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The Does and Don'ts of Using Biologicals

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Summary

Nursery producers can use biologicals in integrated pest management (IPM) or Integrated Plant Health Management (IPHM) programs as stand-alone methods, or to complement chemical products for protecting plants from disease, insects, mites, nematodes, weeds – and other pests. Biologicals for plant pest control are derived from microorganisms, plant extracts, beneficial insects and organic matter. This paper describes how to properly use biologicals in IPM systems for green industry crops.

INTRODUCION

Nursery producers can use biologicals in integrated pest management programs (IPM) as a stand-along method, or to complement chemical products for protecting plants from disease, insects, mites, nematodes, weeds – and other pests https://croplife.org/case-study/what-are-biological-and-why-are-they-important/ By definition, a plant pest is any species, strain, or biotype of plant, animal, or pathogenic agent injurious to plants. Examples include insects, mites, nematodes, fungi, viruses, bacteria, mycoplasmas, weeds, etc.

Agricultural biologicals are a diverse group of products derived from naturally occurring microorganisms, plant extracts, beneficial insects, and organic matter (Fig. 1). This paper reviews: why, which ones, when and where, how they work, compatibility, storage and shelf life, and tank mixing.

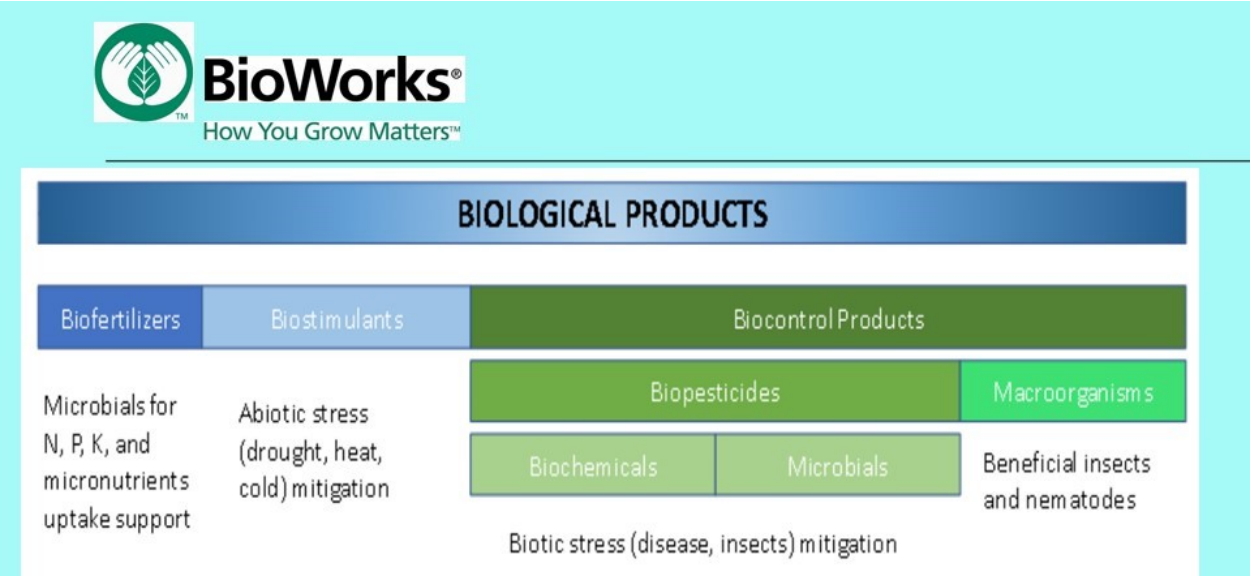


Figure 1. Categories of biological products used in IMP – integrated pest management systems of green industry crops.

Why Use Biologicals?

Biologicals as IPM and IPHM systems offer greater pest resistance than sole reliance on chemicals alone. They offer different modes of action (MOA), opportunities to change rotation of chemicals, greater safety of plants and personnel, faster reentry periods (REI of 0-4 hours) after application, viable use of beneficials (insects, microorganisms) – and it is environmentally friendly. Customers are looking for plant materials that are grown more sustainably. So, there are also enhanced marketing opportunities.

Biologicals are not a panacea. They are not effective under all conditions. They will not "cure" an outbreak/ high pressure population of insect pests or pathogens. They are more effective as preventative control and when pest populations are low and controllable. They are best applied early in a propagation or production program (Fig. 2). Always start with clean, uninfested plant material, and use cultural practices to keep a clean propagation and production environment.

