

# Symbiotic Mycorrhizal Fungi: Quarterback of the Microbial Herd

by Steve Diver

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## Introduction to Mycorrhizal Fungi

Plant roots form a symbiotic link with beneficial fungi in an association known as mycorrhizae. There are two major types of mycorrhizae fungi that surround and penetrate plant roots: ectomycorrhizae and endomycorrhizae.

Dr. Robert Linderman, the USDA Research Leader for Mycorrhizae, once explained to me that mycorrhizae are like the quarterback of the microbial herd. Whereas bacteria and other microorganisms hang out in the rhizosphere, capturing root exudates as they float by, mycorrhizae actually form a symbiotic fungal link with the vascular system of the plant. The result is an elaborate communication system which results in a feedback loop between the plants and the mycorrhizae. The mycorrhizae calls out signals to the microbial herd, which in turn acquire nutrients or antibiotics to feed back to the plant, as needed.

### ***mycorrhiza***

The association, usually symbiotic, of fungi with the roots of seed plants.

### ***ectotrophic mycorrhiza***

A mycorrhizal association in which the fungal hyphae form a compact mantle on the surface of the roots. Mycelial strands extend inward between cortical cells and outward from the mantle to the surrounding soil.

### ***endotrophic mycorrhiza***

A mycorrhizal association in which the fungal hyphae are present on root surfaces as individual threads that may penetrate directly into root hairs, other epidermal cells, and occasionally into cortical cells. Individual threads extend from the root surface outward into the surrounding soil.

### **Canadian Soil Information System Glossary**

<http://sis.agr.gc.ca/cansis/glossary/mycorrhiza.html>

## Suppliers of Mycorrhizal Inoculant

### **AgBio Inc.**

9915 Raleigh St.  
Westminster, CO 80030  
303-469-9221  
303-469-9598 Fax  
877-268-2020  
agbio@agbio-inc.com  
<http://www.agbio-inc.com>

AgBio-Endos™

AgBio-Ectos™

### **Mycorrhizae Overview**

By J.C. Meneley, AgBio Inc.

[http://www.agbio-inc.com/myc\\_ovrvw.html](http://www.agbio-inc.com/myc_ovrvw.html)

Content: A brief, information leaflet published by the company

### **Albright Seed Co. / S & S Seeds**

5690 Casitas Pass Road  
Carpinteria, CA 93013-3061  
805-684-0436  
805-684-2798 Fax  
<http://www.albrightseed.com>

TurboStart™

### **Becker Underwood Biologicals**

801 Dayton Avenue  
Ames, Iowa 50010  
515-232-5907  
515-232-596 Fax  
request@bucolor.com  
[http://www.bucolor.com/products\\_info/rhizanova-Tu.shtml](http://www.bucolor.com/products_info/rhizanova-Tu.shtml)

Rhizanova™ Mycorrhizae Products

### **Bio-Oregon**

P.O. Box 429  
Warrenton, OR 97146

800-962-2001

503-861-3701 Fax

<http://www.bio-oregon.com/flash/biovita532.htm>

BioVita™ Biological Soil Amendment

**Bio-Organics**

53606 Bridge Drive

La Pine, Oregon 97739

888-332-7676

541-536-1583 Tel/Fax

info@bio-organics.com

<http://www.bio-organics.com>

Bio-Organics™ Endomycorrhizal Inoculant (BEI)

Bio-Organics™ Mycorrhizal Landscape Inoculant (LA)

Bio-Organics™ Mycorrhizal Root Dip Inoculant (RD)

**First Fruits, LLC**

RD 1, box 156

Triadelphia, WV 26059

888-489-0162

sales@vamfungi.com

<http://vamfungi.com>

EarthRoots™

**Fungi Perfecti**

P.O. Box 7634

Olympia, WA 98507

360-426-9292

360-426-9377 Fax

800-780-9126

mycomedia@aol.com

<http://www.fungi.com/mycogrow/>

MycoGrow™

Plant Success™ Tabs

**Mycorrhizal Management: A Look Beneath the Surface at Plant Establishment and Growth**

By Michael P. Amaranthus. This article originally appeared in The

Spring 1999 issue of *Florida Landscape Architecture Quarterly*.

