

A look at Charcoal Rot in the Upper Midwest: Host Resistance & Pathogen Diversity

**2013 Soybean Breeders' and
Pathologists' Workshop**

St. Louis, MO



Emerging Problem in the Northern U.S.

- Wisconsin 1982
- Minor incidences
 - 1998-2002
 - IN, IL, NE, OH, WI, SD
- First Reports
 - ND: 2002
 - MN: 2003
 - MI: 2007
- ‘Outbreaks’
 - 2003
 - 2008
 - 2012



CR in the upper Midwest: Questions?

- What is the epidemiology of CR in the Northern U.S.?
- What is the impact of colonization by *M. phaseolina*/CR on yield in Northern varieties?
- Why the increase in frequency of CR in this region? Pathogen adaptation? change in weather? Both?
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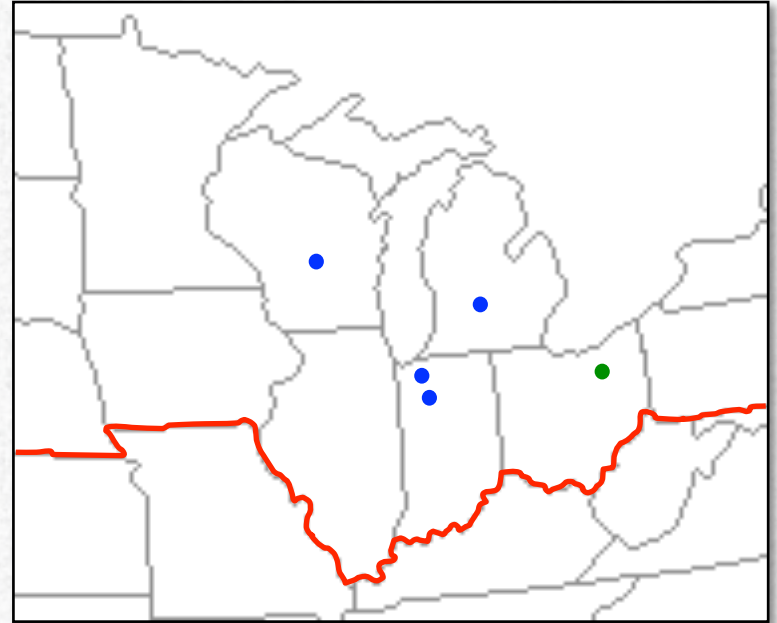
Seasonal Progress of Charcoal Rot and Its Impact on Soybean Productivity

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- Mississippi field sites
 - Infested/non-irrigated
 - Infested/irrigated
 - Non-infested/non-irrigated
 - Non-infested/irrigated
- 2 Resistant, 2 Susceptible
 - MG III-IV
- Disease assessment
 - V5, R1, R3, R5, R6, R7
 - Colonization: CFUs
- Yield impact
 - Yield loss= 6-33%
 - Irrigation did not prevent yield loss
 - 13-17% yield bump with a resistant variety
 - \uparrow CFU = \downarrow yield
 - Earliest CFUs at R3
 - When does infection occur?

2013 Field Experiments

- IN, WI, MI: Development & yield impact
 - Treatments
 - Irrigated/non-irrigated
 - Infested/non-infested
 - Commercial varieties
 - 2 resistant, 2 susceptible
 - MG I-II or II-early III
 - Disease evaluation
 - VC, V5, R2, R4, R6, R7
 - CFUs, *qPCR
- OH: Yield impact & management
 - Grid sample
 - High/low populations of *M. phaseolina*; SCN level
 - Commercial SCN-R varieties
 - Seeding rates



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Geographical differences

- Manici et al. 1995
 - 24 isolates: Optimal temperature 30-35°C
 - Northern isolates: good growth rate at 15°C; adapted to 40°C
 - Southern isolates: poor growth rate at 15°C and 40°C
- Mayek-Perez et al. 2001
 - 84 isolates: High genetic diversity (AFLPs)
 - Isolates grouped by geographic origin
- Babu et al. 2010
 - 50 isolates: Moderate genetic diversity (RAPDs)
 - Genetic grouping correlated to geographic locations
- Baird et al. 2010
 - 109 U.S. : Moderate to high genetic diversity (SSRs)
 - Some clustering by north/south geography

