Beautiful Gardens Begin with Healthy Soil

Soil Quality Assessment and Care as Management Tools

P. Thomas Tiddens, Chicago Botanic Garden
Louise Egerton-Warburton, Chicago Botanic Garden
Ari Novy, U.S. Botanic Garden
Kurt Morrell, New York Botanical Garden
Greg Paige, Bartlett Tree Research Laboratories and Arboretum

**Contact details for each speaker and a summary of their presentation is available at the door.

Soil management at the Chicago Botanic Garden

Exploring new approaches to improve soil and plant health

P. Thomas Tiddens
Supervisor, Plant Health Care
Chicago Botanic Garden

6/21/2017

CHICAGO BOTANIC GARDEN

The Chicago Botanic Garden's journey began on September 25, 1965 when ground was broken on over 300 acres of marshy lowland in Glencoe, Illinois.

CHICAGO BOTANIC GARDEN

Beautiful topography: but…

What about the soil???

CHICAGO BOTANIC GARDEN

Soils at the Garden have been a challenge for years and the source of many plant problems….

- High percentage of clay
- Lack of top soil – then solid clay
- High pH
- Soil pathogen problems

CHICAGO BOTANIC GARDEN

Soil testing

To: CHICAGO BOTANIC GARDEN
1000 LAKE COOK RD
P O BOX 400
GLENCOE, IL 60022

Attn: TOM TIDDENS

SOIL TEST REPORT

Page: 3

Date Received: 10/13/97 Date Reported: 10/15/97

SAMPLE NUMBER	LAB NUMBER	ORGANIC MATTER %	PHOSPHORUS BRAY P1 ppm-P	PHOSPHORUS BRAY P2 ppm-P	POTASSIUM K ppm	MAGNESIUM Mg ppm	CALCIUM Ca ppm	SODIUM Na ppm	pH SOIL pH	pH BUFFER pH	Cation Exchange Capacity meq/100g	PERCENT BASE SATURATION % K	% Mg	% Ca	% H	% Na
NOL16	43095	5.3	52 VH		305 VH	655 VH	2550 M		7.5		19.0	4.1	28.7	67.1		
NOL17	43096	6.9	42 H		260 H	650 H	3350 M		7.4		22.8	2.9	23.7	73.4		
NOL18	43097	6.8	52 VH		308 VH	805 VH	2800 M		7.6		21.5	3.7	31.2	65.1		
NOL19	43098	7.7	26 M		199 H	525 H	3200 H		7.9		20.9	2.4	20.9	76.6		
CIR1	43099	8.1	40 H		267 VH	545 H	2950 M		8.1		20.0	3.4	22.7	73.8		
CIR2	43100	8.6	45 H		302 VH	615 H	3250 M		7.9		22.1	3.5	23.1	73.4		
CIR3	43101	7.7	46 H		301 VH	540 H	2900 M		7.9		19.8	3.9	22.8	73.3		
CIR4	43102	7.8	43 H		284 VH	505 H	2750 M		8.0		18.7	3.9	22.5	73.6		

VL = VERY LOW L = LOW M = MEDIUM H = HIGH VH = VERY HIGH

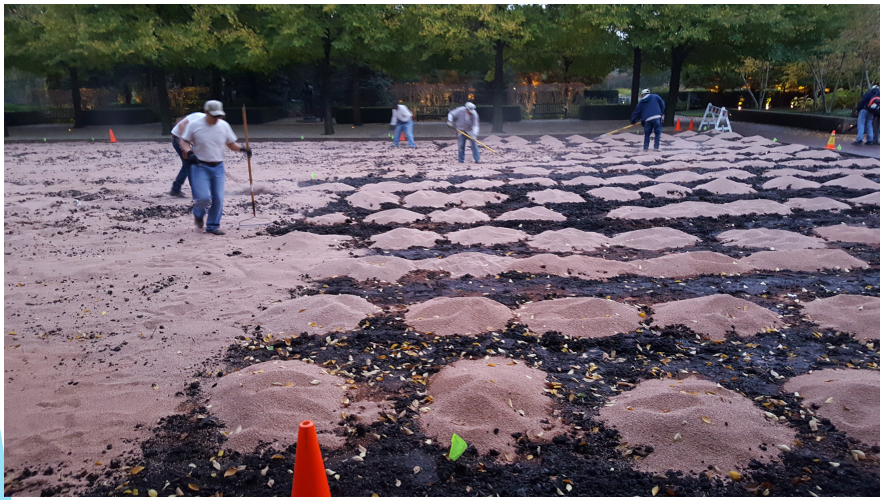
SAMPLE NUMBER	SULFUR S ppm	ZINC Zn ppm	MANGANESE Mn ppm	IRON Fe ppm	COPPER Cu ppm	BORON B ppm	SOLUBLE SALTS mmhos/cm	NITRATE NO_3-N ppm	AMMONIUM NH_4-N ppm	BICARB-P P ppm	COMMENTS

CHICAGO BOTANIC GARDEN

Elaborate drain tile installations

CHICAGO BOTANIC GARDEN

Porous ceramic soil conditioners



CHICAGO BOTANIC GARDEN

Biochar

CHICAGO BOTANIC GARDEN

Compost Tea / bio-stimulants

CHICAGO BOTANIC GARDEN

Commercial mycorrhizal products

[redacted] 220 microns, passes a #70 screen. Contains 9 specifically selected endo mycorrhizal species Glomus intraradices, G. aggregatum, G. etunicatum, G. mosseae, G.deserticola, G.clarum, G.brasilianum, G. monosporum, Gigaspora margarita and 11 species of ectomycorrhizal fungi Rhizopogon villosullus, R. luteolus, R. amylopogon, R. fulvigleba, Pisolithus tinctorius, Scleroderma cepa S. citrinum, Suillus granulatus, Suillus punctatapies, Laccaria laccata and L. bicolor . Also contains two Trichoderma fungal species, 15 beneficial bacterial species, humics, kelp, and vitamins.

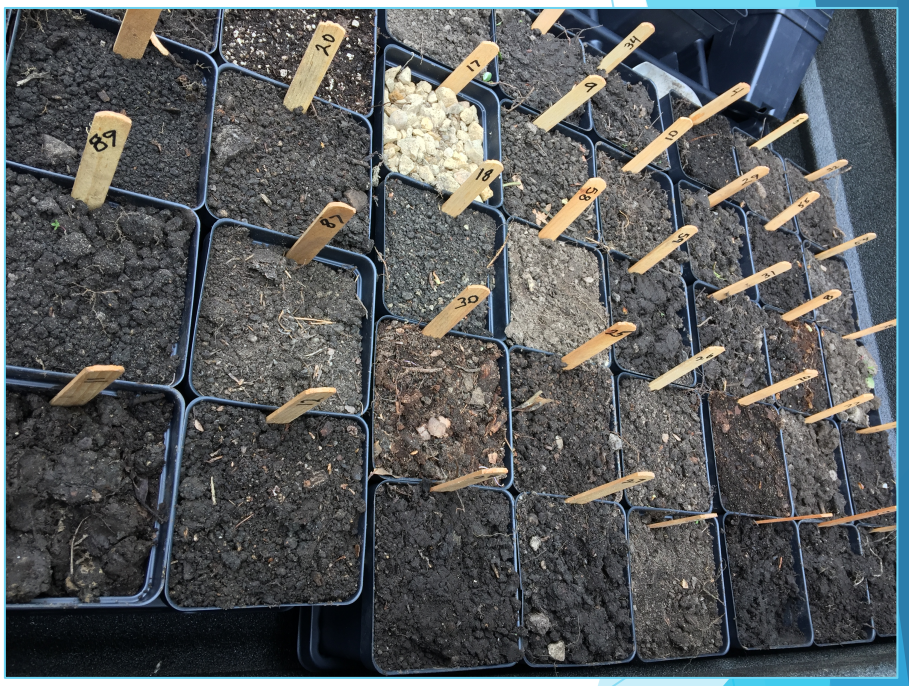
CHICAGO BOTANIC GARDEN

But what if there are already infective mycorrhizal fungi in the soil?

