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Managing Late Blight in Tomato and Potato – An Essential Part of Gardening

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It is important to recognize that late blight is not like other diseases. It can't be lived with because of its potential impact. Without control measures, total loss of tomatoes and potatoes often occurs. Its occurrence in your garden can affect other gardens and farms due to the wind-dispersed spores. Fortunately it has been occurring very sporadically in most of the northeastern U.S. most growing seasons. 2009 was unprecedented because this disease was very widespread, started to develop very early, was present on tomato plants for sale at garden centers, 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.

Information about the pathogen and disease:

Typically potato is the main crop affected because infested potato tubers currently are the main source of initial inoculum. Also, the strain (genotype) that has been occurring on potato is not very 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. Infected petunia plants were a source one year. 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 U.S. forming a potential 'green bridge' for the late blight pathogen (*Phytophthora infestans*) to progress through. Several strains found as far north as Pennsylvania in 2009 are thought to have moved this way. Tomatillo is also a host. Petunia is a host for at least one strain.

Pathogen strains vary in their aggressiveness on their host plants. They arise through chance mutation or recombination during sexual reproduction. The new strains present in 2009 were more aggressive on tomato than on potato, thus tomato plants were often severely affected while near-by potatoes had much less late blight. Those strains are not considered as aggressive as some strains that have occurred on tomato in the past! The 'usual' potato strain (US-8), which is very aggressive on this crop, occurred mostly on potato as usual in 2009.

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 have a thick wall enabling them 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 Poland and Scandinavian countries) for at least the past decade. Consequently late blight occurs more regularly and rotation is now needed to manage this disease. The second mating type may have been transported to Europe in potatoes from Mexico in 1976.

Late blight can destroy a crop if unmanaged. 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 tomato fruit at any stage are susceptible. Potato tubers can become infected when spores on stems are washed into the ground. 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 6 to 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%. And strains tolerating warmer temperatures have been occurring recently primarily on tomato enabling late blight to develop during the summer.

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 the garden:

1. Select varieties with resistance.

Tomato: 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 for 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 strains, and this pathogen has potential to evolve new strains able to overcome these genes. Resistant varieties, therefore, should not be the only management practice used. Late blight was observed to be less severe in 2009 on some other varieties, notably cherry types including Matt's Wild Cherry and Sun Gold Cherry. There is more information about tomato varieties and late blight in a downloadable pdf file posted under 'Tomato' at <http://vegetablemdonline.ppath.cornell.edu/NewsArticles/NewsList.htm>

Potato: There are no varieties with a high level of resistance. Those described as having some resistance include Elba, Kennebec, Allegany, Sebago, Rosa, Defender, Jacqueline Lee, and Ozette. Elba is considered the most resistant. Late blight in 2009 appeared to be less severe on some other varieties, notably Island Sunshine.

2. Select tomato transplants and potato seed with low chance of being infected ('disease-free').

Tomato: Grow your own transplants or use those 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 purchasing to ensure none have symptoms of late blight. The pathogen cannot survive on tomato seed.

Potato: Use certified seed potatoes (which means the producer's crop was inspected and met state requirements that include set tolerances for key diseases). Ask whether late blight occurred where they were produced. Inspect them to ensure none have symptoms of tuber blight. Infected tubers used as seed or not destroyed from the previous crop are considered the primary source of initial inoculum for late blight in the Northeast.

Plant only potatoes (tubers) being sold as 'seed'. Do not use potatoes from your garden, even if you don't think you had late blight. And do not use potatoes from a grocery store: there is higher tolerance for disease in 'table stock'.

