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Contributors: Nancy Morgan, Shiv Reddy, Mark Thomas, Ron Walden and The Technical Network Team

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Editors: *Rick Vetanovetz and Dan Jacques*

Pine Tree Substrate — A Good Idea?

The use of pine trees (white wood, WoodGro®, PTS) or ground up pine tree parts (WTS) has received some attention in the growing medium industry in the last five years, not because of pine bark, but because of the wood and other parts of the tree. Already, there have been two ways, or methods, of harnessing pine trees as a growing medium ingredient, each with differing names:

Pine Tree Substrate or **PTS**, is material derived from grinding tree trunks and branches, including the bark. PTS falling into a certain particle size distribution has been patented and trademarked with the name WoodGro®. This material has been developed by researchers primarily at Virginia Tech University. Further evaluation is ongoing.

Whole Pine Tree Substrate or **WholeTree** is a material that utilizes all the parts of the pine tree, including bark, cones and needles. Researchers at USDA/ ARS in Poplarville, MS have developed and continue to evaluate this method of using pine trees. The primary idea is that smaller pine trees usually discarded in the thinning process of managing forest tree stands are suited to this purpose.

Somehow, grinding up trees to use as a growing medium component seems "counter-culture" to our understanding of how to provide for the growth and development of high quality greenhouse crops. However, the list is growing longer every year of the studies devoted to testing (University and grower field trials) the use of these materials to effectively grow herbaceous crops. While there is some optimism and good reports, there are some "not so good" reports as well.

You may ask, "Why all the interest in this material now?"

And the answer is — Availability and cost. As wide spread availability of pine bark decreases for a whole host of reasons, pine wood in various forms is viewed as a suitable alternative. And as growers are squeezed for gaining more margins from their crops, growing media manufacturers are also trying to find ways to reduce costs to their customers.

Why was this not tried before and what are the risks or the factors to make these materials work?

This takes an explanation.

As most of you know, bark has been used in the greenhouse industry for years. In the late 1960's / early 1970's pine bark was considered a waste product of the forestry industry and university researchers looked for ways to harness this plentiful and inexpensive waste stream. It was found early on that pine bark needed to be "aged" or "composted" to promote the destruction of substances that can be toxic to plant roots and to stabilize the bark, since bark will degrade (or compost) significantly in the growing containers. Over the years and with advances in understanding

The use of ground up pine wood has been of interest to researchers of late. This image is an example of what may be considered Pine Tree Substrate or PTS.

Pine Tree Substrate – A Good Idea?

of composting techniques, the process improved, and in turn the quality of the composts as well. Included in those improvements, nitrogen (N) is usually added to bark before the composting process to offset any concerns with nitrogen immobilization. Nitrogen immobilization is the technical term that is often referred to as nitrogen draft , nitrogen tie-up, nitrogen drawdown, etc. This is somewhat of a two-fold phenomenon in which bark will actually "bind" or "fix" N in the form of ammonium N on negatively charged sites on the bark surfaces. The other aspect is that microorganisms use available carbon (C) from the bark to grow. Microbes need nitrogen to grow as well. Stimulating microbial growth with carbon forces a need to "feed" microbes nitrogen and microorganisms are very efficient at obtaining N. The more available carbon there is, the more nitrogen you need to satisfy the growth of microorganisms. Unfortunately, the more N taken up by microorganisms , the less N that is available to plant roots. The result is that the grower needs to supply more N.

The balance of available carbon and nitrogen content is a major factor in predicting the nitrogen requirement of a growing medium or a crop. This is why carbon / nitrogen ratio (C/N) of a substance has had a bearing on the amount of nitrogen a substance will need to anticipate the amount of N immobilization that will occur.

Generally speaking, bark has a lower C/N ratio than wood, sometimes referred to as "white wood". Using white wood or ground up tree tops gets a little tricky when it comes to nitrogen requirements. The source of the wood (tree species, tree age, parts used), the period following "harvest" and the particle size including the shape / geometry of the particles (as affected by the chipping or shredding process) plays a significant role in the availability of carbon and microbial growth.

But one thing is certain. If you use a significant amount of wood or ground up pine trees in your growing medium, you will need more nitrogen to grow a crop compared to a composted bark. Research has shown that. You need to add N "up front" and you need to assure supply during the crop. The timing and source of the nitrogen is the "trick". And that is one of the reasons why results from scientific and practical field trials are so variable.

Improved composting techniques have not only fostered a more stable nitrogen status but a more stable and beneficial microbial population. Research conducted at the OARDC in Wooster, OH has clearly shown the benefits of encouraging beneficial microbial populations in composts. Adding more carbon without stabilization is somewhat risky.

Is this not being overly cautious? Can a grower still be successful?

The short answer is — Maybe. Various growers of containerized woody nursery crops have been using more wood in their growing media, either directly or indirectly, as a result of more wood in bark. So, the reasoning is, why not greenhouse mixes? Remember however that in a lot of cases containerized woody nursery crops utilize controlled or slow release nitrogen fertilizer to compensate for the enhanced nitrogen demand. Also, the demand for N is not as critical with woody nursery crops as with more herbaceous crops, like say a poinsettia or a pot mum.

Additionally, only certain species of pine trees are acceptable for use with one species reportedly being the best—Loblolly Pine (*Pinus taeda*). This means that growers can't start grinding up any trees available to use in their growing media.

OK, but have not some growers of herbaceous crops reported to be successful?

