ROOT GROWTH & FUNCTION
--The Origin of All that is Green--

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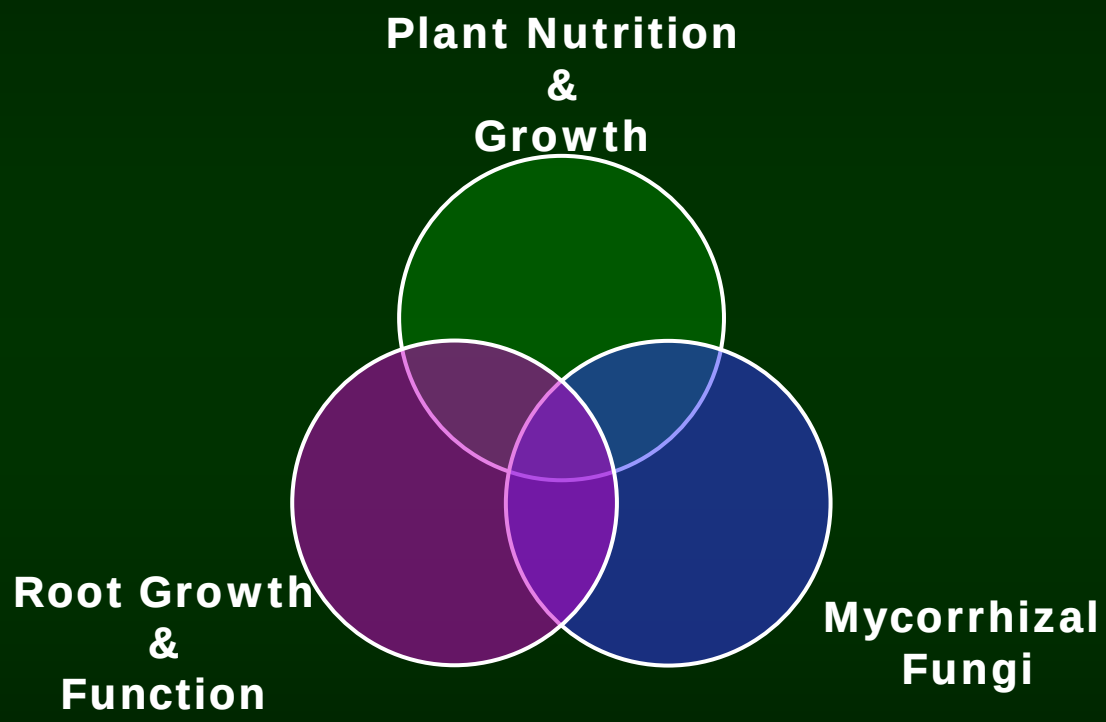
NURSERY RESEARCH PRIORITIES

- Pathogen/Pests
- Media
  - Formulations
  - Amendments
- Containers
  - Size,Configuration
  - Labor
- Hardiness
- Weed Control

- Propagation
  - Cuttings
  - Tissue Culture
  - Labor
  - Turnover
- Nutrition
  - Uptake
  - Efficiency
  - Timing
- Rhizosphere Organisms

ROOT PHYSIOLOGY RESEARCH

- Nutrition
  - Uptake
  - Efficiency
  - Timing
- Propagation
  - Cuttings
  - Tissue Culture
- Rhizosphere Organisms



Physiological aspects of root development, & function influencing crop productivity and quality.

CROP FOCUS

- Woody Perennials
  - Largest portion of PNW nursery crops.
  - Underlying mechanisms for understanding woody plant metabolism requires long-term research.
- Ericaceae
  - Cross over between nursery and small fruit production.
  - Special nutritional requirements.
- Geophyte Floral Crops
  - Grown for cut flower and vegetative production in PNW.
  - Optimal requirements of production dependant on patterns of nutrient and carbon partitioning.

RESEARCH GOAL #1

Help develop cost effective and environmentally sustainable production practices

-Reduce inputs
-Reduce nutrient runoff
-Increase nutrient use efficiency
-Increase water use efficiency

Nutrient Management

- Importance:
  - Optimal rates, timing of application, and formulations used are not well established.
  - Links between nutritional status and stock quality are poorly defined.

RESEARCH GOAL #2

Improve production efficiency and end product quality

-Decrease labor
-Reduce time to market
-Improve quality

Regulation of Root Growth

- Importance:
  - Root formation is the rate limiting step in production of cuttings and tissue culture plants
  - Amount, type, and form of roots correlated with stock quality and plant survival after transplanting

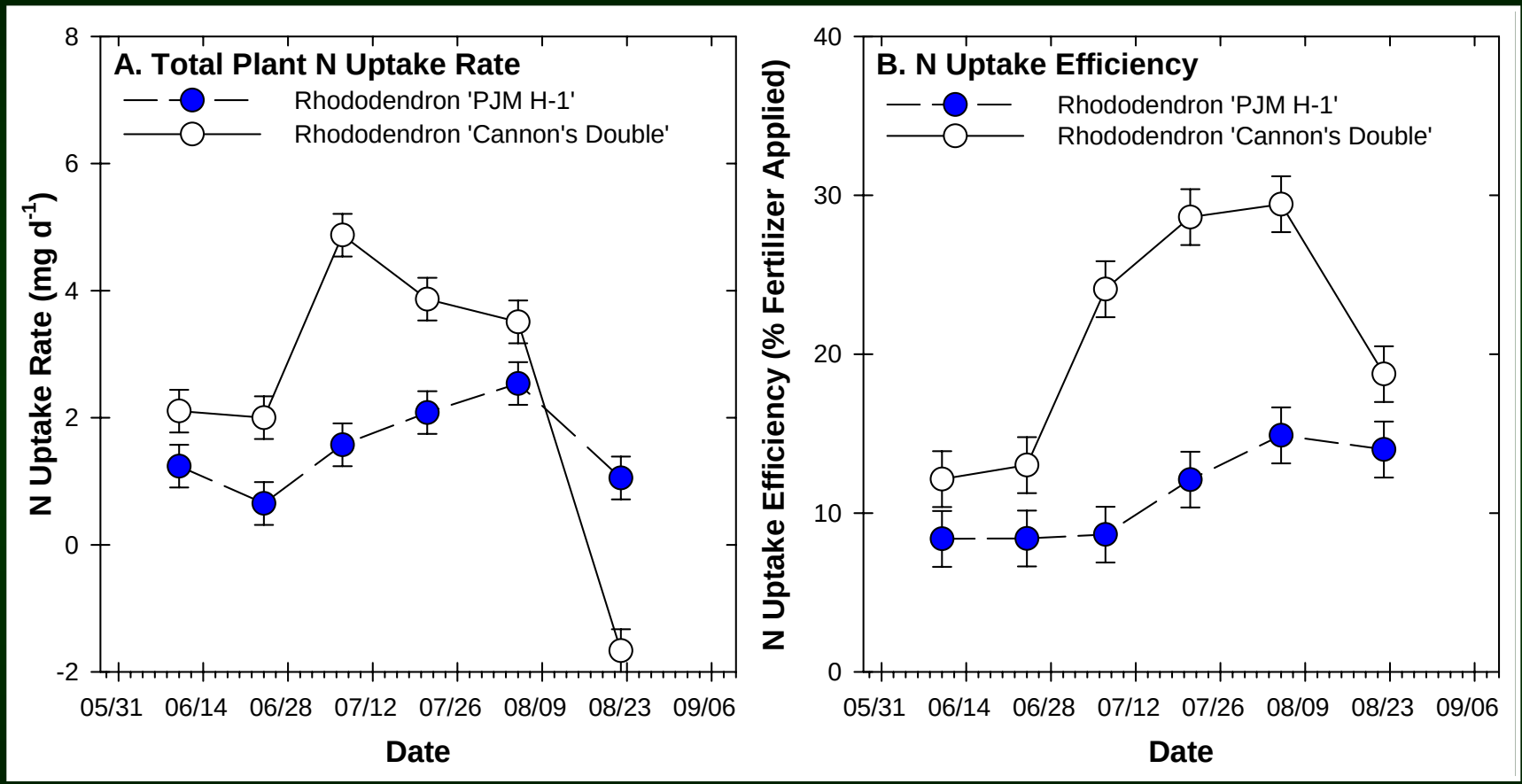
Mycorrhizal Fungi

- Importance:
  - Optimal uses of fungi during commercial nursery production
  - Commercialization without application criteria in horticultural systems.
  - Variable understanding of expected results.

NUTRIENT MANAGEMENT

- Program Scope:
  - Environment/culture
  - Formulations
  - Application methods
  - Timing
  - Plant type
  - Mycorrhizal Fungi
- Assessments:
  - Plant, soil, and water nutrient analyses
  - 15N-compounds
  - Plant growth
  - Storage reserves
  - Transplant quality

