Soybean Aphid Biotypes: Understanding Geographic Distribution 2008-2010

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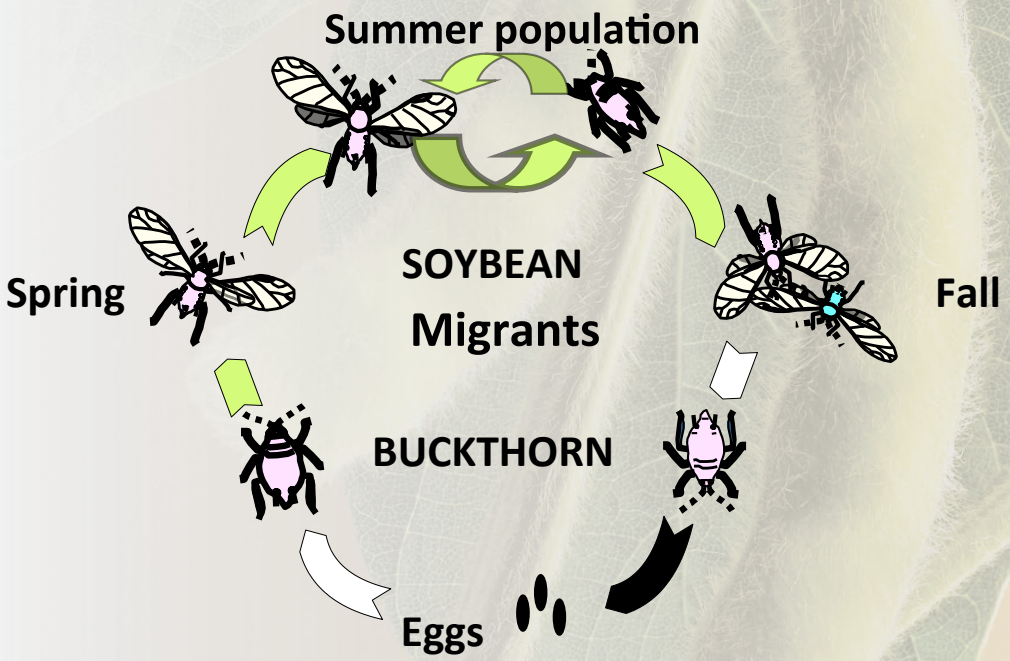
Soybean Aphid

Aphis glycines Matsumura

- Soybean aphids confirmed in Wisconsin in 2000 and quickly spread to the North Central region
- Much of N America suitable climate for soybean aphid
- Expansion limited by availability overwintering host, buckthorn
- Viviparous and Oviparous
  - Population can build-up rapidly
- Migrate large distances



Difonzo CD. 2007. Soybean Facts. MSU Extension Publication

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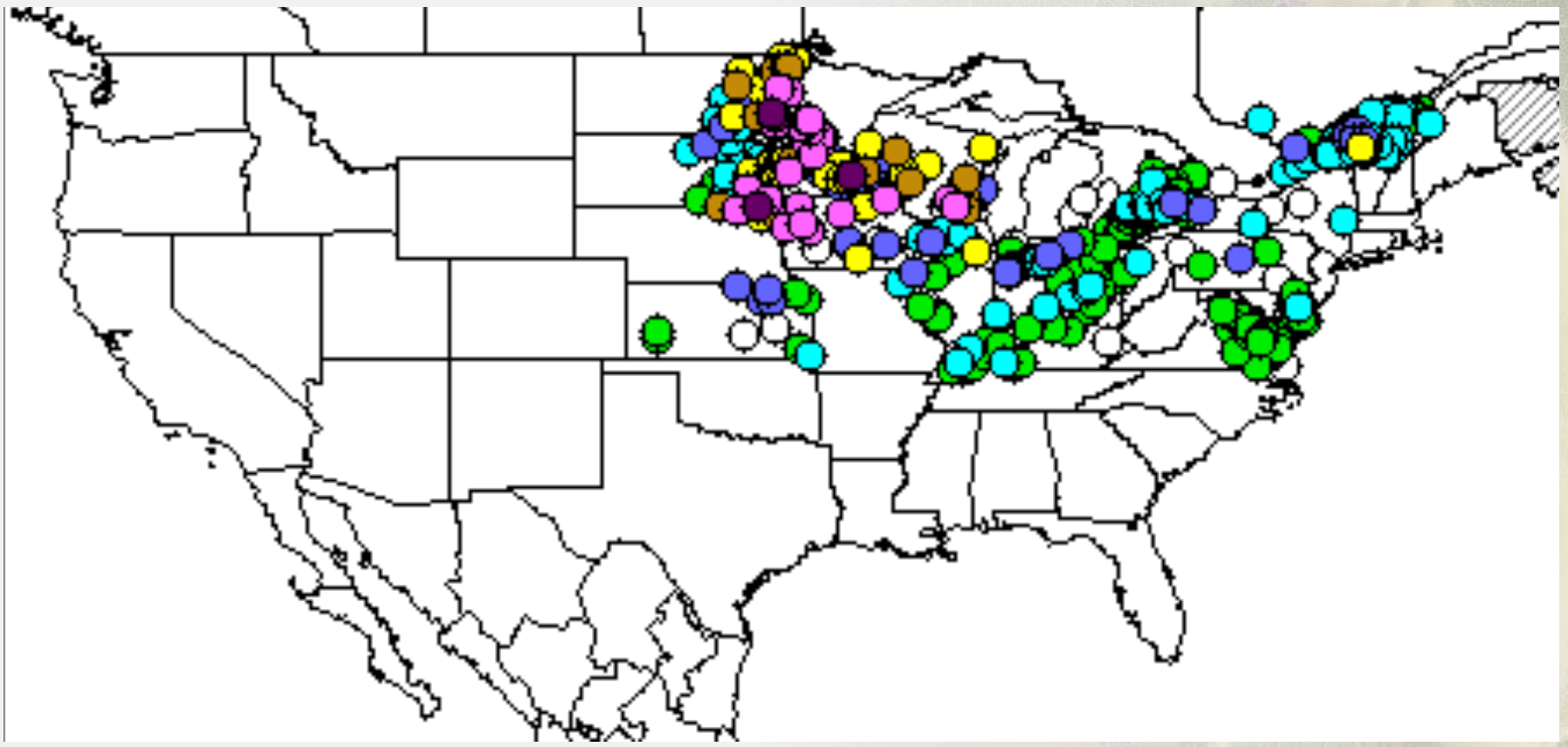
Soybean Aphid Distribution