That is true however, in one widely reported case, the grower has their own source of Loblolly pine trees and their own operation to harvest and process the trees. This certainly helps the grower make adjustments to the process and determine how to adjust the growing conditions and fertility inputs.

Sun Gro has not yet adopted the use of directly adding pine wood to a mix. The economics of doing such a thing has just not become a clear opportunity and the seeming unpredictability of crop response is somewhat of a concern. Especially with the continued availability and success of composted pine bark. Certainly, the economics of using a less expensive product only for the customer to spend more money to fertilize more is a dubious proposition.

Nevertheless, Sun Gro is indeed interested and working on the successful use of wood in growing media. The key is to provide a product that is stable and predictable but that does not necessitate a high amount of added N from the customer. This is apparently the area people are targeting, but again, relies on technology and takes some control out of the hands of the grower.

The areas that Sun Gro is working in include the following:

- Identifying acceptable formulations including available pine tree materials.
- Conducting small and large scale applied grower trials at key Sun-Gro customers on perennial crops
- Studying the effect of adding slowly available nitrogen sources to im-

prove performance of pine tree containing mixes and fine tuning nitrogen loading rates.

- Further identifying appropriate grower applied nitrogen rates versus the particular source of pine tree material.

The take home messages to the reader is if your interested in trialing a material having wood by-product such as PTS you must:

- Understand you will need to provide more nitrogen
- You also need to be prepared to monitor the nitrogen status of the crop to know how much to adjust the fertility rates. Starting from unused media and during the cropping cycle.
- Bear in mind that mixes including wood but left unused, have an opportunity to deplete the added pre-incorporated nitrogen. So, "shelf-life" is a factor.
- Be aware that mixes with a significant portions of PTS (>50% volume) tend to need more frequent irrigation as well.
- The type of wood is important. Use of Loblolly pine is the best. Other pine may be acceptable and hardwoods are unacceptable.

The use of pine tree material regardless if it's PTS or WholeTree will be an option for years to come. Understanding the opportunities as well as the risks will be the key in it's success in the future.

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Rick Vetanovetz and Ron Walden

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Biocontrol products for growing media

Biological fungicides are a group of biocontrol products that have been used in the greenhouse industry for years. They have been increasing in use and "popularity", not only because of their observed effectiveness in preventing disease but also due to their less restrictive application and REI requirements. There is also the perceived more desirable impact on the environment, or "greenness". The wide interest in "sustainability" in the last 5 years has certainly helped the further adoption and use of these products. In November 2003 we published an article on biocontrol products that appeared in The Sun Gro'er. The intent of this article is to **update and reacquaint** the reader with these type of products, to educate about what organisms / products are out in the marketplace and provide some guidance in determining if biological fungicides are right for you or your customers.

… A biological fungicides main form of "control" is preventative through suppression of diseases before they become a problem …

A biological fungicide (BF) is a product that is comprised of a living organism or organisms used to suppress or "control" a plant disease typically caused by a pathogenic (disease) fungus. Biological fungicides utilize microorganisms from one of two groups – Fungi or Bacteria. The most common root diseases found in greenhouse production are *Pythium, Phytophthora, Rhizoctonia, Thielaviopsis, and Fusarium.* So a BF would be a fungus or bacteria that would claim to provide some sort of "control" of one or more of these diseases. Note that the word control can be misleading. BF's do not provide "control" in the sense that they can clean up an existing disease problem like some chemical fungicides are purported to do. A BF's main form of "control" is **PREVENTATIVE** through **SUPPRESSION** of diseases **before** they become a problem. Biological fungicides ideally should be applied before or during planting so that the suppressive organism can become established in the root zone and on plant roots (often termed rhizoplane) or around plant roots (often termed rhizosphere). These beneficial organisms also need to be established in large enough numbers to thoroughly ward off attack by plant pathogenic organisms. It is imperative that this last point - BF's work as preventatives not curatives - be understood.

Product labels perform the primary means of communication about a product and proper use of that product to the user. So it is important to note that when a company develops a biological organism that shows

the ability to suppress a disease or induce a plant to perform better in the presence of a disease, that company can choose two different routes in developing a label and that effects what can be explicitly communicated or what is required by the grower. One, the product can be registered as a microbial inoculant. This usually means that the product does something to promote healthier or stronger plants. In some cases, this may be a result of disease suppression. But, if labeled as an inoculant, a supplier typically cannot make explicit disease control (fungicidal) claims even if horticulturists believe a product has disease suppressive qualities. Two, the other route, is to label the product as a biofungicide or biological fungicide. This requires the supplier to register the product with the USEPA and appropriate state regulatory agencies. This is a much more demanding process and involves significant time and money to perform the testing to prove it is safe to people and the environment as well as support disease control claims. Placing restrictions on the use of a product is a way to limit the cost and shorten the time for a product to be registered. Limiting a product to enclosed structures (i.e. greenhouses) is one strategy that some suppliers have chosen to use. This is why some of the products listed below have that restriction on their label. Other strategies may include limiting target crops, limiting reapplication or application rates, requiring certain PPE and the like. The point is that manufacturers decide on strategies to bring products to market. As a result, the user has to comply with restrictions on the label and in doing so the label limitations are effective and realized.

… By loading the media with BF organisms, the grower can reduce the chances of disease organisms multiplying…

Interestingly enough, some companies may choose to label a product both ways. In that case, the same active ingredient is labeled as a microbial inoculant and a biofungicide. This then broadens the use of the product from a "legal" point of view – Meaning that the intent is to stimulate growth but you're also suppressing diseases. Nevertheless, as mentioned above, all of the products mentioned in this article work only to prevent disease through disease suppression and will not "control" or "eliminate" a disease after it has infested a crop. But for the sake of keeping things simple, and as a "crutch", we will use the very general definition of the term 'biological fungicide' regardless of whether they are labeled as such or not.

