Mycorrhizal Applications

Why Should You Consider Using Mycorrhizae?

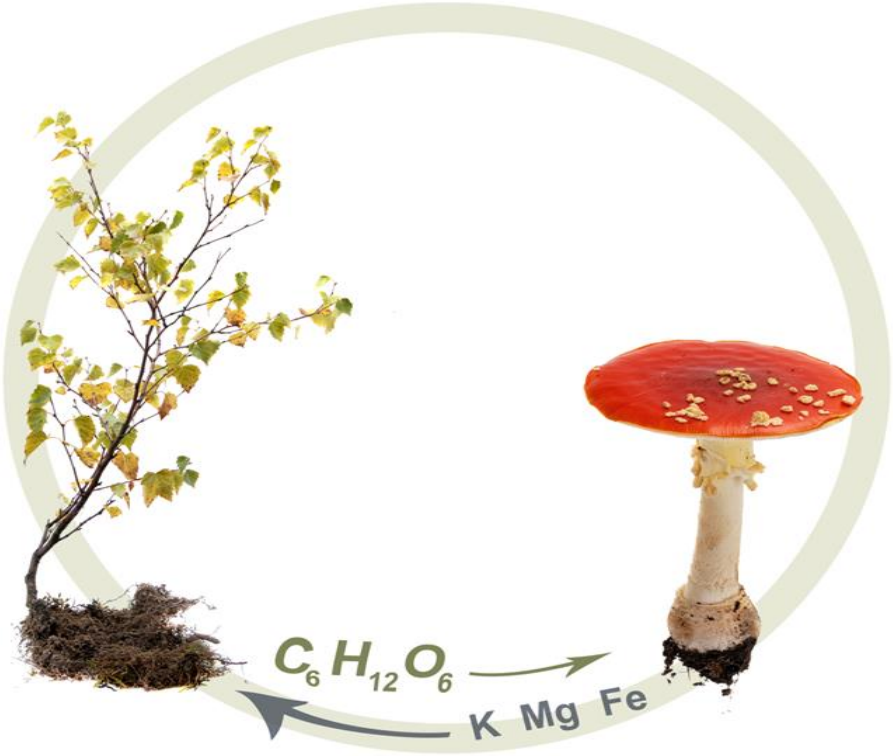
Change Your World

www.mycorrhizae.com

Mycorrhizal Symbiosis

A **mutually beneficial relationship**, which is characterized by movement of carbon flows to the fungus and inorganic nutrients move to the plant, thereby **providing a critical linkage between the plant root and soil/media/substrate.**

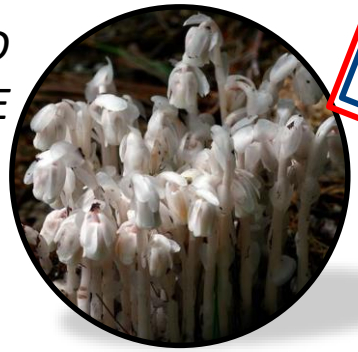
Mycorrhizae provide better absorption of nutrients and increased water uptake to the plant in exchange for carbon supply.



