

An aerial photograph of a large agricultural field, likely a soybean field, showing neat rows of young green plants in a field. The soil is light brown and appears to be a no-till or reduced-till system. In the background, there are some buildings and trees under a clear sky.

Breeding Soybean for SCN Resistance in the Midwest

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Outline

- Background on soybean cyst nematode (SCN).
- Resistance source – yield association.
 - Isoline studies (Jake Delhelmer).
 - SCN Uniform test results.
- SCN resistance QTL from *Glycine soja*.
 - Effect of combining *G. soja* genes with *rhg1* (Myung Sik Kim).

Background on SCN

- SCN is estimated to cause the most yield losses of any soybean pest in North America.
 - Estimated US loss of 172 million bushels in 2008.



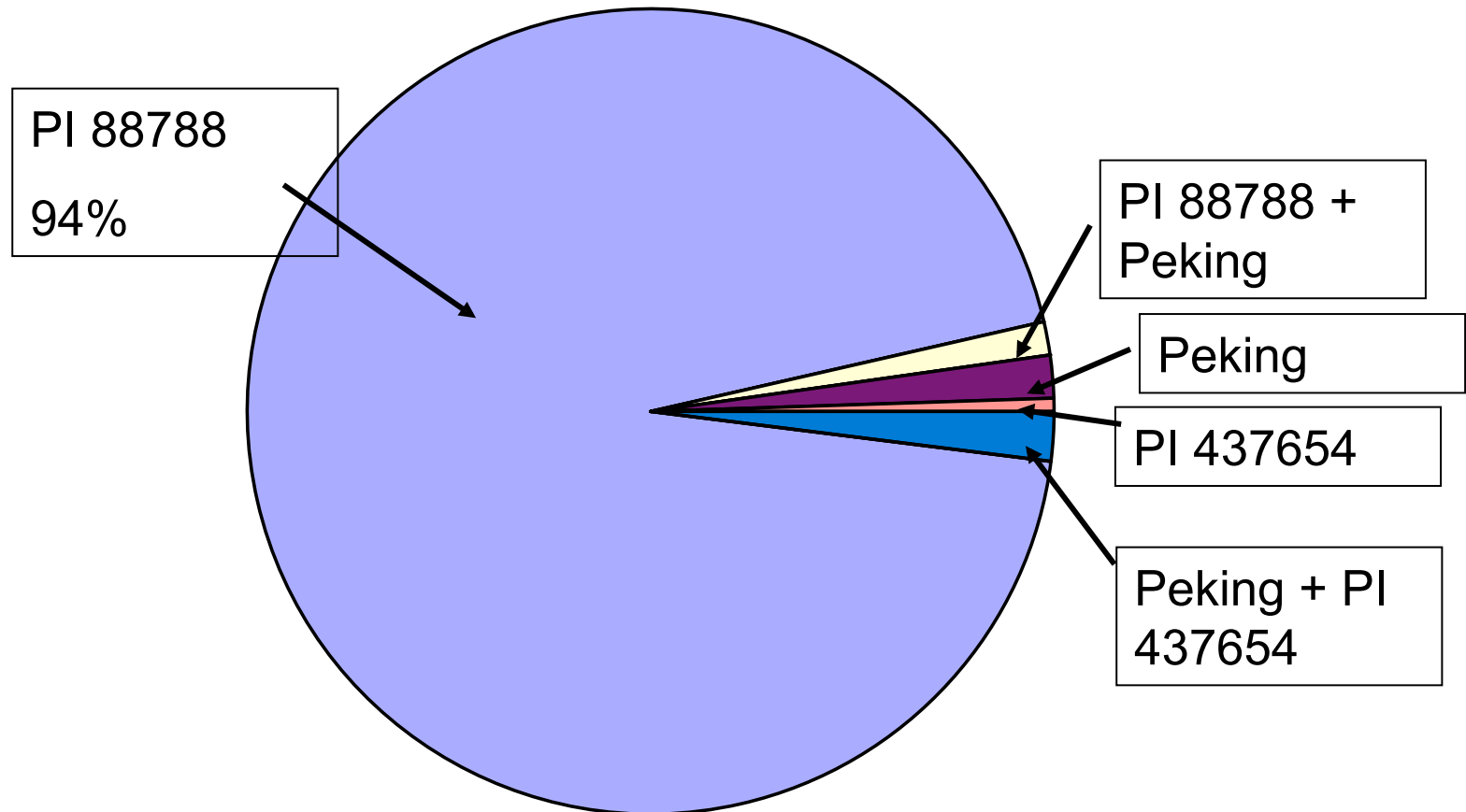
Plant Health Progress Website.

Many SCN Resistance Sources Identified

- Over 118 sources of SCN resistance identified.
- Resistant cultivars have been developed.
- Pickett was the first SCN resistance cultivar released in the US in 1965.



