Suppression of soybean diseases through the use of cover crops

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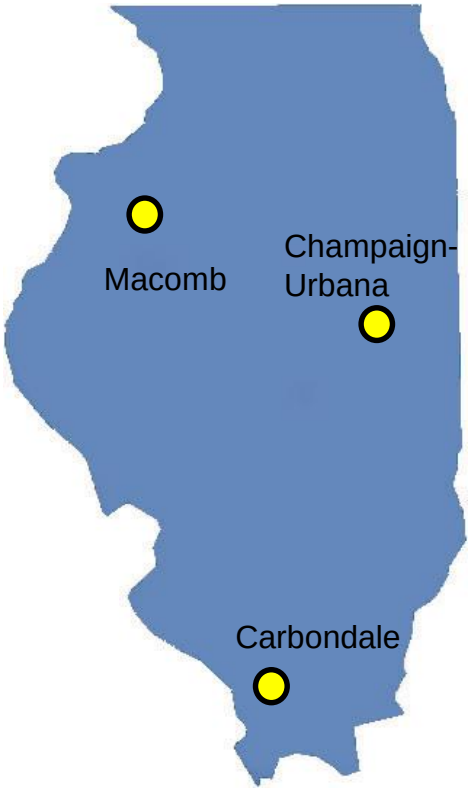
NORTH CENTRAL SARE
Sustainable Agriculture Research & Education



Benefits of Cover Crops

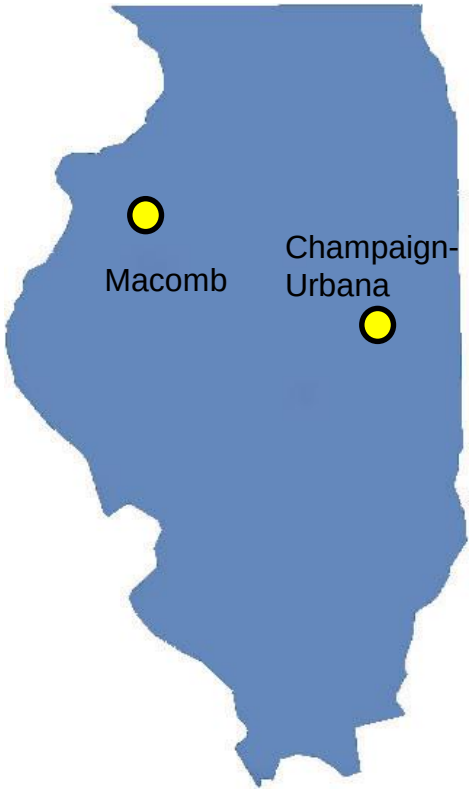
- ✓ Reduce soil erosion
- ✓ Reduce soil compaction
- ✓ Nitrogen scavenging
- ✓ Increase soil organic matter
- ✓ Weed management
- ✓ **Disease management ?**

Disease Suppressive Soil

- Suppressive soil occurs when a pathogen does not become established or persistent, or may become established but causes little or no damage.
- All soils have some natural level of disease suppression.
- In most soils long term management can either reduce or increase this level of suppression.

Evaluating the Suppression of Soybean Diseases Through the Use of Cover Crops

- Three year study
- Three areas of Illinois
  - On station
  - On farm
- Four cover crop species



Collaborators

- Darin Eastburn – University of Illinois
- Loretta Ortiz-Ribbing – U. of Wisconsin
- Joel Gruver – Western Illinois University
- Steve Ayres – Aryes Farms
- Brad Hunt – Hunt Farms

Cover Crops

- On-station – 10 x 40 foot plots
  - Cereal rye (cv. Rymin)
  - Mustard (cv. Pacific Gold)
  - Rapeseed (cv. Dwaf Essex)
  - Canola (cv. Sumner)
  - Winter fallow
- On-farm – 60 x 1000 foot plots
  - Cereal rye
  - Rapeseed
  - Winter fallow

Rye

Rye

Soybeans in standing rye

Rape and Canola

Rape and Canola

Mustard

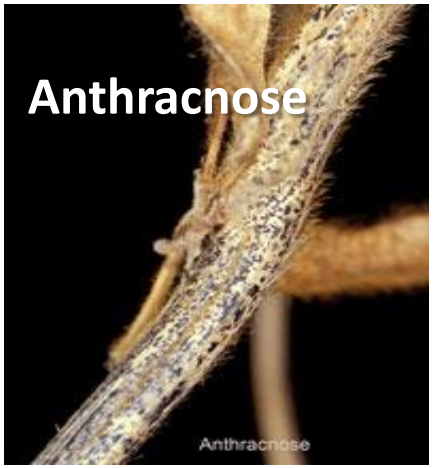
Spring 2011

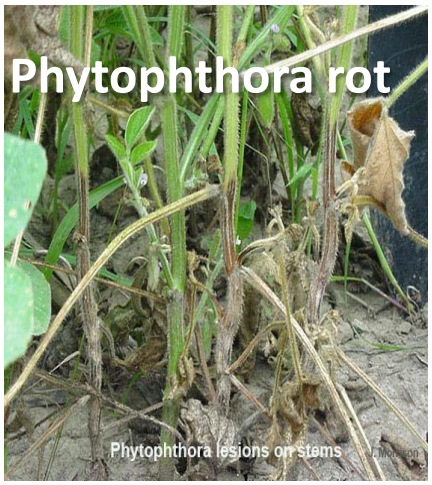
Spring 2012

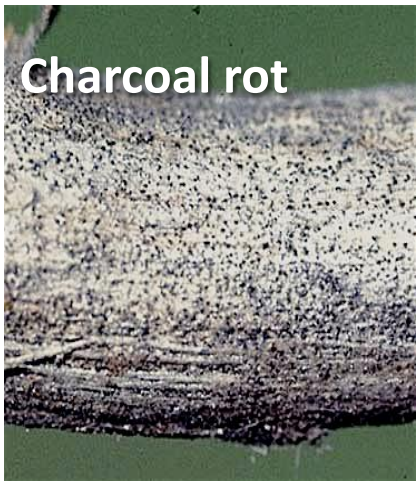
Parameters evaluated

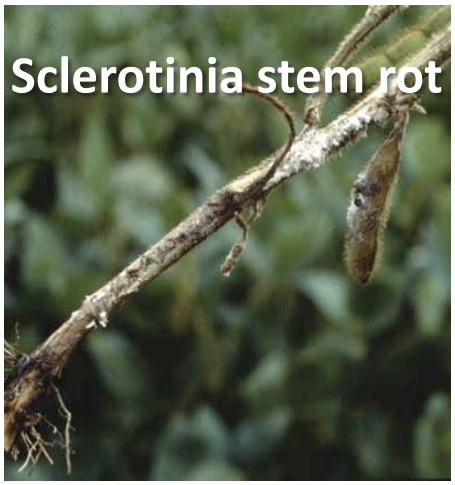
- **Field parameters:**
  - Cover crop biomass (spring)
  - Soybean stand
  - Early (V3-V4) and late (R7-R8) season foliar and root diseases
  - Yield
- **Soil collection for:**
  - Greenhouse disease bioassay
  - SCN egg counts
  - Pathogen population counts
    - DNA analysis

Common soybean diseases caused by soilborne pathogens









-----D. Malvick University of Minnesota Jan 2012

-----Laboratory for Soybean Disease Research

Diseases Rating

Foliar diseases incidence:

- Septoria brown spot
- Bacterial blight

Courtesy Alison Robertson—© APS

Root disease severity:

