Raising 300 Bushel Corn: Chemicals –The Seventh Wonder of the Corn Yield World

Fred Below

Crop Physiology Laboratory
Department of Crop Sciences
University of Illinois at Urbana-Champaign

2011 MACA Annual Meeting
Bloomington, MN September 8, 2011

Crop Physiology

Quest for 300 Bushel Corn

- **Productivity is Chemistry, Environment, and Biology**

- **9 billion people by 2050 requires a doubling of grain production**

Quest for 300 Bushel Corn

- 300 bushel corn is produced each year in the U.S. National Corn Growers Contest

- Intelligent Intensification with the Seven Wonders of the Corn Yield World (i.e. those factors that have the biggest impact on yield each year)

Crop Physiology

Quest for 300 Bushel Corn

Herman
Warsaw's farm
Saybrook, IL
July 1985

Crop Physiology

Seven Wonders of the Corn Yield World

- Ranks those factors that each year can have a positive (and sometimes negative) impact on corn yield
- Gives each factor an average bushel per acre value

Crucial Prerequisites, but not Yield Wonders

- Drainage
- Pest/Weed Control
- Proper soil pH & adequate levels of P and K based on soil tests

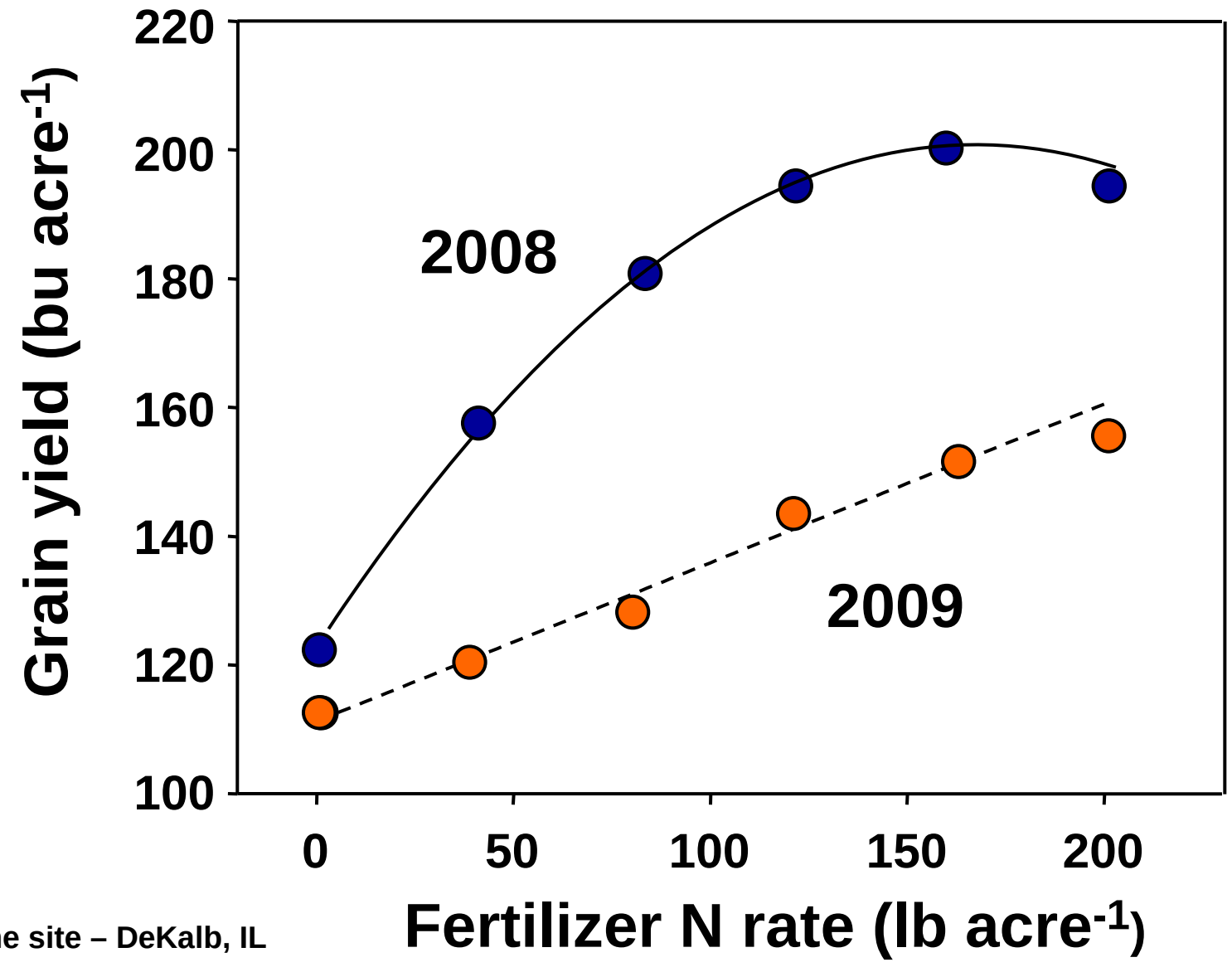
Seven Wonders of the Corn Yield World

Rank	Factor	Value
		bu/acre
1	Weather	70+
2	Nitrogen	70
3		
4		
5		
6		
7		

Given key prerequisites

