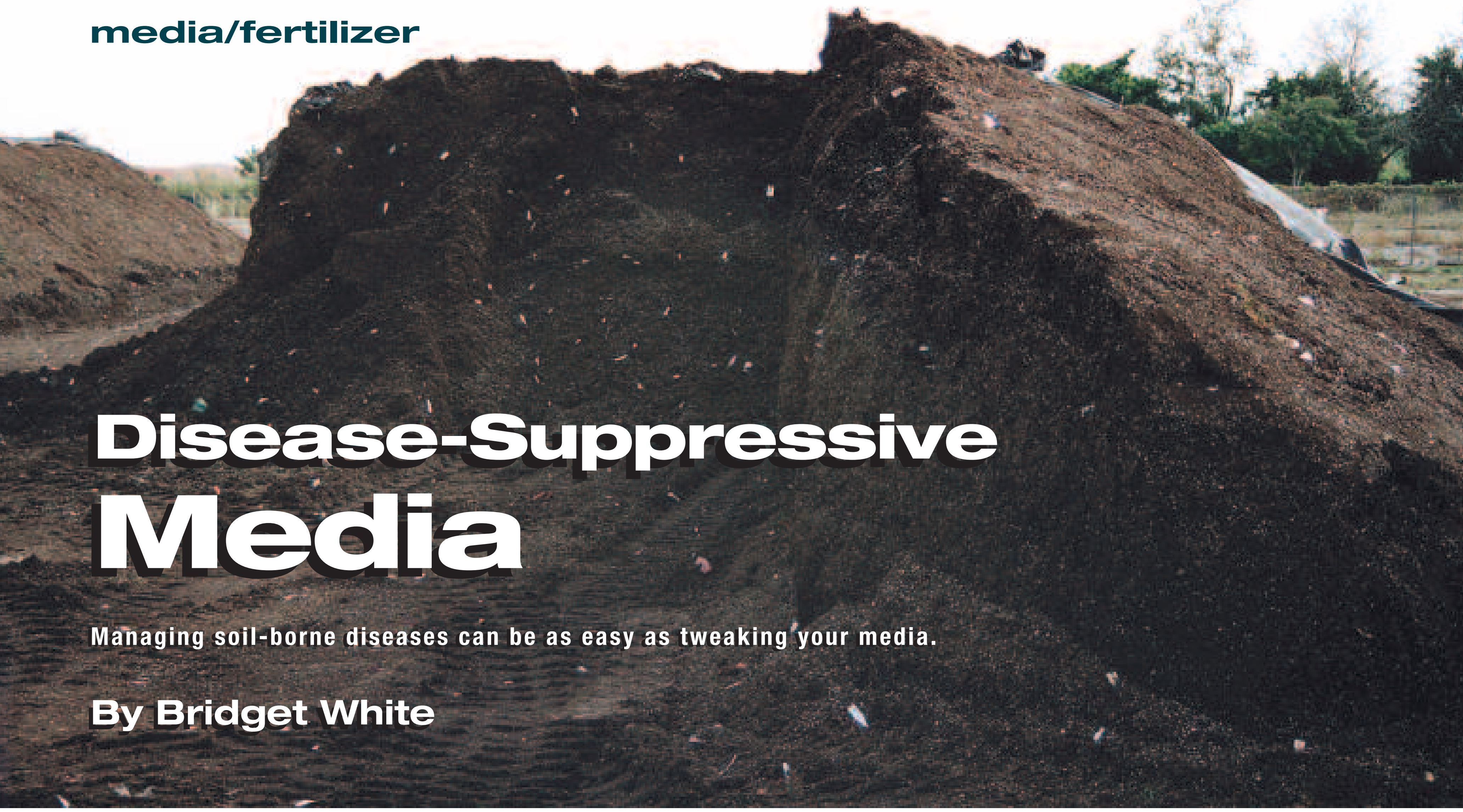

Disease-Suppressive Media

Managing soil-borne diseases can be as easy as tweaking your media.

By Bridget White

Hines Color, Homestead, Fla., has an elaborate system for filtering plastic out of used media before it gets composted for reuse.

Management of soil-borne diseases is critical in greenhouse and nursery production. Soil-borne diseases are caused by the pathogens Pythium and Rhizoctonia (damping off), Thielaviopsis (black root rot) and several other root rot and wilt organisms such as Fusarium and Phytophthora. The conventional approach to control relies on fungicide drenches and soil fumigants. However, appropriate technologies such as steam pasteurization, soil solarization and the use of disease-suppressive media are now widely accepted as viable non-chemical alternatives.