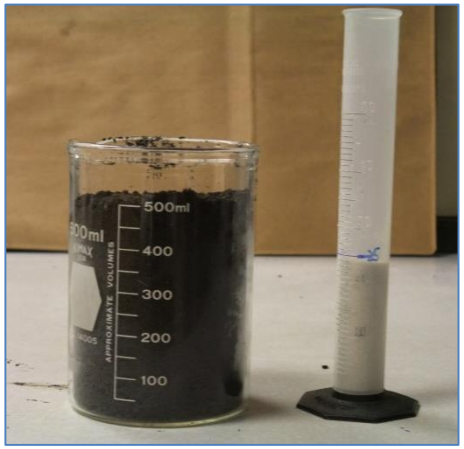
- Sudden death syndrome
- Rhizoctonia root rot

Greenhouse Bioassay

- **Cover crops**
  - soil collected from each cover crop plot
- **Soybean pathogens**
  - soils infested with *Rhizoctonia solani* (Rhizoctonia root rot) or *Fusarium virguliforme* (cause of SDS), or control
- **Measured resulting disease severity**

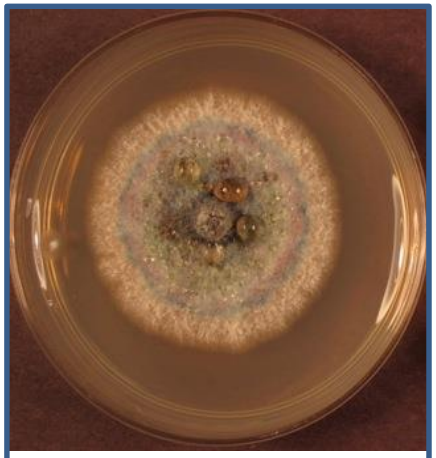
Greenhouse bioassay

- Soil suppressiveness to *R. solani* was tested in greenhouse with 2011 spring and 2012 spring soil



Greenhouse bioassay

- Soil suppressiveness to *F. virguliforme* was tested in greenhouse with 2011 spring and 2012 spring soil.



Fv was grown on PDA for 3 weeks

Fv plugs were transferred to cornmeal, grown for 3 weeks

10ml infested cornmeal was mixed with 500 soil

Soybean was planted with infested soil in conetainers

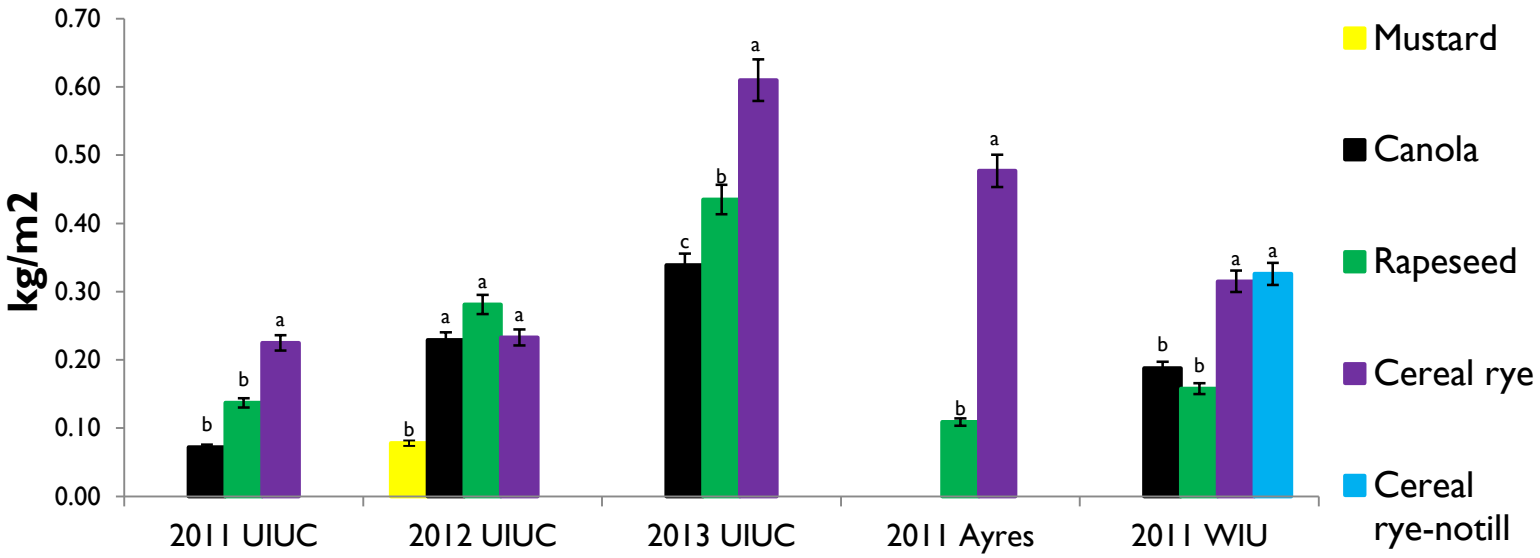
Soil DNA Analysis

- Populations of various soybean pathogens

	Disease	Pathogen
Suite 1	Anthracnose	*Colletotrichum truncatum*
	Brown stem rot	*Phialophora gregata*
	Charcoal rot	*Macrophomina phaseolina*
Suite 2	Soybean cyst nematode	*Heterodera glycines*
	Sudden death syndrome	*Fusarium virguliforme*
	Phytophthora root rot	*Phytophthora sojae*

- General microbial community structure
  - Contribute to soil disease suppressiveness

