Biologically Based Treatments for the Production of Seedlings

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Southern Forest
Nursery Management Cooperative

Biological Control

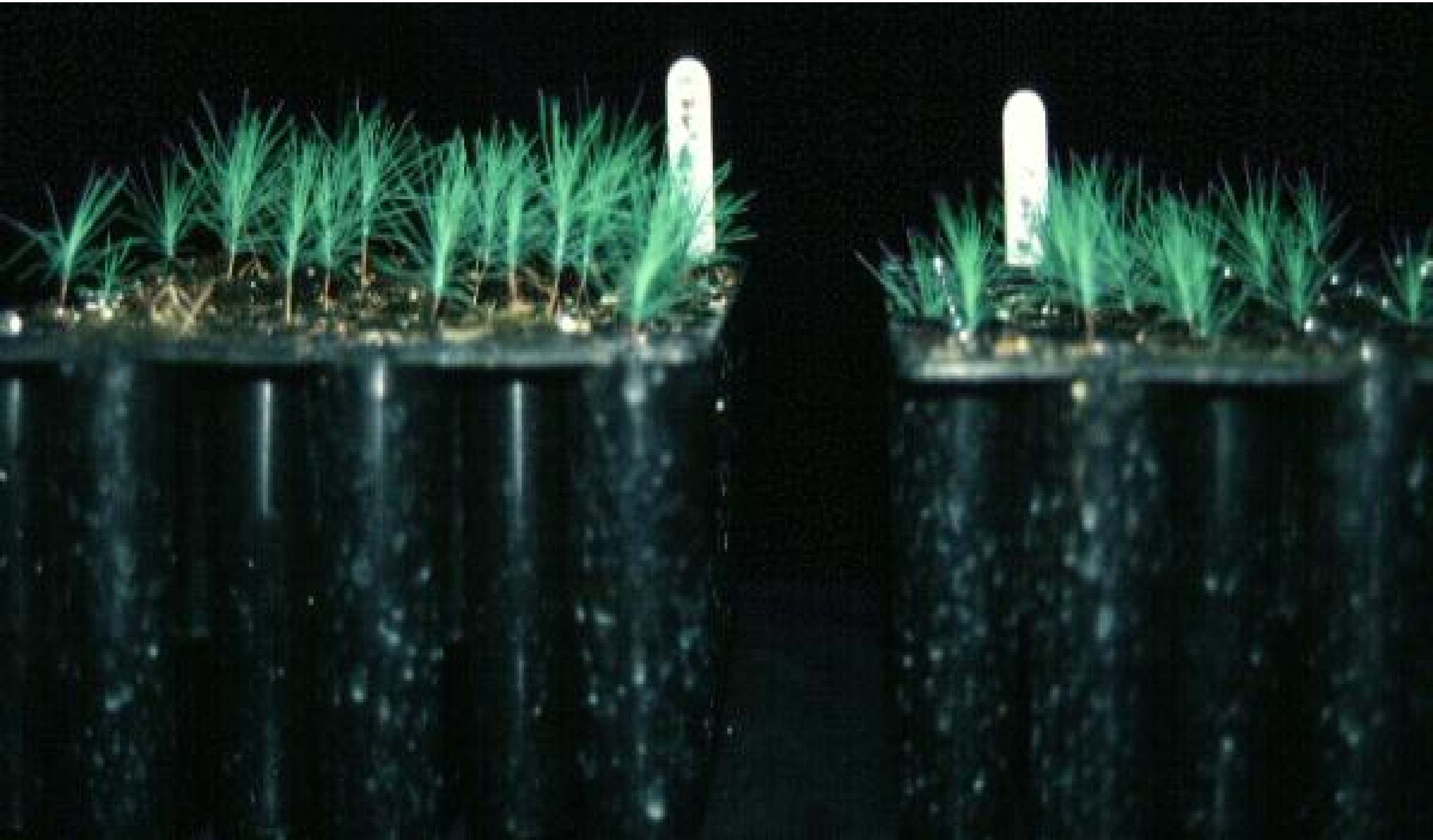
Agents

- Bacteria / Plant Growth Promoting Rhizobacteria or PGPR
- Fungi as antagonists
- Mycorrhizae
- Soil amendments