Crop Physiology

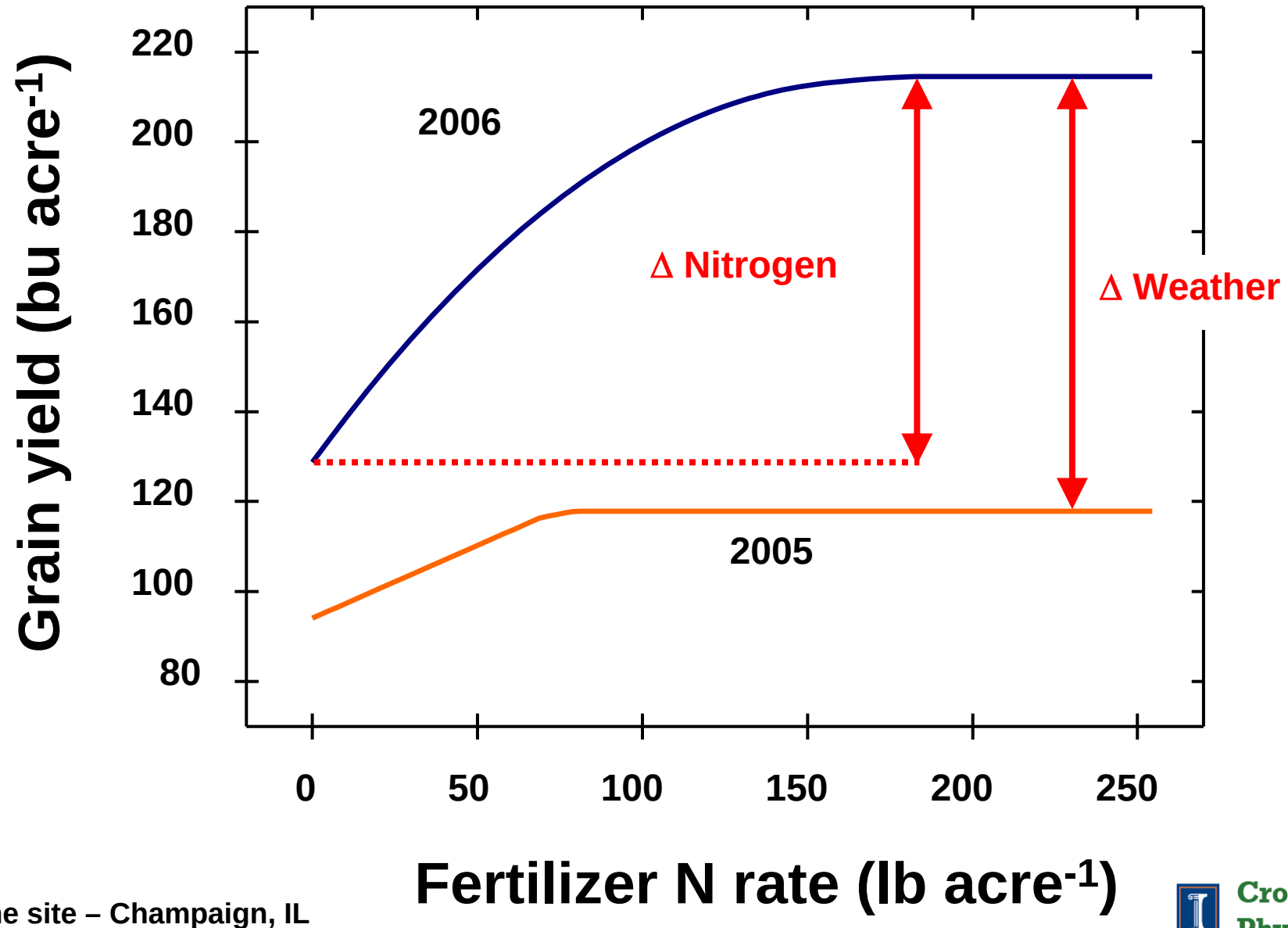
Weather and Nitrogen



Same site – DeKalb, IL

Crop Physiology

Weather and Nitrogen



Same site – Champaign, IL

Crop Physiology

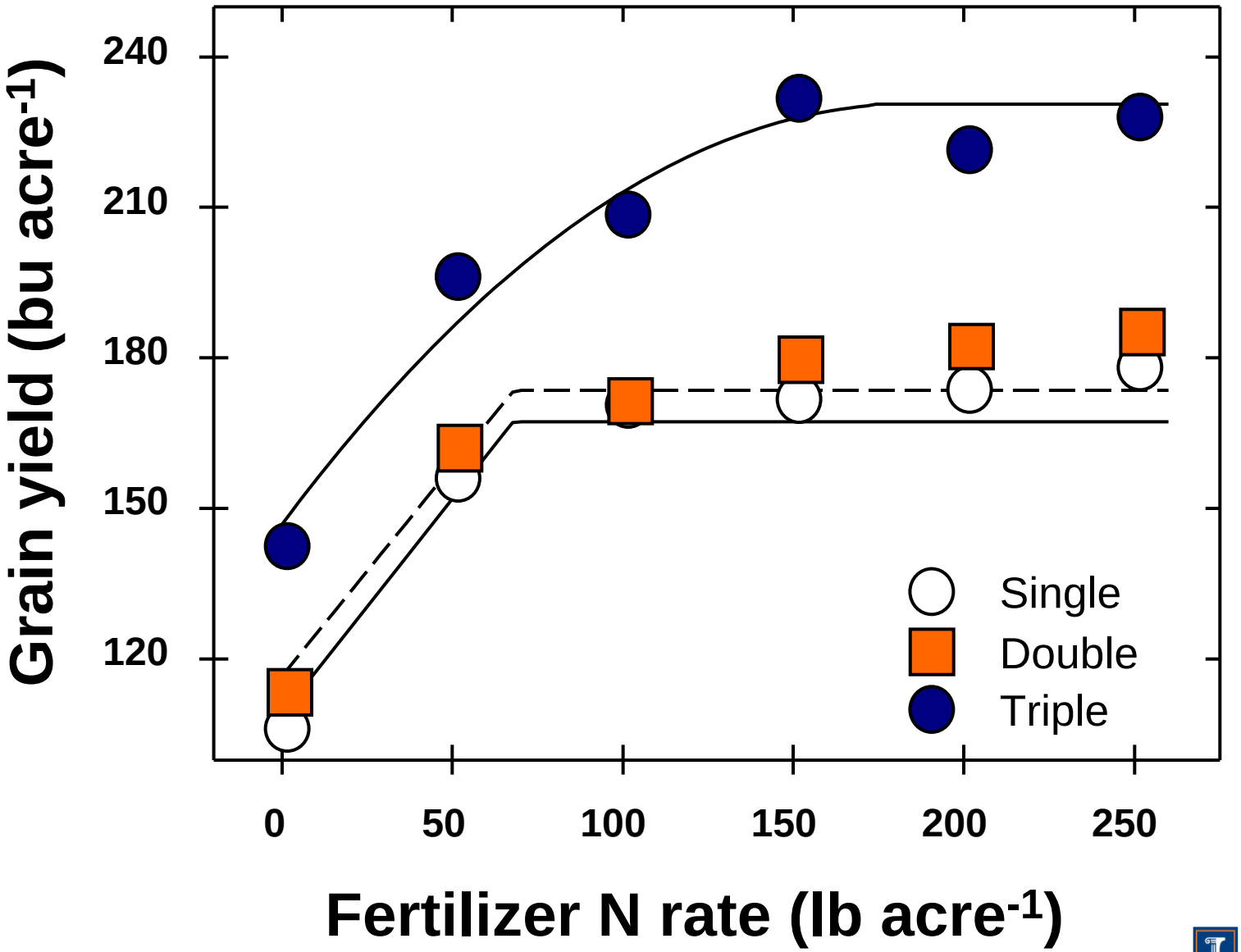
Seven Wonders of the Corn Yield World

Rank	Factor	Value
		bu/acre
1	Weather	70+
2	Nitrogen	70
3	Hybrid	50
4		
5		
6		
7		

Given key prerequisites

Crop Physiology

Better N Use From Biotechnology Traits



Champaign, IL 2006

Crop Physiology

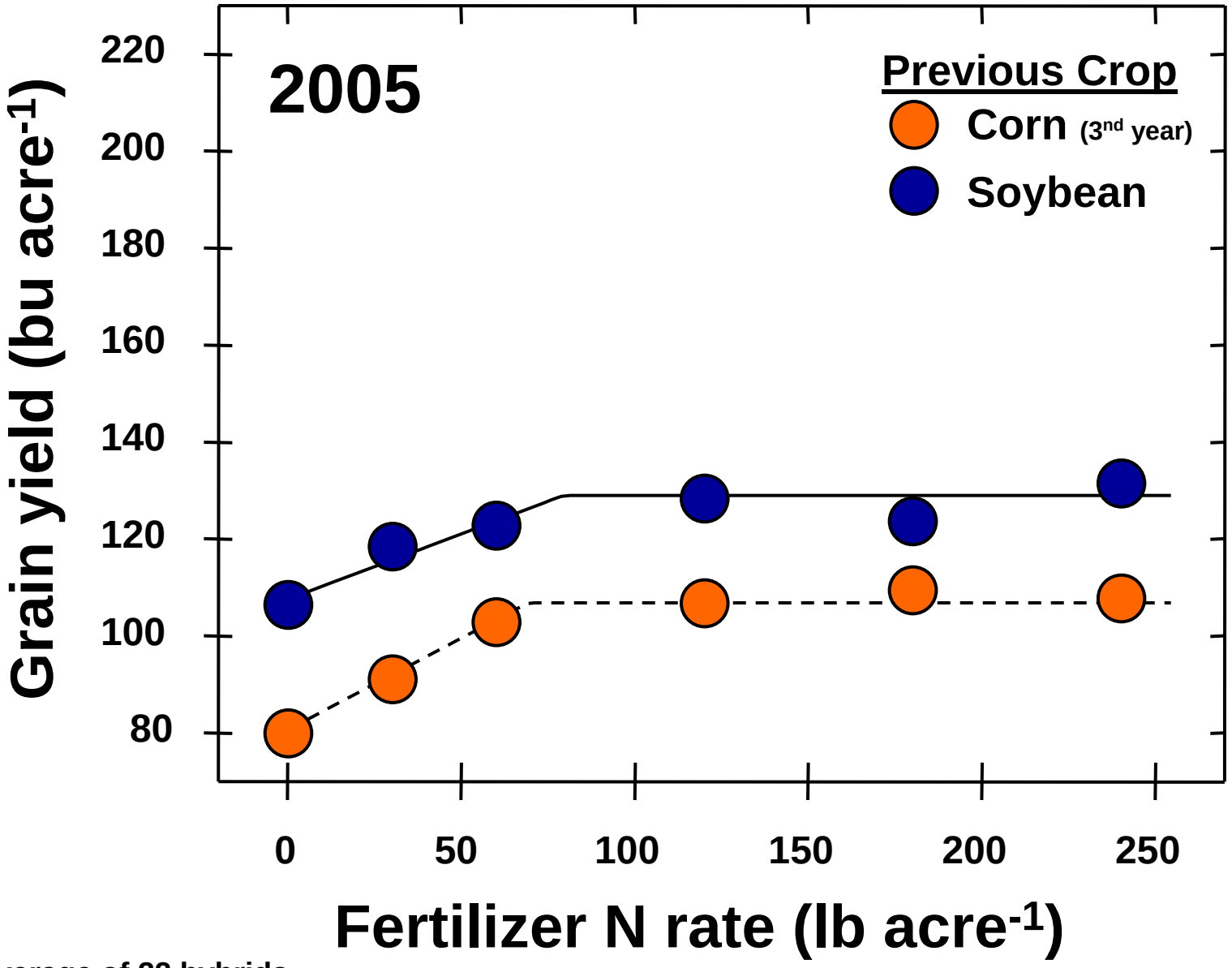
Seven Wonders of the Corn Yield World

Rank	Factor	Value
		bu/acre
1	Weather	70+
2	Nitrogen	70
3	Hybrid	50
4	Previous Crop	25
5		
6		
7		

