Mycorrhizal fungi in urban plantings

Improving plant tolerance to water stress

Canadian Urban Forest Conference, Kelowna, October 20, 2004

Mario Lanthier
CropHealth Advising & Research
Kelowna, B.C.
www.crophealth.com

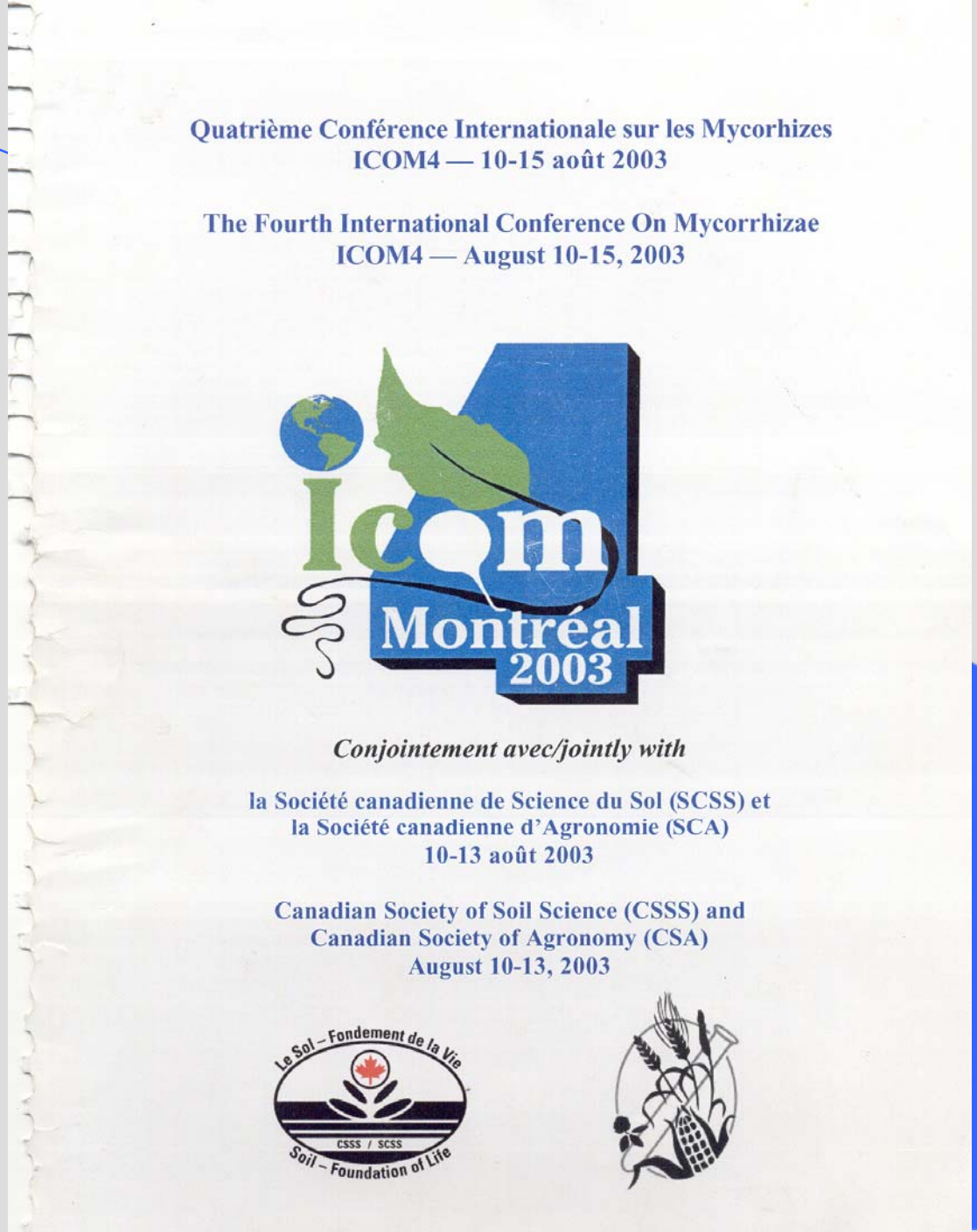
International Mosaiculture
Montréal, 2003

“Myths and Legends
of the World”

Giants of Easter Island
Entry from Chile

4th International Conference on Mycorrhizae

Montréal, Québec
August 10 – 15, 2003



Quatrième Conférence Internationale sur les Mycorhizes
ICOM4 — 10-15 août 2003

The Fourth International Conference On Mycorrhizae
ICOM4 — August 10-15, 2003

icom Montréal 2003

Conjointement avec/jointly with

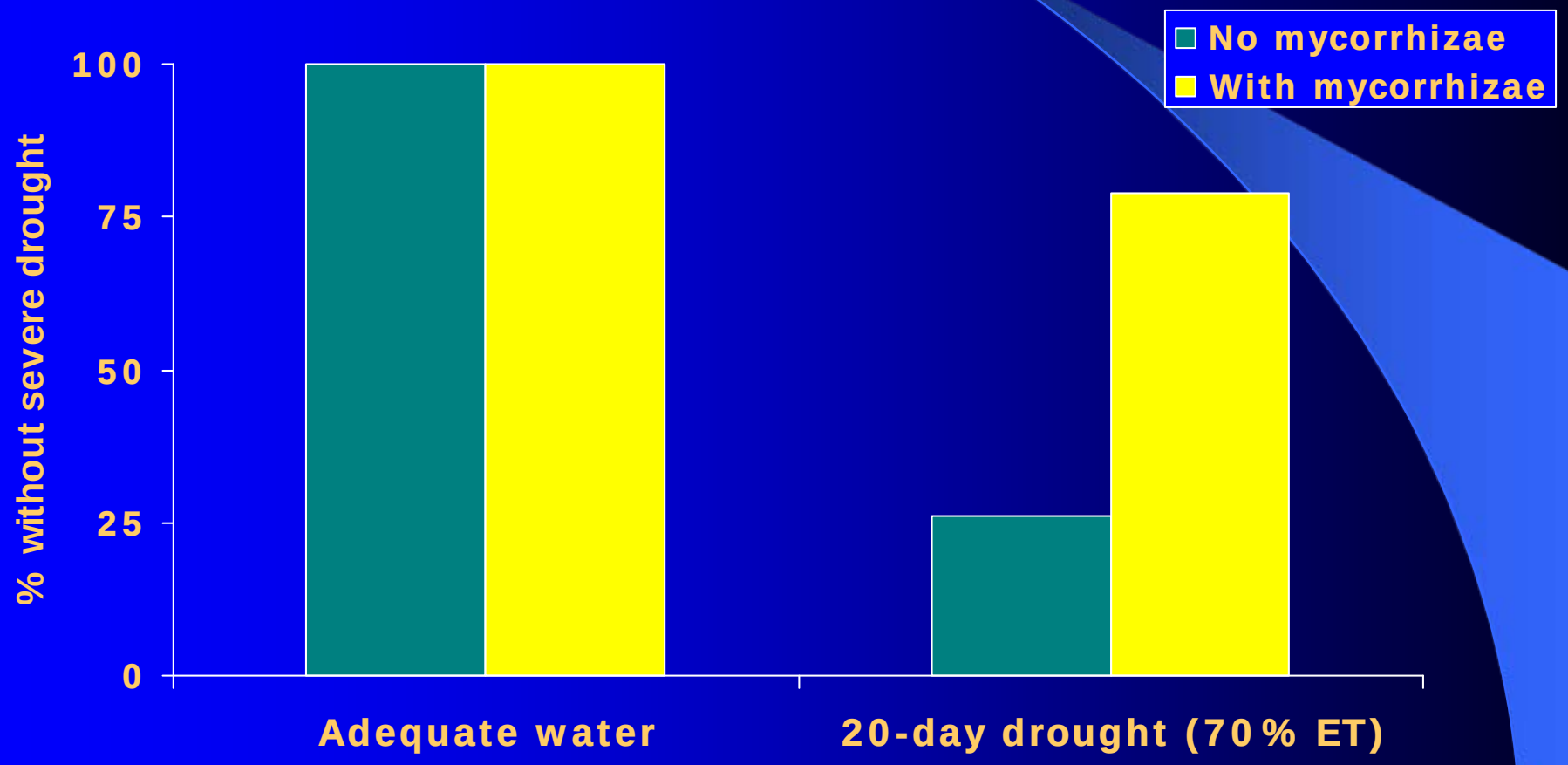
la Société canadienne de Science du Sol (SCSS) et
la Société canadienne d'Agronomie (SCA)
10-13 août 2003