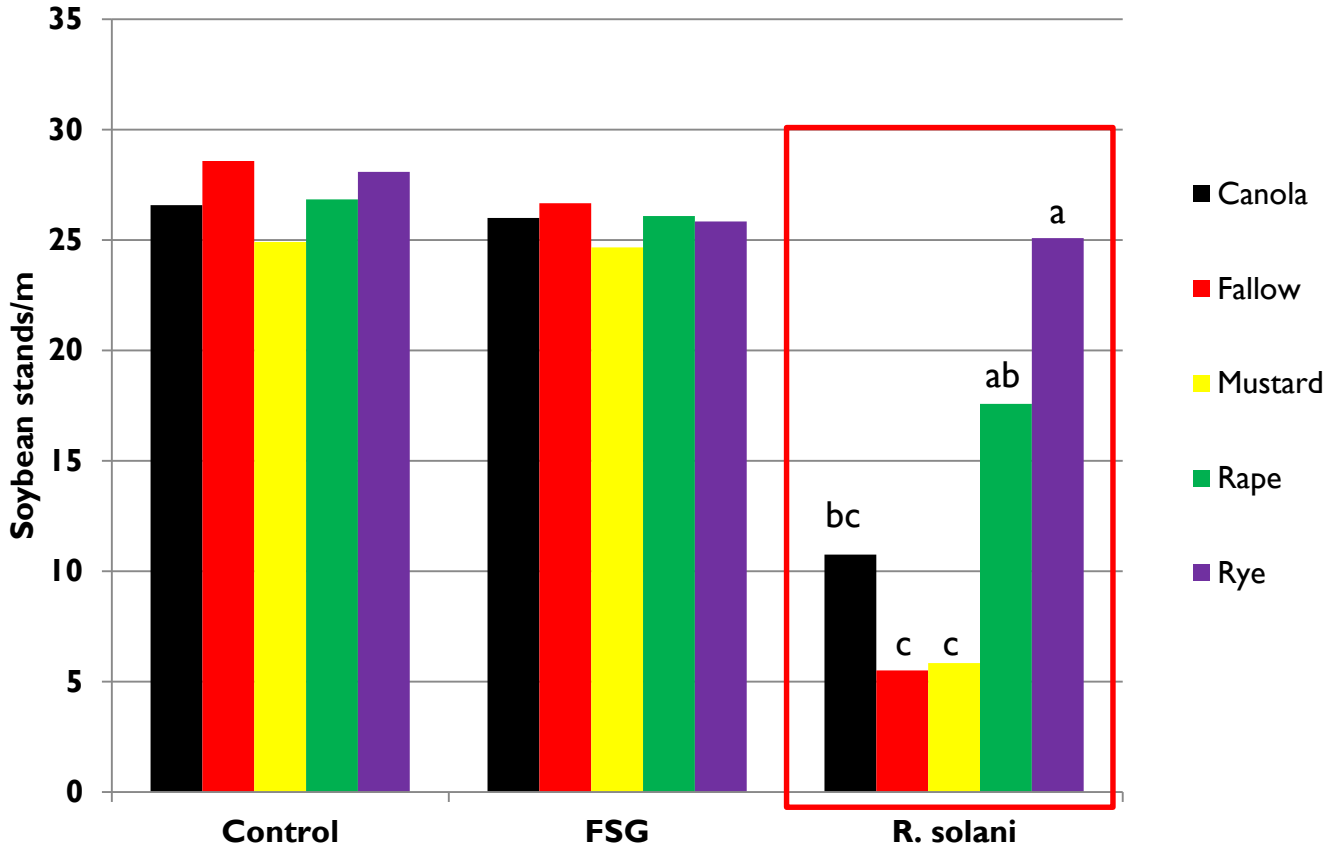
Cover crop biomass



Results: Stand Counts

- No significant difference over cover crop treatments at three locations (2011 and 2012)
- In *R. solani* infested plots (UIUC) counts were significantly greater in plots previously planted with rye and rape in 2011 and 2013, but no difference in 2012

Soybean stand counts in different cover crop plots with diffferent pathogen inoculations, UIUC, 2011



Soybean Stands
Rhizoctonia inoculated plots, UIUC 2011

Fallow

Rape

Rye

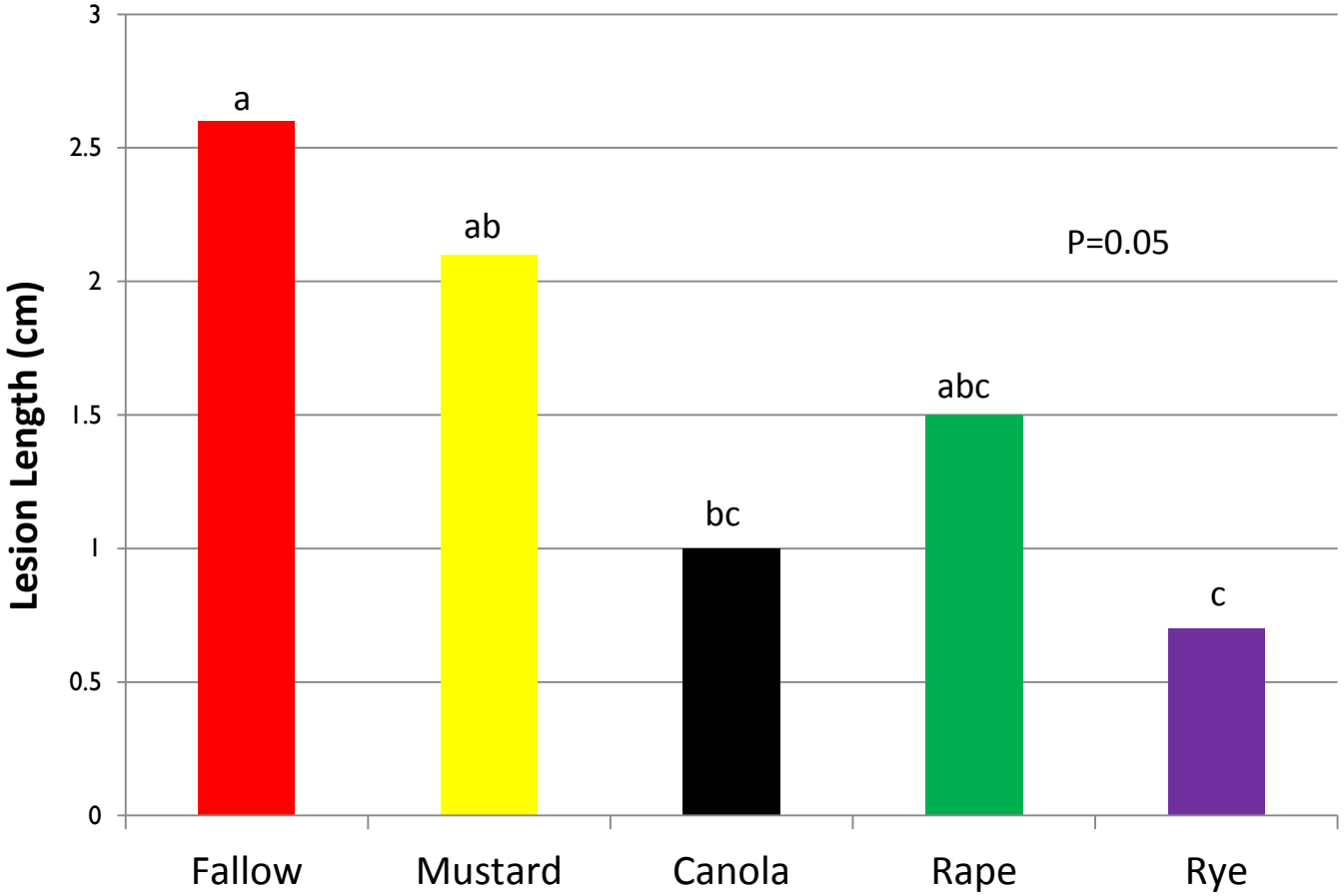
Results: Cover Crops and Stand Counts

Location	2011	2012	2013
Ayres Farm	ns	ns	ns
UIUC - Rhizoc	P<0.0001	ns	P<0.037
Hunt Farm	ns	ns	ns
WIU	ns	ns	P<0.007

Cover Crop	% Stand Count		
	UIUC – Rhizoctonia plots		WIU
	2011	2013	2013
Fallow	5.5 c	71.2 c	79.5 ab
Mustard	5.8 c	78.8 ab	64.6 b
Canola	41.5 bc	77.6 ab	81.0 ab
Rape	67.7 ab	72.8 bc	98.8 a
Rye	96.2 a	79.8 a	94.2 a

