

FUTURE FUNGICIDES FOR SCAB/MILDEW IN THE FACE OF MULTIPLE FUNGICIDE RESISTANCE

Kerik D. Cox
Assistant Professor
Dept. of Plant Pathology and Plant-Microbe Biology
Cornell University, NYSAES
Geneva, NY 14456

Apple Scab and Powdery Mildew in the Northeastern United States

The apple scab pathogen, *Venturia inaequalis*, causes extensive crop loss in all production regions in the northeastern US. The development of durable scab-resistant cultivars to reduce reliance on fungicides has been a major goal of apple management programs for decades. Cultivars fully resistant to scab have been introduced, but both grower and consumer acceptance has been limited to organic production operations due to fruit quality concern. In the absence of durable host resistance and because of emerging fungicide resistance, producers make considerable applications of protectant fungicides to avoid losses. Apple scab is managed with up to 10 fungicide applications per season. The SI (e.g. Rally 40 WSP, Vintage SC, Indar 2F, and Inspire Super) and QoI (Flint WG and Sovran) fungicides are some of the safest and most effective fungicides for use against apple scab. However, because of their specific mode of action, many apple scab populations throughout NY and the Northeastern United States have developed a level of resistance to these highly effective fungicides.

Compared to diseases such as apple scab and fire blight, powdery mildew is not a devastating disease of apples in the eastern United States. However, this disease can cause serious problems on highly susceptible apple cultivars including ‘Cortland’, ‘Idared’, ‘Gingergold’, and ‘Jonagold’ to name a few. Symptoms of infection include a powdery white blight of young leaves and shoots in addition to fruit russeting. Severe mildew infections can lead to reduced yields from aborted blossoms, poor return bloom, and compromised shoot growth. Powdery mildew infection can occur in the absence of free moisture; hence the disease can even be a problem in dry seasons such as the early 2010 apple season. Apple powdery mildew is managed by fungicide programs applied during apple scab infection periods because susceptible phenological stages for both diseases often overlap. The sterol biosynthesis inhibitor (SI) fungicides have excellent activity against powdery mildew, and the widespread use of SIs in apple scab fungicide programs in NY has likely kept powdery mildew in check. However, SI resistance in NY apple scab populations has also raised concerns regarding SI resistance in mildew populations. It has been suggested that SI applications at lower label rates are becoming insufficient to control mildew in the region. Moreover, some the newer SI fungicides that are more effective against SI resistant apple scab appear to be less effective against powdery mildew.

As SI resistance in NY apple scab populations becomes more prevalent, fungicide management programs has focused on SIs and QoIs that are more effective on apple scab, but less effective on powdery mildew. In the last two seasons, the proportion of orchard sites submitted to the fungicide resistant survey service with QoI resistant apple scab populations has increased. Moreover, statistical analysis of five years of apple scab data from over 100 orchards and more than 5000 isolates have indicated unexpected multiple resistance in isolates and populations of

the apple scab pathogen that have SI resistance. As a result growers will continue to rely on a full protectant program of ethylenebisdithiocarbamate (EDBC) and Captan applications to manage fungicide resistant apple scab populations, powdery mildew may continue to become a larger problem as these fungicides have no effect against the disease. In the coming seasons, site-specific fungicides will still need to be used to manage the multitude of diseases on apples, and several new products will be coming to the apple market in the near future. The potential of these new products in orchards with apple scab populations with multiple fungicide resistance needs to be determined.

New Fungicide Products for Apple Scab and Powdery Mildew

The recent registration of SI chemistries with higher intrinsic activity against apple scab has raised questions as to the ability of resulting fungicide products to manage both apple scab and powdery mildew. In addition, new fungicide chemistries belonging to the succinate dehydrogenase inhibitor (SDHI) class of fungicides will also soon be released. New generation SDHI fungicides appear to be very effective against apple scab, but they may not have mildewcidal activity comparable to that of SI fungicides. Field trials were conducted from 2009 to 2011 in orchards with SI and QoI resistant apple scab populations at the NYSAES to look at the potential of newly introduced fungicide chemistries to manage apple scab and powdery mildew.