Do we really need to inoculate?

CHICAGO BOTANIC GARDEN

The biological soil investigation begins…



CHICAGO BOTANIC GARDEN

Inoculating Plants with Mycorrhizal Fungi: Essential or Excessive Practice?

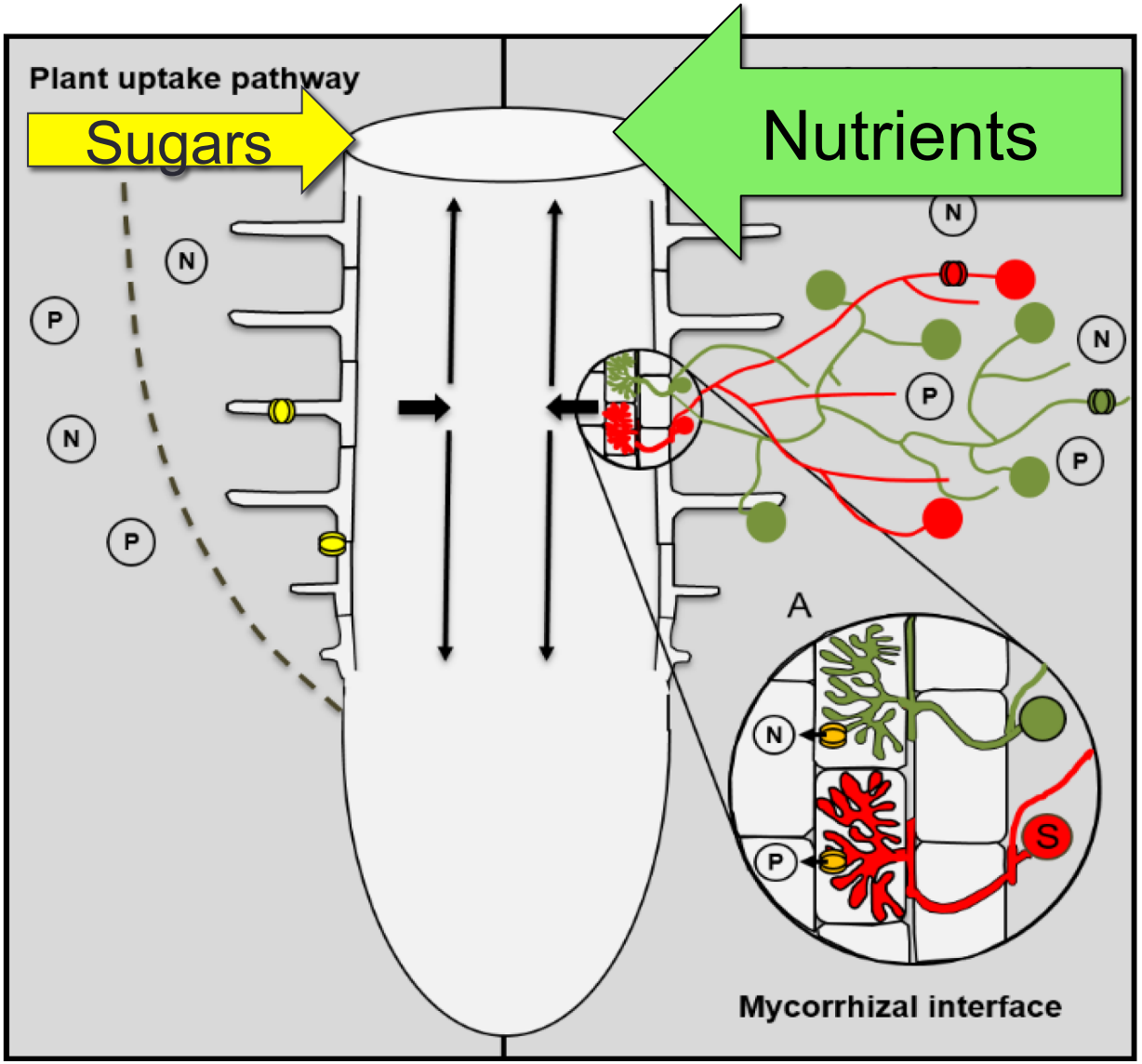
Louise Egerton-Warburton

CHICAGO BOTANIC GARDEN

Increasing Use of Mycorrhizal Inoculants

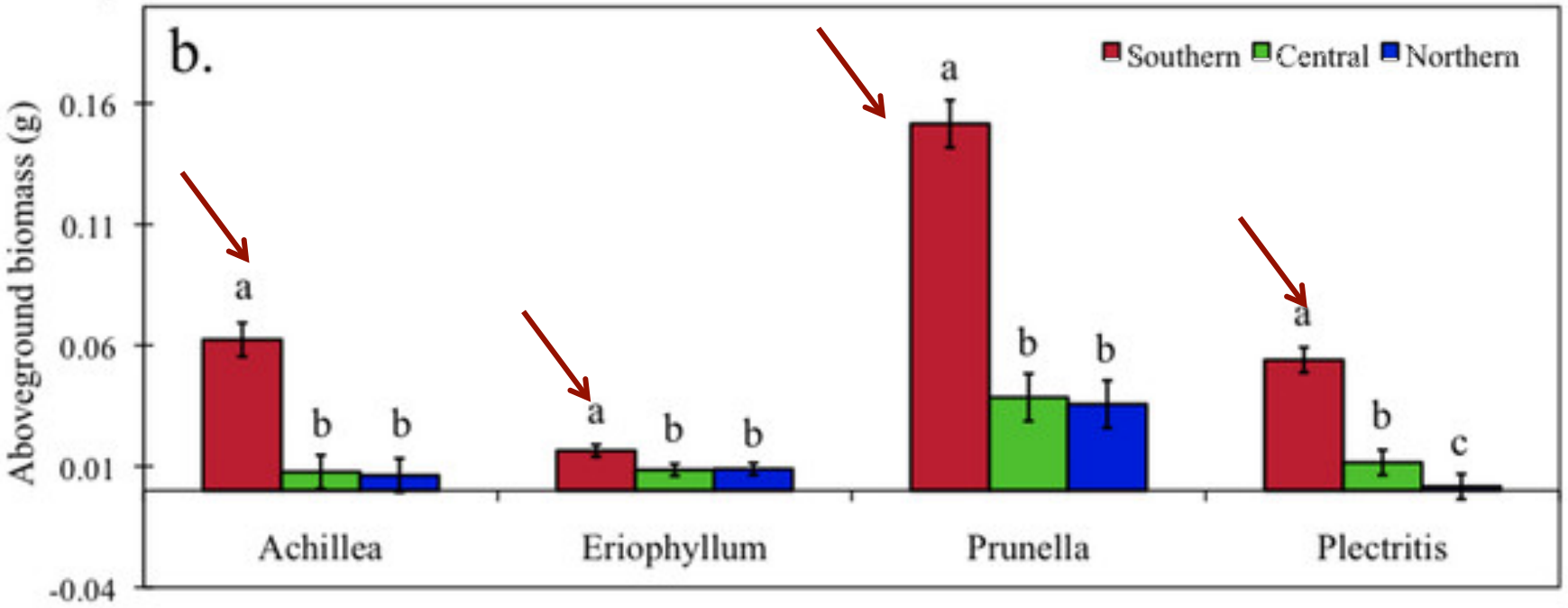
Three Considerations:

1) Resource economics of the symbiosis



Three Considerations:

2) Not all mycorrhizas have the same effect on plant growth



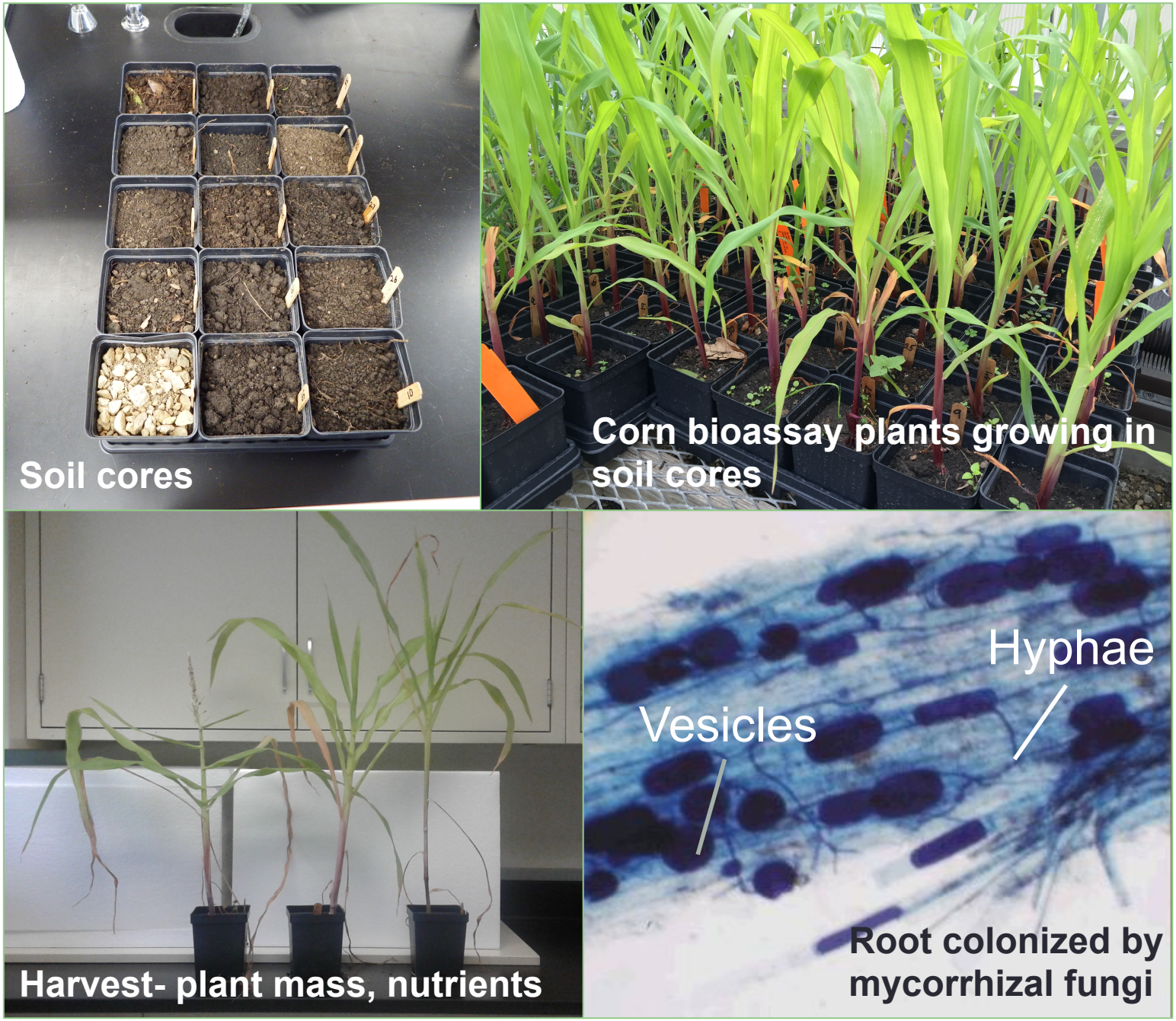
Three Considerations:

3) Are mycorrhizas already abundant in the soil and functioning?

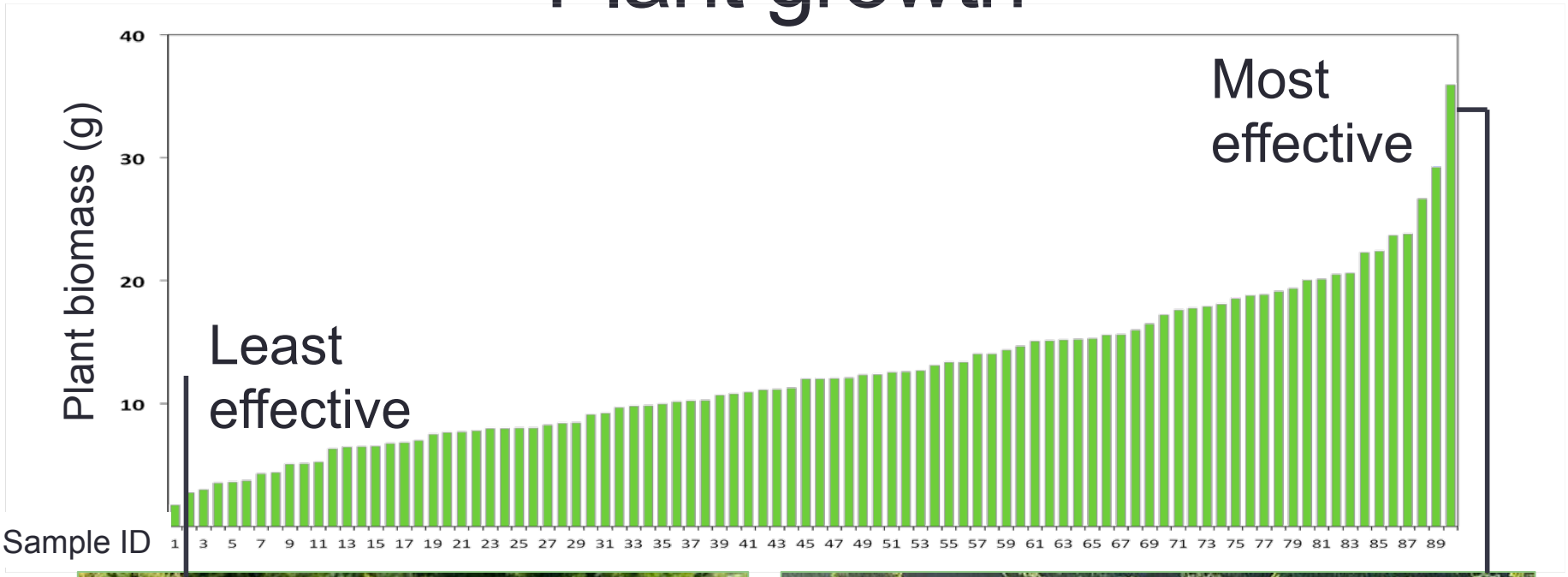
Three Considerations:

3) Are mycorrhizas already abundant in the soil and functioning?