A disease-suppressive media sustains plant growth, but due to its physical, chemical or microbial composition, it does not support plant diseases. This characteristic of media was first noticed casually; now researchers can more clearly articulate the mechanisms and methods that make media suppress disease. And while this documentation is accepted and applied in nurseries, greenhouses are just starting to investigate its potentialities and assess the possibilities of this alternative.

THE BASICS

Disease-suppressive potting mixes are developed by a) incorporating suppressive organic amendments such as certain types of peat moss and good quality composts, b) inoculating composts and/or potting media with microbial biocontrols such as Trichoderma, Gliocladium, Bacillus and Pseudomonas, or c) inoculating potting media with plant-health promoting microorganisms such as mycorrhizae.

Harry Hoitink, a plant pathologist at The Ohio State University, has pioneered much of the work with disease-suppressive medias, mostly using composted bark as a disease-suppressive ingredient in nursery mixes.

Through research, Hoitink and others have determined that pathogens such as Pythium are suppressed by general competition, while others such as Rhizoctonia require specific microbial antagonists.

Light peat moss, or sphagnum peat, is known to be suppressive against Pythium for approximately 6-7 weeks. However, dark peat moss that comes from deeper layers in the bog does not exhibit suppressiveness and may in fact be conducive to pathogens. Apparently, sphagnum peat contains naturally occurring microflora. As long as a plethora of microflora are present, they compete for nutrients with pathogens such as Pythium and Phytopthora through a process known as "general suppression." Thus, when sphagnum peat is used in potting mixes to start plugs and transplants, it often doubles as a natural disease suppressant for the lifetime of the seedling. Likewise, microflora-rich composts are generally suppressive to Pythium and Phytophthora. However, to provide reliable control of Rhizoctonia, media inoculation after the thermophyllic stage with known antagonists such as Trichoderma and Flavobactereium is required.

HOW DOES IT WORK?

Pathologists describe two different types of disease suppression in compost and soil. General suppression is due to many different organisms that compete with pathogens for nutrients and/or produce general antibiotics that reduce pathogen survival and growth. This type of suppression is effective on those pathogens that have small propagule size, resulting in small nutrient reserves and the need to rely on external carbon sources. Thus an active microflora in the soil or compost will often prevent disease since the pathogens are outcompeted. Examples of this mechanism are damping off and root rot diseases caused by Pythium and Phytophthora.

Specific suppression, on the other hand, is usually explained by one of a few organisms. They exert hyperparasitism on the pathogen or induce systemic resistance in the plant to specific pathogens, much like a vaccination. With specific suppression, the causal agent can be clearly transferred from one soil to another. Pathogens such as *Rhizoctonia solani* and *Sclerotium rolfsii* are examples where specific suppression may work but general suppression does not work. This is because these organisms have large propagules that are less reliant on external nutrients and thus less susceptible to microbial competition. Specific hyperparasites such as Trichoderma species will colonize the propagules and reduce disease potential.

The disease-suppressive effect of composts can easily be eliminated by heat greater than 140º F. For example, studies of compost windrows heated to this level have shown loss of suppressiveness in the center but retention of suppressiveness in the cooler, outer layers. The suppressiveness returns after cooling when the general microflora recolonize the compost. A few beneficial species can survive the high temperatures, but the bulk of the desirable organisms need more moderate temperatures. This suggests that sphagnum peat moss, composted bark or compost should not be heat sterilized or pasteurized prior to incorporation in a potting mix.

Washington State University greenhouse tomato study shows the effect of compost rates from 0-40 percent in the potting mix, using water only. (Photo courtesy of Washington State University)

The biological vacuum created after periods of high temperature offers a chance to introduce a custom microflora into the media, and researchers have successfully inoculated composts with microbial mixes to enhance biocontrol. This should be done as soon as possible after heating so that the introduced organisms have minimal competition with the native microbes that will be recolonizing the compost.

The Ohio State University researchers demonstrated that the beneficial microbes in compost and other decomposing organic matter can activate certain disease-resistance systems in plants. When a pathogen infects a plant, the plant mobilizes certain biochemical defenses, but these are often too late to avoid the disease. Plants grown in compost appear to have these systems already running, which prevents pathogen infestation. This mechanism, called systemic acquired resistance, is somewhat pathogen specific.