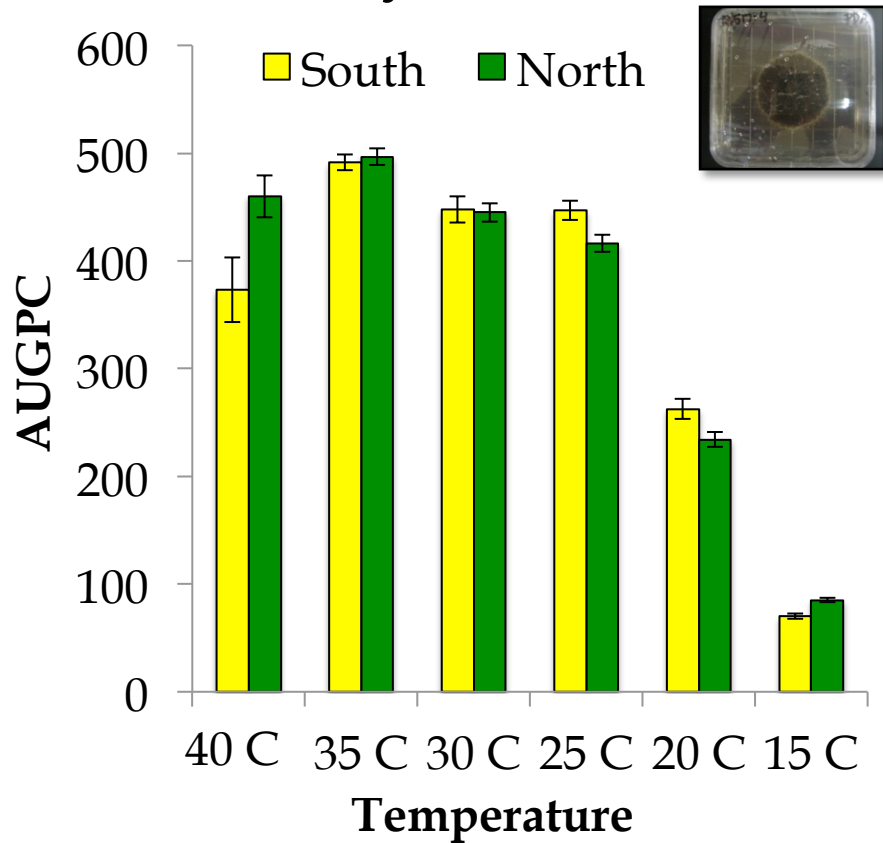
Temperature Experiment

- Six isolates:
 - 3 southern (MS, LA, TX); 3 northern (all WI)
- Two different media:
 - Soybean seed agar (SSA); Potato dextrose agar (PDA)
- Six temperatures:
 - 15°, 20°, 25°, 30°, 35°, 40°C
- 4 replicates
- Daily measurements for 7 days
 - Colony diameter: Area under growth progress curve (AUGPC)
 - Microsclerotia density