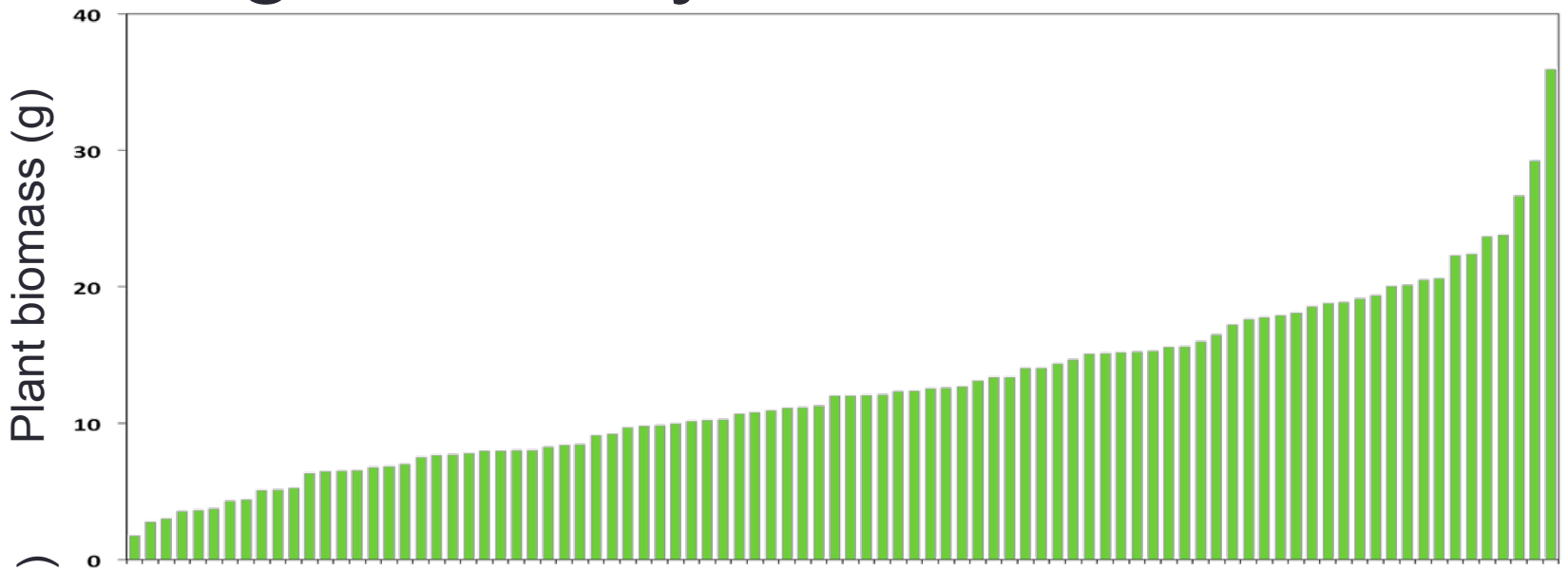
- Soil core bioassay

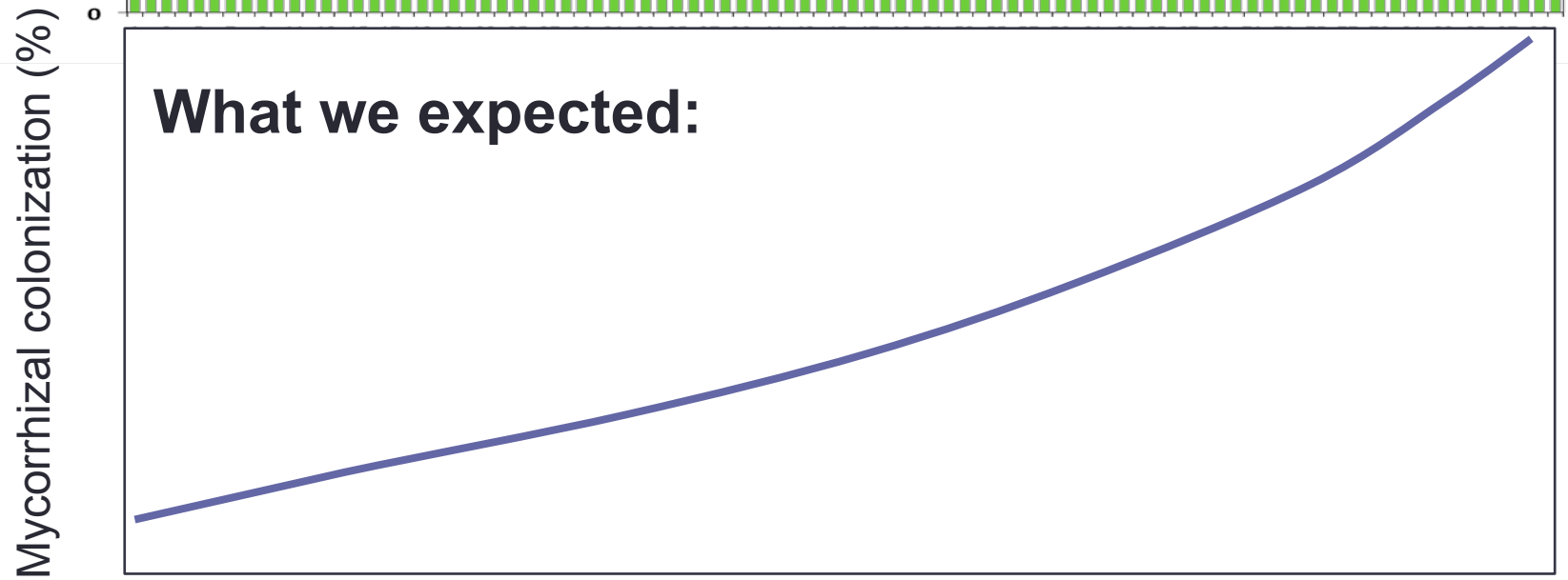

Soil cores
Corn bioassay plants growing in soil cores
Harvest- plant mass, nutrients
Hyphae
Vesicles
Root colonized by mycorrhizal fungi