Sources of SCN Resistance for Maturity Group II to IV Varieties



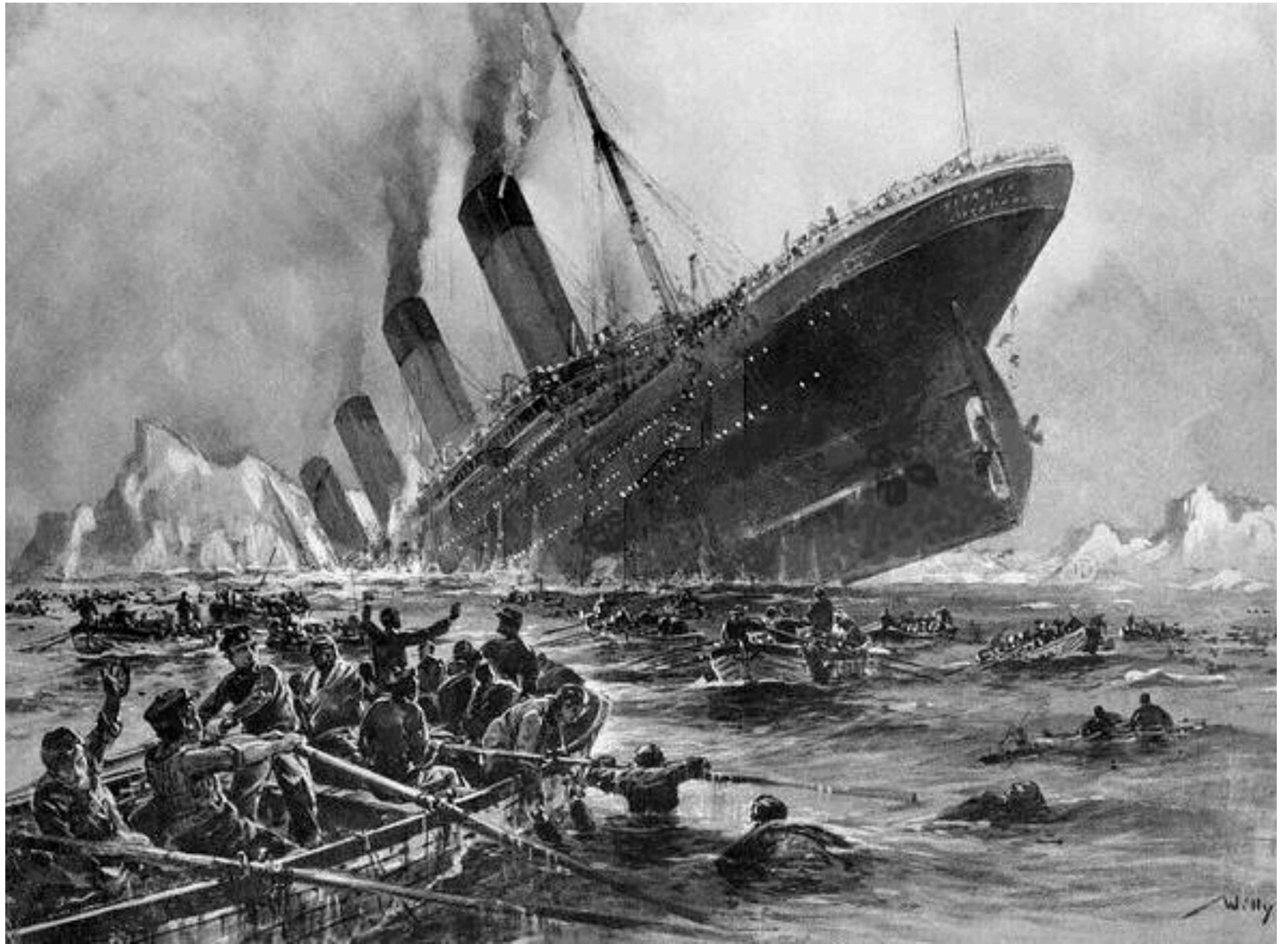
These data are from the 2008 extension publication "Soybean varieties with soybean cyst nematode resistance" by Marion Shier, Crop Systems Unit Educator, Livingston County Extension Unit.

Why PI 88788 Overuse?

- PI 88788 resistance has been successfully combined with high yield in the Midwest.
- Breeders have more difficult time combining resistance and high yield in other sources.
- Use of PI 88788 resistance is contributing to SCN population shifts.

Nematodes Adapting to PI 88788 Resistance

- 1989-1990 - 36% of sampled nematode populations in Illinois could overcome PI 88788 (Sikora and Noel).
- 2005 - 70% of sampled nematode populations in Illinois could overcome PI 88788 (Niblack et al.).
 - FI on PI 88788 ranged from 10-98 on positive samples
 - 83% of Illinois fields infested in 2005.



What is the Impact of SCN Population Shifts on Yield?