<http://www.fungi.com/mycogrow/amaranthus.html>

Content: Article reprint; the author worked for Oregon State University and USDA Forest Service.

### **Gro-Power**

15065 Telephone Avenue  
Chino, California 91710-9614  
909-393-3744  
909-393-2773 Fax  
gropower@gte.net  
<http://www.grolife.com>

Note: GroLife™ is joint venture of Gro-Power and Tree of Life Nursery. Mycorrhiza.com appears to be their educational web page.

GroLife™

### **Tree of Life Nursery**

<http://treeoflifenuresery.com>

### **Mycorrhiza.com**

<http://www.mycorrhiza.com>

### **Hoodridge International**

6699 NW 66 Way  
Parkland, FL 33067  
954 340-3300  
800 745-6963  
954 340-3299 fax  
info@hoodridge.com  
<http://www.hoodridge.com/mycoroot.htm>

MycoRoot™

### **Horticultural Alliance, Inc.**

P.O. Box 5744  
Sarasota, FL 34277  
800-628-6373  
941-917-0670  
941-917-0671 Fax  
Contact: Jim Quinn  
jamesq@bigfoot.com

[http://www.hortsorb.com/DIEHARD\\_Mycorrhizal\\_Inoculants.htm](http://www.hortsorb.com/DIEHARD_Mycorrhizal_Inoculants.htm)

## DIEHARD™ Mycorrhizal Inoculants

### **ROOTS, Inc.**

3120 Weatherford Road  
Independence, MO 64055  
800-342-6173  
sales@rootsinc.com  
<http://www.rootsinc.com>

mycorrhizaROOTS™  
endoROOTS™  
M-ROOTS™

### **Mikko-Tek Labs**

P.O. Box 2120  
Timmons, Ontario  
Canada P4N 7X8  
705-268-3536  
Contact: Mark Kean  
mikrotek@onlink.net  
[Note: This is an old listing; still in business?]

### **Plant Health Care**

440 William Pitt Way  
Pittsburg, PA 15238  
800-421-9051  
info@planthealthcare.com  
<http://www.planthealthcare.com>  
<http://www.planthealthcare.com/fungi.html>

Mycor™  
Mycor™ Plant Saver™  
Mycor™ Tree Saver™  
Mycor™ Flower Saver™  
MycorTree™ Root Dip  
MycorTree™ Ecto Spore Spray  
PHC™ Colonize™ VAM Stimulant

### **Mycorrhizal Fungi: Endo or Ecto Species Finder**

<http://www.planthealthcare.com/endo.html>

Content: A handy table comparing the two types of mycorrhizal fungi

**PlantHealthCare.com online magazine**

<http://www.planthealthcare.com/magazine.html>

Content: Award-winning online magazine, about 32 pages each. See articles on mycorrhiza, rhizosphere, root health, rhizobacteria, biological control, organic amendments, etc.

**PHC TV: Educational Videos**

<http://www.planthealthcare.com/phctv.html>

Content: Award-winning video clips for Flash or RealPlayer. See *The Fungus Among Us* (7 minutes) and *Beneficial Bacteria* (7.5 minutes)

**Premier Enterprises Ltd**

326 Main Street  
Red Hill, PA 18076  
800-424-2554  
215-679-4119 Fax  
MycorRise™

[Note: This is an old listing; still in business?]

**Premier Tech Biotechnologies**

<http://www.premiertech.com/unites/ptb/products.htm>

MYKE™

MYKE™ Pro

**Poulenger USA, Inc.**

3705 Century Blvd. #3  
Lakeland, FL 33811  
866-709-8102  
863-709-8102  
863-644-4038 Fax  
info@poulengerusa.com

[http://www.poulengerusa.com/rutopiam/rutopiaM\\_by\\_poulenger\\_usa\\_inc.htm](http://www.poulengerusa.com/rutopiam/rutopiaM_by_poulenger_usa_inc.htm)