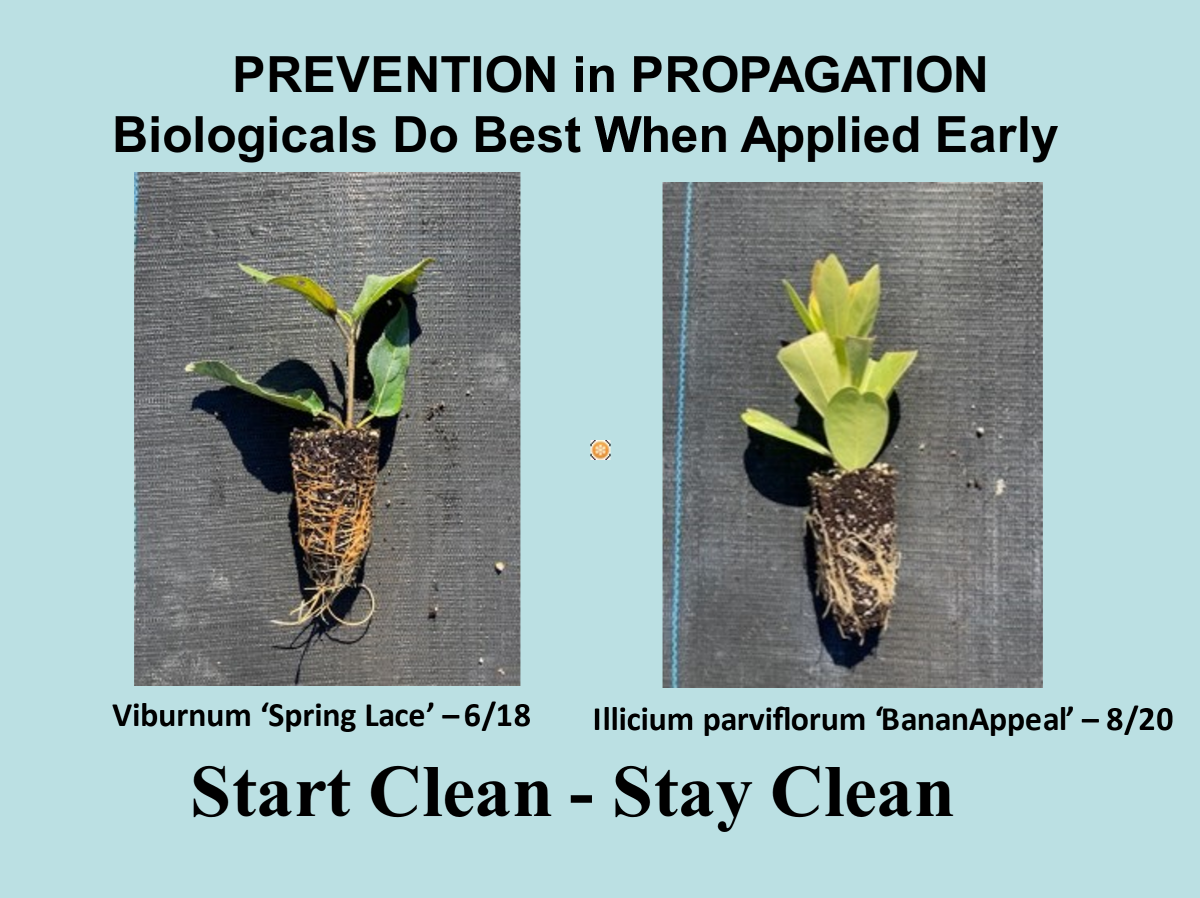


Figure 2. Biological control, such as *Trichoderma harzianum* for controlling fungal pathogens is incorporated, applied before pest problems occur. The use of uninfected plant material, and adaption of cultural practices to keep a clean propagation and production environment are equally critical.

Appropriate Biological, Environment and Compatibility

It is important to use the appropriate biological for control of a specific pest or pathogen (Fig. 3). The propagation and production environment is an important consideration for effectiveness of the biological. Such variables as temperature extremes, pH, moisture and humidity all come into play. It is important to follow recommended usage and conditions for a specific biological.

Compatibility is also critical. How does the biological interact with other chemical and cultural practices in the propagation and production systems? What changes are needed to maximize the effectiveness of the biological?