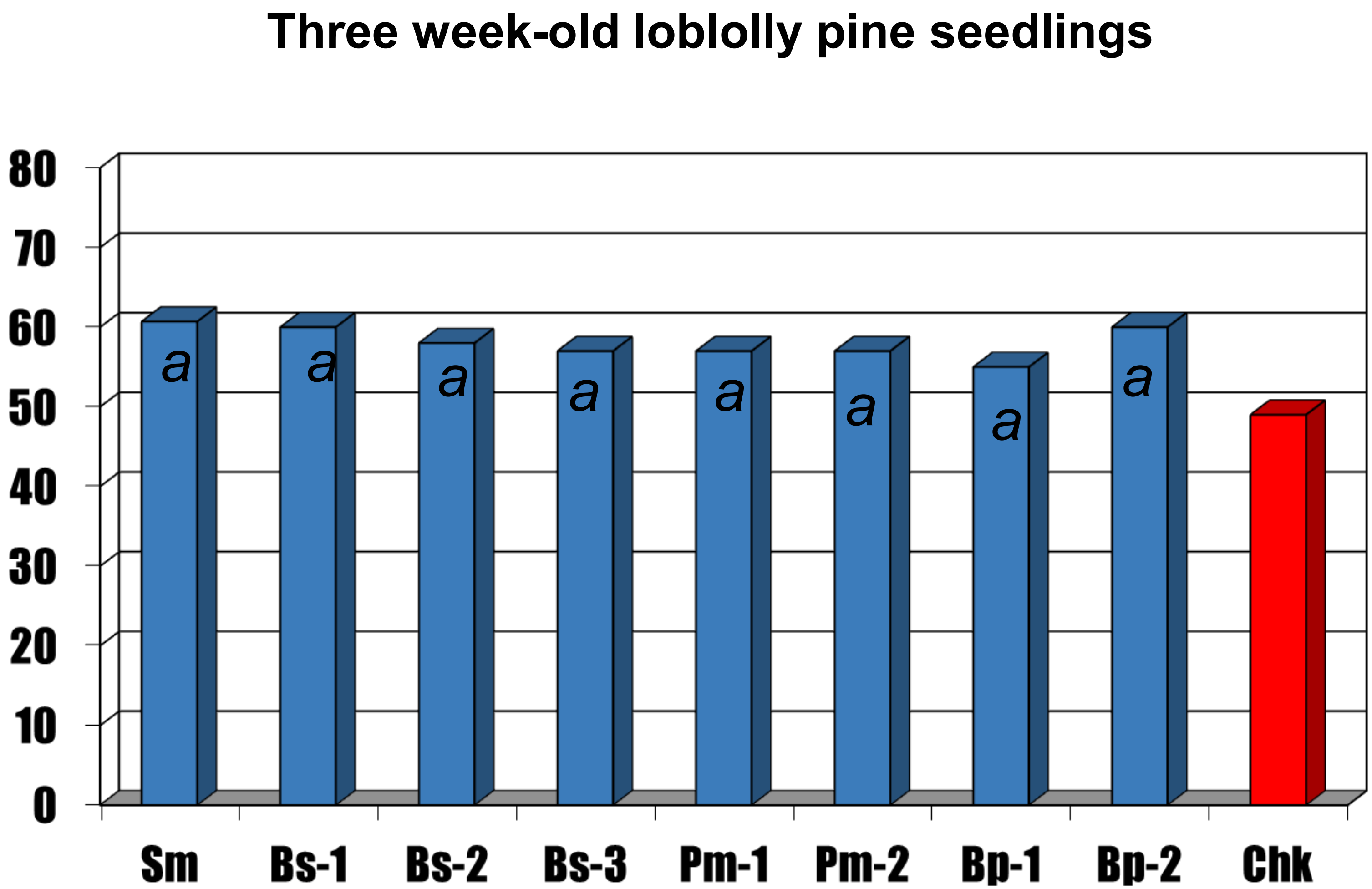
Commercially Available Products

PRODUCT	BACTERIA	TARGET EFFECT
Kodiak	Bacillus subtilis	Growth promotion & Biocontrol of Rhizoctonia and Fusarium
Deny	Burkerholdia cepecia	Biocontrol of Fusarium & Pythium
Actinovate	Streptomyces lydicus	Biocontrol of Pythium, Fusarium, & Rhizoctonia
YIB	Bacillus spp.	Root growth promotion
Epic	Bacillus subtilis	Growth promotion & Biocontrol of Rhizoctonia and Fusarium

EPR – Emergence Promoting



EPR – Emergence Promoting



Bacterial and Fungal Symbiotic Relationships

Studies have shown that:

- They can Increase or Decrease ectomycorrhizae infection
- They can Increase or Decrease endomycorrhizae infection
- Alter species of mycorrhizae