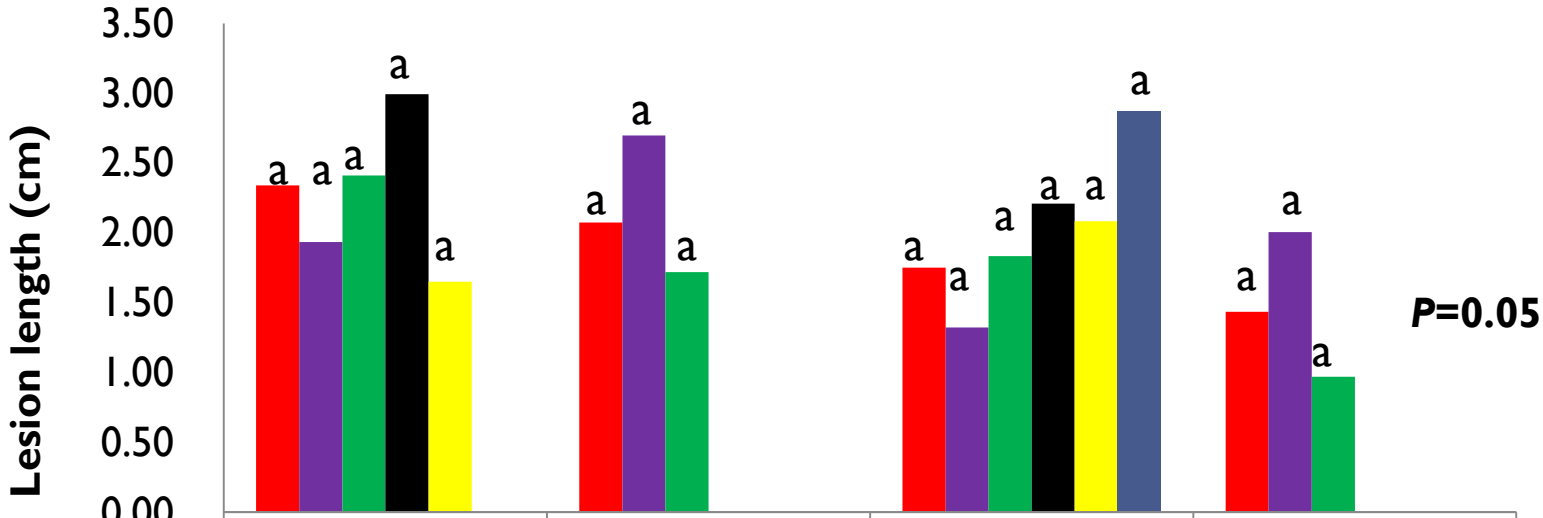
Disease Rating - Rhizoctonia

Rhizoctonia root rot, UIUC 2012



Greenhouse suppressive soil assay

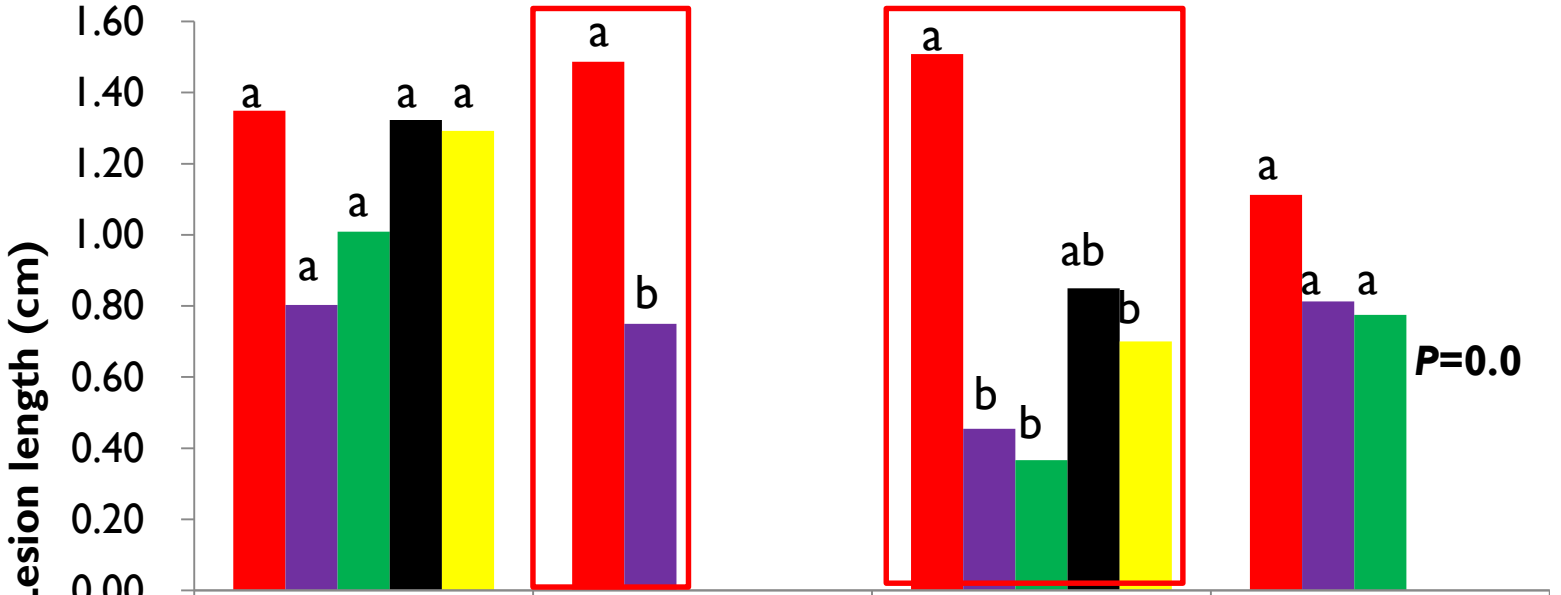
R. solani, 2011 soils



	UIUC	Ayres	Allison	Hunt
Fallow	2.34	2.08	1.75	1.43
Rye	1.93	2.70	1.32	2.00
Rape	2.41	1.72	1.83	0.97
Canola	2.99		2.21	
Mustard	1.65		2.08	
Rye-notill			2.87	