Given key prerequisites

Crop Physiology

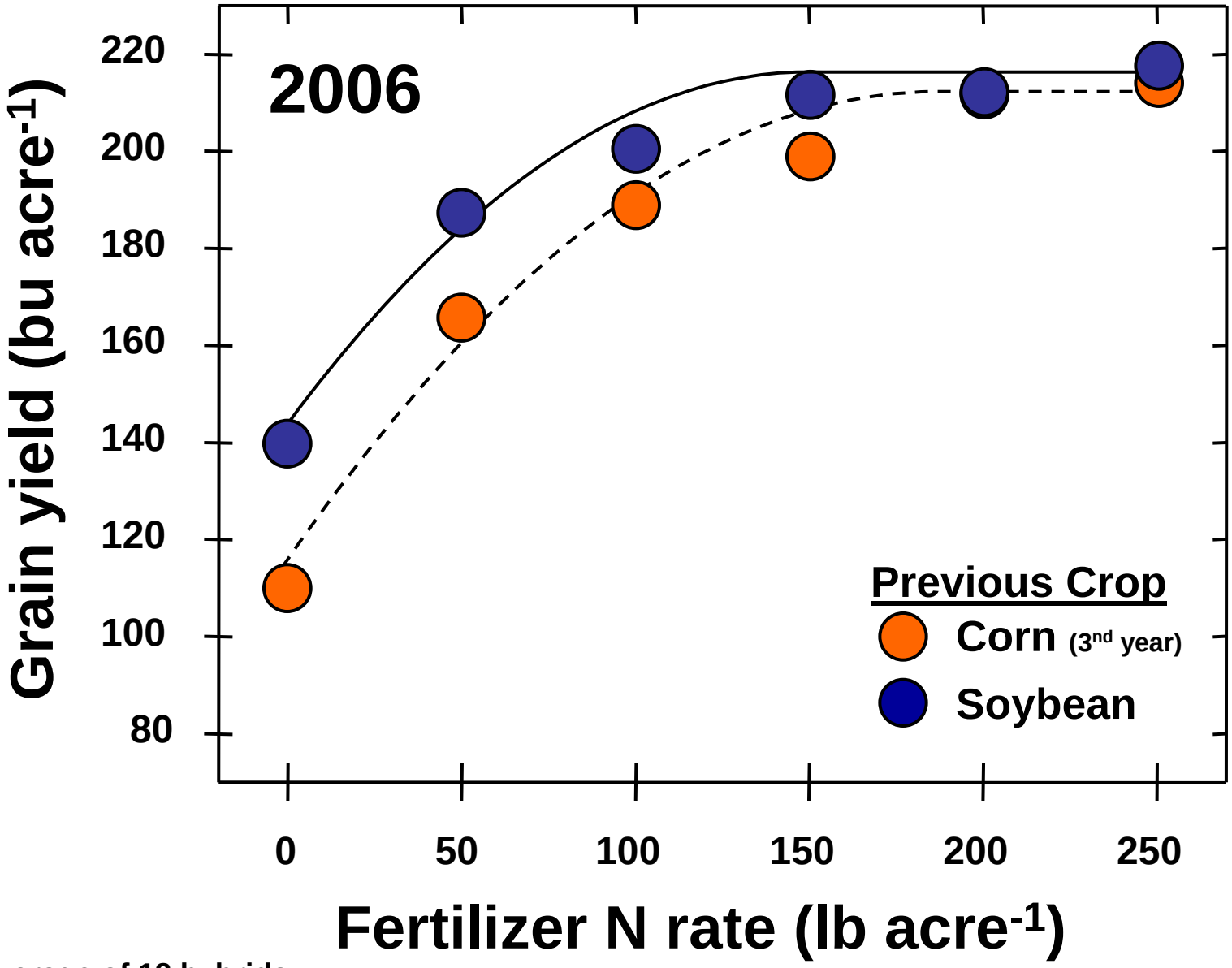
Previous Crop and N Response



Average of 22 hybrids

Crop Physiology

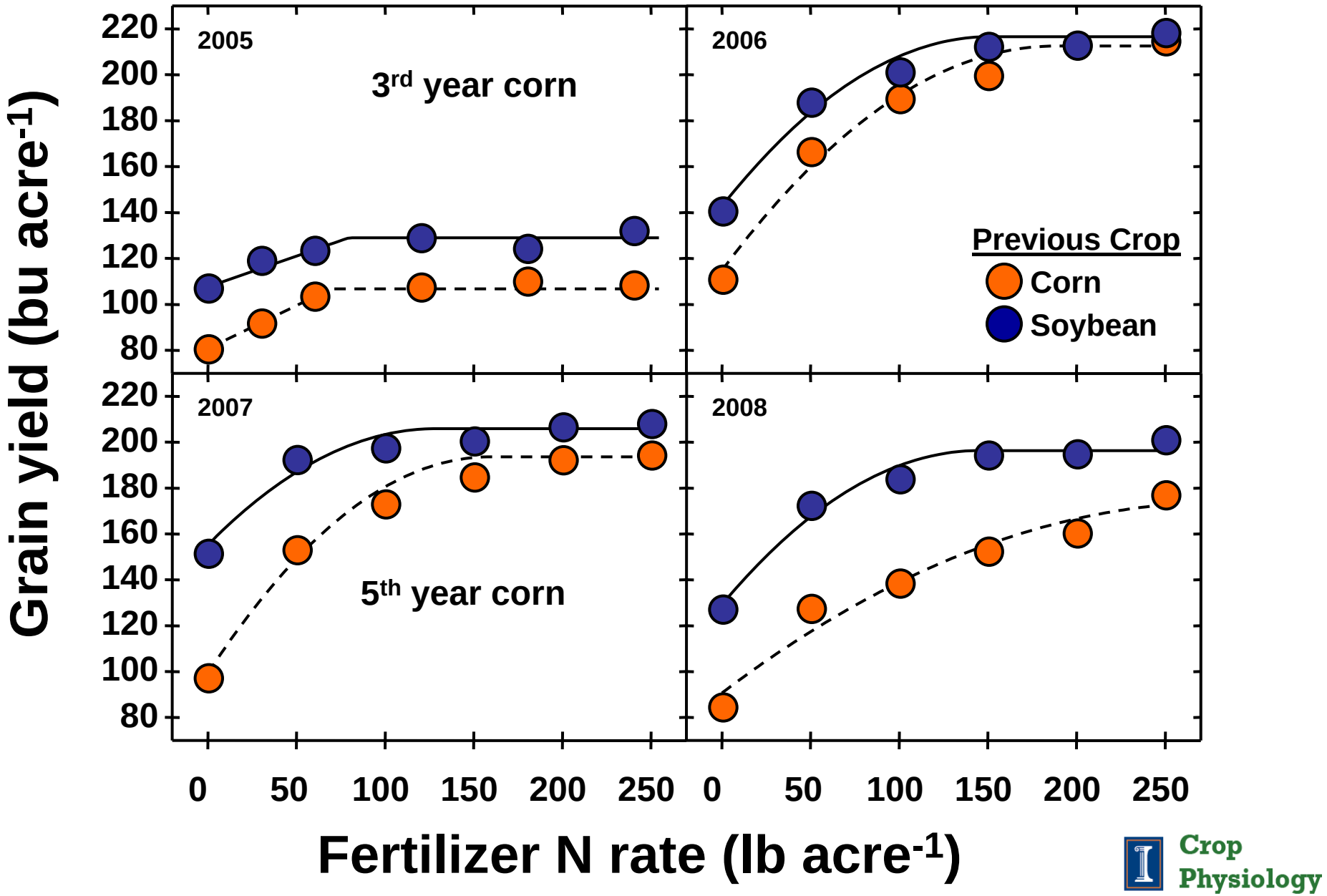
Previous Crop and N Response



Average of 12 hybrids

Crop Physiology

Continuous Corn Needs More N



Crop Physiology

Seven Wonders of the Corn Yield World

Rank	Factor	Value