RUTOPIA+M™

**Reforestation Technologies International**

341 Dayton Street, Unit G  
Salinas, CA 93901  
800-784-4769

831-424-1495 Fax

RTI@reforest.com

<http://www.reforest.com>

Silva Dip™

AM120™

MycoPaks™

**List of Economically Important Plants Responding to Endo- and Ecto-Mycorrhizae**

<http://www.reforest.com/species.html>

**The Tree Doctor**

617 Deery Street

Knoxville TN 37917

865-633-5400

865-633-6624 Fax

treeguru@treedoc.com

<http://www.treedoc.com>

DieHard™ Injectable

DieHard™ Root Reviver

**Tree Pro**

3180 W. 250 North

West Lafayette, IN 47906

800-875-8071

765-463-3157 Fax

sales@treepro.com

<http://www.treepro.com>

MycorTree™

**VAMTech, Inc.**

3186 Pine Tree

Road, Unit D

Lansing, MI 48911

517-272-7359

<http://www.vamtech.com>

Mycoform® and Myconate® mycorrhizal stimulants

## Web Resources on Mycorrhizae Fungi & Related Topics on the Rhizosphere & Soil Biology

### Educational: Leaflets, Articles, Reviews

#### **Managing Soilborne Diseases by Managing Root Microbial Communities**

Dr. Robert G. Linderman, SARE 2000 Conference Proceedings

<http://wsare.usu.edu/sare2000/060.htm>

When mycorrhizae form, great changes take place in the physiology of the roots and the whole plant, and in the soil surrounding the roots, now appropriately called the "mycorrhizosphere." In this paradigm, the mycorrhizal fungus is the quarterback, and the other associated microbes are the rest of the team. Due to specific changes in the microbial community resulting from altered root exudation plus the specific chemicals exuded by the fungal hyphae that have grown out into the soil, the "team" is ready to compete with pathogens, increase the availability of nutrients derived from organic substrates, help the plant acquire water and nutrients from well beyond the range of the roots themselves, and increase plant tolerance to other environmental stresses, such as toxicity from soil salinity.

#### **Glomalin: A Manageable Soil Glue**

Sara Wright, USDA-ARS-Soil Microbial Systems Lab

<http://www.barc.usda.gov/anri/sasl/glomalin/brochure.pdf>

Content: 5-page PDF download; Educational leaflet from USDA

A strong glue, glomalin, is produced by a beneficial fungus that grows on plant roots. The glue comes off of the fungus and is deposited on soil particles. This process leads to build up and stabilization of aggregates.

Soil aggregation is a complex process that is largely dependent upon microorganisms to provide glues that hold soil particles together. These glues are carbon-containing compounds that protect microorganisms from drying out. We are beginning to understand the importance of one group of soil fungi and the glue that is produced in large amounts by these fungi. The fungi are the arbuscular mycorrhizal fungi (AMF) and the glue was named glomalin after Glomales — the taxonomic order of this group of fungi.

#### **Glomalin—Soil's Superglue**



*Agriculture Research*, October 1997 | USDA -ARS

<http://www.ars.usda.gov/is/AR/archive/oct97/glomalin1097.htm>

Glomalin, a fungal protein derived from mycorrhizal fungi in the genus *Glomalin*, is the glue that binds soil together. "It coats soil particles and may be what holds them together in the stable structures we call aggregates."

### **A Practical Guide to Mycorrhiza**

<http://www.mycorrhiza.org>

Content: Articles, papers, and mycorrhizal restoration projects; largely from Ted St. John, Ph.D., the mycorrhizae researcher associated with Tree of Life Nursery for many years.

### **The Kinds of Mycorrhiza**

<http://www.mycorrhiza.org/types.htm>

### **The Importance of Mycorrhizal Fungi and Other Beneficial Microorganisms in Biodiversity Projects**

Ted St. John

[http://www.fcnanet.org/proceedings.html?article\\_id=162](http://www.fcnanet.org/proceedings.html?article_id=162)

<http://www.fcnanet.org/proceedings/1992/stjohn.pdf>

Content: Ted St. John paper presented at Western Forest Nursery Associations, 1992.

### **Importance of Mycorrhizae for Agricultural Crops**

Florida Cooperative Extension, June 2001

[http://edis.ifas.ufl.edu/BODY\\_AG116](http://edis.ifas.ufl.edu/BODY_AG116)

### **Soil Fungi Critical to Organic Success**

By Don Comis, May 2001, *USDA Agricultural Research* magazine.