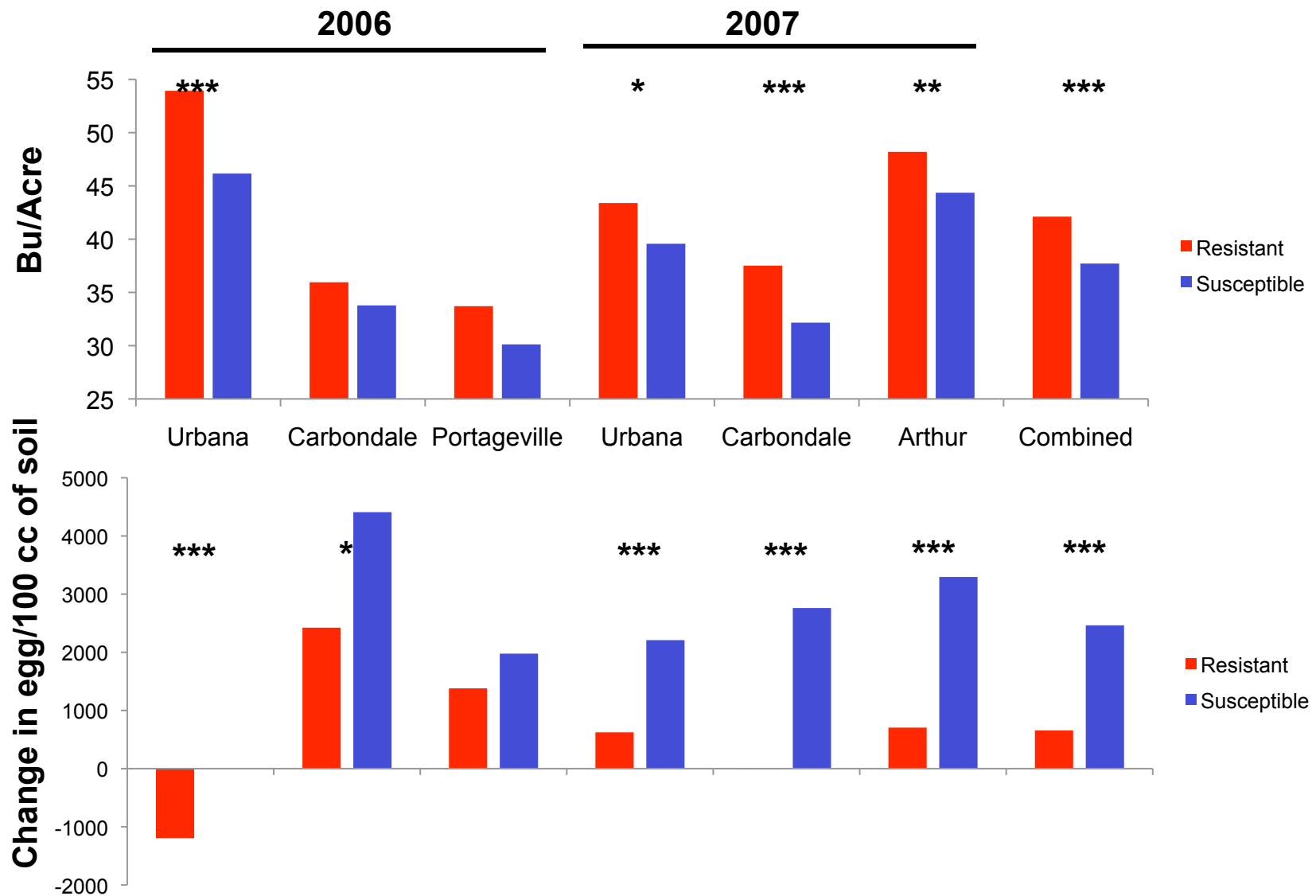
- Can we see a general advantage of Peking or PI 437654 resistance compared to PI 88788 resistance?



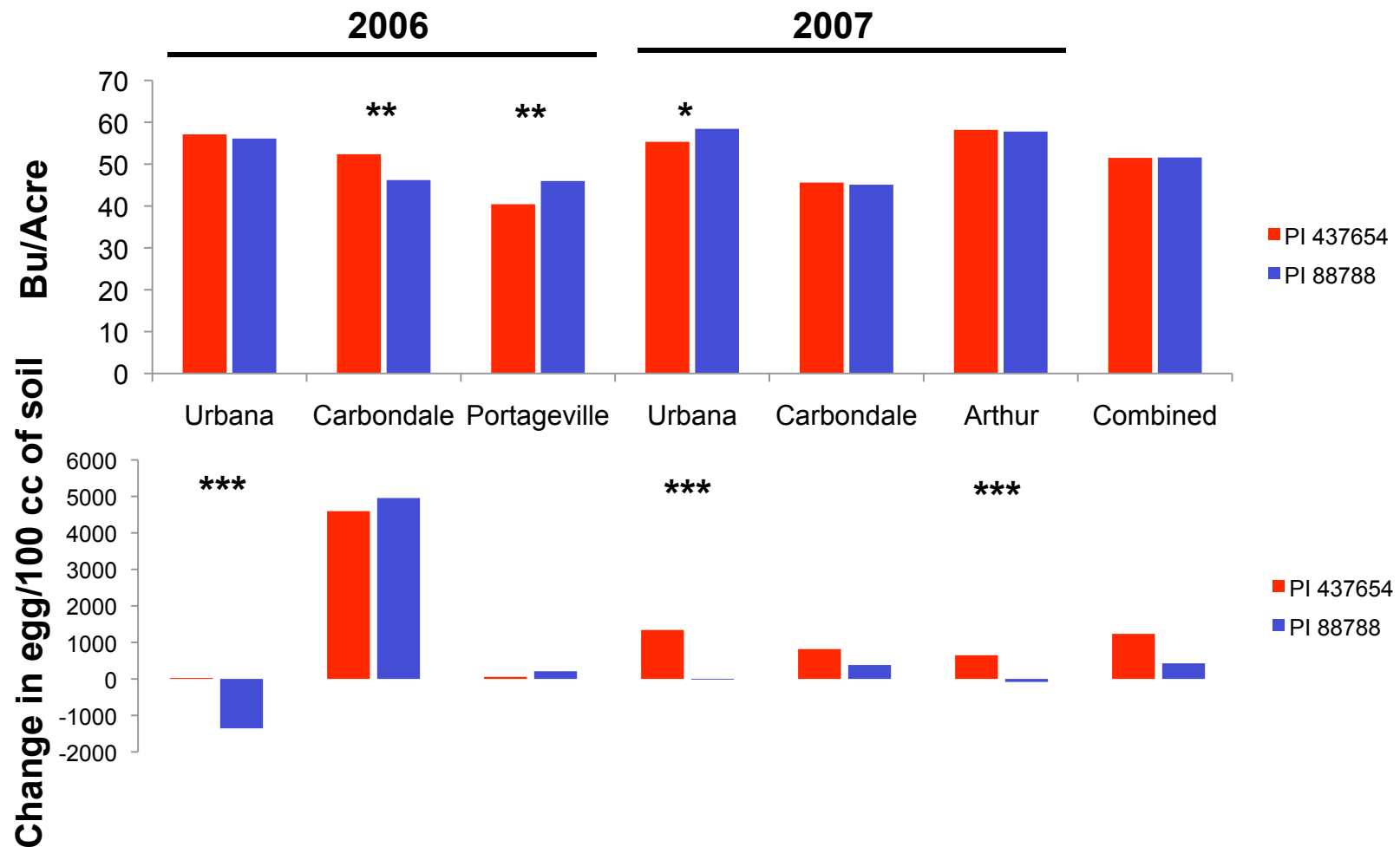
Effect of *rhg1* Alleles on Resistance and Agronomic Traits

