

MANAGING LATE BLIGHT IN ORGANICALLY - PRODUCED TOMATO

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Information about the pathogen and disease:

Late blight is a potentially very destructive disease that fortunately has been occurring very sporadically in most of the northeastern US most growing seasons. 2009 was unprecedented because this disease was very widespread, started to develop very early, and had tremendous impact on growers and gardeners. While another year like 2009 is not expected, late blight could be important again in 2010 if measures are not taken to ensure the pathogen does not survive in the region through the winter.

Typically potato is the main crop affected because infested tubers currently are the main source of initial inoculum. Also, the strain (genotype) that has been occurring on potato (US-8) is not as aggressive on tomato. Other potential sources are infected tomato transplants and infected crops in frost-free areas that produce spores wind-dispersed to crops in other areas. Late blight has been occurring most years in Florida since at least 1993. Affected tomatoes survived the cold period in January 2010, thus late blight is expected to keep on developing into the spring in Florida again this year. Since 2005 late blight has continued developing into May in Florida, which is several weeks later than in the past. This suggests a strain has developed able to tolerate warmer temperatures, and it means this potential source of inoculum persists until crops are being produced north of Florida. Tomato and potato are grown throughout most of the eastern US forming a potential 'green bridge' for the late blight pathogen (*Phytophthora infestans*) to progress through.

Currently the late blight pathogen is only known to be able to survive on living host plant tissue (which includes tubers) in the US. It is an obligate pathogen unlike the early blight pathogen that can survive between crops on infested debris. This is because usually only one mating type of the pathogen exists in an area. Mating types are the fungal equivalent of males and females. When just one mating type is present, the pathogen can only reproduce asexually, which yields wind-dispersed spores (sporangia containing zoospores) that are in the fuzzy fungal growth that is common on affected tissue. When both mating types infect the same plant tissue and grow together, they can reproduce sexually and produce oospores, which are able to survive in soil overwinter in the absence of host tissue. Both the A1 and A2 mating types exist in Florida, but oospores have not been found there yet. Most pathogen isolates (individuals) typed recently in other states have been A2, including in 2009. A1 was found in PA and VA in 2009. Both mating types have been present and producing oospores in some areas of Europe (including Scandinavian countries) for at least the past decade. Consequently late blight occurs more regularly and rotation is now needed to manage this disease.

Late blight can destroy a crop if unmanaged. It is the same disease that caused the Irish Potato Famine in the 1840s. The pathogen is well named: 'Phytophthora' in Latin means 'plant destroyer'. Affected foliage tissue is quickly killed. Impact is especially great when stems are infected because all tissue above this point will die. Additionally fruit at any stage are susceptible. This disease can be explosive especially under favorable conditions because the pathogen can produce a lot of wind-dispersed spores and it can cycle very quickly, progressing from infection to new lesion (spot) producing spores in about 7 days. While cool, rainy conditions are especially favorable, late blight can develop in the absence of rain when relative humidity is at least 90%. Many images of symptoms are available on the internet to assist with identification. Mine are posted along with additional information at:

<http://www.hort.cornell.edu/lateblight>

Steps for managing late blight in organically produced tomato:

1. Select varieties with resistance. Mountain Magic and Plum Regal are the first varieties released with resistance to late blight; they also have resistance to early blight and Septoria leaf spot. They were developed in the northeast. Seed is expected to begin to be marketed by 2011. More are in development. These varieties are all being bred to contain known major genes for resistance. It is important to understand that resistance genes with the greatest suppressive effect tend to have activity for specific genotypes, and this pathogen has potential to evolve new genotypes able to overcome these genes. Therefore, use an integrated management program to minimize selection pressure on the pathogen to adapt and to increase likelihood of effective control. Obtain current information on genotypes occurring. Late blight was observed by growers to be less severe in 2009 on some other varieties, notably cherry types including Matt's Wild Cherry and Sun Gold Cherry.
2. Use transplants produced in an area where late blight is not developing on plants inside or near the greenhouse. Some strains of the late blight pathogen can infect petunia and some solanaceous weeds. Inspect transplants carefully before planting to ensure none have symptoms of late blight. The pathogen cannot survive on tomato seed. Avoid southern-grown transplants.
3. Control volunteer tomato and potato plants as well as solanaceous weeds, in particular hairy nightshade and bittersweet nightshade. Other weeds and ornamental plants that are also susceptible to some pathogen genotypes include jimson weeds, golden henbane, climbing nightshade, devil's trumpet, Sodom apple, potato vine, apple of Peru, porcupine tomato, mandrake, tree tobacco, petunia, and calibrachoa. The late blight pathogen cannot survive over winter on these plants, even perennial species, because the pathogen only infects leaves and other tissue killed by cold temperatures; but they do serve as a place where the pathogen, once in an area, can multiply unsuppressed when they are not located in a fungicide-treated crop.
4. Regularly inspect tomato as well as potato and tomatillo crops, which are also susceptible, for symptoms of late blight. Most extension offices provide diagnostic services.
5. Check local extension newsletters each week for information about late blight occurrence. Note that during cloudy conditions spores of the late blight pathogen can survive being dispersed in wind currents long distances (miles!) because they are protected from the killing effects of UV radiation. Rain can bring these spores down on to plants far from the affected plants that were their source.
6. Monitor the late blight forecast model at http://uspest.org/risk/tom_pot_map. This provides forecasts of when conditions have been and likely will be favorable for specific locations, but does not consider presence of inoculum, which is usually the limiting factor and thus the deciding factor for outbreaks.
7. When there is a risk of late blight occurring and fungicide applications are going to be used as a component of management, apply approved fungicides on a regular preventive schedule. Limited evaluations conducted to date of individual organic products suggest that copper is the most effective. Late blight is difficult to control, and can be impossible when fungicides are not applied before disease onset. Thorough spray coverage is critical. See section at end if any fungicide will be used.
8. If symptoms of late blight are found in isolated areas in a planting, it may be possible to save the crop. Success depends on how early in disease development symptoms are found, how many infections are present that have not yet resulted in symptoms (spore germination to symptom takes about 7 days), how quickly and thoroughly diseased tissue will be removed, environmental conditions, proximity to other gardens or farms where late blight is developing, and what management steps will be taken. Immediately remove affected plant