<http://www.ars.usda.gov/is/AR/archive/may01/fungi0501.htm>

### **What All Growers Should Know About Mycorrhizal Fungi**

By Don Chapman. Article reprint, from *Rare Fruit Grower*.

<http://www.treemail.nl/eurobio/inform/mycart.htm>

### **Mycorrhizal Management: A Look Beneath the Surface at Plant Establishment and Growth**

By Michael P. Amaranthus. This article originally appeared in The Spring 1999 issue of *Florida Landscape Architecture Quarterly*.

<http://www.fungi.com/mycogrow/amaranthus.html>

### **Overview of Mycorrhizal Symbioses**

David M. Sylvia, University of Florida Page

<http://dmsylvia.ifas.ufl.edu/mycorrhiza.htm>

Note: Chapter from *Principles and Applications of Soil Microbiology*

Note: Also see PowerPoint slide show on Mycorrhizae on this page (requires IE browser)

### **Tips for the Municipal Arborist: Root Physiology**

Edited by Leonard E. Phillips, Jr.; From *City Trees*, The Journal of The Society of Municipal Arborists; Vol 35, Number 4, July/August 1999

<http://www.urban-forestry.com/citytrees/v35n4a06.asp>

<http://www.urban-forestry.com/citytrees/v35n4a06.html>

Content: A practical review published by the Society of Municipal Arborists: how roots grow, morphology of plant roots, root microorganisms, mycorrhizae, tips on soil preparation.

### **A Practical Look at Mycorrhizal Fungi in Nurseries -- Part I**

Forest Nursery Notes, April 1993

<http://www.na.fs.fed.us/spfo/rngr/fnn/apr-93/eco493.htm>

Content: Informative article in forest nursery newsletter, Part 1.

### **A Practical Look at Mycorrhizal Fungi in Nurseries -- Part II**

Forest Nursery Notes, July 1993

<http://www.na.fs.fed.us/spfo/rngr/fnn/jul-93/eco793.htm>

Content: Informative article in forest nursery newsletter, Part 2.

### **The Container Tree Nursery Manual | Volume 5 - The Biological Component: Nursery Pests and Mycorrhizae**

USDA Agriculture Handbook No. 674-5.

HTML Gateway:

[http://www.rngr.fs.fed.us/nurseries/ctnm\\_vol\\_5.html](http://www.rngr.fs.fed.us/nurseries/ctnm_vol_5.html)

PDF:

[http://www.rngr.fs.fed.us/nurseries/ctnm/vol\\_5\\_chapter\\_2.pdf](http://www.rngr.fs.fed.us/nurseries/ctnm/vol_5_chapter_2.pdf)

Content: A 71-page PDF download; informative summary with lots of color photos.

### **Arbuscular Mycorrhizal Inoculation in Nursery Practice**

Ted St. John, 1996: Forest and Conservation Nursery Associations, Salem, OR. [http://](http://www.fcnanet.org/proceedings.html?article_id=103)

[www.fcnanet.org/proceedings.html?article\\_id=103](http://www.fcnanet.org/proceedings.html?article_id=103)

<http://www.fcnanet.org/proceedings/1996/stjohn.pdf>

Content: A 9-page PDF paper presented at forest nursery conference.

### **How to Recognize and Quantify Ectomycorrhizae on Conifers**

USDA Forest Service, Southeastern Area, 1979.

<http://www.forestry.auburn.edu/sfnmc/class/ecto.html>

Content: Online reprint of Forest Service bulletin.

### **Mycorrhiza Agriculture Technologies**

Chapter 10. p. 185-203. In: *Innovative Biological Technologies for Lesser Developed Countries* (July 1985), Office of Technology Transfer

[http://www.wws.princeton.edu/~ota/disk2/1985/8512\\_n.html](http://www.wws.princeton.edu/~ota/disk2/1985/8512_n.html)

### **Information on Adding Mycorrhiza to the Planting Hole**

By David South, Auburn University

<http://www.forestry.auburn.edu/sfnmc/hole.html>

Content: A skeptical view on adding mycorrhize to the planting *hole* in the field at the time of transplanting

### **Tree Roots and Their Microbial Partners**

By Donald H. Marx and Rob McCartney; Article published in April 1997 issue of *Arbor Age*.