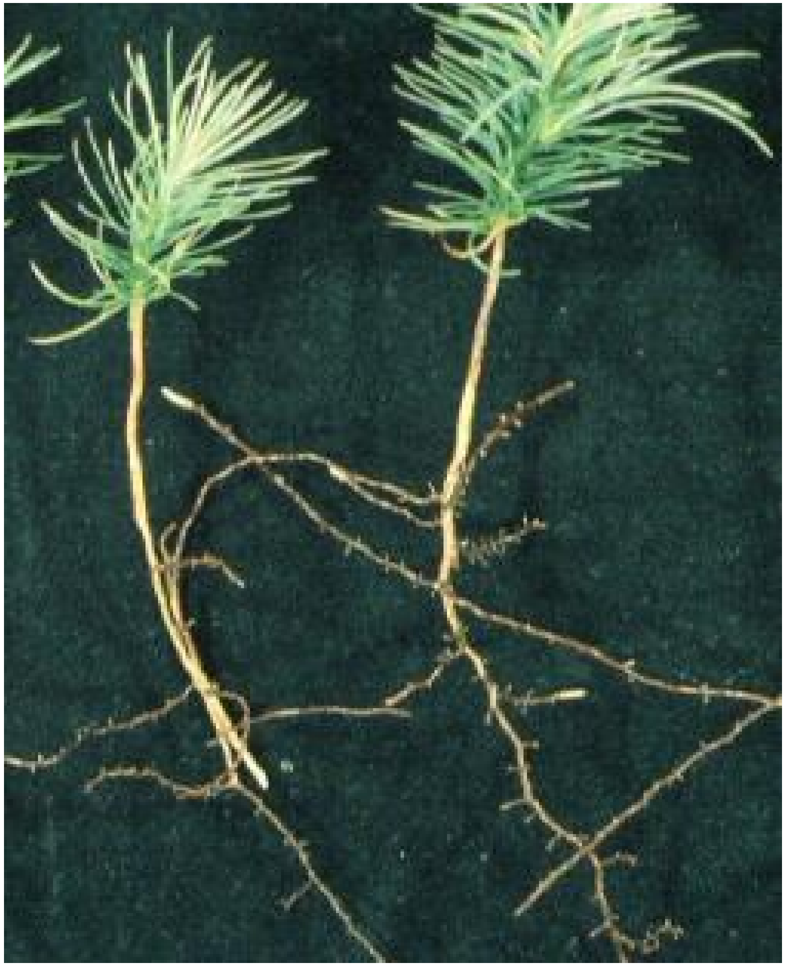


Table 1. Mean seedling density, size and dry weight by seed treatment with *Paenibacillus macerans* for loblolly pine at Flint River GA over three years.

Year	Bacteria	Density (ft2)	RCD (mm)	Hgt (cm)	Root Wgt (g)	Shoot Wgt (g)
1	No	**21.4**	**4.3**	**21.4***	**0.68**	**3.1**
	Yes	**21.8**	**4.2**	**19.7**	**0.72**	**3.0**
2	No	**21.7**	**3.6**	**25.3***	**0.71**	**2.7**
	Yes	**22.7**	**3.6**	**24.5**	**0.66**	**2.6**
3	No	**22.0**	**4.2**	**27.0**	**0.85**	**2.9**
	Yes	**22.4**	**4.1**	**26.6**	**0.81**	**2.9**

Table 2. Mean seedling density, size and dry weight treated with *Paenibacillus macerans* for loblolly pine at Hauss and Carter Nurseries over three years.

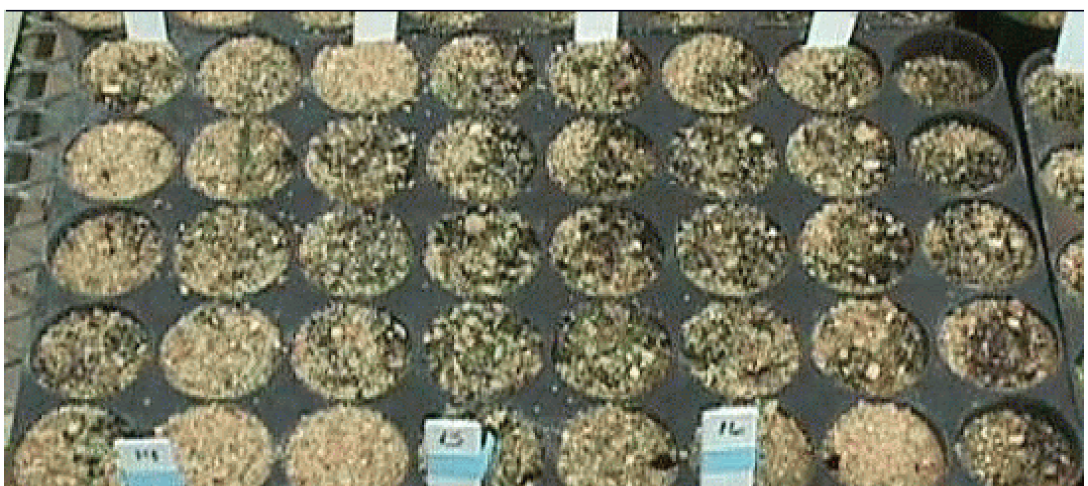
Year	Bacteria	Density (ft2)	RCD (mm)	Hgt (cm)	Root Wgt (g)	Shoot Wgt (g)
1	No	**22.5**	**4.6**	**na**	**0.79**	**2.9***
	Yes	**23.8***	**4.4**	**na**	**0.72**	**2.7**
2	No	**21.6***	**5.0**	**na**	**0.89**	**3.1**
	Yes	**19.4**	**5.2**	**na**	**0.96***	**3.4***
3	No	**24.8**	**5.1**	**na**	**0.90**	**3.4**
	Yes	**25.4***	**5.1**	**na**	**0.90**	**3.3**