tissue. It is best to do this in the middle of a sunny day after the leaves have dried when there will be fewer spores and those dislodged in the process will likely be exposed to UV radiation. Put affected tissue in garbage bags, dig a hole and bury it, or put it in a pile and cover with a tarp. Heat that develops from sunlight hitting the tarp will quicken death of plant tissue and the pathogen. Inspect plants daily thereafter for a week in order to find any additional affected plants that develop symptoms, then return to inspecting at least once a week. Apply organic fungicides at least every 7 days as indicated on the label until final harvest or the crop is destroyed. It is not possible to control late blight by solely relying on removing affected tissue. Even when rain is not occurring, high humidity and dew over night can provide a sufficient moisture period for infection. Especially when conditions are favorable it may not be possible to control late blight with copper. Monitor disease development and be prepared to destroy foliage if late blight isn't controlled (see step 11 below).

Aggressive management will minimize the opportunity for both mating types if present in an area to infect the same plant tissue (chance event for spores to land on same plant), grow together, and produce oospores through sexual reproduction.

9. Promptly inform neighbors growing susceptible crops and also state extension staff when you find late blight so that others can be informed and take action to protect their plants. Due to the potential for spores to move from your plants to others, which could be destroyed if not protected, late blight needs to be treated as a 'community disease' for which communication is an important management tool.
10. Work in affected fields last. Between fields, clean and disinfest equipment with a product and rate allowed by your certifier. The NOP national list allows chlorine materials (calcium and sodium hypochlorite, chlorine dioxide), hydrogen peroxide, and peracetic acid.
11. When late blight starts to become severe the foliage should be destroyed to eliminate the planting being a source of spores for other tomato or potato plantings on the farm or other farms. Propane flammers are a good way to quickly kill foliage, but are not suitable where tomatoes are grown with straw or plastic mulch or trellised. This is an obligate pathogen that needs living host tissue to survive. To initiate plant death with trellised tomatoes, go through the planting and cut all main stems at the base, then come back through and cut stems further up in the canopy. Disturb foliage as little as possible to minimize the amount of spores dislodged. It is best to do this work in the middle of a sunny, preferably calm day after any moisture on leaves has dried to minimize the quantity of spores and also their likelihood of survival in the process. Next remove trellising line and stakes, then flail chop. Bagging affected tissue or burying is recommended where feasible with small plantings.

The late blight pathogen is not able to survive in plant debris unless the pathogen produces oospores, therefore it is not necessary to physically remove affected plant tissue from a field.

The late blight pathogen cannot survive on stakes, therefore it is not necessary to trash or even disinfect the stakes to manage this disease. Stakes should be disinfected however, especially if bacterial diseases also developed in the planting.

12. Fruit from an affected field can develop symptoms after harvest and thus should be inspected just before marketing. Customers should be aware of the potential that fruit could have a shortened shelf life when picked from an affected field. It may be wise to recommend that any fruit that rot be put in the trash rather than on a compost pile since there is a possibility that the pathogen could produce spores before the fruit completely rotted.

