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Technical Bulletin

01 -Updated 7/21/06

FUNGICIDE EFFECTS ON MYCORRHIZAE

When using mycorrhizal fungi inoculants, it is important to consider what effect your fungicide treatments will have. It would make no sense to inoculate with mycorrhizal fungi, only to kill them with fungicide application. The obvious question is, "Can fungicides be applied at all when mycorrhizal fungi inoculants are being used?"

Mycorrhizal fungi can be quite sensitive to some fungicides, but not all. Some fungicides can actually stimulate mycorrhizal fungi, while other fungicides are detrimental. PHC has compiled the following lists of fungicides for which published data exists regarding their effect on mycorrhizal fungi. Furthermore, based on field tests, PHC has composed some good general rules regarding fungicide use. These rules are presented here:

General Rules Regarding Use of Fungicides with Mycorrhizal Fungi Inoculants.

1. Typically, **foliar application of nonsystemic fungicides** has very little impact on mycorrhizal fungi, which reside on the roots. Even though some fungicide will reach the soil, the amount reaching the root zone is usually too low to have a significant, long-term effect on mycorrhizal fungi.
2. **Soil drench applications of nonsystemic fungicides** can be detrimental to mycorrhizal fungi if applied before root colonization takes place. Therefore, it is important to avoid use of fungicides too close to inoculation time.
3. Once spores have thoroughly colonized the roots, mycorrhizal fungi tend to be less sensitive to detrimental, but *nonsystemic* fungicides applied by soil drench because:
 - a. Fungicide levels will be high in the soil, but tend to be considerably lower inside root tissue.
 - b. High levels of fungicides in soil can kill off fungal tissue in the soil, but not fungal tissue embedded inside the root.
 - c. When fungicide levels in soil diminish from leaching or gradual degradation, fungal tissue inside the root will grow a new absorbing network out into the soil to restore the mycorrhizal effect.
4. Foliar or soil application of **systemic fungicides** can lead to accumulation of fungicide in the root tissue having a negative impact on mycorrhizal fungi. Roots of treated plants are not susceptible to colonization by mycorrhizal fungi for up to 3 weeks after systemic fungicide treatment.

Summary of Fungicide Use with Mycorrhizal Fungi

1. Foliar *nonsystemic* fungicides typically can be used at any time.
2. Avoid using soil drench fungicides too close to time of inoculation, 2 weeks before inoculation (longer if systemic) and 4 weeks after inoculation.

Specific Fungicide Effects From Published Literature

PHC has compiled the following lists of fungicides for which published data exists regarding their effect on mycorrhizal fungi. Of course, no one has been able to test any fungicide against all mycorrhizal fungi species, so some basic assumptions were made in the compilation of these lists:

1. For this list a fungicide was considered to be inhibitory if it was reported to inhibit, regardless of other contradictory reports.
2. The two major groups of mycorrhizal fungi, VAM and Ecto-, are treated separately, as fungicides detrimental to one group, need not be detrimental to the other.

Fungicide Effects on VAM

No Inhibitory Effect	Inhibitory Effect⊗
Carbamate (Ferbam, Fermate)	*Alette (Fosetyl-AI)*
Carbendazim (Bavistan)	Benomyl (Benlate, Tersan-1991)
Chloroneb (Tersan, Demosan)	Captan (Orthocide)
Chlorothalonil (Bravo, Daconil-2787, Exotherm)	Copper Oxychloride Sulfate (CDCS)
Difolatan (Sulfonimide, Difosan, Captafol)	Formalin (Formaldehyde)
Mancozeb (Dithane M-45, Manzate; Fore)	*Metalaxyl = Mefenoxam (Subdue, Ridomil)*
Manate (Dithane M-22, Maneb)	PCNB (Terrachlor, Tri-PCNB)
Rovral (Chipco-26019)	Phaltan (Folpet; Thiophal)
Thiabendazole (Mertect)	Terrazole (Truban, ETMT)
Thiram (Tersan 75, Arasan)	Tilt (CGA-65250, Banner, Propiconizol)
Topsin-M (Easout, Fungo, Duosan)	Thiophanate Methyl (Cleary 3336)
Triforine (Funginex)	Triadimefon (Bayleton)
	Vitavax (Carboxin, DCMO)
	Azoxystrobin (Abound, Dynasty, Heritage, Protégé, Quadris, Quilt, Soyard, Uniform)
	Kresoxim-methy (Cygnus, Sovran)

*There are some published reports indicating that these fungicides actually stimulated VAM development. (See Notes below.)

⊗**NOTE:** Inhibition occurs with soil drench application, not with foliar spray application.

See next page for ectomycorrhiza list.

Fungicide Effects on Ectomycorrhizae

No Inhibitory Effect	Inhibitory Effect
Aliette (Fosetyl-Al)	Banrot
Benomyl (Benlate, Tersan-1991) below 100 µg/g	Chlorothalonil (Daconil-2787, Bravo)
Captan (Orthocide) below 100 µg/g	Mancozeb (Dithane)
Carbamate (Fermate, Ferbam)	PCNB (Terraclor, Tri-PCNB)
Carbendazim (Funaben T)	Triadimefon (Bayleton)
Dexon	Zineb (Ziram, Zerlate)
Dichlofluanid (Euparen 50WP)	Hymexazol (Tachigaren)
Difolatan (Sulfonimide, Difosan, Captafol)	Iprodione (Rovral, Chipco 26019)
Fuberidizole	
Metalaxyl (Subdue, Ridomil)	
Prpoamocarb (Banol, Prevex, Previcur, Tattoo, Dynone, Filex, Proplant)	
Thiophanate Methyl (Cleary 3336; Topsin M70)	
Thiram (Arasan) below 100 µg/g	

Notes

- For this list, a fungicide is considered to be inhibitory if there exists a published report documenting inhibition, regardless of other contradictory reports.
- For this list, a fungicide is considered to have no detrimental effect whether it had no effect, or whether it had a positive effect on mycorrhizal development.
- There are often many different trade names for the same fungicidal chemical. There may be other names not shown here.
- No fungicide eradicates mycorrhizae; they only decrease development for a short time after application. The time of this effect depends on the duration in which the chemical persists in the environment.
- Most foliar spray fungicides, if applied correctly (except those that are systemic, like Bayleton), do not affect mycorrhizae because the fungicide does not come in contact with the mycorrhizae in the soil (in significant quantities).

Other Pesticides

- There are no reports of any insecticide or herbicide, applied at label rates, affecting mycorrhizal development. Of course, herbicides can affect mycorrhizal fungi indirectly by harming or killing their host plant.