Microorganisms to the rescue...

Microbial inoculants or “biofertilizers” or “microbe-containing crop biostimulants” (*gasp*) are “a thing” these days. Not without good reasons. What are they, what can they do, and do they work?

What are Microbial Inoculants?

The field of Microbiology is ever expanding. Advances in technologies involving DNA detection allow scientists to observe and measure things that were unimaginable only a few decades ago. This thing called the “microbiome” is all around us: in and on our bodies, as well as all other organisms, and in all environments, including all surfaces, living or dead, and of course in the soil.

Most people are now familiar with the term “Probiotic,” which is a microbial inoculant for gut health. (Interestingly, according to this article [https://www.scientificamerican.com/article/do-probiotics-really-work/] - probiotics have no known benefits for healthy people.) Similarly, microbe species or species mixtures are applied to plants or the soil they are growing in for the purpose of improving plant growth or maintaining plant health. In some cases, these microbial species may not be present, thus, the soil (or plant surface) gets inoculated. In other cases, these organisms may only be present in small numbers, so the population is augmented with addition of more.

Like the gut, the soil is a really complicated place. In fact, it’s a jungle down there. All “microbiota” are in need of nutrients, the right conditions, and the right physical space in which to flourish. They can also destroy each other. One of the important places in the soil where they reside is in very close association with plant roots, which produce carbohydrate-rich compounds, which is food for microbes, such as arbuscular mycorrhizal fungi (AMF). These, in turn, produce a substance called glomalin, which helps to “glue” together micro-aggregates into macro-aggregates. Root hairs penetrate macro-aggregates, so this where the action is.

The close-ups at right feature the AMF that live in intra-cellular spaces in the roots and grow out into the soil that surrounds root hairs. Finally a day of rain- it seems that some could actually do without it, given that it’s high season for every plant disease under the sun. But plantings due to come to fruition by September will grow like rockets. And the soil moisture will make for good conditions for seeding fall greens... when you’re not picking, packing and schlepping.

--> Need to discuss? Got something you need looked at? URI Extension: 401-874-2967/andy_radin@uri.edu, hfaubert@uri.edu

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Mycorrhizal fungus forming a network and infecting plant roots. Photo from Building Soils for Better Crops, 3rd Ed., Dr. Fred Magdoff and Dr. Harold van ES.
Microorganisms to the rescue, continued...

What can they do?

There are now many microbial products available, and are categorized as biofertilizers, biostimulants, and biopesticides. A number have well-proven track records and are commonly in use, probably by YOU. Some examples include: *Rhizobia* inoculants for legumes; *Streptomyces, Trichoderma* or *Bacillus* species inoculants applied as antagonists, in products such as Actinovate, RootShield or Serenade; or either of the two entomopathogenic nematodes available to control soil insects.

A biofertilizer that is a manufactured, labeled product (as opposed to compost, manure, or some organic residual byproduct) involves at least one microorganism that increases availability of plant nutrients. Therefore, a *Rhizobium legume inoculant* can fall into this category. A mycorrhizal inoculant can as well, since this type of product can, in some circumstances, solubilize soil phosphorus that is unobtainable by plant roots.

In a recent journal article, five categories of biofertilizers were described, based on a survey of 171 research studies: 1) Arbuscular mycorrhizal fungi, 2) P solubilizers, 3) N fixers, 4) a combination of both P solubilization and N fixation, either in one strain or by applying two strains, and 5) other biofertilizers with unspecified modes of action, also in combination with AMF. The authors’ “meta-analysis” showed that 1) they are most effective in dry climates, 2) response is small when soil test P is low, and 3) success of inoculation with AMF was greater at low organic matter content and at neutral pH. That’s interesting to consider for those of you with high soil organic matter here in wet RI.

The EPA definition of a biopesticides “include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs.” This discussion only involves microbials, which by EPA definition “consist of a microorganism (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient.” *Bacillus thuringiensis* is far and away the most common example, allegedly making up over 90% of all biopesticide use in the world. Note that B.t. spores do not germinate and infect their insect pest targets; it is the crystalline proteins in their spores that do the killing. The following is four ways in which biopesticides work (Adapted from Green Bulletin, U of California Ag and Nat Res, April 2014).

1) *Competition:* The microbe colonizes the physical space or out-competes a pathogen for nutrients.
2) *Antibiosis:* The microbe produces a chemical compound that poisons or kills the pathogen.
3) *Predation or parasitism:* The microbe directly attacks the pathogen.
4) *Induction of host plant resistance:* The microbe triggers a defensive response in the host plant that makes it resist the pathogen.
Crop issues close to home...

**Powdery Mildew of Cucurbits** was finally seen on a nearly worn out planting of zucchini in Warwick this week. This is the first known siting this year, which is pretty good! If you have a new planting coming on, consider yanking the old right out of the field - it is much more susceptible and can propagate the pathogen in your field. The most recent reports of nearby *cucurbit downy mildew* are from Hunterdon and Somerset Counties in NJ. Weather has not brought it to us yet.