Summary of Bacteria Used in Bareroot Nurseries

- Enhance seedling emergence
- Enhance some seedling growth
- Dose sensitive
- Nursery specific
- Species and family specific
- Fine tuning for nursery, species & family would take years
- More amenable to container systems

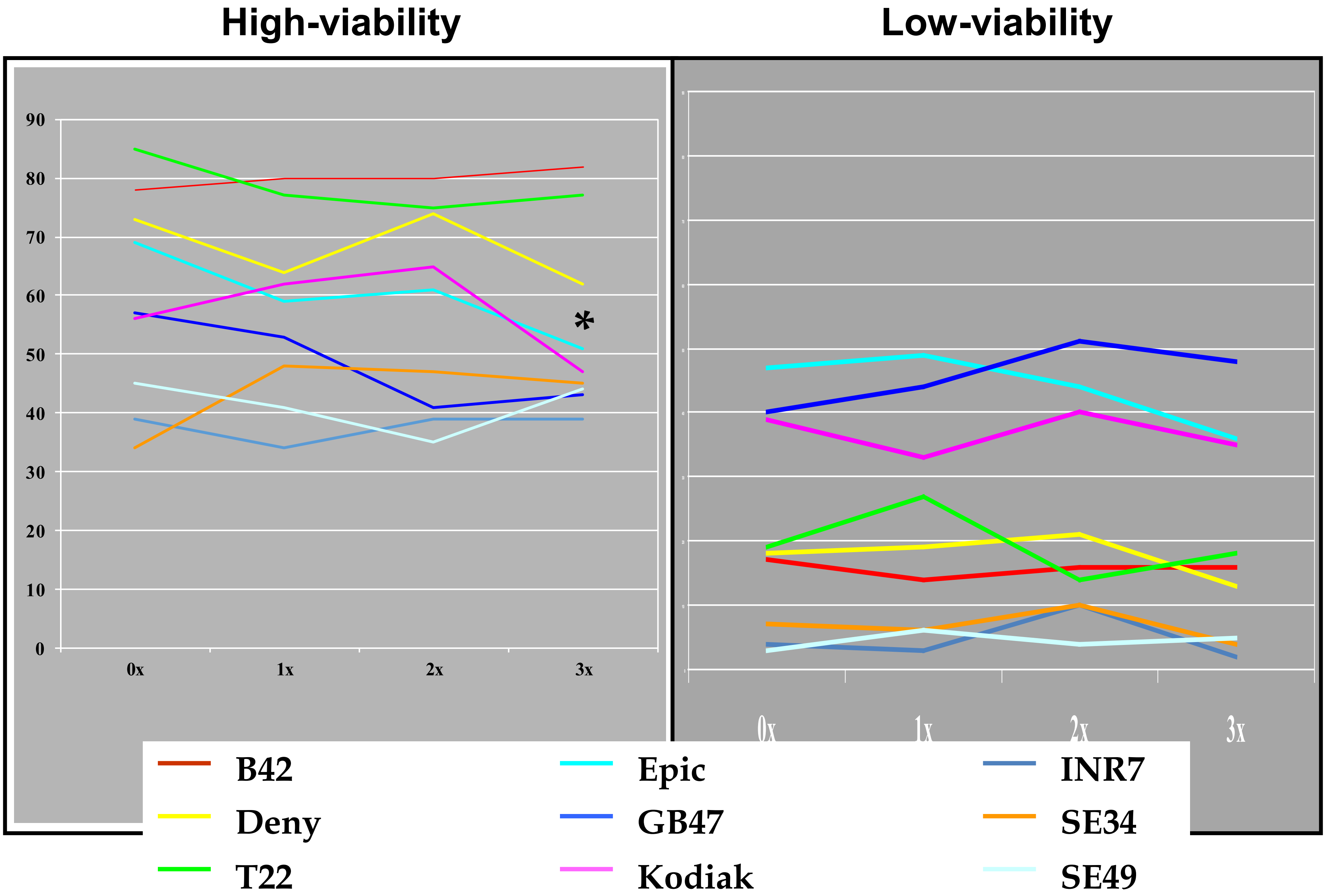
Fungal Seed Treatment – Longleaf Pine

Pre-treatment
high-viability seed lot



Pre-treatment
low-viability seed lot

Biological Seed Treatment



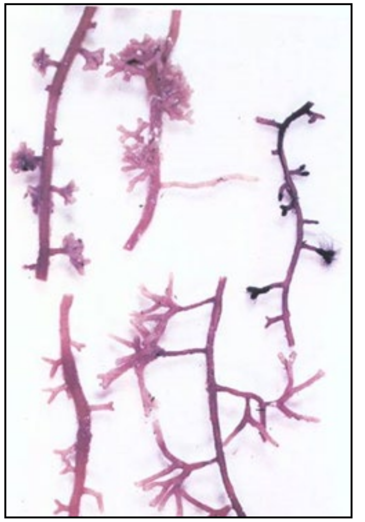
Summary & Conclusions

- Biological agents neither increased nor decreased longleaf seed germination.
- Fungicide treatments resulted in a 10% increase in percent germination.