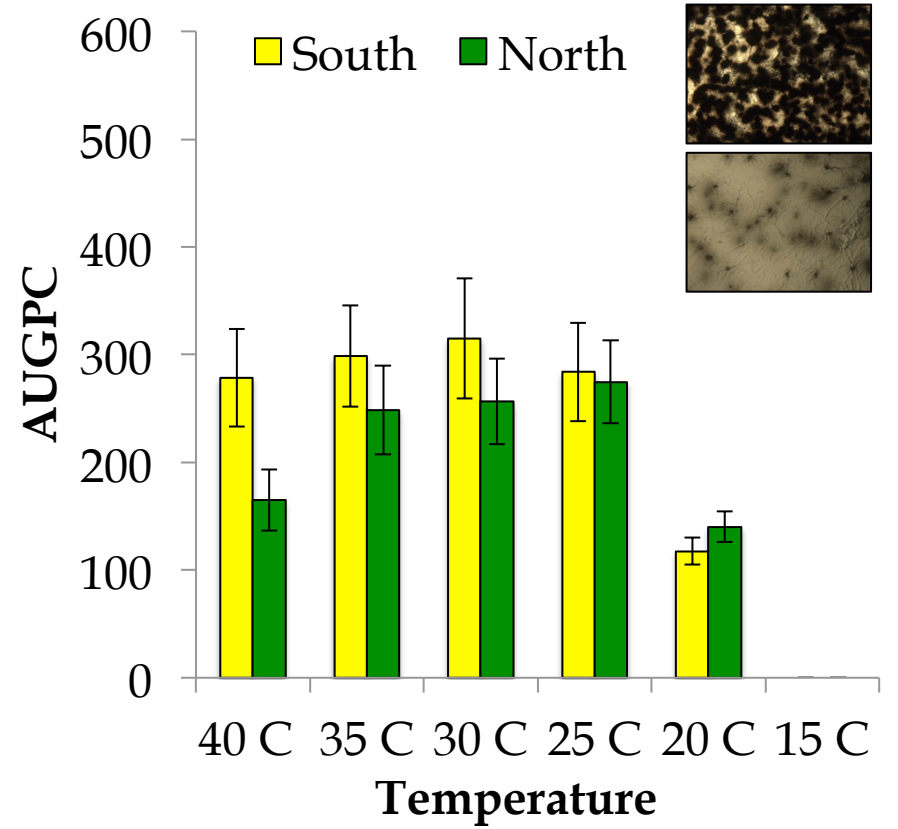


Temperature Experiment

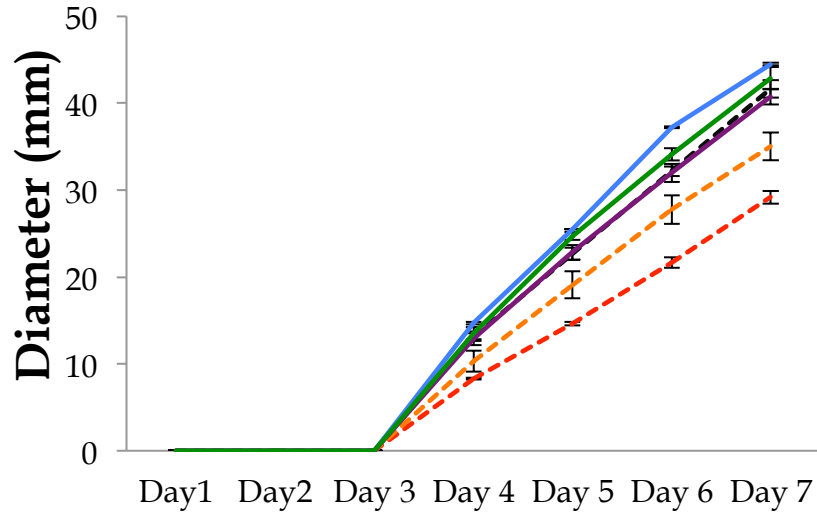
Colony Diameter



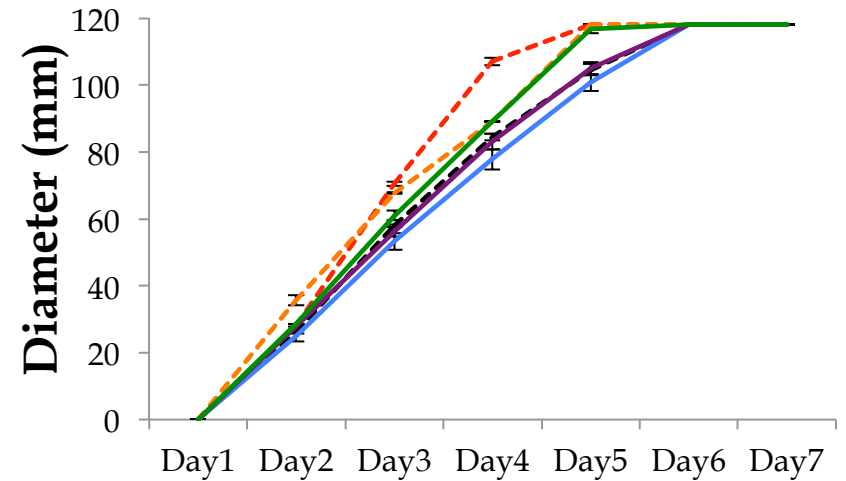
Microsclerotial Density



Colony Diameter at 15° C

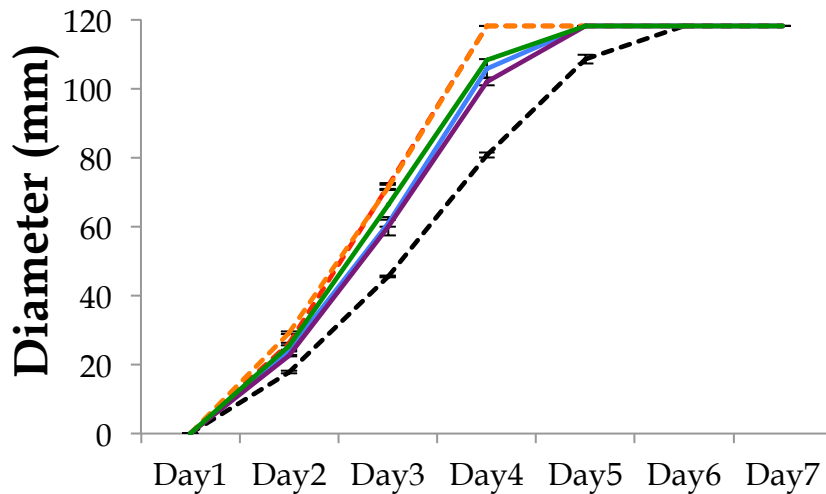


Colony Diameter at 25° C

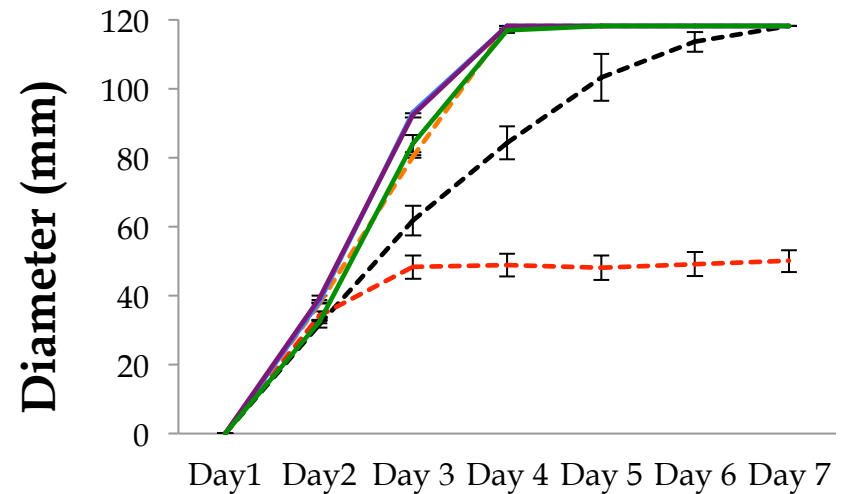


— Md7 — Et13 — Dm13 - - - - TN-420 - - - - TN-517 - - - - TN-501

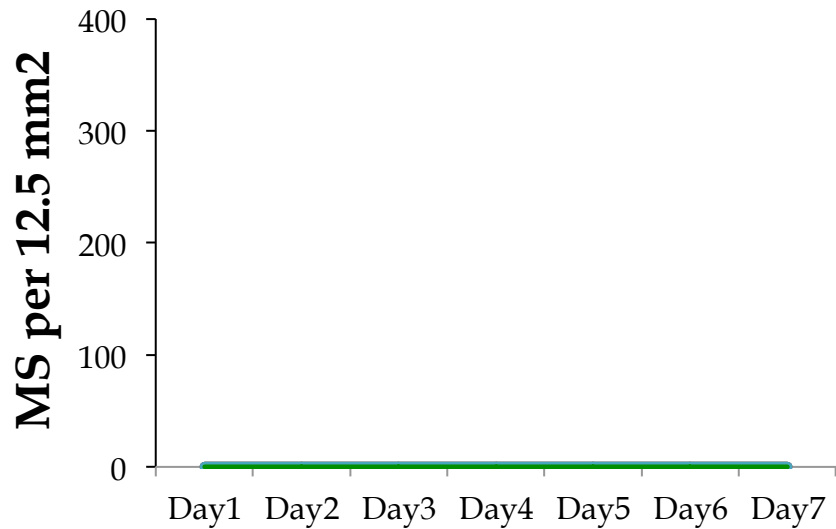
Colony Diameter at 30° C



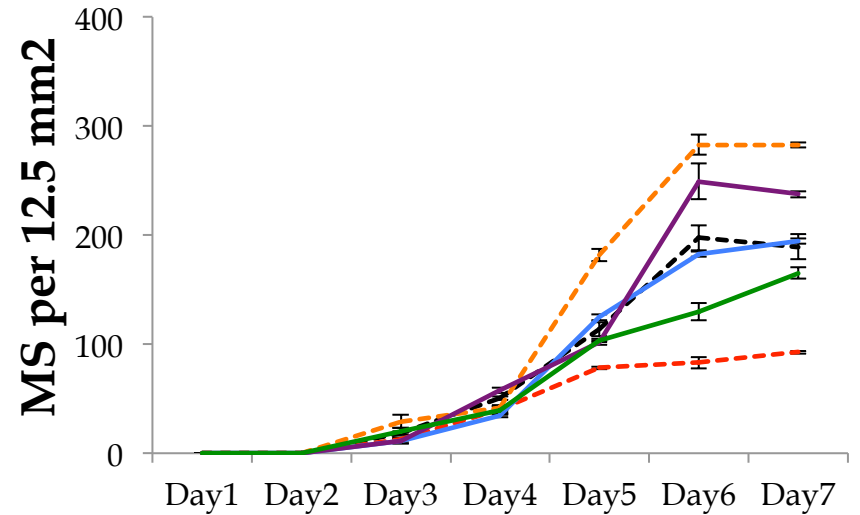
Colony Diameter at 40° C



Microsclerotia Density at 15°C

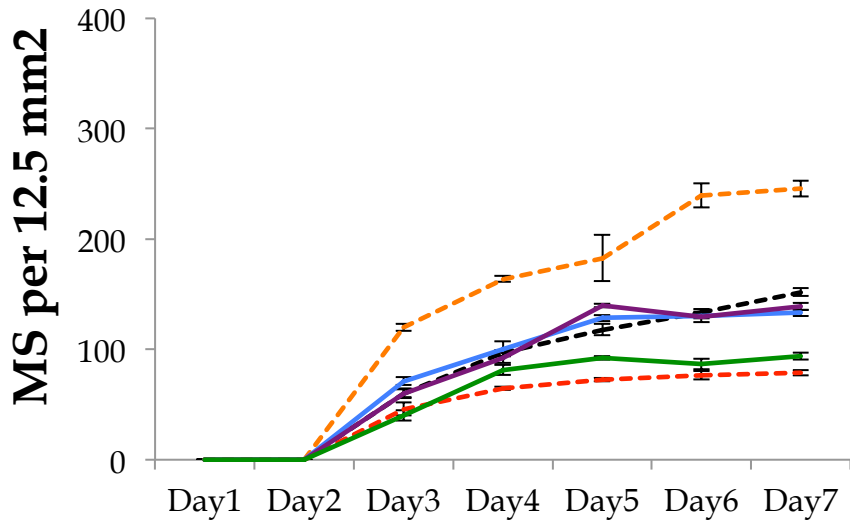