Bean plantings can suffer from critter attacks in hot, droughty conditions. Hopper burn from *potato leafhopper* can really put a dent in bean production. Worse still, **two-spotted spider mites** have been seen, and once they get going, they are hard to stop. Look for tiny de-pigmented areas (photo, right), and very fine webbing on the undersides of leaves. Nymphs are translucent while adults have the characteristic two reddish spots. They reproduce very quickly.

**Tomato hornworms** are being commonly found in both tunnels and the field, though they usually have a greater impact in the tunnel. B.t. kurstaki or aizawai knocks them right out, even when they are the size of Vienna sausages. **Septoria** and **Alternaria** are commonly being seen on lower leaves of big lush tomato plants. **Bacterial canker** has also been seen again this year, but these are isolated cases. This is not something like late blight that swoops down over a region. Speaking late blight, there have been no new cases any nearer to RI than earlier in the summer, according to USABlight. Many are having tomato fruit abnormalities (left), including “catfacing” and “zippering.” (photo: Corey C.). These disorders are mysterious, possibly a combination of excessive heat and nitrogen. It has also been attributed to 2,4-D exposure or cool nights during pollination. Unfortunately, they are a loss.

**Carrot weevil** trouble is not usually seen in RI but that’s what this damage is, pictured right. (photo from Matt T.) An interesting article from the Ontario Ministry of Ag (http://www.omafra.gov.on.ca/english/crops/hort/news/hortmatt/2017/03hrt17a2.htm) explains that in some of the northerly carrot producing regions of North America, a second generation is now being seen, which is a serious problem because these regions already have a battle with this insect. Females overwinter in crop debris and lay their eggs at the crown of the plants in mid to late May, possibly extending longer. **If you are seeing this kind of damage on your farm, please let us know.**

**Sweet Corn caterpillar counts are finally high** - time to really pay attention to your silking corn. Second generation European corn borer larvae are now feeding, and earworm moth counts are very high at some trap sites, not at others. There are fewer Fall Army Worms around.
Microorganisms to the rescue, continued...

The Plant Biostimulants Industry

Product categorization seems to involve a lot of hair-splitting. Matt Kleinhenz and his research group at THE Ohio State University have been actively working on research involving those products which actually contain microbes, and according to their database, there are now 235 OMRI-listed products, and many more which are not listed. And that doesn’t include OTHER biostimulants, such as those containing seaweed extracts. But the U.S. BioStimulant Coalition, an industry group, lumps all “bio-products” together, and works to keep the industry’s hands in any regulatory issues that may come their way. And here’s some late-breaking news (April 2018): the draft version of the 2018 farm bill has a first-ever definition of biostimulants. This being the case indicates that there’s a lot of business (and profit) to be had in the plant biostimulants industry. It’s projected to be a $250 million industry by 2022. Below is a science-y image from one company’s brochure.

Do they work?

There’s no doubt that a lot of research went into bringing these various products to market, but no farm would be able to duplicate the experimental field conditions in which these products showed positive results. In other words, many of these products may work in some sets of conditions, but they may not work in YOUR particular set of conditions. This is particularly the case for the biofertilizer products. However, most of the biopesticides actually do show some efficacy in varieties of conditions.

Another issue is that when biofertilizers DO work, they don’t always work dramatically, or they don’t work every time (lots of variability). Manufacturers of these products emphasize that they have to be incorporated into a production system for use over the long term (I know this from participating in conference calls with industry reps.) This is asking a lot of a farmer who is operating a business: how much would you spend per year and for how many years on something which may or may not be improving your crops over time? Many subscribe to the “insurance” philosophy: it certainly can’t hurt to apply it, and really, it doesn’t cost that much. That can certainly be absorbed, philosophically, as an input cost.

Perhaps you are already doing the insurance strategy by planting cover crops, year after year. However, there’s so much data out there that justifies the use of cover crops because their use significantly improves crop yield and quality, and also provides so many other benefits that it’s pretty much a slam dunk. Not so with many of these products.

The manufacturers have performed many trials, but is there a product that’s right for what you are doing and how you do it? That’s a maybe. Some of them are single organism, others are mixtures of microbial species. Because these are biological products, timing, rate, location and conditions may strongly influence whether or not they do something good for your production system. **If you choose to work with any of these products, please let us know!**

You can look at a current list of microbe-containing biofertilizers, assembled by the people at OSU, here: http://u.osu.edu/vegprolab/microbe-containing-products/. You have to go in a few layers, and it’s easier if you select the “view in a separate window” option. This list doesn’t have specific recommendations; it just shows you what’s out there that’s been OMRI approved, and no endorsements are made.
Greenhouse Planning for 2019: Lights (LED) ... Biologicals ... Action!

Thursday, August 16, 2018
3:30 PM

Mistaken Identities: Tips on Scouting Your Greenhouse Crops
- Leanne Pundt, UConn Extension Educator: Leanne will share tips on identification and how to scout for some of the key insect and disease pests affecting your greenhouse crops.

Microbial inoculants for Disease Control in Container Production - Rosa E. Raudales, Assistant Professor of Horticulture & Greenhouse Extension Specialist

LED Lighting Options - Jason Grimmett from Philips Lighting

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Please RSVP Andy Radin at 401-874-2967 or email andy_radin@uri.edu

***TWO PESTICIDE CREDIT HOURS***

RI Greenhouse Growers is a committee of the Rhode Island Farm Bureau