Average Number of Aphids per Plant							
	0	>0-5	6-39	40-149	150-249	250-499	>500

Source: Integrated Pest Management – Pest Information Platform for Extension and Education (PIPE) 8/9/2008

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Management Techniques

- Biological Control
  - Lady beetles
  - Parasitic wasps (*Binodoxys communis)*
- Scouting
- Insecticide Treatments
- Aphid associated loci
  - *Rag1, Rag2, rag3, rag4*
  - Insect Biotypes

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Insect Biotypes

- The performance of a genotype or group of genotypes of unknown relation on particular host (host differentials) *Downie. 2010.J. Insect Science 10:176(1-18)*

- Not: A population or group of individuals having the same genotypes

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Understanding More about Soybean Aphid Biotypes

- Initiated in 2008
- Collaborated with with public entomologists/ breeders to design and conduct evaluations

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Identification of 'Biotypes' in Soybean Aphid

- Reports of aphids proliferating on *Rag1* germplasm in OH (2005) & MI (2006)
- 2008: Kim et al. Crop Sci 28:923-928

Table 3. The average number of aphids per plant 10 d after infestation and the plant damage index (PDI) 15 d after infestation with the Ohio isolate in the choice test.

	Soybean genotype	No. of aphids plant^{-1} 10 d after infestation	Average PDI 15 d after infestation†	
Rag1	Dowling	157a‡	4.2a	
	Dwight	180a	4.0a	*Susceptible*
	Jackson	110b	4.3a	
	PI 200538	24c	1.2d	
	Williams 82	166a	4.5a	*Susceptible*
	PI 567541B	38c	2.2c	
	PI 567597C	32c	2.2c	
Rag1	LD05-16611	172a	3.0b	

†The plant damage index (PDI) ranges from 1 (no stunting and leaf distortion) to 5 (severe plant damage).

‡Means followed by the same letters in a column are not significantly different by the least significant different test ($P = 0.05$).

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Collaborators

- Vaino Poysna and David Hunt
  - Ag Canada: Harrow, ON
- Mike Gray and Ron Estes
  - University of Illinois
- Matt O'Neal
  - Iowa State University
- Brian McCornack
  - Kansas State University
- Christian Krupke
  - Purdue
- Dechun Wang
  - Michigan State University
- David Ragsdale
  - University of Minnesota (currently at Texas A &M)
- Deirdre Prischmann-Voldseth
  - N. Dakota State University
- Guo-Liang Jiang and Marci Green
  - S. Dakota State University
- Rouf Mian
  - USDA –Wooster, OH
- Eileen Cullen (2008)/ Ag Stat (2009-10)
  - University of Wisconsin

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Objectives

- Understand the distribution of aphid biotypes
- Develop a panel of host differentials to characterize aphid biotypes

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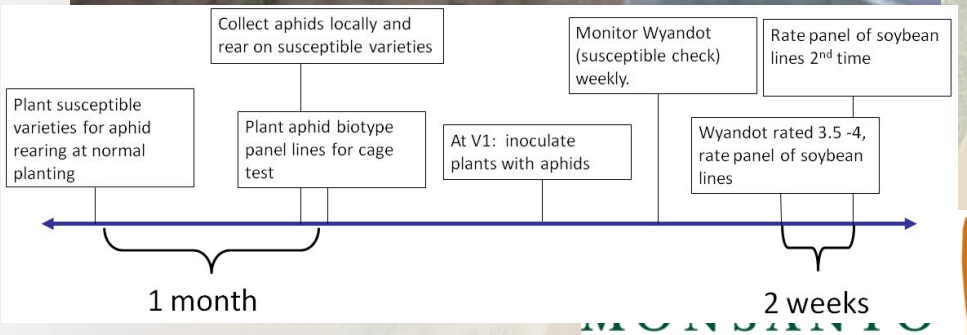
Host Differentials

Line	Institution	Gene	LG
K1621	KSU		F
PI567598B	MSU	*rag1_b, rag3*	M, J
PI567541B	MSU	*rag1_c, rag4*	M, F
Dowling	Univ IL	*Rag1*	M
Jackson	Univ IL	*Rag*	M
PI243540	USDA-OH	*Rag2*	F
PI200538	Univ IL	*Rag2*	F
UGA-MON PI	UGA-MON		
CNS	Public	Variable Rxn	
Wyandot	USDA-Ohio	Susceptible Check	