NUTRIENT MANAGMENT
– Timing of Fertilizer Applications –

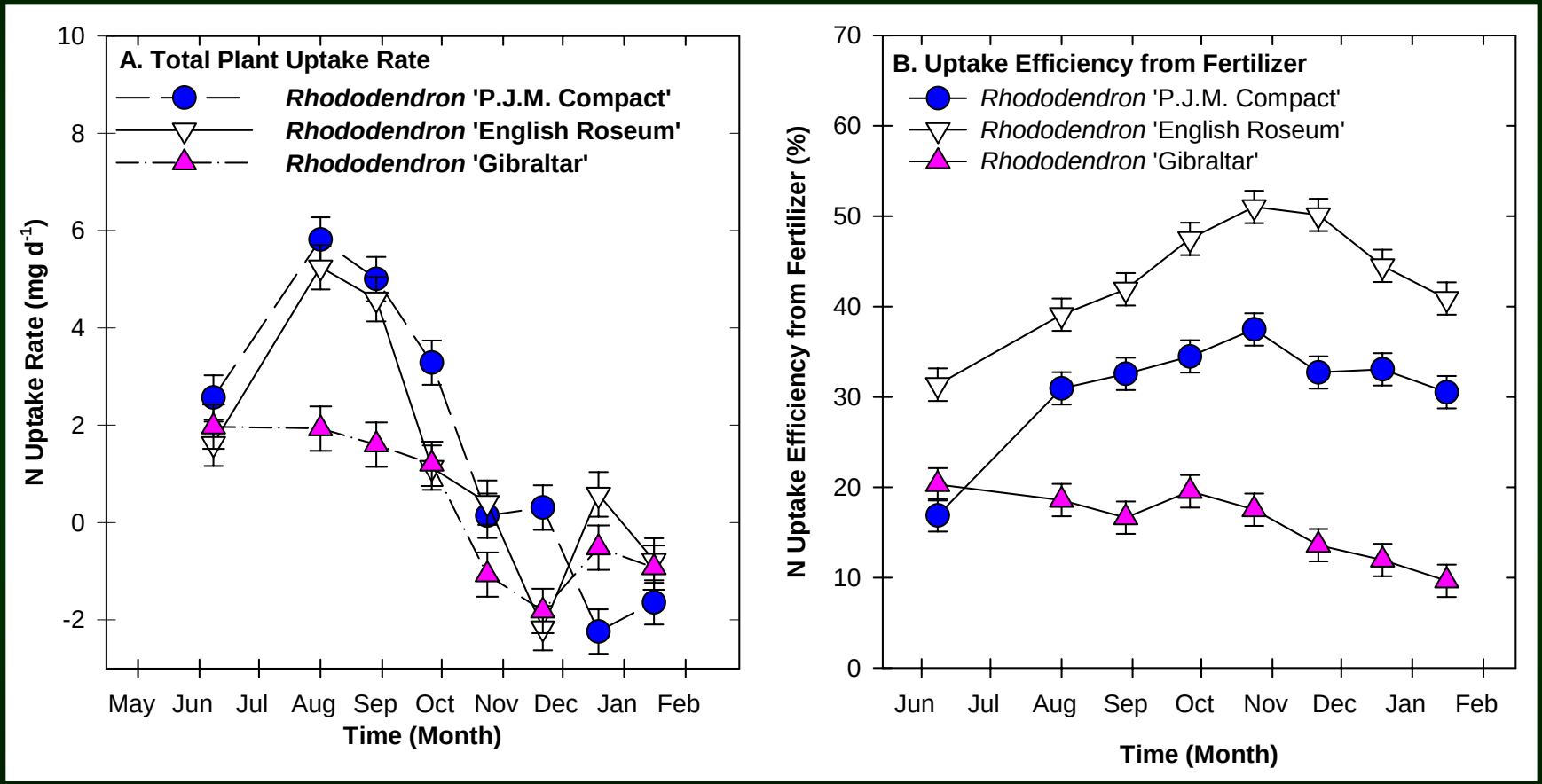


Highest uptake efficiency occurs when fertilizer availability is synchronized with plant uptake

(With Oregon State and Mississippi State University)

Bi et al. 2006

NUTRIENT MANAGMENT
– Timing of Fertilizer Applications –

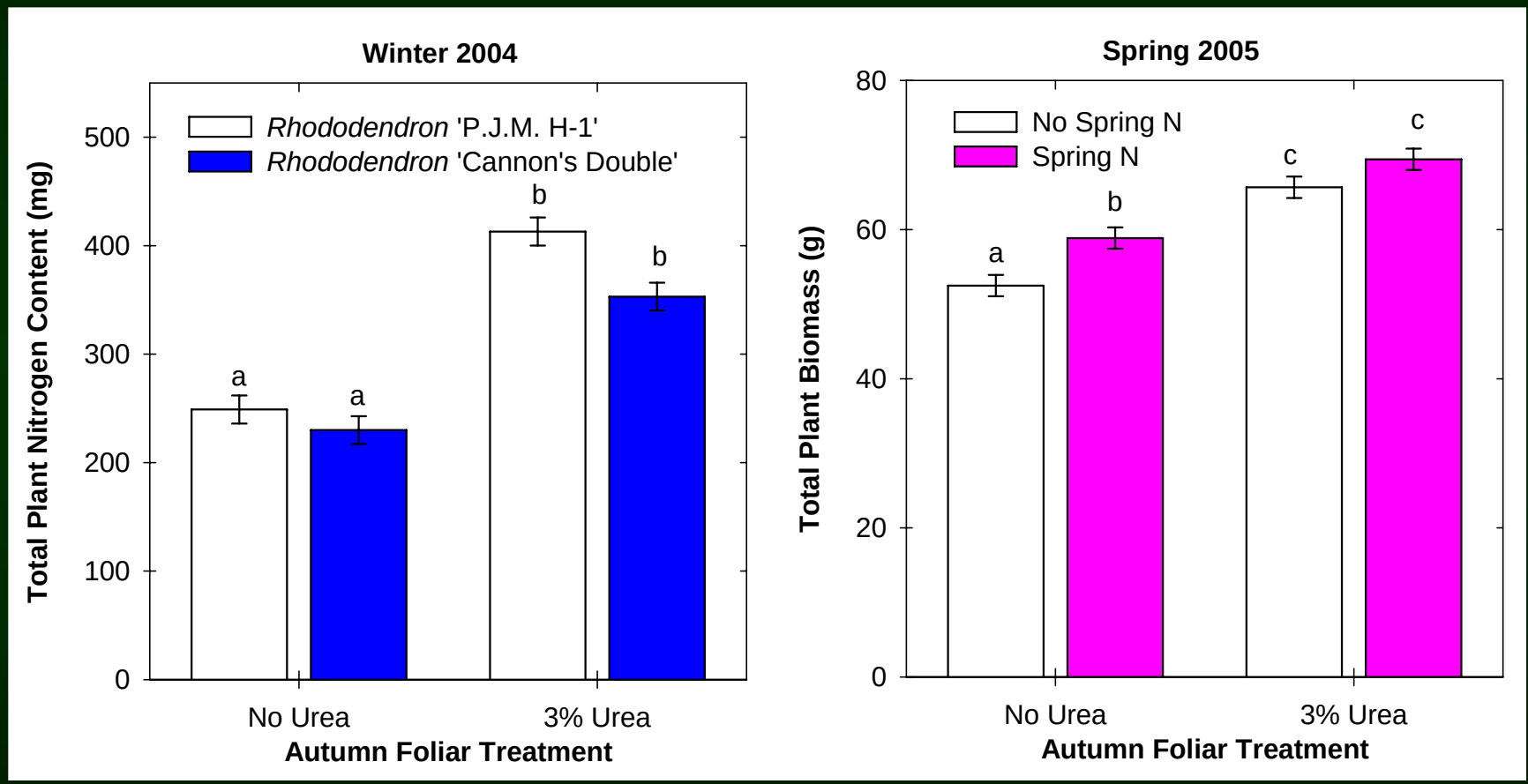


Uptake can occur in the autumn.
Root and leaf losses decrease uptake efficiency

(With Oregon State and Mississippi State University)

Bi et al. 2006

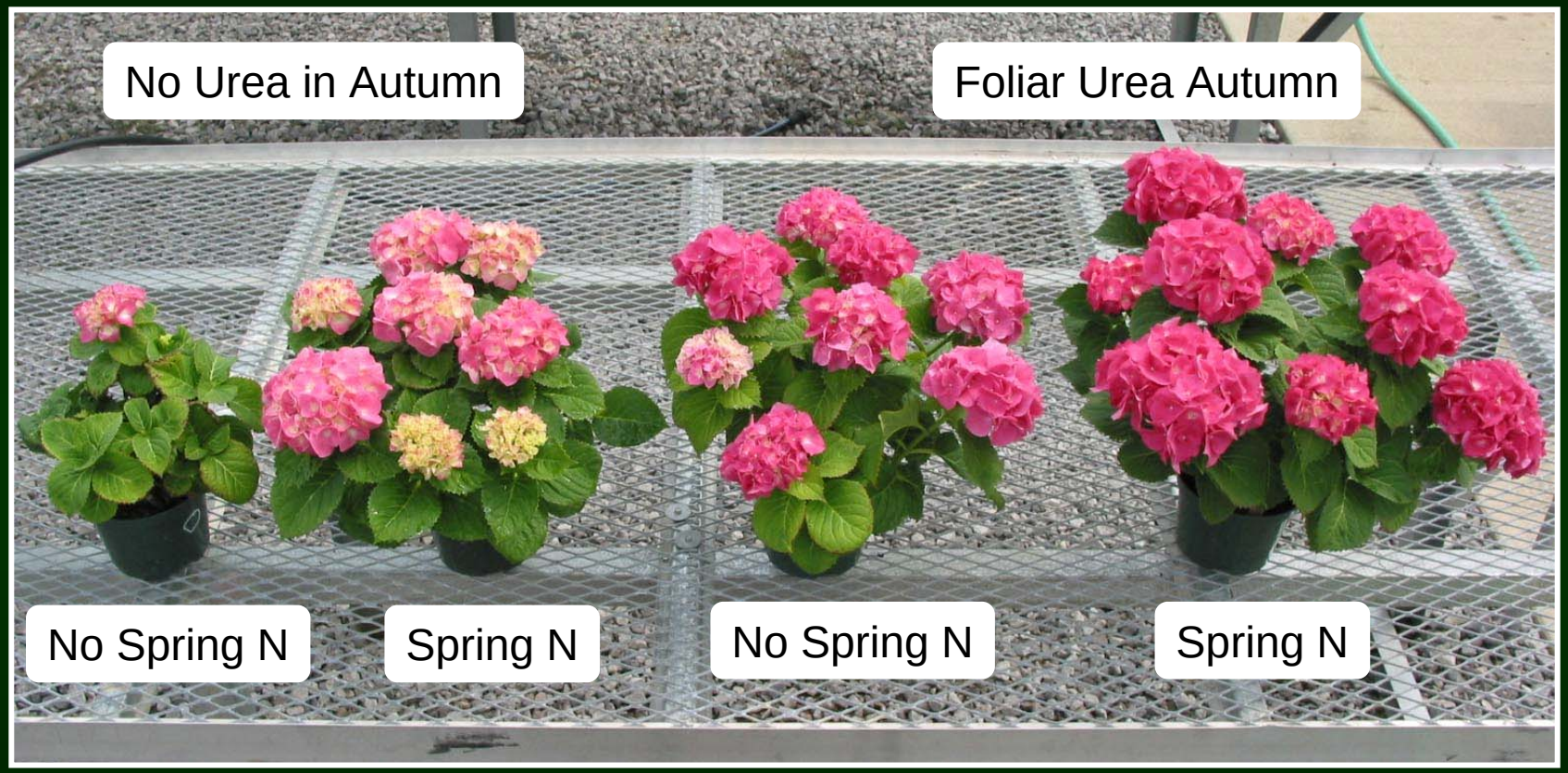
NUTRIENT MANAGMENT
– Fertilizer Application Methods –



Foliar Urea improved growth and efficiency of fertilizer use

(With Oregon State and Mississippi State University) Bi et al. 2006

NUTRIENT MANAGMENT
– Fertilizer Application Methods –



Hydrangea

Foliar urea improved growth and flowering.
Foliar urea decreased dependence on N in spring.

