Development and Use of Cultivars with Resistance or Tolerances to Late Blight, Early Blight and Septoria Leaf Spot
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Each season tomato production in the moist cooler conditions of the NE faces the problem of defoliation and loss of fruit yield or quality due to one or more three major diseases affecting tomatoes: early blight (EB) (caused by \textit{Alternaria tomatophila}) and late blight (LB) (caused by \textit{Phytophthora infestans}), and Septoria leaf spot (SLS) (caused by \textit{Septoria lycopersici}). Until recently no tomato cultivars possessed tolerance or resistance to these diseases. Since 2000, researchers at Cornell and NCSU developed tomato lines resistant to LB and tolerant to EB (LB/EB lines), and the Cornell program added SLS resistance to create LB/EB/SLS lines. LB/EB and LB/EB/SLS hybrids were tested for fruit type/yield as well as blight control by cooperators in NY, NC, WV, and VA. The best LB/EB and LB/EB/SLS lines were released to seed companies. This is now resulting in release of commercial tomato hybrids possessing genetic control of one or more of these diseases. So it is an opportune time to review 1) genetic controls available for control of these diseases, 2) current commercially cultivars possessing genetic control of these diseases, and 3) how best to use these cultivars.

**Early blight genetic control:** The genetic EB control currently available is tolerance, rather than resistance. The level of EB control provided by \textit{homozygous} tolerance is definitely beneficial in plants, and will allow reduction in reliance on fungicides for EB, but homozygous tolerance does not completely control EB. Stems are clean of all but small lesions in plants with homozygous EB tolerance, preventing plant collapse; however leaves can still sustain substantial lesion and disease development under conditions that favor EB. Fruit lesions are rarely a problem.

For best control of early blight use cultivars homozygous for tolerance, and to supplement with core horticultural practices (rotation out of tomato/potato crops for at least 2 seasons, no solanaceous weeds in the field during this period, an adequate N$_2$ fertilization program). If supplemental fungicides are needed, select those with low environmental impact quotient (EIQ) values like Quadris Top or the protectant mancozeb, and make the first application after fruit set occurs. For organic production choose from among the 6 copper fungicides registered in NYS.

Do not rely on heterozygous EB tolerance for disease control; if the season is highly favorable for this disease then heterozygous resistant cultivars could have similar levels of disease as cultivars fully susceptible to EB, and require similar horticultural/spray control measures.

**Late Blight genetic control:** Three different genes have been described for LB resistance in tomato. These resistance genes are not equally affective, so it is important to know which of these genes are contained by cultivars listed as having “late blight resistance”.

\textit{Ph1}: is the LB resistance gene in the old tomato cultivar \textit{New Yorker}. \textit{Ph1} does NOT control any current pathogen genotypes such as US22 or US23, and is not used in modern cultivars.

\textit{Ph2}: was found in the cultivar \textit{West Virginia 63}, and is present as the sole LB resistance in a few cultivars. \textit{Ph2} is only effective against a subset of pathogen genotypes. \textit{Ph2} slows, rather than
providing complete control of the disease. *Ph2* is not effective as a stand-alone genetic control. Do not rely on late blight control from cultivars possessing only *Ph2*. In a mild LB season *Ph2* cultivars might be of some value, however if the season is highly favorable for LB then *Ph2* cultivars could have similar levels of disease as cultivars fully susceptible to LB, and require similar horticultural/spray control measures.

### Ph3

*Ph3* was found in a wild cherry tomato. *Ph3* is almost dominant: hybrids homozygous for *Ph3* have virtually complete resistance against almost all genotypes including US22 and US23. Very mild disease can still be present on hybrids heterozygous for *Ph3*. Some plum tomato and processing tomato cultivars in production possess *Ph3* as the sole control of late blight.

The best genetic control of late blight is provided when the cultivar is homozygous for both *Ph2* and *Ph3*; a combination now available in a few new freshmarket tomato hybrids. The nature of the synergy between these two genes is not yet known. However, to date, no genotype of late blight pathogen has been found to cause significant disease on plants homozygous for both *Ph2* and *Ph3*. No supplemental sprays should be required for late blight control with such cultivars.

Some new hybrids are heterozygous for both *Ph2* and *Ph3*. A low level of leaf lesions have been observed on plants heterozygous for both *Ph2* and *Ph3*, and we suspect that some late season infection of fruit is possible in this type of plant of under LB-favorable conditions. If using plants heterozygous for *Ph2* and *Ph3*, or heterozygous for only *Ph3*, scout for lesions, and be aware that some supplemental sprays might be required some seasons for full late blight control.

### Septoria Leaf Spot genetic control

This genetic control appears to be due to a nearly dominant single gene; plants heterozygous or homozygous for SLS resistance both show good control of this disease in field trials. SLS resistant plants develop initial lesions that stay small, but SLS resistance strongly impedes increase in lesion size and pathogen reproduction, which in turn suppresses epidemic development of this polycyclic disease. One newly available commercial freshmarket, Iron Lady, hybrid is heterozygous for this SLS resistance, as well as being homozygous for *Ph2* and *Ph3* for LB resistance, and homozygous for EB resistance.

Since best SLS control is obtained by minimizing initial inoculum, for longest control of SLS grow SLS resistant cultivars separate, and perhaps upwind, from susceptible cultivars. Also continue to use good horticultural practices (rotation out of tomato/potato crops for at least 3 seasons, no solanaceous weeds in the field during this period). During seasons with weather conditions extremely conducive to SLS, one or spray of a low environmental impact quotient (EIQ) values like Quadris Top or the protectant mancozeb could be beneficial as a supplement. For organic production choose from among the 6 copper fungicides registered in NYS.

### Additional information and materials

A table listing current tomato cultivars possessing resistance or tolerance to one of more of the diseases LB, EB and SLS, and the genes they possess, will be provided. The list, and more detail in the control of LB, EB, and/or SLS using these cultivars will be uploaded at the Vegetable MD website (http://vegetablemonline.ppath.cornell.edu/). Additional tomato cultivars with genetic control of LB/EB or of LB/EB/SLS are in the testing phase and will probably be released by a number of seed companies in the coming years, providing growers a wider selection of tomato cultivars possessing genetic control of these important diseases.