

Understanding the Limitations of Newer Apple Fungicides

David A. Rosenberger, Cornell's Hudson Valley Lab
P.O. Box 727, Highland, NY 12528
E-mail: dar22@cornell.edu

DMI fungicides have provided apple growers with a golden era of disease control that is drawing to a close as the appearance of DMI-resistant apple scab gradually reduces the usefulness of this class of fungicides. The DMI fungicides include Rally (formerly sold as Nova), Vintage (formerly sold as Rubigan), Procure, Indar, Inspire Super, Tebuzol, and Topguard. Inspire Super is a package mix of a DMI (difenoconazole) and Vangard, which is in the anilinopyrimidine fungicide class.

The DMI fungicides had advantages that have not yet been duplicated with any other fungicide chemistry. They provided effective control of the three major fungal diseases of apple that occur in spring: apple scab, powdery mildew, and rust diseases. They also provided 96 hr of post-infection or "kick-back" activity, and they suppressed lesion expression and sporulation when applied any time before lesions appeared on leaves. When applied in combinations with captan or mancozeb, the DMIs provided effective disease control when applied at 9 to 12 day intervals as compared to the 7-day spray intervals required for most other fungicides during spring. Because none of the newer fungicides can duplicate the activity of the DMIs, growers will need to carefully consider the limitations of the available fungicides that they will be using to replace the DMIs.

Following is a summary of fungicide classes that are currently available for apple disease control, along with some of the advantages and weaknesses that are common to most of the fungicides within the respective classes.

Contact fungicides: Captan and the mancozeb fungicides (Manzate, Dithane, Penncozeb) were developed more than 50 years ago, but they are still essential for disease control on apples. They are multi-site inhibitors that arrest fungal growth by attacking multiple biochemical pathways simultaneously. As a result, fungi do not develop resistance to these fungicides. Their weakness is that they lack post-infection activity, so they must be applied before germinating spores penetrate leaves. Captan is intrinsically more active against apple scab than are the mancozeb fungicides, but captan does not control rust diseases and is not compatible with oil. Neither captan nor mancozeb control powdery mildew.

Dodine (now sold as Syllit) is an old fungicide that was largely abandoned due to resistance, but it is now regaining consideration as an early-season scab fungicide. Recent work by Kerik Cox and his group at the Geneva Experiment Station has shown that resistance to Syllit is less common than was previously thought. Dodine is an excellent scab fungicide with good retention, redistribution, and anti-sporulant properties. It also provides 48 hr of post-infection activity. However, dodine does not control rust or powdery mildew. Uncertainties about where dodine-resistant strains are lurking dictates that it must always be used in combination with a contact fungicide so as to avert disaster if some dodine-resistant strains are present. A dodine-mancozeb combination can be especially useful for working around early-season oil sprays and may provide better protection during the prebloom period than programs that depend exclusively on captan and mancozeb, especially if prebloom weather generates conditions where protective fungicide coverage may have lapsed between sprays due to heavy rains or weather that precluded

timely applications. However, the maximum label rate of Syllit must be used in combination with captan or mancozeb if the objective is to inactivate visible scab lesions. Using dodine to clean up scab after it appears on leaves will create selection pressure for rapid re-appearance of dodine-resistant scab.

Anilinopyrimidine fungicides include Vangard and Scala. These fungicides work best in cool weather, do not redistribute well, and will not control scab on fruit. Thus, they work best in prebloom sprays. They provide 48 to 72 hr of post-infection activity and can be useful if applied in combinations with captan or mancozeb in prebloom sprays where some post-infection activity is needed, especially if reliability of dodine is uncertain for the orchards in question.

DMI fungicides are still effective against apple scab in many orchards. However, their reliability against scab will always be questionable because the incidence of DMI-resistant scab is gradually increasing in most orchards. Disease control failures can therefore be expected if DMI fungicides are used to arrest established scab lesions (i.e., if they are used for post-infection control of scab) in orchards with high levels of DMI-resistant scab. Even where DMIs no longer control scab, however, they still provide excellent control of rust diseases, especially quince rust, due to their extended post-infection activity against rust diseases. They may also be the best option for controlling powdery mildew, especially if they are used in the petal fall and first cover sprays. Inspire Super is the strongest scab fungicide in this group, but Inspire Super and Indar are weaker than other DMIs against powdery mildew. Rally and Topguard are the best mildewcides. For a variety of reasons, all fungicides in this group should be applied in combination with captan or a mancozeb fungicide. In orchards known to have DMI-resistant scab, the rate of the contact fungicide must be high enough to control scab without assistance from the DMI and spray intervals must be shortened to those that are appropriate for a contact fungicide program.