- NILs populations segregating for *rhg1* resistance alleles.
 - Population 1: S42-M1(R from PI 88788) x S22-C3 (S). Developed from a F₆-derived line.
 - Population 2: S38-T8 (R from PI 88788) x LD00-2817 (R from PI 437654). Developed from a F₄-derived line.
- Tested in six environments that have SCN populations that can overcome PI 88788 resistance. (HG type 1.2.5.7 or 2.5.7 or 2.7).
 - FI on PI 88788 average 20.5.

Effect of *rhg1* from PI 88788



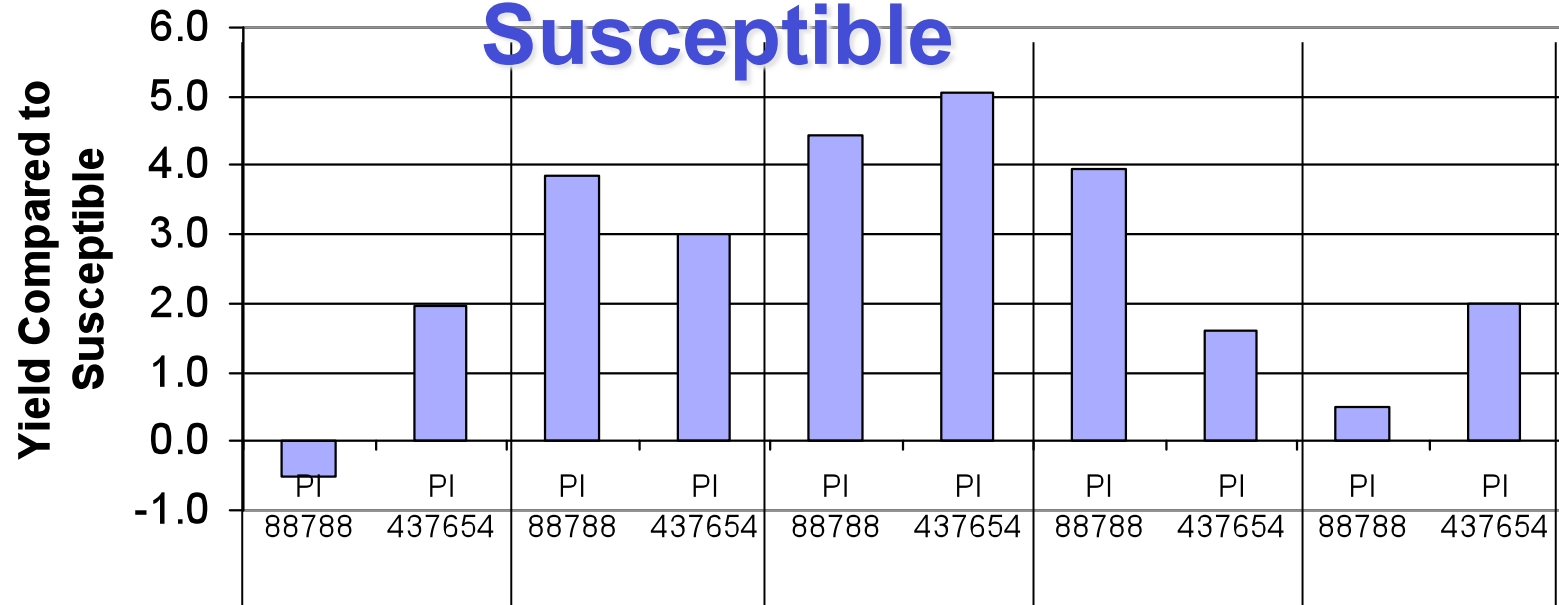
Effects of *rhg1* from PI 88788 and PI 437654