(Mississippi State University)

Bi 2006

NUTRIENT MANAGMENT
– Integrated Nutrient Management –

Defoliant in Autumn

Urea & Defoliant in Autumn

Using foliar urea with defoliant improves performance

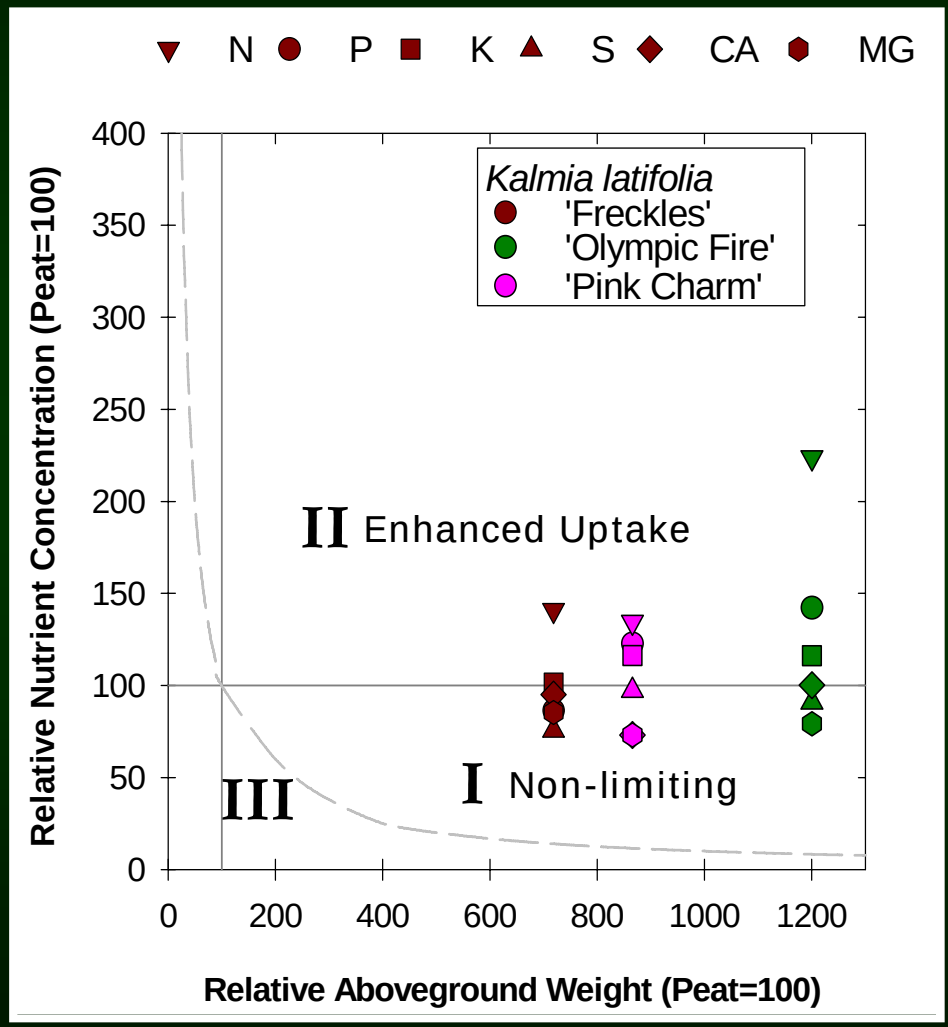
(With Oregon State and Mississippi State University)

Bi et al. 2005

NUTRIENT MANAGMENT
– Media Composition –

Kalmia latifolia

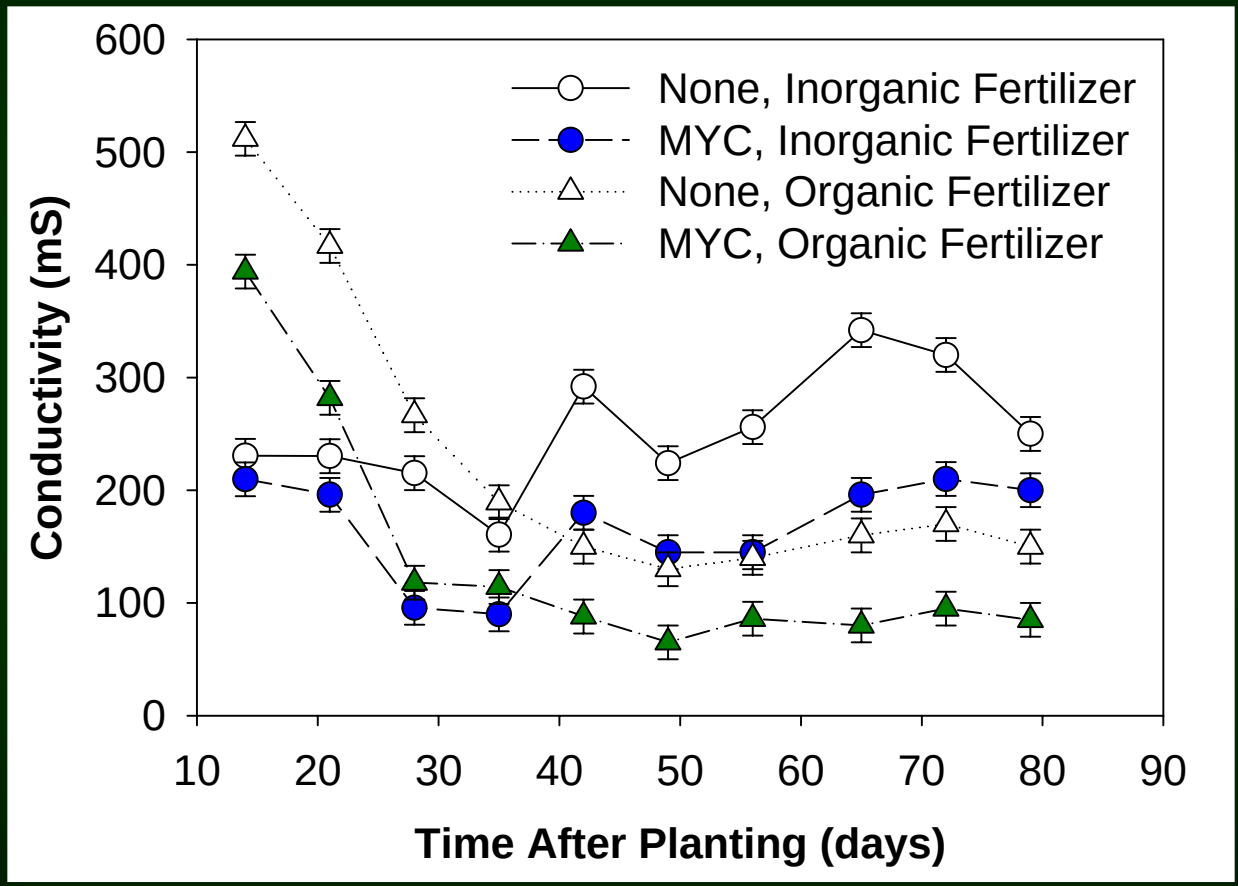
Coir can be use to improve growth and enhance uptake of N, P, and K



Scagel 2003

NUTRIENT MANAGEMENT
– Mycorrhizal Fungi & Fertilizer Type –

Vaccinium ovatum



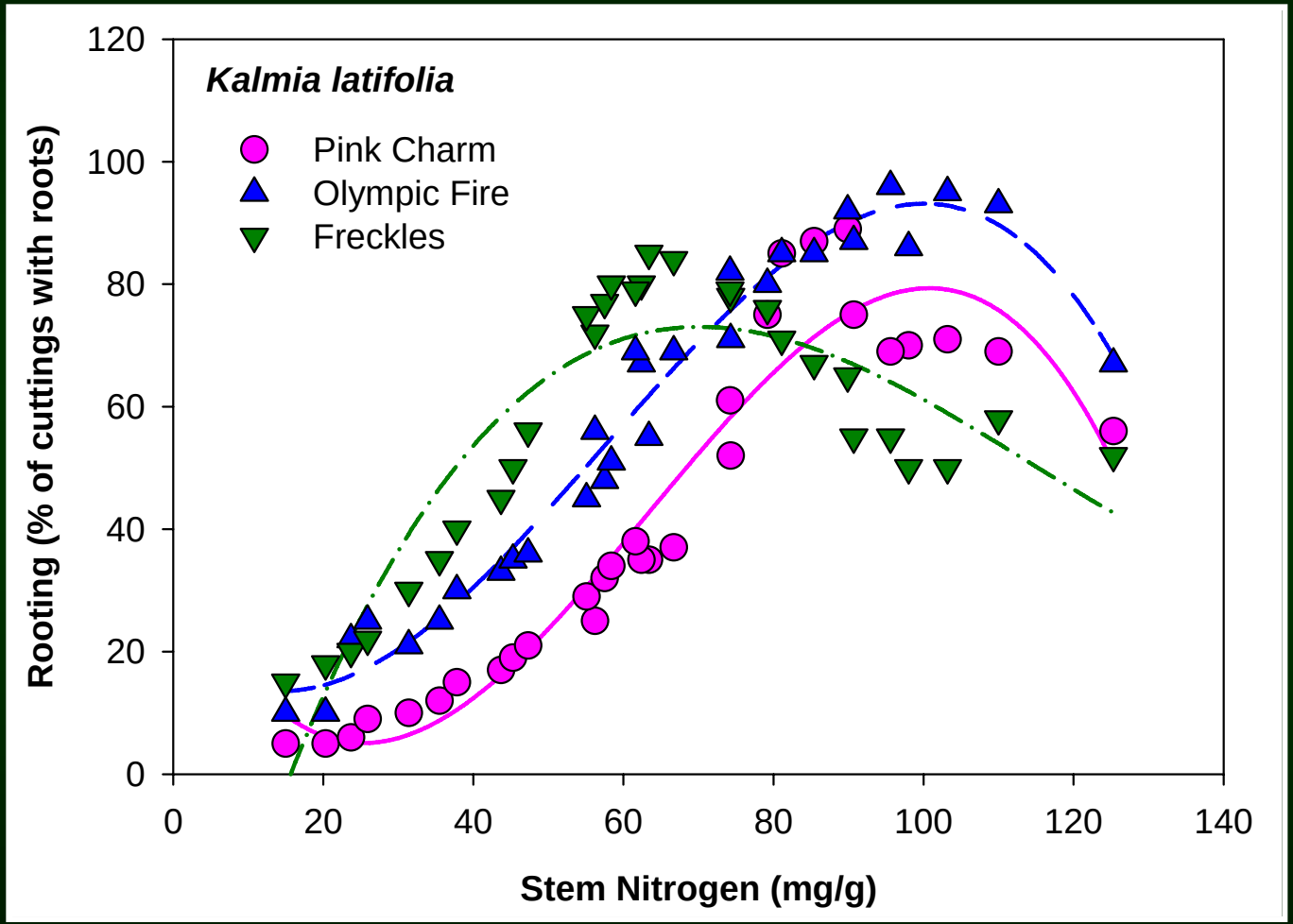
Mycorrhizae decreased conductivity of leachate