Microsclerotia Density at 25°C

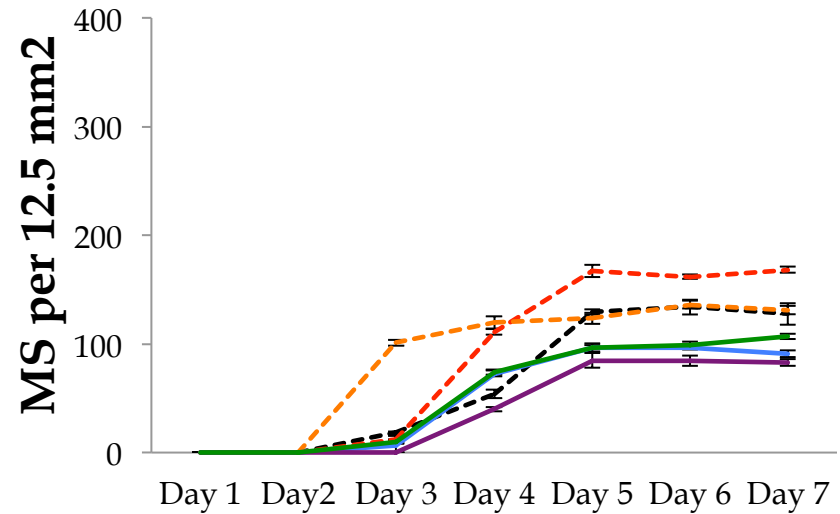


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Microsclerotia Density at 30°C



Microsclerotia Density at 40°C



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Resistance in northern varieties

- Commercial varieties
 - 2012 WI Variety Trial
 - 30 Entries, MG I-II
 - 2012 IN Variety Trial
 - 70 Entries, MG II-III
 - 2013 Field Experiments (IN, WI, MI)
 - 10-20 varieties, MG I-III
- Advanced breeding lines
 - 2012 Northern Uniform Soybean Test
 - 385 entries, MG 00-IV
- Plant introductions
 - USDA Core collection
 - ~700 entries, MG I-III