Canadian Society of Soil Science (CSSS) and
Canadian Society of Agronomy (CSA)
August 10-13, 2003

Le Sol – Fondement de la Vie
CSSS / SCSS
Soil – Foundation of Life

Mycorrhizae and water stress

Pepper plants (*Capsicum a.*) under different water regimes
Adapted from F.T. Davies, Texas A&M University, ICOM 2003



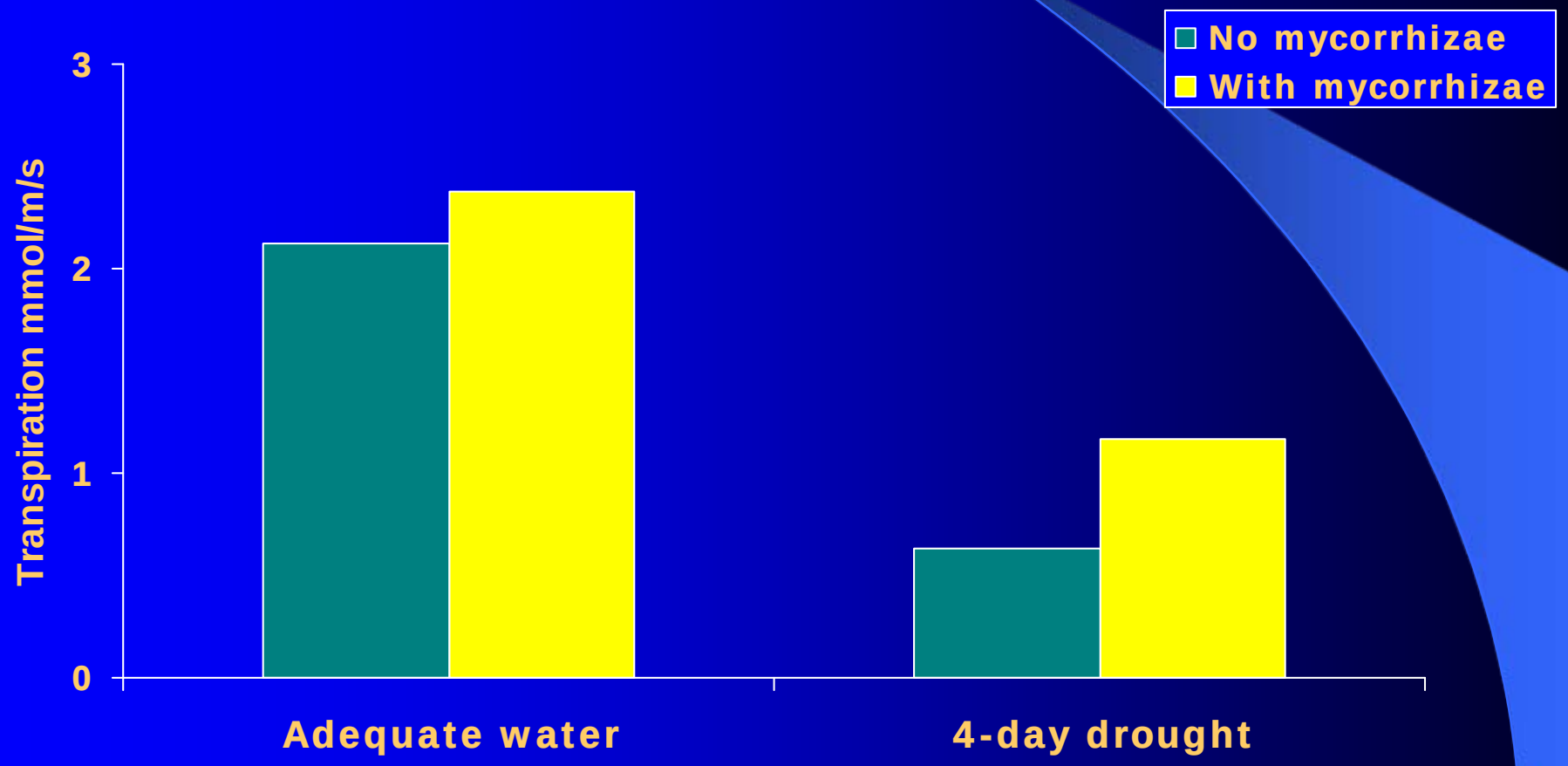
Mycorrhizae and water stress

Chile pepper plants (*Capsicum a.*) 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