You might ask, "How do organisms suppress plant disease organisms?" BF's work mainly by one of several methods, they may include:

Competition- BF's compete with disease organisms for food supplies. Plants excrete sugars and/or other nutrients into the soil as they grow. Fungi and bacteria in the soil use these materials as food sources. BF's are usually more aggressive in seeking out these food sources and therefore prevent the growth of disease organisms by significantly re-ducing or eliminating the food supply. By loading the media with BF organisms, the grower can reduce the chances of disease organisms multiplying using the available food sources.

Antibiosis- This is direct control through the release of substances that can kill other organisms and form a "barrier zone" around plant roots into which other organisms will not grow. Many bacteria use this mechanism including S*treptomyces,* which produces the chemical streptomycin. Incidentally, this is the active ingredient in Agri-Mycin® 17 or Agri-Strep®. Organisms may also exude growth promoting substances. This is one of the reasons why some companies promote their products as "biostimulants".

Predation or Parasitism- Some BF's actually feed on other organisms in the soil, by attacking them. This works well when disease populations are low, but if there is a large disease infes -tation, the BF most likely will not be able to keep up. This is one of the mechanisms that *Trichoderma* and *Gliocladium* use in suppressing other organisms. You many also see this called mycoparasitism.

SAR (Systemic Acquired Resistance) -- This is something that biological scientists are still working to understand better. SAR involves the symbiotic relationship between the BF organism and the host plant. The BF organism releases chemicals that the plant interprets as disease causing. This then triggers the plant to engage its own defense mechanisms, which may include such events as thickening of cell walls, enhanced rooting and increased reproductive traits. The last point is what has created the most interest since the increased yield of fruits and vegetables has a tangible economic return. The SAR response at the very least is alleged to produce a slightly larger, healthier plant with reduced crop time. This is one of the mechanisms used by some *Bacillus* species.

It should be noted that other terms are used for SAR. For example, ISR or Induced Systemic Resistance is a term used for a type of SAR response. The ISR response works in a different way such that the plant supposedly uses different biochemical pathways to transmit the signal to respond. However, the result in plant growth is the same -- It is two different terms for the same thing.

The Organism Roundup

Let us look at some of the BF organisms and products currently available to the horticulturist before we address some of the benefits of using BF's over chemical fungicides. The products noted below are those that are labeled in the US and have some form of growing medium application instructions including pre-plant incorporation or root drenches for ornamental crops. We will start with bacteria and then the fungi.

***Bacillus subtilis* MBI 600**

Formulations containing this organism are branded as Subtilex® and are manufactured by MicroBio Group Ltd., a subsidiary of Becker-Underwood, Inc. Just recently Becker-Underwood introduced Subtilex® NG which is labeled as a BF for protection of soil borne pathogens, specifically the suppression of *Rhizoctonia, Fusarium* or *Pythium* . It is labeled as a growing medium pre-incorporation treatment or post-plant drench for greenhouse crops. The mode of action, according to the product labeling and MicroBio Group's website is to exclude other organisms and exude an anti-fungal metabolite that will suppress or kill pathogens. The bacteria, since it is a spore former, can persist in the soil for some time with a reported shelf life of close to 2 years. Other products containing Subtilex® include growing media products manufactured by Premier Horticulture Ltd. Premier's literature claim control of *Pythium, Rhizoctonia* and *Fusarium* and general germination and growth stimulation. While there is data about *B. subtilis* MBI 600 efficacy primarily geared toward agricultural crops, there is still limited University trials evaluating *Bacillus subtilis* MBI 600 compared to commonly used biological fungicides for greenhouse ornamental crops. Tests results used by Premier in their technical literature are very limited and photographs depicting plants from trials are not clear about what the treatments specifically were – In one place it shows the treated mix compared to untreated competitive mix and in another, a "control". General anti-microbials like ZeroTol® will kill *B. subtilis*. Therefore, if a grower wishes to use ZeroTol® or other materials that kill bacteria, then Subtilex® is not for them. Premier claims no reapplication of Subtilex® is necessary although it could be possible with the recently introduced Subtilex® NG product if desired or necessary.

