Update on late blight management: can resistant varieties play a role?

Margaret Tuttle McGrath

Department of Plant Pathology and Plant-Microbe Biology, Cornell University
Long Island Horticultural Research and Extension Center,
3059 Sound Avenue, Riverhead, NY 11901. 631-727-3595. mtm3@cornell.edu

Late blight has developed on tomato in the Northeastern USA every season since 2009. Change in occurrence of this destructive disease is at least partly due to the fact there are new genotypes (strains) of the pathogen in the USA. Many are more aggressive on tomato and more tolerant of warm temperatures than genotypes like US-1 and US-8 that previously were dominant.

Resistant varieties can indeed play an important role in managing late blight in tomato. Several have proven very effective against the pathogen genotype that has been the dominant one in the northeast recently, which is US-23. Resistant varieties are a valuable tool for managing any plant disease, but they are especially valuable for late blight, because this disease can be very difficult to control with fungicide applications started after onset and it cannot be 'tolerated'. Left unmanaged, late blight is much more likely than other diseases to completely destroy a crop and also to have devastating impact on other tomato plantings in a region due to the quantity of pathogen spores that can be produced and easily dispersed by wind.

Evaluations of resistant varieties are being conducted each year on Long Island, NY, as well as elsewhere. Very good resistance of foliar and fruit symptoms of late blight was exhibited by all tomato varieties and experimental hybrids evaluated that have the *Ph2* and/or *Ph3* major genes for resistance, plus some with undetermined resistance, which were Plum Regal (homozygous Ph3), JTO-545 (heterozygous Ph3), Legend OP (Ph2), Matt's Wild Cherry (undetermined resistance, possibly Ph3), Jasper (undetermined resistance, likely Ph2 and/or Ph3), Iron Lady (homozygous Ph2 + Ph3), and Defiant PHR, Mountain Magic, Mountain Merit, and experimentals from the Cornell University Dept of Plant Breeding (all heterozygous Ph2 + Ph3). Heterozygous means the hybrid has one copy of the resistance gene; homozygous means it has a copy from both parents which is expected to impart a higher level of resistance. Legend, the only entry with just the Ph2 gene, was numerically, but not significantly, more severely affected by late blight than the other resistant entries in 2012 (2013 data has not been analyzed yet). Tomatoes with just the Ph3 gene were more severely affected by late blight than the resistant entries that also had the Ph2 gene.

Late blight became severe in New Yorker (Ph1). Severity of symptoms was similar to the varieties without major resistance genes, which were Mountain Fresh Plus, Juliet and Brandywine. In addition to being ineffective against genotype US-23, the Ph1 gene is also not effective for other genotypes of the pathogen that have occurred in recent years. Thus varieties with only this gene are not recommended.

In conclusion, best suppression of the late blight US-23 genotype was achieved with tomato possessing both the Ph2 and Ph3 resistance genes. Only a few fruit with symptoms of late blight were observed on these entries. Mountain Magic, Jasper, and Matt's Wild Cherry were the three

resistant varieties receiving the highest overall rating in the 10 evaluations conducted by public groups in 2012.

Resistant varieties need to be part of an integrated program for managing late blight.

Being ready is an important aspect of successfully managing late blight in tomato and potato. This entails not only understanding in advance how to manage this destructive disease, but also understanding that it can start to develop in a crop at any time, as well as understanding the importance of reporting occurrences and managing all outbreaks of this highly contagious, community disease. The pathogen population has changed in the USA, which partly explains why late blight has been occurring more often recently. Preparing is critical because late blight is a top contender for most difficult disease to manage after detection.

Reporting occurrences of late blight is very important. This is a community disease requiring community action based on knowledge of outbreaks to avoid major losses. There is also a need to know where late blight occurs throughout the growing season in order to study movement of the pathogen and develop a predictive system to enable growers to be more informed about potential outbreaks in the future. This is a goal of the national late blight project. Thus it is important to report all occurrences. Success of this late blight project is dependent on growers reporting.