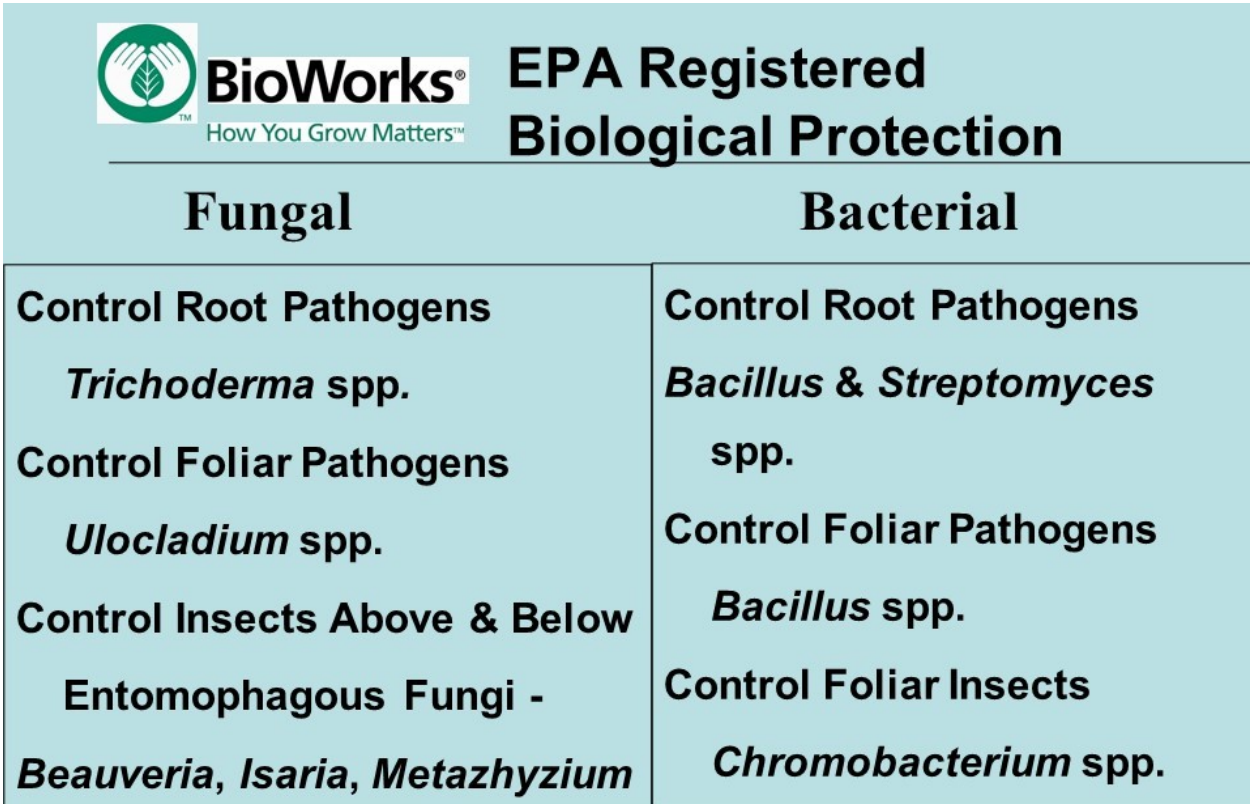


Figure 3. Some examples of fungi and bacteria used as biologicals to control pests and pathogens.

Mechanisms of Biological Control

There are a number of mechanisms for biocontrol of pests. These include:

- Mycoparasitism (growth toward target fungi, lectin-mediated attachment, cell wall degrading enzymes) (Fig. 4)
- Predators and parasitoids – BCAS (BioControl Agents) (Fig.5)
- Production of secondary metabolites
- Competition for nutrients or space (Fig. 6)
- Tolerance to stress through enhanced root and plant development
- Induced resistance (Fig. 7)
- Solubilization and sequestration of inorganic nutrients