<http://www.greenindustry.com/aa/1997/0497/497treeroots.html>

### **Unlock Sustainability: Mycorrhizal Fungi are the Keys to Long-term Health**

By Felicia Gillham; Article published in August 2001 issue of *Arbor Age*.

<http://www.greenindustry.com/aa/2001/0801/>

<http://www.greenindustry.com/aa/2001/0801/0801us.asp>

### **Managing Soils For Sustainability**

by Felicia Gillham; Article published in June 2000 issue of *Arbor Age*.

<http://www.greenindustry.com/aa/2000/0600/>

<http://www.greenindustry.com/aa/2000/0600/0600soil.asp>

### **Mycorrhizae on the Horizon**

By Colleen Heraty; Article published in August 1999 issue of *Arbor Age*.

<http://www.greenindustry.com/aa/1999/0899/>

<http://www.greenindustry.com/aa/1999/0899/899myc.asp>

### **INVAM -- International Culture Collection of Arbuscular & Vesicular-Arbuscular Mycorrhizal Fungi**

<http://invam.caf.wvu.edu/invam.htm>

**Mycorrhizae.** pp. 324-327. In: McGraw-Hill *1997 Yearbook of Science and Technology*, McGraw-Hill Co., NY. By Joe Morton, INVAM.

<http://invam.caf.wvu.edu/Abstracts/mcgraw.htm>

Content: Educational summary and diagram on mycorrhizae; encyclopedia entry.

### **Evolution of Fungi in Glomales**

by Joseph B. Morton; reprint from *Evolution of Endophytism in Plants*.

[http://invam.caf.wvu.edu/Myc\\_Info/Taxonomy/Evolution/Evolution.htm](http://invam.caf.wvu.edu/Myc_Info/Taxonomy/Evolution/Evolution.htm)

Content: Academic chapter with interesting notes and pictures.

### **Mycorrhiza Information Exchange**

<http://mycorrhiza.ag.utk.edu>

#### **What is a Mycorrhiza?**

<http://mycorrhiza.ag.utk.edu/what.htm>

Content: Collection of introductory articles & leaflets

#### **Mycorrhizal IMAGE Exchange**

<http://mycorrhiza.ag.utk.edu/mimag.htm>

### **Mycorrhizae--Essential Partners in Plant Health**

By Craig Elevitch and Kim Wilkinson, *The Overstory* No. 8

<http://www.agroforester.com/overstory/overstory8.html>

Content: Special issue on mycorrhizae in agroforestry newsletter, *The Overstory*.

### **Troubles in the Rhizosphere**

By Dr. Alex Shigo

<http://www.chesco.com/~treeman/SHIGO/RHIZO.html>

Content: Article reprint on mycorrhizae with color photos; from Volume VII, Number 10. (October 1996) of *Tree Care Industry*.

### **Mycorrhizas**

Lecture notes from Dr Louis Chinnery; Mycorrhiza Research Group,  
The University of The West Indies

<http://users.sunbeach.net/users/lec/types.html>

## **Mycorrhizal Images and Photo Galleries**

### **Mycorrhizal Fungi Image Gallery, Part I**

The Bruns Lab, UC-Berkeley

<http://plantbio.berkeley.edu/~bruns/fungi2.html>

### **Mycorrhizal Fungi Image Gallery, Part II**

The Bruns Lab, UC-Berkeley

<http://plantbio.berkeley.edu/~bruns/fungi3.html>

### **Mycorrhizal Photos**

College of Forestry, Oregon State University

<http://www.cof.orst.edu/cof/teach/for442/cnotes/sec3/myco.htm>

### **Endomycorrhizae (VAM)**

College of Forestry, Oregon State University

<http://www.cof.orst.edu/cof/teach/for442/cnotes/sec8/endo.htm>

### **Ectomycorrhizae**

College of Forestry, Oregon State University

<http://www.cof.orst.edu/cof/teach/for442/cnotes/sec8/ecto.htm>

### **Mycorrhizal IMAGE Exchange**

<http://mycorrhiza.ag.utk.edu/mimag.htm>

## Literature: Databases, Bibliographies, Publications

### **Mycorrhizal Reference Database**

David Sylvia, University of Florida

<http://dmsylvia.ifas.ufl.edu/references.htm>

Note: More than 8000 literature references on mycorrhiza and related topics, since 1980.