Compost quality plays a role in the degree of suppressiveness and the length of suppressive activity. Composts that are allowed to mature are more suppressive than those used after the heat phase. Composted hardwood bark is more suppressive and remains active longer (up to two years) than pine bark composts (up to five months). Composts that are in the open (i.e., exposed to naturally occurring microbial organisms) are more suppressive than compost piles sheltered by a roof.

In order for compost to substitute for currently used fungicides, the disease-suppressive character must be consistent and somewhat quantifiable to reduce risk for the growers. Research into the mechanisms of disease suppression in compost have led to the ability to produce consistently suppressive composts.

FIELD EXPERIENCE

The nursery industry and field crops are using disease-suppressive compost widely and routinely, and the results are impressive.

• Researchers in California showed that soils on organic farms were more suppressive to two tomato diseases than soils from conventionally managed farms, due to differences in soil organic matter, microbial biomass and nitrate levels.

• A Florida researcher found that compost all but eliminated macrophomina, a fungal disease on beans, compared to the severe disease on the untreated plots. Bean yields in the composted plots were nearly double that of the untreated, and this carried over to the next crop. Rhizoctonia-related disease was reduced by 80 percent with the high compost rates and 40 percent with the medium rates.

• In another Florida experiment, composted sewage sludge was applied to a tomato field. The researcher noticed that early blight disease was significantly less with compost than without, as was bacterial leaf spot. He also observed a dramatic difference in rootknot nematode damage.

• Other applications include use of compost to combat alfalfa decline in Pennsylvania, Phytophthora root rot on soybeans and peppers in Ohio, and nematodes on potatoes in Idaho. In addition, several investigators are testing the use of compost teas as a foliar spray to combat leaf diseases. In Ohio, Hoitink has patented a process to inoculate compost with beneficial microbes for biocontrol.

• Bioassays were conducted for suppressiveness to R*hizoctonia solani*, *Pythium ultimum* and *Fusarium solani*. Many of the batches of compost were suppressive prior to inoculation, but inoculation did increase suppressiveness up to 80 percent. Combinations of beneficial organisms gave better results.

GETTING STARTED

Growers who want to make their own compost-containing media may want to explore resources and practices associated with compost preparation. Compost seminars, compost methods and compost analysis are gaining popularity in response to the need for improved compost quality. Many manufacturing companies now offer technical support, testing services and training.

The following excerpt from *HortIdeas* summarizes several factors that help make peat moss and compost-based potting mixes more suppressive to diseases: "…Pythium root rot is suppressed for over two months by a growing mix containing 50 percent or more light (as opposed to dark) fibrous sphagnum peat, at least 20 percent composted pine bark, and enough lime to produce a pH of 5.3-5.5. This mix, with 40-45 percent water content, should be aged for a couple of weeks at temperatures between 65º F and 90º F before planting, to allow beneficial organisms to become well-established."

Researchers have found that compost from most sources is suppressive to Pythium after proper heating and curing but not so for Rhizoctonia. *R. solani* can proliferate in uncomposted materials such as fresh bark or straw. Pythium is just the opposite; it needs decomposed materials that contain soluble nutrients. Minimal composting and curing eliminates the ability for either pathogen to establish in the finished product.

A mix of both fungi and bacteria appears most desirable. The curing process generally takes about 20-30 days for microbial recolonization. If the compost is too dry (less than 30 percent moisture by weight), fungi are more likely to recolonize. Such composts have been shown to be very conducive to Pythium-related diseases. Nursery operators will prewet the potting mix and incubate it for 4-10 days to allow for the desired fungal and bacterial balance. Also, uncured compost may contain high levels of soluble nutrients that create favorable conditions for Pythium and Fusarium pathogens. These concerns are most crucial for composts used in potting soils.

Perhaps the biggest challenge for consistent suppressiveness is producing a very consistent compost. Some facilities will be more able to do this than others, in part based on the stability of feedstock source and composition over time. A homogeneous material is needed for use as a potting amendment, since variation from pot to pot could lead to production problems.

In the attempt to predict compost suppressiveness to pathogens, several tests have been developed. The first test uses fluorescein diacetate. A second test is pending distribution in the United States. In addition, a number of labs provide compost analysis, microbial analysis and other biological-activity indicators such as organic matter and humus content. A list of these labs can be found at www.attra.org/attra-pub/soil-lab.html, along with various other sources for disease-suppressive media, including suppliers and researchers who can supply addition creditable information about this emerging new tool. GPN

Bridget White is editorial director of* GPN. *She can be reached by phone at (847) 391-1004 or E-mail at bwhite@sgcmail.com.

LearnMore
For more information related to this article, go to www.gpnmag.com/lm.cfm/gp030502