Biological Control Of Soilborne Pathogens In Soilless Potting Mixes

The favorable environment for soilborne pathogens has to occur in the growing medium: Read on to understand how biological controls and soilless potting media affect soilborne pathogens in the greenhouse.

By George Elliott, Wade Elmer and Anuthep Pasura

Damping off, root rots and stem rots are constant threats in greenhouse production. These diseases are caused by soilborne pathogens such as Pythium, Phytophthora, Rhizoctonia, Thielaviopsis and Fusarium. Plant diseases occur when both a pathogen and a susceptible host are present in a favorable environment. In the case of soilborne pathogens, the favorable environment has to occur in the growing medium.

Water and nutrient management are two key factors in cultural management affecting the incidence of disease. It is well known that overwatering predisposes plants to root and stem rots caused by Pythium or Phytophthora. Some soilborne pathogens, like Phytophthora and Thielaviopsis, can be effectively managed by controlling pH or plant nutrition. Managing nitrogen nutrition can be important, as high nitrogen can favor Phytophthora and Pythium. A high proportion of nitrate-nitrogen can reduce the incidence of Fusarium wilt, but a high proportion of ammonium-nitrogen can reduce the incidence of Thielaviopsis.

Biological Activity

Another aspect of the growing medium that can have an effect on disease incidence is biological activity. Soilless potting mixes (SPM) are used for practically all greenhouse crops. In most regards, the adoption of soilless mixes has been beneficial, as the soil-based mixes they replaced were a source of pathogens. However, soilless mixes may also lack the beneficial microbes that help keep pathogens in check in field soil. Soil-based mixes that are pasteurized to suppress pathogens, weeds and insects also lack a full complement of beneficial microbes.

Microbial inoculants (MI) are preparations containing living microorganisms that can be added to soil and soilless growing media to enhance beneficial microbial activity. Some MIs are labeled as biocontrols to reduce the incidence or severity of plant diseases. MIs include fungi, bacteria and actinomycetes. The mechanisms by which the beneficial microbes can reduce the incidence of disease include the production of antibiotics, direct parasitism, competition and activation of host plant resistance.

Biocontrols In The Greenhouse

The biocontrols currently available for use in greenhouse production growing media include three products containing strains of the bacterium *Bacillus subtilus*: Companion (*B.s.* GB03), Rhapsody (*B.s.* QRD 713) and Subtilex (*B.s.* MBI600). Products containing fungi include PlantShield and RootShield, both containing *Trichoderma harzianum* T-22, and SoilGard, containing *Gliocladium virens* GL21. Three products containing actinomycetes are Actinovate Fe and Actinovate M, both containing *Streptomyces lydicus* WYEC 108, and Mycostop, containing *Streptomyces griseoviridis* K21. Several other products have been registered with the U.S. Environmental Protection Agency for control of soilborne diseases in greenhouse crops but are not currently on the market.

Several biocontrols are approved for use in certified organic production systems, and they are generally recommended for integrated pest management programs. Many growers use them routinely as an alternative to preventative applications of chemical fungicides. However, remarkably little evidence is available to show that biocontrols are truly effective at reducing the incidence of plant disease.

Over the past 10 years, we have conducted numerous controlled trials with a variety of biocontrols, plant species, potting mixes and pathogens. In some cases, disease control with biocontrols was as good as the standard chemical treatment. In other cases, biocontrols failed to control disease or even were associated with increased disease incidence. Similar results have been reported from other research trials.

Comparing Biocontrols

Our two most recent greenhouse trials have examined the interaction of biocontrols and potting mixes on blackleg disease of seed-propagated geraniums caused by *Pythium ultimum*. In the first trial, we compared three biocontrols: Actinovate Fe, Companion and RootShield.

Geranium seed was sown in 98-cell trays in Premier PGX plug mix either uninoculated or inoculated with the products according to label recommendations. The seedlings were transplanted to 4½-inch square pots containing about 30 cubic inches of potting mix. The potting mixes for growing on were Fafard 3B and Berger BM-3 either uninoculated or inoculated with Actinovate Fe, Companion or RootShield at label rates. ➧

Top: *Effect of Pythium on geraniums: This shows early symptoms include stunting and chlorosis. Left, infected plant; Right, control.* ***Middle:*** *Advanced symptoms of blackleg disease on geranium.* ***Bottom:*** *Effect of biocontrols on the growth of vinca in two potting mixes: foreground, Pro-Gro PX-1; background, Berger BM-3. No pathogen was applied.*

"America's Leading Supplier of Material Handling Equipment"

Toll-Free 800-628-3183

Cart-Mart

Div. of Matco Distributors, Inc.