		bu/acre
1	Weather	70+
2	Nitrogen	70
3	Hybrid	50
4	Previous Crop	25
5	Plant Population	20
6		
7		

Given key prerequisites

Crop Physiology

Grain Yield is a Product Function of Yield Components

Yield = (plants/acre) x

(kernels/plant) x

(weight/kernel)

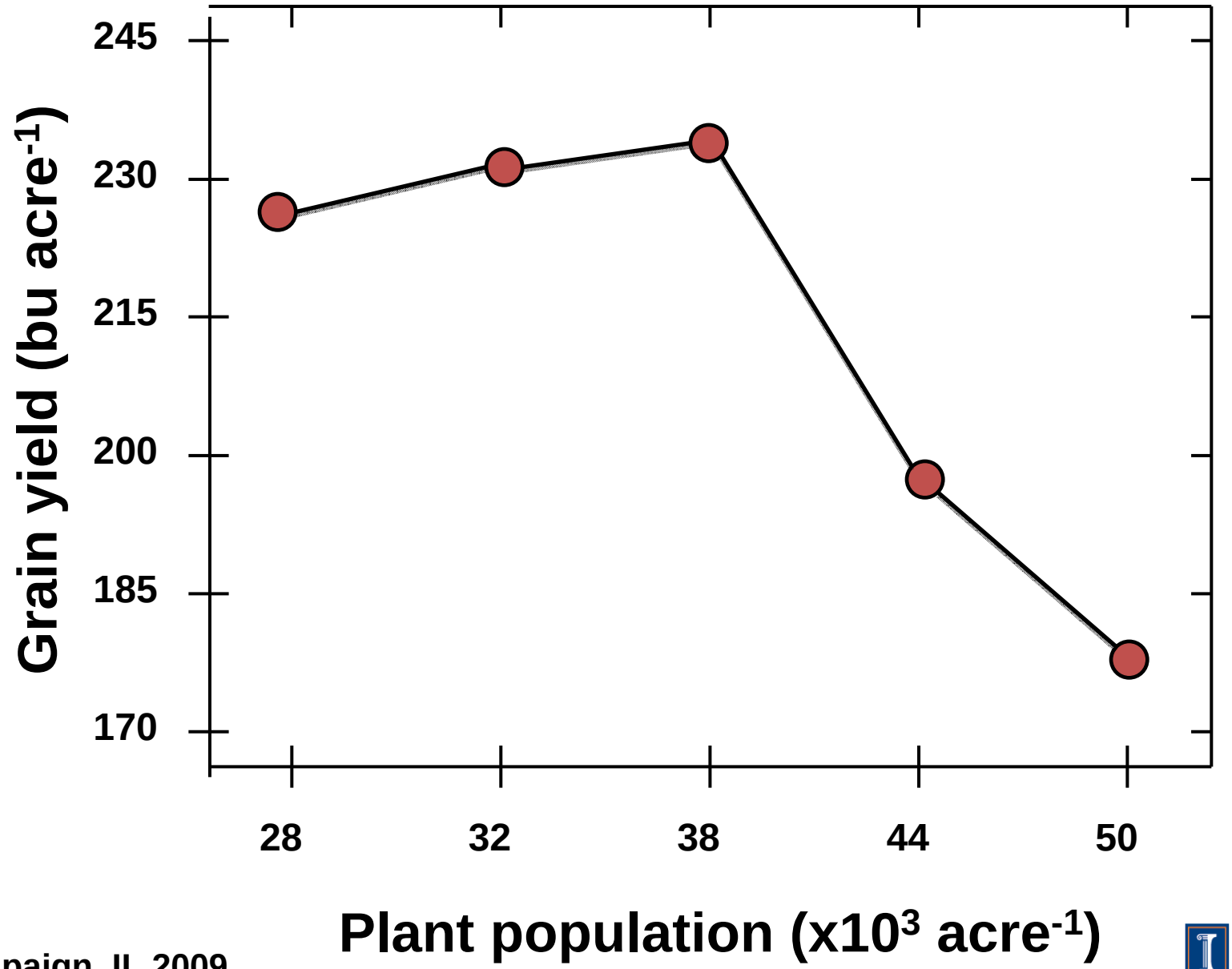
Some Examples of Yield Component Combinations for Different Yields