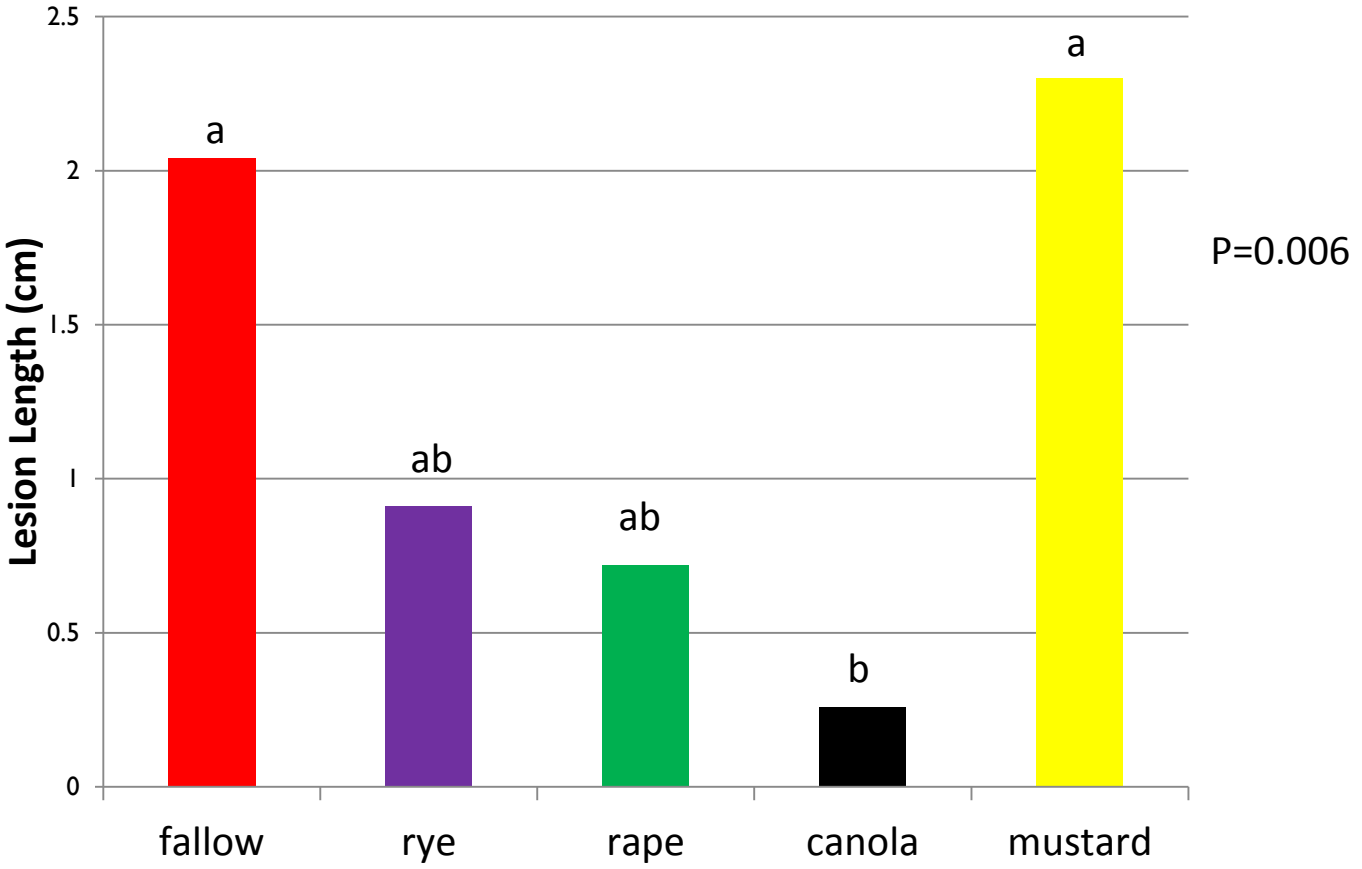
Greenhouse suppressive soil assay

R. solani, 2012 soils



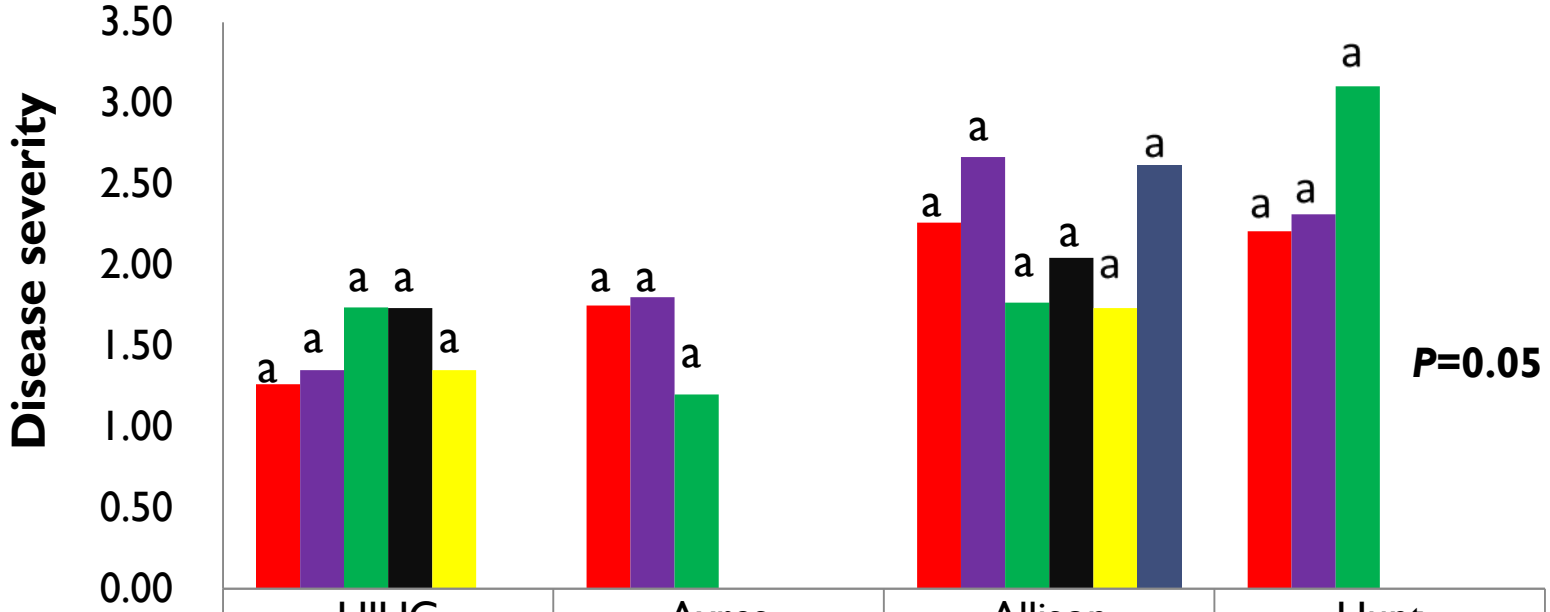
	UIUC	Ayres	Allison	Hunt
fallow	1.35	1.49	1.51	1.11
rye	0.80	0.75	0.46	0.81
rape	1.01		0.37	0.78
canola	1.32		0.85	
mustard	1.29		0.70	

Greenhouse suppressive soil assay
R. solani, 2013 UIUC soils



Greenhouse suppressive soil assay

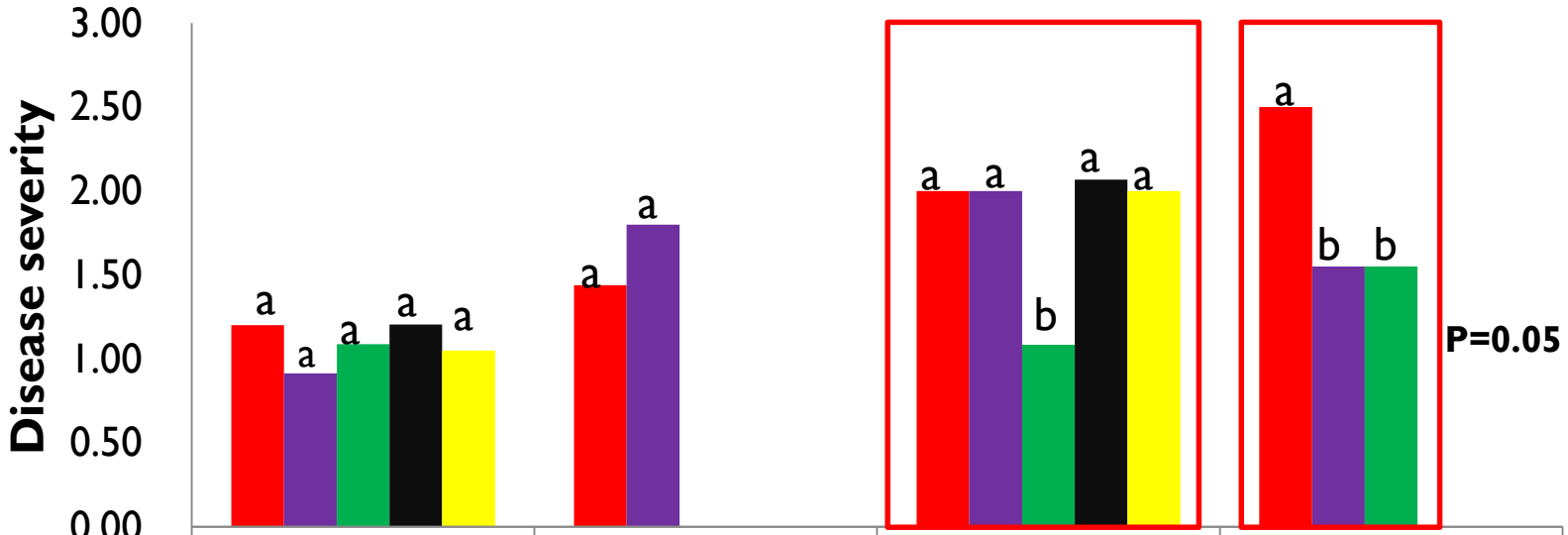
F. virguliforme (SDS), 2011 soils



	UIUC	Ayres	Allison	Hunt
Fallow	1.26	1.75	2.26	2.21
Rye	1.35	1.80	2.67	2.31
Rape	1.74	1.20	1.77	3.10
Canola	1.73		2.04	
Mustard	1.35		1.73	
Rye-notill			2.62	