3. Control volunteer tomato and potato plants as well as solanaceous weeds, in particular hairy nightshade and bittersweet nightshade. It is important to destroy any volunteer potato plants as soon as they sprout, rather than waiting until symptoms are seen because by then new spores likely will have already developed and spread to other gardens or farmers' fields. Other weeds and ornamental plants that are also susceptible to some pathogen strains 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. At least once a week, inspect tomato, potato and tomatillo for symptoms of late blight. Most extension offices provide diagnostic services.
5. Check the web 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 them on a regular preventive schedule. Late blight is difficult to control, and can be impossible when fungicides are not applied before disease onset. Thorough spray coverage is critical.

Read the label of the fungicide, or the label of any other pesticide you are considering using, before purchasing the product. The specific directions on fungicide labels must be adhered to. Electronic versions of labels are available on the web. Labels for some products formulated for homeowner use are available at the Bonide web site. Make sure the plant to be treated plus the disease or insect pest are listed on the label. Fungicides can be toxic to some plants and they are not effective for all diseases. It is important to know the precautions for a product in advance so that you can obtain any necessary protective gear. There can be potential hazards to humans from exposure to a pesticide while applying it. Some are harmful if swallowed, absorbed through skin, inhaled, or get in eyes. Labels contain information on what "Personal Protective Equipment" is needed for the person handling the pesticide and first aid if exposure occurs. For example, anyone using chlorothalonil fungicide must wear: 1) A NIOSH approved respirator with an organic vapor cartridge or canister plus prefilter. (note that this is not a dust mask), 2) Waterproof gloves, 3) Protective eye wear, 4) Shoes plus socks, and 5) Long-sleeved shirt and long pants.

8. If suspected symptoms of late blight are found, take a sample in a plastic bag to the local extension office for confirmation as soon as possible. If it is confirmed:
 - a. 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. But don't wait days for these conditions. 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. For the same reason, leave garbage bags in sun for a few days before throwing out.

It may be possible to save plants affected by late blight. 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.

- b. Promptly inform neighbors growing susceptible crops so that they 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.
 - c. Inspect plants daily thereafter for a week in order to find any additional affected tissue that develop symptoms, then return to inspecting at least once a week.
9. Apply fungicides frequently (typically weekly) as indicated on the label until the last tomatoes are picked or potatoes are dug. It is rarely 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 very favorable, it may not be possible to control late blight even with fungicides due to how quickly and destructively the disease can develop. Monitor disease development and be prepared to destroy foliage if late blight isn't controlled (see step 11). See step 7.

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.

10. Tomato: Any fruit that rot after picking should be put in the trash or buried in a compost pile since there is a possibility that the pathogen could produce spores before the fruit completely rot. Unaffected parts of fruit can be consumed, but fruit from affected plants should not be canned due to concern that the pH may not be sufficiently low.
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 in nearby gardens and farms. This is an obligate pathogen that needs living host tissue to survive. 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. Bag affected tissue or bury in the ground or in a compost pile. Bags with affected plants should be left for a few days where they will be exposed to sun so that the plant tissue is killed before the bags go to the trash. Do not just leave plants on the ground or on top of a compost pile where spores will continue to be produced until the plant tissue dies. Other options where there are a lot of affected plants include putting them in a pile then covering

them with a tarp until heat from the sun kills the plants or using a propane flamer for weeds.

Tomato: 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 plus trellising line to enable plant removal. It is best to do this work in the middle of a sunny, preferably calm day. Bag, bury, or tarp removed plants as described in 8 above.

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

Potato: If tubers are present, plants could be cut at the base and the tubers left for about two weeks to provide an adequate time for pathogen spores to die and to allow the skin of the tubers to mature. Otherwise plants could just be pulled up and disposed of. Dig potatoes when soil is not too wet or cool (above 54F). Avoid bruising them. Tubers from plants that had late blight should be consumed as soon as possible. Check them for symptoms before consuming. Tubers not eaten immediately should be kept in a cool, dry place where there is air movement if possible.

12. The late blight pathogen is not able to survive overwinter in plant debris unless the pathogen produces oospores, therefore rotation is not presently a necessary management practice for this disease, but it is needed for other diseases (e.g. early blight).