THE DISEASE MANAGEMENT CHALLENGES OF 2012

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Apple Scab and Powdery Mildew in NY during the 2012 season

The 2012 growing season came unexpectedly in early March during a period of warm weather following a warmer than usual winter. The early season was characterized by number borderline apple scab infection periods until the beginning of April a time when most model predictors were in agreement. The spring freeze hit during bloom which was flanked by brief periods of colder wet weather. Aside from destroying the apple crop, this weather resulted in another series of borderline infection periods. Ascospores were mature there was adequate leaf wetness, but the temperatures were cool for the time of the year. It was situation that was never modeled during the research that investigated the biology and epidemiology of the apple scab fungus, *Venturia inaequalis*. Not unlike 2011, 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. With the loss of the crop there was less of an incentive to apply fungicides for apple scab and mildew and with the borderline infection periods, western NY seemed to experience varying degrees of disease control failures and losses depending on which places still had a crop.

Apple scab 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, caused by *Podosphaera leucotricha,* is not a devastating disease of apples in the eastern United States. However, this disease can cause considerable foliar damage 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 or mid-2011 and 2012 apple seasons. 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.

Now that SI resistance in NY apple scab populations is widely prevalent, fungicide management programs have focused on SIs and QoIs that are more effective on apple scab, but less effective on powdery mildew. In the last three 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 175 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 protectant fungicides have little effect against the disease. However, the addition of a sulfur fungicide to the captan and EBDC tank mix would help control powdery mildew, but other site-specific fungicides may still be needed to manage the multitude of diseases on apples that don't manifest on a yearly basis such as cedar apple rust and Glomerella leaf spots.

2012 trial results from Geneva indicated that:

1. Fungicide products containing difenoconazole (Inspire Super) or fenbuconzaole (Indar 2F) are more effective against SI-resistant apple scab on susceptible cultivars and less effective against powdery mildew. These provide a level of control comparable to a QoI fungicide. These differences in control only become apparent toward the season's end.
2. 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 or greater than that of Fontelis, a non-premix SDHI fungicide for two years in a row. The efficacy of the Mervion and Luna Sensation was not affected by the development of multiple resistance to fungicides in the apple scab population.
3. 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. At the newly increased maximum rate of 8 oz/A, Rally 40WSP performs much more like Inspire Super, but with increased mildew control.
4. Interestingly, the addition of mixing partner such as captan or mancozeb to a strong mildew fungicide (Topguard, Rally 40WSP, or Merivon, or Luna Sensation) often seemed to diminish the ability of the fungicide to manage powdery mildew compared to programs where the fungicides were applied alone.
5. Treatment programs that received Inspire Super, Merivon, or Pristine during summer covers had a similar to lower severity of mildew at harvest compared to those receiving a highly effective fungicide such as Topguard or Rally 40WSP in the primary scab season, but only received captan in the summer covers.

6. 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 of control apple scab and a high level of mildew control even in research orchards with resistant populations.

Preparing for apple scab and powdery mildew in 2013

In 2013 growers should be poised to deal with preseason apple scab inoculum, powdery mildew carry over inoculum in buds, and variable seasonal weather. The level of powdery mildew inoculum and apple scab inoculum will vary from site to site depending on the success of the 2012 program. Although the newer fungicide chemistries/products will not be available in NY in 2013, growers will need to address both diseases with the products currently available. To manage both diseases in 2013, consider matching the fungicide program to either variety susceptibility or seasonal weather. If the acreage is primary 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 you operation, be prepared to have a fungicide 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 until petal fall. 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. Finally, when you do choose a to use a SI or QoI product, bear in mind that a single application will not likely provide the desired the results. The successes of the products in research trials are often contingent using the labeled maximum number of applications allowed for a season (i.e. 4 applications).

Fire Blight and the emergence of streptomycin resistance in NY during the 2012 season

The 2012 season was a good season for managing blossom blight. The spring freeze came at full bloom in April and the subsequent cold weather really kept the blossom blight risk fairly low during the bloom period. There was some shoot in blight in operations towards the middle to end of the season, but our program received no complaints in regard to blossom blight.