Greenhouse suppressive soil assay

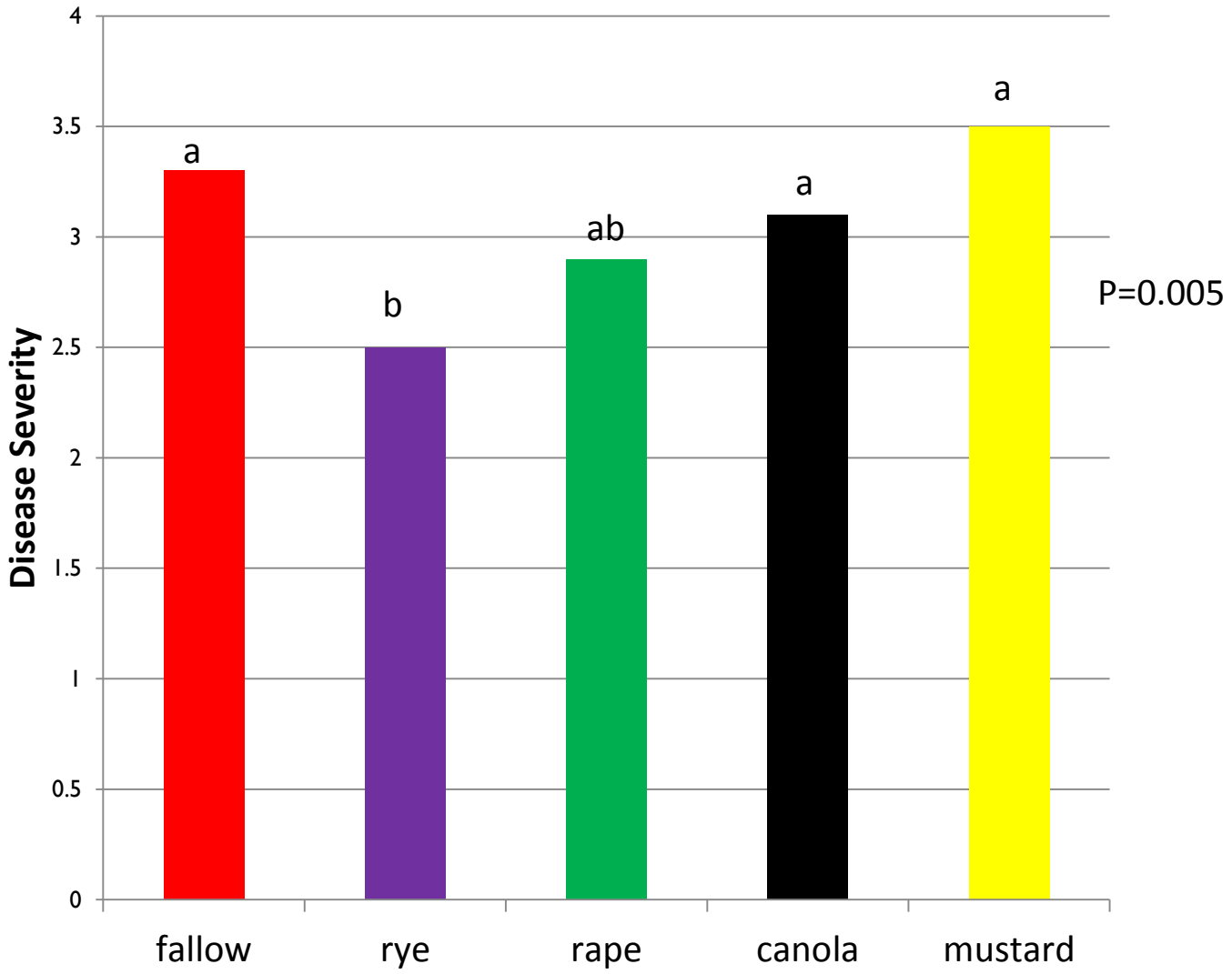
F. virguliforme (SDS), 2012 soils



	UIUC	Ayre	Allison	Hunt
Fallow	1.20	1.44	2.00	2.50
Rye	0.91	1.80	2.00	1.55
Rape	1.09		1.08	1.55
Canola	1.20		2.07	
Mustard	1.05		2.00	