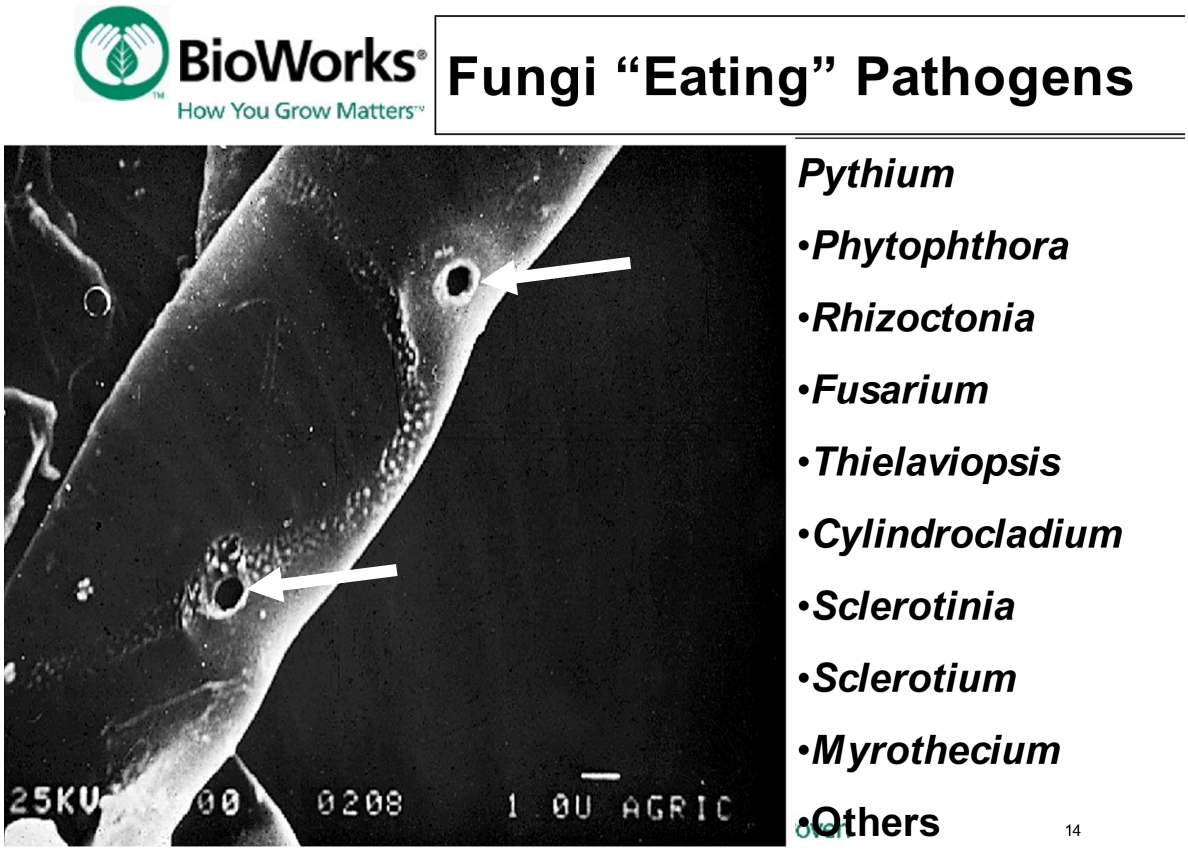


Figure 4. Biological solutions of beneficial fungi "eating" pathogenic fungi (arrows)

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7734056/

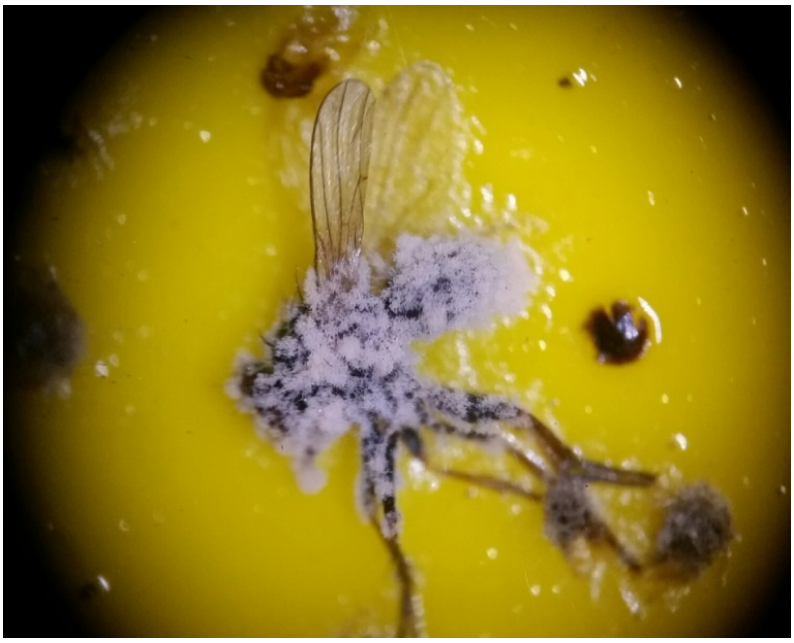


Figure 5. *Beauveria bassiana* strain GHA is feeding on a fungus gnat adult. Many strains of *Beauveria bassiana* fungi are found worldwide in the soil. They control insects by growing on them, secreting enzymes that weaken the insect's outer coat, and then getting inside the insect and continuing to grow, eventually killing the infected pest.

