Mycorrhizal fungi in urban plantings
Improving plant tolerance to water stress
Canadian Urban Forest Conference, Kelowna, October 20, 2004

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International Mosaiculture
Montréal, 2003

“Myths and Legends of the World”

Giants of Easter Island
Entry from Chile
4th International Conference on Mycorrhizae
Montréal, Québec
August 10 – 15, 2003
Mycorrhizae and water stress

Pepper plants (*Capsicum a.*) under different water regimes

Adapted from F.T. Davies, Texas A&M University, ICOM 2003
Mycorrhizae and water stress

Chile pepper plants (*Capsicum annuum*) exposed to drought cycles

Plant on the right was inoculated with a desert mycorrhizal fungi

Photo by F.T. Davies, Texas A&M University, 2002
Mycorrhizae and water stress
Midday transpiration of container-grown *Rosa hybrida*
Adapted from F.T. Davies, Tree Physiology, 1996

![Bar chart showing the effect of mycorrhizae on transpiration in Adequate water and 4-day drought conditions.](chart.png)

- **Adequate water**
  - No mycorrhizae: Transpiration mmol/m/s
  - With mycorrhizae: Transpiration mmol/m/s

- **4-day drought**
  - No mycorrhizae: Transpiration mmol/m/s
  - With mycorrhizae: Transpiration mmol/m/s
Mycorrhizae and drought avoidance

From F.T. Davies, A&M University, ICOM 2003

- Direct water transport
  - Fungi may supply 10% of plant water need
  - Hyphal threads forage more soil surface

- Better host nutrition
  - Higher phosphorus and nitrogen in leaves
  - Current research: does P improve drought resistance?

- Plant - osmotic adjustments
  - Helps maintain leaf turgidity and photosynthesis rate
  - Current research: changes in soil – water relations
Plants that are colonized by mycorrhizal fungi have a higher tolerance to environmental stresses caused by drought, replant, cold, low fertility, saline soil, or pressure from root rot pathogens.
Mycelial network of ectomycorrhiza *Suillus b.* in association with *Pinus sylvestris*

Photo from J.R. Leake, University of Sheffield, UK 2001
Mycorrhizal Associations
D.H. Marx, Plant Health Care Inc., 1997

- **No mycorrhizae**
  Early-succession plants
  Lamb’s quarter, buckwheat, broccoli, spinach, beet

- **Endo-mycorrhizae**
  VAM, Ericaceous (rhododendron), Orchidaceous
  Very common, occurs on 85% of green plants
  Turf grass, vegetables, most shrubs, most trees

- **Ecto-mycorrhizae**
  On about 10% of plants, mostly late succession plants
  Fir, spruce, pine, birch, beech, oak, linden, willow
Mycorrhizal Root Colonization
Liners potted July 2001, roots cut September 2002 (n=8)
Laboratory analysis at Premier Tech, Quebec

% root colonization

Cornus Ivory Halo

- Nursery mix
- Add Premier Mycorise
Mycorrhizal Root Colonization
Liners potted August 2002, roots cut October 2003
Laboratory analysis at Mycorrhizal Applications, Oregon

![Graph showing % root colonization for Juniper 'Bar Harbor' and Juniper 'Moordense'.]

- Nursery mix
- Add Premier Mycorise
Laboratory plant-drying oven with bagged samples
Mycorrhizae on top growth
Liners in 1-gallon pots July 2001, cut September 2002 (n=20)
Measure of top dry weight after 24 hours at 105°C

- Spiraea Froebeli
- Cornus Ivory Halo
Mycorrhizae on potting survival
Bare-root trees potted in April. Rating of «live» trees in July
Commercial mycorrhizal fungi applied during potting

![Bar chart showing the percentage of trees with shoot growth for different species and treatments.](chart.png)
Mycorrhizae on root weight

Juniperus 'Blue Star' cuttings planted 23 September.
Measure of root dry weight at 20 weeks after potting. (n=63)
Our soil is alive... with microorganisms that maximize the disease resistance and fertility of your garden's ecosystem. Our custom soil blends are inoculated with life-enhancing mycorrhizae, a natural fungi that strengthens root growth, improves nutrient absorption, and ensures better tolerance to transplant shock.