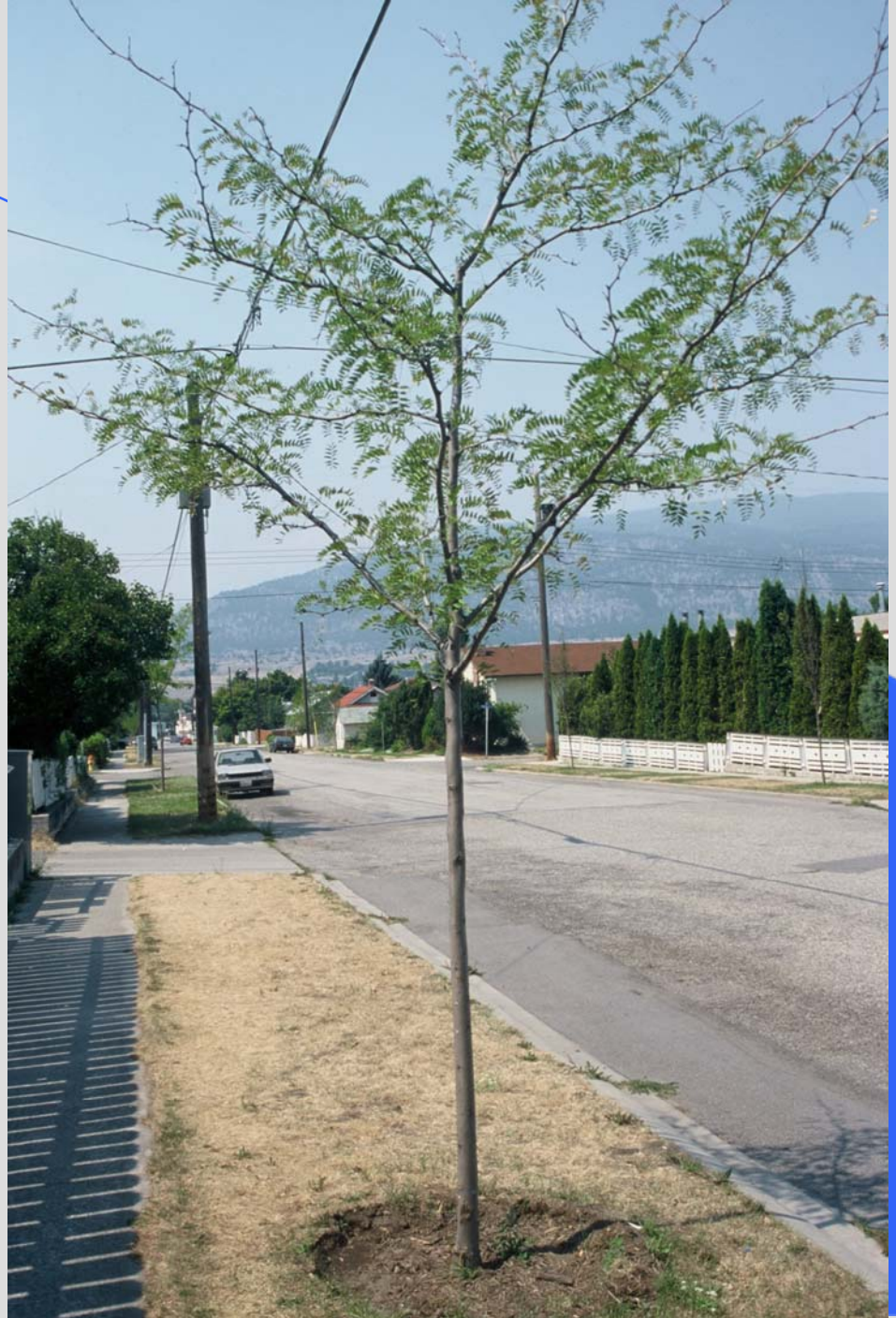


Mycorrhizae and drought avoidance

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

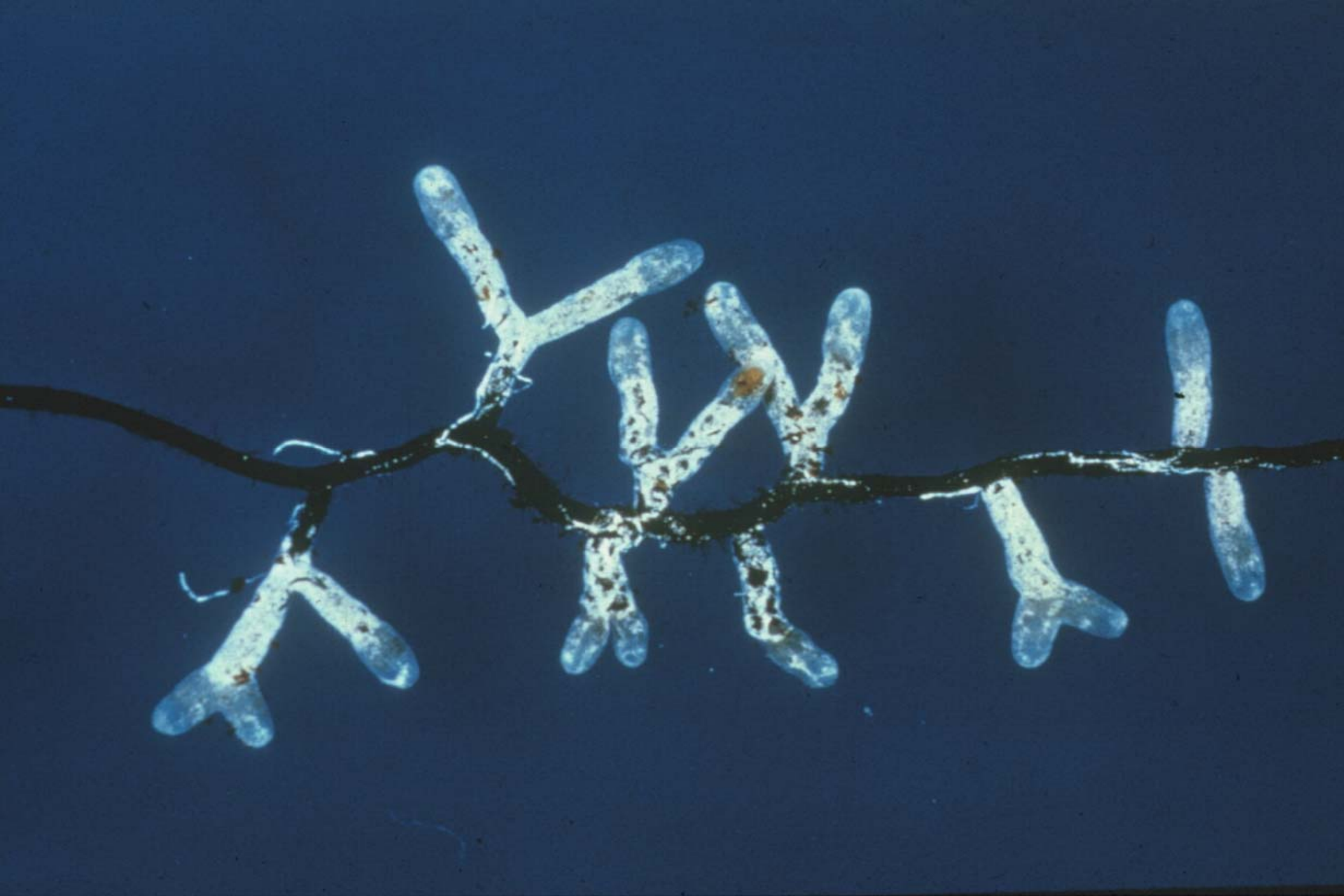
- Direct water transport
  - Fungi may supply 10% of plant water need
  - Hyphal threads forage more soil surface
- Better host nutrition
  - Higher phosphorus and nitrogen in leaves
  - Current research: does P improve drought resistance?
- Plant - osmotic adjustments
  - Helps maintain leaf turgidity and photosynthesis rate
  - Current research: changes in soil – water relations