- Biological agents inconsistency is still a factor in their lack of adoption
- Summary Research Report 2009-05

Biological - Mycorrhizae

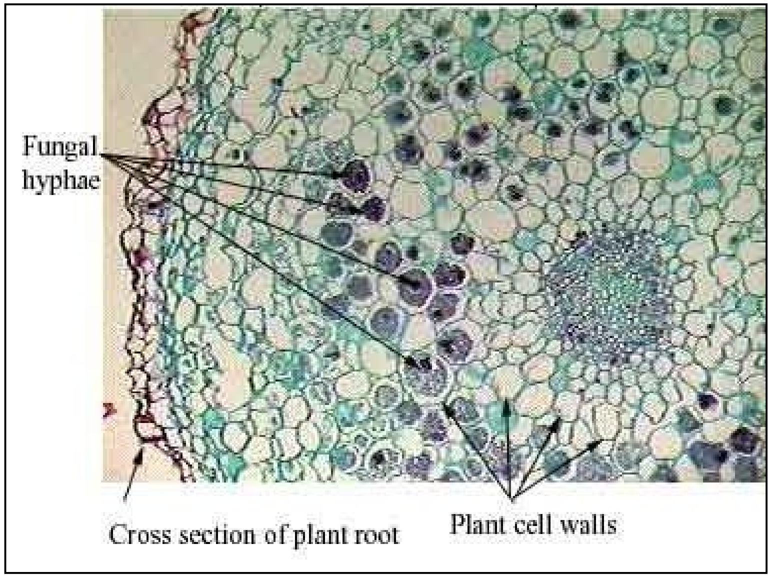
- Mycorrhizae: A Greek word that means Root - Fungus.
- Mycorrhizae are a critical ingredient to the survival of forest trees.
- Symbiotic relationship. Both tree and fungus benefit.
- Tree benefits from increased root area for absorption of nutrients and water.
- Fungus benefits because it receives food from the tree’s roots.

Ectomycorrhizae (outside)



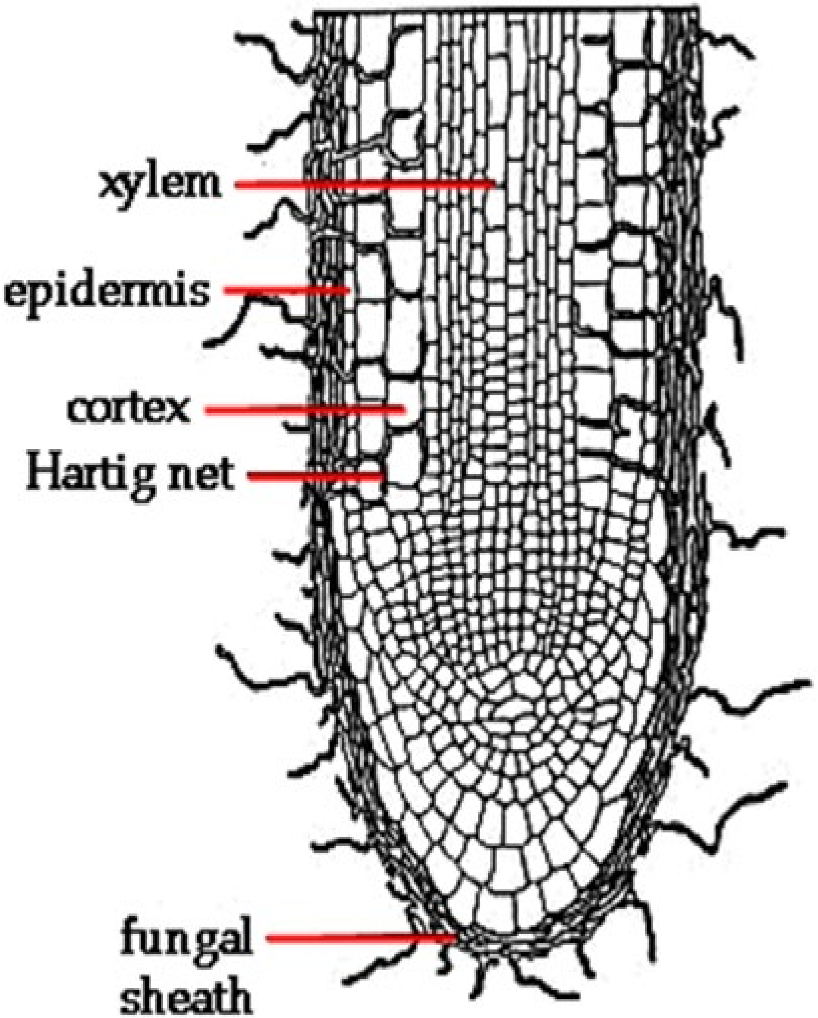
- Produces a fungal mantle
- Roots tend to be "forked"
- Spread via spores in the wind
- Found on many conifer species
- Found in many bare-root and container systems