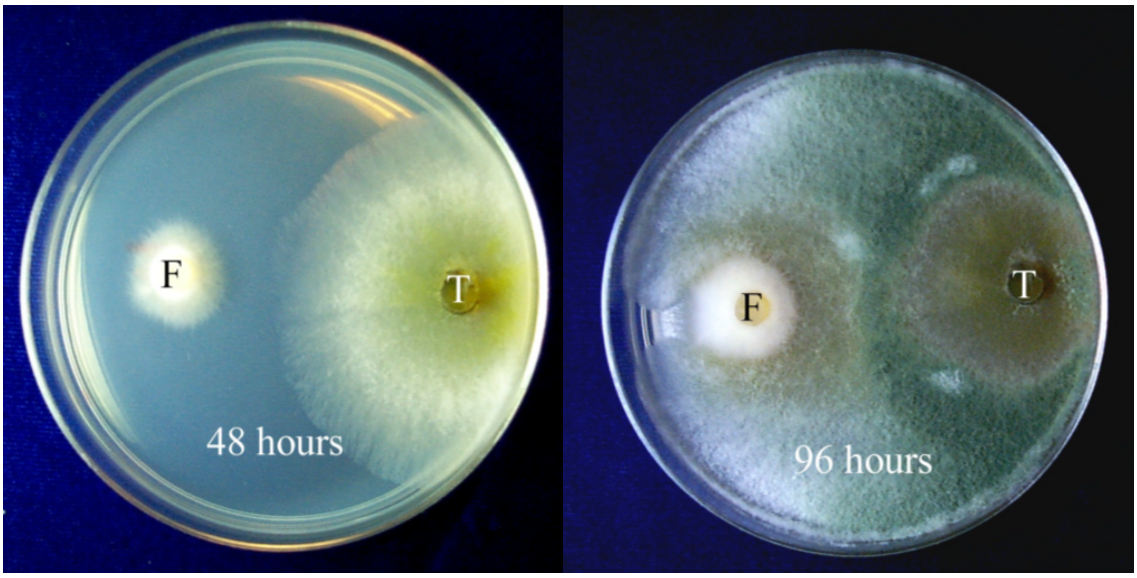


Figure 6. Speed is of the essence. An example of how rapidly the hyphae of *Trichoderma harzianum*, T22 (T) contains the pathogenic *Fusarium* (F) from 48-hours to 96-hours.

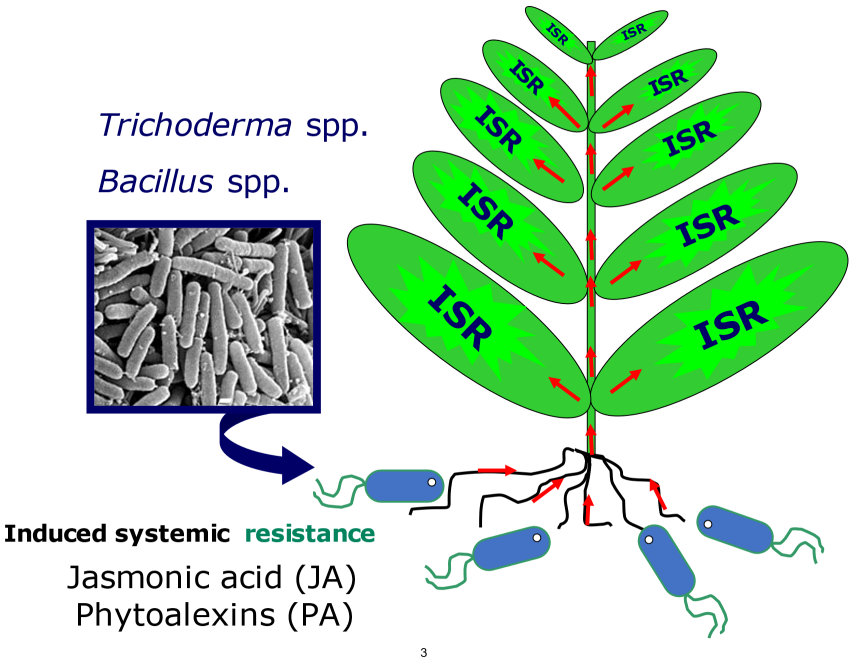
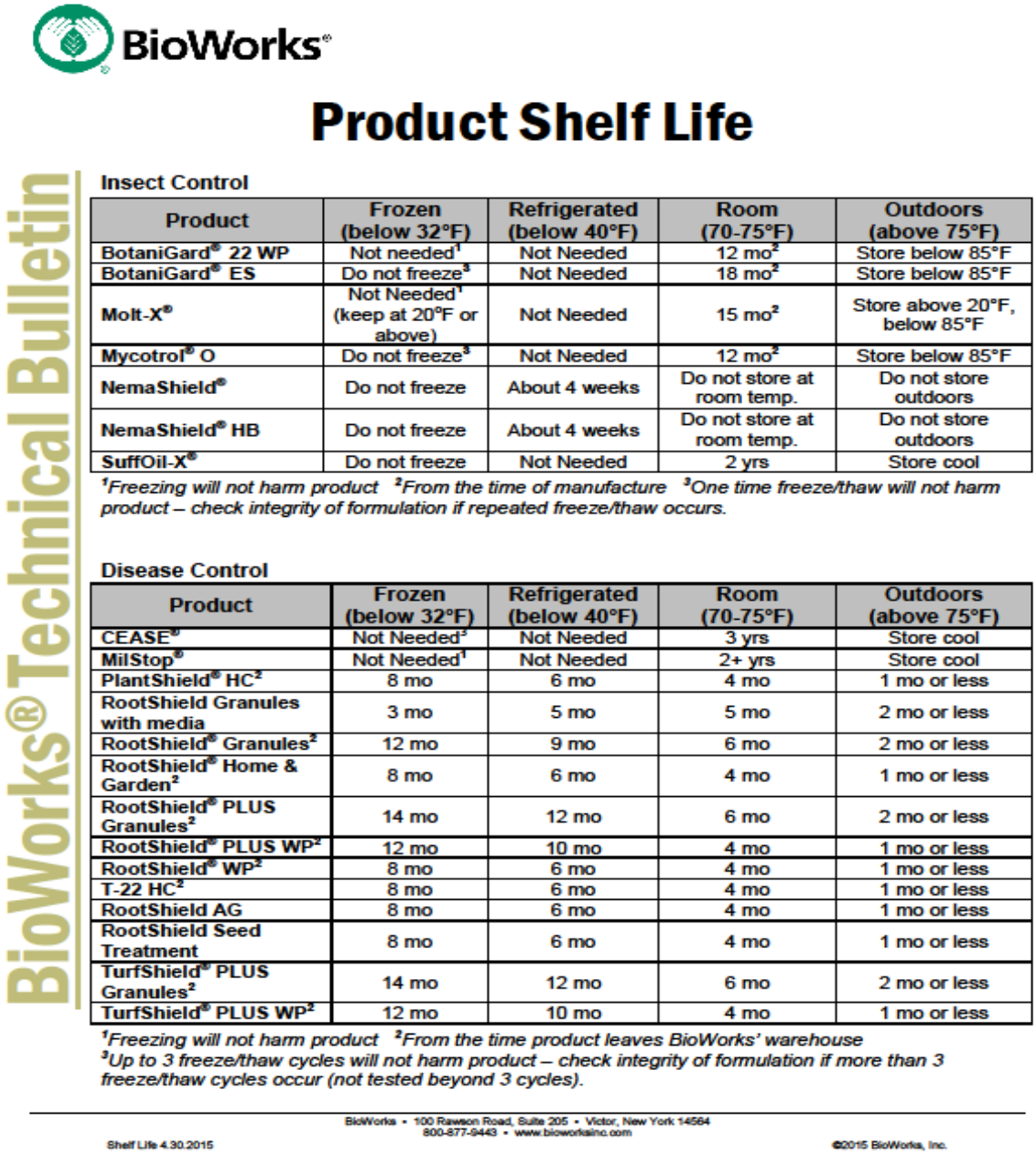