Plant growth

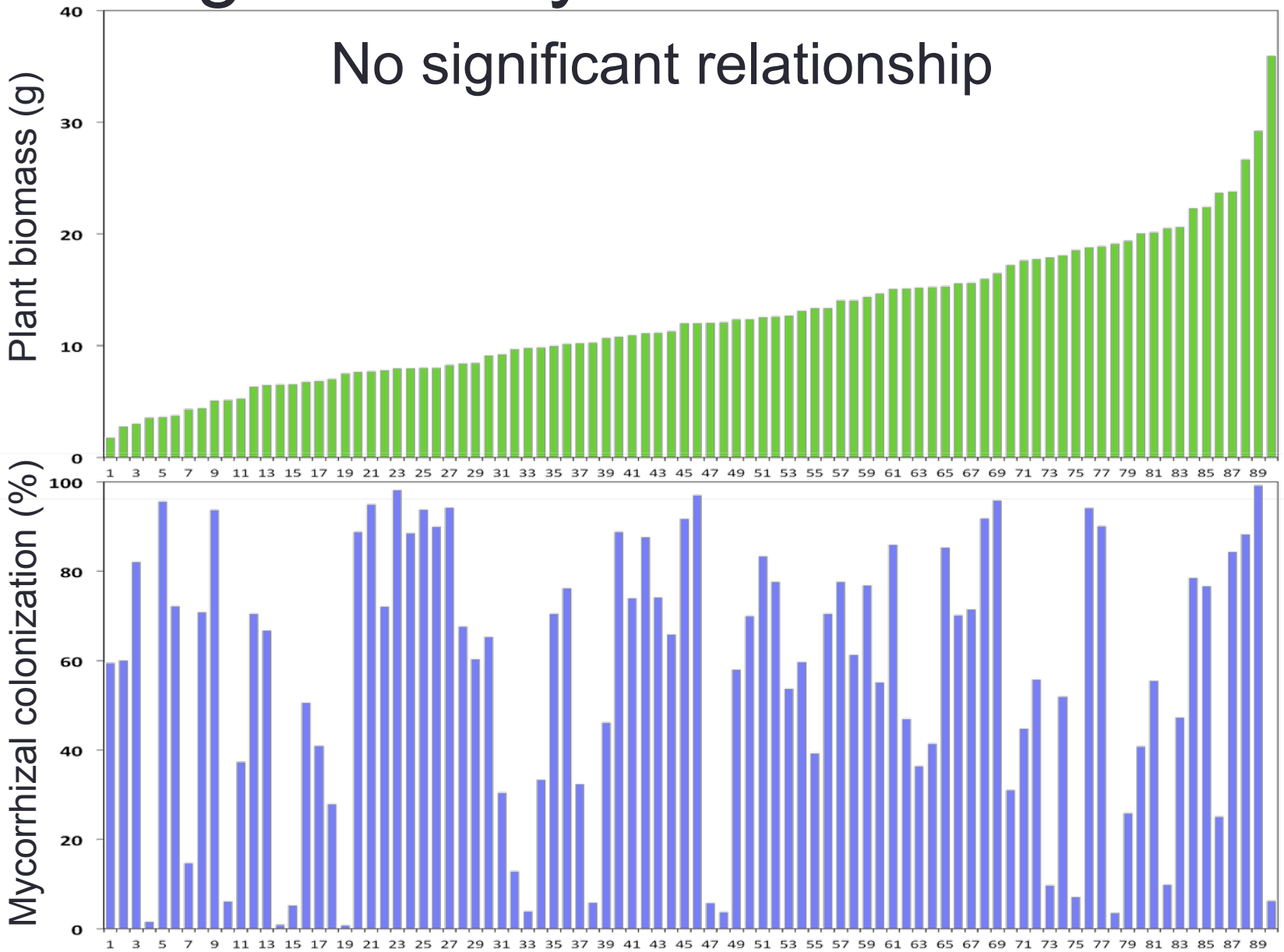


Plant growth- Mycorrhizal Colonization

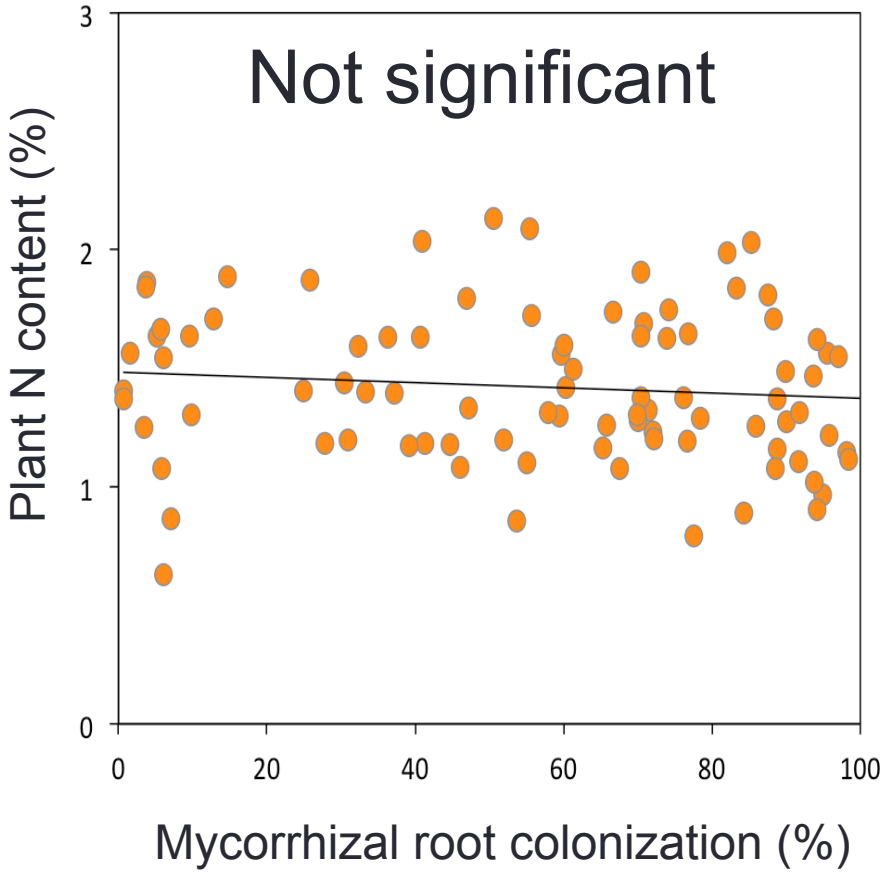




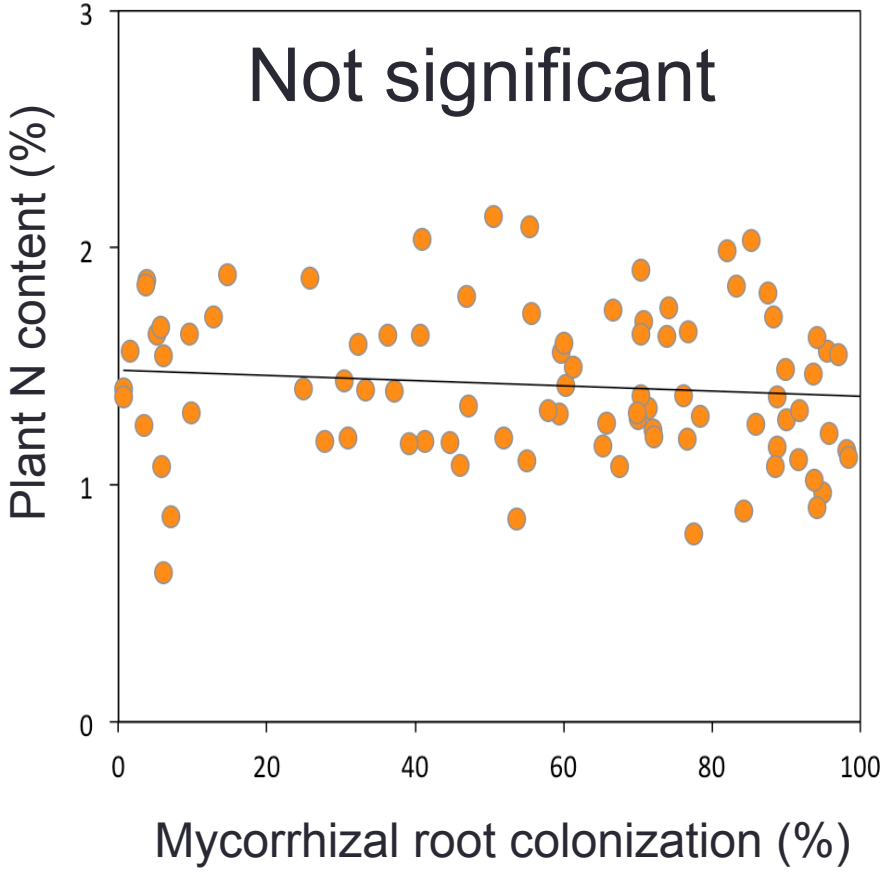
Plant growth- Mycorrhizal Colonization