***Bacillus subtilis* GB03**

Gustafson LLC manufactures this organism and formulations containing this organism for greenhouse and nursery use are manufactured and marketed by Growth Products, Ltd. under the brand name Companion®. There are three formulations labeled for greenhouse use – Companion® Dry Concentrate, BioBlender™ Media Mix 3-0-3 (i.e Grower's Companion® Plus) and Companion® Liquid Biological Fungicide 2-3-2. The dry concentrate is meant for incorporation into growing media for the control of *Pythium, Phytophthora, Rhizoctonia, Fusarium* and *Sclerotinia.* Treated media is restricted to be used in protected structures. There are no unusual PPE requirements and the REI is 0 hours after application. The BioBlender™ 3-0-3 is labeled as a pre-plant additive having growth enhancing qualities and no disease suppression claims so there are no special requirements for use on the label. The BioBlender™ product is intended for growing media situated for indoor and outdoor use. The Companion® Liquid Biological Fungicide has a label that includes a wide range of use situations (horticulture and turf) with added growth promoting claims. It is intended to be used on a wider range of ornamental and horticultural crops to suppress root disease causing organisms including *Pythium, Phytophthora, Rhizoctonia, Fusarium, Sclerotinia* and *Alternaria.* This product is designed to be used as drench application after planting to suppress root diseases. The Companion® Liquid Fungicide label recommends reapplication intervals every 7 to 28 days depending on crop and can be used in tandem with the pre-incorporated products. The use of PPE such as gloves and dust/mist filtering devices are on the label (as with most other BF products). Bear in mind that both the BioBlender™ 3-0-3 and Companion® Liquid Biological Fungicide 2-3-2 also add nutrients which needs to be considered in the growing program. The claimed mode of action for the Companion® products include: competition, antibiosis and SAR, or in their case, ISR or Induced Systemic Resistance. The same cautions with the use of anti-microbial products should hold true with this *Bacillus subtilis* strain. As found with the *Bacillus subtilis* MBI 600 strain, there seems to be little University research or practical trial data on greenhouse crops with this *B. subtilis* GB03 strain. However, from our experience, growers who used this particular product have not had any complaints and seemed pleased with the performance. Gustafson LLC also markets a water applied formulation of this organism for the Agricultural seed market, called Kodiak®.

***Bacillus subtilis* strain QST713**

This strain of *Bacillus* is the active ingredient in a product called Cease®. This liquid BF product is manufactured by AgriQuest Inc. and marketed by BioWorks, Inc. Cease® is labeled for the suppression and control of a broad range of foliar and root diseases. Labeling information indicates the product suppresses root diseases caused by *Rhizoctonia, Pythium, Fusarium* and *Phytophthora*. There are no granular formulations of this organism and only post-plant applications of the liquid product for the control of root diseases are specified on the label.

***Bacillus subtilis* var. *amyloliquefaciens* strain FZB 24**

This is another *Bacillus subtilis* strain that was marketed under the brand name Taegro® by Earth Biosciences, Inc. (and Taensa, Inc, before that) It was originally labeled as a drench only application and there were no instructions for pre-incorporation application nor was there a granular formulation for such use. Its mode of action was that of competition and the organism was claimed to exude enzymes and other exudates that retarded plant pathogenic growth. You will find this product in reviews from internet searches or other scientific studies with comparisons to currently marketed BF products. In 2006, Novozymes, Inc. purchased Earth Biosciences, Inc. This product or organism was not found on the Novozymes, Inc. website (May 2011) but company officials state that the plan is for the product to be re-introduced in the future.

***Pseudomonas chlororaphis* 63-28**

This organism was originally used in a product called AtEze® and was labeled for the control of root rots and wilt diseases. It was originally granted EPA registration in September 2001 to EcoSoil Inc. of San Diego, CA. Some articles indicate this product was marketed by Agrium, Inc. although the last company of record to market this product is Turf Science Laboratories, Inc. of National City, CA. We were unable to make contact this company to learn of the status of this product.

***Streptomyces lydicus* strain WYEC108**

This bacterial organism is used in formulations called Actino-Iron® or Actinovate® and manufactured and marketed by Natural Industries, Inc. Actino-Iron® is a granular product formulated on humic / fulvic acid for ornamentals / turf and Actinovate® SP is formulated as a soluble powder. Actino-Iron® is marketed as a biological soil additive and biofungicide and Actinovate SP is marketed as a biological fungicide only. The Actinovate® SP product label claims a broad range of suppression including diseases caused by *Pythium, Rhizoctonia, Pythophthora and Fusarium*. Mode of action is competition and antibiosis. The pre-incorporation rate for Actino-Iron® is 5 lbs per cubic yard of growing media. No reapplication is reported to be necessary for annuals and perennials following pre-incorporation of the Actino-Iron® product although it could be accomplished using the Actinovate® SP product applied as a drench. Natural Industries claims the use of Actino-Iron® has the capability of adding iron safely and is sometimes considered a benefit for situations where iron deficiency is a problem, although we have not seen any scientific data to support this benefit. The company also claims that the organism makes nutrients more available as well, and again, there are limited data to support these claims. There are apparently no significant storage considerations with these products before or after mixing into growing media. The same general anti-microbial materials (such as ZeroTol®) that affect *Bacillus* will affect *Streptomyces* although there may be exceptions. This product has a well proven track record in the greenhouse industry.

***Streptomyces griseoviridis* K61**

This organism is manufactured by Verdera Oy of Finland and used in a formulation called Mycostop® marketed by AgBio Inc. As with *S. lydicus* strain WYEC 108, this microbe populates the plant roots and exudes substances that suppress or kill pathogenic organisms. Mycostop® is labeled for control of root and stem rots caused by *Pythium, Phytphthora, Rhzoctonia, Alternaria* and *Fusarium.* As with Actionovate® SP / Actino-Iron®, Mycostop® is claimed to be a growth stimulant. One study at the Vineland Research Station in Ontario (HortTechnology Vol. 13(1), pgs. 149- 153) shows excellent results with this product on plant growth although not as effective against *Pythium* as Subdue®. The Ag-Bio, Inc. web-site suggests that the *Streptomyces* organism exudes root growth enhancing hormones or suppresses other minor root damaging organisms. The formulation is temperature sensitive and needs to be refrigerated before use. The Mycostop® label states that it can be pre-incorporated into growing media as a coarse spray treatment during mixing with the rate being 1-4 grams per cubic yard. To our knowledge, there is no dry granular formulations of Mycostop® specifically geared to be blended with growing media. According to the label, the treated medium needs to be used soon after treating and cannot be stored above 85 degrees F.

