



**Dr. Nathaniel Mitkowski**, Associate Professor of Plant Pathology  
URI - Department of Plant Sciences

The SDHI fungicides (succinate dehydrogenase inhibitors) have been used in turf since the early 1990's. Also known as the carboximide group of fungicides, most turfgrass managers will recognize the oldest member of this group, flutolanil (Prostar®). By 2003, BASF had registered the second active ingredient in this class of fungicides, boscalid (Emerald®). And in 2011, Dupont is scheduled to register the third fungicide in this class for use on turf, penthiopyrad (Velista®).

The SDHI name is derived from the fact that these three fungicides interfere with a molecule in the electron transport chain. In order to make energy, fungi move electrons through a chain of different molecules. At the end of this chain (which resembles a molecular factory line), ATP is produced, a molecule that all living organisms use as an energy source. ATP is often called the fuel that runs cells. The SDHI/carboximides interfere with succinate dehydrogenase (a molecule in the electron transport chain) and shut down the cell's energy factory. When this happens, the fungus cannot grow, runs out of energy and dies.

Despite being in the same group, flutolanil, boscalid and penthiopyrad are all very different. Flutolanil belongs to a subgroup called the phenylbenzamides, boscalid is in the phenyl carboximide group and penthiopyrad is a pyrazole carboximide. Because of these differences, these three fungicides have widely different activity on fungi. This is very different than almost any other class of fungicides. A good example would be the DMI fungicides. All of the active ingredients within that group (propiconazole, triticonazole, tebuconazole, triadimefon, etc.) have activity against dollar spot (*Sclerotinia homoeocarp*). Some are more effective than others at controlling dollar spot but they will all work. This is not the case for the SDHI fungicides. Flutolanil works very well against brown patch (*Rhizoctonia solani*) and other

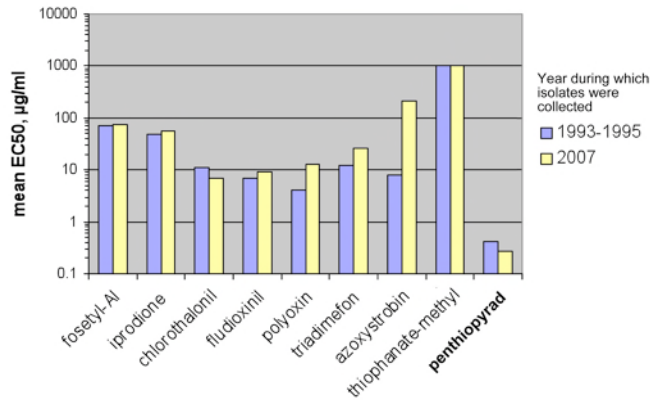
*Rhizoctonia* pathogens. It also works very well against fairy rings and many other fungi that typically produce mushrooms. This is different from boscalid, however, which has no effect on *Rhizoctonia*, fairy ring or mushroom fungi. Despite this, boscalid is one of the most active known fungicides against dollar spot. Conversely, flutolanil has very little effect on dollar spot. Penthiopyrad bridges the gap between these two fungicides. Penthiopyrad is effective at controlling both dollar spot and brown patch.



**Figure 1.** Penthiopyrad (Velista®) is a new fungicide from DuPont that has activity against dollar spot, brown patch and anthracnose, a disease that can cause severe damage like that shown above.

Penthiopyrad also includes activity against diseases that neither flutolanil or boscalid control, particularly anthracnose. In 2009, we examined the activity of penthiopyrad against almost 60 isolates of anthracnose (*Colletotrichum cereale*) from across New England. While our study demonstrated that polyoxin-D (Endorse®) and fludioxonil (Medallion®) were the most effective currently registered fungicides against *C. cereale* in the lab, penthiopyrad could achieve control of the pathogen even more effectively than either. While

fludioxonil and polyoxin-D required approximately 3 ppm of active ingredient to control 50% of fungal growth, penthiopyrad required only 0.19 ppm of active ingredient to achieve the same result. Researchers at other institutions have also conducted field trials against anthracnose using penthiopyrad and found similar results.



**Figure 2.** Penthiopyrad controls anthracnose (*Colletotrichum cereale*) in laboratory trials more effectively than any other fungicide tested (lower bars mean more control with less active ingredient). Note: scale is logarithmic.

While all three of the SDHI fungicides have been shown to be very effective against their respective target diseases, there is some concern over the development of resistance. The SDHI fungicides all belong to FRAC Group 7. This group is characterized as “medium-high” risk for resistance development. Because these fungicides work by disabling only a single molecule in the fungus, it is possible for a population of fungi to find ways around the SDHI fungicides. The strobilurins also block the electron transport chain (although in a different location) and over the past decade there have been continual reports of resistance development to the strobilurins. What this means is that “over use” of these three chemicals carries a significant risk of stimulating fungicide resistance,

which will ultimately result in these chemicals becoming less effective.



**Figure 3.** No fungicide controls every disease. In the figure above (right side), boscalid provides excellent control of dollar spot but does not control copper spot (*Gloeocercospora sorghi*). On the left side, chlorothalonil provides very good copper spot control but has allowed a breakthrough of dollar spot after 14 days.

To date, most of the fungicide resistance to members of this group have been found on cucurbits. But because of the limited number of target pathogens for either boscalid or flutolanil, neither of these two chemicals sees excessive use in the turfgrass industry. Recently, BASF has packaged boscalid with pyraclostrobin (Insignia®) in their Intrinsic® brand of fungicides, which is likely to result in more overall SDHI usage. With the introduction of penthiopyrad, there is going to be additional use of SDHI fungicides in turf and a greater risk of resistance development. Consequently, rotation of fungicide chemistries based on FRAC group will continue to be very important in maintaining the usefulness of these chemicals.

**Dr. Nathaniel Mitkowski** can be reached at [mitkowski@uri.edu](mailto:mitkowski@uri.edu) or 401-874-5996. The URI Turf Program can be accessed online at [www.uriturf.org](http://www.uriturf.org). Disease samples are accepted all year long.

PESTICIDES ARE POISONOUS! Read and follow all safety precautions and all labeled directions. The label is the law. Handle carefully and store in original containers out of reach of children, pets or livestock. Dispose of empty containers immediately, in a safe manner and place. Pesticides should never be stored with foods or in areas where people eat.

When trade names are used for identification, no product endorsement is implied, nor is discrimination intended against similar materials. Be sure that the pesticide you wish to use is registered for the state of use.

The user of this information assumes all risk for personal injury or property damage. RI Cooperative Extension provides equal opportunities.