Scagel 2006

REGULATION OF ROOT GROWTH

- Program Scope:
  - N & C metabolism
    - Storage reserves
    - Stock plant nutrition
  - Hormones
    - IAA
    - Ethylene
    - Polyamines
  - Mycorrhizal Fungi
    - AMF
    - Ericoid
    - Ecto
    - Arbutoid
- Assessments:
  - Hormone analysis
  - Nutrition & composition
  - Rooting/survival
  - Gene regulation

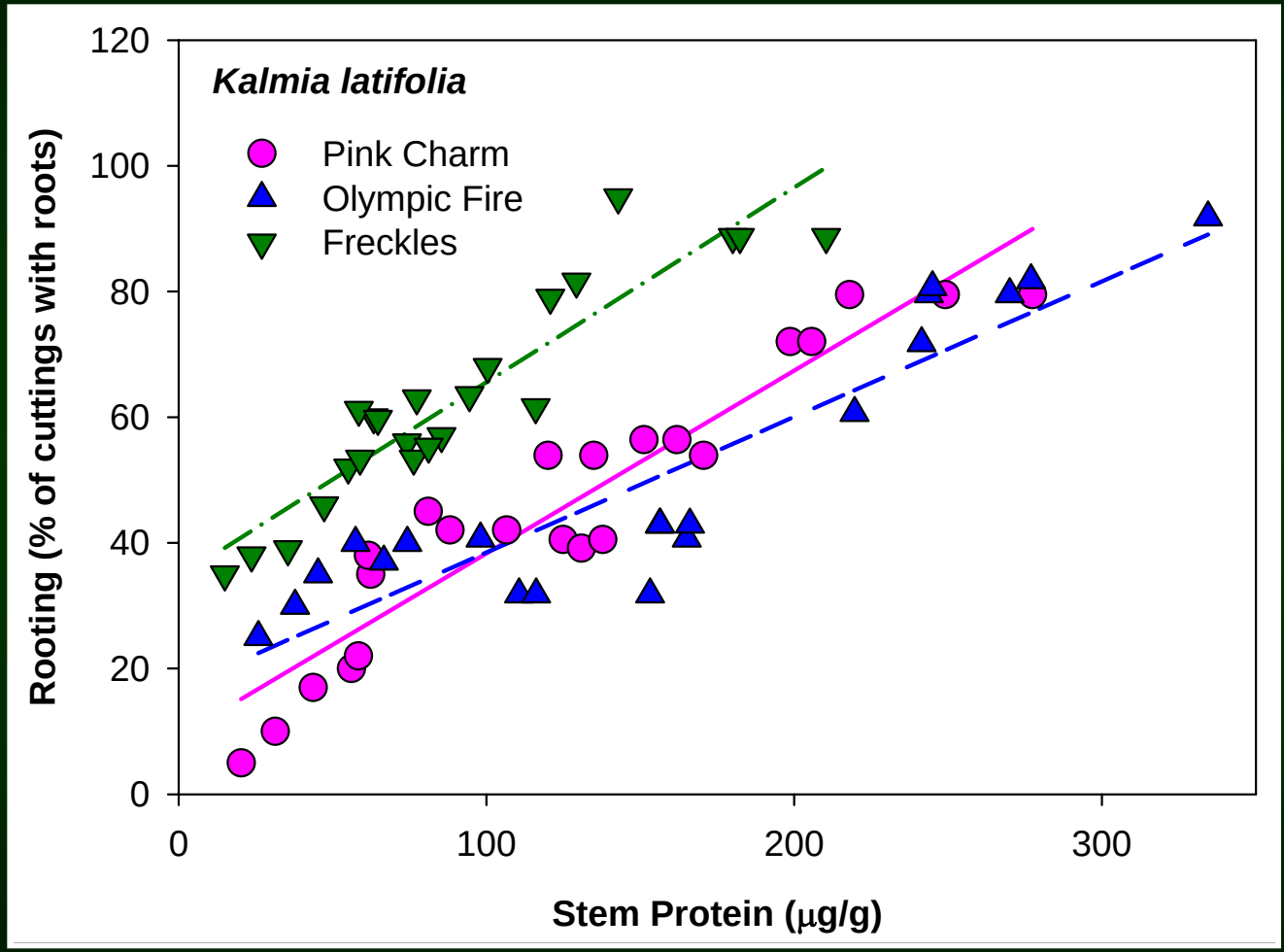
REGULATION OF ROOT GROWTH
– Plant Composition –



Optimal levels of stem N for rooting

Scagel 2001

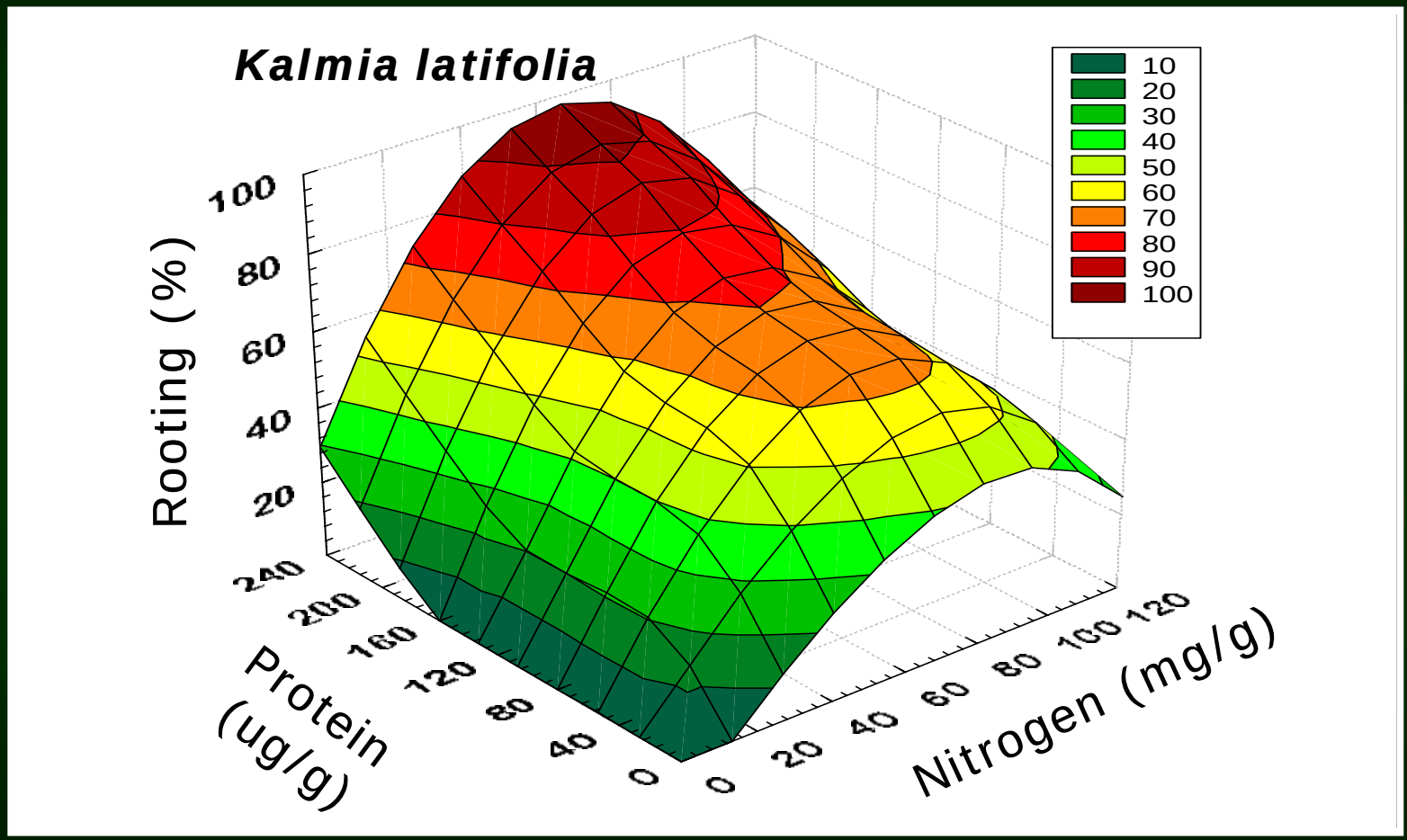
REGULATION OF ROOT GROWTH
– Plant Composition –