TYPES OF MYCORRHIZAE

ENDOMYCORRHIZAE - ARBUSCULAR MYCORRHIZAE

MONOTROPOID MYCORRHIZAE



ECTOMYCORRHIZAE

ERICOID MYCORRHIZAE

ECTENDO-MYCORRHIZAE

ARBUTOID MYCORRHIZAE

ORCHID MYCORRHIZAE

Ecto vs. Endo Colonization of Plant Roots

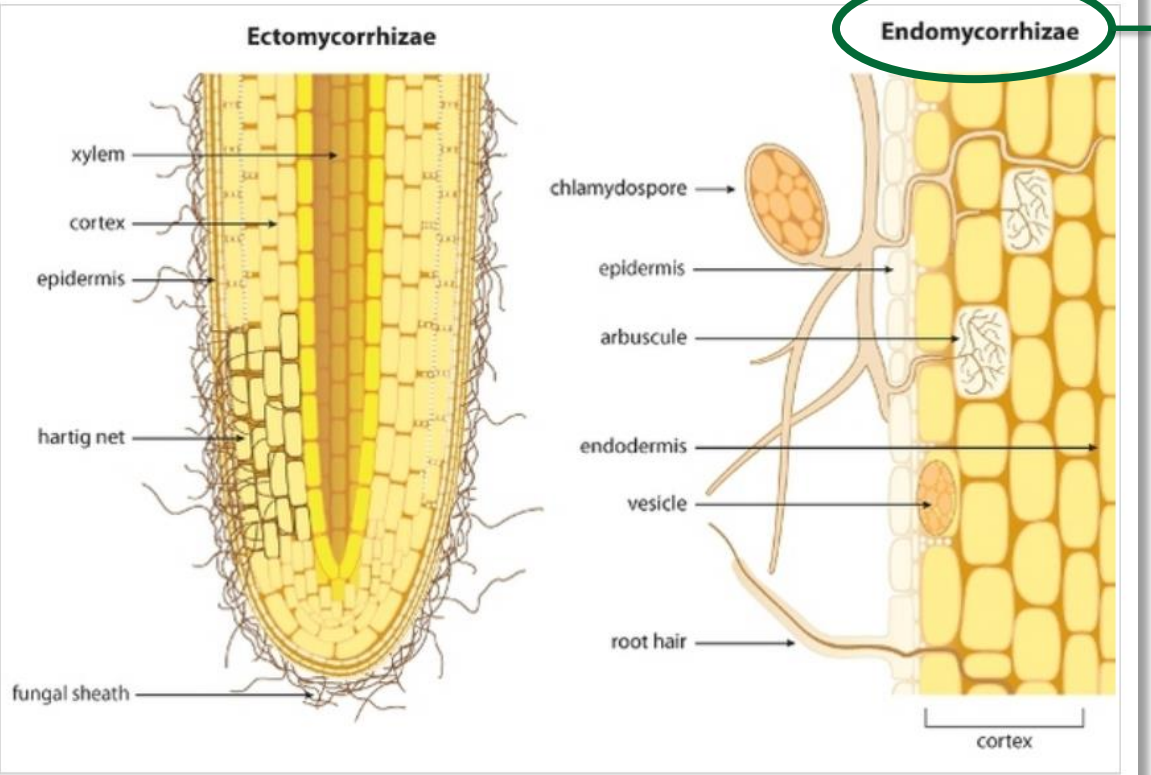


Figure 6
Schematic showing the difference between ectomycorrhizae and endomycorrhizae colonization of plant roots.

Endomycorrhizae
(Arbuscular Mycorrhizal Fungi)

Arbuscular Mycorrhizal Fungi (AMF) colonize plant roots intracellularly (inside the root cell) and are dependent upon a living plant for growth.

General Life Cycle of
Arbuscular Mycorrhizal Fungi (AMF)

1. ***Chlamydospores*** *(spores)* form at the end of fungal hyphae either within the plant root or outside in the soil.
2. Upon receiving ***Strigolactones*** signal from plant root, the spores germinate, penetrate & colonize plant roots.
   - ***a. Hyphae*** - Each of the branching filaments (fungal roots) that make up the mycelium of a fungus.
   - ***b. Arbuscules*** - Hyphal structures with many branches within the plant roots that serve as the site of nutrient exchange.
   - ***c. Vesicles*** - Mycorrhizal storage structures within the roots.

Mycorrhizal Propagules

Entities which can re-establish the mycorrhizal hyphal network with host plant roots:

COLONIZED ROOT FRAGMENTS

Fungal hyphae network within root tissues. Provide a fast fungal hyphae (re-)growth and quick colonization of target plants.

FUNGAL SPORES

Spores are normally dormant and germinate slower than root fragments. Very resilient structures.

FUNGAL HYPHAE

Extra-radical fungal hyphae can colonize plant roots quickly but have a very limited shelf-life (<2 years).

MYCORRHIZAL PRODUCT FORMULATIONS

Mycorrhizal inoculants come in a number of different formulation types. Many contain mycorrhizae only, some contain additional beneficial ingredients.