SCN Uniform Test Analysis

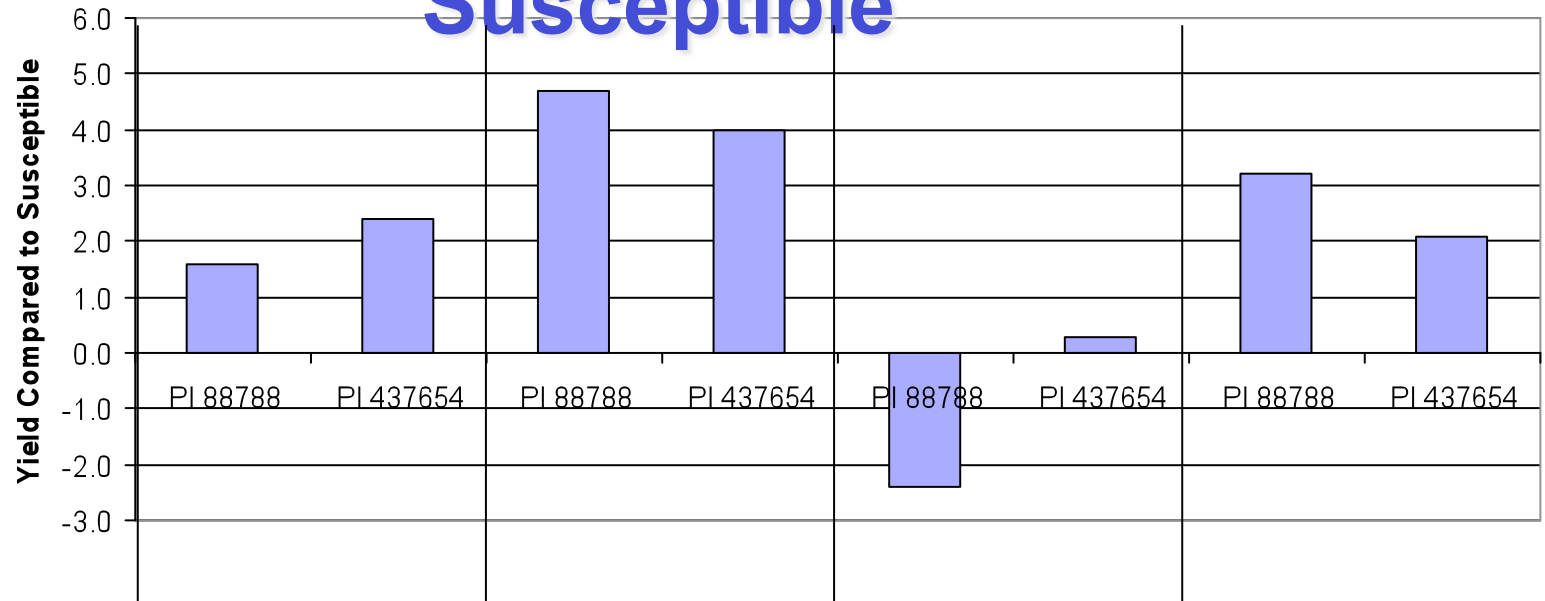
- Multi-location tests of publicly developed SCN resistant experimental lines organized by Troy Cary.
- Soil from each environment is sampled and nematode number and HG type of the is determined (Terry Niblack).
- MG III test is over 2004-2007.
- Each test includes a susceptible, PI 88788 resistant line and a PI 437654 resistant lines.

Yields of U98-311442 (PI 88788) and LD01-5907 (PI 437654) Compared to Susceptible



SCN Egg Ave. (Spring)	0	173	599	2,778	9,668
SCN Egg Range	0	1-300	301-1,000	1,001-5,000	5,001-10,000
Yield of Suscept.	55.1	51.4	51.8	58.7	58.7
No. Env.	24	12	12	7	6

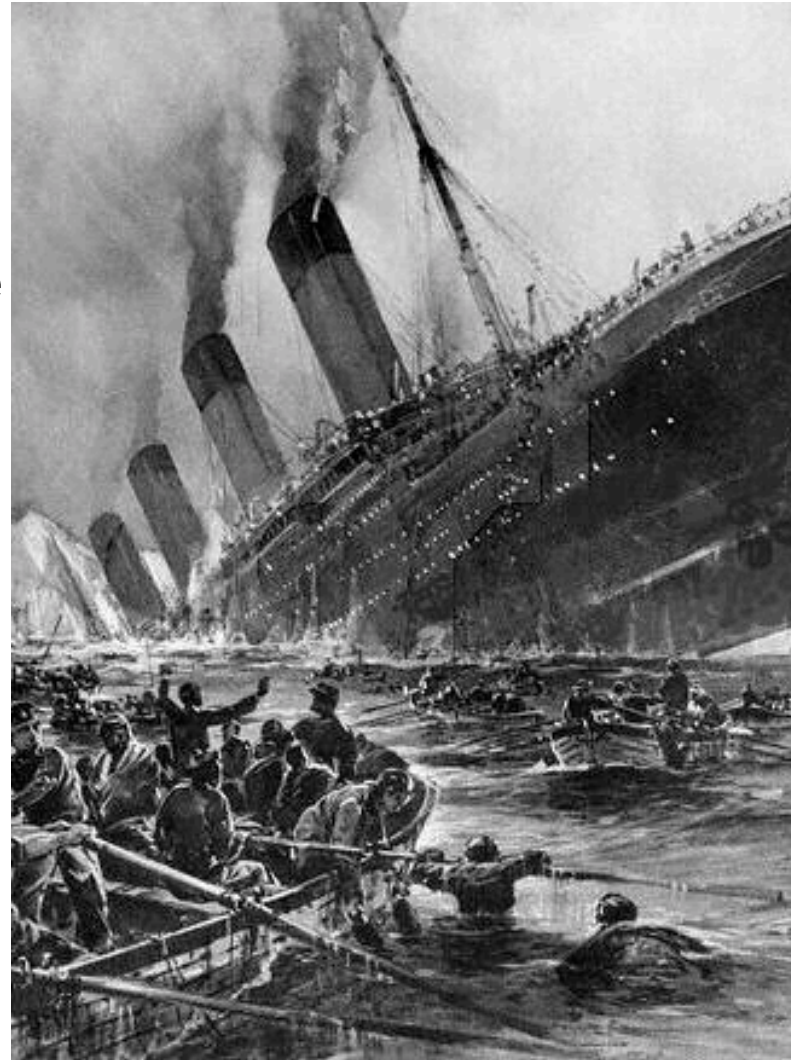
Yields of U98-311442 (PI 88788) and LD01-5907 (PI 437654) Compared to Susceptible