200 bushels =
32,000 plants/ac x 550 kernels/plant x 250 mg/kernel

250 bushels =
36,000 plants/ac x 600 kernels/plant x 255 mg/kernel

300 bushels? =
45,000 plants/ac x 565 kernels/plant x 260 mg/kernel

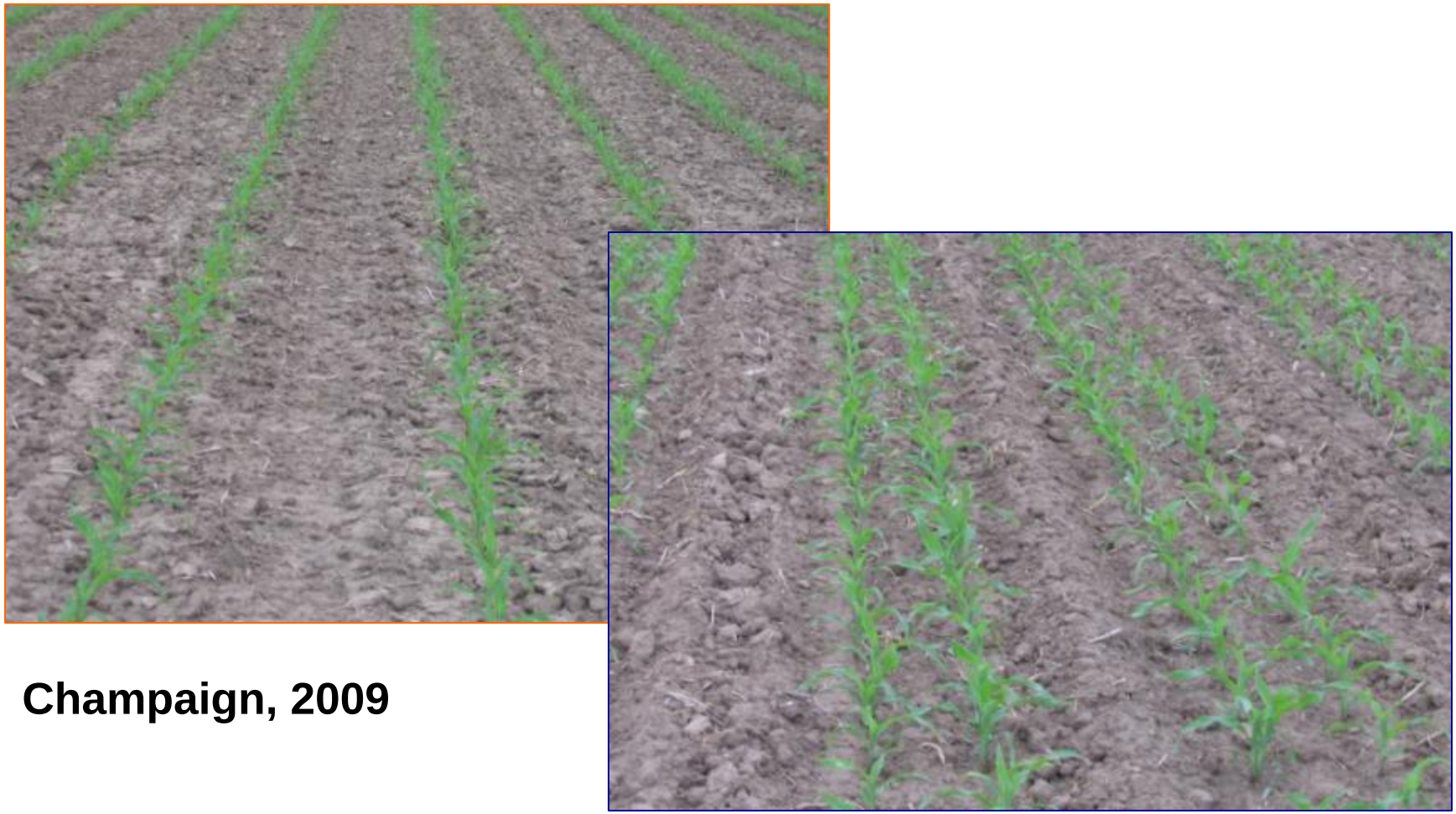
Plant Competition Can Decrease Yield



Champaign, IL 2009

Crop Physiology

Are Twin Rows a way to increase Plant Population?