Unlike most commercial soils, ours contains compost to help increase water retention and release precious nitrogen, naturally.

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Mycorrhizae and soil compaction

Seedlings of *Acer nigrum* planted in soil manually compacted

Adapted from J.N. Klironomos, Guelph University, 2002

![Bar chart showing the number of live trees in different treatments over two years.](chart.png)
# Mycorrhizae on street trees

Root samples of *Carpinus* and *Acer p.*, City of Penticton
Laboratory analysis at Soil FoodWeb Inc., Oregon

<table>
<thead>
<tr>
<th>Location</th>
<th>Planted</th>
<th>Inoculation?</th>
<th>Sample</th>
<th>Colonisation</th>
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<tbody>
<tr>
<td>101 Eckhardt</td>
<td>1991</td>
<td>Yes</td>
<td>Oct 2003</td>
<td>20 %</td>
</tr>
<tr>
<td>103 Eckhardt</td>
<td>1991</td>
<td>No</td>
<td>Oct 2003</td>
<td>0 %</td>
</tr>
<tr>
<td>205 Martin</td>
<td>Oct 2001</td>
<td>Yes</td>
<td>Oct 2003</td>
<td>0 %</td>
</tr>
<tr>
<td>247 Martin</td>
<td>Oct 2001</td>
<td>No</td>
<td>Oct 2003</td>
<td>0 %</td>
</tr>
<tr>
<td>Gallery SE</td>
<td>Apr 2003</td>
<td>Yes</td>
<td>Oct 2003</td>
<td>0 %</td>
</tr>
<tr>
<td>Gallery NE</td>
<td>Apr 2003</td>
<td>No</td>
<td>Oct 2003</td>
<td>0 %</td>
</tr>
<tr>
<td>350 Ellis</td>
<td>Apr 2004</td>
<td>Yes</td>
<td>Sep 2004</td>
<td>4 %</td>
</tr>
<tr>
<td>346 Ellis</td>
<td>Apr 2004</td>
<td>No</td>
<td>Sep 2004</td>
<td>1 %</td>
</tr>
</tbody>
</table>
Vandalism

Broken stems on newly-planted street trees
Mycorrhizae and water stress

Study of *Glomus* species on lettuce subjected to water stress

Adapted from Ruiz-Lozano et al, *App & Env Microbiology*, 1995
Commercial bag
“endoRoots granular” from Roots Inc.

*Glomus mosseae*
*Glomus intraradices*
*Glomus deserticola*
+ 5 other species

+ analysis 3 - 3 - 4
+ kelp meal
humus
amino acids
OM Booster
Humate Mini-Granular

Manufactured for:
Pioneer Organics Inc.
483 Bond Road,
Waterville, NS
B0P 1V0

Net Weight: 25 kg.
Tree quality with amendments

Application Sept 2003, rating Oct 2004, City of Penticton
Rating from 1 (dead) to 5 (excellent) (n=8)
Biostimulants and water stress

Street-planted B&B English oak (Quercus robur)
Adapted from Ferrini and Nicese, J Arboriculture, March 2002

Water use efficiency = Net photosynthesis / Evaporation rate
Mycorrhizae and urban plants
Donald H. Marx, Plant Health Care Inc., 1996

- **Possible applications**
  - The plant is a known mycorrhizal host.
  - The soil is poor quality, small volume, or not irrigated.

- **Potential benefits**
  - Increased tolerance to transplant, drought, stress, and root rot.
  - Improved availability of nutrients.

- **To encourage root colonisation**
  - Inoculate prior to transplanting.
  - Maintain adequate water and fertiliser, mulch if possible.