Form of N (protein) may be equally important to rooting

Scagel 2001

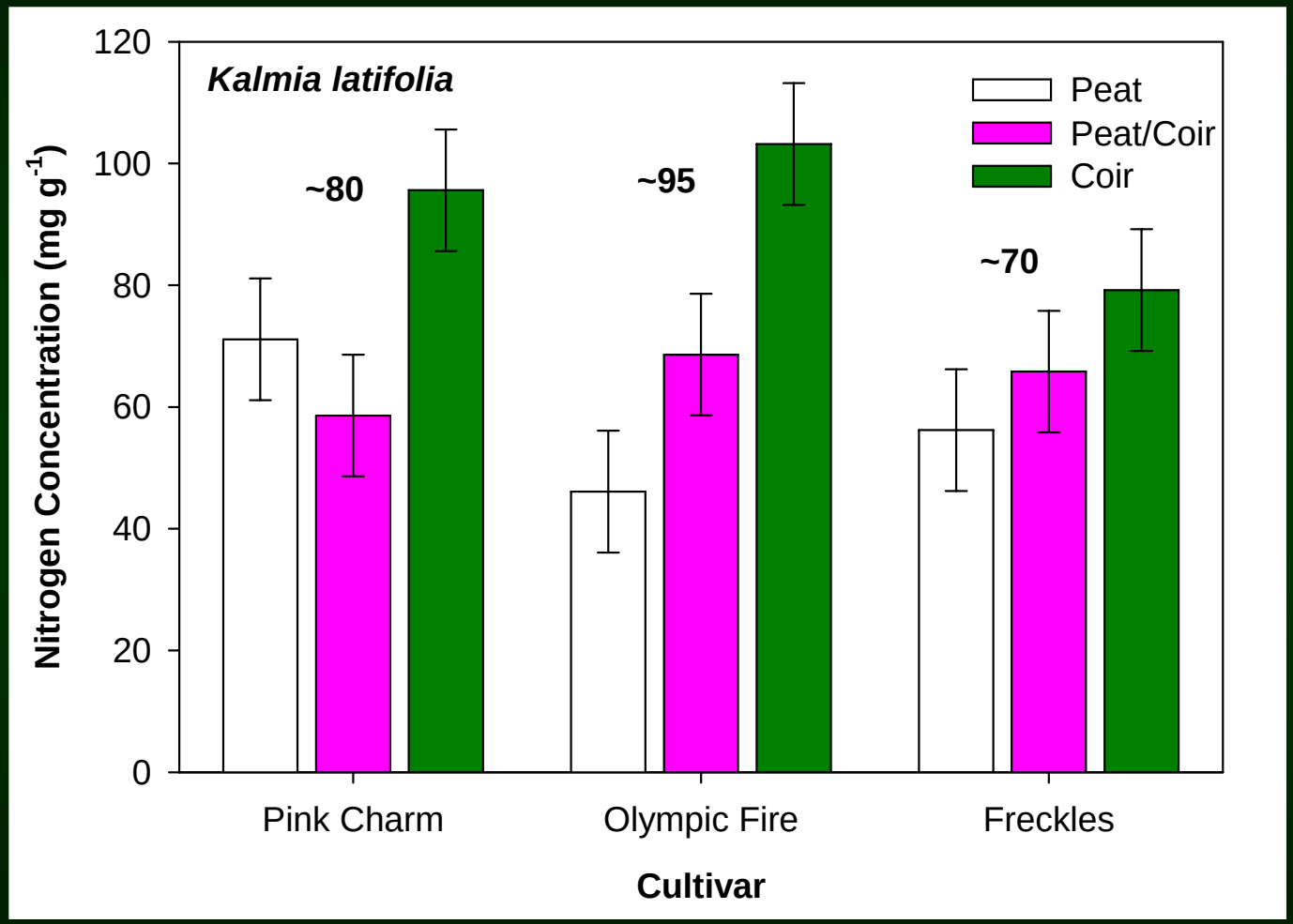
REGULATION OF ROOT GROWTH
– Plant Composition –



Optimal rooting as a function of N form and N level

Scagel 2001

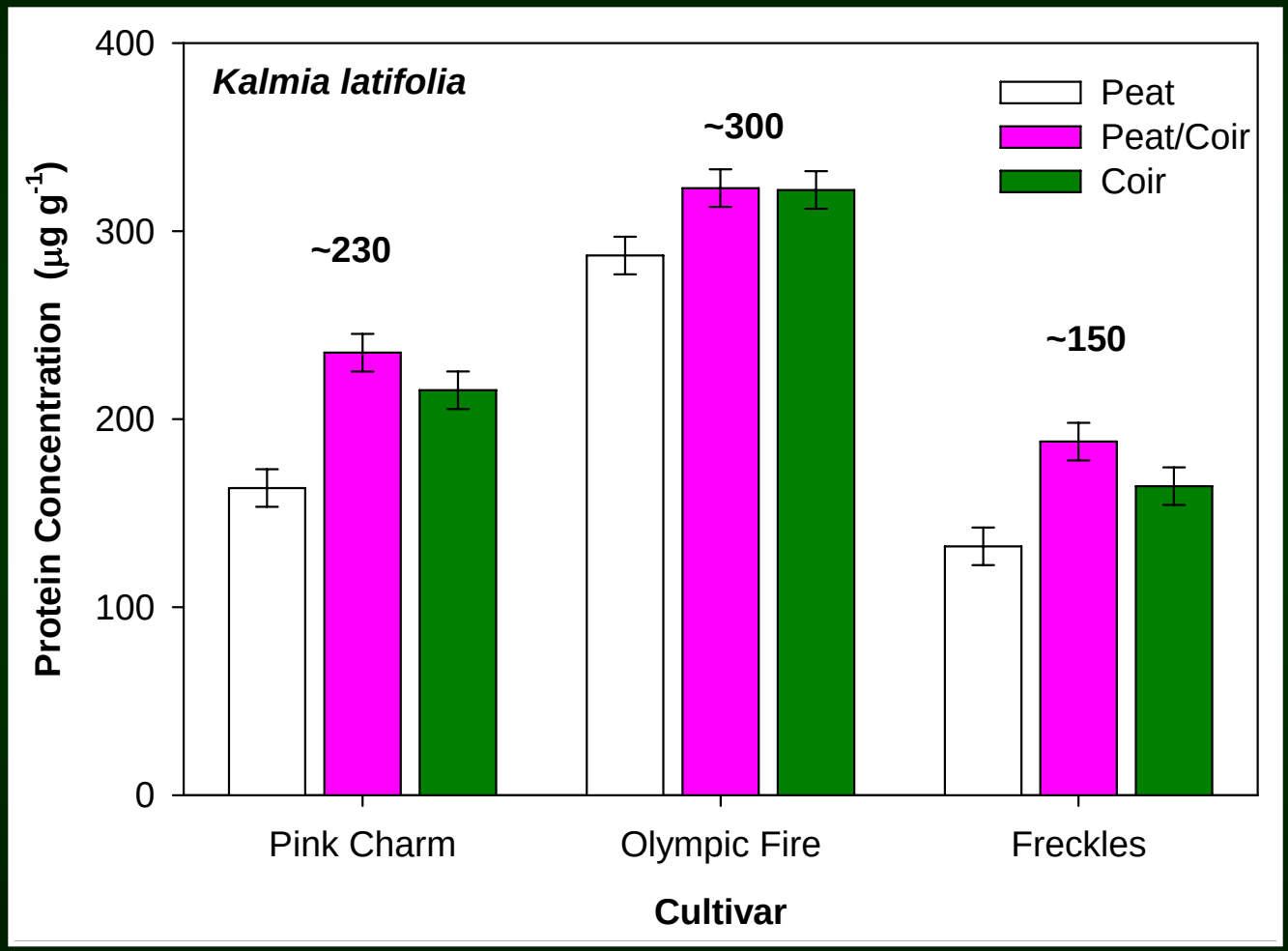
REGULATION OF ROOT GROWTH
– Media Composition –