Figure 7. Biologicals such as *Trichoderman spp*. and *Bacillus spp*. can stimulate plants to have induced systemic resistance (ISR) to pests by producing phytochemicals such as jasmonic acid, and phytoalexins.

DO BIOLOGICALS WORK?

Biologicals do work and can be preventative from weeks to months in controlling specific pests. The appropriate biological needs to selected to deal with the specific pest. The problem site is most effectively controlled when there is low to moderate pest pressure – not after a high-level outbreak of the insect or disease. It is important that the biological is compatible to your propagation and production system – thrives and grows. Effective coverage includes treating where the pest "hides". Maintaining the proper conditions enhances the shelf-life longevity of the biological, i.e. avoiding high temperature conditions (Fig. 8).



BioWorks®

Product Shelf Life

BioWorks® Technical Bulletin

Insect Control

Product	Frozen (below 32°F)	Refrigerated (below 40°F)	Room (70-75°F)	Outdoors (above 75°F)
BotaniGard® 22 WP	Not needed[1]	Not Needed	12 mo[2]	Store below 85°F
BotaniGard® ES	Do not freeze[3]	Not Needed	18 mo[2]	Store below 85°F
Molt-X®	Not Needed[1] (keep at 20°F or above)	Not Needed	15 mo[2]	Store above 20°F, below 85°F
Mycotrol® O	Do not freeze[3]	Not Needed	12 mo[2]	Store below 85°F
NemaShield®	Do not freeze	About 4 weeks	Do not store at room temp.	Do not store outdoors
NemaShield® HB	Do not freeze	About 4 weeks	Do not store at room temp.	Do not store outdoors
SuffOil-X®	Do not freeze	Not Needed	2 yrs	Store cool

[1]Freezing will not harm product [2]From the time of manufacture [3]One time freeze/thaw will not harm product – check integrity of formulation if repeated freeze/thaw occurs.