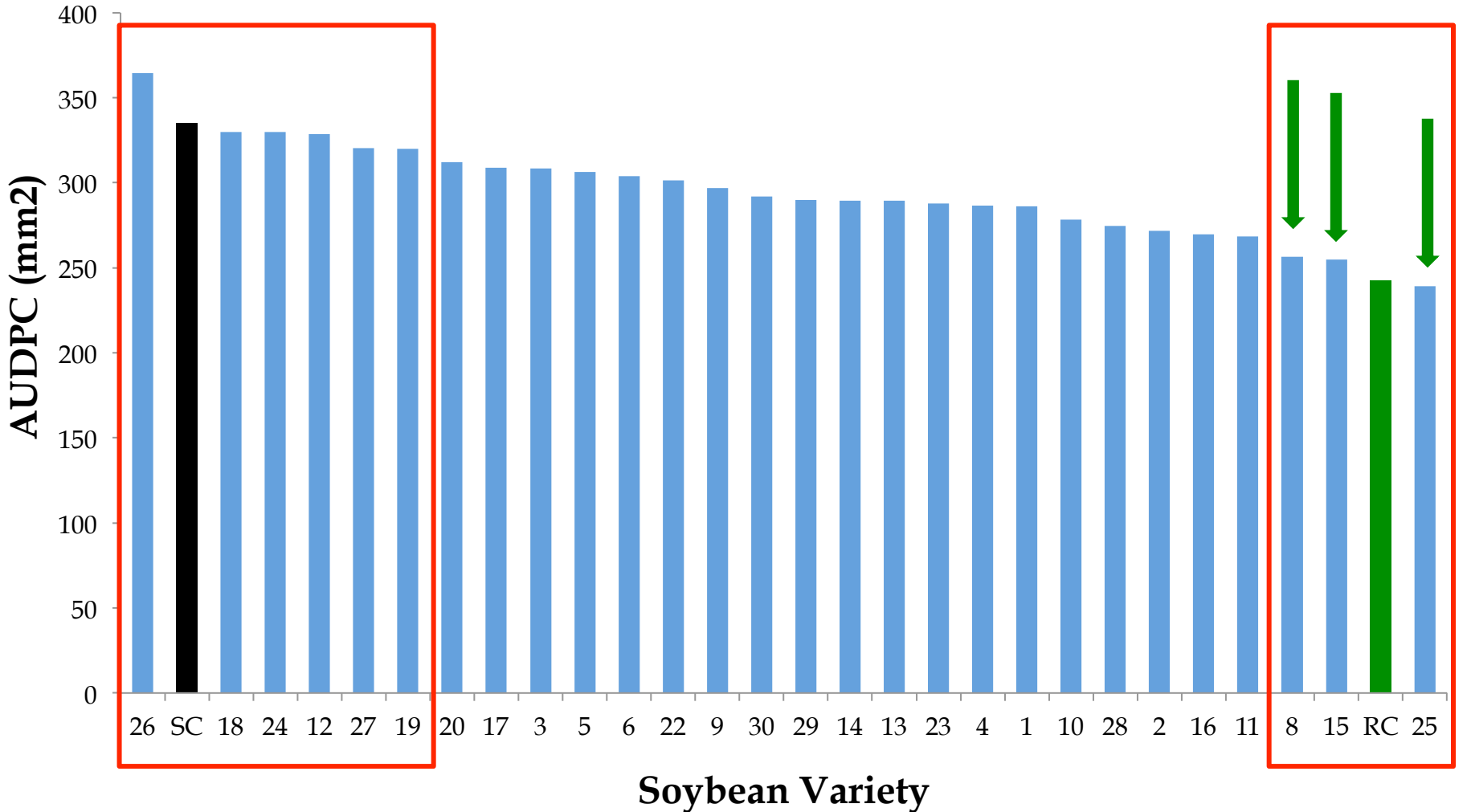
Greenhouse Evaluations

- Evaluated several methods
- Cut-stem was selected
 - Consistent results
 - Time and labor efficient
 - Quantitative measurements