Champaign, 2009

Crop Physiology

Seven Wonders of the Corn Yield World

Rank	Factor	Value
		bu/acre
1	Weather	70+
2	Nitrogen	70
3	Hybrid	50
4	Previous Crop	25
5	Plant Population	20
6	Tillage	15
7		

Given key prerequisites

Crop Physiology

Previous Crop Affects Soil Tilth

Seven Wonders of the Corn Yield World

Rank	Factor	Value
		bu/acre
1	Weather	70+
2	Nitrogen	70
3	Hybrid	50
4	Previous Crop	25
5	Plant Population	20
6	Tillage	15
7	Growth Regulators	10

Given key prerequisites

Crop Physiology

Leaf Greening from Strobliurin Fungicides

Leaves greener 50 days after VT application

Crop Physiology

Seven Wonders of the Corn Yield World

Rank	Factor	Value
		bu/acre
1	Weather	70+
2	Nitrogen	70
3	Hybrid	50
4	Previous Crop	25
5	Plant Population	20
6	Tillage	15
7	Growth Regulators	10
	TOTAL	260 bu

Given key prerequisites

Crop Physiology

Seven Wonders of the Corn Yield World

Rank	Factor	Value	
		bu/acre	%
1	Weather	70+	27
2	Nitrogen	70	26
3	Hybrid	50	19
4	Previous Crop	25	10
5	Plant Population	20	8
6	Tillage	15	6
7	Growth Regulators	10	4
	Total =	260bu	100%

Given key prerequisites

Crop Physiology

How to Get 300 Bushels?

- **Provide better prerequisites, especially mineral nutrients**
- **Optimize each of the seven wonders and their positive interactions**

Prerequisites for 300 Bushels?

- **Proper soil pH & adequate levels of P and K based on soil tests**

- **Fertility- Use technology to apply required amounts of nutrients each year, Sulfur & Micronutrients?**

Crop Physiology

How to Get 300 Bushels?

- **Better prerequisites along with packages of optimized yield wonders.**
- **Is the value of combined factors greater than their individual impact?**

Seven Wonders of the Corn Yield World

Rank	Factor	Value
		bu/acre
1	Weather	70+
2	Nitrogen	70
3	Hybrid	50
4	Previous Crop	25
5	Plant Population	20
6	Tillage	15
7	Growth Regulators	10
	Total	260 bu

Improved Fertility Prerequisites

Crop Physiology

Standard vs. High Tech Package

Fertility

No P or K based on soil test

100 lbs P_2O_5 as MESZ (N, P, S, & Zn)

Nitrogen

180 lbs pre-plant as UAN

100 lbs extra N sidedress as Super-U

Genetics

RR Refuge Hybrid (DKC 61-22)

Triple stack Hybrid (DKC 61-19)

Both with soil insecticide at planting

Population

32,000 plants/ac vs 45,000 plants/ac

Both in 30 inch rows and twin rows in 2010

Fungicide

No Fungicide

Headline or Quilt-Xcel (@ R1)

Crop Physiology

Omission Plot Experimental Design

		FACTORS				
	TREATMENT	Fertility	Nitrogen	Genetics	Population	Fungicide
	HIGH TECH	MESZ	Base + Slow release	Triple stack	45,000	Strobilurin
Remove Technology	Fertility	No P & K	Base + Slow release	Triple stack	45,000	Strobilurin
	Nitrogen	MESZ	Base	Triple stack	45,000	Strobilurin
	Genetics	MESZ	Base + Slow release	Refuge	45,000	Strobilurin
	Population	MESZ	Base + Slow release	Triple stack	32,000	Strobilurin
	Fungicide	MESZ	Base + Slow release	Triple stack	45,000	none
	STANDARD	No P & K	Base	Refuge	32,000	none
Add Technology	Fertility	MESZ	Base	Refuge	32,000	none
	Nitrogen	No P & K	Base + Slow release	Refuge	32,000	none
	Genetics	No P & K	Base	Triple stack	32,000	none
	Population	No P & K	Base	Refuge	45,000	none
	Fungicide	No P & K	Base	Refuge	32,000	Strobilurin