Media composition effects on N content can alter rooting

Scagel 2002

REGULATION OF ROOT GROWTH – Media Composition –

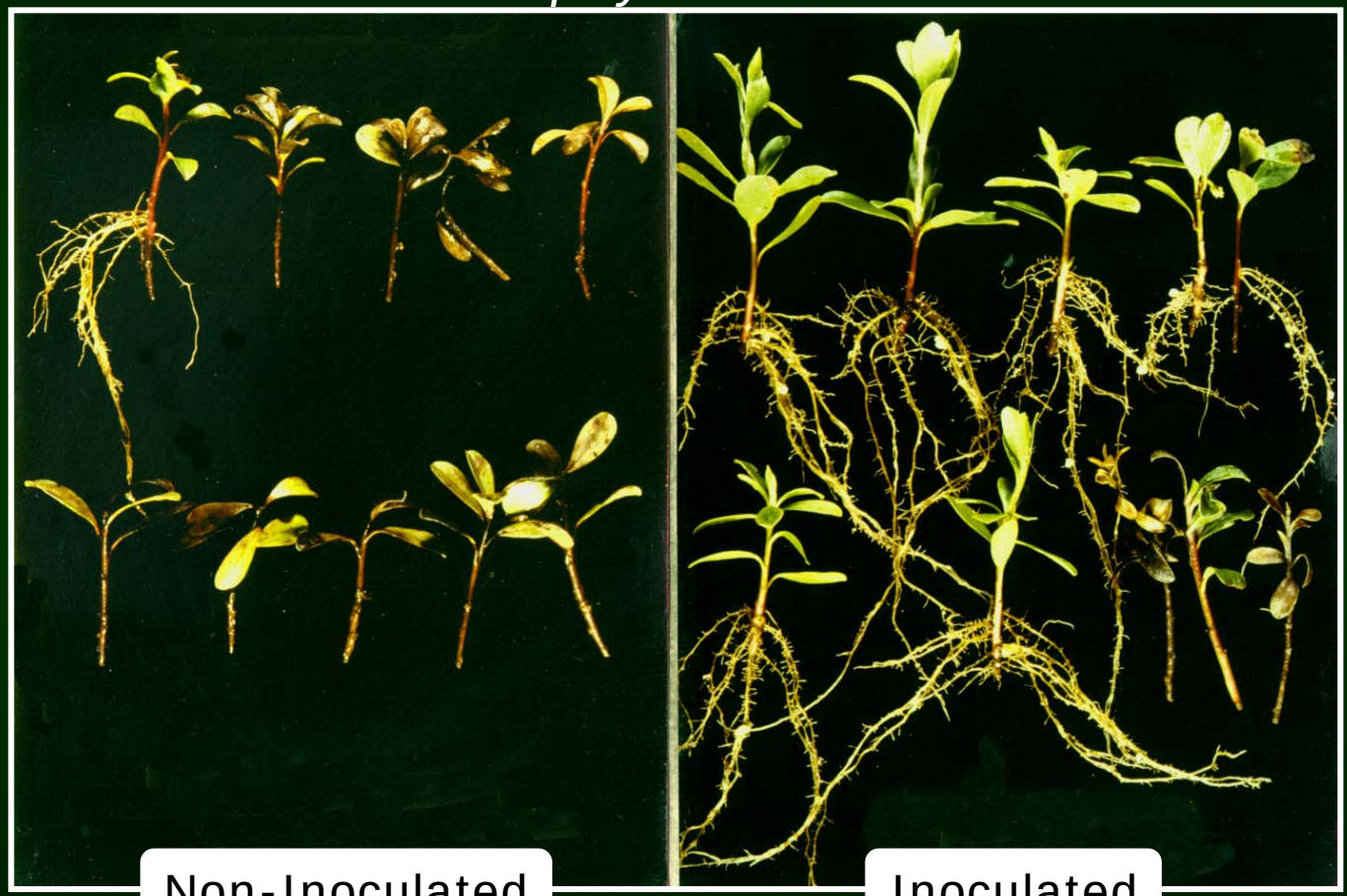


Media composition effects on protein content can alter rooting

Scagel 2002

REGULATION OF ROOT GROWTH
– Mycorrhizal Fungi in Propagation –

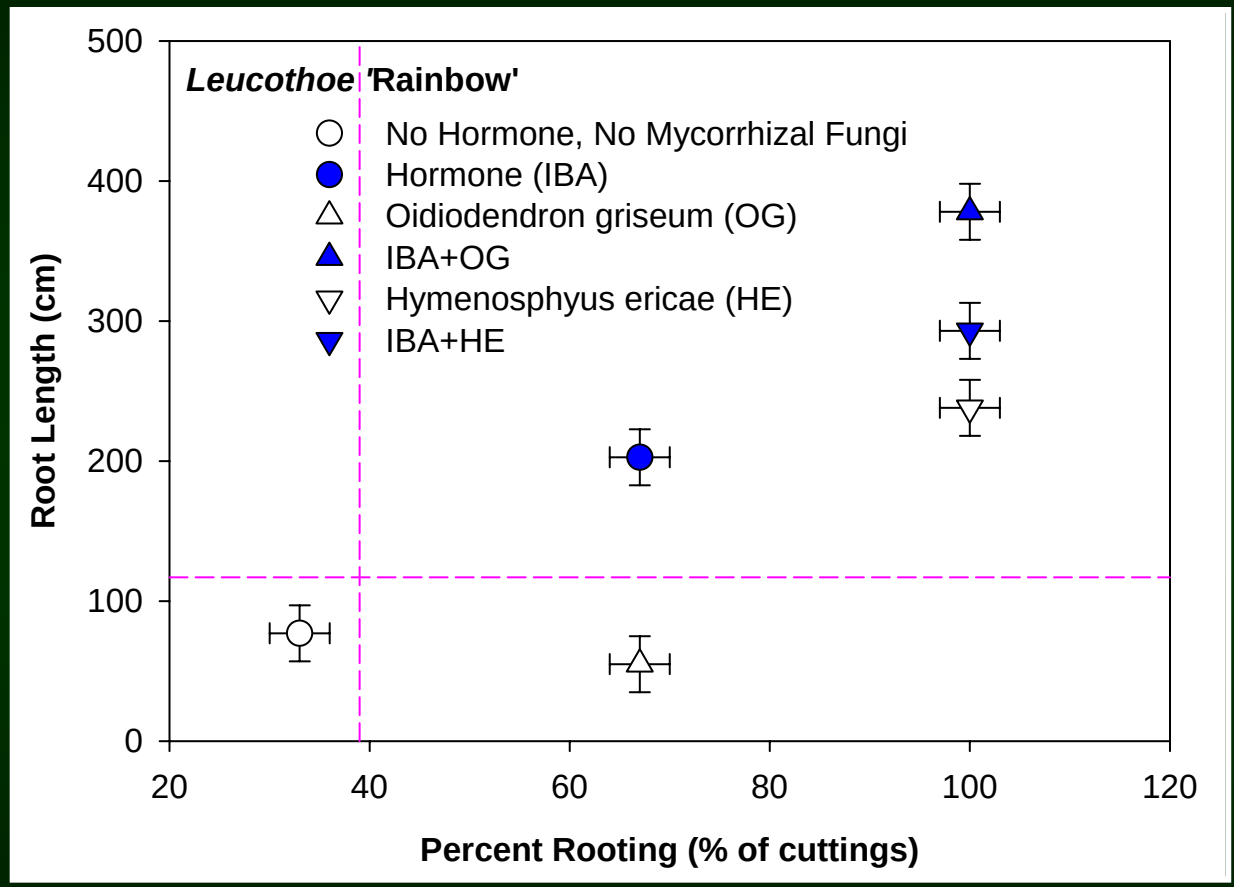
Arctostaphylos uva-ursi



Increased adventitious roots on cutting using mycorrhizal fungi

Linderman & Call 1977

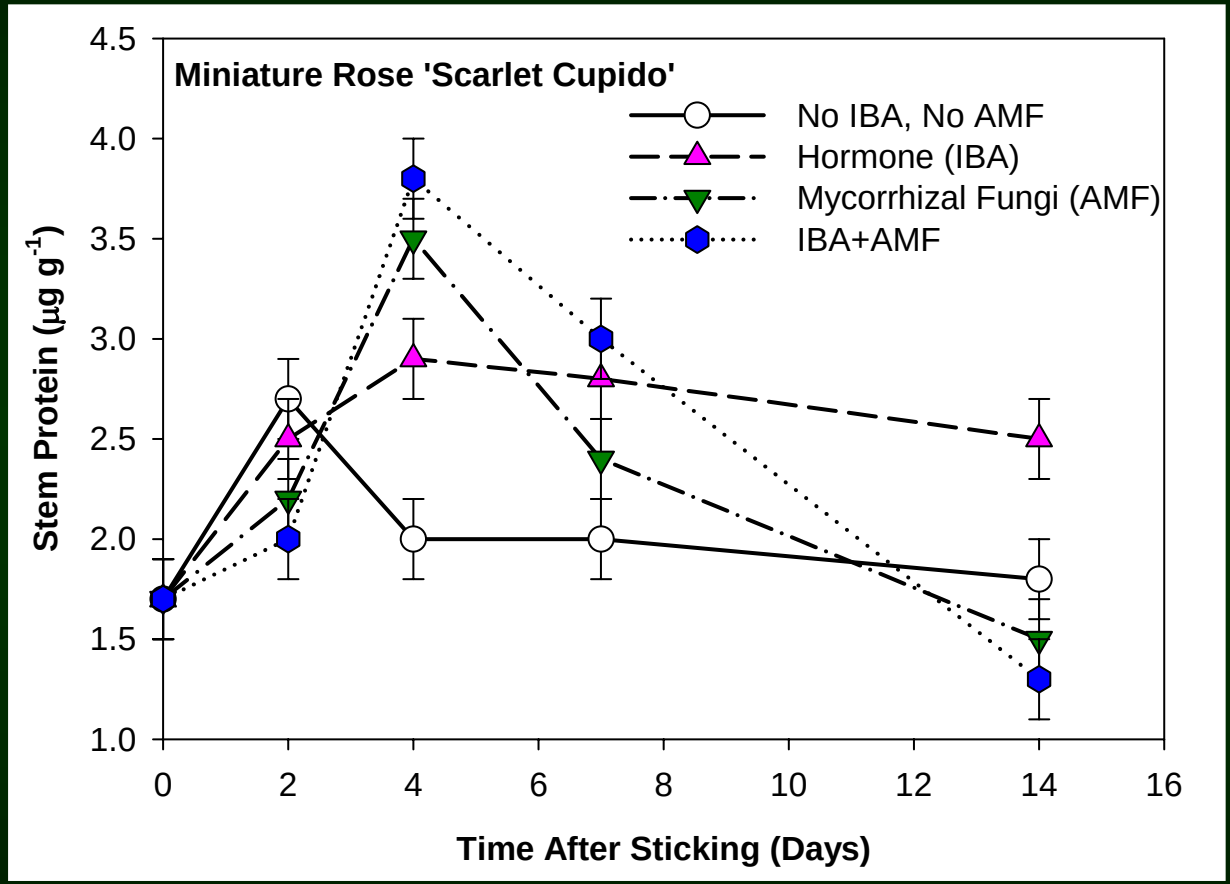
REGULATION OF ROOT GROWTH –Mycorrhizal Fungi in Propagation –



Adding fungi to the rooting medium can achieve a rooting response that is equal to or better than the response obtained by using rooting hormones alone.

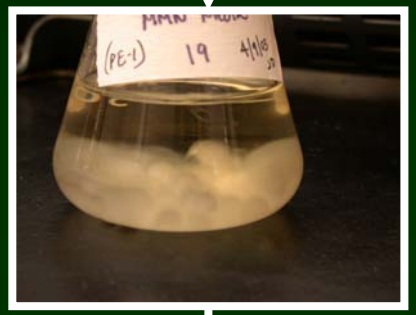
Scagel 2004

REGULATION OF ROOT GROWTH
– Mycorrhizal Fungi in Propagation –



AMF induced changes in rooting may involve different regulatory mechanisms than those involved primarily with auxin response

Scagel 2004

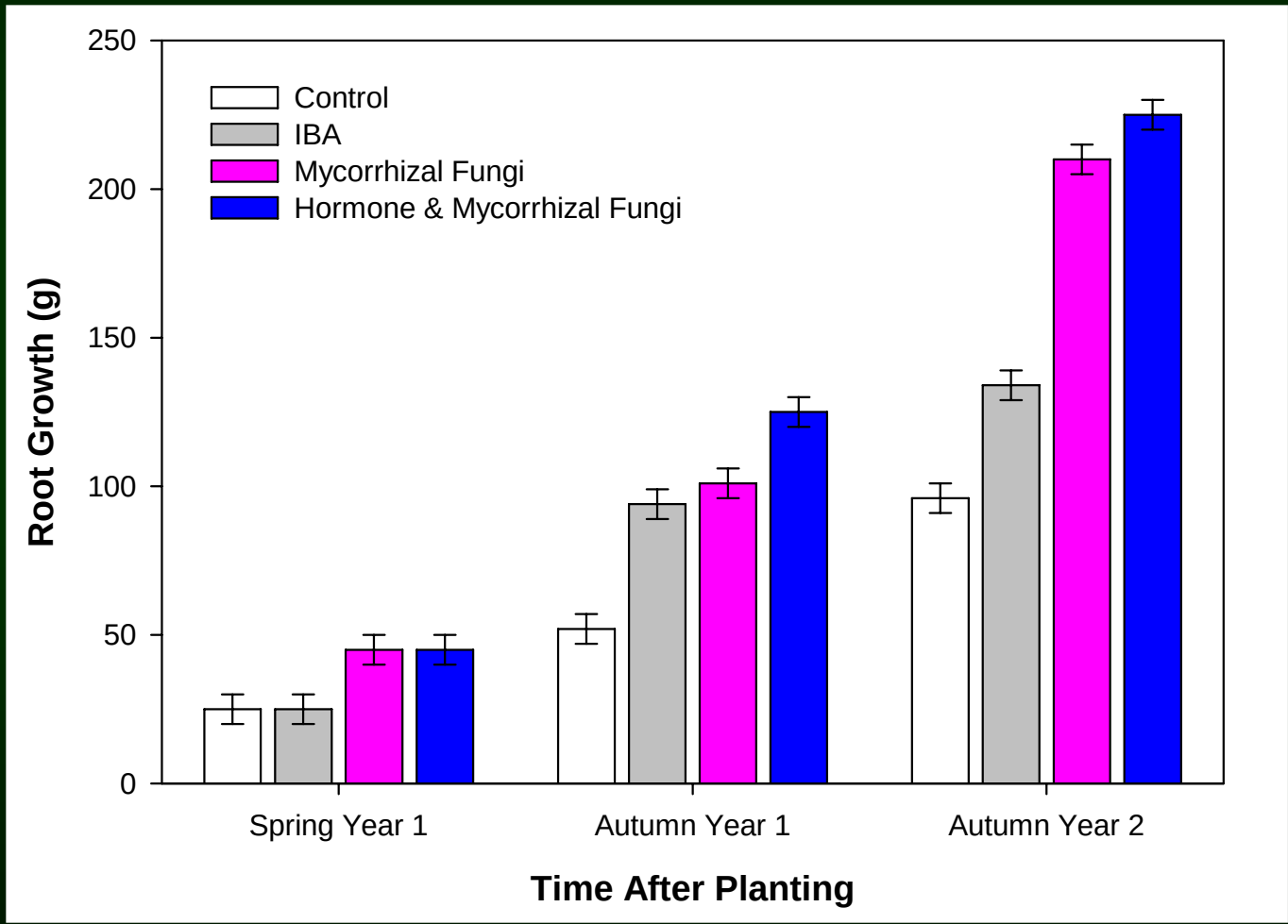


GC-MS
HPLC

Hormonal signals during root induction by mycorrhizal fungi
(With University of Helsinki)