Granular Formulations

- Ideal for media incorporation

Suspendable Powders

- Can be highly concentrated
- Most versatile

Liquids

- Aqueous - Limited Shelf Life

Primary Benefit of Mycorrhizae

- Expanded Root Mass
  - As much as 50 times over time, up to 2 more ft.
  - Nutrient and water absorption occurs along the entire length of the hyphae
  - Mineral nutrient uptake from the soluble and insoluble pool
  - More efficient nutrient uptake (greater nutrient inflow)
  - Better roots lead to better plants

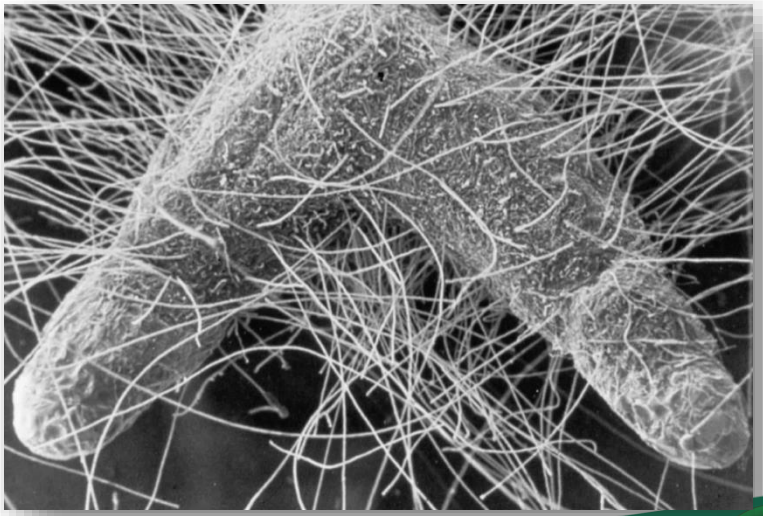
ROOT HAIR vs. MYCORRHIZAL FUNGAL HYPHAE

Root hair:

- Maximum length is a few millimeters
- Cation absorption occurs only at the tips
- Mineral nutrient uptake from available (soluble) pool only
- The rate of nutrient inflow is lower

Mycorrhizal fungi:

- Maximum length 20-25”
- Nutrient and water absorption occurs along the entire length of the hyphae
- Mineral nutrient uptake from the soluble and insoluble pools
- The rate of nutrient inflow is greater



Expanded Root Mass

CAST 2017

Full Fertilizer,
MycoApply Treatment on Right

1/3 Less Fertilizer,
MycoApply Treatment on Right

Expanded Root Mass

Cultivate 2018

Full Fertilizer,
MycoApply Treatment on Right

Full Fertilizer,
MycoApply Treatment on Right

Secondary Benefits of Mycorrhizae

- Efficiency in Nutrient Uptake
  - Reduced Nitrogen & Phosphorus run off
  - Nutrient buffer
  - Ability to modify nutrients into a form plants can use
  - Reduced plant stress
  - Reduce high EC stress