SCN Egg Ave.(Spring)	329	418	8,860	5,430
SCN Egg Range	1-1000	1-1,000	1,001-10,000	1,001-10,000
Yield of Suscept.	HG 7	HG 2.5.7	HG 7	HG 2.5.7
No. Env.	5	17	2	11

Conclusions

- Difficult to show a yield advantage of lines with PI 437654 resistance across multiple environments with SCN population that can overcome PI 88788 resistance.
- In these environment, most population have FI on PI 88788 in the moderate range (FI of 11-40).
- **STILL NEED TO DEVELOP CULTIVARS WITH OTHER RESISTANCE SOURCES. THESE ARE NEEDED IN IN SOME SPECIFIC ENVIRONMENT!**

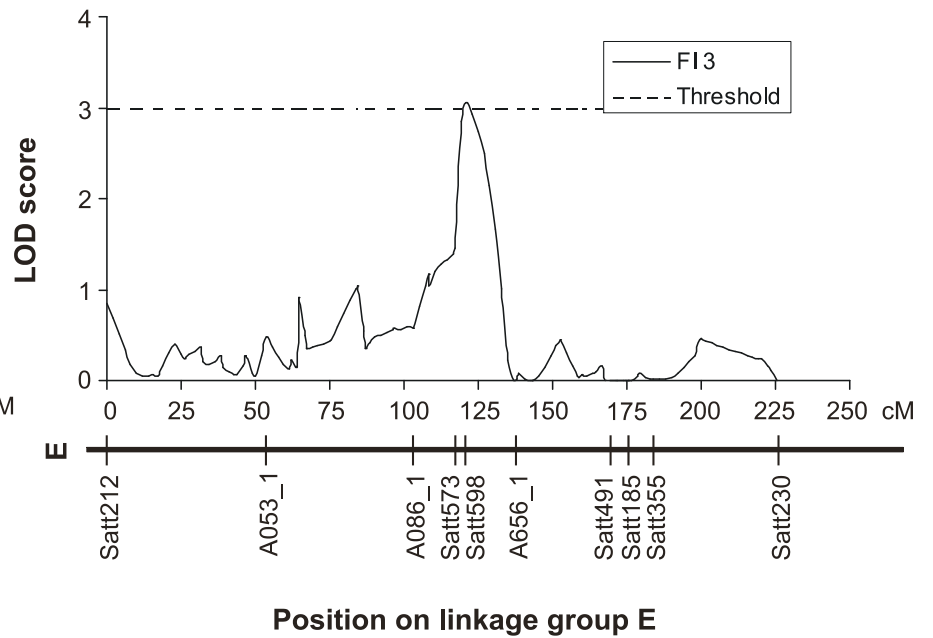
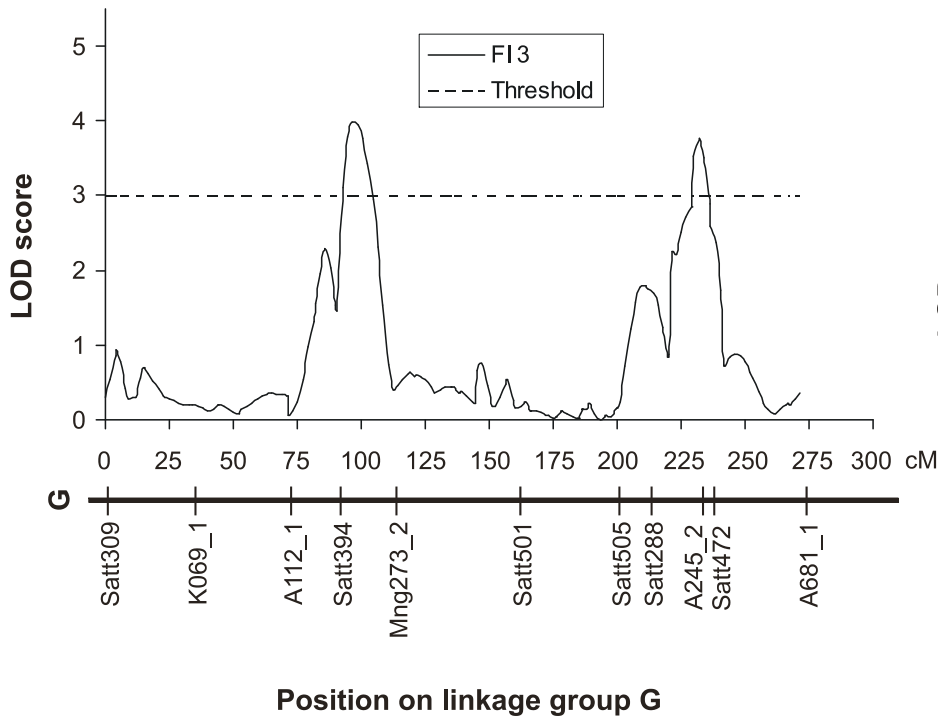