Plants that are colonized by mycorrhizal fungi have a higher tolerance to enviromental 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-successsion 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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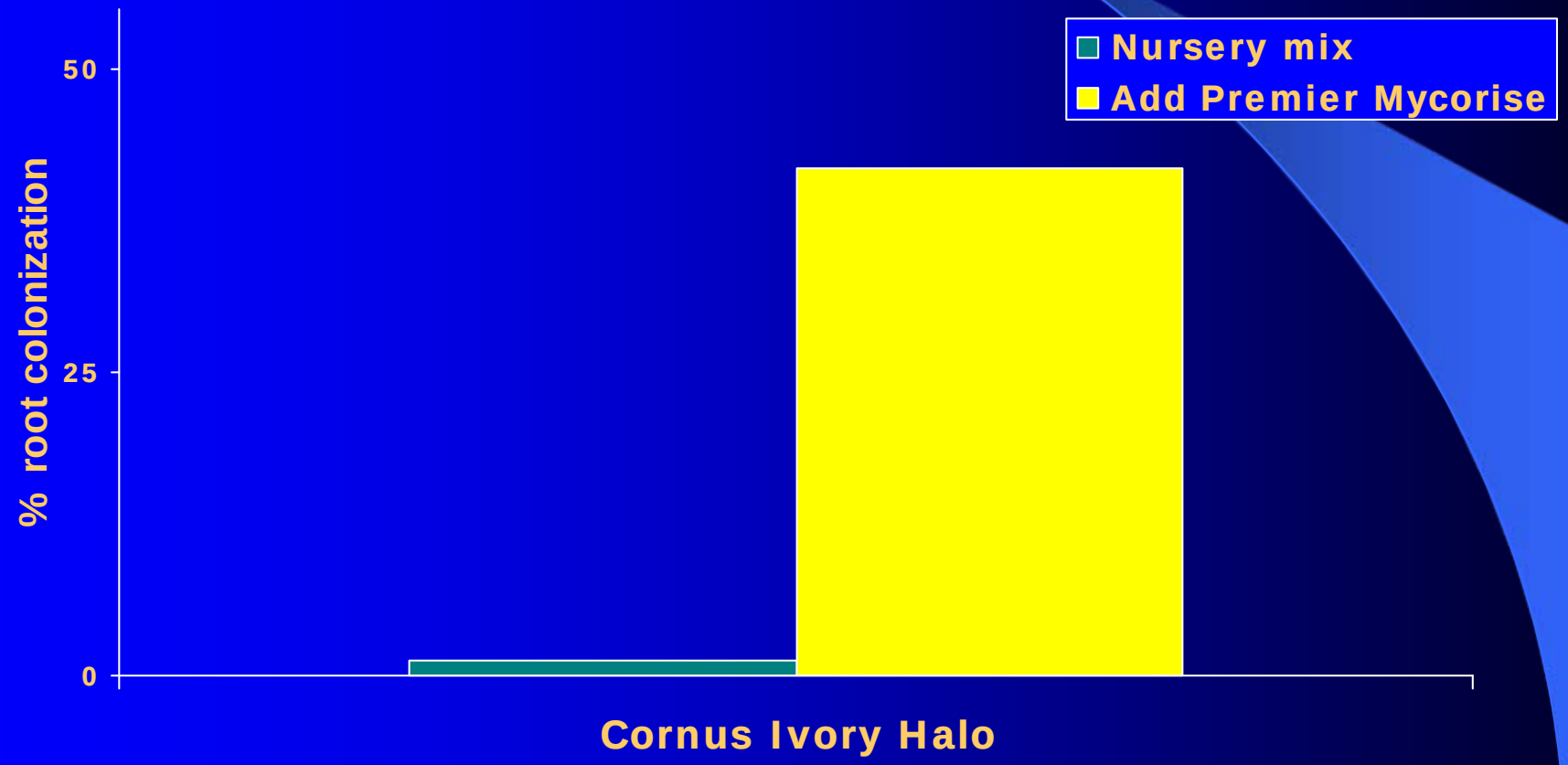
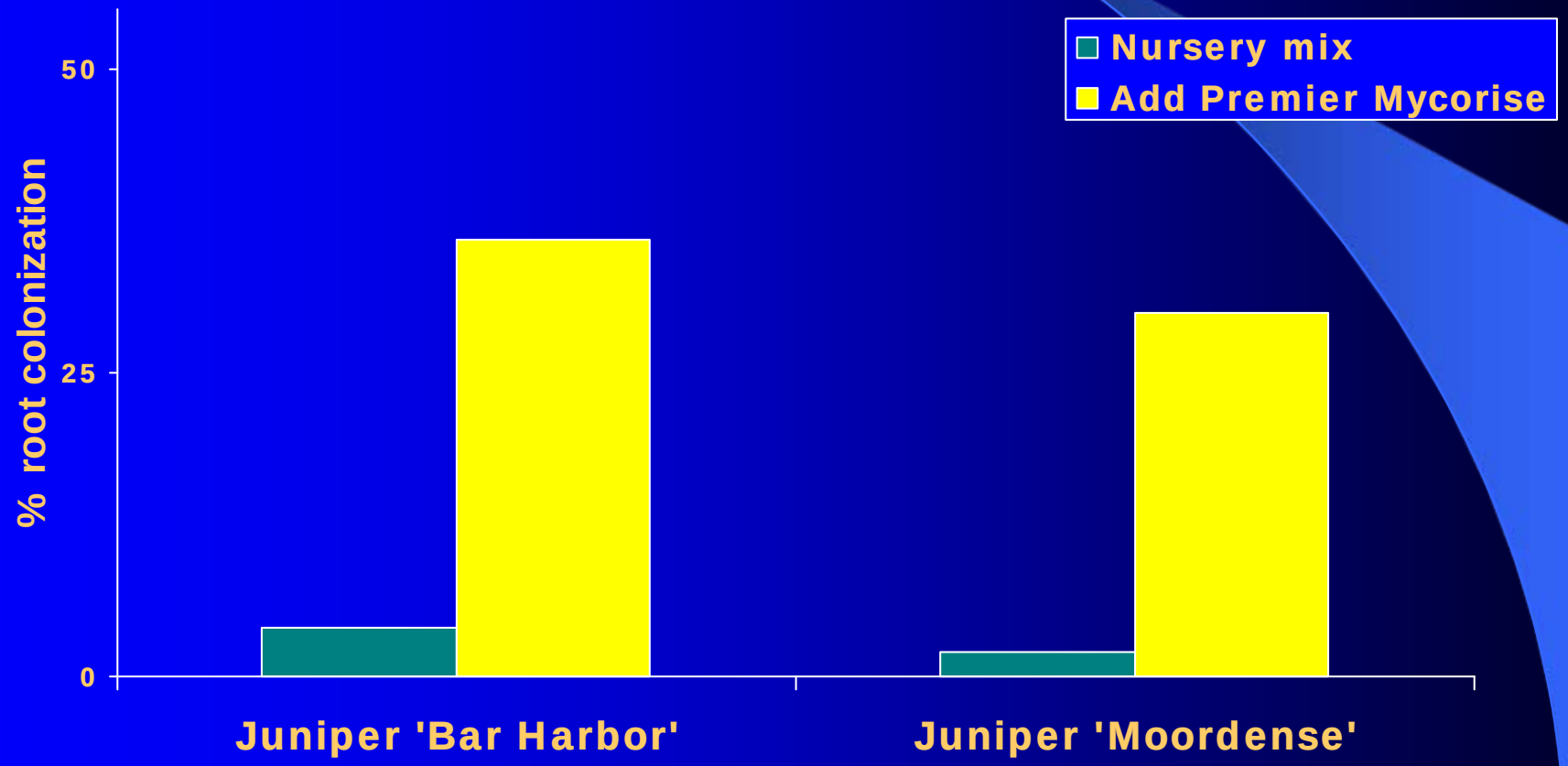
Mycorrhizal Root Colonization

Liners potted July 2001, roots cut September 2002 (n=8)
Laboratory analysis at Premier Tech, Quebec