Less Fertilizer, More Plant

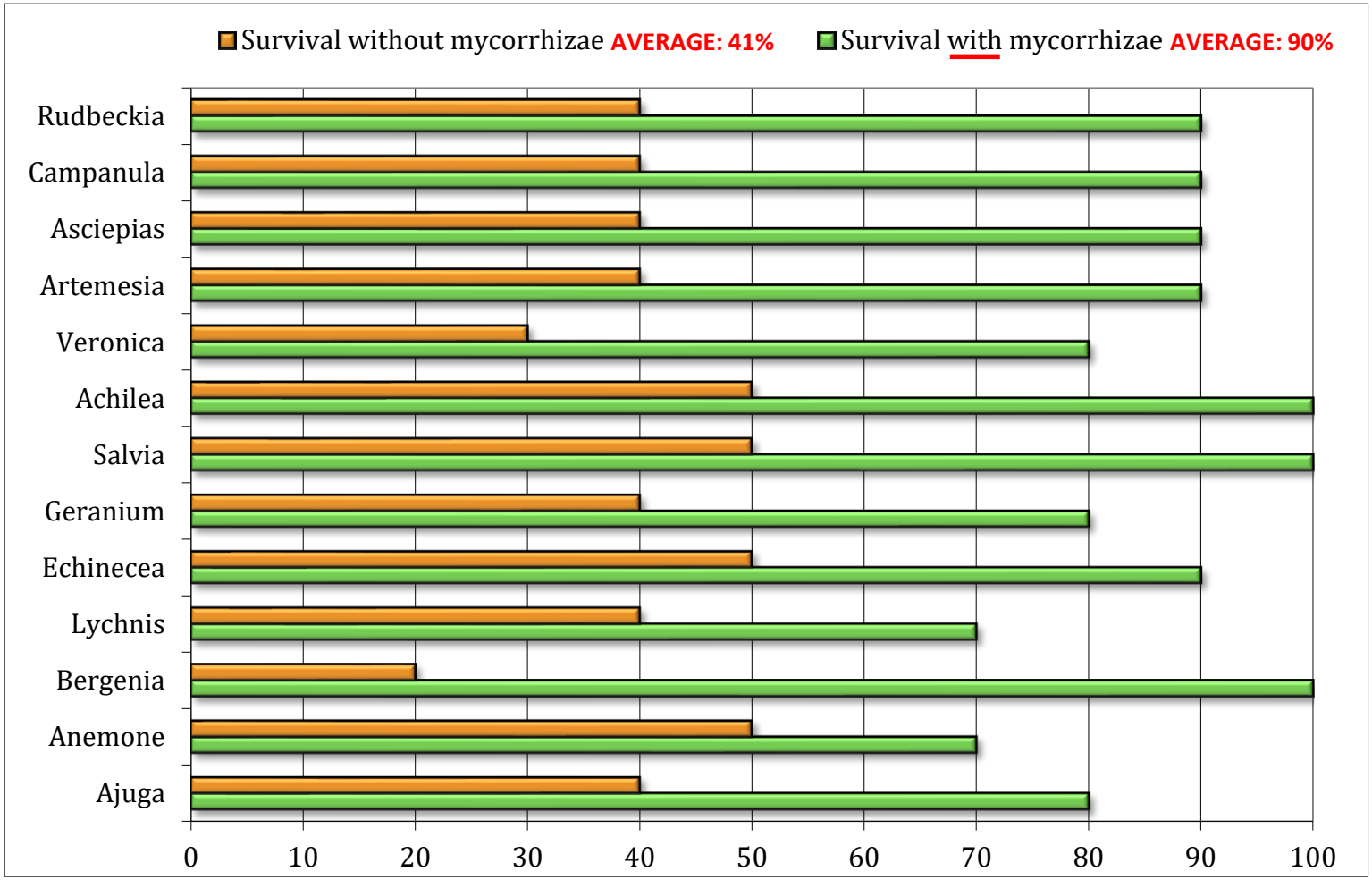
Secondary Benefits of Mycorrhizae

- Improved extraction of water
  - Enhanced in ground performance
  - Reduced plant stress
  - Water buffer
  - More efficient utilization of irrigation
  - Storage of water and lipids for periods of drought

Nutrient and Water Uptake
Drought Tolerance/Shelf Life

Mycorrhizal Applications

Study: "The effect of inoculation with the mycorrhizal fungus *Glomus intraradices* and extended drought on transplant survival of perennial herbaceous plants."



-Klironomos, et al 2008 University of Guelph, Ontario, Canada

Benefits of Mycorrhizae

- Increased transplant success – both as a liner/plug and in the landscape
- Improved flowering – can be earlier, more prolific and more uniform
- Increased fruiting – can be earlier and have higher yield
- Enhanced plant habit – more lateral branching, darker foliage, higher plant grade out

Pay it Forward

- Mycorrhizal treatment benefits everyone in the customer channel after the treatment
  - Grower
  - Retailer
    - Pay by Scan
    - Guaranteed plant material
  - Landscaper
  - Home Gardener