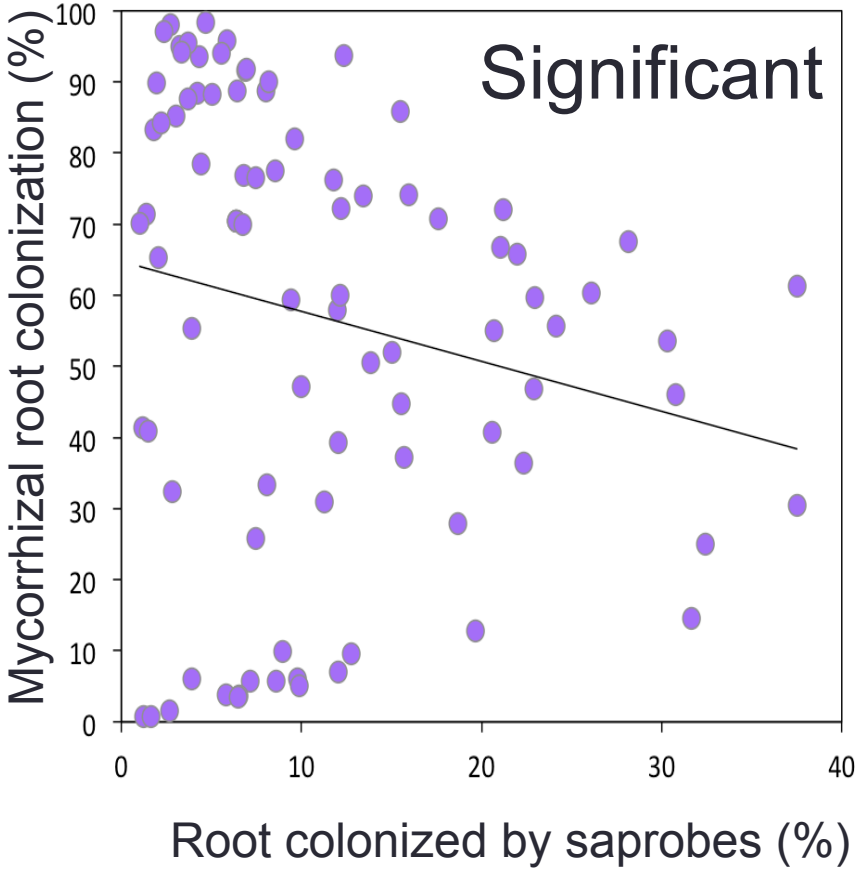
Plant Nitrogen



Plant Nitrogen

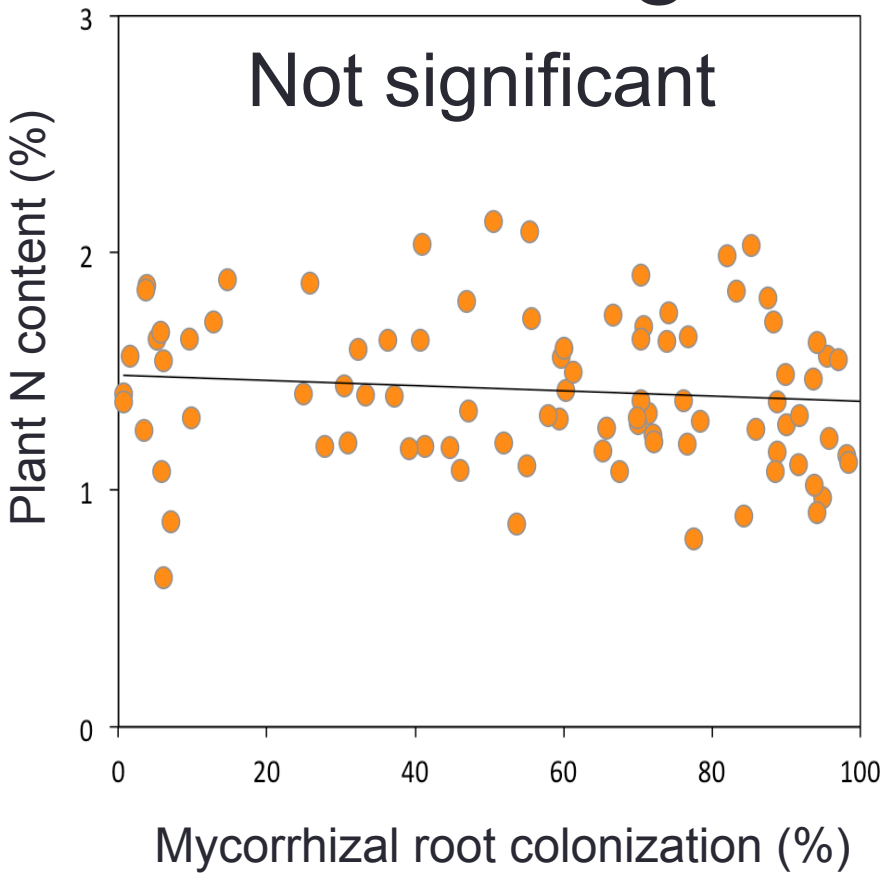


Saprobes

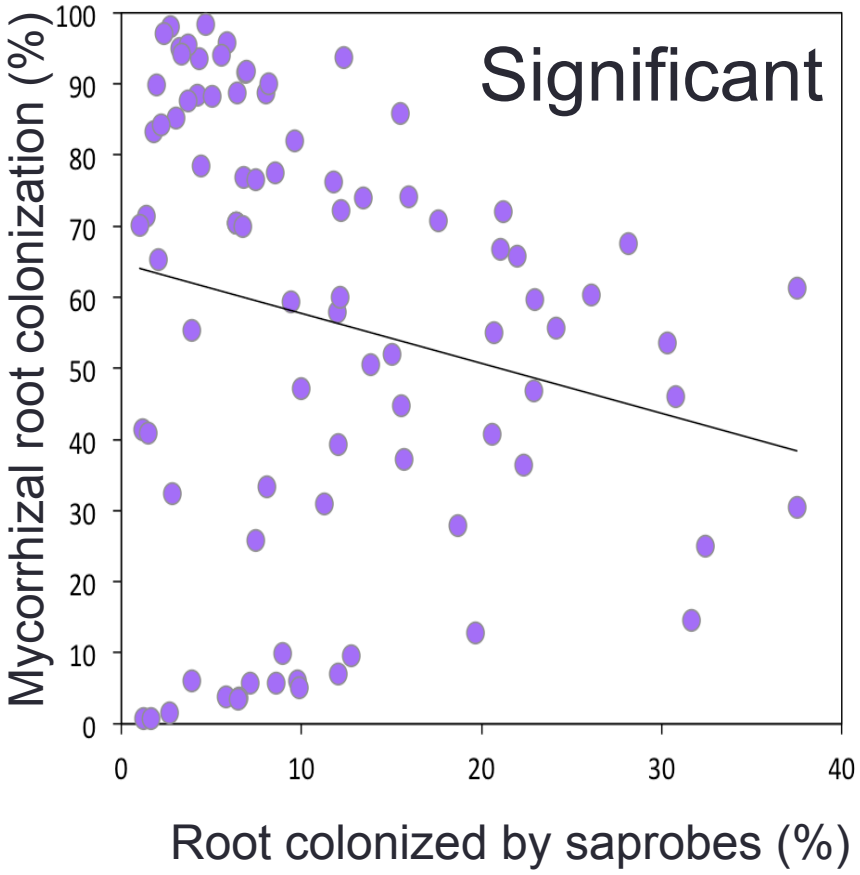


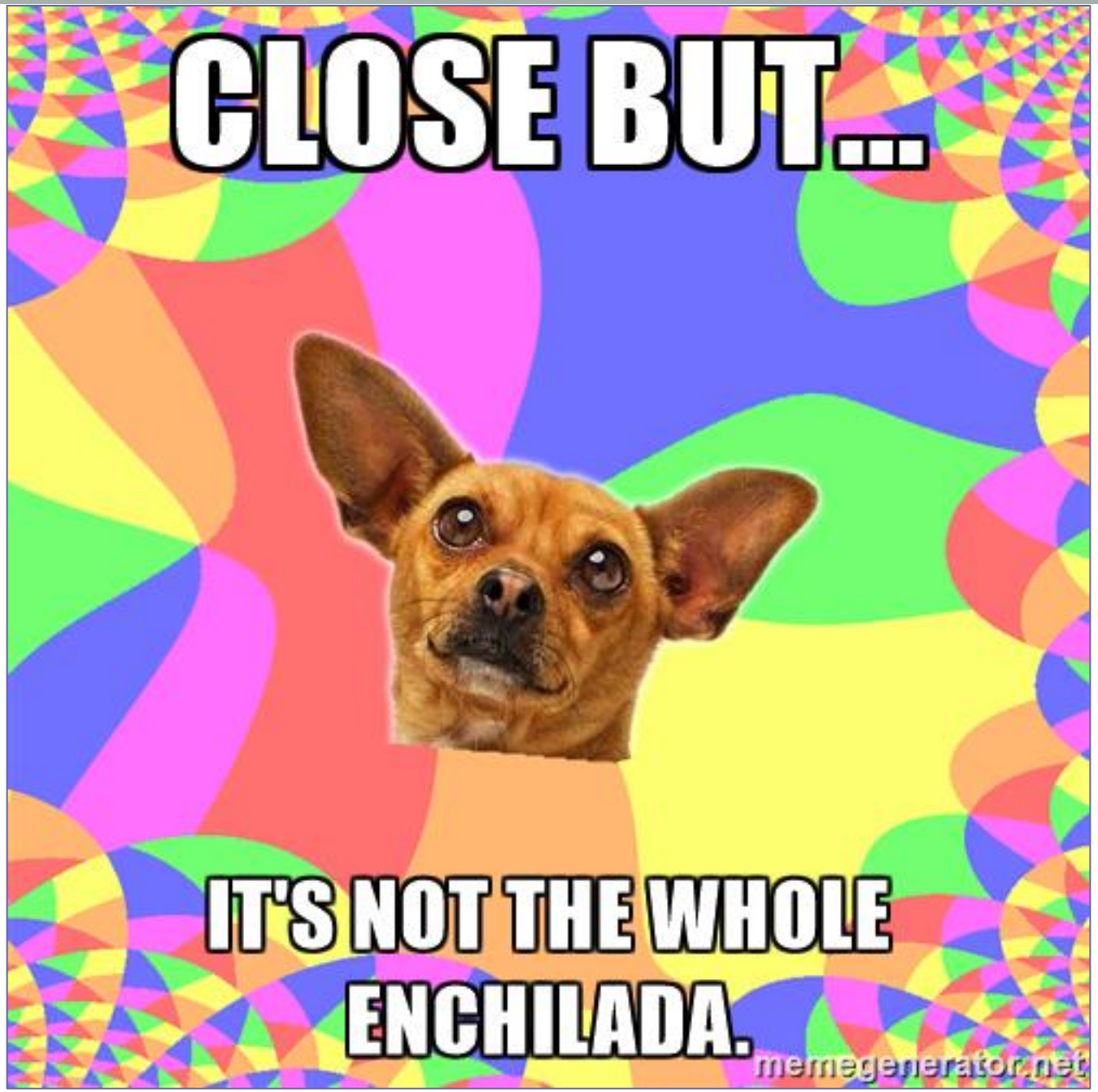
An unexpected result.