REGULATION OF ROOT GROWTH
– Mycorrhizal Fungi & Stock Quality –

Pseudotsuga menzesii



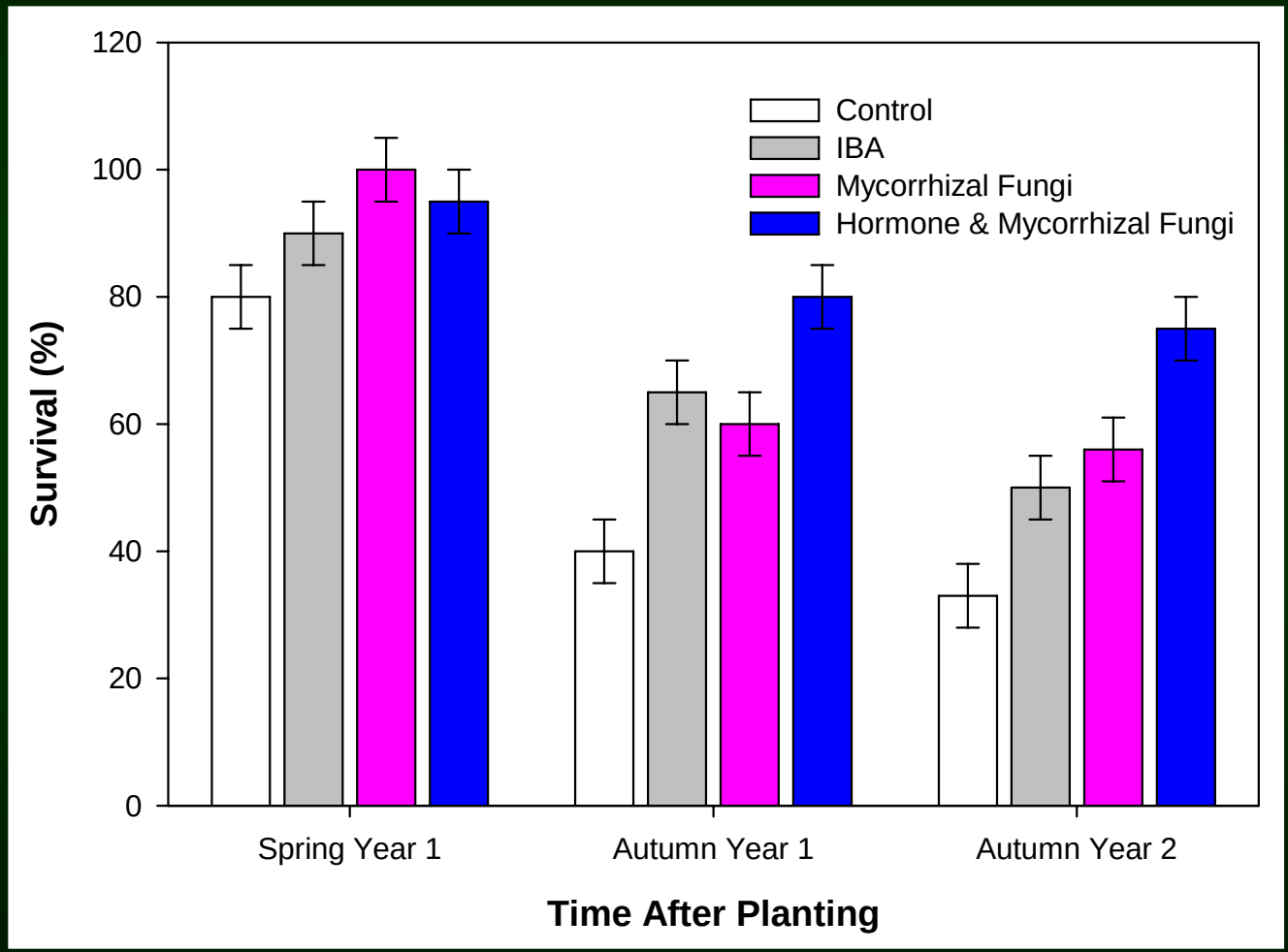
Improved root growth after transplanting

From Scagel, 1999

Scagel 2001

REGULATION OF ROOT GROWTH
– Mycorrhizal Fungi & Stock Quality –

Pseudotsuga menzesii



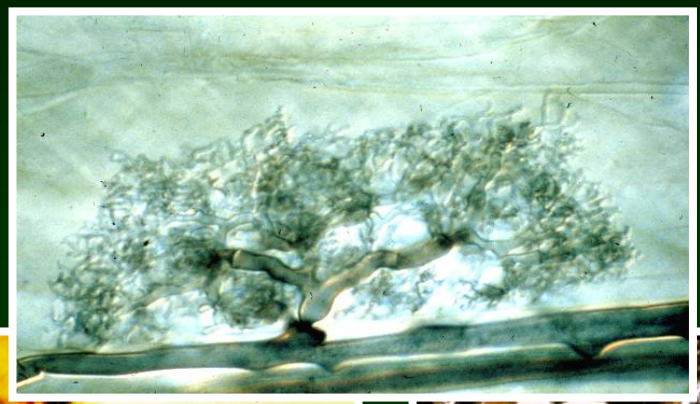
Improved survival after transplanting

From Scagel, 1999

Scagel 2001

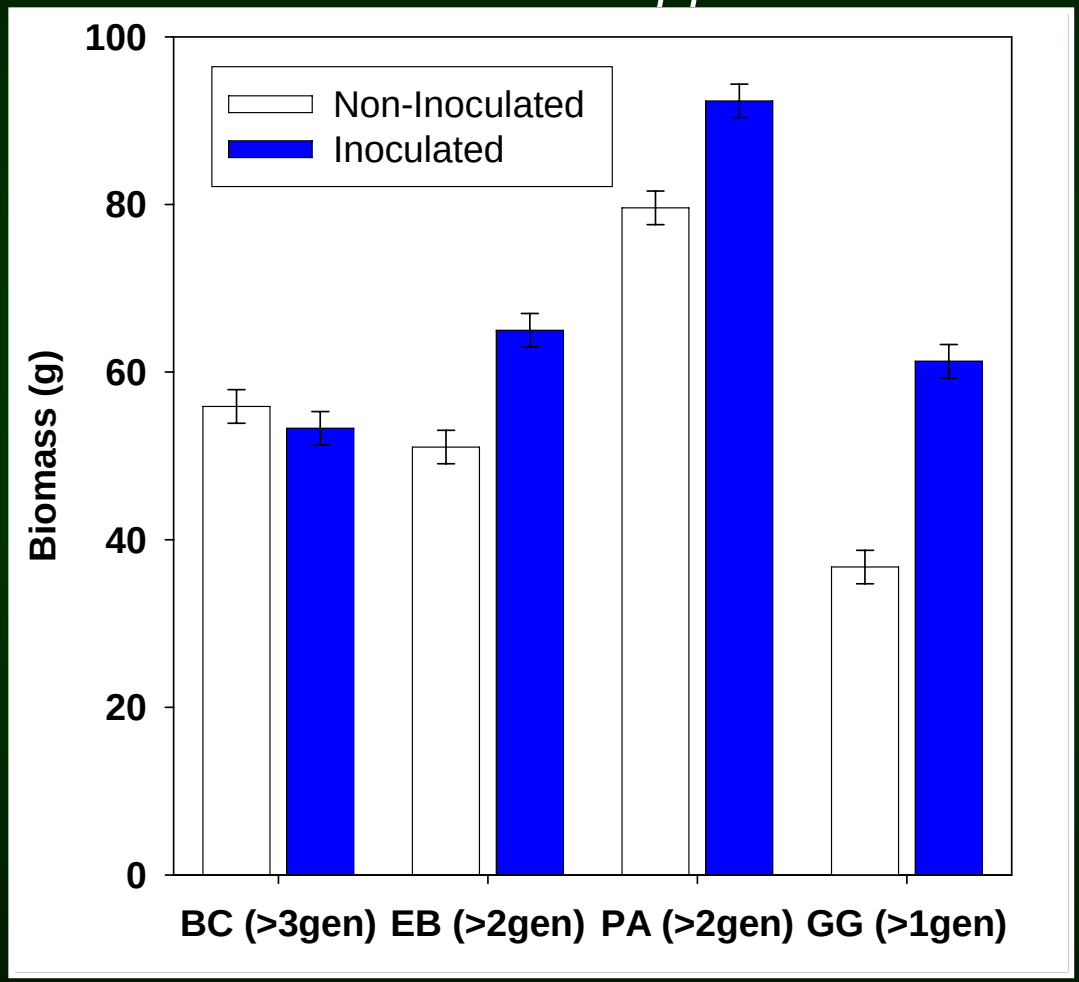
MYCORRHIZAL FUNGI

- Program Scope:
  - Fertilizer use
  - Hormones and rooting
  - N & C metabolism
- Assessments
  - Surveys & inoculation trials
  - Plant & soil analyses
  - Growth/partitioning
  - Colonization
  - Bulb & Flower Production



MYCORRHIZAL FUNGI
– Responsiveness to Inoculation –

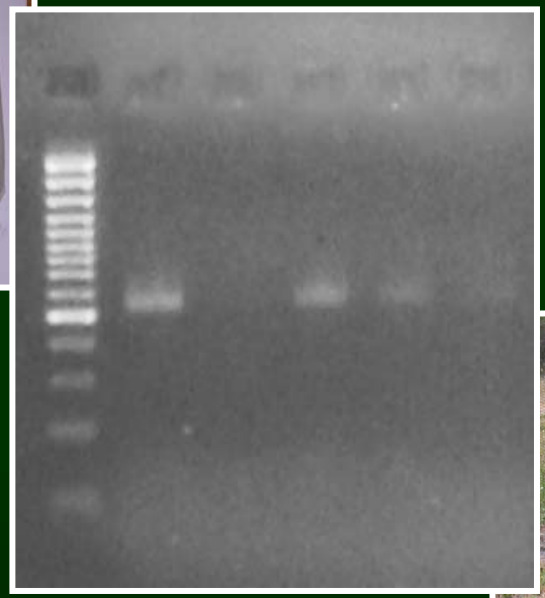
Vaccinium spp.