### **MYCOLIT - Mycorrhiza Literature Database**

Forest Mycology and Mycorrhiza Research Team, USDA Forest Service

Forestry Sciences Laboratory, Corvallis, OR

<http://mgd.nacse.org/cgi-bin/qml2.0/fslmyco/mycolit.qml>

### **Mycorrhiza Information Exchange**

<http://mycorrhiza.ag.utk.edu>

### **Search Mycorrhizal Information Exchange**

<http://mycorrhiza.ag.utk.edu/mycor.htm>

### **Search Mycorrhiza at University of Tennessee Host Site**

<http://search.tennessee.edu/query.html>

### **Literature Search for Mycorrhizal Articles**

<http://mycorrhiza.ag.utk.edu/mlate.htm>

## **Mycorrhizal Reviews in the Literature**

Citations & Abstracts

<http://mycorrhiza.ag.utk.edu/mrevi.htm>

## **Mycologue Publications**

Mycological Books, CD-ROMs, & Databases

<http://www.mycolog.com/index.html>

## **MYCOLIT Version 2: The Most Comprehensive Mycorrhiza Database**

14,000 References | US\$250

<http://www.mycolog.com/mycodata.html>

## **The Fifth Kingdom on-line by Bryce Kendrick**

20 chapters, 800 pictures and animations

<http://www.mycolog.com/fifthtoc.html>

## **Chapter 14 | Fungi as agents of Biological Control | (23 pictures)**

<http://www.mycolog.com/chapter14.htm>

## **Chapter 17 | Mycorrhizae - mutualistic plant-fungus symbioses | (35 pictures)**

<http://www.mycolog.com/chapter17.htm>

## **Mycorrhizae: Impacts on Production**

Quick Bibliography from National Agricultural Library, QB 95-11.

January 1989 - January 1995. 300 Citations from the AGRICOLA Database. [http://www.nal.usda.gov/afsic/AFSIC\\_pubs/qb95-11.htm](http://www.nal.usda.gov/afsic/AFSIC_pubs/qb95-11.htm)

## **Mycorrhiza journal**

<http://link.springer.de/link/service/journals/00572/index.htm>

## **Mycorrhizae Mailing List**

To join, send the message subscribe micronet Your Name (e.g. subscribe micronet John Doe) to [listserv@uoguelph.ca](mailto:listserv@uoguelph.ca)

<http://www. Isoft.com/scripts/wl.exe?SL1=MICRONET&H=LISTSERV.UOGUELPH.CA>

Content: Mainly an academic discussion list with occasional resource postings and practical discussions.

# Soil Biology: Soil Biota & The Rhizosphere, Mycorrhizal Botany

## **Rhizosphere Diversity in Forest Ecosystems**

Northern Forest Research & Extension Partnership (NFREP), BC

[http://www.nfrep.org/features\\_june.html](http://www.nfrep.org/features_june.html)

Content: Educational poster, 4 sheets in html.

## **Soil Biota and Biodiversity: The "Root" of Sustainable Agriculture**

Land and Water Development Division, FAO

HTML Source:

<http://www.fao.org/landandwater/agll/soilbiod/>

PDF:

<http://www.fao.org/landandwater/agll/soilbiod/docs/SB-brochure-sept.pdf>

Content: Educational leaflet; a 4-page PDF download.

## **Life Underground**

By Kate Goff; article reprint from Erosion Control.

[http://www.forester.net/ec\\_9909\\_underground.html](http://www.forester.net/ec_9909_underground.html)

## **Sustainable Soil Management: Web Links to Make Your Worms Happy!**

Steve Diver, ATTRA

<http://ncatark.uark.edu/~steved/soil-links.html>

Content: Web resource list from ATTRA.

## **Soil Biology Information Resources For Land Managers, Resource Professionals, and Educators**

<http://www.statlab.iastate.edu/survey/SQI/SBinfo.htm>

Content: Web resource list from NRCS.