Design

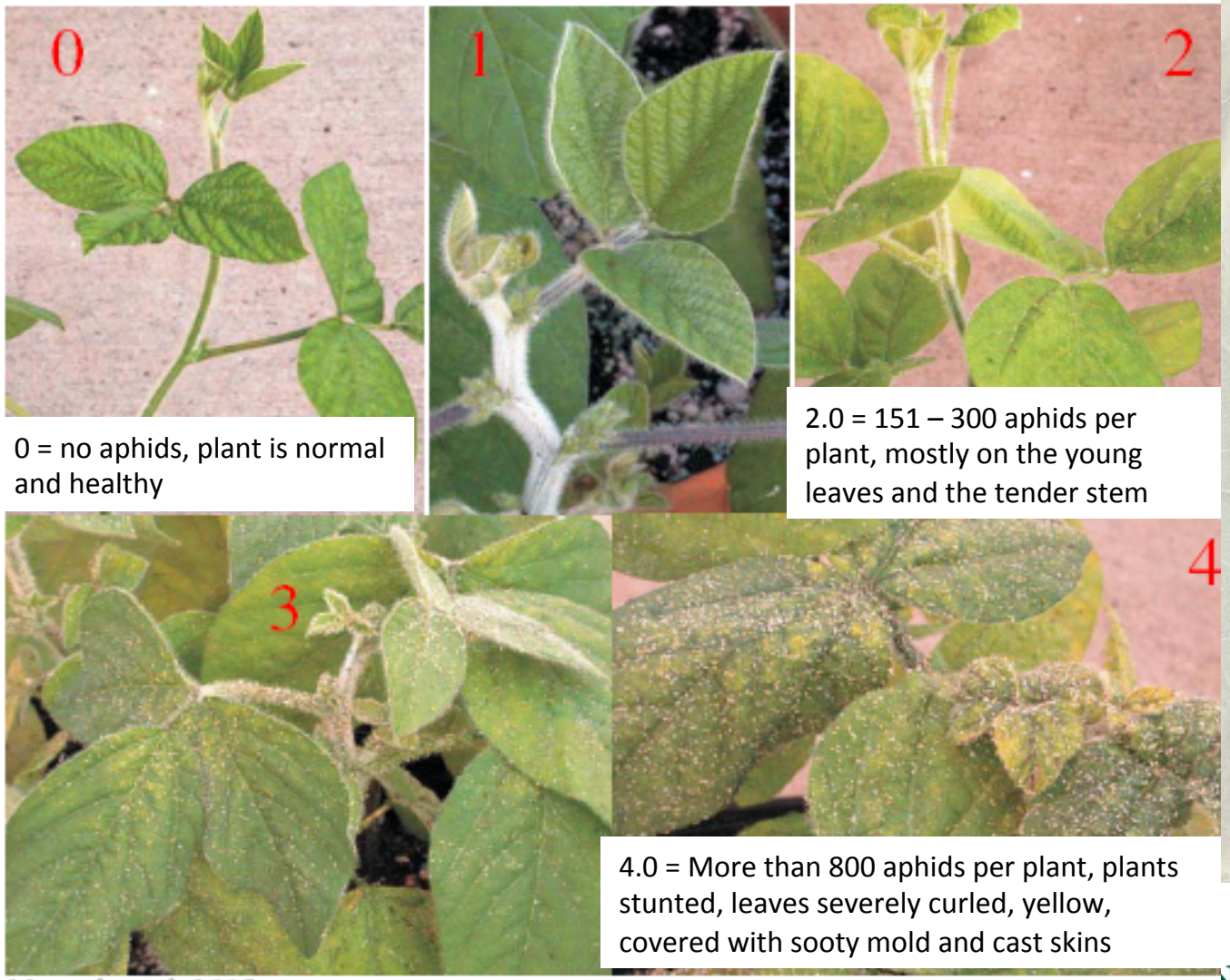
- Protocol based on Mensah et al. 2005
- No-choice evaluation in small field cages
- 15 seed/ cage
- 3 replications/ entry
- 10 entries

- Field collected aphids reared on Wyandot or susceptible variety
- Plant inoculated at V1 and monitored weekly
  - 5 wingless aphids/ plant
- Rating (0-4):
  - Evaluate entire panel when Wyandot reaches 3.5-4
- 8-11 locations