Mycorrhizal Root Colonization

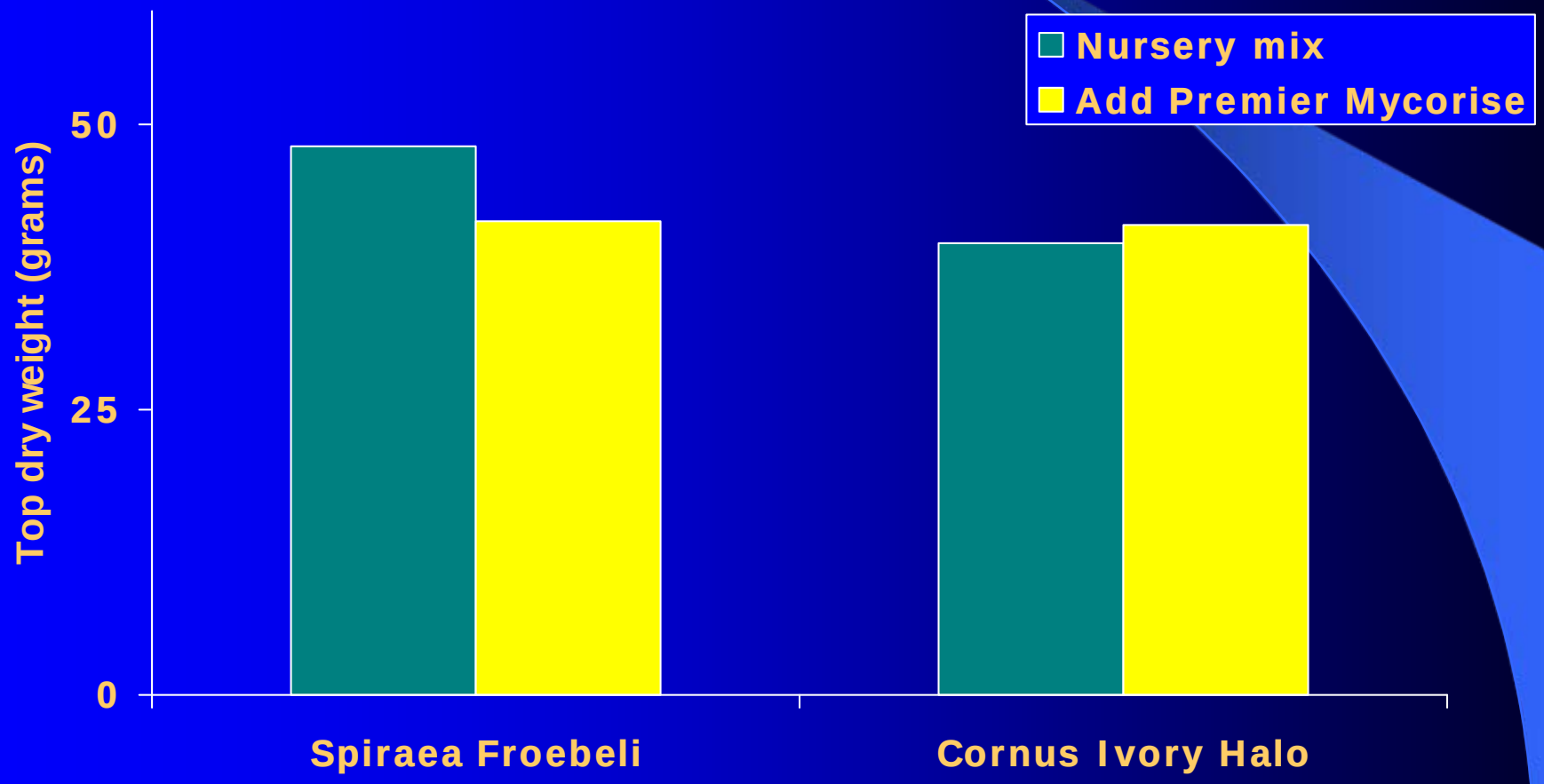
Liners potted August 2002, roots cut October 2003
Laboratory analysis at Mycorrhizal Applications, Oregon



Laboratory
plant-drying oven
with bagged samples

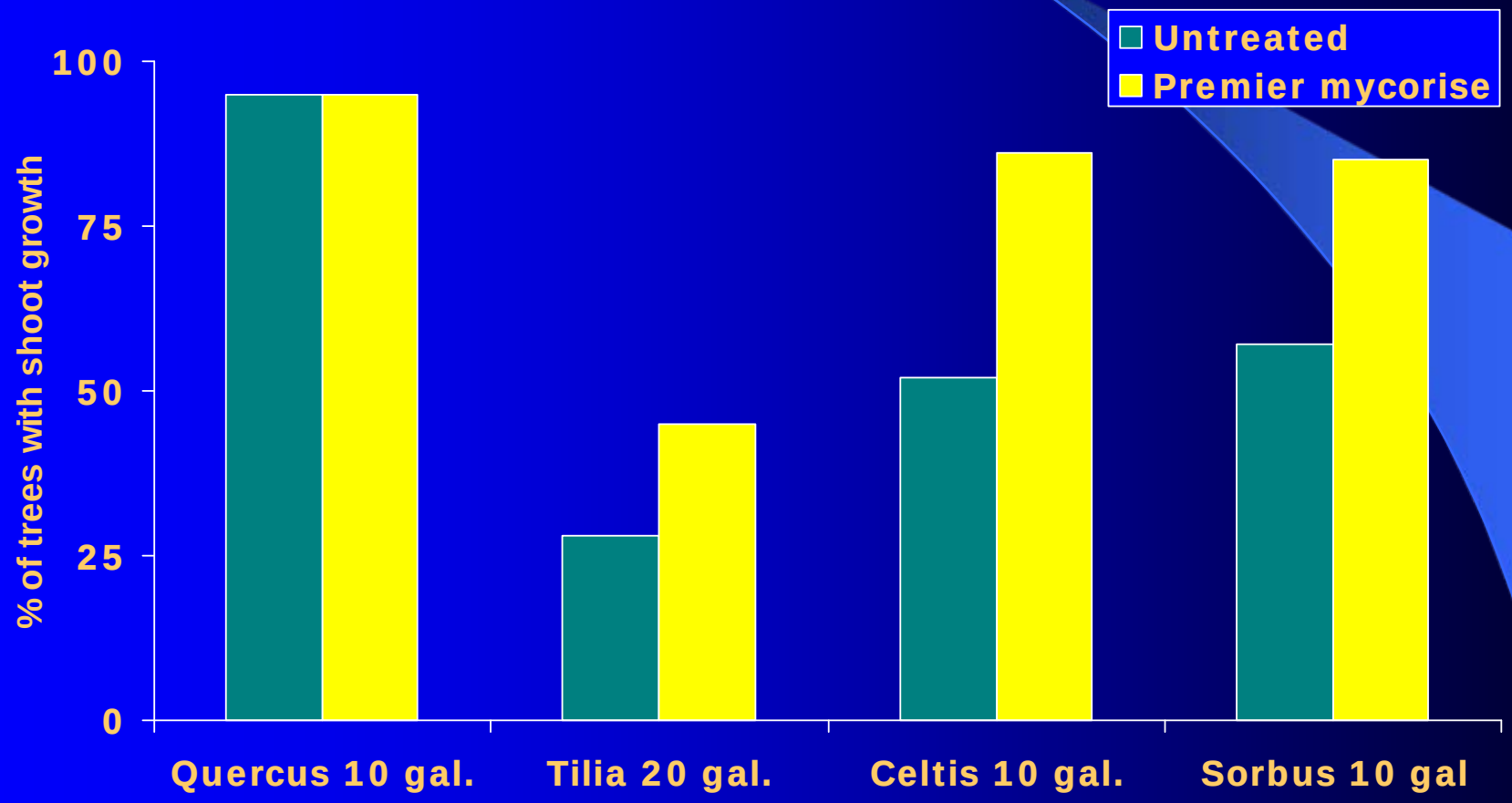
Mycorrhizae on top growth

Liners in 1-gallon pots July 2001, cut September 2002 (n=20)
Measure of top dry weight after 24 hours at 105ºC