## **Possible Mechanisms of Reduction of Infection by Root Pathogens by Mycorrhizae**

College of Forestry, Oregon State University

<http://www.cof.orst.edu/cof/teach/for442/cnotes/sec8/more3.htm>

- Production of Antibiotics by Fungal Symbionts
- Mechanical Barrier Created by Fungal Mantle
- Chemical Inhibitors produced by Higher Plant
- Chemical Exudation of Mycorrhizae
- Protective Microbial Rhizosphere Populations

## **Controlling Root Pathogens with Mycorrhizal Fungi and Bacteria**

Robert G. Linderman and Marielle Hoefnagels

[http://www.fcnanet.org/proceedings.html?article\\_id=168](http://www.fcnanet.org/proceedings.html?article_id=168)

<http://www.fcnanet.org/proceedings/1992/linderman.pdf>

Content: Robert Linderman paper presented at Western Forest Nursery Associations, 1992.

### **Arbuscular Mycorrhizae**

Y.Dalpé, DSc., Eastern Cereal and Oilseed Research Centre, Canada

<http://res2.agr.ca/ecorc/fr/mycorhiz/index.htm>

Content: A researcher's page on mycorrhizae, yet quite informative as an introduction to these symbiotic fungi with links to description, organisms, morphology, function, and benefits to agriculture, with color images.

### **Biodiversity of Mycorrhizal Fungi**

Y.Dalpé, DSc., Eastern Cereal and Oilseed Research Centre, Canada

[http://res2.agr.ca/ecorc/fr/mycorhiz/bio\\_sols.htm](http://res2.agr.ca/ecorc/fr/mycorhiz/bio_sols.htm)

### **The Microbial World: Mycorrhizas**

University of Edinburgh

<http://helios.bto.ed.ac.uk/bto/microbes/mycorrh.htm>

#### **Supplementary Note and Images: Ectomycorrhizas**

The Microbial World, University of Edinburgh

<http://helios.bto.ed.ac.uk/bto/microbes/ectoimag.htm#Supplementary>  
[information: Ectomycorrhizas](#)

### **Mycorrhizae in Aquatic Plants**

Laura Marx's Senior Exercise, Kenyon College, 1999

<http://www.msu.edu/~marxlau1/contents.htm>

## ICOM Links - International Conferences on Mycorrhiza

### **ICOM 1 | 1st International Conference on Mycorrhiza**

University of California, Berkeley, California in 1996

<http://plantbio.berkeley.edu/~bruns/icom.html>

#### **Abstracts Listed by Author | ICOM 1, Berkeley 1996**

<http://plantbio.berkeley.edu/~bruns/icom/abstracts.html>

### **Effects of organic substances or extracts on VA mycorrhizae**



LINDERMAN, R. G. & E. A. DAVIS

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Organic soil amendments, especially humic-rich substances, often stimulate plant growth, possibly due to stimulation of VAM fungi.

Solid or water extracts of humic amendments greatly stimulated growth compared to the unamended controls. Addition of VAM fungi in combination with humic extracts caused further growth enhancement but without increasing the level of VAM colonization.

These studies suggest that VAM fungi can be influenced significantly by organic components of soil or growth media, but the response is both substance and fungus specific.

### **Contribution of microbial associates of VA mycorrhizae to mycorrhiza effects on plant growth and health**

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A number of soil microorganisms can affect the growth and health of plants. Some of them have been shown to positively interact with VA mycorrhizae (VAM) when dual inoculation of plants is made. These findings suggest that growth enhancement of plants by VAM fungi could be the result of combined effects of the VAM and some of the microbial associates.

We investigated this hypothesis by isolating antagonistic bacteria (shown in other studies to inhibit several fungal root pathogens and stimulate seedling plant growth) from the mycorrhizosphere soil of onions.

Root rot disease was suppressed by the slurry from pot cultures inoculated with VAM alone and bacterial antagonists alone, but most from that inoculated with GI + bacterial antagonists. These results support the hypothesis that microbial associates of VAM function in tandem to enhance the growth and health of plants.

### **ICOM Abstract Booklet**

<http://plantbio.berkeley.edu/~bruns/ftp/ICOM-abstracts.DOC.hqx>

Note: A large file (1.6 megabytes - 137 pages) ; available only in a Microsoft Word v5.1 file for the Macintosh.