Rating Scale

Mensah et al. 2005



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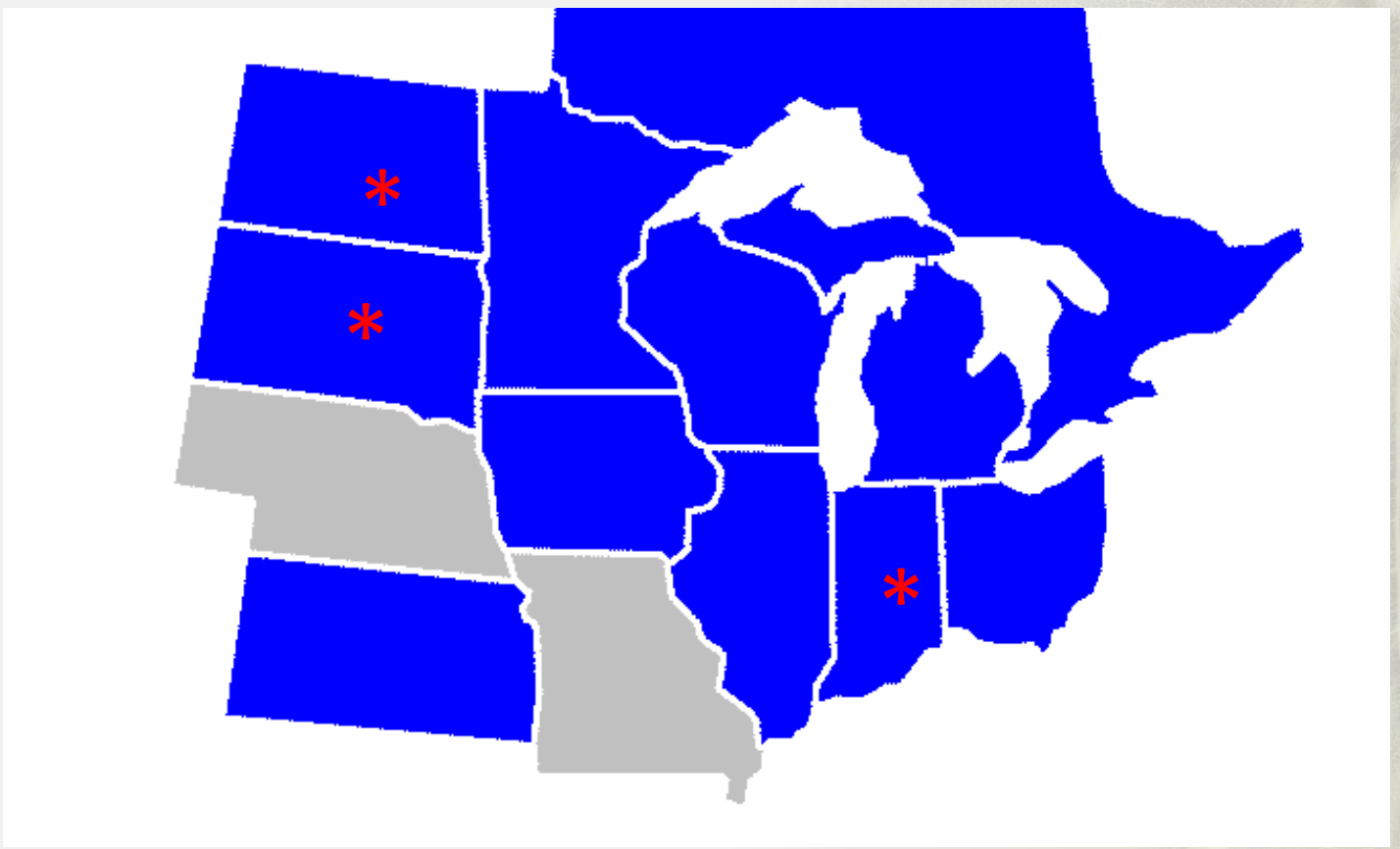
Locations