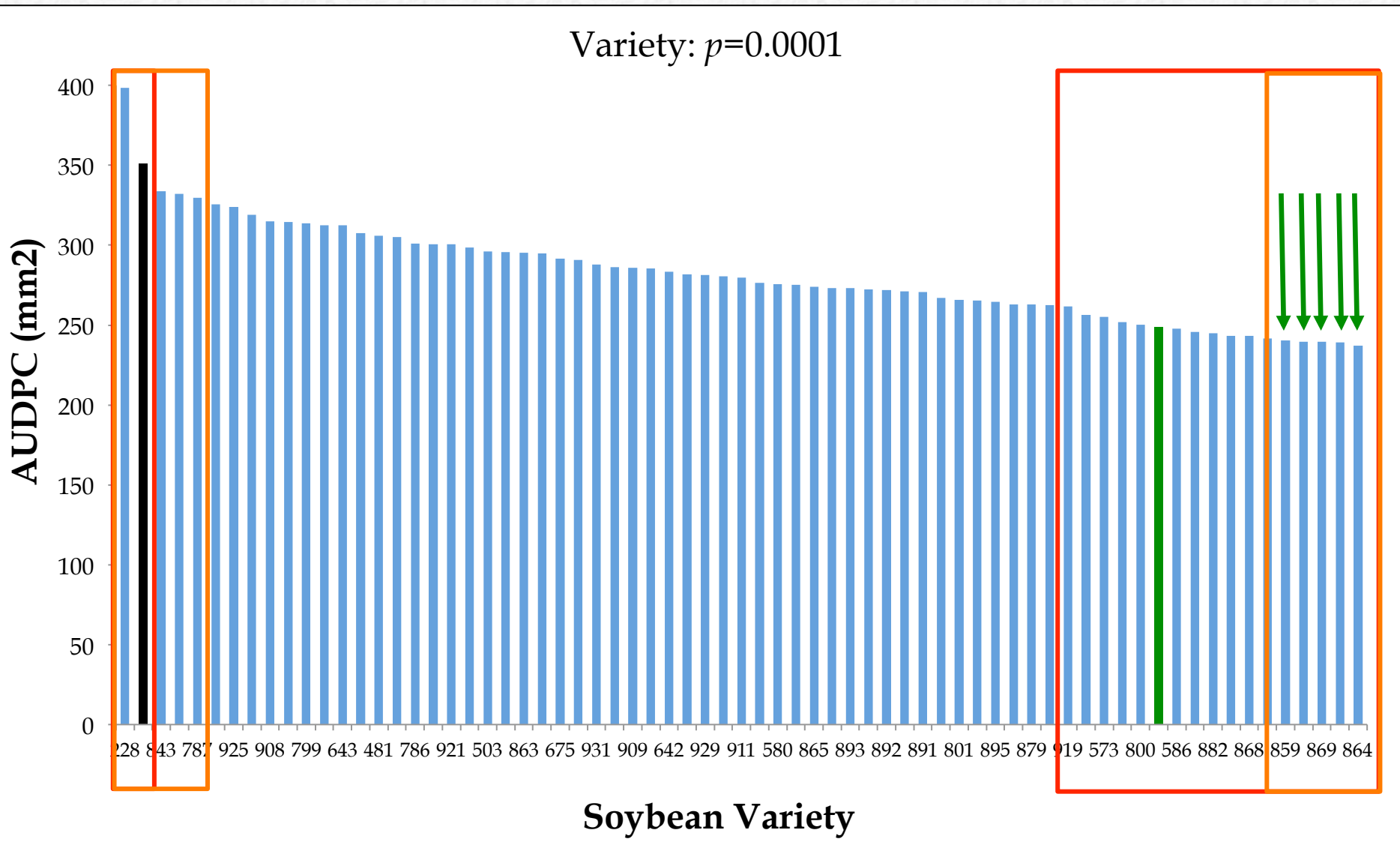


Commercial Wisconsin lines

Variety: $p=0.001$

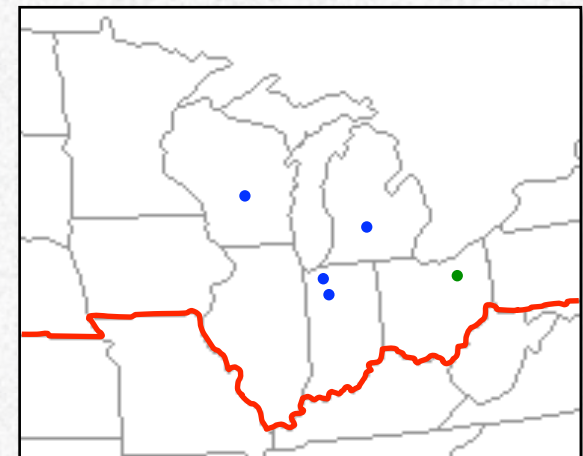
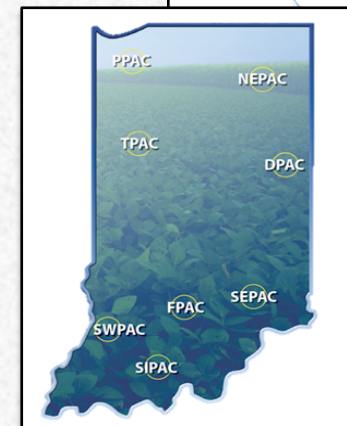
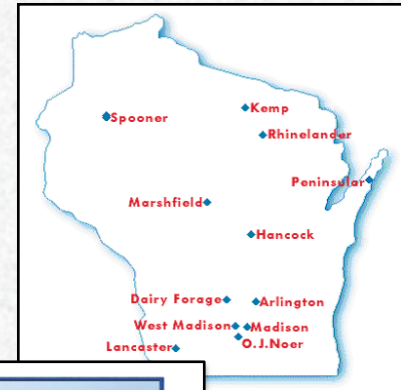


Commercial Indiana lines



Greenhouse to field

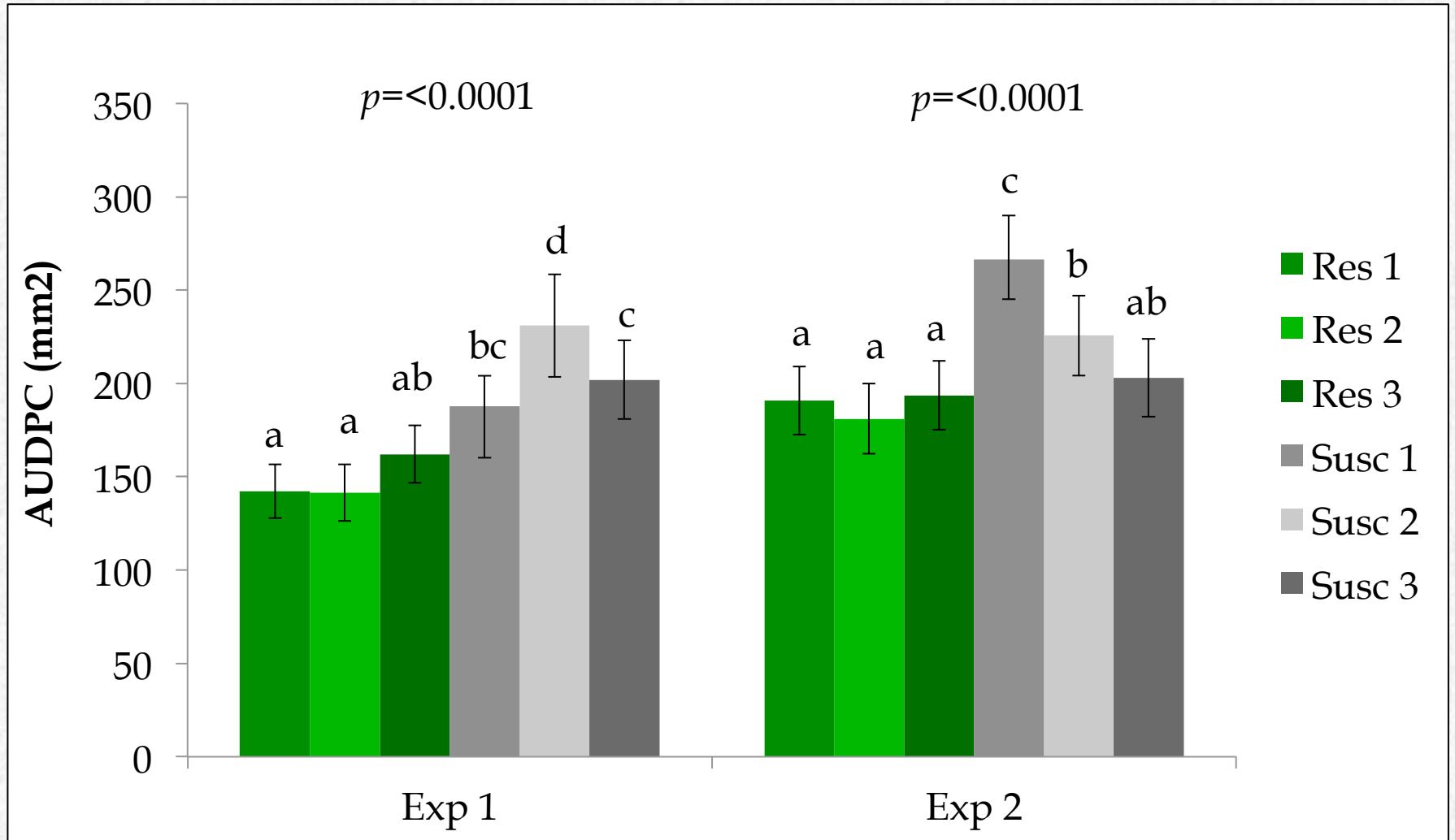
- WI and IN lines were grown in 2012
 - Hancock, WI (UW-ARS)
 - Wanatah, IN (Purdue-PAC)
- Plant samples were collected at R7
- Colonization by *M. phaseolina*
 - CFU's (Mengistu et al. 2007)
 - qPCR (Babu et al. 2011)
- Commercial varieties to be evaluated in the field in 2013
 - WI, IN, MI



