

Disease Management Strategies

for Horticultural Crops

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Fungicide Mobility for Nursery, Greenhouse, and Landscape Professionals

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Fungicides are classified in a variety of ways, including biochemical mode of action, fungicide resistance action committee (FRAC) code, or their mobility. This publication describes fungicide mobility — other publications in this series examine other fungicide properties, and are available from the Purdue Extension Education Store, www.extension.purdue.edu/new.

Mobility describes fungicide movement after it is applied to a plant. To understand differences in mobility, it's important to know the difference between **absorption** and **adsorption**.

Fungicides that can be taken up by the plant are absorbed. Fungicides that adhere in an extremely thin layer to plant surfaces are adsorbed. Because fungicides are either adsorbed or absorbed, they have two basic forms of mobility: contact and penetrant.

Regardless of the type of mobility that a fungicide possesses, no fungicide is effective after the development of visible disease symptoms. For that reason, timely fungicide application **before** establishment of the disease is important for optimal disease management.

Contact Fungicides

Contact fungicides are adsorbed. They are susceptible to being washed away by rain or irrigation, and most (but not all) do not protect parts that grow and develop after the product is applied.

Most older, multi-site fungicides (such as captan, chlorothalonil, mancozeb, and copper) are contact fungicides. Contact fungicides:

- Must be applied *before* spores land on and infect leaves.
- Prevent spore germination, so they are preventative treatments.
- Have no effect once the infection is established.

Penetrant Fungicides

Penetrant fungicides are absorbed, so they move into plant tissues, and penetrate beyond the cuticle and into the treated leaf tissue itself.

There are various kinds of penetrants, characterized by their ability to spread when absorbed by the plant. **Localized penetrants** remain in the area of initial plant contact and undergo very little movement within the plant (a process called translocation).

All penetrant fungicides are systemic, because they are absorbed by the plant and translocated to other plant tissues — in other words, they move through the plant's system. **Systemic fungicides** can be further subdivided based on the direction and degree of movement once they have been absorbed and translocated inside the plant:

Table 1. Mobility and Classification of Commonly Used Fungicides

Group Code ¹	Fungicide Family ² or Class	Common Name	Example Trade Name	Mobility
1	benzimidazole or MBC	thiophanate-methyl	3336, [®] Cleary's 3336 [®]	xylem mobile
2	dicarboximide	iprodione	Chipco 26GT, [®] Iprodione Pro 2SE [®]	localized penetrant/ translaminar
3	demethylation inhibitor (DMI)	triflumizole	Procure, [®] Terraguard [®]	xylem-mobile
		triforine	Funginex, [®] Sapro [®]	
		myclobutanil	Eagle, [®] Systhane [®]	
		tebuconazole	Folicur [®]	
		<i>Banner Maxx Propiconazole</i>	<i>Banner Maxx,[®] Propiconazole[®]</i>	
4	phenylamide (PA)	mefenoxam	Subdue Maxx [®]	xylem-mobile
7	carboximides	flutalonil	Contrast [®]	locally systemic
		boscalid	Mix partner of Pristine [®]	
11	quinone outside inhibitor (QoI) — strobilurins	kresoxim-methyl	Cygnus [®]	locally systemic/ translaminar
		azoxystrobin	Heritage [®]	xylem-mobile
		trifloxystrobin	Compass [®]	locally systemic / translaminar
12	phenylpyrrole (PP)	fludioxonil	Medallion [®]	contact
14	aromatic hydrocarbons	dicloran	Botran 70 [®]	contact
		etridiazole	Truban, [®] Terrazole [®]	
17	hydroxyanilide	fenhexamid	Decree [®]	locally systemic
18	antibiotic streptomycetes	streptomycin	Agri-Mycin, [®] Agri-Step [®]	xylem-mobile
19	polyoxin	polyoxin D	Endorse [®]	xylem-mobile
21(P) ³	host plant defense inducers, systemic acquired resistance (SAR)	acibenzolar-S-methyl	Actigard [®]	amphimobile
		harpin	Messenger [®]	
M (33)	multi-site activity phosphonate	fosetyl-aluminum	Aliette [®]	amphimobile
		phosphorous acid	Alude, [®] BioPhos [®]	
40	cinnamic acid	dimethomorph	Stature DM, [®] Stature SC [®]	localized penetrant/ translaminar
M	multi-site activity inorganics	copper	Kocide, [®] Champ [®]	contact
M	multi-site activity inorganics	sulfur	Microthiol Disperss, [®] Sulfur	contact
M	multi-site activity dithiocarbamate	mancozeb, maneb, dimethyldithio- carbamate	Mancozeb, [®] Maneb, [®] Thiram [®]	contact
M	multi-site activity chloroalkythios	captan	Captan [®]	contact
M	multi-site activity chloronitrile	chlorothalonil	Bravo, [®] Daconil 2787 [®]	contact
U(28)	unknown carbamate	propamocarb	Banol [®]	xylem-mobile

¹ FRAC code is listed in parentheses under the EPA Group code when the codes differ. Neither system includes biofungicides.

² For the sake of consistency, group codes, fungicide classes, fungicide names, and abbreviations are those used by the Fungicide Resistance Action Committee (FRAC) and by the EPA Office of Pesticide Programs. This program is part of the pesticide classification system developed to assist growers in resistance management. Only fungicides registered in the USA are included.

³ Although similarly described, the modes of action are different.



Fungicide Application



Contact Fungicides



Systemic Fungicides

Fungicide Mobility in Plants

The red areas show the mobility of fungicides in plants. Note that where the fungicide is applied is important. Contact fungicides remain on plant surfaces only where applied. Xylem-mobile fungicides are absorbed by the plant and translocated upward to other tissues. Amphimobile fungicides move throughout the plant. Translaminar fungicides can move across and through the leaves, but are not truly systemic.



Translaminar Fungicides



Amphimobile Fungicides

- **Xylem-mobile** fungicides (also called **acropetal penetrants**) move upward from the point of entry through the plant's xylem.
- **Amphimobile** fungicides (also called **true systemic penetrants**) move throughout the plant through its xylem and phloem.
- **Locally systemic** fungicides (essentially synonymous with localized penetrant) have limited translocation from the application site.

Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer.

- **Translaminar** fungicides are absorbed by leaves and can move through the leaf to the opposite surface they contact, but are not truly systemic and do not move throughout the plant.

Systemic fungicides:

- Can stop or slow infections within 72 hours of exposure.
- Must be applied soon after initial infection.
- Are ineffective once the fungus begins producing spores.
- Have limited curative activity.

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