* Only 2 years of testing

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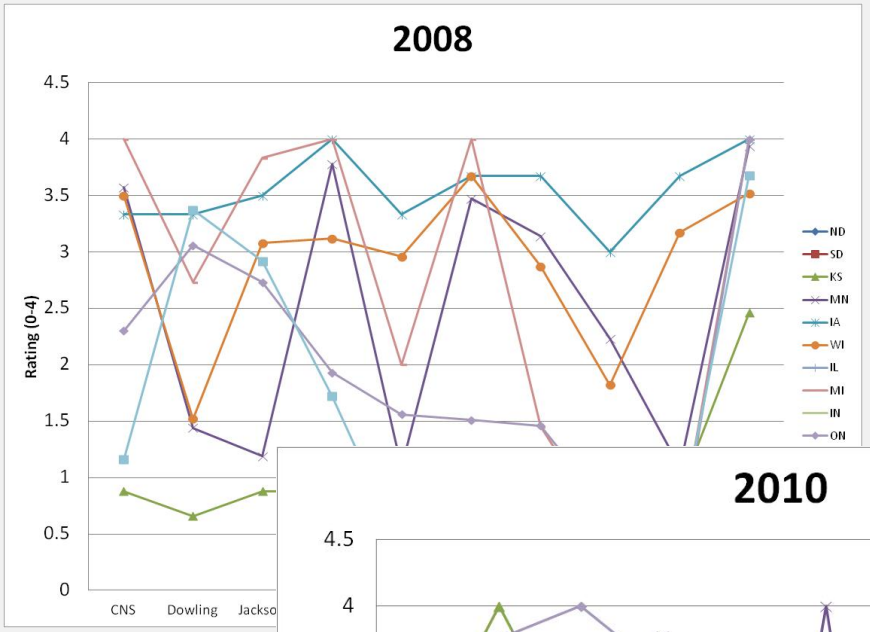
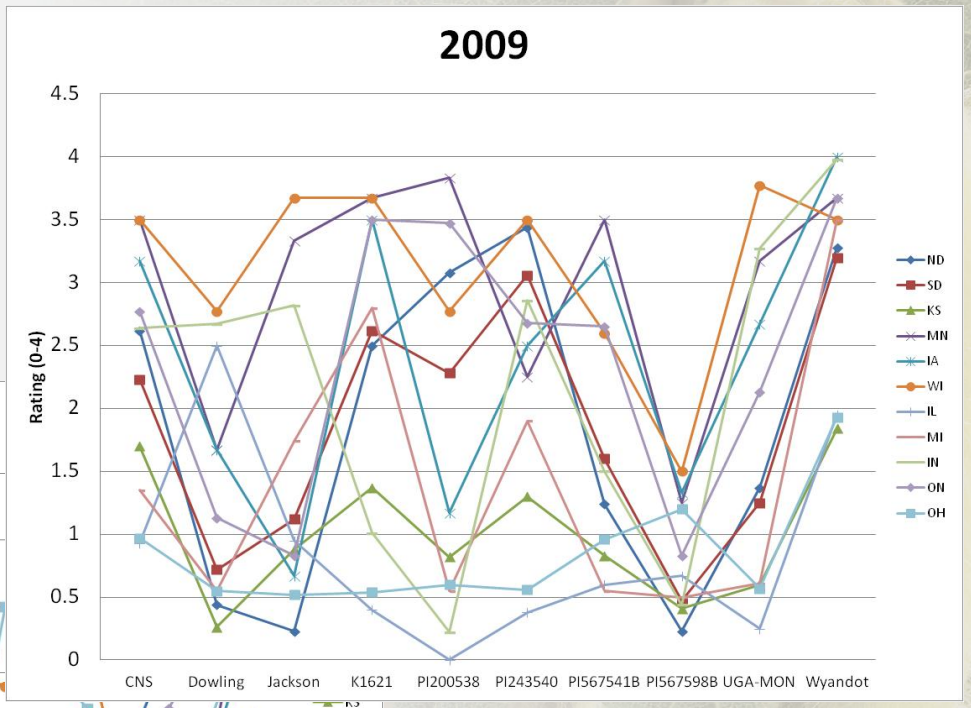
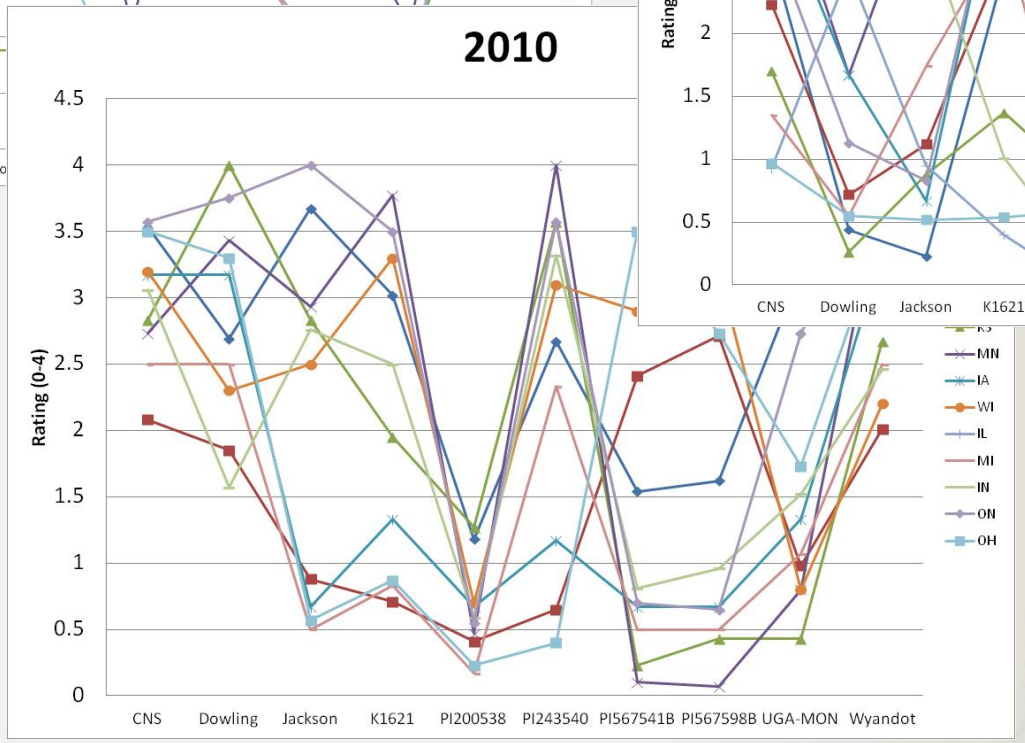
Snapshot of Data







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Data Transformation

- Rating Scale Converted to Damage Index (DI)

$$DI = \frac{\text{Average Scale Value of Entry}}{\text{Average Scale Value of Susceptible Check}} \times 100$$

Damage Index	Cluster Analysis Value	Color
0	50	
10	40	
20	30	
30	20	
40	10	
50	0	
60	-10	
70	-20	
80	-30	
90	-40	
100	-50	
120	-60	

- DI Scores ranged from 0-115%
- Cluster Analysis:
  - Gene Cluster© and TreeView© used to visualize trends
  - Transformed ratings by (50-DI)%