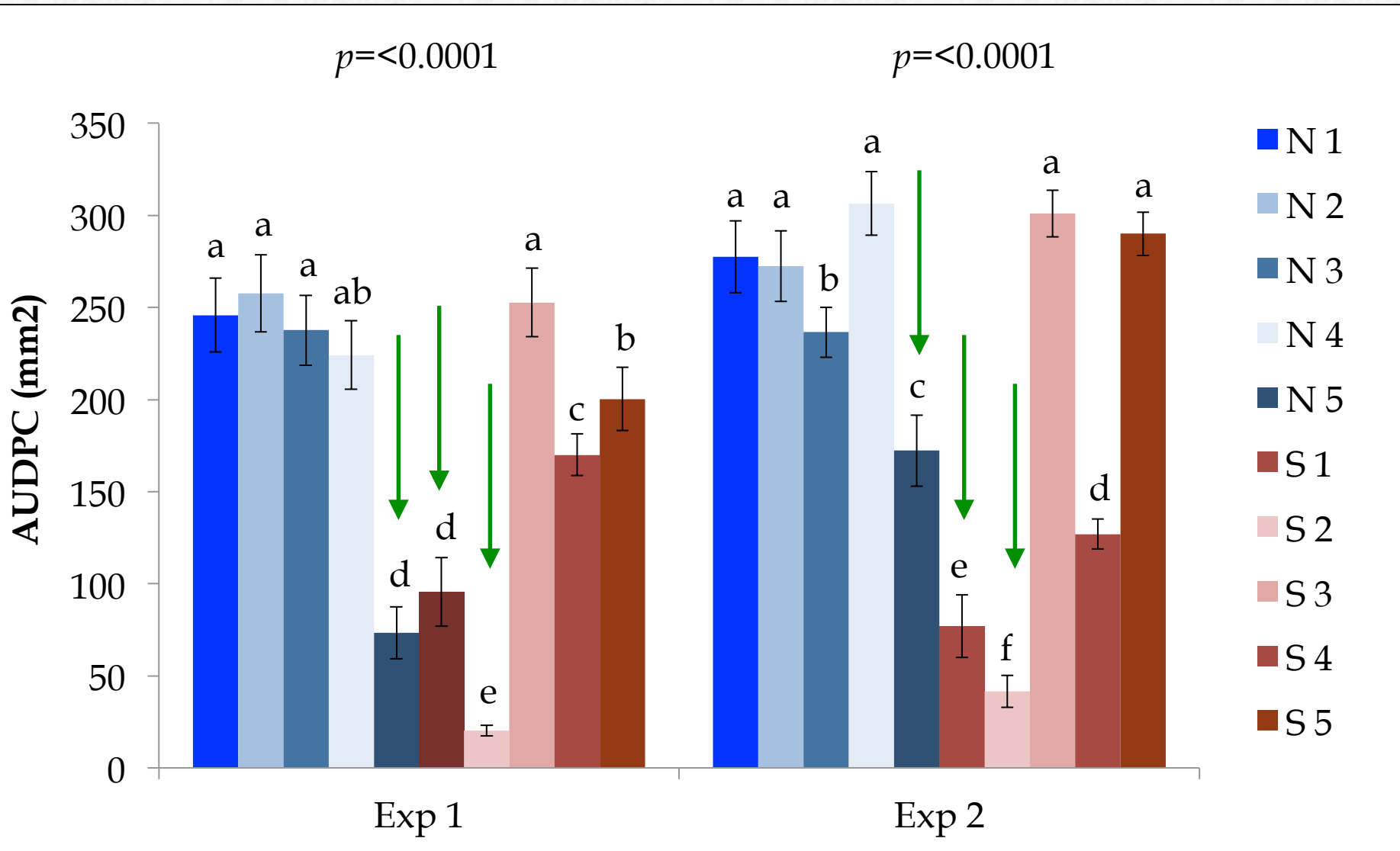
Isolate x Variety interaction

- Cut-stem assay
- Soybean lines selected based on previous greenhouse results (MG I, II, early III)
 - 3 resistant, 3 susceptible
- 10 isolates
 - 5 “Northern” (2 from WI, 2 from IN,MN)
 - 5 “Southern” (TN, KY, MS, LA, TX)
- 3 replicates
- Experiment repeated once

