

FUNGICIDE RESISTANCE IN THE GREENHOUSES

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Fungicides should be used intelligently to prevent the loss of fungicide effectiveness by the development of resistance. Table 1 lists of fungicides and their chemical classes that are most likely to develop pathogens with resistance. Do not make repeated applications of these materials. Rather, rotate with materials outside of their chemical class. For example, you can rotate Cleary's 3336 with Chipco 26019 but not with Fungo Flo. Once resistance occurs to one fungicide in a chemical class, all of the fungicides in that class will be ineffective against the resistant pest.

A survey of 13 different greenhouses in Pennsylvania found that all of the had *Botrytis* that was resistant to benzimidazoles and 6 had *Botrytis* resistant to dicarboximides. Several had *Botrytis* that were resistant to both classes of fungicide¹. In Connecticut 75 % of *Botrytis* strains in six greenhouses were resistant to benzimidazoles and 40% were resistant to dicarboximides. *Botrytis* strains resistant to both fungicides were common². In South Carolina 35 greenhouses were surveyed and 65% of the *Botrytis* strains were found to be resistant to both benzimidazoles and dicarboximides³. In some cases, participating greenhouses used little if any of these chemicals; however, they probably brought the resistant strains into the greenhouse on plant material.

Closer to home I have been examining *Pythium* resistance to metalaxyl (mefenoxam). In 1997 about 30% of isolates recovered from greenhouses were resistant. Currently our collection shows about 50% of the isolates from greenhouses are resistant. Isolates from field soil tend to be sensitive, presumably because they are not exposed to metalaxyl on a frequent basis.

Metalaxyl has always been our best fungicide for *Pythium* and *Phytophthora*. The late blight fungus, *Phytophthora infestans*, and the tobacco blue mold fungus, *Peronospora tabacina* have widespread resistance to metalaxyl. Now that many greenhouse strains of *Pythium* are resistant to metalaxyl, I am reluctant to recommend the use of this material until we carry out resistance tests in the lab. After culturing *Pythium* it takes about 2 days to determine if it is resistant.

Not all fungicides will produce resistance in pathogens. For example chlorothalonil (Daconil, Exotherm, Bravo) and Mancozeb have not resulted in resistance. Fungicides that usually result in resistance typically have a single site mode of action against the fungus. For example the fungicide may inhibit an important enzyme. When the fungus is subjected to these kinds of toxins, they find new ways to carry out their metabolic needs, and in the process become resistant.

Preventing the development of fungicide resistance. The fungicides in the chemical classes listed in Table 1 tend to result in resistance. They are all excellent fungicides so temptation is to use them repeatedly. This is a mistake. Once the fungi become resistant they may not revert to being susceptible (although some will).

Rotate fungicides from these classes with materials in a separate class. Make sure the class of fungicides you choose to rotate with is effective against the target pest. Other fungicides not listed here should also be considered. Subdue can be rotated with Banol, Truban, Aliette, and Terrazole.

Editor's note: This article is based on a talk Rob gave at the Massachusetts Flower Growers Winter Meeting, January 30, 2001.

References

- ¹ Moorman and Lease. 1992. Plant Disease 76:477-480
- ² LaMondia and Douglas. 1997. Plant Disease 81:792-732
- ³ Yourman and Jeffers. 1999. Plant Disease 83:569-575

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Table 1. Fungicides and their chemical classes most likely to develop resistant pathogens,

Trade name	Common Name
Class: Sterol inhibitors	
Rubigan	fenarimol
Strike	triadimefon
Systhane	myclobutanil
Terraguard	triflumizole
Class: Benzimidazoles	
Cleary=s 3336	thiophanate methyl
Fungo Glo	thiophanate methyl
Class: Dicarboximides	
Chipco 26019	iprodione
Vorlan	vinclozolin
Class: Strobilurins	
Compass	trifloxystrobin
Cygnus	kresoxim-methyl
Heritage	azoxystrobin
Class: Phenylamides	
Subdue Maxx	mefenoxam*

*Earlier formulations of Subdue (metalaxyl) are chemically related to mefenoxam. Subdue can be rotated with Banal, Truban, Aliette, and Terrazole

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