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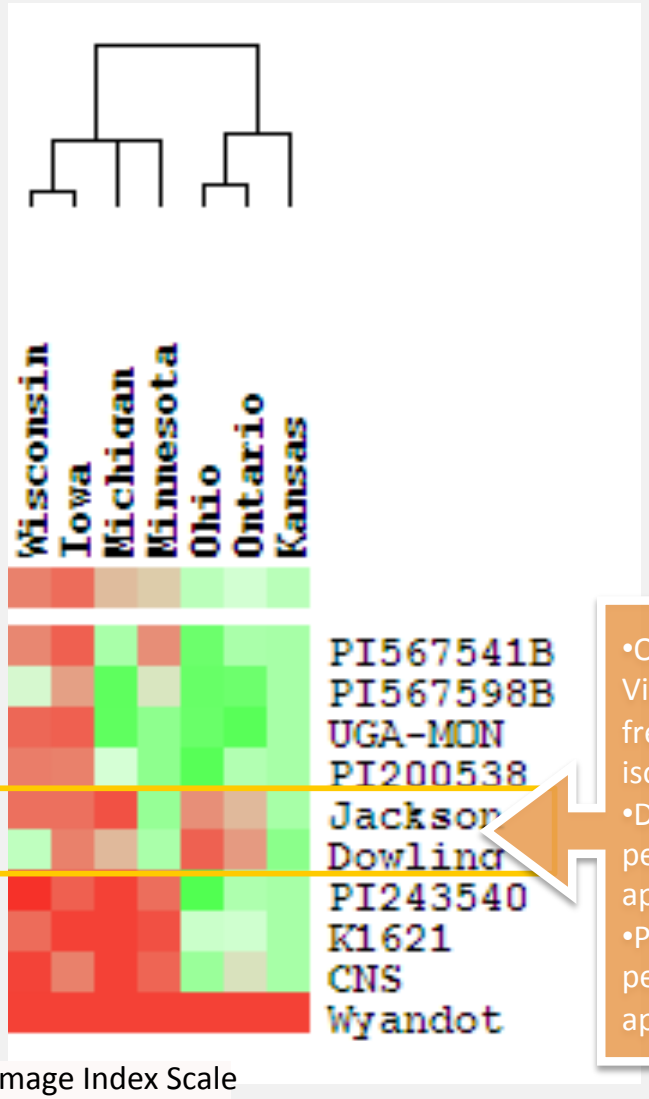
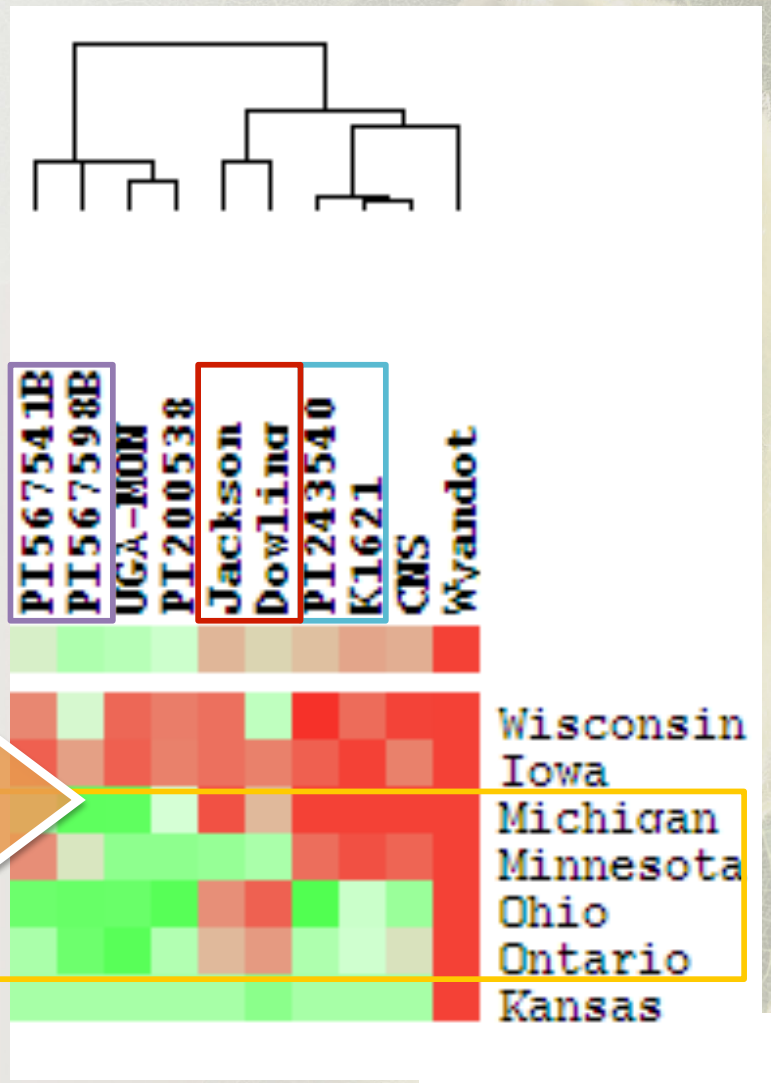
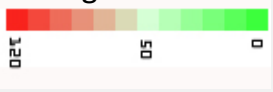
2008



- Ohio Biotype (*Rag1* Virulence) have high frequency in eastern aphid isolates
- Dowling and Jackson perform similarly across aphid isolates
- PI567541B and PI567598B perform similarly across aphid isolates



Damage Index Scale



DI = Σ(Scale value x No. of plants in the category)/(4 x Total no. of plants evaluated) x 100.