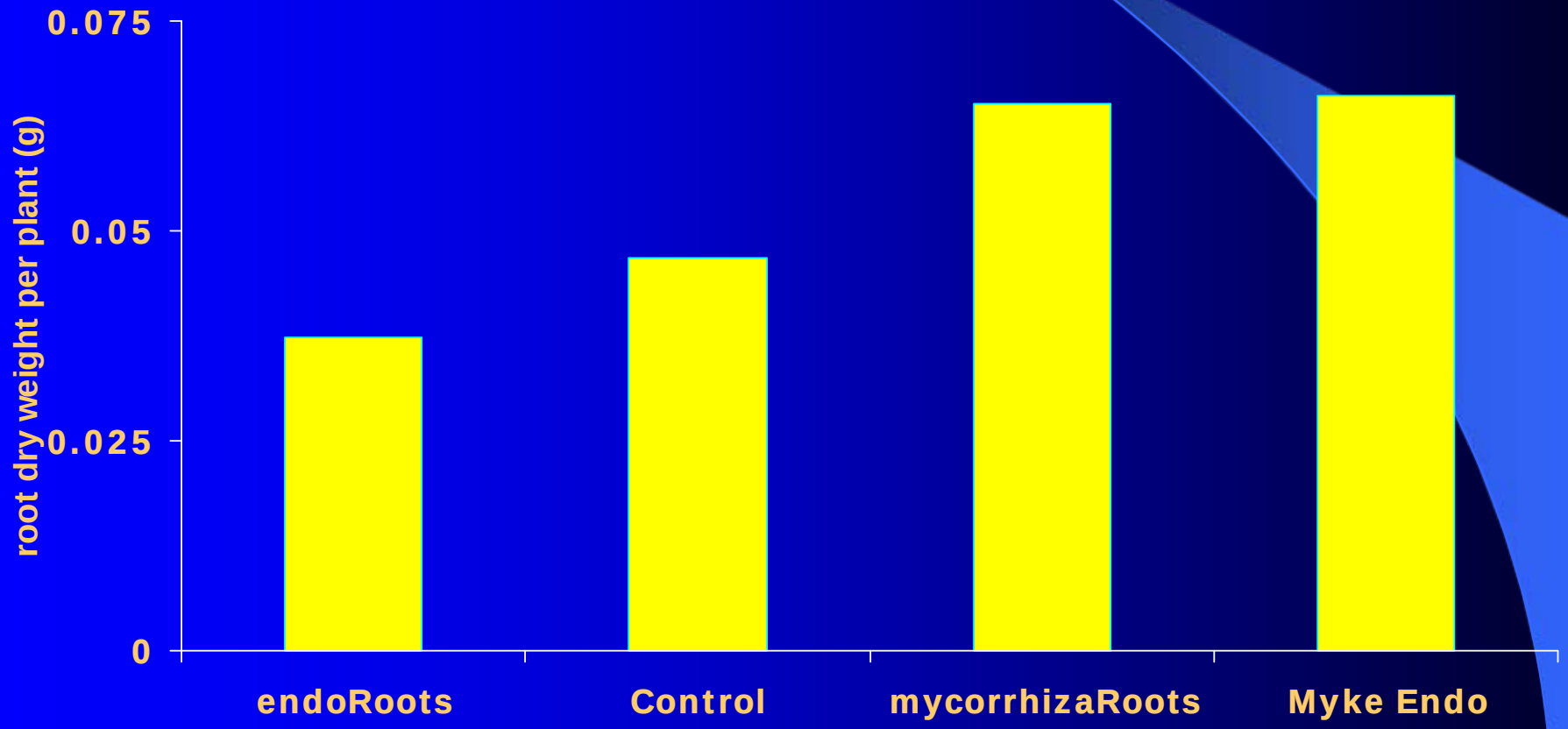
Mycorrhizae on potting survival

Bare-root trees potted in April. Rating of «live» trees in July
Commercial mycorrhizal fungi applied during potting



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.

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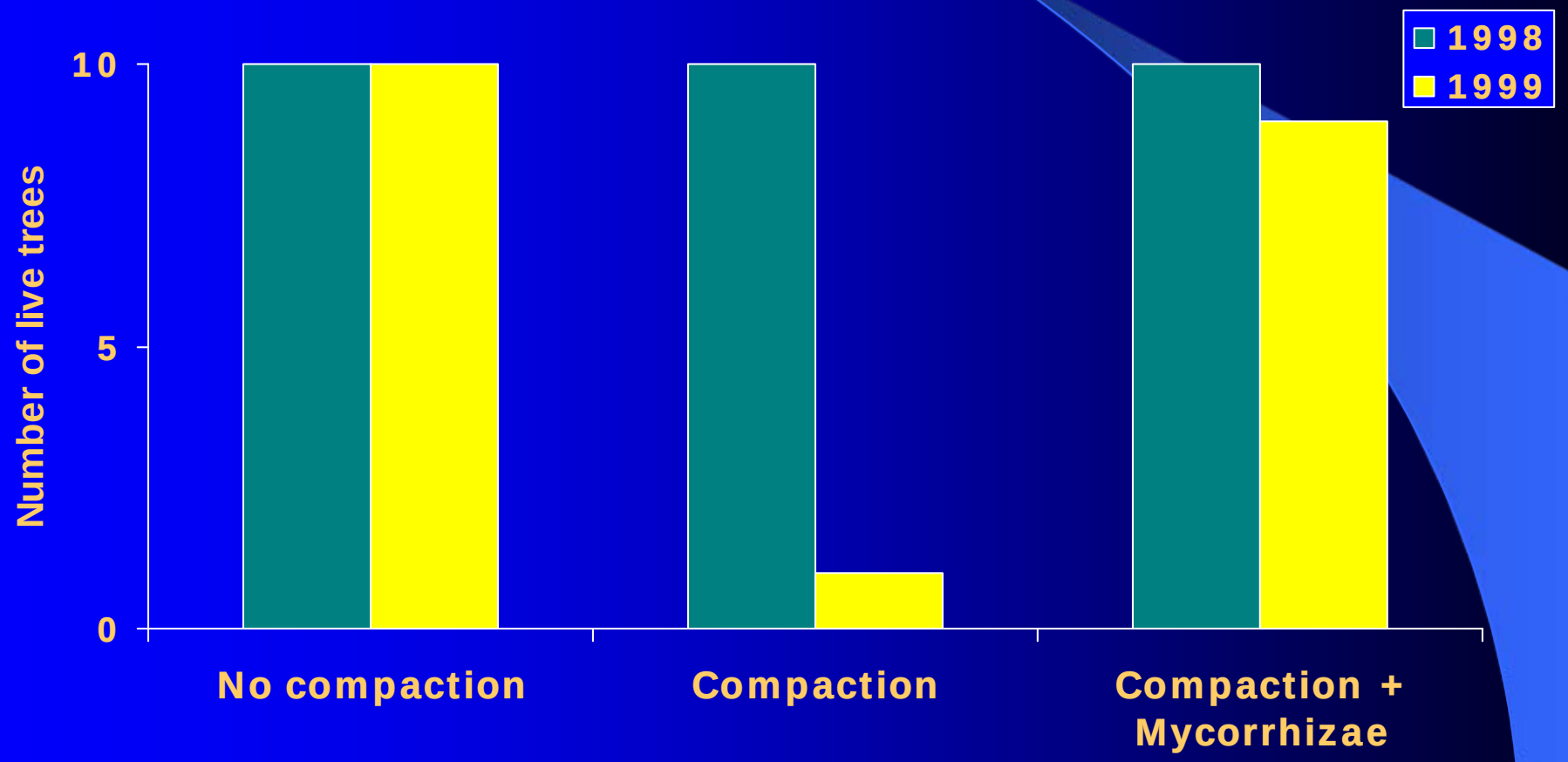
Mycorrhizae and soil compaction

Seedlings of *Acer nigrum* planted in soil manually compacted
Adapted from J.N. Klironomos, Guelph University, 2002