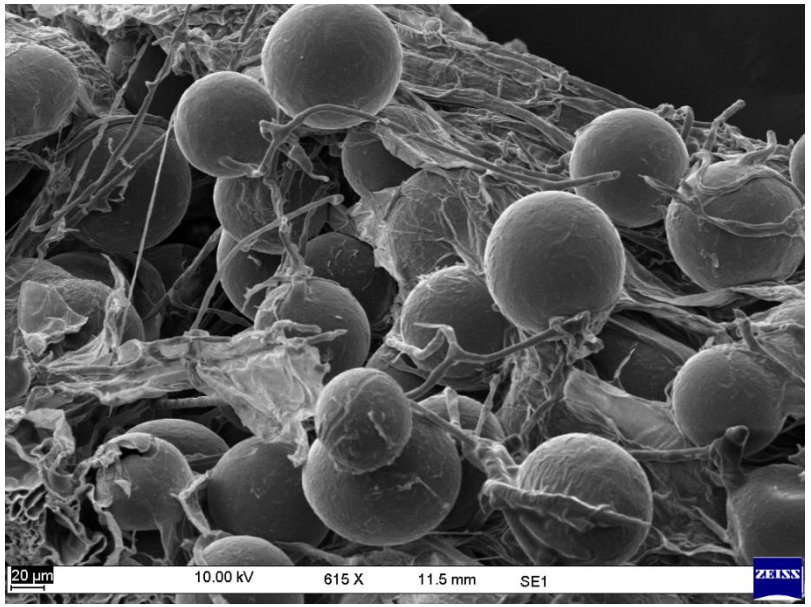
COST OF TREATMENT

- $0.10/tray for drench treatment
  - Divided by number of cells…
    - Ex: $0.10 / 72 cells = $0.0014 per plant
- Production benefits
  - higher plant grade out, improved plant health, reduced production costs
- Retail benefits
  - reduced stress during shipment, improved shelf life, less customer returns

Photo by Proven Winners

FOUR SPECIES PERFORMANCE

- MycoApply products contain a four species consortium (at a minimum).
  - Glomus mosseae
  - Glomus aggregatum
  - Glomus intraradices
  - Glomus etunicatum



Specificity of Endomycorrhizae

- Great deal of variability
- One fungal species may form association with many different plant species – low specificity
- One host plant can have mycorrhizal associations with a number of different fungal species (even at the same time)
- Each species colonizes roots at different speeds
- Each species colonizes different plant species to a different extent

Specificity of Endo Mycorrhizae

- Different species are responsible for different functional benefits
- Seasonal changes of rhizosphere microbial communities – "One does not fit all"
  - Soil microclimate (e.g., changes in soil moisture, phosphate availability)
  - Plant phenology
  - Plant physiology
  - Ecological conditions
- **Diversity in microbial inoculants is important, because the species complement each other**

SINGLE VS. FOUR SPECIES PERFORMANCE

Beneficial Factors Attributed to 4-Species MycoApply Endomycorrhizal Fungi and Their Relationships with Plants		Endomycorrhizal Fungi			
		Glomus mosseae	Glomus aggregatum	Glomus intraradices	Glomus etunicatum
Plant Nutrition Attributes					
	Increased Nitrogen (N) uptake	X	X	X	X
	Increased Phosphorus (P) uptake	X	X	X	X
	Can access organic forms of N and P			X	
	Increases mineral uptake			X	X
	Effective root colonization with time-release fertilizers	X	X		
	Tolerant of high fertility levels (Phosphorus)		X		
	High levels of enzyme activity benefiting nutrient and micronutrient acquisition	X		X	X

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Plant Growth and Establishment					
	Improved performance of woody perennials	X		X	X
	Increases fruiting and flowering	X		X	X
	Improves plant performance in sandy soils		X		
	Improves performance of palms and fruit trees		X	X	
	Increases crop yields	X		X	X
	Improves growth and performance of turf grasses, agricultural crops and nursery stock	X		X	
	Very effective in agricultural soils	X		X	X
	Improved plant establishment	X		X	X
	Well adapted to a wide variety of plants and soil conditions	X		X	
	Improved growth of grain crops	X		X	
	Increases production of vegetable crops	X		X	
	Improved growth of tropical and sub-tropical fruits		X	X	

SINGLE VS. FOUR SPECIES PERFORMANCE

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Heat and Drought Tolerance					
	Drought protection	X	X	X	X
	Greatly improves drought tolerance	X		X	X
	Active during periods of low water availability	X		X	X
Suppression of plant pathogens and root diseases					
	Stimulates root development	X		X	X
	Keeps root systems healthier	X	X		
	Nematode protection of roots	X		X	X
	Promotes disease suppression	X			X
	Effectively suppressed Verticillium wilt				X
Soil Physical and Chemical Conditions					
	Salt tolerance	X		X	X
	Effective in mine reclamation	X	X	X	X
	Protects against heavy metal toxicity	X	X		X

MYCORRHIZAE FAQ

- What is the best application method?
  - An application that gets good contact with the roots will produce great results. Growers can choose the application method that best fits into their growing practices.
    - Soil/media incorporation
    - Plug dip
    - Direct application to roots at transplant
    - Traditional drench
      - Not via large scale horticulture injection systems, until early 2019

MYCORRHIZAE FAQ

- How many applications are recommended?
  - Once treated, mycorrhizae remain in a symbiotic relationship with the plant for the plant's entire life. When a plant is transplanted, the mycorrhizae join the soil ecosystem and change as it changes.
  - **In most cases only once!**
  - You can not overdose.

