you save your own seed or buy from a small producer, hot-water treatment may well be worthwhile. The procedure is suitable for small-seeded vegetables including tomato, pepper, brassicas, and lettuce. Treatment temperature and time are critical to achieve success without adversely affecting seed. Information about how to treat seed including specifics for several crops is at <http://vegetablemdonline.ppath.cornell.edu/NewsArticles/HotWaterSeedTreatment.html>. The recommended precision water baths are available at several locations in the Northeast, including three in NY (contact M McGrath). Companies that test seed include STA Laboratories ([www.eurofinsus.com/stalabs/](http://www.eurofinsus.com/stalabs/)). This is a destructive procedure typically done with a minimum of 10,000 seed, but it can be done with less.

*Sanitation.* To manage pathogens that may be present from the previous season, thoroughly clean and then disinfect planting containers and greenhouse surfaces before beginning to grow transplants. Disinfectants include GreenShield, Physan 20, SaniDate 12.0, and StorOx (approved for organic production).

In greenhouses with natural floors, cover the ground with landscape cloth to form a barrier over the soil.

Use sterilized potting mix.

During production of transplants implement practices to minimize the opportunity for pathogens to be brought into the greenhouse. Clean boots of soil to avoid bringing in soil-borne pathogens such as *Pythium*. Use a boot brush then a foot bath. Or have shoes dedicated for wearing while in the greenhouse.

Environment modifications to make the greenhouse less favorable for disease development. Most fungal and bacterial pathogens affecting foliage require a certain amount of time with free moisture (wetness) in order to infect. High humidity is sufficient for others, including those causing downy mildews, gray mold, and late blight. Minimize leaf wetness and humidity by using bottom watering, wide plant spacing, fans, ridge venting, lights, and also open doors during warm mornings and avoid overwatering. Keep plants on benches. Adjust water amount based on conditions and plant needs so that the seeding mix does not stay wet for long periods and is dry the next day. Check greenhouse roof for dripping from condensation in morning or from rain. Do not locate plants where water drips if the reason can't be rectified.

Some pathogens, including those causing tomato bacterial spot and Septoria leaf spot, are primarily dispersed by splashing water. This is another reason to use bottom watering. When this is not feasible, water plants after any guttation has dried and when there will be time for leaves to dry before night time.

Manage insects that can vector plant pathogens. These include thrips, aphids, and fungal gnats. Clean up spilt potting mix as this can provide habitat for fungal gnat larvae.

Manage weeds and do not grow ornamental plants in the same greenhouse as vegetable transplants. These plants can harbor pathogens, notably viruses, as well as insects that can vector them.

Routinely inspect plants for symptoms. Obtain help with diagnosis when at all unsure.

Dispose of dead and diseased plants away from the greenhouse.

Do not brush plants. Mechanically brushing the top of tomato and other vegetable seedlings results in plants that are shorter with greater stem and petiole strength; however, it also can move bacterial pathogens and cause wounds (including broken leaf hairs) that enable bacterial pathogens to infect.

Apply fungicides and/or biological control products. This can be a warranted addition to the management program with diseases not effectively controlled with cultural practices in the past or at first symptom. Note that some pathogens, including those causing bacterial spot and canker in tomato, can be present, multiplying, and spreading without causing symptoms. See last section for products.

**Managing Botrytis Gray Mold in Greenhouse Vegetable Transplants.** This disease is hard to avoid because the pathogen has a wide host range and produces an abundance of wind-dispersed spores. Keeping humidity below 90% is key. Also remove dead plant tissue because the pathogen usually first develops on dead tissue then invades adjacent living tissue.

**Managing Damping-off in Greenhouse Vegetable Transplants.** Damping-off can be very destructive in the greenhouse due to close plant spacing. Fortunately, ability to prevent the pathogen from being present and to avoid favorable conditions in the greenhouse means it is easier to manage damping-off there than in the field. Use good sanitation: clean and disinfect everything before seeding. Pathogens that cause damping-off can be in soil around the greenhouse and unsterilized seeding mix, and they can survive on trays and pots. Clean shoes before entering the greenhouse. Keep the hose end off the ground. Select sterilized seeding mix with good drainage. There are several biological control products that can be added to seeding mix when damping-off has been a problem in previous seasons (see list at end). While watering plants, avoid the possibility of splash moving soil to plants. Be careful not to overwater, especially during periods of cloudy, rainy conditions. Adjust water amount based on conditions and plant needs so that the seeding mix does not stay wet for long periods and is dry the next day. Water early in the day and provide air flow to reduce humidity so that soil will dry quickly. Provide good plant spacing.

Where seedlings are dying or growing poorly (wilting, stunted), first confirm that it is damping-off by looking at the roots of affected plants. Roots of diseased plants usually have brown tissue and the outer layer may be partly rotted off. Seedlings can collapse due to other causes, including excessive fertilization, high levels of soluble salts, excessive heat or cold, excessive or insufficient soil moisture, bleach residue on trays, and severe infestation of fungal gnat larvae or other insects. Roots of these plants will be a healthy white to tan color. If damping-off is likely the cause, it is important to separate trays with diseased seedlings from those that are not affected. Trays with affected seedlings should be discarded. Fungi that cause damping-off can be spread by splashing water. Fungal gnats can also move some fungi. The most common pathogen causing damping-off, *Pythium*, develops best under wet soil conditions. It is also important not to underwater as dry conditions are favorable for *Rhizoctonia*, another damping-off pathogen, and will stress seedlings, which can increase susceptibility. Another important step in management is to try to determine the source of the pathogen when damping-off occurs so that it can be controlled to minimize the chance of this disease occurring again next year. Damping-off pathogens exist in soil. Look for sources of soil in and around the greenhouse that could have gotten into seeding trays such as by splashing water. Dispose of trays that held diseased plants.