High tunnels and greenhouses do NOT always protect tomatoes from late blight. While often less severe, the disease can still develop because the pathogen does not need leaf wetness for infection and its spores can be dispersed by wind through open vents when the disease is developing on field-grown crops in the region. Relative humidity of at least 90% is favorable. Use cultural practices to minimize humidity and monitor with a sensor.

Additional Information About Copper and Other Fungicides for Late Blight.

OMRI-listed fungicides labeled for late blight include Sonata, Serenade, Sporatec, Regalia, OxiDate, and copper. Companion meets NOP guidelines and is in review with OMRI. Check to make sure product is registered in the state and check with your organic certifying agency to determine what products, including specific copper formulations, are approved. In some states products that are exempt from EPA registration because of their ingredients, such as Sporatec, do not need to be registered in the state (this is the case in NY but not in ME). There is limited data from replicated experiments on efficacy for late blight of products approved for organic production. Copper has provided some control where other products have failed in efficacy trials. Effective control of late blight with copper was achieved by some organic growers in 2009; however, copper is not considered inherently highly effective by pathologists studying late blight management, thus some suspect the main pathogen genotype present in 2009 is not as aggressive as genotypes present in fungicide evaluations. Lack of highly effective organic products, combined with the fact that established spots, being uncontrollable with fungicides, will continue to produce spores, plus the explosive nature of late blight, is why a preventive spray program is recommended including by organic growers in areas where late blight occurs regularly. It is especially important to use a preventive schedule with products such as Regalia and Companion that act by affecting plants' natural defense mechanisms.

Before using any fungicides read the label. Note that the 'signal word' for copper fungicides is 'danger'. The signal word assigned to a pesticide is based on how harmful it might be if swallowed, inhaled, or exposed to skin or eyes of the person handling it. Danger is assigned when the pesticide is highly hazardous by at least one of these routes of entry into a person. The other signal words used for pesticides are 'warning' for moderately hazardous chemicals and 'caution' for slightly hazardous chemicals. In the precautionary statement on pesticide labels is a section on 'hazards to humans', which explains how the product could affect someone exposed to it. This is followed by the 'personal protective equipment' (PPE) that is needed when mixing and applying the pesticide. Hazards for copper fungicides are: "Corrosive. Causes irreversible eye damage. May cause skin sensitization reactions in certain individuals. Do not get in eyes or on clothing. Harmful if swallowed or absorbed through the skin. Avoid contact with skin." Also 'avoid breathing dust.' for some formulations. PPE that applicators and other handlers must wear when using copper is: long-sleeved shirt and long pants, chemical-resistant and waterproof gloves, shoes plus socks, and protective eyewear. First aid information is also provided on labels for accidental exposure; know this in advance to avoid delay in treatment. There are also important 'Agricultural Use Requirements' described on labels. This includes the 'restricted-entry interval' (REI), which is 24 hours for copper, what PPE is required for anyone who enters and will contact anything treated before the end of this interval, which for copper is the same as for applicators, and what precautions must be followed after an application, which for copper includes having an eye flush container at the WPS decontamination site for workers entering the field for 7 days after treatment. Note that fruit cannot be harvested during the REI. EPA's Worker Protection Standard for Agricultural Pesticides (WPS) is a regulation that must be complied with on farms where any pesticide is used, including those approved for organic production. Under this regulation, all agricultural workers on the farm must receive pesticide safety training, decontamination supplies, notification of pesticide applications, access in a central location to a log of pesticide applications plus information about these pesticides, any

required personal protective equipment, and emergency medical assistance when needed. Restricted-entry intervals must be adhered to. Also, pesticide safety posters must be displayed.

Labels also specify how often the product can be applied. Most copper fungicides are labeled for use every 5 or 7 to 10 days. These labels will change in the near future following re-registration of copper fungicides in the US. Changes will include more explicit use descriptions plus a defined minimum retreatment interval of 3 days and maximum annual rate of 17.4 lbs metallic copper per acre for tomato (these limits are specified in EPA Reregistration Eligibility Decision (RED) for coppers). However, applying copper more frequently than every 5 days generally is not considered necessary, even following rain, because these products are formulated with adjuvants that help keep them on foliage. Labels always should be checked on new product containers for changes such as this before using. It is especially critical where copper is being applied frequently to test soil regularly to ensure this is not resulting in an unacceptable accumulation of copper. Before applying copper more frequently than every 5 or 7 days it is advisable to confirm with the certifier that this is permissible. Also check on additional limits such as number of applications.

Calibrate sprayers before needed to ensure rate applied will be neither above nor below labeled rate.

When using any pesticide note that it is a violation of Federal law to use the product in a manner inconsistent with its labeling.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Confirm state registration and organic approval with certifier. Any reference to commercial products, trade or brand names, is for information only; no endorsement is intended.

Prepared: 08-10-09. Updated: 03-03-10