MYCORRHIZAE FAQ

- When will I start to see a difference after applying mycorrhizae?
  - Benefits can start within four weeks, visible benefits can be seen within eight weeks.
  - Crop time can include time as a plug and/or cutting.
  - Once propagation material is planted in a larger container, benefits start to become more visible.

MYCORRHIZAE FAQ

- Can I use fungicides if I grow with mycorrhizae?
  - Yes. A detailed list of fungicide compatibility is available from Mycorrhizal Applications.
  - Most fungicides can be used with mycorrhizae without negative impact.
  - The longer you wait to apply an “avoid use” fungicide after mycorrhizal inoculation, the better it will be for the mycorrhizal establishment and development.

MYCORRHIZAE FAQ

- Can mycorrhizae be used with other biological products?
  - Yes. Mycorrhizae work well with other biological products, such as beneficial bacteria (Actinovate®) and Trichoderma (RootShield®).

MYCORRHIZAE FAQ

- Can mycorrhizae be used with beneficial insects and mites?
  - Yes. Mycorrhizae do not interfere with these natural pest predators. In fact, mycorrhizal inoculation reduces plant stress, which in turn can reduce pest insect infestations.

MYCORRHIZAE FAQ

- How do mycorrhizae differ from other microbes?
  - Without the plant, they cannot live
  - They provide a long-term impact
  - They thrive in a diverse range of conditions
  - Mycorrhizal structures store nutrients and water for later use by the plant

MYCORRHIZAE FAQ

- What is the recommended fertility program if I use mycorrhizae?
  - For best results, we recommend keeping N levels at 200 ppm (EC 0.4)or lower and P_2O_5 levels at 100 ppm(EC 0.2) or lower while using mycorrhizae.
  - Higher levels of fertility during inoculation can reduce the ability of the mycorrhizal inoculum to form the symbiotic relationship with the root system.

MYCORRHIZAE FAQ

- Are there any plants that will not benefit from mycorrhizal inoculants?
  - Brassicas – non-mycorrhizal
  - Mustards – non-mycorrhizal
  - Carnation/Dianthus – non-mycorrhizal
  - Orchids & Ericaceous – special mycorrhizae
  - It does not hurt a non-mycorrhizal if you treat it

MYCORRHIZAE FAQ

- What are the application options?
  - Soil Incorporation – lbs. per yard
  - Drench – volume per container
  - Plug Dip – 15 second absorption
  - Bareroot Dip – wetting agent, 15 second absorption

MYCORRHIZAE FAQ

- Can mycorrhizae reduce plant diseases?
  - Not an EPA registered pesticide
  - University Research has shown the benefits
  - Improved plant health by producing stronger root system
  - Life of mycorrhizae connected to life of plant
  - Research shows other mechanisms exist
  - Think of it as a good secondary defense
  - Potential to reduce need for fungicidal treatments

Who is Mycorrhizal Applications?

- 1995 – company established in Dr. Mike Amaranthus' garage
- 1999 – MA branched out beyond the forestry industry, and added endomycorrhizae into its product mix, establishing the MycoApply® brand.
- 2015 – Mycorrhizal Applications became a wholly owned subsidiary of Valent BioSciences, a Sumitomo Chemical Company

MycoApply® Mycorrhizal Inoculants

Granulars

Suspendable Powders

MycoApply® Mycorrhizae

- OMRI Listed and CDFA
- Two year shelf life
- Can be stored under normal warehouse conditions, under 140°F
- Products registered in all 50 states, considered a soil amendment

Please stop by our booth and say hello!

Booth 48, 49

Questions/Technical Support

What questions do you have?

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