Endomycorrhizae (inside)

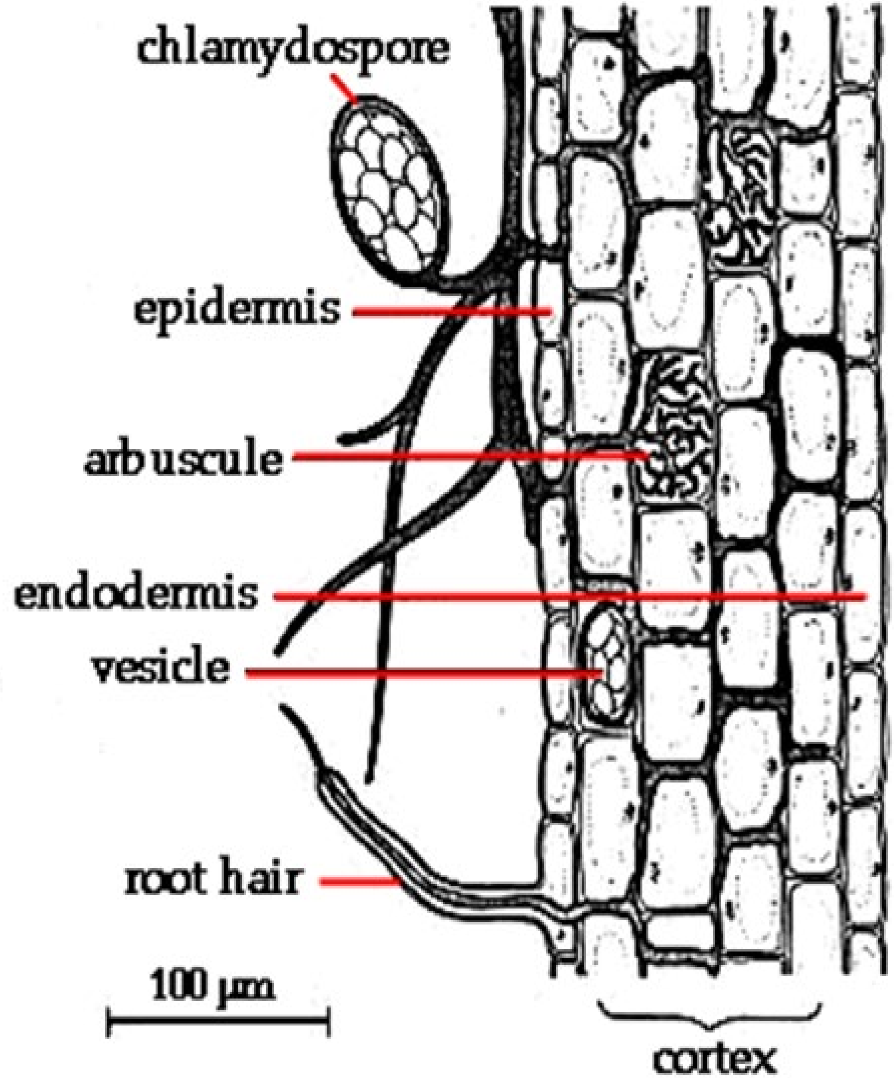


- No visual difference externally
- Produce swellings on plant roots
- Spread via infected roots
- Found on many hardwoods and cover crops

Ectomycorrhizae



Endomycorrhizae



Mycorrhizae

- Selectively absorb and accumulate certain nutrients, especially Phosphorus
- Solublize and make available non-soluble minerals
- Keeps feeder roots functional longer
- “Protects” feeder roots from soil pathogens
- Result in forking of fine roots

Thelephora terrestris

- Most common ectomycorrhiza in nursery soils.
- Spread via spores from neighboring fields.
- Not unusual to have 100% colonization.
- ‘Smothering’ fungus.
- Can be quickly replaced by native mycorrhizae after outplanting.

Pisolithus tinctorius
(also known as Pt)

- Second most common ectomycorrhizal
- Has been shown to increase survival of seedlings after outplanting on harsh sites.
- Not easily spread. Needs vegetative mycelia.
- Easily replaced after outplanting.