Disease Control

Product	Frozen (below 32°F)	Refrigerated (below 40°F)	Room (70-75°F)	Outdoors (above 75°F)
CEASE®	Not Needed[3]	Not Needed	3 yrs	Store cool
MilStop®	Not Needed[1]	Not Needed	2+ yrs	Store cool
PlantShield® HC[2]	8 mo	6 mo	4 mo	1 mo or less
RootShield Granules with media	3 mo	5 mo	5 mo	2 mo or less
RootShield® Granules[2]	12 mo	9 mo	6 mo	2 mo or less
RootShield® Home & Garden[2]	8 mo	6 mo	4 mo	1 mo or less
RootShield® PLUS Granules[2]	14 mo	12 mo	6 mo	2 mo or less
RootShield® PLUS WP[2]	12 mo	10 mo	4 mo	1 mo or less
RootShield® WP[2]	8 mo	6 mo	4 mo	1 mo or less
T-22 HC[2]	8 mo	6 mo	4 mo	1 mo or less
RootShield AG	8 mo	6 mo	4 mo	1 mo or less
RootShield Seed Treatment	8 mo	6 mo	4 mo	1 mo or less
TurfShield® PLUS Granules[2]	14 mo	12 mo	6 mo	2 mo or less
TurfShield® PLUS WP[2]	12 mo	10 mo	4 mo	1 mo or less

[1]Freezing will not harm product [2]From the time product leaves BioWorks' warehouse
[3]Up to 3 freeze/thaw cycles will not harm product – check integrity of formulation if more than 3 freeze/thaw cycles occur (not tested beyond 3 cycles).

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Shelf Life 4.30.2015

Figure 8. Product shelf-life and storage of biological products.

IPM USING NON-LIVING BIOLOGICALS & CULTURAL CONTROLS

There is also usage of non-living biological controls and cultural control agents. There must be good coverage for these products to be effective. Examples of non-living biologicals and cultural control agents include:

- Salts
- Bicarbonates – Dehydrates & alters pH (Fig. 9)
- Oils & Soaps (Fig. 10)
- IGRs (Insect Growth Regulators – Residual Activity), i.e., Azadirachtin
- Pyrethrums - insecticidal compounds present in pyrethrum flowers.

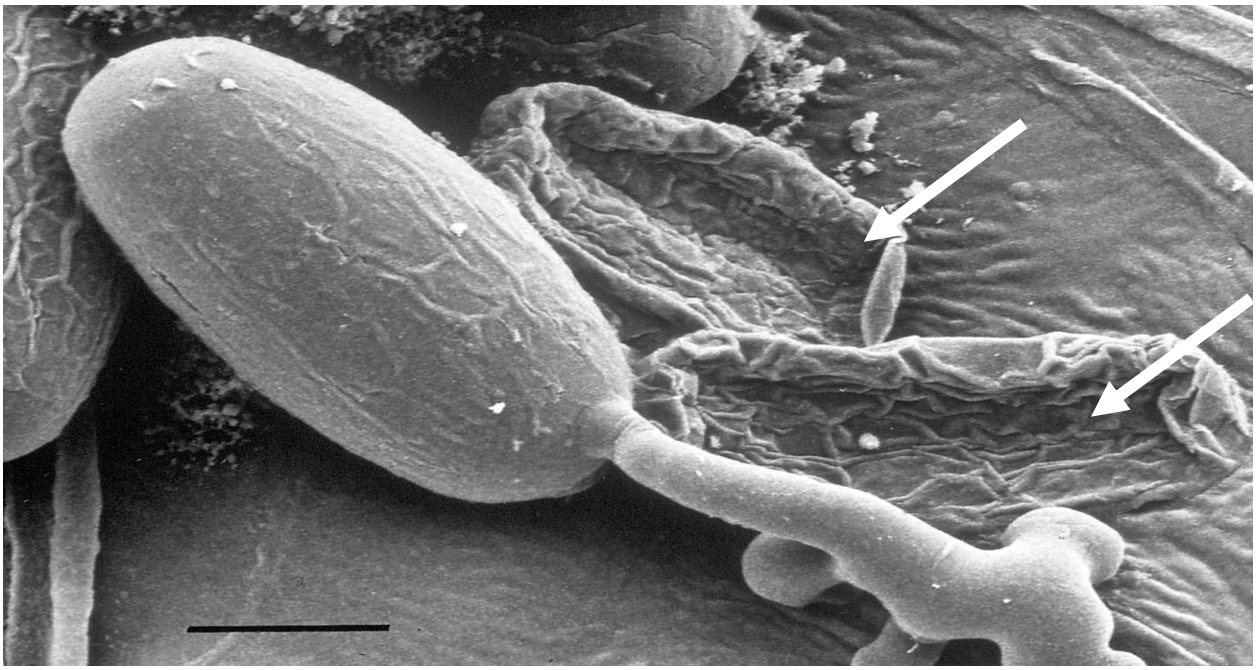

Figure 9. Bicarbonate treated (arrows) and untreated powdery mildew spores. The treated spores are desiccated and dead.

