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# Late Blight: Recent Occurrences, Challenges, and Future Outlook (2013)

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Late blight is a potentially very destructive disease that unfortunately has been occurring routinely recent years in the northeastern US. For many years before 2009 it occurred very sporadically in most of the region most growing seasons, with the exception of major potato production areas. Late blight is the disease associated with the Irish Potato Famine in the 1840s. The pathogen is well named: 'Phytophthora' in Latin means 'plant destroyer'. Typically potato is the main crop affected because infested tubers have been the main source of initial inoculum of the pathogen (*Phytophthora infestans*). Also, there has been one genotype (strain) occurring during recent years on potato (US-8) that is not as aggressive on tomato. Potato growers have been diligent about implementing a sound management program and recent fungicide registrations mean conventional growers now have several highly effective fungicides to use, thus affected potato crops are less likely to be important sources of the pathogen especially for tomato crops. Other sources of the pathogen that have occurred recently are infected tomato transplants, infected petunia bedding plants (one genotype), and infected crops in frost-free areas that produce spores wind-dispersed to crops in other areas.

The late blight pathogen in Florida has changed recently, which has affected disease occurrence there as well as in other states in the eastern US. Late blight has been occurring most years in Florida since at least 1993. Affected tomatoes in South Florida have been surviving extreme cold periods in December and January, thus late blight has been able to keep on developing into the spring in Florida each year. In contrast with the situation in potato, several genotypes have been detected in Florida with some year-to-year variation in the pathogen population. Since 2005 late blight has continued developing into May in Florida, which is several weeks later than in the past. This suggests a genotype 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 to progress through eventually reaching the northeast. Since 2005 in the northeast there have been sporadic reports of late blight on tomato appearing from August to October.

2009 was unprecedented especially in the northeastern US because late blight was very widespread, started to develop very early (June), was present on tomato plants for sale at garden centers, and had tremendous impact on growers and gardeners. Many gardeners and some growers saw late blight for the first time. Genotypes of the pathogen differ in their ability to cause late blight on susceptible host plants. They arise through chance mutation or recombination during sexual reproduction. The genotype on tomato in the northeast in 2009 was fairly aggressive on tomato, but not considered as aggressive as some genotypes that occurred in previous years on tomato, while it was much less aggressive on potato and thus easier to control. US-8 also occurred on potato in some areas in 2009. Additional genotypes were found from FL through PA, likely resulting from pathogen spread northwards through the eastern US.

Late blight occurred less commonly in 2010 than feared. There was a lot of concern after the 2009 epidemic that the pathogen would be surviving throughout the northeast in potato tubers left un-harvested in the ground or kept to use to plant in 2010, and that it would be impossible to educate all gardeners and growers about late blight who did not previously have experience with this disease and thus lacked knowledge about how the pathogen survives. Infested tubers were anticipated to be an especially good way to survive for the main pathogen genotype occurring in 2009 because it is not very aggressive on potato, thus infested tubers would not rot as quickly as when infested by an aggressive 'potato' genotype. There evidently was not a lot of inoculum in the region in 2010, conditions were less favorable with far fewer rain events than in 2009, plus many growers and gardeners were prepared to respond when late blight developed. The source of the pathogen for several occurrences of late blight on tomato in 2010 remains undetermined, which is disconcerting. Potatoes near-by could have been the source, but affected potato plants were not always found. This may be because symptoms caused by a 'tomato' genotype would be harder to find on potato, and the size of many potato crops precludes examining each plant. High tunnels, greenhouses, and gardens were the locations of affected tomatoes found early in the 2010 growing season (May – June). Definitive knowledge of the source of these outbreaks would be helpful for managing late blight in the future.

There were several important developments in 2011. A large, five-year, national project with government funding was started to investigate late blight, monitor pathogen genotypes, and improve management by developing resistant varieties and a monitoring program. Project web site is http://usablight.org/. Through this project it was documented that there were several genotypes present in the northeast including ones not detected here previously. One of these (US-23) was responsible for a severe outbreak of late blight that occurred on Long Island in 2011. It had greater impact than the outbreak that occurred there in 2009. It likely started in a garden environment, possibly a single garden. *Phytophthora infestans* was shown to be able to be transmitted to seedlings growing from tomato fruit recently rotted by late blight.