## **ICOM 2 | 1st International Conference on Mycorrhiza**

Swedish Agricultural University (SLU), Uppsala, Sweden in 1998

<http://www-icom2.slu.se>

**Abstracts Listed by Author | ICOM 21, Uppsala 1998**

<http://www-icom2.slu.se/ABSTRACTS/abstract.html>

**Bacterial associations with the mycorrhizosphere and hyphosphere of the arbuscular mycorrhizal fungus *Glomus mosseae***

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<http://www-icom2.slu.se/ABSTRACTS/Andrade.html>

Roots and mycorrhizal fungi may not associate with soil bacteria randomly, but rather in a hierarchical structure of mutual preferences. Elucidation of such structures would facilitate the management of the soil biota to enhance the stability of the plant-soil system.

The results indicate that the hyphosphere-specific *A. eutrophus* depended on the presence of *G. mosseae* as its AM-fungal host, but that the nonspecific *A. globiformis* did not. The mycorrhizal status of soils may selectively influence persistence of bacterial inoculants as well as affecting the numbers of other native bacteria.

**Comparison of the potential functional activities of bacteria in mycorrhizosphere vs rhizosphere soils**

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<http://www-icom2.slu.se/ABSTRACTS/Linderman.html>

These results indicate that VAM induce microbial changes in the mycorrhizosphere soil that could significantly affect disease suppression and nutrient availability and cycling compared to rhizosphere soil from non-VAM plants, and therefore contribute to the positive VAM effects.

**Interaction between the AM fungus *Glomus intraradices* and different rhizosphere microorganisms**

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<http://www-icom2.slu.se/ABSTRACTS/Filion.html>

AM fungi can reduce plant diseases caused by soilborne pathogens through mechanisms that are not well characterized. We used an in vitro experimental system to test the hypothesis that mycelium of AMF can interfere directly with soil microorganisms.

The results suggest that direct interactions exist between AMF and soil microorganisms which may lead to microbial equilibrium changes detrimental for pathogens.

### **ICOM 2 Abstract: Titles & Authors & Key Words**

<http://www-icom2.slu.se/ABSTRACTS/ab-ti-au-ke.html>

Note: Large file arranged alphabetically by filename

Use Ctrl+F (Find in Page) on your browser to search for keywords

### **ICOM 3 | Third International Conference on Mycorrhizas**

Held at Adelaide University, Adelaide Australia, July 2001

[http://www.waite.adelaide.edu.au/Soil\\_Water/3icom.html](http://www.waite.adelaide.edu.au/Soil_Water/3icom.html)

#### **Abstracts: ICOM 3, Adelaide 2001**

[http://www.waite.adelaide.edu.au/Soil\\_Water/3ICOM\\_ABSTs/Abstracts/abstract.html](http://www.waite.adelaide.edu.au/Soil_Water/3ICOM_ABSTs/Abstracts/abstract.html)

#### **Comparison of antagonistic potential of rhizobacteria from mycorrhizosphere and rhizosphere soils against soilborne fungal pathogens**

R.G.Linderman, J.L.Marlow and E.A.Davis

USDA-ARS Horticultural Crops Research Laboratory, Corvallis, Oregon [http://www.waite.adelaide.edu.au/Soil\\_Water/3ICOM\\_ABSTs/Abstracts/L/R.G.Linderman.html](http://www.waite.adelaide.edu.au/Soil_Water/3ICOM_ABSTs/Abstracts/L/R.G.Linderman.html)

Specific functional groups of rhizobacteria in rhizosphere soil can influence plant growth and health, and formation of mycorrhizae can alter their populations in the mycorrhizosphere.

These results indicate that mycorrhizae stimulate antagonistic rhizobacterial populations that could suppress fungal pathogens and thereby the diseases they cause.

### **Further Reading: Articles, Books, Chapters, Literature Reviews**

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## **Mycorrhizal Books**

Mycorrhiza Information Exchange

<http://mycorrhiza.ag.utk.edu/mbook.htm>

Content: Many with Table of Contents, citations only; An extensive list of academic books on mycorrhizae.

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