

How to Develop a Season-Long Disease Control Program

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Prepare. The first step in disease management is determining what diseases could occur, learning the early symptoms and management practices, and deciding specifically what will be done. This is best accomplished when there is time during the winter. It is especially important to decide what diseases will be managed with fungicides applied starting after detection, as the early symptoms of these diseases are most critical to learn. Diseases are most effectively managed with fungicide applications started preventively or very early in disease development. This is because there are few products that can eradicate an established disease spot, thus these spots not only remain, but will continue to produce inoculum (fungal spores or bacterial cells) making the task of protecting the remaining healthy tissue more difficult; and starting when symptoms are common puts selection pressure on the pathogen to evolve to overcome the fungicides applied. Diseases most likely to occur are those caused by pathogens easily moved long distances, such as one producing a wind-dispersible spore, and pathogens able to survive over winter in the soil. State production recommendations/guidelines are a good source of information about diseases likely to occur in a particular area, as well as their management. Many images of disease symptoms have been posted on the web. These can easily be found using Google image search. I have a growing collection of vegetable disease images at: <http://www.longislandhort.cornell.edu/vegpath/photos/index.htm>. Being ready for unlikely diseases is also important as learned from the late blight outbreak last summer. Weekly newsletters are a good source of information about such developments.

Select resistant varieties. Check seed catalogues for new varieties to consider. Varieties with resistance to early blight, late blight, and Septoria leaf spot are expected to start being available in 2010. There are tables at <http://vegetablemndonline.ppath.cornell.edu/Tables/TableList.htm> of resistant varieties.

Use seed that has been treated and tested for pathogens. Treatments for seed-borne pathogens include hot water, hydrochloric acid, and sodium hypochlorite. Hot water is effective for pathogens inside seeds but it can impact germination if not done incorrectly or there is a long period of time between treatment and planting or the seed is old. Fungicides are then applied to seed for seed decay. It is best to have seed treated by the seed company. Bacterial diseases, early blight and Septoria leaf spot.

Clean and sanitize greenhouses and planting materials, also trellising stakes. Several pathogens can survive between seasons in the greenhouse where transplants were grown and on planting materials. First remove loose dirt and debris. Organic matter decreases disinfectant activity. Sweep greenhouse floors and power-wash to remove dirt and debris stuck on surfaces. Use a greenhouse cleaner (such as Strip It or P.A.C.). Let stand a few minutes before rinsing. Trays and stakes also need to be cleaned of debris. Disinfect everything after cleaning with a product such as MicroBloc, Green-Shield, or OxiDate (OMRI-listed). Follow the label directions carefully to obtain full benefit. Important to soak used trays; cleaning and dipping is not enough

based on testing for fungal pathogens. Use weights to keep materials submerged while soaking in disinfectant. Replace solution used to soak trays if it becomes visibly dirty. Allow trays to dry before using. Clorox or other household chlorine bleach (5.25%) is another option for flats and pots. Use at 0.5% (= 1 part bleach + 9 parts water). Note that it is short-lived after mixing in water, with a half-life of only 2 hours, and it is corrosive. Bacterial pathogens are especially notorious for being able to survive on trellising stakes. Re-using stakes, even after disinfecting them, is not recommended following bacterial canker.

Inspect transplants for symptoms. Purchase certified transplants. Do not plant seedlings with symptoms. An entire tray with symptomatic seedlings should be discarded, especially with bacterial diseases, because the pathogen could have been spread.

Rotate land to control diseases caused by pathogens that can survive in soil on infested crop debris, which include anthracnose, bacterial diseases, early blight, and Septoria leaf spot. Very long rotation is needed for white mold. This practice should be used routinely rather than waiting to rotate out of a field after the pathogen has built up to the point that disease is very severe.

Plant in a field with good drainage on raised beds to manage root rots and seedling damping-off. Do not over water. Avoid practices that compact soil (e.g. driving on wet soils).

Mulch and trellise to physically and spatially separate foliage from pathogens in soil.

Minimize leaf wetness. Select a site with good air movement and use drip irrigation or overhead irrigate when leaves will have time to dry before evening dew period to manage foliar diseases. Plant parallel to the prevailing wind direction. Manage weeds. Most fungal and bacterial diseases.

Reduce humidity in protected crops (greenhouses and high tunnels) with fans and vents, spacing plants (5-ft row spacing recommended), and pruning lower leaves.

Physically separate successive plantings. To minimize pathogen movement between plantings, late plantings should be located upwind from earlier plantings, with as much distance between plantings as possible, plus a barrier such as a corn planting.

Manage volunteer tomatoes, solanaceous weeds and other weeds susceptible to tomato diseases. These can be primary sources of pathogen inoculum.

Avoid moving infested soil into clean fields. Work last in fields where pathogens occur that survive in soil, then clean equipment before working in fields where these diseases haven't occurred (see list under rotate above).

Do not handle wet plants. Routinely clean hands and disinfect tools contacting plant sap. This is especially important for bacterial pathogens.

Inspect plants weekly for symptoms, especially during fruit production. Include leaves that are low and buried in the canopy where conditions are most favorable for several diseases. Early in

the day when humidity is high is the best time to look because fungal growth characteristic of some diseases is more likely to be present.