Mycorrhizae

- Except for purposes of ‘market forces’ or EXTREMELY harsh sites, the addition of fungal inoculum to either nursery soils or container systems to “increase mycorrhizae” and consequently seedling survival, is not necessary with respect to growing conifer seedlings in the southern United States.
- However, Endomycorrhizae are more sensitive and thus, deficiencies do occur with hardwood species after fumigation.
- Appears as stunted seedlings and purple discoloration in hardwoods.
- Difficult to establish endo-mycorrhizae due to cost and effectiveness.
- Often can be mitigated using Phosphorus additions.

Soil Amendments

- Bark – Conifer / Hardwood
- Green manures, cover crops
- Pulp mill waste
- Saw dust
- Chicken House waste
- Cotton-gin trash
- Composted organic matter

Biologicals / Amendments

Test on small areas over a period of a few years under normal conditions before adopting wide scale use.

SPECIMEN

Hydra-Hume® 0-0-1

GUARANTEED ANALYSIS:
Soluble Potash (K_2O)..1.00%

Derived from potassium hydroxide.

ALSO CONTAINS NON-PLANT FOOD INGREDIENTS:

ACTIVE INGREDIENTS: 12.00% ....Humic Acid (Derived from leonardite)
INERT INGREDIENTS: 87.00%...............INERT INGREDIENTS

KEEP OUT OF REACH OF CHILDREN

CAUTION

See Inside Panel for Additional Precautionary Statements.

SN 0505/0108-Ag WEIGHT PER GALLON: 8.8 lbs (3.99 kg)

NET CONTENTS:
- ☐ 5 gal (18.93 L) Net Wt: 44 lbs (19.96 kg)
- ☐ 250 gal (946.25 L) 2,200 lbs (997.92 kg)
- ☐ 275 gal (1,040.88 L) 2,420 lbs (1,097.71 kg)

Information about the components of this lot of fertilizer may be obtained by writing to Helena Chemical Company, 225 Schilling Boulevard, Suite 300, Collierville, TN 38017 and giving the lot number which is found on the container.

Information regarding the contents and levels of metals in this product is available on the Internet at http://www.aapfco.org/metals.htm .

F224
MANUFACTURED FOR
HELENA CHEMICAL COMPANY
225 SCHILLING BOULEVARD, SUITE 300
COLLIERVILLE, TN 38017

SPECIM

NutrAsyst™

FERTILIZER ADDITIVE

ACTIVE INGREDIENT(S):
5.00%...Fulvic Acid.
95.00%...Other Ingredients
100.00%...TOTAL