***Trichoderma harzianum* Rifai strain KRL-AG2**

This organism is formulated into products labeled as RootShield® Granules and RootShield® WP, which are manufactured and marketed by BioWorks, Inc. *Trichoderma harzianum* Rifai strain KRL-AG2 (often called T-22) is a hybrid strain of Trichoderma. RootShield® granules are labeled to protect plant roots from root pathogens such as *Pythium, Rhizoctonia, Fusarium, Cylindrocladium and Thielaviopsis.* The labeled rate is 1.0 to 1.5 pounds per CY. Reapplication is needed 10-12 weeks after initial application and can be achieved using the RootShield® WP product. RootShield® WP is compatible with many insecticides and fungicides even including ZeroTol®. Concerning ZeroTol®, RootShield® is compatible with ZeroTol as long as ZeroTol® is: a) not tank-mixed as a concentrate and b) used at concentrations lower than 1:200. There-

fore, ZeroTol® foliar sprays and drenches that are more dilute than 1:200, or maintenance levels in irrigation water have no effect on RootShield® colonization and growth.

Since RootShield® is a fungus instead of being a spore forming bacteria like some of the above-mentioned products; it does have some storage considerations. It is currently recommended that once incorporated into a growing medium, that it be used within six months. In extremely hot climates or during the summer months this time frame is re-duced. Despite some of these handling / environmental issues, Root-Shield® has a long-term and significant positive track record of use in the greenhouse and nursery industry.

Gliocladium virens GL-21

This fungal organism is used in a formulation labeled as SoilGard™ 12G and manufactured by Certis, Inc. Currently, OHP, Inc. (formerly Olympic Horticultural Products, Inc.) markets this BF formulation. The mode of action is very similar to *Trichoderma* based products since *Gliocladium* is botanically similar to *Trichoderma* and which the label indicates as being "antagonistic" to *Pythium* and *Rhizoctonia.* Application rate is 1 to 1.5 lbs per cubic yard. Storage precautions are similar to *Trichoderma* products although the SoilGard™ 12G label indicates that temperatures of 75° to 100° F may accelerate loss of bioactivity with temperatures above 100° F being detrimental. It is not clear if this precaution is for the unused SoilGard™ 12G product that is still in the package (pre-use) or for the treated growing media following blending. However, it still seems that the same use considerations as with other *Trichoderma* products would apply to SoilGard™ 12G. This product is not well known in the marketplace but the organism has been used in the industry for quite some time marketed formerly under the brand name GlioGard®.

Gliocladium catenulatum Strain J1446

This fungal organism is used in a formulation labeled as Prestop® WP and is manufactured by Verdera Oy, Finland. It has a US label which specifies control of damping off, root and stem rots and wilt caused by *Alternaria, Cladosporium, Fusarium, Penicillium, Phytophthora, Plicaria, Pythium, Rhizoctonia* and *Verticillium* on many greenhouse ornamental plants. AgBio Inc. represents this product in the US but their web-site did not have any information on this product as of this writing. There is not that much known about this product. While it does not have a dry granular formulation used specifically for pre-incorporation, the Prestop® WP product label has instructions for spray application pre-plant. Treated but unplanted growing media should be stored below 77°F and used within 3 weeks of treatment for best performance. Re-applications can be made within 3 to 6 weeks following planting. Unopened packages must be refrigerated and you must use the entire package after opening.

OK, So Now What?

One might ask the question "What makes biofungicides better than the chemical controls that I have been using for years?" The advantages of biocontrols over chemical controls are often seen more as indirect benefits. First, biological fungicides are often claimed to have growth stimulatory effects that are somewhat separate from the effect on suppression of disease organisms. Although these growth stimulatory effects are reported to be real, they are not consistent, meaning that customers will not always observe a positive effect. That does not mean the organisms are "not working" but it may be that the plants are growing well without any further aids. Also most growers do not have a non-treated control for comparison, so it is hard to evaluate effects of a BF product on a day to day basis. Secondly, handling and safety requirements are more "relaxed" when using BF's. Biological fungicide products usually have zero re-entry intervals whereas most chemical fungicides have a 12 REI. In most cases, BF's do not require any special protective clothing (PPE) although there are exceptions, where dust masks and/or latex gloves are advised. Check the label for specific requirements. Certainly, faster re-entry times and using less bulky PPE provides a safer and more productive work environment for employees.

Ease of use can be enhanced in some cases depending on the perspective of the user. While chemical controls can be used as preventative and treatment measures, biological products **must** be used as a preventative measure if to be successful. If BF's are <u>incorporated</u> into the mix before planting, they will begin colonizing the root zone, providing protection from the time of transplanting. Chemical applications used as a preventative are often viewed as an indiscriminant use. So, chemical applications are not made until some point after planting or when growers see a problem, which means the chemical has to 'catch up' and in the meantime, plant growth has often been checked by the pathogen. Additionally, with chemicals there is always the possibility, especially with repeated applications, for disease organisms to build up resistance to the chemical, thus reducing its effectiveness, or the risk of phytotoxicity. Resistance is not apparently an issue with BF's since their control mechanisms are so different from chemical fungicides. Then of course, is the environmental stewardship aspect of BFs. Since most of the organisms occur in

nature, there is not the concern attached to using them as there is with using chemicals that are man-made and may be perceived to linger in and harm the environment. Cost can also be a consideration. If a grower is in the habit of using preventative chemical treatments and then goes back and hits hot spots with additional treatments, they could save money in the long run with BF's together with the adoption of proper IPM techniques. However, for growers already following IPM practices and using spot application of chemical fungicides to specific crops for specific problems, the use of BF's will not be as likely to save them money. Although using BFs with IPM techniques / proper sanitation practices will enhance success. On the other hand, growers who are not diligent about utilizing proper IPM techniques, and think that biological fungicides will correct cultural problems, will often be disappointed.