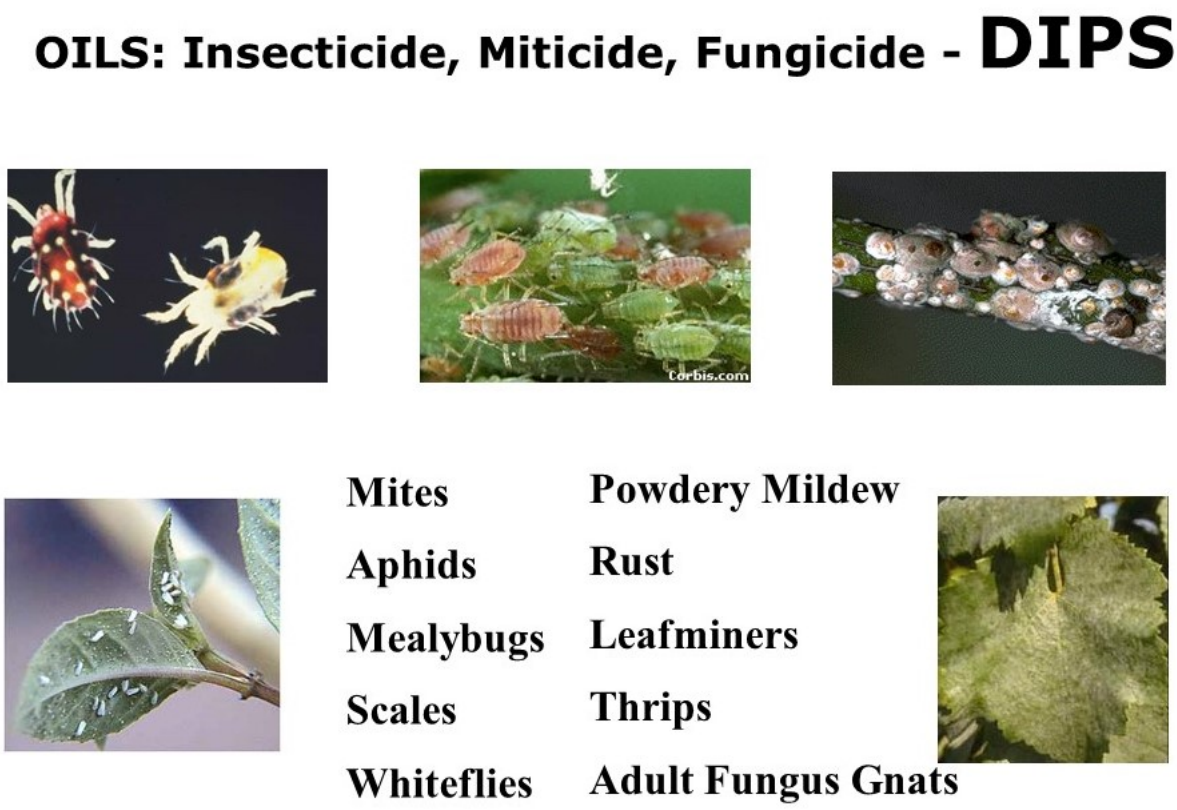

Figure 10. Various oils, petroleum and plant based, can be used as effective, safe alternatives to synthetic insecticides, miticides and fungicides.

https://agrilifeextension.tamu.edu/library/farming/using-oils-as-pesticides/

THINGS TO CONSIDER IN TANK MIXING WITH BIOLOGICALS AND CHEMICAL PRODUCTS

Important issues to consider in tank mixing is the compatibility of the biological with other chemicals, and the need to adjust chemical mixtures. The compatibility between one biological and another biological is also important. And everything is about ***timing***. This includes applying the biological at the appropriate time in the propagation and production schedule to control the pest. It also means the right season, i.e., horticultural oils are often best when the host crop is

dormant. Also, releasing the biological during the appropriate time of the day and environmental conditions - so they can establish themselves and be effective control agents. As an example, parasitic nematodes released early enough during a controllable level of a pest population can be effective controls (Fig. 11).

Figure 11. Insect-parasitic nematodes (white curved structures) consuming an insect pest. Nematodes work in controlling pests such as with: *S. feltiae* - fungus gnat larvae, thrips pupae, flies; *S. carpocapsae* – armyworms, sod webworms, cut worms; *S. scapterisci* – mole crickets; and *H. bacteriophora* – white grubs, black vine weevils, borers.

CONCLUSION

Biologicals for plant pest control can be highly effective in IPM and IPHM systems when appropriately applied. Biology does work!