Strobilurin or QoI fungicides include Flint, Sovran, and Pristine. (Pristine is actually package mix of the strobilurin pyraclostrobin with another product, boscalid, that is a member of the SDHI group). These fungicides should be viewed as "super protectants" in that they work best when applied ahead of rains even though they can provide up to 48 hr of post-infection activity against apple scab. They lack post-infection activity against rust diseases, so they appear weak on rust diseases when compared to DMI fungicides. They also lack the strong post-infection and antispore activity that the DMIs exhibit against mildew, so they must be applied before petal fall if they will be used as the primary mildewcide during spring. Apple scab that becomes resistant to this group will show the benomyl-type of resistance where even high doses will not control the pathogen. Such resistant isolates have already been found in many orchards in Michigan and in a few orchards in New York and elsewhere. Fungicides in this group can also be useful for controlling black rot, sooty blotch, and flyspeck during summer. However, all of the product labels restrict use of these fungicides to a total of only four applications per year for any combination of products within the group.

SDHI fungicides are a new class of fungicides, with several products approaching registration. Fontelis (penthopyrad) is being developed by DuPont. Luna Sensation is a package mix of fluopyram with Flint that will be marketed by Bayer, and BASF will be marketing Merivon, a package mix of fluxapyroxad and pyraclostrobin (the latter being the strobilurin component in Pristine). Other products in the SDHI group are being evaluated by other companies but have not yet been named. In general, the SDHI group provides good control of scab and mildew, but only marginal control of rust diseases. There is some evidence that these products may provide 48 to 60 hr of post-infection activity against apple scab. Their activity

against rust diseases may be largely dependent on the protectant activity of the strobilurin or other combination product with which they are mixed. Fontelis may be sold as a stand-alone product, but it has performed best in my trials when mixed with mancozeb. Disappointment awaits anyone who is hoping that the SDHI fungicides will have all of the attributes that we came to associate with DMIs. The best seasonal timing for the SDHI fungicides remains to be determined, but overuse will almost certainly result in rapid development of SDHI-resistant apple scab. This will be especially problematic if Luna Sensation or Merivon, which are package mixes with a strobilurin, are applied in orchards that already contain strobilurin-resistant apple scab. Use of Luna Sensation and Merivon may also be limited by the 4-spray-per-season limitation on any combination of strobilurin sprays since both of these are formulated with a strobilurin fungicide.

Phosphite fungicides are sold under many different brand names such as ProPhyt, Fosphite, K-Phite, Phostrol, and Agri-Fos, as well as numerous others. We have been unable to show that the phosphites provide any advantage when added to captan or mancozeb in springtime sprays. However, when added to captan in summer sprays, that combination will control sooty blotch and flyspeck just as well as a combination of Captan plus Topsin M. Thus, a phosphite-captan combination can be used to fill gaps in summer spray programs where label restrictions on total numbers of sprays or on total lb/A/yr might limit full-summer applications of Topsin M or strobilurin fungicides. However, the phosphite fungicides do NOT enhance activity of captan against black rot and bitter rot fruit decays, so higher rates of captan are required where these pathogens are a concern than would be the case if captan were combined with Topsin M. Crops, diseases, rates, and application intervals vary with product labels, so read the labels carefully.

Fungicides for summer diseases: The combination of captan plus Topsin M has become the standard for controlling summer diseases. Topsin M is usually used at rates of 9 to 16 oz/A, with the higher end of this range required for situations where sooty blotch and flyspeck (SBFS) are especially prevalent. Rates of captan used with Topsin vary from 2 lb/A to 4 lb/A of Captan-80, with the higher rates required where bitter rot is a concern because Topsin M does not control bitter rot. Pristine applied alone is reasonably effective against bitter rot, and bitter rot control can be further enhanced by using a combination of Pristine plus 2 lb/A of Captan-80. Pristine provides the longest residual activity against SBFS and is therefore especially useful as the "last spray" of summer for late-season yellow cultivars such as Golden Delicious and Crispin. However, the residual activity of Pristine will be totally lost after 2.2 to 2.5 inches of rain, so a follow-up spray may be required in September to keep SBFS off of late-season cultivars in southern New England if heavy rains occur in early September and remove the residues of the planned "last spray" that was applied prior to the rains.

Flint initially provided excellent control of SBFS, but we have found in recent years that Flint is no longer controlling some species of sooty blotch when it is applied in late summer.

Inspire Super and Indar both provides good control of SBFS and fair control of fruit decays when applied during summer. However, using Inspire Super or Indar during summer will add selection pressure for DMI-resistant apple scab. Therefore, these fungicides should not be applied after second cover except where DMI activity against apple scab is already totally lost due to DMI-resistance.