Selection during breeding can decrease responsiveness to mycorrhizae

Scagel 2005

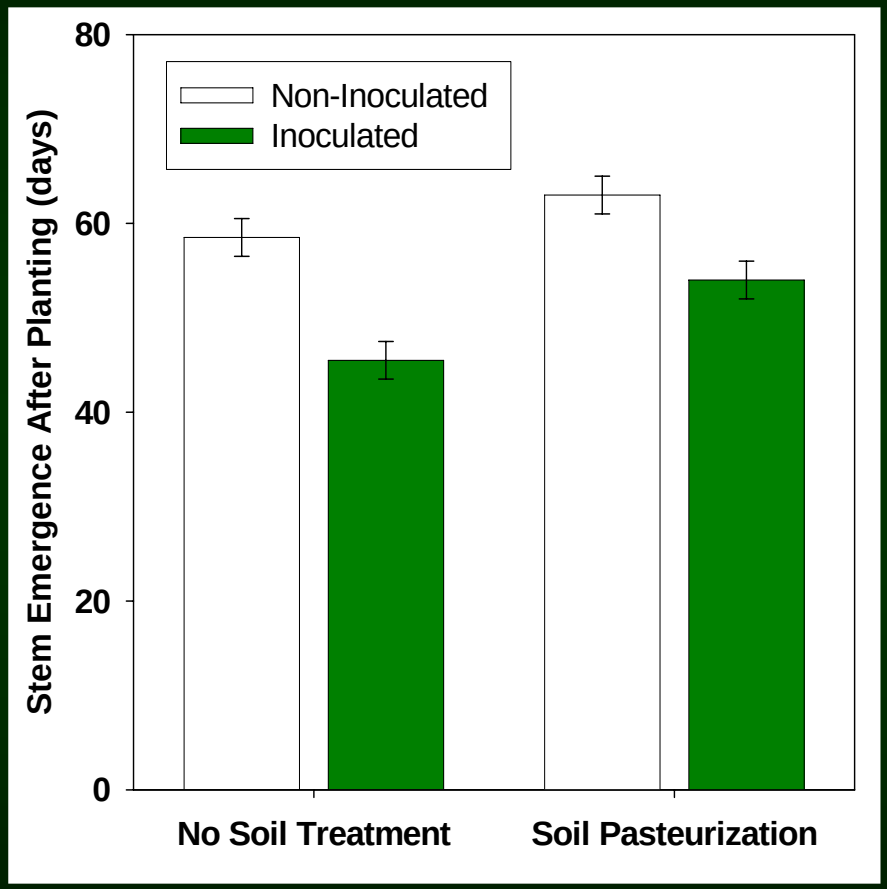
MYCORRHIZAL FUNGI
– Who's On Your Roots –



Using a combination of techniques to identify and evaluate function of ericoid mycorrhizal fungi in different production systems

(With University of Melbourne and Wisconsin)

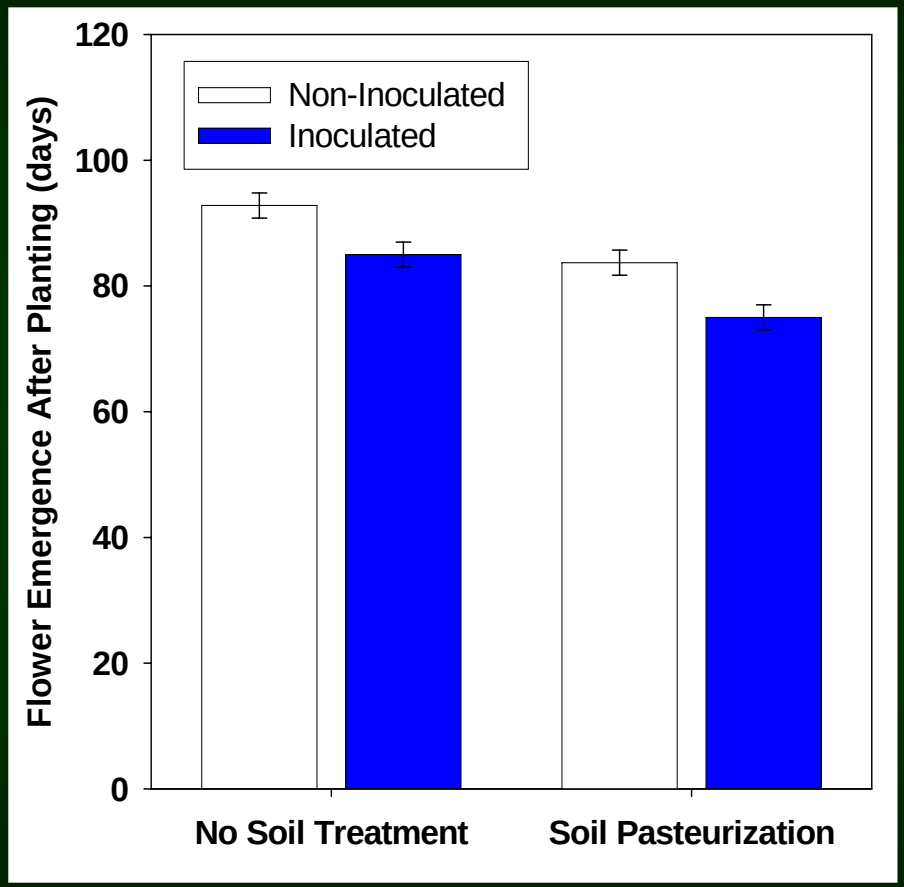
MYCORRHIZAL FUNGI
– AMF & Production Time –



Inoculation decreases time of stem emergence

Scagel 2004

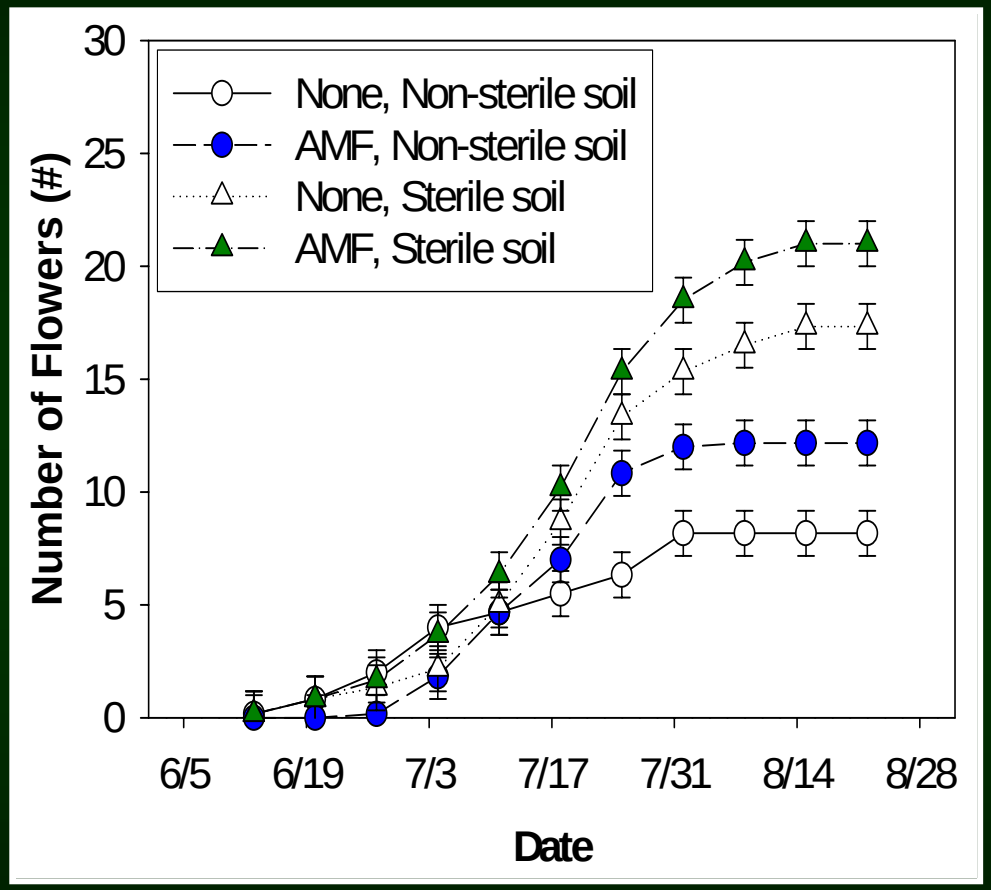
MYCORRHIZAL FUNGI
– AMF & Production Time –



Inoculation decreases time of flower emergence

Scagel 2003

MYCORRHIZAL FUNGI
– AMF & Quality –



Inoculation increases flower production

Scagel 2004

COOPERATORS

- Oregon State
  - Les Fuchigami
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  - Shufu Dong
- Mississippi State University
  - Guihong Bi
- Cornell University
  - Lailang Cheng
- Ohio State
  - Hannah Mathers
- University of Wisconsin
  - Kevin Kosola
- University of Helsinki
  - Karoliina Niemi
- University of Melbourne
  - Cas McLean
- Meadow Lake Nursery
- Fisher Farms
- Fall Creek Farm & Nursery
- Monrovia
- Briggs Nursery
- Brush Prairie Bogs
- Winsmuir Farm
- ZCallas

Symptoms of poor root health occur above ground before you realize roots are in trouble and mimic symptoms of other problems.