Variety performance

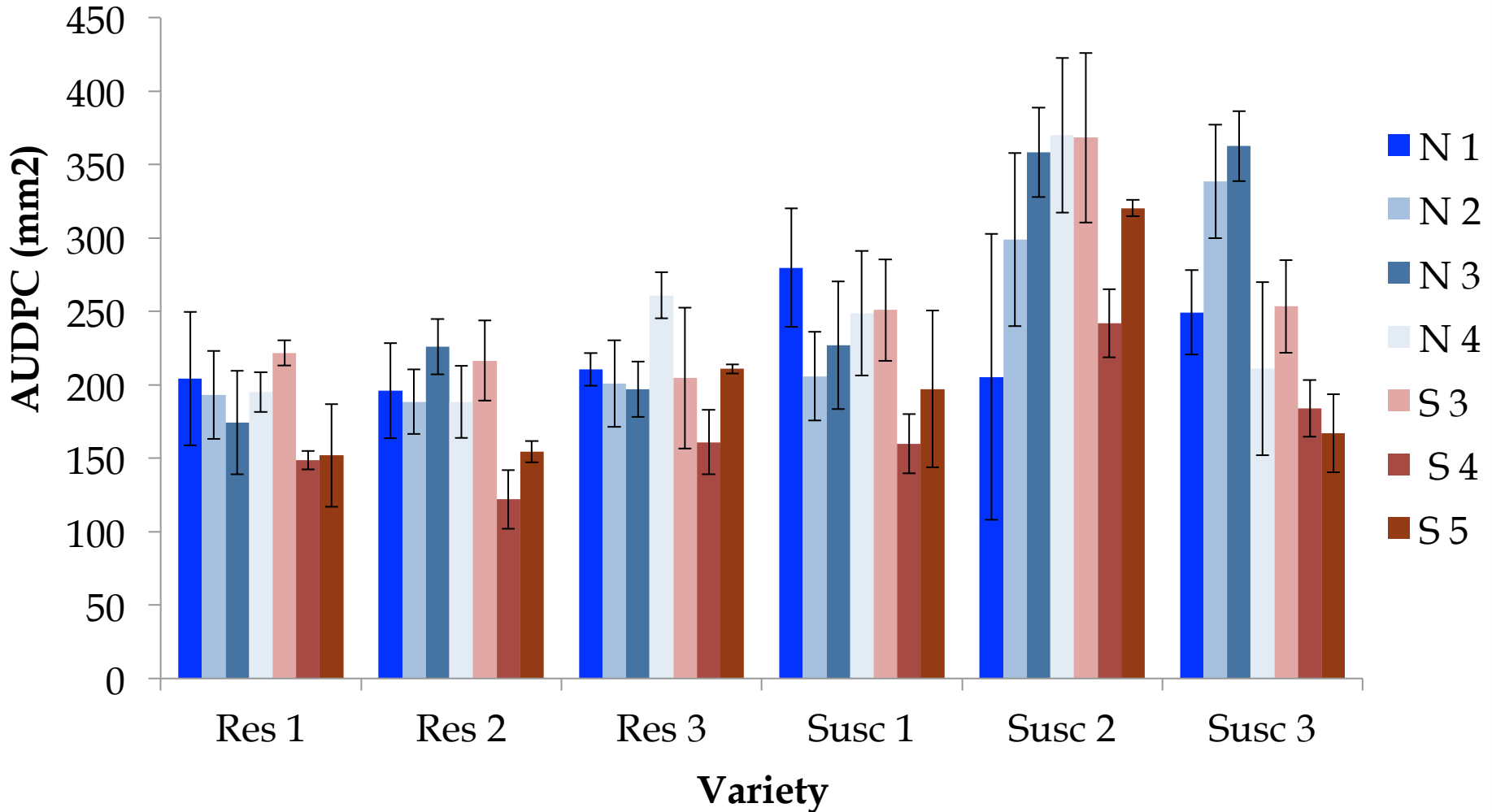


Isolate performance



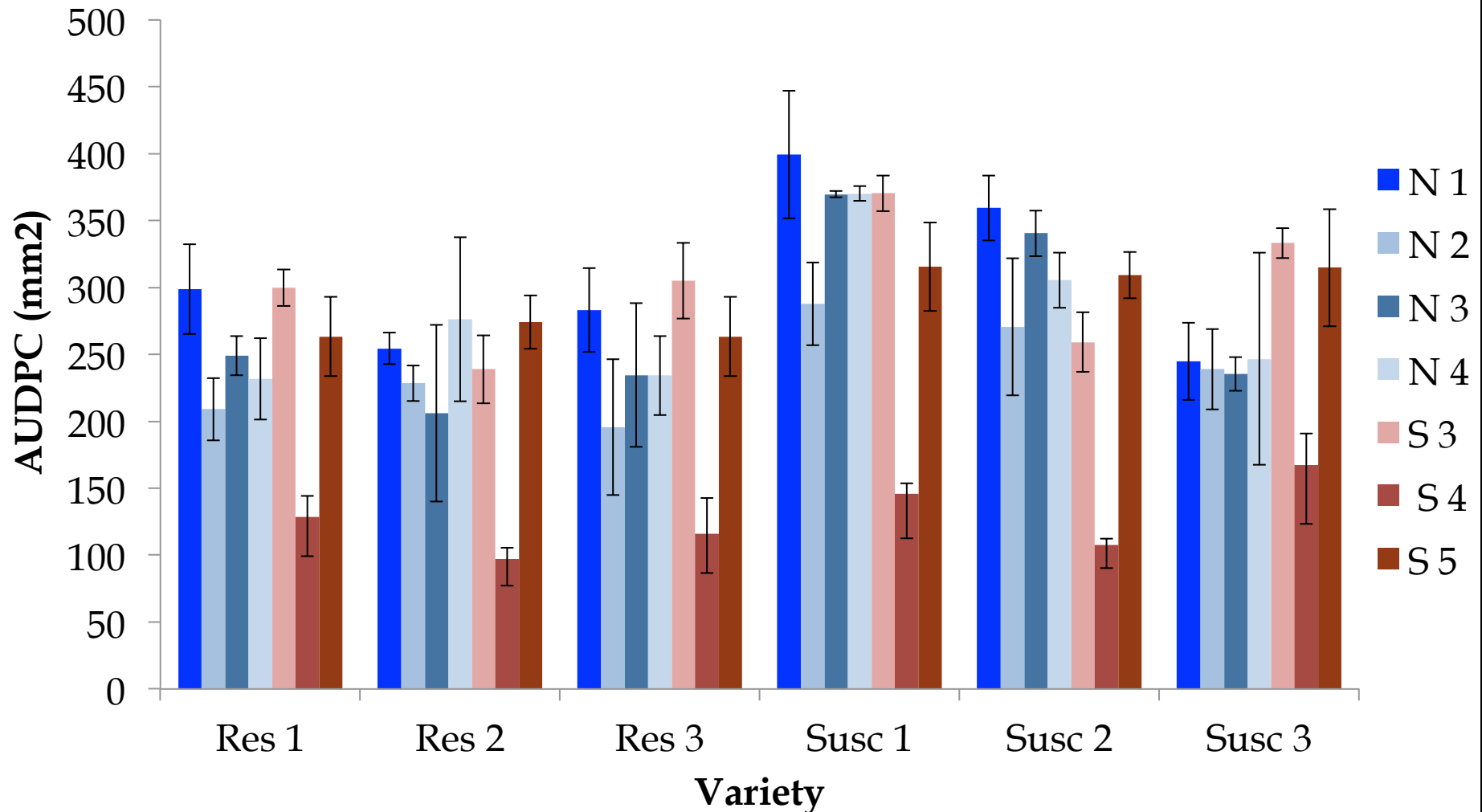
Isolate x Variety Interaction

Experiment 1: $p=0.003$



Isolate x Variety Interaction

Experiment 2: $p=0.653$



Summary points....so far

- CR Epidemiology and yield impact: 2013 field season
- Pathogen diversity
 - Geographical differences observed
 - Greater variability in isolates from Southern U.S.
 - Isolate x variety interactions inconclusive
- Host resistance
 - Present in varieties adapted to the North Central U.S.
 - Resistance similar to, or better than DT97-4290 (elite resistance source)
 - Correlation between resistance identified in greenhouse assay to field resistance TBD

Acknowledgements

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Questions?