Plant Nitrogen



Saprobes




CLOSE BUT...
IT'S NOT THE WHOLE ENCHILADA.
memegenerator.net

Contributors to plant growth

Soil

Mycorrhizal

Contributors to plant growth

Soil

Mycorrhizal

Factor	% Influence	Effect (+ or -)
Organic Matter	44%	+
Nitrogen	21%	+
Moisture	10%	+
pH	6%	+

Contributors to plant growth

Soil

Factor	% Influence	Effect (+ or -)
Organic Matter	44%	+
Nitrogen	21%	+
Moisture	10%	+
pH	6%	+

Mycorrhizal

Structure	% Influence	Effect (+ or -)
Coils	**30%**	**-**
Non-colonized	28%	+
Hyphae	**18%**	**-**
Vesicles	**10%**	**-**

Contributors to plant growth

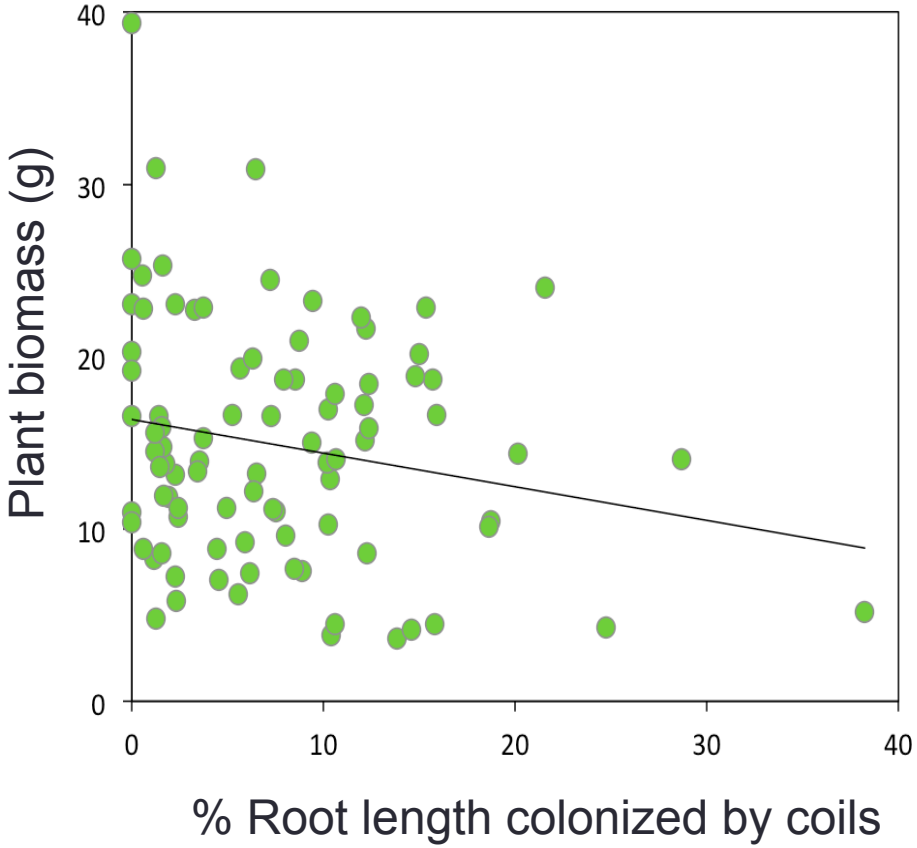
Soil

Factor	% Influence	Effect (+ or -)
Organic Matter	44%	+
Nitrogen	21%	+
Moisture	10%	+
pH	6%	+

Mycorrhizal

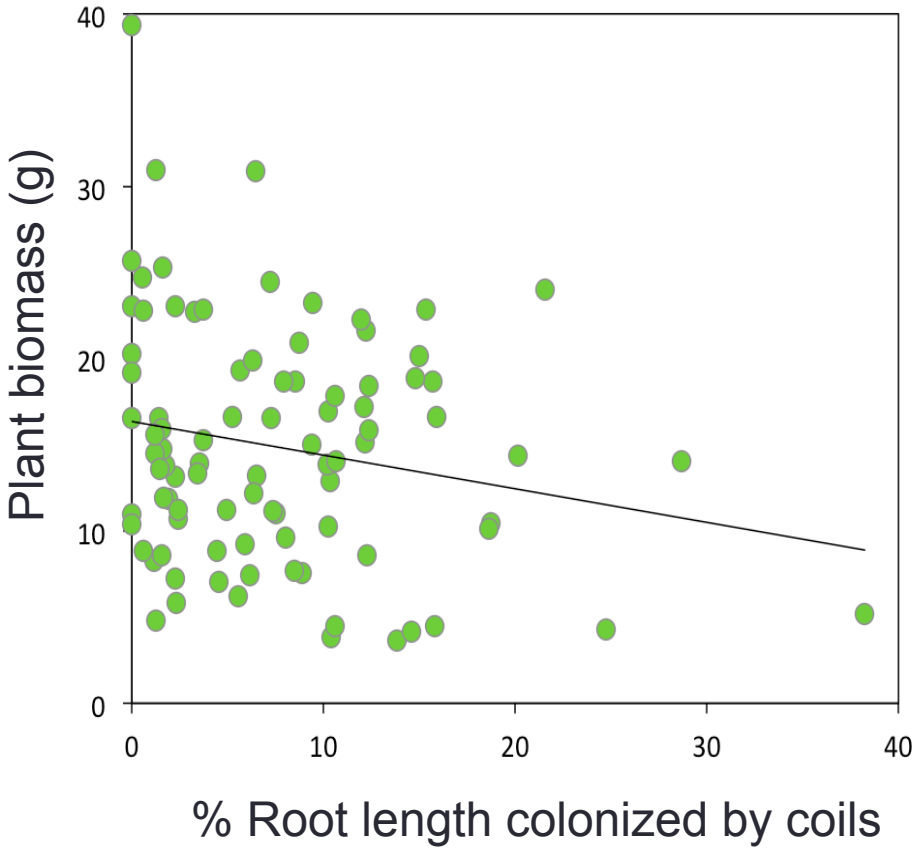
Structure	% Influence	Effect (+ or -)
Coils	**30%**	**-**
Non-colonized	28%	+
Hyphae	**18%**	**-**
Vesicles	**10%**	**-**