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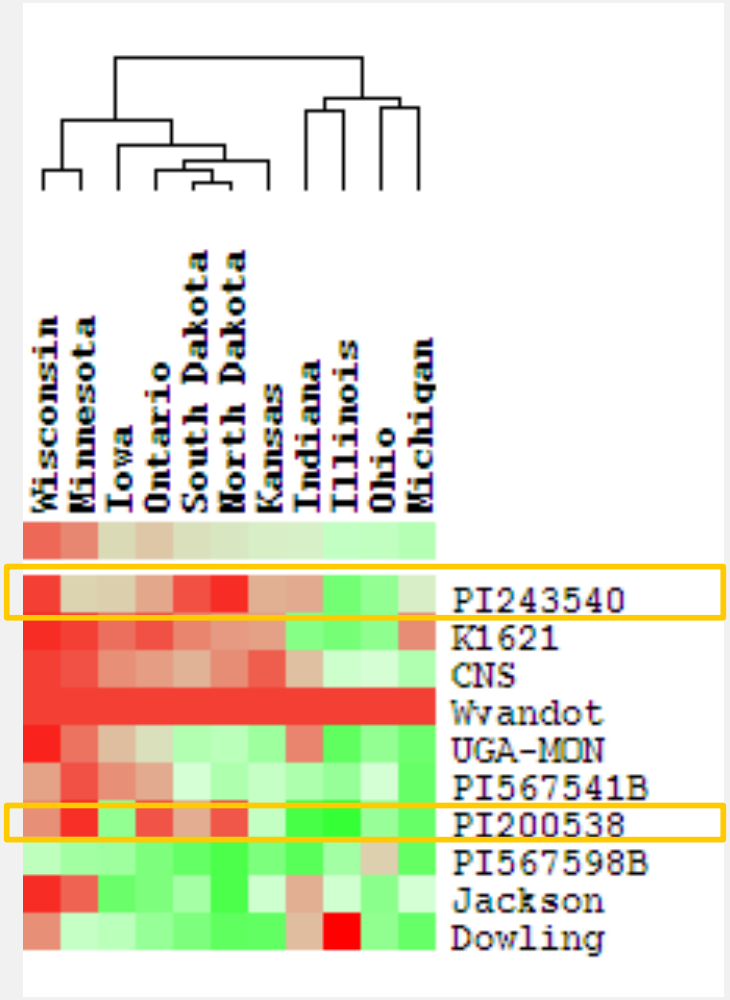
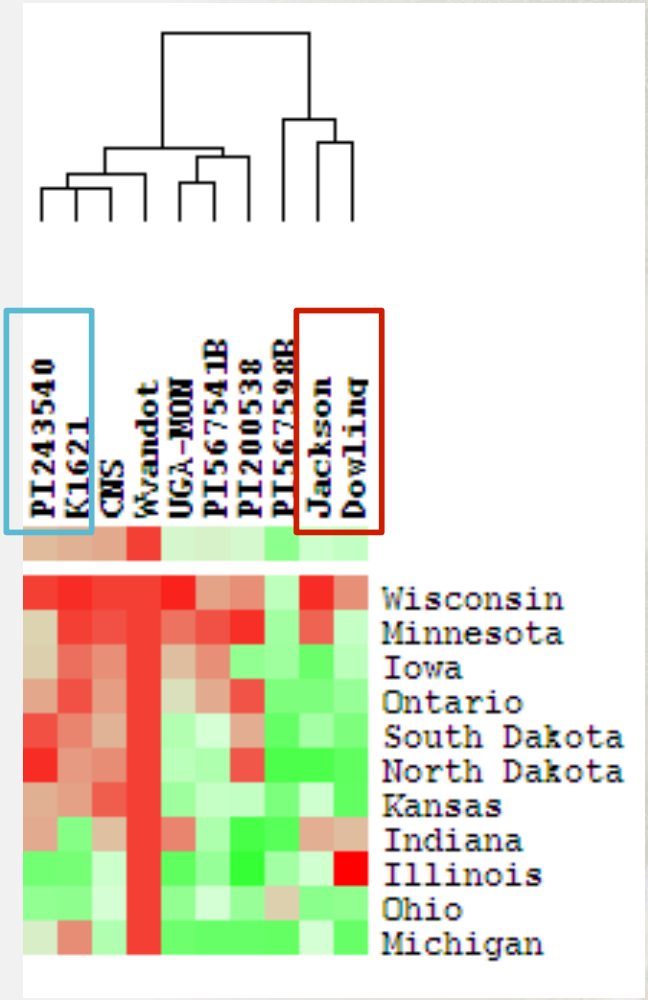
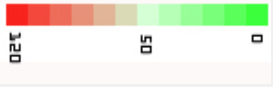
2009





- *Rag1* virulent isolates were less frequent compared 2009
- Dowling and Jackson perform similarly across aphid isolates
- *Rag2* (PI243540 and PI200538) sources performed differently across aphid isolates
- Virulence to PI567598B appears to be rare

Damage Index Scale



DI = Σ(Scale value x No. of plants in the category)/(4 x Total no. of plants evaluated) x 100.