SCN Resistance from *G. soja*

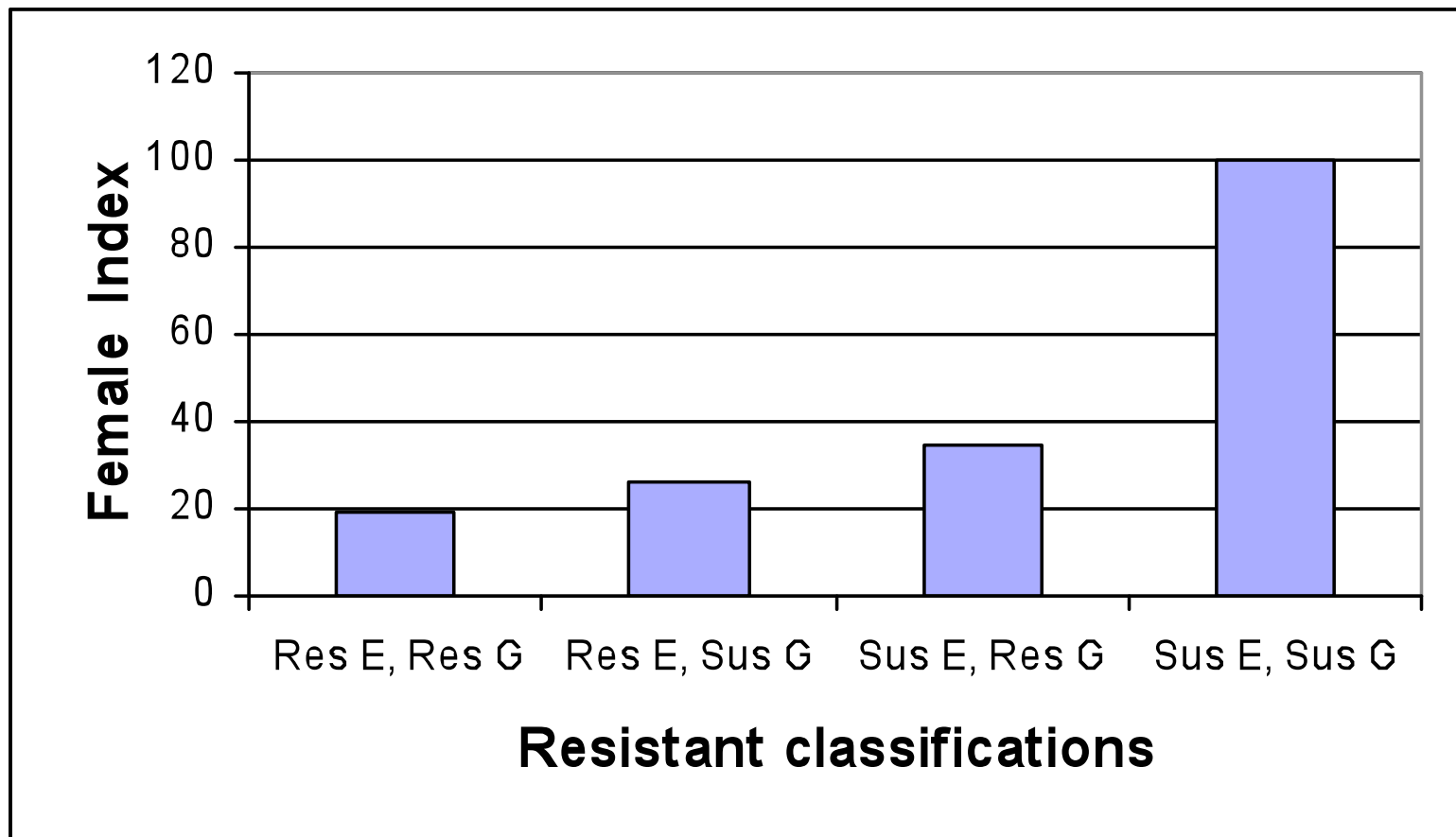
- SCN resistance was identified from *G. soja* PI 468916.
- Does this genotype have resistance genes different than current sources?



LOD Plots of SCN QTL in F₂-Derived Lines



Resistance of Lines in a BC4 Population Segregating for *G. soja* QTL (HG Type 0)



Yield Test of a BC4 Population Segregating for *G. soja* Resistance

Linkage Group	Yield			Other significance
	P>F	<i>G. soja</i>	<i>G. max</i>	
E	0.006	46.6	45.4	Later mat. (0.75 days)
G	0.004	46.8	45.4	Greater lod. (0.15 units)

New SCN Gene Combinations

- Can broad-based SCN resistance be developed by combining genes from different resistance sources?
- Combine genes from *G. soja* with those from PI 88788 or PI 437654.