Website martforcarts.com

GREEN MONSTER — NEW

HEAVY DUTY GREEN MONSTER — NEW

GALVINIZED GREEN MONSTER — NEW

SUPER ZINC CART — NEW

SUPER GREEN CART — NEW

CARTOLOGY CART

TECHNO CART — USED

2 SHELF TANDEM CART — USED

JUMBO GRAY SHOP CART — USED

SMALL GRAY CART — USED

HEAVY DUTY STRUCTURAL PLASTIC

USED NESTING PLATFORM TRUCKS 30" X 60"

$119.00 each
&
$129.00 each
with basket

SCALE PALLET TRUCK WEIGHS THE LOAD

$799.00 each

NEW

27" W x 48" FORKS

PALLET TRUCK

$199.00 each

NEW

CASTERS

OTC SHOP CART

USED

BIG BOY — NEW

SILVER STREAK CART — NEW

Cart-Mart

www.martforcarts.com

Milwaukee & Chicago • 800-628-3183

In Las Vegas as of 9/1/06 • 800-785-1115

Write in 418

A group of uninoculated mix pots was drenched with Banrot as a chemical control. The potting mix in half the pots was infested with *Pythium ultimum* var *ultimum*, using a strain isolated from a geranium with blackleg disease found in the University of Connecticut Floriculture Greenhouse. We monitored plants for occurrence of disease, and harvested the shoots 12 weeks after transplanting when the crop was in full flower. MIs were enumerated in samples of SPM collected at intervals throughout the trial. Pythium was enumerated in samples of infested SPM at the final harvest.

Only a few plants in this trial showed symptoms of blackleg disease. However, in Fafard 3B, Pythium significantly reduced shoot fresh weight in the uninoculated, Companion and RootShield treatments. Root appearance and shoot fresh weight were not affected by Pythium or MI treatment in Berger BM-3 (see Figure 1, below). Enumerations showed that all three MIs persisted in both SPM for the duration of the trial, although populations decreased over time. Pythium counts were similar in Berger BM-3 and Fafard 3B in the uninoculated and Actinovate Fe treatments. Treatment with Banrot completely eliminated the pathogen in both mixes. In Berger BM-3, Companion and RootShield also eliminated Pythium, but neither MI treatment had any effect in Fafard 3B.

The results of this trial show that MIs can persist for up to 12 weeks and can suppress Pythium in SPM. However, this was irrelevant to the outcome because suppression occurred only in the non-conducive potting mix in which the pathogen had no effect on plants in the uninoculated control.

The Second Trial

Last year, we conducted another trial with the same MIs and six SPM: Berger BM-3, Fafard 3B, Premier HP, Sungro SB400, Metro-Mix 360 and Metro-Mix 360 Coir. Procedures were identical to the previous trial except we used PlantShield instead of RootShield. We also measured water retention and air-filled porosity at container capacity in the SPM.

Incidence of blackleg and mortality was significant in this trial. Some mortality occurred in three non-infested SPM inoculated with Actinovate Fe (see Figure 2, opposite). Even with Pythium infestation, no blackleg disease occurred in Premier HP in any treatments. None of the treatments were significantly different from the control in any SPM. In infested Berger BM-3, low (8 percent) mortality occurred in the Actinovate Fe and Banrot treatments. The highest mortality, ranging from 17 to 50 percent, occurred in Metro-Mix 360.

Although the data were insufficient to establish a correlation, the greatest incidence of disease occurred in the SPM with the lowest air-filled porosity, and the least incidence of disease occurred in the SPM with the highest air-filled porosity.