Trial results indicated that:

1. Fungicide products containing difenoconazole (Inspire Super) or fenbuconazole (Indar 2F) are more effective against SI-resistant apple scab and less effective against powdery mildew providing control comparable to a QoI fungicide.
2. Fungicide products containing flutriafol (Topguard) or myclobutanil (Rally 40WSP) are weaker against SI-resistant apple scab, but are still some of the most effective fungicides against powdery mildew, especially on susceptible cultivars.
3. Generalizations about the new SDHI fungicide products are complicated by formulation paradigms used by different agrichemical companies. Fontelis SC by DuPont provides a high level of control against apple scab, and although it'll not likely be marketed for mildew, it provides > 50% control of mildew on highly susceptible varieties. Luna Sensation by Bayer and Merivon by BASF are premixes that contain a SDHI fungicide formulated with a QoI fungicide. As formulated, Luna Sensation and Merivon provide exceptional control of apple scab and a high level of mildew control in orchards with sensitive population.
4. In an orchard with an apple scab population with both QoI and DMI resistance, both Mervion and Luna Sensation provide a level of control comparable to that of Fontelis, a non-premix SDHI fungicide. Against powdery mildew, the efficacy of the Mervion and Luna Sensation was not affected by the development of multiple resistance to fungicides in the apple scab population.

Preparing for apple scab and powdery mildew in 2012

2011 was characterized by heavy rains and flooding during primary apple scab season resulting in heavy disease pressure for apple scab. After primary apple scab season, there were drought conditions from late June to July resulting in high pressure for powdery mildew. By harvest rains were heavy and disease pressure for summer diseases was high. This was one of

the most a severe primary apple scab seasons in several years, and growers appropriately responded in 2011 with full protectant programs, or SI-fungicides stronger against apple scab and weaker on mildew. Unfortunately, there were still losses to apple scab in NY, but powdery mildew was less of a problem. In 2012 growers should be poised to address a high level of apple scab inoculum and variable seasonal weather. Although the newer fungicide chemistries/products will not be available in 2012, growers will need to address both diseases with the products currently available. To manage both diseases in 2012, consider matching the fungicide program to either variety susceptibility or seasonal weather. If the acreage is primarily planted to scab susceptible varieties such as those with a 'McIntosh' background, use an SI or newer material with a strong activity against scab that still provides some mildew control at bloom to 1st cover. On varieties that are highly susceptible to mildew, consider using an SI or newer material with strong activity against mildew mixed with an appropriate rate of protectant from bloom to 1st cover to control apple scab. If variety specific paradigms aren't suitable for your operation, be prepared to have extra fungicide material specifically for mildew if the early season is exceptionally hot and dry, or specifically for apple scab if the season is still cold and wet by bloom. The final alternative would be to spray protectively with captozeb (captan tank mixed with mancozeb), but also start a sulfur program on mildew susceptible varieties. There are a lot of new fungicides coming to the market, but the environment, new varieties, and fungicide resistance pressures will require considerable attention and flexibility when planning a chemical management program.

1. Villani, S.M., and Cox, K.D. 2011. Qualitative and practical resistance to QoI fungicides in *Venturia inaequalis* populations in the Northeastern US. Paper presented Dec. 1-2 at the 2011 Cumberland Shenandoah Fruit Workers Conference, Winchester VA.
2. Villani, S.M., and Cox, K.D. 2010. Difenconazole: Apple scab sensitivity and field performance on apples. Paper presented Nov. 19-20 at the 2010 Cumberland Shenandoah Fruit Workers Conference, Winchester VA.
3. Cox, K.D., and Villani, S.M. 2009 Apple scab fungicide resistance in the Northeastern United States: Prevalence and Practical Resistance. Paper presented Nov. 19-20 at the, 2009 Cumberland Shenandoah Fruit Workers Conference, Winchester VA.
4. MacHardy, W. E., D. M. Gadoury, and C. Gessler. 2001. Parasitic and biological fitness of *Venturia inaequalis*: Relationship to disease management strategies. *Plant Dis.* 85:1036-1051.