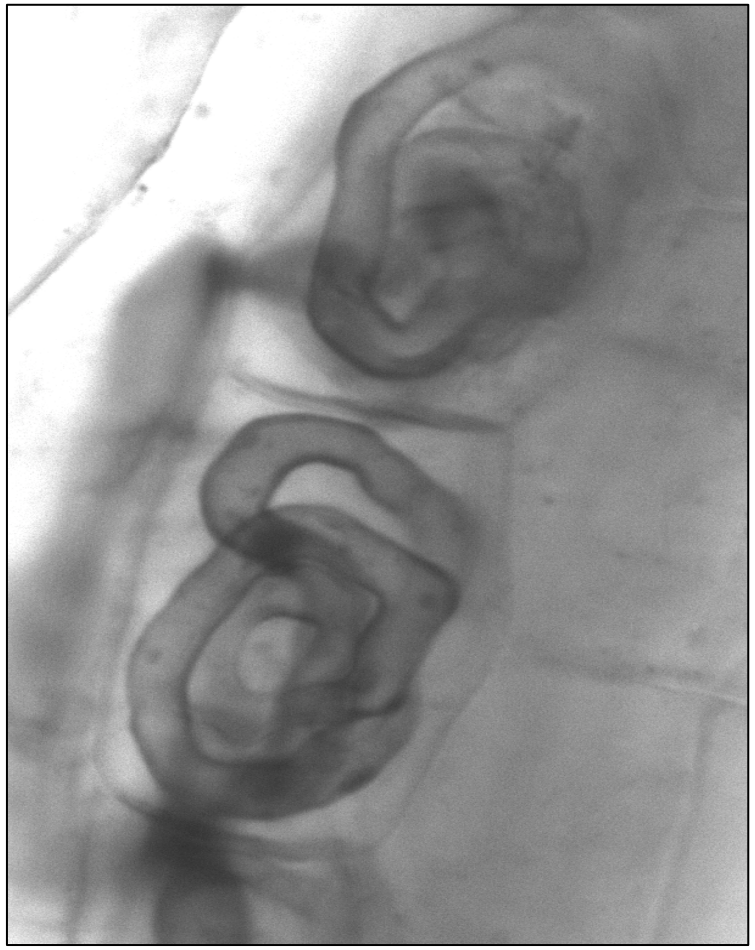
Mycorrhizal Coils



More coils = reduced plant biomass

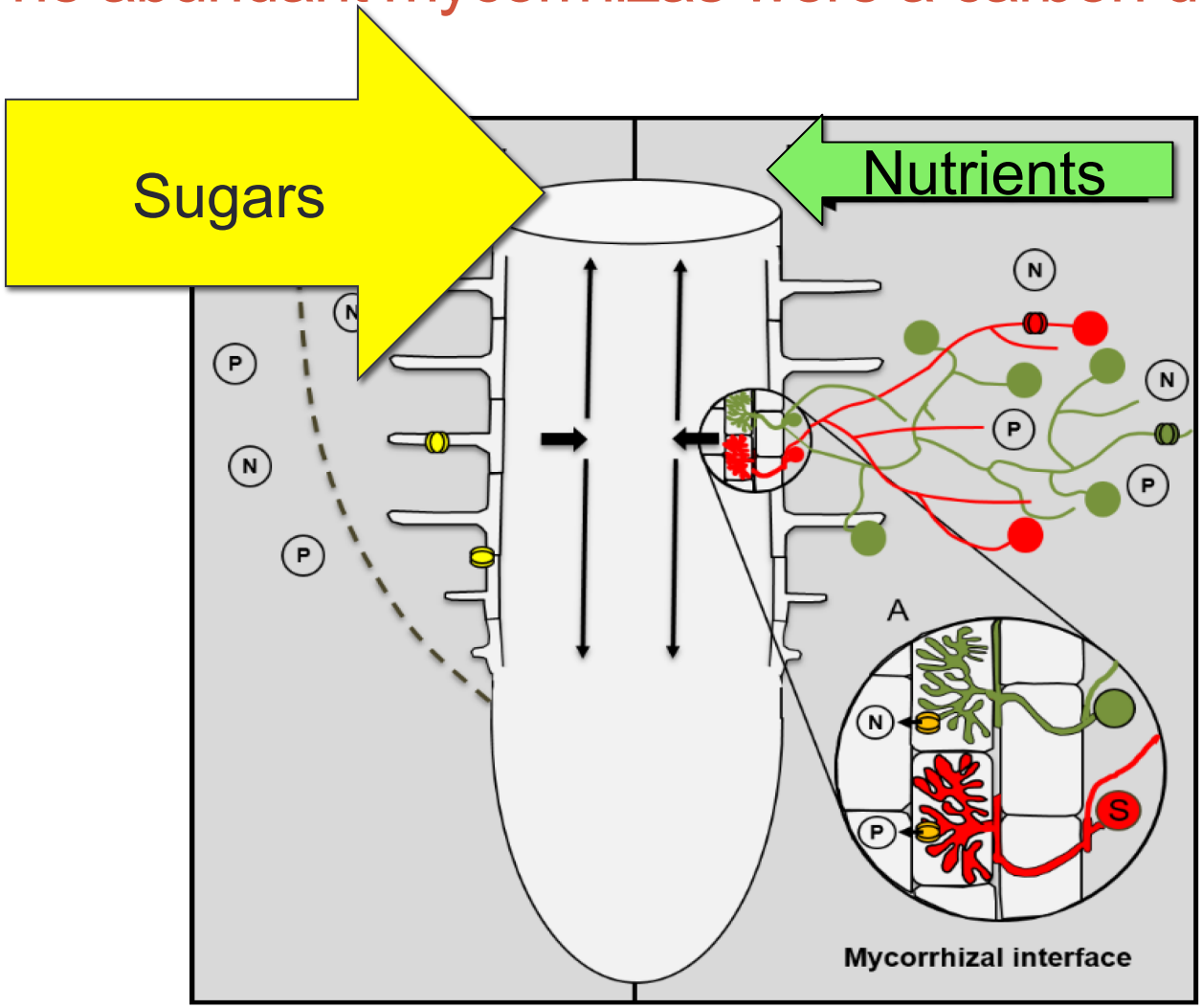
Mycorrhizal Coils





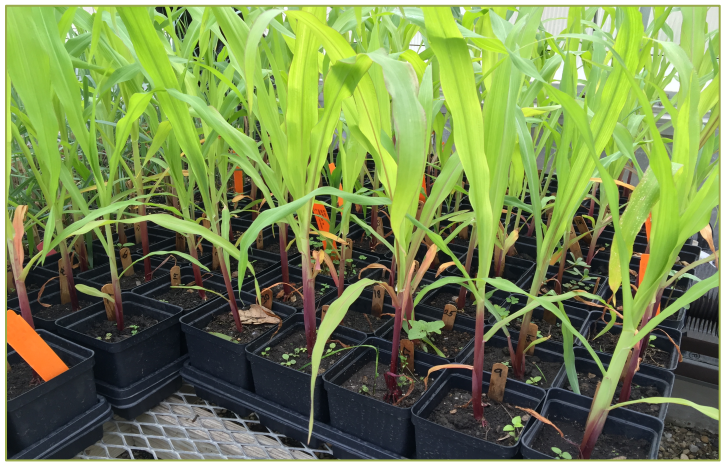
Expensive- require large investments of carbon to build

The abundant mycorrhizas were a carbon drain:



Bioassay: Take home messages:

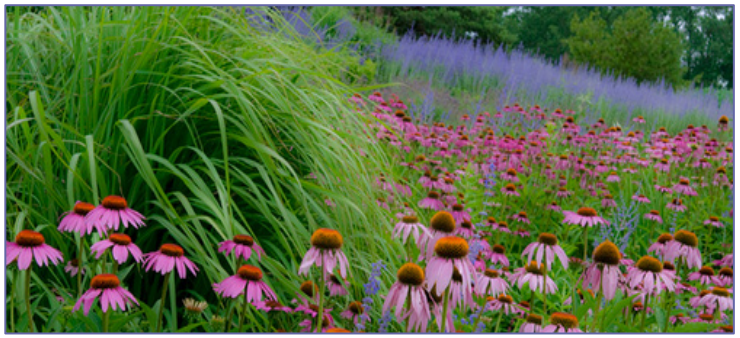
- Easy, fast way to assess mycorrhizal infectivity and effects on plant growth.



- Important to test mycorrhizal activity *before* before considering treatments.

At CHICAGO BOTANIC GARDEN

- Mycorrhizas were highly infective, but root colonization was not correlated with plant growth or nutrient uptake.



To inoculate or not?

This is an ideal opportunity to introduce inoculum, and develop a healthy diversity of mycorrhizal fungi.

How to introduce a diverse inoculum?

- Collect soil plugs from high quality native prairies or forests;
- Add to seed propagation mixes or into soil when planting shrubs and trees.

To inoculate or not?

This is an ideal opportunity to introduce inoculum, and develop a healthy diversity of mycorrhizal fungi.

How to introduce a diverse inoculum?

- Collect soil plugs from high quality native prairies or forests;
- Add to seed propagation mixes or into soil when planting shrubs and trees.

Thank you!