Submitting samples is also very important. Scientists involved with the national USAblight project can in a day determine the genotype of the pathogen on submitted plant tissue. This is useful for identifying the source of the pathogen. And it is very valuable to know if the strain present is sensitive to mefenoxam, the active ingredient in Ridomil, as it continues to be the most effective fungicide for late blight. US-22 and US-23 genotypes are sensitive. US-8 genotype is completely resistant. Samples are needed from multiple farms affected in a region to determine if more than one strain is present. It is very valuable to know when multiple strains are present in a region, especially if they differ in sensitivity to mefenoxam or in mating type, which is the pathogen equivalent of gender. There are now strains of both mating type in the USA. If they grow together the pathogen will reproduce sexually, creating new strains, and, even more importantly, producing a type of spore (oospore) that will enable the pathogen to survive over winter in soil in the absence of living plant tissue, allowing late blight to become a more routinely occurring disease. Therefore, finding both mating types together warrants more aggressive management.

Educating gardeners about late blight is important because a small, unmanaged outbreak can lead to a major epidemic. This is likely what happened in 2009 and on Long Island in 2011. A trifold brochure has been prepared with pictures of symptoms and information about the importance of late blight plus management practices geared primarily for gardeners. It is available for growers to provide to their customers who garden. Call 631-727-3595 (or email mtm3@cornell.edu) to request copies. Or direct gardeners to http://www.usablight.org/node/44 and http://www.hort.cornell.edu/lateblight.

Late Blight Management Steps for 2014:

1. Destroy potato volunteers and cull piles.
2. Use treated, certified seed pieces.
3. Select less susceptible potato varieties and resistant tomato varieties when possible.
4. A broad-spectrum fungicide (e.g. chlorothalonil for conventional production and copper for organic crops) applied before disease onset will protect crops.
5. Monitor occurrences at http://usablight.org/. Sign up to receive alerts.
6. Know symptoms. Inspect all potato and tomato crops weekly from emergence or transplanting. Plants in high tunnels and greenhouses are not protected. The first occurrence of late blight in 2010 in the northeast was in a high tunnel in Maryland in late April.
7. Submit any suspect symptoms (bagged) for diagnosis promptly to a Diagnostic Laboratory or an Extension Specialist.
8. Notify neighboring growers when late blight is confirmed on your farm so they can protect their crops.
9. Apply fungicides for late blight when confirmed on your farm or nearby. Alternate among fungicides in different chemical groups (as indicated by FRAC Code)(see list below) and tank mix with a protectant fungicide to manage resistance.
10. Use the Late Blight Decision Support System to decide when to apply fungicides (it is under the 'Cornell DSS' tab at the USAblight web site).
11. Promptly destroy tomato plants after harvest or when late blight becomes too severe to manage. Options include applying a fast-acting herbicide like diquat, or mowing or disking preferably on a sunny day when foliage is dry.
12. With potato crops affected by late blight, vine kill early before there are many symptoms on main stems (the most important source of inoculum for tuber blight) and before heavy rain is forecast to avoid an opportunity for spores to be washed down to tubers. Harvest at least two weeks after vine kill and before soil temperatures drop below 54 F. Avoid bruising and skinning while harvesting. Best to market after inspecting tubers for blight. If stored, cool down quickly, provide good ventilation in storage, and inspect routinely.

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. 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 New York but not in Maine). Any reference to commercial products, trade or brand names is for information only; no endorsement is intended. There is limited data from replicated experiments on efficacy for late blight of products approved for organic production other than copper.

Conventional Fungicides with Targeted Activity for Late Blight (listed alphabetically):

Curzate 60DF (FRAC Group 27). Active ingredient is Cymoxanil. EPA Reg No. 352-592. 3.2-5 ounces per acre (3.2 ounces for potatoes). 5 oz on 5-day interval when late blight present. 30 oz/A seasonal max. 12 h REI. 3 d PHI. Must be tank-mixed with a protectant fungicide. Curzate has some kickback activity when it is cool (maximum of about two days), but little residual activity (about five days).

Forum (Group 40). Dimethomorph. EPA Reg No. 241-427. 6 fluid ounces. 30 fl oz/A seasonal max. 2 consecutive spray max. 12 h REI. 4 d PHI. Must be applied with another fungicide.