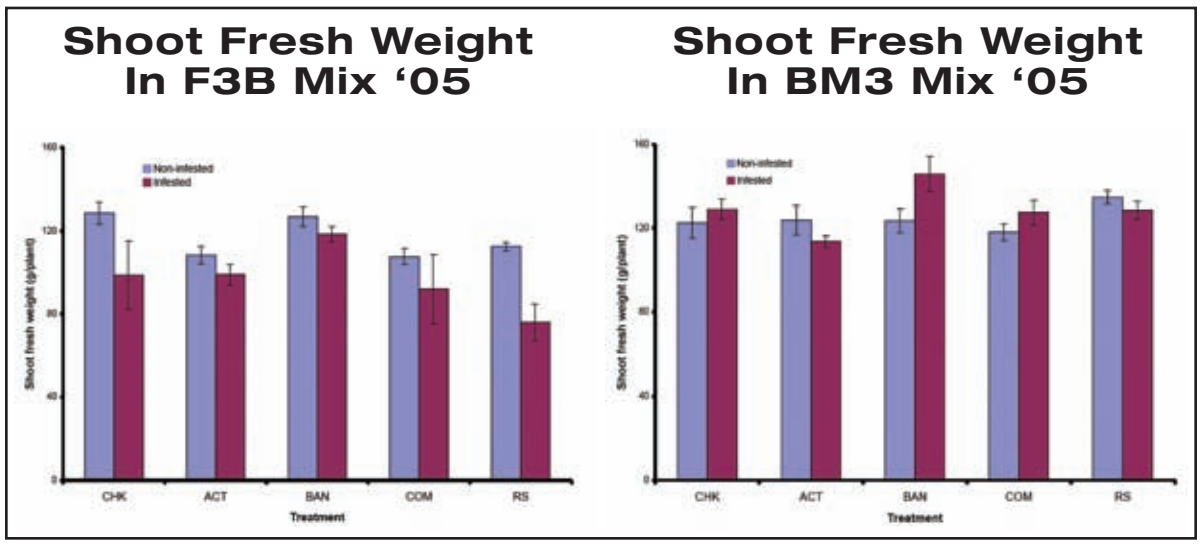

Figure 1. Effect of biocontrols and Pythium infestation on shoot fresh weight of geranium 'Score Scarlet' grown in two potting mixes: F3B, Fafard 3B and BM3, Berger BM-3. (CHK, uninoculated control; ACT, Actinovate FE; BAN, Banrot drench (chemical control); COM, Companion; RS, RootShield)

Why No Consistent Control?

Why have biocontrols failed to provide consistent control in our trials? One possibility is that the level of pathogen used was unrealistically high and was, therefore, able to simply overwhelm the biocontrols. However, the level of mortality was relatively low even in SPM most conducive to disease, and in non-conducive SPM, no mortality occurred even with the level of Pythium that was added.

Biocontrols might fail because the environmental conditions are unfavorable either for persistence or activity. The observation that MI persisted in different SPM for 12 weeks argues against the first possibility. However, the observation that MI were able to suppress Pythium in Berger BM-3 but not Fafard 3B suggests that environmental conditions might have inhibited the activity of the MI

even though the populations of both MI and pathogen were similar in the two SPM.

Another cause for biocontrol failure would be that environmental conditions were more favorable for the pathogen. Conditions in the growing medium clearly favored Pythium in some SPM but not others. It appears that some SPM are simply more conducive to the development of disease. A level of Pythium infestation that caused disease in some SPM was completely ineffective in others.

Using Microbial Inoculants

Although the main reason for using MI is disease suppression, some benefits have been obtained in the absence of disease pressure. A striking example occurred in a trial we conducted with vinca grown in two potting mixes (Berger BM-3 and SunGro PX1) with three biocontrols (Deny, *Burkholderia cepacia*, no longer marketed; RootShield; and SoilGard) and untreated controls. The plants grown in untreated SunGro PX1 were stunted and chlorotic with symptoms that strongly resembled iron deficiency. Plants in the treated SunGro PX1 were larger and greener, although even in the Deny treatment, they were still smaller and paler than the plants grown in Berger BM-3. In Berger BM-3, the control plants did not show any signs of stress, but the plants grown in inoculated mix were significantly larger. SoilGard had the greatest positive effect.

If biocontrols were consistently beneficial by alleviating non-biological stress and stimulating plant growth, growers could justify using them even if they did not consistently suppress disease. Unfortunately, a subsequent experiment showed that biocontrols could actually be harmful. In this trial, poinsettias were grown in three different potting mixes with different biocontrols. The trial was conducted at a commercial greenhouse. In previous years, the grower had experienced persistent problems with root rot in large pots. We didn't observe any incidence of disease in this trial, nor did we see any benefits from the biocontrols. However, plants in all three SPM inoculated with SoilGard were noticeably stunted compared to the control. This effect was most pronounced in Berger BM-3.