Effects of *rhg1* from PI 88788 and Two *G. soja* Genes

Resistance Gene			SCN Isolate		
<i>rhg1</i>	<i>G. soja</i> LG G	<i>G. soja</i> LG E	Type 0 (PA3)	Type 5.7 (PA1)	Type 2.5.7 (PA5)
-----Female Index-----					
S	S	S	97	83	81
R	S	S	21	65	85
R	R	R	20	28	16

Effects of *rhg1* from PI 437654 and Two *G. soja* Genes

Resistance Gene			SCN Isolate		
<i>rhg1</i>	<i>G. soja</i> LG G	<i>G. soja</i> LG E	Type 2.5.7 (PA3)	Type 2.5.7 (PA1)	Type 2.5.7 (PA5)
-----Female Index-----					
S	S	S	60	107	104
R	S	S	43	31	44
R	R	R	19	12	14

Conclusions

- SCN resistance QTL from *G. soja* have been confirmed in a backcross population.
- The *G. soja* QTL are associated with greater yield.
- The *G. soja* resistance QTL act additively with *rhg1* to provide more broad based resistance.

Participants



**Eric
Brucker**



**Terry
Niblack**

Eileen Kabelka

Jake Delheimer



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**Prakash
Arelli**

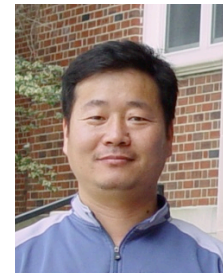
Grover Shannon

Mike Schmidt

Troy Cary



**Dechun
Wang**



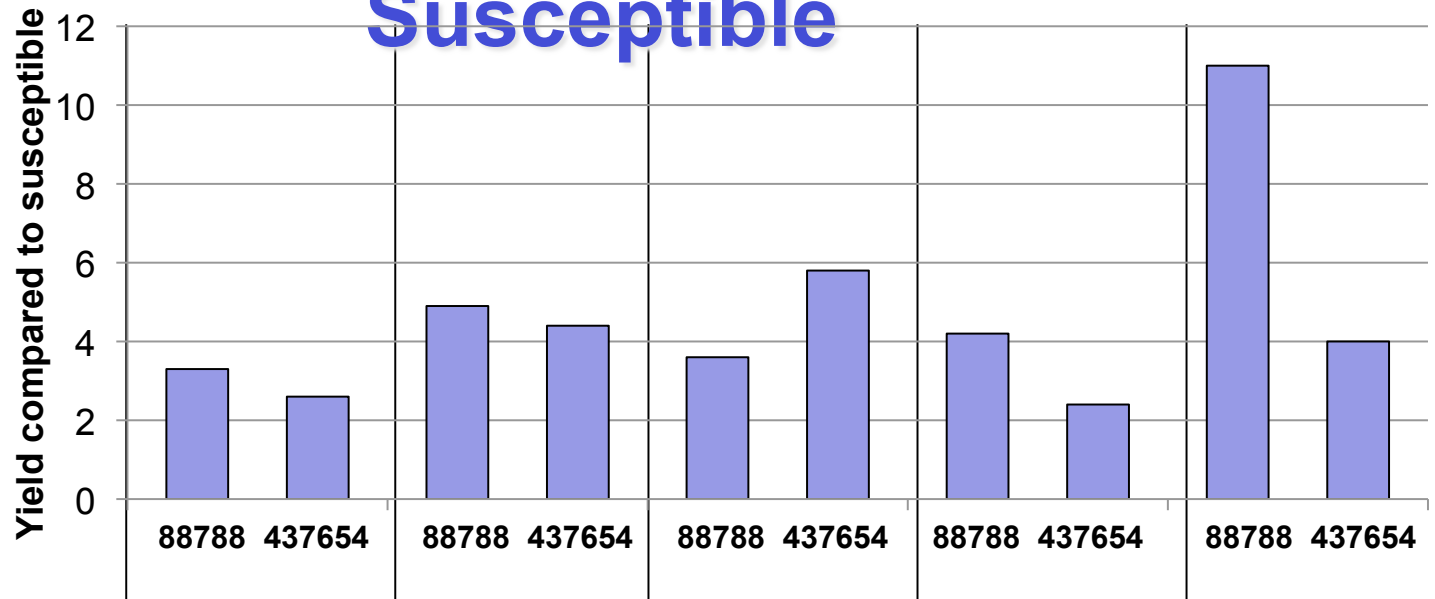
**Myung Sik
Kim**

Acknowledgements

- Research was supported by:
 - United Soybean Board.
 - Illinois Soybean Checkoff Board.
 - USDA-NRI competitive grant program.



Yields of LD00-3309 (PI 88788) and LD00-2817 (PI 437654) Compared to Susceptible



SCN Egg Ave. (Spring)	0	144	584	2,010	7,720
SCN Egg Range	0	1-300	301-1,000	1,001-5,000	5,001-10,000
Yield of Suscept.	49.3	54.1	48.2	57.3	50.3
No. Env.	22	17	16	4	2

Effect of *rhg1* Alleles on Resistance and Agronomic Traits

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Effect of *rhg1* in greenhouse tests with SCN HG type 0 (Race 3).