THIS PRODUCT IS NOT A PLANT FOOD OR SOIL AMENDMENT

KEEP OUT OF REACH OF CHILDREN

CAUTION

See Inside Panel for Additional Precautionary

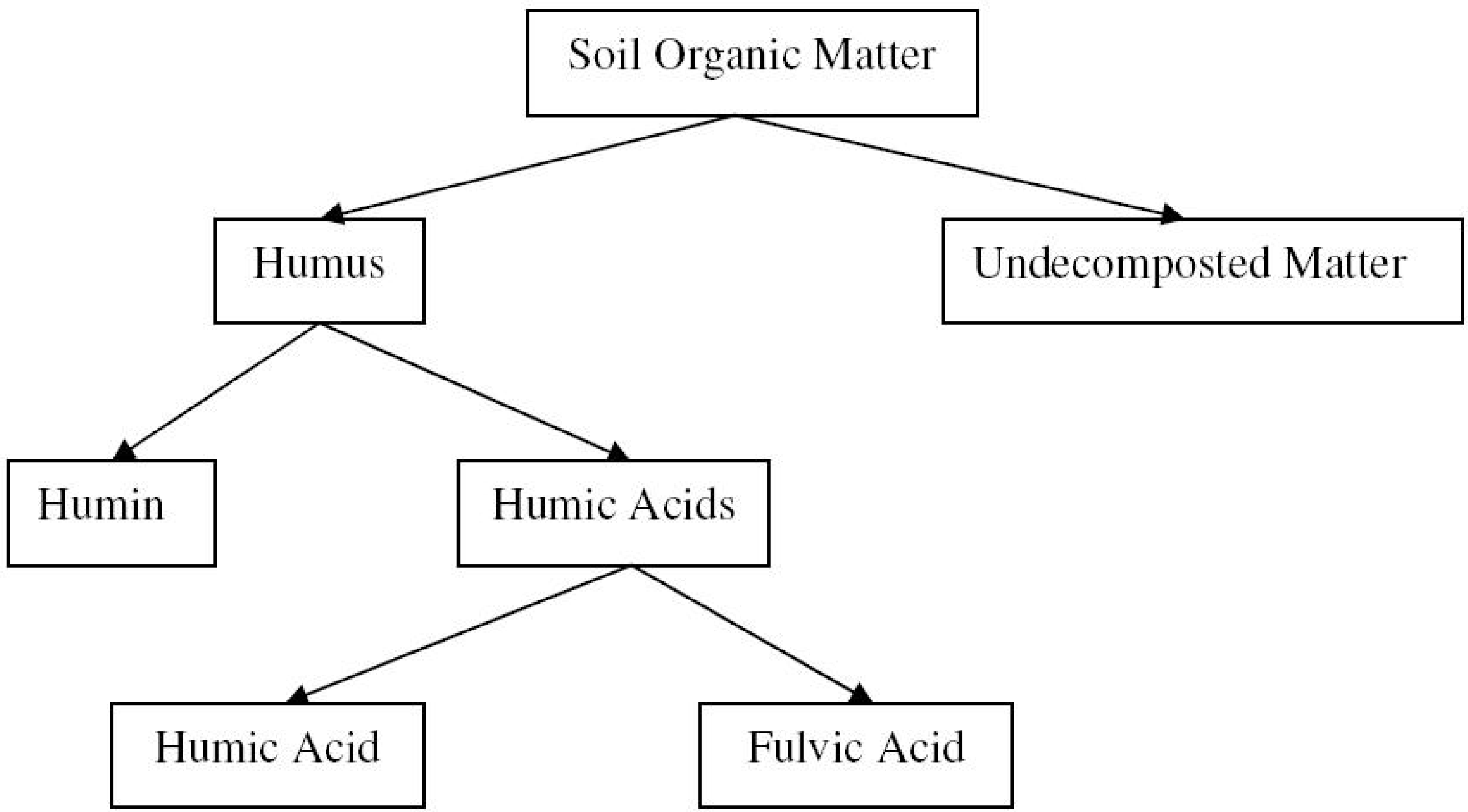
SN 090308
NET CONTENTS: 5 Gallons (18.93 Liters)
30 Gallons (113.55 Liters)
275 Gallons (1040.88 Liters)
Bulk gallon

WT. PER GALLON: 8.5 lbs. @ 68°F (3.95 kg PER LITER @20°C)

MANUFACTURED FOR
HELENA CHEMICAL COMPANY
225 SCHILLING BOULEVARD, SUITE 300
COLLIERVILLE, TN 38017

GENERAL INFORMATION

Where do Humic Acids Come From?



What are “Humic Acids”?

Humic Acids

- HA defies a precise definition. It is a black or very dark brown, high molecular weight water soluble at pH >2.

- The color has been used effectively as a sales or advertising attribute – conjuring up images of dark fertile soils.

Fulvic Acid

- FA light yellow to yellowish brown in color and are small molecular weight water soluble at all pH ranges

- More active in the plant than HA

What are "Humic Acids"?

Humic Acids

- Some studies have shown HA to increase the effectiveness of inorganic fertilizer by improving nutrient uptake and enhancing the physical, chemical and biological properties of the soil.

Fulvic Acid

- Used as a fertilizer additive, compatible with most fertilizers and pesticides. Commonly applied as foliar/soil application

What are "Humic Acids"?

Humic Acids

- Humic Acid is probably the most common carrier in the many "biologicals" that are being marketed today.
- Used as a carrier for many chelated iron solutions.
- It has very high cation exchange capacity (CEC) – 500 to 600 meq/100 g soil (sandy soil - 3 to 25 meq/100 g soil)
- Available in both liquid and granular form

Fulvic Acid

- Studies using marked FA have shown that FA is capable of entering the plant while HA remain outside.
- Available in liquid form.

Nursery Cooperative Studies

- 2008 – Greenhouse study comparing HA and 2 biologicals on growth of slash and loblolly pine
- 2009 – Study at 2 nurseries looking at 3 rates of granular HA. (Applied post sowing)
- 2009 – Greenhouse study comparing 2 "biologicals" with HA and FA.
- 2010 – Rate response of 3 levels of HA & FA

Conclusions and Observations

- Slash pine responded more to "Humic Acids" than loblolly pine.
- Slash pine responded more to fulvic acid than humic acid.
- Optimum rate for HA may be higher than study rates
- More potential for use in container nurseries which rely on water soluble liquid feed than bareroot nurseries
- HA and FA are safe for use in nurseries @ label rate
- When purchasing HA or FA stay with a reputable vendor. Industry standards (especially for HA) have not been developed.

Biologicals / Amendments

- In the competitive business such as forest-tree nurseries, the lack of a consistent response of a biologically based practice for the control of a target pest (insect, pathogen, weed) makes their wide-spread use limited.
- Does not mean there is no place for them in seedling production.
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- Nursery Cooperative continues to examine their competitive effectiveness.
- Welcome to try in your own organization. Use replications, collect data, compare seedlings produced, do a cost:benefit analysis.