The programs of Cox and Aldwinckle et al., industry collaborators, and members of the NYS IPM program and Cornell Cooperative Extension regional fruit programs formed a statewide survey effort for SmR fire blight bacteria in 2012. Although orchards with fire blight infections were sampled throughout the state, survey efforts focused on orchards and regions where streptomycin resistance was confirmed in 2011, newly planted orchards, and 1-3 year old orchard plantings. In 2012, 173 samples were collected from 42 apple production operations throughout the state. The majority of samples were collected from operations in the Lake Ontario/Niagara production region and the Hudson Valley. Of these 173 samples, 13 samples from 8 different production operations were confirmed as resistant. Interestingly, 7 of 8 locations with confirmed SmR Ea also had samples infected SmS Ea in similar or in greater abundance. The majority of the affected operations were in Monroe, Ontario, and Wayne Counties, and there

were no instances of SmR Ea in samples from the Hudson Valley or eastern NY as a whole. Overall, 'Gala', 'NY2', and 'Ginger Gold' were the cultivars most frequently assayed for fire blight infection with 'Gala', 'NY2', 'SweeTango', 'Ginger Gold', 'Azetc Fuji', 'Cameo', and 'Idared' representing the cultivars with infections from which SmR Ea was obtained. SmR Ea was only isolated from one M.26 rootstock infection, but SmR Ea was obtain from scion grafted to B.9., M.26, and M.9 rootstocks.

All 13 SmR Ea strains grew on 100ppm streptomycin. Of these 13 strsins 4 grew on 1000 ppm streptomycin. None of these 4 strains had the chromosomal mutation in the *rpsL* gene conferring stable resistance to streptomycin. However, strain 292 had a silent mutation at codon 43 (AAA to AAG). All 13 strains did possess *strA-strB* resistance genes in Tn*5393* on pEa29.

In short, SmR Ea is present in several apple production operations in NY, and in some operations, across several blocks and varieties. Fortunately, SmR Ea appears to be restricted to production operations in western NY, but with increased sampling in other regions in coming years, we may find that SmR Ea is more prevalent than previously believed. In regards to SmR genotype, no strains possessed chromosomal mutations conferring resistance and all strains possessed the plasmid borne resistance prevalent known to present in the Great Lakes region. More interesting is the fact that there were equal numbers of SmS sensitive samples at each location. Such a find provides hope that SmR Ea could be managed by the inclusion of an additional bactericide to manage the resistant population members. One possible bactericidal option would be buffered copper. Indeed, in the 2012 trial results from Geneva we found that applications of streptomycin with a low rate of a buffered copper product resulted in a lower incidence of blossom blight than a program, which consisted of streptomycin applied alone. Despite the use of copper at bloom, the program of copper and streptomycin afforded no incidence of fruit finish blemishes at harvest.

Table 1 Characteristics of SmR Ea strains isolated from fire blight infections in NY in 2012.

Strain ID	County (Location #)[a]	Cultivar	# of SmS, SmR samples at location[b]	*strA-strB* genes	Growth on 1000pm streptomycin	*rpsL* codon 43 seqeunce
299-2c	Wayne (1)	NY2	6, 5	A & B	No	AAA
299-2d	Wayne (1)	NY2	6, 5	A & B	No	AAA
300-2a	Wayne (1)	Gala	6, 5	A & B	No	AAA
300-2d	Wayne (1)	Gala	6, 5	A & B	No	AAA
300-2e	Wayne (1)	Gala	6, 5	A & B	No	AAA
301	Niagara (2)	SweeTango	1, 1	A & B	No	AAA
189	Wayne (3)	Ginger Gold	3, 1	A & B	Yes	AAA
254	Wayne (4)	M.26 RS	0, 1	A & B	No	AAA
230	Ontario (5)	Idared	2, 1	B	Yes	AAA
249	Orleans (6)	Aztec Fuji	11, 2	A & B	No	AAA

278	Orleans (6)	Cameo	11, 2	A & B	No	AAA
292	Wayne (7)	Idared	4,1	A & B	Yes	AAG
306	Ontario (8)	Lady apple	3,1	A & B	Yes	AAA

[a]The number in parentheses refers to the location or production operation where the SmR strain was discovered .

[b]Numbers of SmS and SmR samples represent the numbers for the location (Location #) from which the strain was obtained. Strains with identical numbers of SmS, SmR samples are from the same location.

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2. **Cox, K.D.,** Aldwinckle, H.S., Villani, S.M., and Bekoscke, K. 2013. Evaluation of bactericide programs for the management of fire blight on 'Idared' apples in NY, 2012. PDMR. (7) PF001.

3. Rosenberger, D.A, **Cox, K.D.**, Rugh, A., Villani, S.M., and Frederick, Z. 2012. Apple scab management options for high inoculum orchards. New York Fruit Quarterly 20(4): 9-13.

4. **Cox, K.D.**, Breth, D. Carroll, J., Kuehne, S., Borejsza-Wysocka, E., Eve, J., and Aldwinckle, H.S. 2012. Presence and characteristics of streptomycin resistant fire blight in NY. Paper presented Nov. 29 at the 88th Annual Cumberland Shenandoah Fruit Workers Conference, Winchester VA.