In the end, biological fungicides are not a magic bullet that will solve all disease problems for a grower. For growers that are interested in reduced reliance on chemical treatments, BFs serve a valuable purpose. But any grower that is considering switching their main disease control to biological fungicides must be aware that none of the products claim to cure an existing problem. Therefore, all the past advice and recommendations related to IPM techniques such as sanitation, buying clean plant material, well thought out fertility programs and monitoring the physical environment (watering, air movement, temperatures) are **even more critical** (really they always were important) when using biological fungicides in a disease management program.

Remember though, that Sun Gro Horticulture can provide custom blended growing medium products with several of the above biological fungicides / inoculant products and has considerable experience with their use. The Technical Specialist Team is available to assist our customers in determining what products would work best to meet their operational objectives.

Rick Vetanovetz and Mark Thomas

Information contained in this article has been extracted and compiled from sources that can be readily obtained by anyone searching on the internet or by reading product labels or technical sheets that are available at the time of this writing. Any mention of product names, trade names and the like do not in any way convey endorsement of these products by the authors or Sun Gro Horticulture. Omission of products do not convey criticism or rejection in any way. Rates discussed are those from available product labels or technical sheets and are not intended to be considered recommendations or instructions for use. As always, read product labels before use.

Considerations and Other Random Thoughts When Using Biocontrol Products

One of the benefits of using biological control products is that they can be used in an organic program, but there are some things you need to know. For those who are interested in becoming a certified organic operation by the USDA National Organic Program (NOP) you need to work with an agent that is approved by USDA to certify operations or crops as "certified organic". Obviously, to comply with the program requirements, one needs to use products that are also deemed as natural and organic. The issue is that USDA has not generated any program that certifies ingredients or "growing tools" as natural and organic in and of themselves. So the certifying agent needs to evaluate all ingredients and tools to abide by the USDA's NOP guidelines. This is where OMRI comes in. OMRI, or Organic Materials Review Institute, is an organization that has "filled this gap" by the USDA to review ingredients, grower aids and the like to provide guidance if they abide by the USDA's NOP guidelines. The OMRI web-site literature states:

"Founded in 1997, the Organic Materials Review Institute (OMRI) provides organic certifiers, growers, manufacturers, and suppliers an independent review of products intended for use in certified organic production, handling, and processing. OMRI is a 501(c)3 nonprofit organization. When companies apply, OMRI reviews their products against the National Organic Standards. Acceptable products are OMRI Listed® and appear on the OMRI Products List. OMRI also provides subscribers and certifiers guidance on the acceptability of various material inputs in general under the National Organic Program (NOP)."

With that said, using products that are OMRI listed can make the certification process more successful because certification agents recognize OMRI and usually, but not always, forego further scrutiny of that particular input. So, if a grower wishes to employ a particular biocontrol product, if it is OMRI listed, in most cases this will be accepted by the certifying agent without issue. Bear in mind that suppliers of biocontol products need to pass muster with OMRI and growers need to make sure that the product they wish to use is listed and in good standing. The OMRI website has a search function that allows you to search for the biocontrol product that you're interested in. Of course you can always contact the company if you are not sure and most products will have the OMRI logo on the label if they are OMRI listed.

The grower still needs to follow the uses as specified on the label especially con-

cerning use of the product for food crops versus ornamental crops. While the certifying agent can help in this regard, the one thing that helps tremendously is to use biocontrol products from reputable companies that have products labeled for your specific use and that are knowledgeable about greenhouse growing. Most well known, established companies supplying the greenhouse industry with biocontrol products have in-house technical organizations that can help you with any questions you may have and also have invested in research and grower trials to understand the efficacy, use requirements and idiosyncrasies of their product.

Quality products are also important. With the increased interest in "greener" growing there are new products out in the industry that make "wild" claims to sell their products. Just because some company "touts" that their product has a *Trichoderma* or a *Bacillus subtilis* or the like, does not mean that it is great for use as a biocontrol agent. The type of organism, the amount of organisms in a product, as well as the "purity" of the isolates is important. If you are deciding to be adventurous, it is wise to check if the product is used by other growers with good reviews and if the product is backed by research or properly organized grower trials. Customers requesting customized products from Sun Gro typically use biocontrol products from well established companies in the greenhouse industry.

The key in using microorganisms is that you need to "seed" or "inoculate" the growing medium with the right amount of organisms (i.e. rate) to assure rapid establishment of that microorganism around the plant roots. Most biological products using microorganisms list the number of colony forming units (CFU) as a means of describing the concentration or "strength" of the formulation. For example, on the label of a popular biocontrol product, the label states that there is 1.15% of the organism (which is the active ingredient). However, you see as a footnote that there are at least 1 x 10^7 CFUs per gram of the active ingredient. That means there are at least 10,000,000 colony forming units per every gram of product. If you were to add 1.5 lbs of the product per cubic yard of mix, you would be applying about 4.54 x 10^9 CFUs per cubic yard of mix or 1.7 x 10^8 CFUs per cubic foot of mix. The point is that it does not take much active ingredient to provide significant inoculum - The percent (%) weight of what is added is not the critical issue but it is the number of colony forming units which provides the biological potential number of CFU's to the crop. This is not to say that adding more is better because the efficacy of the product with that particular organism is what is most important and you want the organism to "work for you". You must consider that the organism is going to grow rapidly in the right conditions. But if a product has instructions to apply a very low level of CFUs, that may signal an issue, or at least a few questions on your part.