Evaluating the performance of biocontrols is complicated. It is impossible for a research trial to test all possible combinations of potting mixes, pathogens and plant species not to mention that the greenhouse environment is continually changing. The results of our trials show that growing medium characteristics are the ➧

Soilless Potting Media Effects

		Treatment				
Soilless Potting Media	**Pythium**	**Uninoculated**	**Banrot**	**Actinovate Fe**	**Companion**	**PlantShield**
		% Mortality				
Berger BM-3	-	0b	0b	17a	0b	0b
	+	0a	8a	8a	0a	0a
Fafard 3B	-	0	0	0	0	0
	+	8ab	17ab	0b	0b	25a
Premier HP	-	0	0	0	0	0
	+	0	0	0	0	0
Metro-Mix 360	-	0a	0a	50b	0a	0a
	+	17a	50a	42a	33a	42a
Metro-Mix 360 Coir	-	0a	0a	33a	0a	0a
	+	25ab	33a	17ab	0b	8b
SunGro SB400	-	0	0	0	0	0
	+	25ab	0b	8b	8b	33a

Numbers within a row followed by the same letter are not significantly different (Fisher's LSD; P=0.05)

Figure 2. Effect of soilless potting mixes, biocontrols and Pythium infestation on mortality of geranium from blackleg disease.

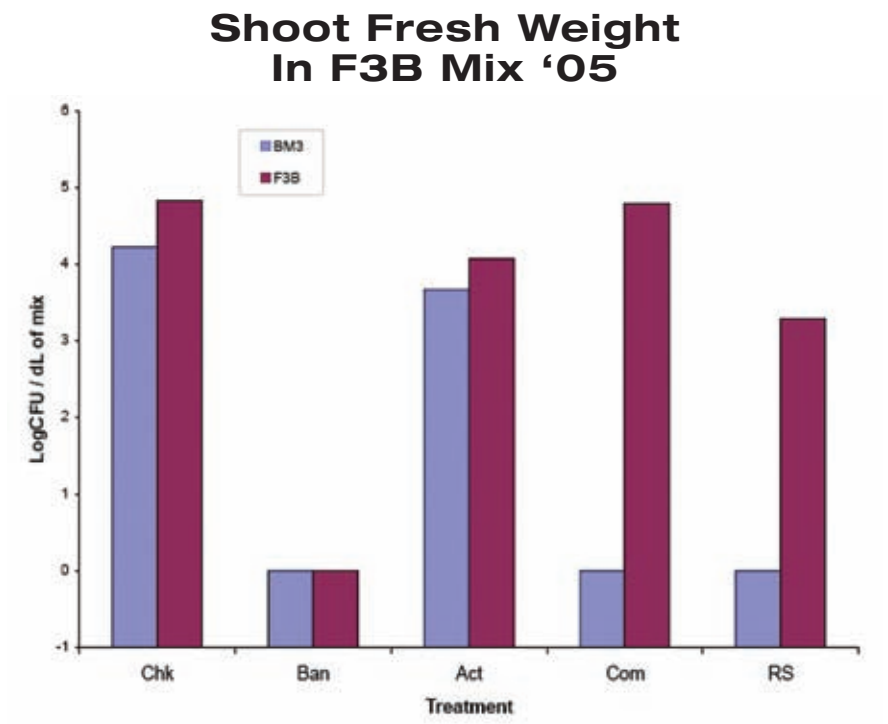

Figure 3. Effect of biocontrols on the number of Pythium propagules in two potting mixes cropped with geraniums and infested with Pythium at an initial level of about $2x10^6$ propagules per liter. (CHK, uninoculated control; ACT, Actinovate FE; BAN, Banrot drench (chemical control); COM, Companion; RS, RootShield)

Effect of SoilGard on poinsettias grown in Berger BM-3 potting mix. Left, control; Right, SoilGard. Similar results were obtained in two other potting mixes.

most important factor determining whether or not disease occurs.

Alleviation of non-biological stress or growth stimulation can occur with MI, but plant injury is also possible. The most important lesson from our research is that growers have to be capable of evaluating MI in their own situations. Statistically replicated trials may not be necessary, but it is impossible to tell if a product is doing any good without a control. GPN

George Elliott is an associate professor and Anuthep Pasura is a Ph.D. student in the Department of Plant Science at the University of Connecticut, Storrs, Conn. Wade Elmer is a plant pathologist in the Department of Plant Pathology and Ecology at the Connecticut Agricultural Experiment Station, New Haven, Conn. Elliott can be reached at george.elliott@uconn.edu.

Authors' Note: This research has been supported by the New England Greenhouse Conference, the Fred C. Gloeckner Foundation and the American Floral Endowment. We thank Bioworks, Growth Products and Natural Industries for providing products and Ball Horticultural Co. for geranium seed.

LearnMore For more information related to this article, go to www.gpnmag.com/lm.cfm/gp060704

Reader Interest Review Please write in the appropriate number on the Reader Service Card to indicate your level of interest in this article.

High 1509 Medium 1510 Low 1511