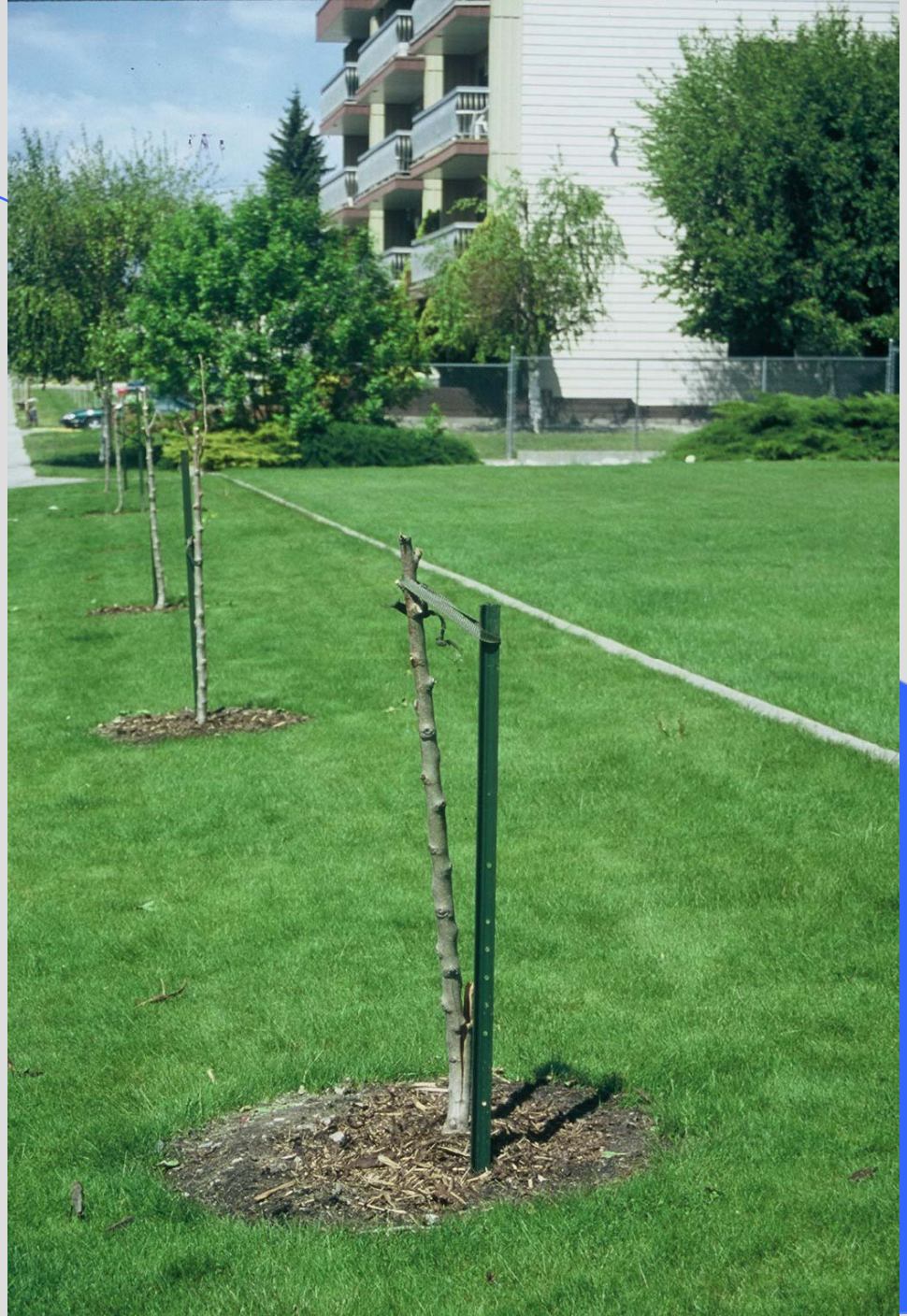
Mycorrhizae on street trees

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

Location	Planted	Inoculation?	Sample	Colonisation
101 Eckhardt	1991	Yes	Oct 2003	20 %
103 Eckhardt	1991	No	Oct 2003	0 %
205 Martin	Oct 2001	Yes	Oct 2003	0 %
247 Martin	Oct 2001	No	Oct 2003	0 %
Gallery SE	Apr 2003	Yes	Oct 2003	0 %
Gallery NE	Apr 2003	No	Oct 2003	0 %
350 Ellis	Apr 2004	Yes	Sep 2004	4 %
346 Ellis	Apr 2004	No	Sep 2004	1 %