Gavel (Group 22). Zoxamide + mancozeb (protectant fungicide). EPA Reg No. 62719-441. 1.5-2 pounds. 16 lb or 8 application seasonal max. 48 h REI. 5 d PHI tomato; 3 d PHI for potato (14 d in some states). Latron surfactant recommended.

Presidio (Group 43). Flupicolide. EPA Reg No. 59639-140. 3-4 fl oz for tomatoes. 12 fl oz/A seasonal max. 2 consecutive spray max. 12 h REI. 2 d PHI. Current label has a rotational restriction of 18-mo for non-labeled crops which includes sweet corn.

Previcur Flex (Group 28). Propamocarb hydrochloride. EPA Reg No. 264-678. 0.7-1.5 pint (1.2 pints max for potatoes). 7.5 pts/A seasonal max for tomatoes; 6 pts/A for potatoes. 12 h REI. 5 d PHI for tomato; 14 d PHI for potato. Previcur Flex has some systemic activity and thus can protect stems and new growth.

Ranman (Group 21). Cyazofamid. EPA Reg No. 71512-3-279. 1.4–2.75 fluid ounces (2.1-2.75 for tomato). 16.5 fl oz or 6 application seasonal max for tomatoes; 27.5 fl oz or 10 applications for potatoes. 12 h REI. 0 d PHI for tomatoes; 7 d for potatoes. Use an organosilicone and/or non-ionic surfactant (see label for directions).

Reason (Group 11). Fenamidone. EPA Reg No. 264-695. 5.5 to 8.2 fluid ounces. Alternate with other fungicides; do not make consecutive applications. 24.6 fl oz/A seasonal max. 12 h REI. 14 d PHI.

Revus (Group 40). Mandipropamid. EPA Reg No. 100-1254. 5.5 to 8 fluid ounces. 2 consecutive spray max. 32 fl oz/A seasonal max. 12 h REI. 1 d PHI for tomato; 14 d PHI for potato. Revus has some kickback activity.

Ridomil Gold Bravo (Group 4) or OLF. Mefenoxam + chlorothalonil (protectant fungicide). EPA Reg No. 100-1221. ONLY recommended for sensitive pathogen strains. 2.5 pt/A. 48 h REI. 5 d PHI for tomato; 14 d PHI for potato. Seasonal max use for tomato (potato): 15 (11.25) lbs. a.i./A chlorothalonil and 0.5 (0.4) lb. a.i./A foliar-applied mefenoxam.

Zampro (Group 40 and 45). Dimethomorph + Ametoctradin. EPA Reg No. 7969-302. 14 fluid ounces for tomato; 11-14 for potato. 42 fl oz/A seasonal max (3 applications). 2 consecutive spray max. 12 h REI. 4 d PHI. Including a spreading/penetrating adjuvant is recommended.

Fungicides for Organic Production (all OMRI-listed) and Labeled for Late Blight.
These are recommended used in combination or alternation with copper fungicide:

Actinovate AG. *Streptomyces lydicus* strain WYEC 108. EPA Reg. No. 73314-1. Efficacy documented in an experiment conducted in Florida.

Regalia. Extract of *Reynoutria sachalinensis*. Boosts plants' natural defense mechanisms against certain fungal and bacterial diseases. EPA Reg. No. 84059-2.

DoubleNickel 55. 25% *Bacillus amyloliquefaciens* strain D747. EPA Reg. No. 70051-108.

Sonata. 1.38% *Bacillus pumilus* strain QST 2808. EPA Reg. No. 69592-13.

Serenade Max. 14.6% *Bacillus subtilis* strain QST 713. EPA Reg. No. 69592-11

Companion biological fungicide. 0.03% *Bacillus subtilis* strain GB03. EPA Reg. No. 71065-3.

Sporatec AG. 18% rosemary oil, 10% clove oil, + 10% thyme oil. Exempt from registration.

OxiDate. 27% hydrogen dioxide. EPA Reg. No. 70299-2.