**Biofungicides for damping-off and other diseases.** There are potting mixes enriched with a biofungicide and products that can be applied to potting mix from before seeding to after plants are established. Pro-Mix BX Biofungicide is a peat-based mix that has *Bacillus subtilis*. The products are best used preventively, and where damping-off has previously occurred despite cultural controls. Most are labeled for the major pathogens causing damping-off, plus others. Bio-Tam (*Trichoderma asperellum* strain ICC 012 and *Trichoderma gamsii* strain ICC 080) can be applied as a greenhouse drench to transplant trays. A concentrated solution may be prepared 24 to 36 hours prior to treatment to initiate conidial germination which will result in faster soil colonization. Combine 1 oz of Bio-Tam for every 10 fl oz of water. Mix this solution periodically to promote the germination of conidia. Dilute to 2.5 to 7.5 oz per 100 gallons water

before applying. Typical application rate is 1 pint of solution per square foot of growing medium that is 4 inches deep. RootShield PLUS WP (*Trichoderma harzianum* Rifai strain T-22 and *T. virens* G-41) can be incorporated into mix before seeding. Serenade Soil (*Bacillus subtilis* strain QST 713) is a new formulation of Serenade for soil application. This bacterium colonizes roots and produces compounds that affect pathogens directly and trigger metabolic pathways to activate the plant's natural defenses and modulate growth. Actinovate (*Streptomyces lydicus* WYEC 108) and also Double Nickel 55 (*Bacillus amyloliquefaciens* strain D747) can also be applied as a soil drench plus they can be applied to foliage for several diseases. Regalia (extract of *Reynoutria sachalinensis*), previously labeled only for foliar diseases, is now labeled to permit application as a soil drench as well as in transplant water. It boosts the plants' natural defense mechanisms against certain fungal and bacterial diseases. Most biofungicides are approved for organic production.

**Conventional fungicides that can be applied in the greenhouse.** Start at or before first symptoms. Ensure disease is correctly identified. Apply regularly (e.g. weekly) maximizing coverage. Check label for restrictions on use on transplants and on greenhouse use. Some products are permitted for use only outdoors. These include Bravo, Cabrio, Endura, Flint, Forum, Quadris, and Presidio.

Some fungicides labeled for use in greenhouses include Agri-mycin 17, Armicarb, Botran, Contans, copper (some formulations), Decree, Dithane, JMS Stylet-Oil, Kaligreen, MilStop, Oxidate, Ranman (see below), Previcur Flex (see below), Scala, and Sonata. Fungicides with no restrictive statement about greenhouse use: Curzate, Gavel, Penncozeb, Tanos, Revus, Revus Top, Switch (except small-fruited tomatoes) and phosphorous acid fungicides (ProPhyt, Phostrol, etc.). The antibiotic Agri-mycin is labeled for controlling bacterial spot in tomato and pepper seedlings. It can be applied as frequently as every 4-5 days beginning when first true leaves appear.

Previcur Flex (propamocarb hydrochloride, FRAC Code 28), a conventional fungicide with targeted activity for some pathogens causing damping-off and root rot, *Pythium* and *Phytophthora*, is labeled for use in the greenhouse to manage damping-off in tomato, leaf lettuce, cucurbits, and peppers. It can be applied before seeding and/or after emergence, and through drip irrigation. Note the use directions state not to apply to dry growing mix, not to apply to plants when sunlight will be intense afterwards (evening application recommended), and not to mix with other products.

Ranman (cyazofamid, FRAC Code 21) is another fungicide with targeted activity for *Pythium* and *Phytophthora*. It is labeled for use in the greenhouse to manage damping-off on tomato (and downy mildew in basil). It can be applied once to the seedling tray at the time of planting or at any time thereafter up until 1 week before transplanting. Apply the fungicide solution as a drench to thoroughly wet the growing medium. This results in the use of approximately 1 pint of solution per square foot if the growing medium is 4 inches deep as stated on the label; however, trays used for producing vegetable transplants are 2.5 inches deep. Product rate is 0.887 ml per gal.

Calculating amount of fungicide to use for trays of vegetable seedlings. Standard trays are 10 X 20.5 inches, which is 1.43 sq ft. The amount of Previcur Flex needed per tray is 1.35 ml for the

32 fl oz/sq ft rate (at seeding) and 0.67 ml for the 16 fl oz rate (after emergence). Amount of Ranman is 0.1 ml if the tray is the standard 2.5 in depth. The amount of water to use for Ranman is about 420 ml per tray. This is likely a good amount for other fungicides. But in all cases it should be checked to ensure it is not too much resulting in leaching out of the bottom of the tray. Check using the hand-sprayer that will be used to make the application and with the soil at the moisture level when the application will be made (slightly damp). Accurately measuring pesticides is always critical. For the small amounts needed with greenhouse applications, there are plastic disposable syringes that do not use a needle and graduate cylinders. They come in many sizes for measuring small quantities in milliliter amounts and are available to order on the internet.

Controlling root rot after transplanting. The fungicides mentioned above when applied to seedlings before transplanting can control pathogens in field soil that attack roots. Previcur Flex can also be applied through chemigation (including drip and transplant/setting water). Note that when applied in transplant water, workers handling the plants need to wear the PPE (personal protective equipment) specified on the label, which includes chemical-resistant gloves. Avoiding this need can be an advantage of applying Previcur Flex to trays of transplants.

*Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Before purchase, make sure product is registered in your state and approved by your certifier for organic production. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.*

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