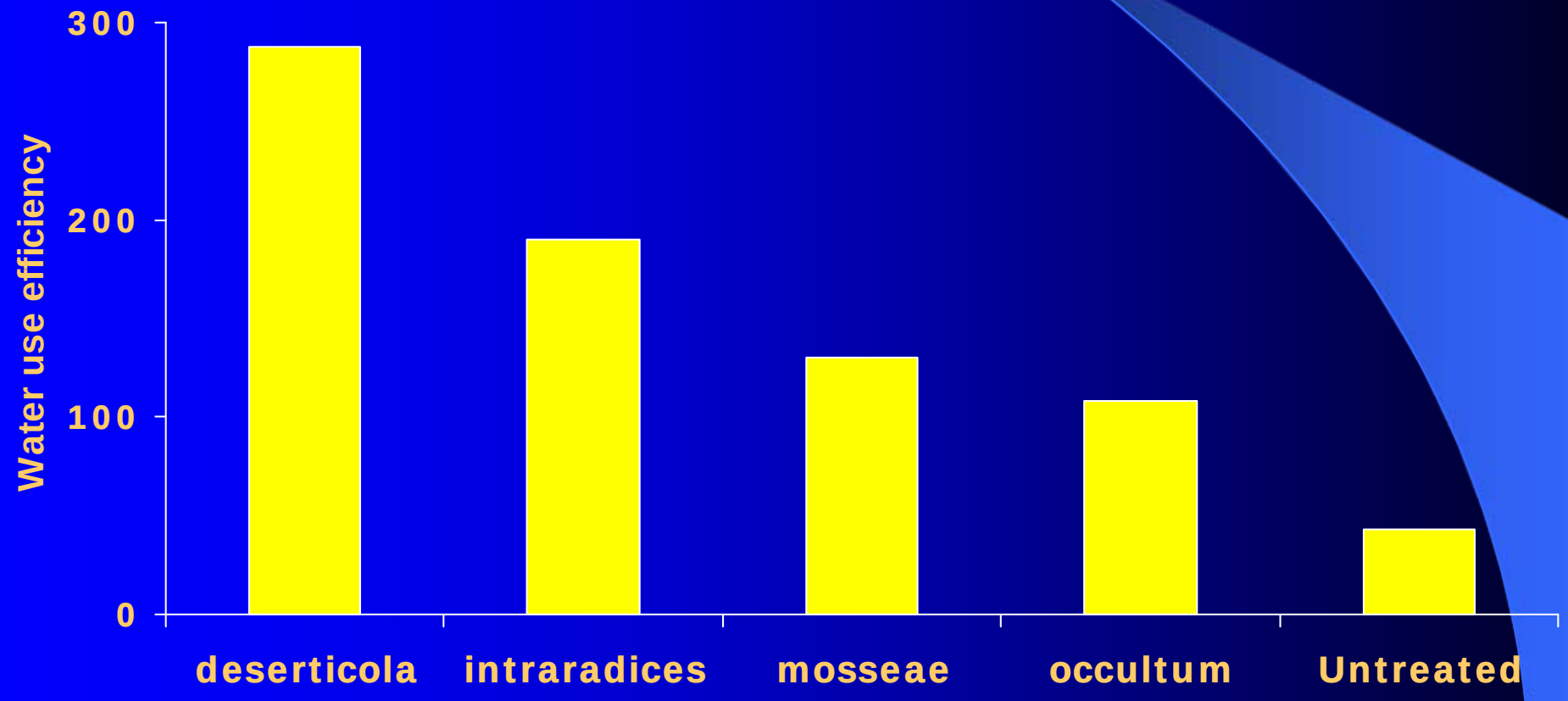
Vandalism

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

Bradfield

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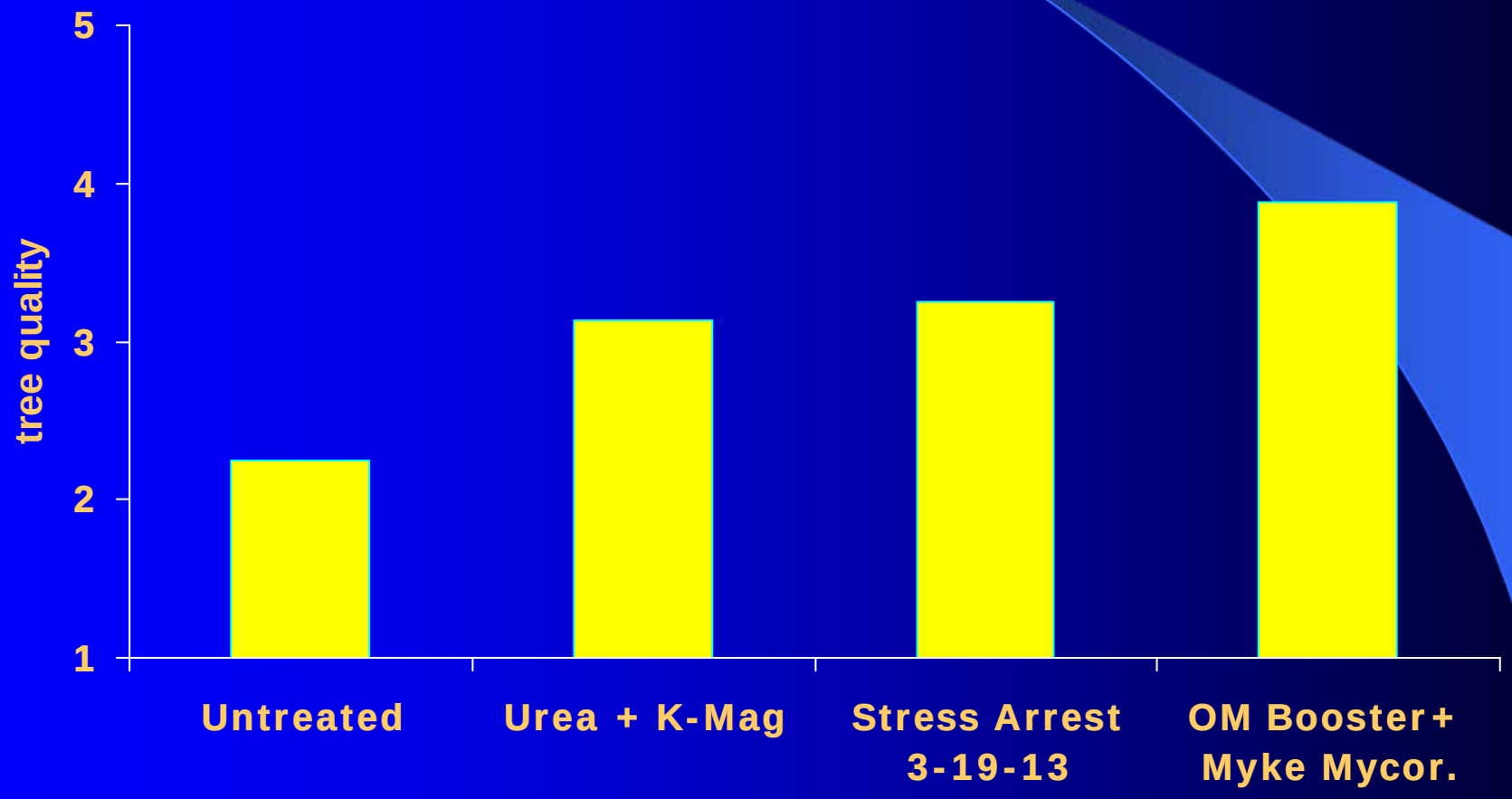
Humate Mini-Granular

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

Net Weight: 25 kg.

Tree quality with amendments

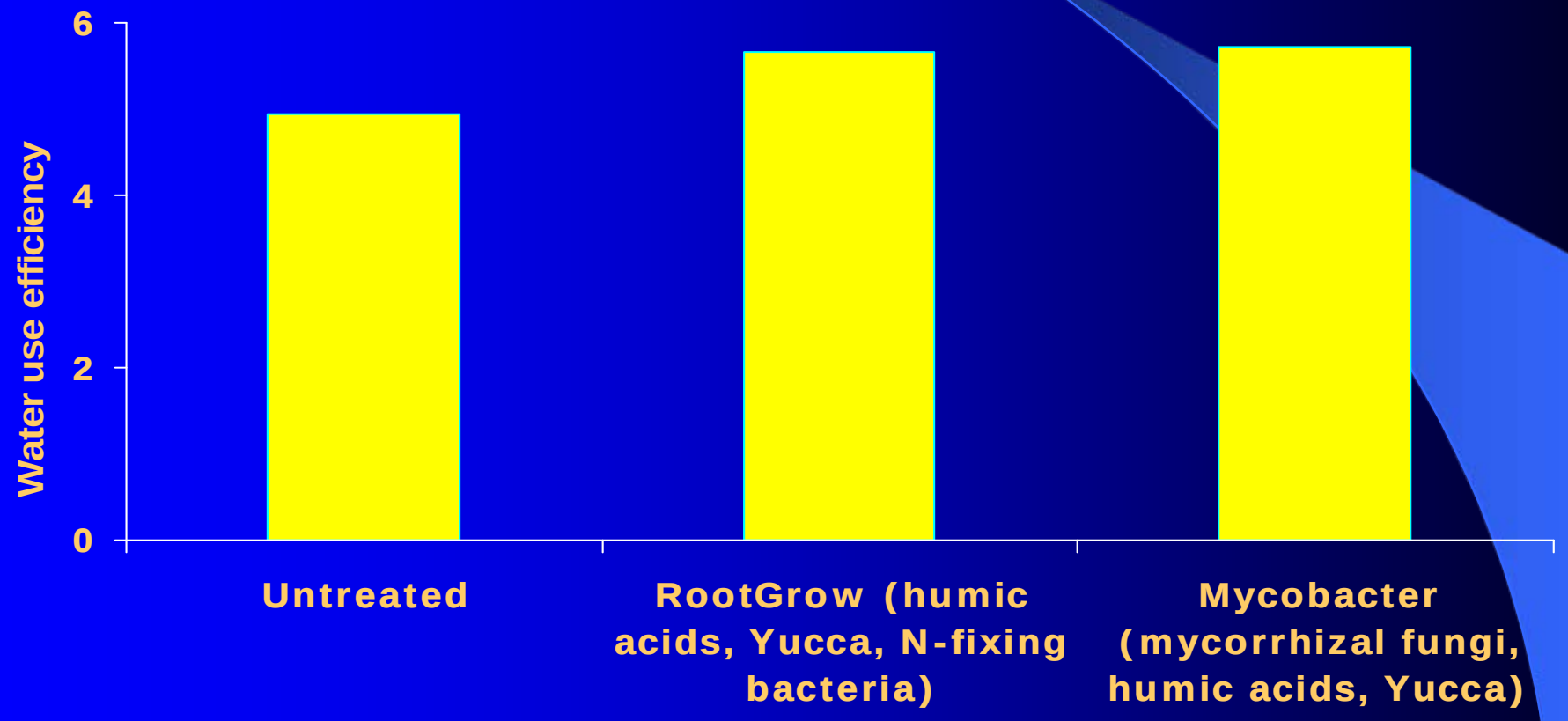
Application Sept 2003, rating Oct 2004, City of Penticton
Rating from 1 (dead) to 5 (excellent) (n=8)



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.