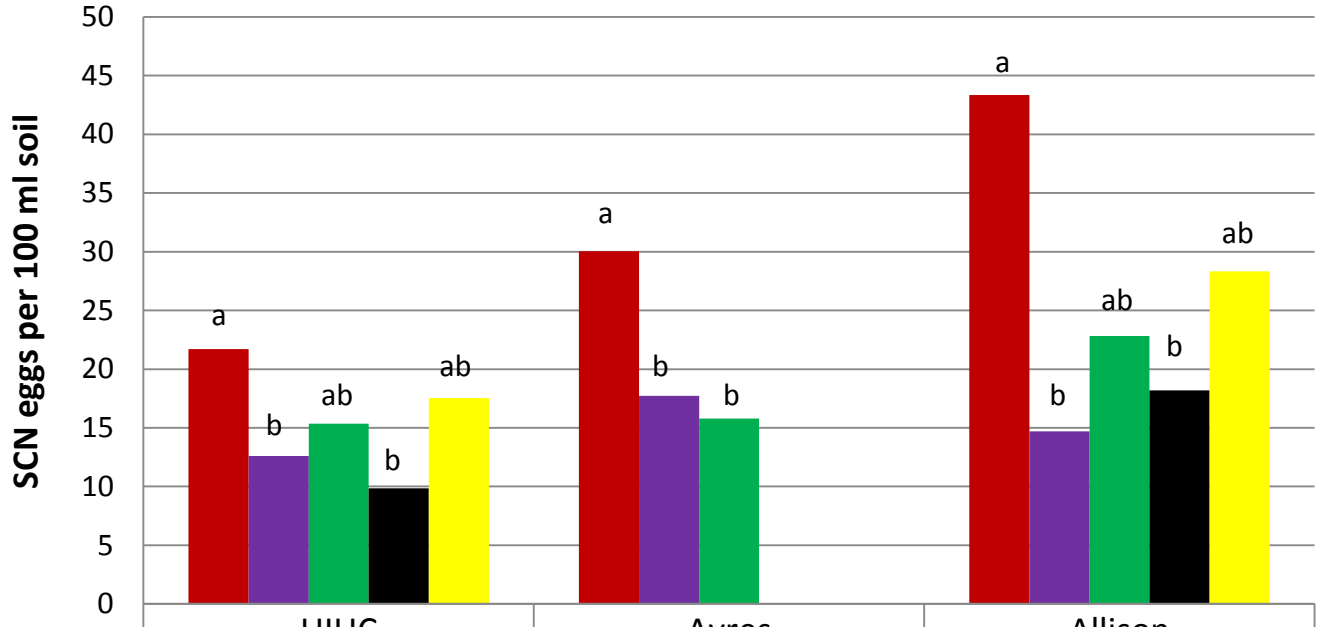
Greenhouse suppressive soil assay

F. virguliforme (SDS), 2013 WIU soils



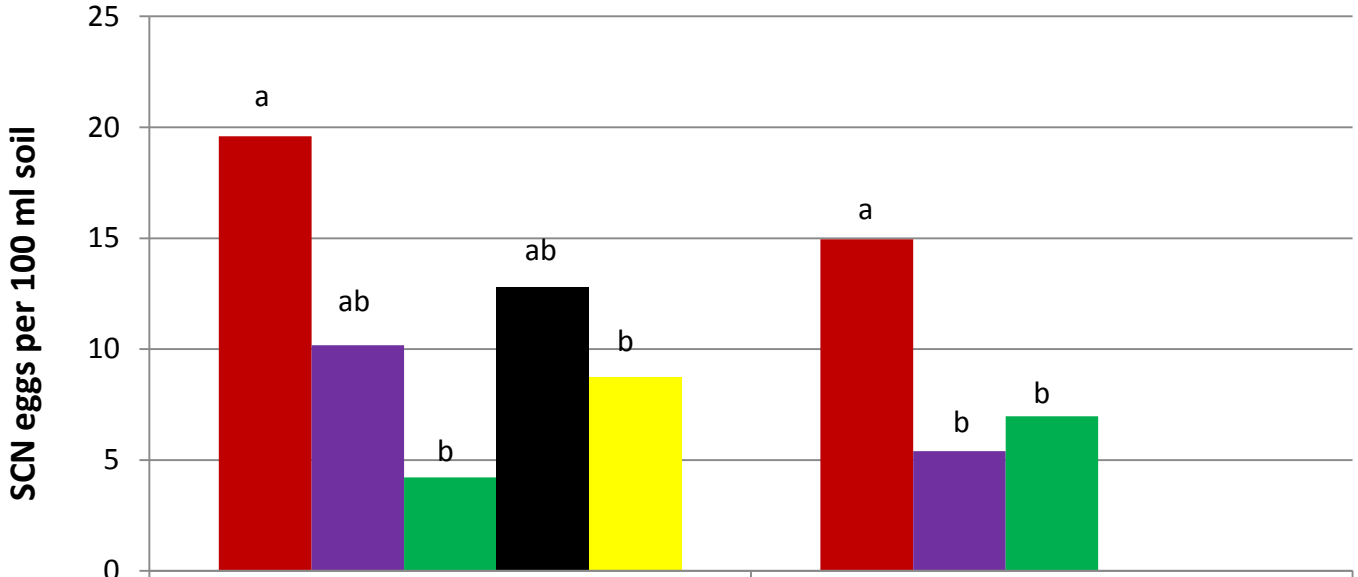
Soybean Cyst Nematode

2011 soil samples



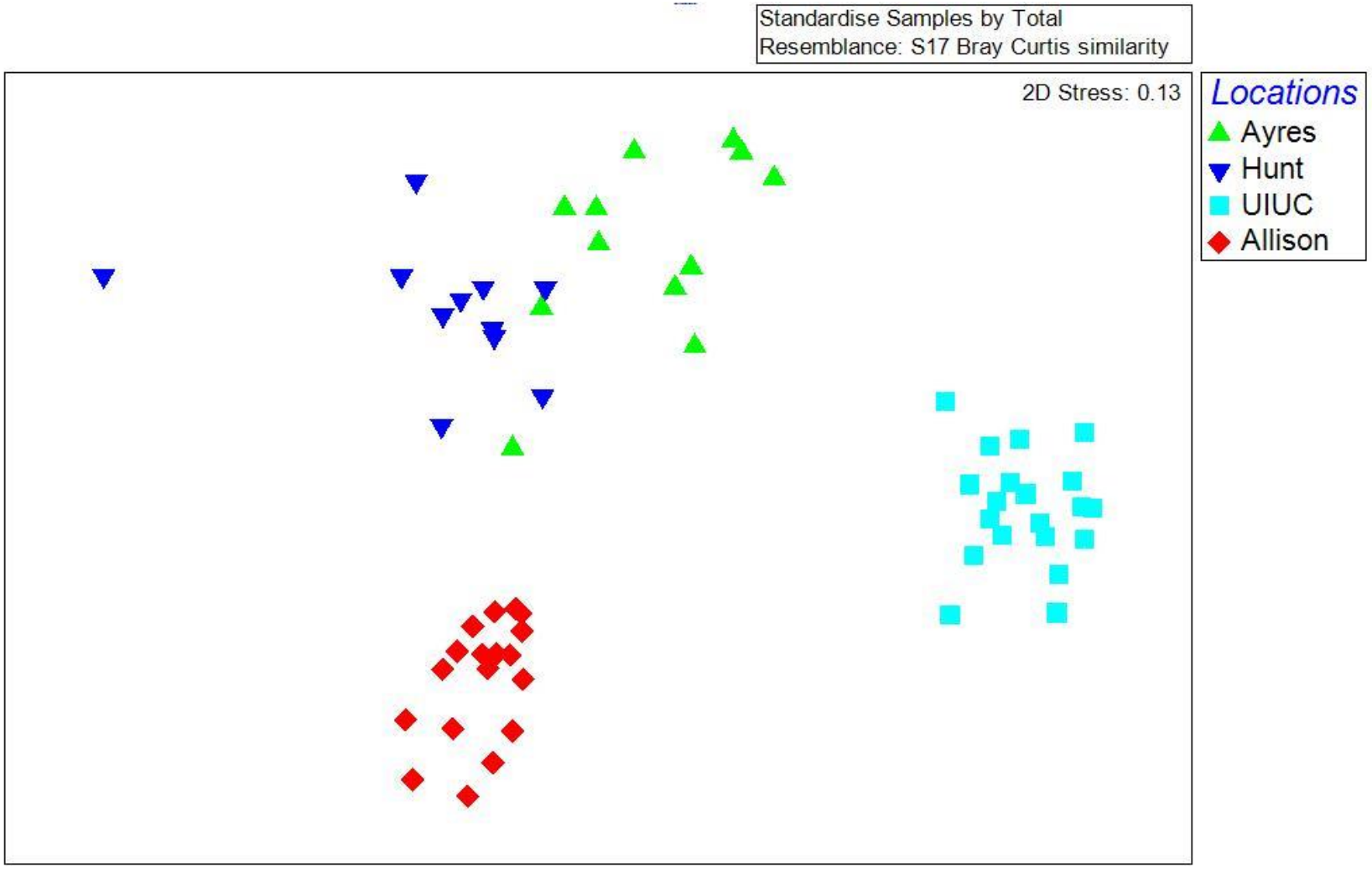
	UIUC	Ayres	Allison
Fallow	21.7	30.04	43.34
Rye	12.61	17.72	14.69
Rape	15.35	15.79	22.82
Canola	9.86		18.18
Mustard	17.53		28.32