Assuming that the rate of inoculation is correct, the environment in which the biocontrol organism is to grow and establish itself needs to be correct as well. Cultural practices are usually cited for variability of effectiveness of biocontrol agents.

The physical and chemical qualities of the finished mix are both important. Characteristics like water holding, air porosity, medium pH and salinity are all important considerations, although for the most part, if the mix is acceptable for plant roots it is acceptable for a biocontrol agent. Thereafter, how a crop is irrigated and fertilized come into play.

Root applications of fungicide or insecticides can have an effect on the growth and viability of a biocontrol agent. It is prudent to check out the compatibility of the products you are interested in with other treatments you may apply to the growing medium throughout the production of your crops.

Shelf life of the biocontrol product and shelf life of the treated mix is a consideration as well. For growers who use customblend growing medium products containing a biocontrol agent, you need to make sure you are storing the product in an environment that is not going to reduce the viability of the biocontrol organisms. Using up the product as soon as possible after manufacture is a wise choice. Shelf life varies for different organisms / products and their viability are usually contingent on the prevailing temperatures. For those who choose to mix their own or apply drenches to the growing medium after planting, you must also assure you store the biocontrol product in the proper conditions as well. In all cases, guidance for storing the product and the treated media is on the product label. Typically manufacturers of these products have technical information on their websites or have technical services that can answer questions regarding this subject.

... Organic Materials Review Institute (OMRI) provides organic certifiers, growers, manufacturers, and suppliers an independent review of products intended for use in certified organic production, handling, and processing ...

Biological fungicides or inoculants have a place in growing greenhouse crops but users of these products need to be well informed on all factors that contributed to their successful implementation and use. Bear in mind that there is a plethora of information that is readily available via the internet. Of course, when you have questions there are people that can help.

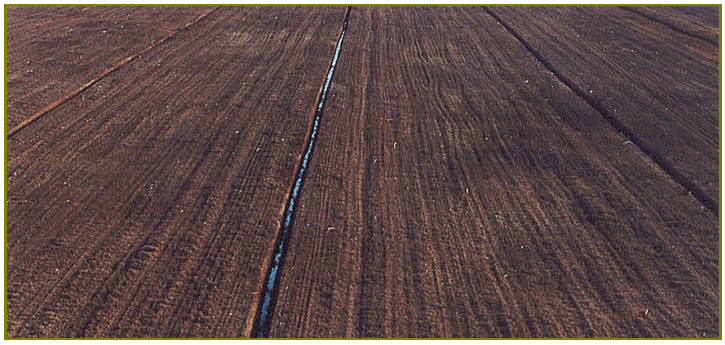
Rick Vetanovetz and Nancy Morgan

Sphagnum Peat and Root Diseases

Diseases are becoming increasingly important in the production of ornamental crops due to restrictions on not only the use of chemicals but also movement of diseased-plants across borders. Growers are always seeking safer practices for controlling plant diseases. In this context, I present information to help growers better understand biological properties of peat and thus reduce the potential of root diseases.

Sphagnum peat moss is the main component in my growing media. I want to know peat's role in soil-borne diseases such as *Pythium, Phytophthora, Rhizoctonia, Fusarium, Thielaviopsis* rots. First of all, is peat sterile?

Peat is not sterile. However, new peat is virtually free of plant pathogens. This pathogen-free characteristic has been a major factor for the success of peat as a component of growing media. Peat reduces the risk of introduction or dissemination of soil-based pests. That's why phytosanitary inspectors approved peat as a growing medium for import of established plants. The disease-free nature of peat can be traced to its origin. Generally peat comes from areas where crops and associated debris are absent, so chances of occurrence of plant pathogens there is very low. The microorganisms in peat, however, are either harmless or considered by scientists to have the capability to suppress plant disease causing fungi.



Peat coming from clean areas that are not associated with crops is virtually free of plant pathogens. *Photo courtesy of Sun Gro*

Contrary to what some growers believe, peat producers do not sterilize peat. Sterilization destroys all microbes including those that are thought to suppress diseases, thereby creating a biological vacuum. Immediately after sterilization, microbes in the air, water, dust or after planting, inoculate or "contaminate" the peat. If the contamination is primarily a plant pathogen, the absence of competition in the sterilized peat, can reach epidemic proportions rapidly. This creates a larger problem for the grower.

OK, So what microbes are in peat?

Sphagnum peat moss contains many microbes although the number of species are not as diverse compared with mineral soil. In an undisturbed peat bog, common microbes at or near the bog surface include bacteria genera such as *Bacillus, Micrococci, Pseudomonas* and fungal genera such as *Penicillium, Trichoderma, Cephalosporium, Mortierella*. Drainage of bogs (done before harvesting peat) leads to further increase in the numbers of these aerobic bacteria and fungi. Following the commencement of harvesting peat, major changes in the composition, numbers and activity of microbes occur. Most common microorganisms then include bacterial genera such as *Bacillus, Streptomyces, Arthrobacter* and fungal genera such as *Penicillium, Mortierella, Cladosporum, Aspergillus, Trichoderma*. Of these, *Bacillus, Psuedomonas, Trichoderma, Streptomyces* are well known to be beneficial in suppressing plant diseases.