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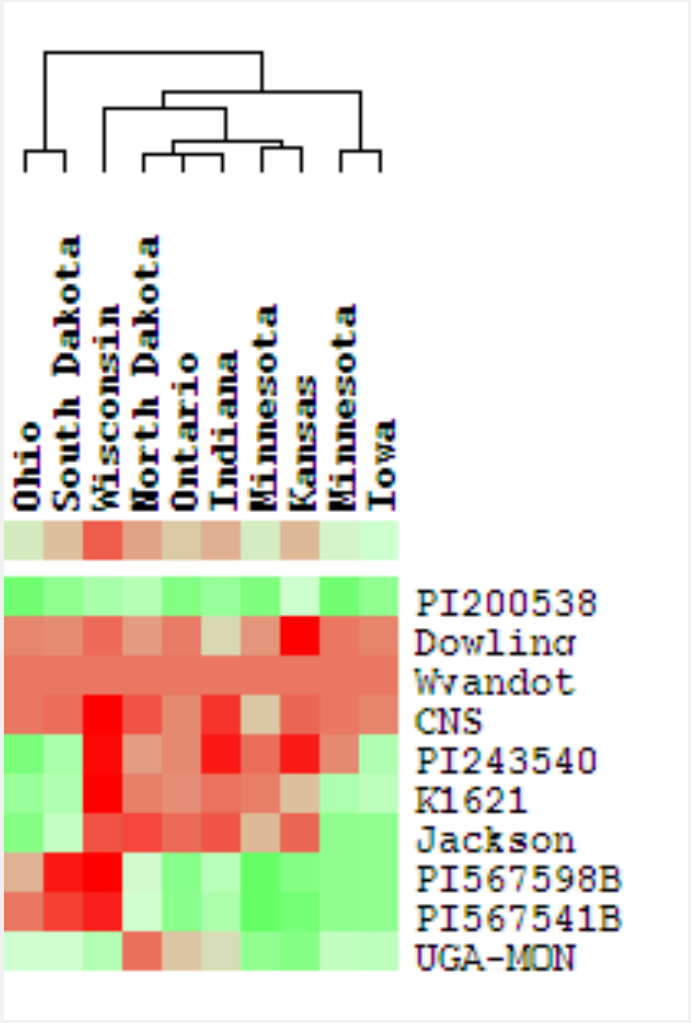
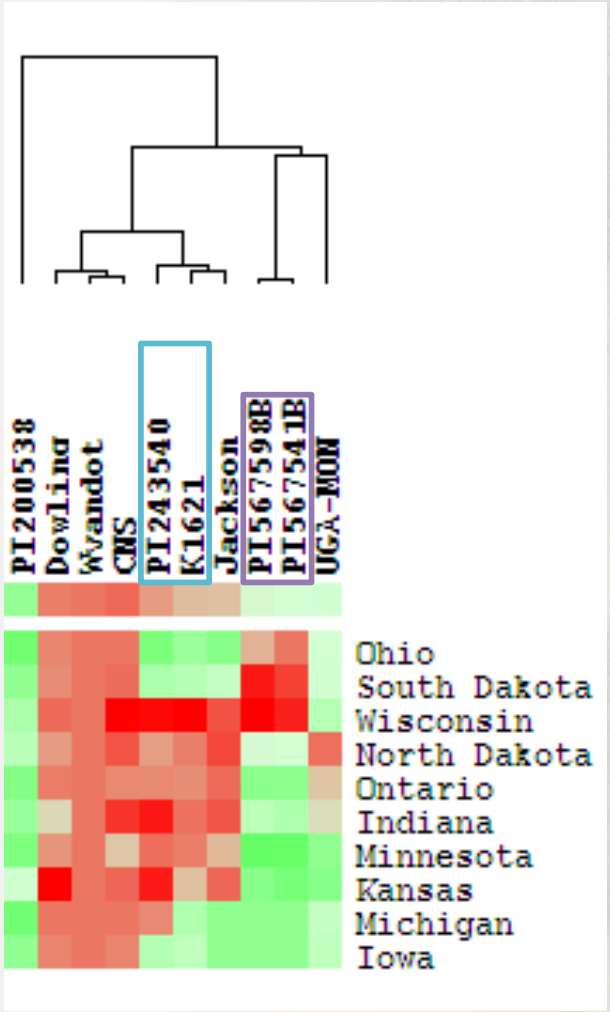
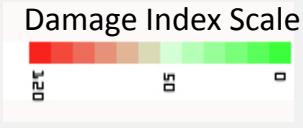
2010





- Dowling and Jackson perform differently across aphid isolates
- *Rag1* virulent isolates were common and not limited to eastern sites
- *Rag2* (PI243540 and PI200538) sources performed differently across aphid isolates
- Virulence to PI567598 B appears to be rare



DI = Σ(Scale value x No. of plants in the category)/(4 x Total no. of plants evaluated) x 100.

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Trends

Line	Gene	Comment
K1621		Clustered together in 2008-2010
PI243540	*Rag2*	
PI200538	*Rag2*	Performed differently than PI243540
PI567598B	*rag1_b, rag3*	Clustered together in 2008 and 2010; In general lowest aphid ratings; both 2 recessive genes
PI567541B	*rag1_c, rag4*	
Dowling	*Rag1*	Clustered together in 2008-2009; single genes
Jackson	*Rag*	
UGA-MON PI		Did not consistently cluster with other entries
CNS	Variable Rxn	Often Susceptible

Learnings

- Prevalence of Ohio-biotype (*Rag1* tolerance) populations varies year-to-year and geography-to-geography
- Aphid isolates often perform similarly on Dowling and Jackson across geographies
- Aphid isolates performed differently PI243540 and PI200538 across geographies
- Aphid isolates tolerant on PI567598B are also tolerant on PI567541B
- Isolates from different geographies did not consistently cluster together across years

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Acknowledgements

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- Ag Stat (2009-10)
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- Brian McCornack
- Rouf Mian
- Matt O'Neal
- Vaino Poysna
- Deirdre Prischmann-Voldseth
- David Ragsdale
- Dechun Wang

Seed

- Rouf Mian
- Dechun Wang
- John Reese
- Monsanto MSP and Purity for increasing seed

Monsanto

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Questions?

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