Soybean Cyst Nematode
2012 soil samples

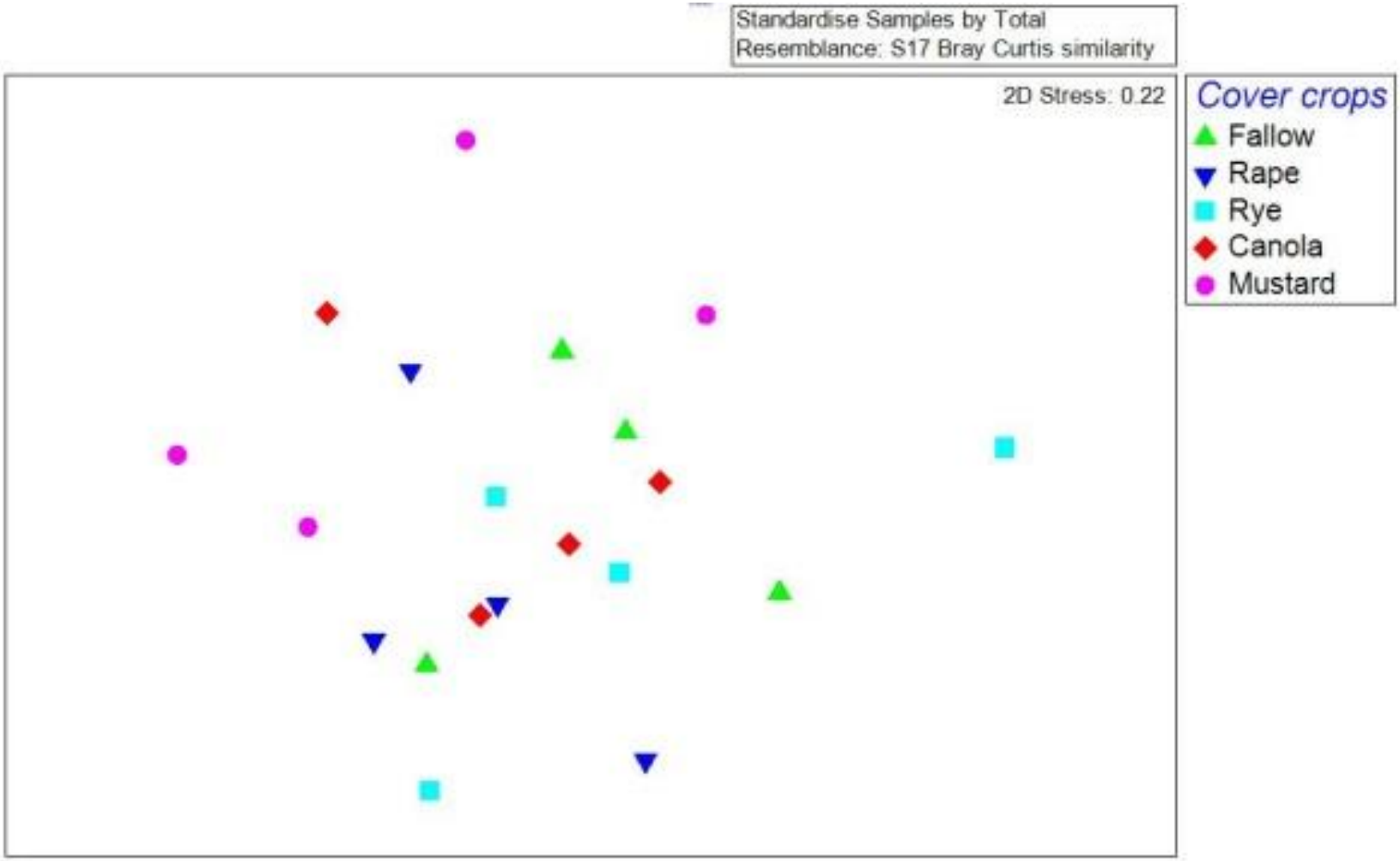


	Allison	Hunt
Fallow	19.59	14.95
Rye	10.18	5.4
Rape	4.22	6.98
Canola	12.78	
Mustard	8.74	

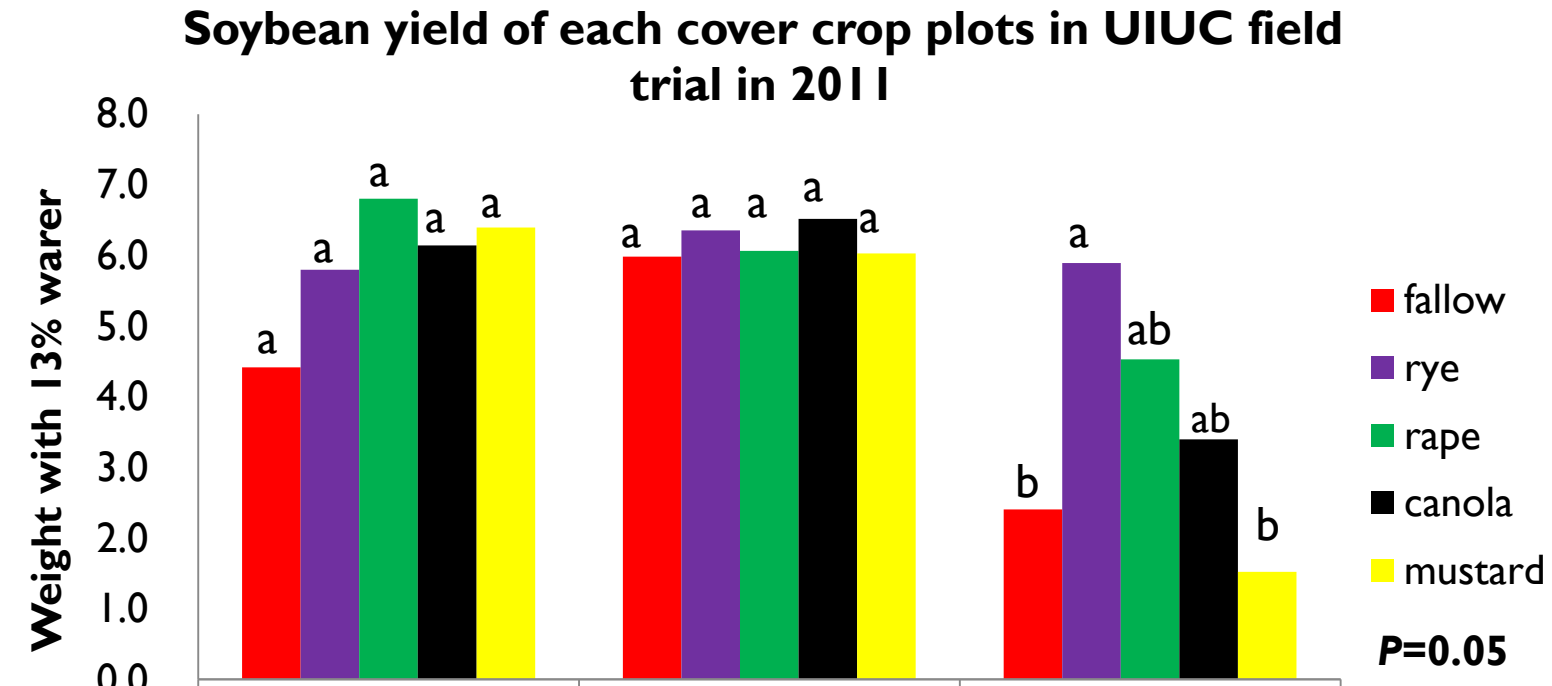
ARISA Community Analysis



ARISA Community Analysis



Yield, UIUC 2011



	Control	Fsg	R.solani
fallow	4.4	6.0	2.4
rye	5.8	6.4	5.9
rape	6.8	6.1	4.5
canola	6.1	6.5	3.4
mustard	6.4	6.0	1.5

Conclusions

- Rye and rape resulted in the highest soybean stands, but results were not consistent among locations.
- Rye and rape have the potential to induce soil suppressiveness to Rhizoctonia root rot and sudden death syndrome.
- Rye, rape, and canola can significantly decrease soybean cyst nematode egg counts.
- Other pathogen populations were not significantly affected by cover crops.
- Cover crops did not result in significant differences in microbial community structure.