Keep records of disease occurrence. Note when symptoms are first seen. Likely this is when they might start to develop in the future. Note how severe diseases become. Take pictures of any symptoms of uncertain identity. Use the macro setting to get a good close-up. Pictures are worth a thousand words of description about the severity of a disease. Also maintain records of management practices used.

Make sure diseases are accurately identified. This is critical for ensuring the proper management practices are used. There are some highly effective but narrow-spectrum fungicides that are the best choice for the targeted disease but ineffective for other diseases. Submit fresh samples immediately by overnight mail to in-state diagnostic labs. For future reference, take photographs and/or press leaves between paper towel in a phone book with additional books on top for weight.

Check weekly extension newsletters. This is a good source of information on disease outbreaks and up-dates on management.

CT <http://www.ipm.uconn.edu/IPM/veg/htms/pestmsg.htm>

MA <http://www.umassvegetable.org/newsletters/index.html>

ME (organic) <http://www.mofga.org/Publications/PestReports/tabid/732/Default.aspx>

NH <http://extension.unh.edu/Agric/AGFVC.htm>

VT <http://www.uvm.edu/vtvegandberry/newsletter/welcomemain.htm>

Weekly updates on late blight occurrence are being posted on the web at

http://nysipm.cornell.edu/scouting/late_blight/default.asp and they will be available in 2010 through a listserv for growers. Contact Abby Seaman at ajs32@cornell.edu for information.

Apply fungicides and bactericides preventively or beginning at disease onset. Do not wait until a disease is well established to start treatments. Actigard, phosphorous acids, Regalia, Companion and other fungicides that activate the plant's defenses (systemic acquired resistance = SAR) need to be applied starting well before disease onset to be effective. Also begin applying copper fungicides for bacterial pathogens before symptoms are seen. Use TOM-CAST to determine when to apply fungicides for early blight. Do not spray when plants are wet and do not use an airblast sprayer on crops that have bacterial diseases to avoid moving the pathogen. A list of fungicides labeled for use on tomatoes is on-line at

http://vegetablemndonline.ppath.cornell.edu/NewsArticles/Tom_LabeledRts.html.

Fungicide program with conventional products for all diseases that could occur on field-grown tomatoes in the northeastern US:

Contans for white mold before or at planting or transplanting. Apply to soil. Treatment in the fall and again in the spring may improve control.

Streptomycin (ex Agri-mycin) for bacterial diseases, Decree (Group 17) for Botrytis gray mold, and copper for bacterial and fungal diseases during transplant production in the greenhouse.

Products for damping-off on seedlings include Ridomil Gold to soil at planting and Previcur Flex as a directed spray to lower stems and soil.

Protectant fungicides (copper, chlorothalonil, mancozeb) before disease observed. Alternate with Actigard for bacterial speck and spot.

Foliar fungicides for specific diseases (alternation amongst products in different FRAC Groups is needed for managing resistance and often is a label restriction, also tank-mix with protectant fungicides):

Anthracnose: QoI fungicides (FRAC Group 11; Quadris, Cabrio, Flint); apply one of these tank-mixed and in alternation with protectant fungicides.

Bacterial diseases: Actigard, copper fungicide applied with mancozeb. Tanos is labeled for suppression used with copper plus mancozeb.

Botrytis gray mold: Endura (no more than 2 sprays)(Group 7), Scala (9), Cabrio (11) (suppresses); apply these with protectant fungicides and in alternation. Uncommon in field-grown crops.

Phytophthora fruit rot and root rot: Quadris or Tanos (11), Ridomil (3), Gavel (22).

Early blight: Endura (FRAC Group 7), Scala (9), Tanos (27), QoI fungicides (11; Quadris, Cabrio, Flint or Reason); apply these alternately and with protectant fungicides. Pathogen strains resistant to QoI fungicides and strains with reduced sensitivity to chlorothalonil have been detected in a few locations in the US where these products are used intensively.

Late blight: Curzate or Tanos (both have same active ingredient in FRAC Group 27), Presidio (Group 43), Previcur Flex (28), Ranman (21), Reason (11), Revus (40), Gavel (22), and Forum (40). These need to be tank-mixed with a protectant fungicide, except for Gavel, which contains mancozeb. Note that applying chlorothalonil weekly starting before disease onset has provided good control in fungicide efficacy experiments. This disease is extremely difficult to control with fungicide applications started after detection. Curzate and Tanos have good curative activity but short residual activity, thus another fungicide will be needed about 5 days after application. Previcur Flex has good systemic activity and thus protects stems and new growth. Uncommon.

Septoria leaf spot: QoI fungicides (FRAC Group 11; Quadris, Cabrio, Flint, Reason, Tanos); apply one of these tank-mixed and in alternation with protectant fungicides.

Powdery mildew: Rally (3), QoI fungicides (FRAC Group 11; Quadris, Cabrio, Flint); apply these with protectant fungicides and in alternation.

Leaf mold: Tanos, protectant fungicides. Uncommon in field-grown crops.

Fungicides for organic production: Actinovate, Companion, Regalia SC, Sporatec AG, Organocide, Serenade, Sonata, and copper (e.g. Champ WG, Nordox 75 WG, and NuCop HB).

Destroy infested crop debris after harvest and incorporate deeply into soil to hasten decomposition for pathogens that can survive on debris in soil. Anthracnose, bacterial diseases, early blight, and Septoria leaf spot.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Check labels for local use restrictions (eg Reason cannot be used on LI). Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.