In processed peat, occasionally there are very low levels of *Fusarium, Pythium, Rhizoctonia*. Their occurrence is probably due to contamination during processing or transport. Good peat producers safeguard against such contamination and maintain the pathogen-free nature of peat. But these stray genera are often found to be non-pathogenic species/strains.

How do beneficial microbes in peat control plant diseases?

The control mechanisms of various microorganisms differ. For example, when peat contains a plethora of nonpathogenic microbes, they compete for nutrients and suppress potentially pathogenic organisms such as *Pythium* or *Phytophthora* which rely on the same nutrients for growth. *Bacillus, Streptomyces, Trichoderma* in peat produce antibiotics as well and suppress pathogens such as *Rhizoctonia*, which do not rely on outside nutrients for germination and infection. Antibiotics produced by *Bacillus* or *Streptomyces* are effective against Fusarium. *Streptomyces* and *Trichoderma* even directly attack fungal cells of pathogens. Such diverse biological activity suppresses the disease spread in peat.

Light colored peats generally have beneficial microorganisms that suppress plant pathogens. *Photo by Nicole Regimbald, Sun Gro*

There are different kinds of peat and one would expect that they all don't behave the same way?

The difference in peats makes it difficult to make explicit statements about disease suppression by peat. Sphagnum peats from different sources vary in their microbial composition. Generally blond or lighter colored peats (termed H1-H2 peat on the von Post decomposition scale) are very suppressive to diseases. Light colored sphagnum peats harbor high population levels of antagonists such as *Trichoderma* or *Streptomcyes*. These peats have high levels of microbial food bases to sustain the activity of microorganisms.

The microbial food bases govern the duration of microbial activity and in turn disease suppression. For example, H2 peat microbial activity can remain high enough to suppress *Pythium* throughout a poinsettia crop cycle. H3 peat, which is more decomposed, can suppress disease for 6-7 weeks—still a "lifetime" for plugs. Disease suppressive activity depends on growing media temperature as well.

Don't physical characteristics of growing media affect diseases?

Not just biological properties of peat, but physical as well as chemical properties of the final growing media based from peat have a significant effect on soilborne diseases. A high water content in the media during growing enhances the movement of disease causing spores and decreases the availability of oxygen to the plant roots, thereby increasing the susceptibility of plants to attack by pathogens. As an example, a media with an air content of 20-25% (by volume, in 6-inch deep pot) is needed when *Phytophthora* is a frequent problem.

High salinity or fertility in the media aggravates *Phytophthora, Pythium, Fusarium* diseases. In this aspect, it is an advantage to use peat because guidelines as to what is high salinity are available and predictable for peat media.

How can I better utilize the suspected disease suppressive qualities of peat?

Knowingly or unknowingly the peat you used for growing often doubled as a natural disease suppressant. To try to capitalize on this phenomenon, some experiments were conducted at the then Fison's Horticulture lab in New York in the early '90s. The idea at that time was to offer an 'anti-disease peat' that would have consistent disease suppressive qualities because of the broad spectrum of beneficial microbes already colonized and adapted to that peat. The objective during these experiments was to create a biological or chemical measurement that would help predict the level of suppressiveness of different peat lots. Unfortunately, the work was never completed but hopefully peat producers will continue this work and include such a parameter on the product label in the future.
Until then-- to prevent or reduce diseases-- There are things the producer can do and some things the grower can do. Generally, peat is free of plant pathogens. Most peats supplied by high quality producers for greenhouse crops are H1-H3 on the von Post decomposition scale. Also, peats are obtained from uncropped land. Good peat producers take measures to ensure that peat is not contaminated during processing, pack it properly and transport it in clean trucks.

So, the main thing growers can do is to keep the peat from becoming contaminated. Avoid contact of peat with the bare ground and any other infested material. If you are blending your own growing medium, ensure the other components are free of pathogens as well.

Beneficial bacteria do not colonize dry media but fungi, like *Pythium* can. So don't' allow peat or mixes to become too dry— Its moisture content should be above 40% (on a weight basis).

Since disease suppression in peat comes from microbes, treatments such as steaming, chemical disinfestation or fungicide drenches can reduce or destroy beneficial microbial populations, so be cautious when using these practices.

Shiv Reddy

(A version of this article appeared in GrowerTalks March 2005 issue.)

Pasteurization of peat destroys many beneficial microbes, thereby increasing disease.

Top: Vinca in pasteurized peat

Bottom: Vinca in unpasteurized peat

Left: Uninfected; Center: Infected by low level *Pythium*; Right: Infected by high level *Pythium*

Photo courtesy of Dr. Mike Evans (University of Arkansas)

Suggested Reading and Other References about Biocontrol

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Technical Specialists at the Ohio Florists' Short Course

In addition to Sun Gro's outstanding sales representatives, several of the technical specialists will be attending the Ohio Florists' Short Course Trade Show on July 10 –12 in Columbus, Ohio. If you'd like to catch up with us, one or two of the techs will be at the booth at all times. We'd be happy to answer any questions that you have or just catch up with you on how things are going at your operation.

Visit the Sun Gro booth #2304. The techs in attendance will be:

- Todd Cavins, Central
- Dan Jacques, Eastern
- Michelle Miller, Western
- Rick Vetanovetz, Central
- Ron Walden, Eastern

SUN GRO HORTICULTURE

15831 N.E. 8th Street, Suite 100

Bellevue, WA 98008

Internet: www.sungro.com

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