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 pathogen equivalent of males and females. When just one mating type is present, the pathogen can only reproduce asexually, which yields ephemeral, 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 in the absence of host tissue and during adverse conditions such as cold winter. Both the A1 and A2 mating types have been found in FL, which means the pathogen could reproduce sexually, but oospores have not been found there yet. Most pathogen isolates (individuals) typed recently in other areas have all been either A1 or A2, the two have rarely been found in proximity. It is important to understand that both mating types have been present and producing oospores in some areas of Europe (including Scandinavian countries) for at least the past decade, and consequently late blight occurs more regularly and rotation is now needed to manage this disease. This could occur in the US.

On Long Island, NY, late blight has been detected early in the growing season every year since 2009. First observations were on 23 June 2009, 16 June 2010, 24 June 2011, and 29 May 2012. In 2010, symptoms were first seen by gardeners who responded promptly by submitting a sample for diagnosis immediately, then destroying all tomatoes and potatoes as soon as they got confirmation. There was no evidence that the pathogen

had spread. Source of this outbreak was thought to be potatoes from a grocery store used to start plants. Outbreak in 2011 likely started on garden tomatoes. First symptoms in 2012 were found in an early potato crop. Based on the symptoms seen (scattered spots on upper leaves), late blight did not originate in this crop. Source of the pathogen was not found; possibly it was one of the many volunteer potato plants that grew following the mild winter. US-22 (A2 mating type) was the only genotype found in 2009 and 2010 while US-23 (A1) was the only one found in 2011 and 2012. US-23, which was first detected in 2010, was the main genotype found in 2012 in the US.

Late blight is a challenging disease because it can be difficult to manage, especially when a preventive approach is not taken, and it cannot be 'lived with'. Not managing the disease is rarely an acceptable option because of the huge impact late blight can have on the affected crop as well as crops at other farms that receive spores from an unmanaged outbreak. This is especially problematic for organic growers who choose to produce crops without any approved pesticides. Additionally, if both mating types of the pathogen are present in a crop, when left unmanaged there is greater potential for the two to become together in a plant (this is a chance event) and have the opportunity to produce oospores, which enable the pathogen to survive without living plant tissue as well as evolve new genotypes through sexual reproduction, which is how oospores are produced. Most other diseases can be 'lived with' because the entire crop will not be lost. Late blight can destroy a crop if unmanaged. Affected foliage tissue is quickly killed. Impact is especially great when stems are infected because all tissue above this point will die. Tomato 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, but as few as 4 days with a highly virulent genotype. While cool, rainy conditions are especially favorable, late blight can develop in the absence of rain when relative humidity is at least 90% (including in a greenhouse or high tunnel). And genotypes tolerating warmer temperatures have been occurring recently primarily on tomato enabling late blight to develop during the summer.

Many plant diseases affecting foliar tissue can be successfully managed with fungicides by at least weekly inspecting plants for symptoms and/or monitoring conditions, and then starting applications at first detection or when conditions are favorable; but this is not usually possible with late blight, especially in tomato, making management challenging. When symptoms are first seen, too often they are too numerous and widespread in the crop to be able to successfully protect the remaining healthy tissue, even with the most effective, systemic conventional fungicides. Organic fungicides, and most conventional ones, cannot control the pathogen once established in the plant, thus the pathogen in diseased tissue continues to produce spores. Fungicides cannot 'cure' like human medicines can, nor does the diseased plant have the capacity to 'heal' as animals can, thus the tissue damaged by late blight (or any other disease) will remain so. When late blight begins to develop in a potato crop from infested seed pieces, it can be possible to detect the disease while localized at the source and then destroy the source before spread has occurred. There are programs available that predict the risk of late blight developing based on environmental conditions that have occurred plus forecasts. These do not consider whether the pathogen is present, which of course is essential for disease occurrence, thus anyone using these programs needs to decide the risk of the pathogen being present based on reports from other growers and extension specialists (see item 7 below). There is a decision support system to assist growers with timing of fungicide applications.

Future outlook depends on growers, plant breeders, researchers, product developers, as well as the pathogen itself. Late blight could return to occurring sporadically if growers (including gardeners) are diligent about management and

effective tools are available through the work of plant breeders, researchers, and product developers. The pathogen has proven capable of evolving to overcome fungicides and resistant varieties. Late blight was severe in the US in the 1990s when a genotype appeared that was not controlled by the main fungicide being used by conventional growers. On the other hand, late blight could become a common disease like early blight if both mating types of the pathogen become established together in the north. If this happens it could have a profound impact on production of tomatoes and potatoes, especially for organic growers and gardeners.