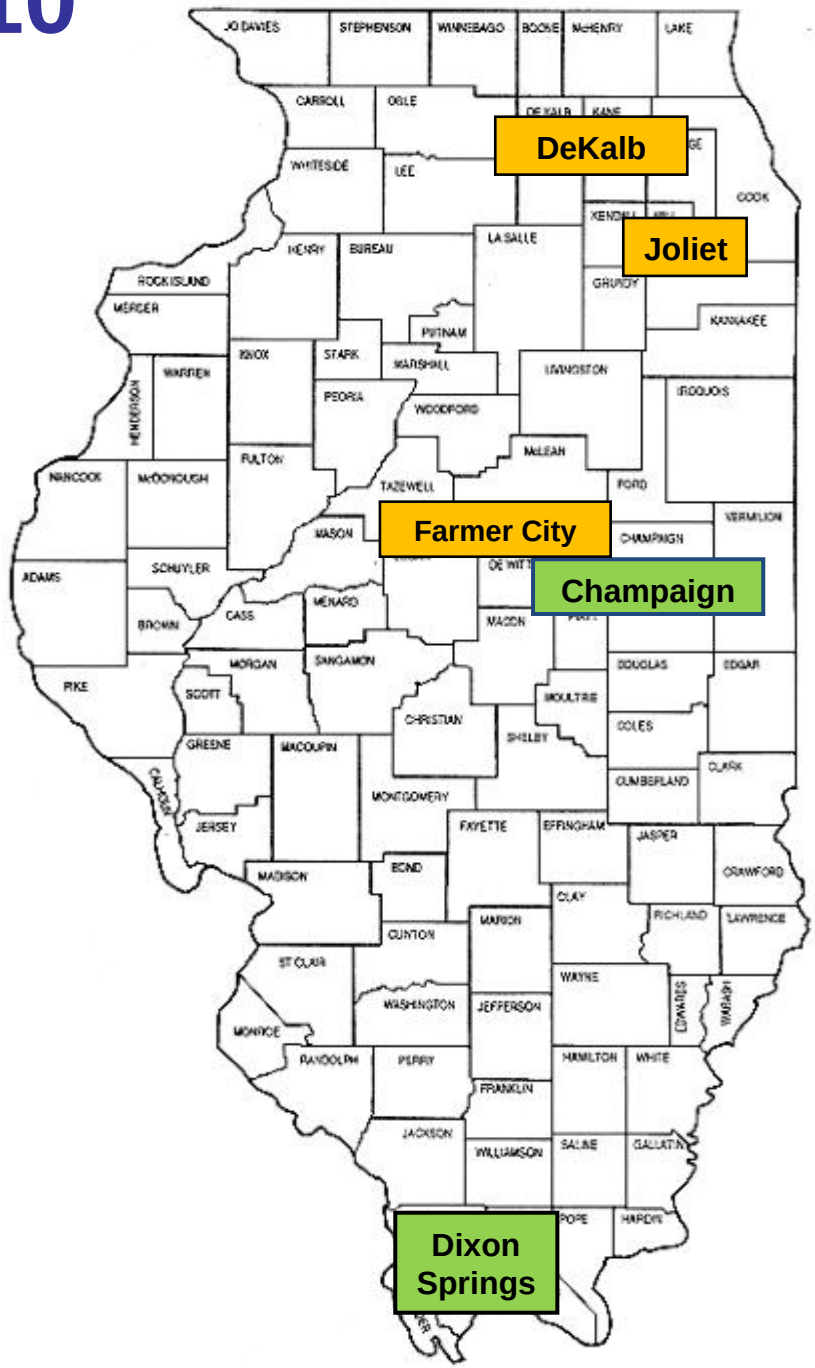
Omission Plots 2009-10

All Sites in both Years

- Medium to high soil P & K
- 180 lbs base N as UAN
- DKC 61-19 or 61-22
- Soybean as previous crop
- Conventional tillage
- 30 inch & twin-rows in 2010

Weather

- Wet spring in both years
- Abnormally cool in 2009
- Abnormally hot in 2010



Weather Damage at DeKalb - 2010

Severe wind damage at R3

Crop Physiology

Equipment Fire at Joliet -2010

Yield loss due to combine fire

Crop Physiology

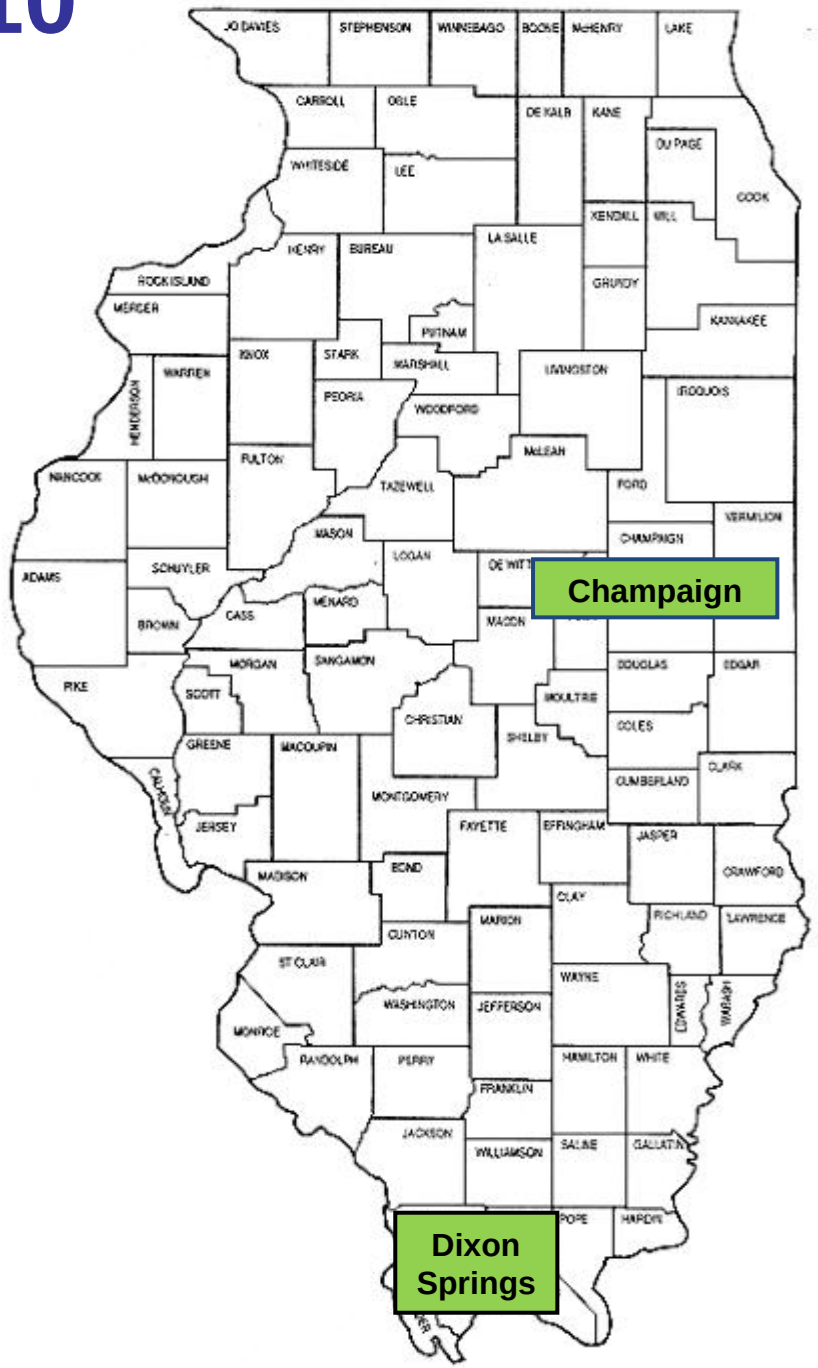
Omission Plots 2009-10

All Sites in both Years

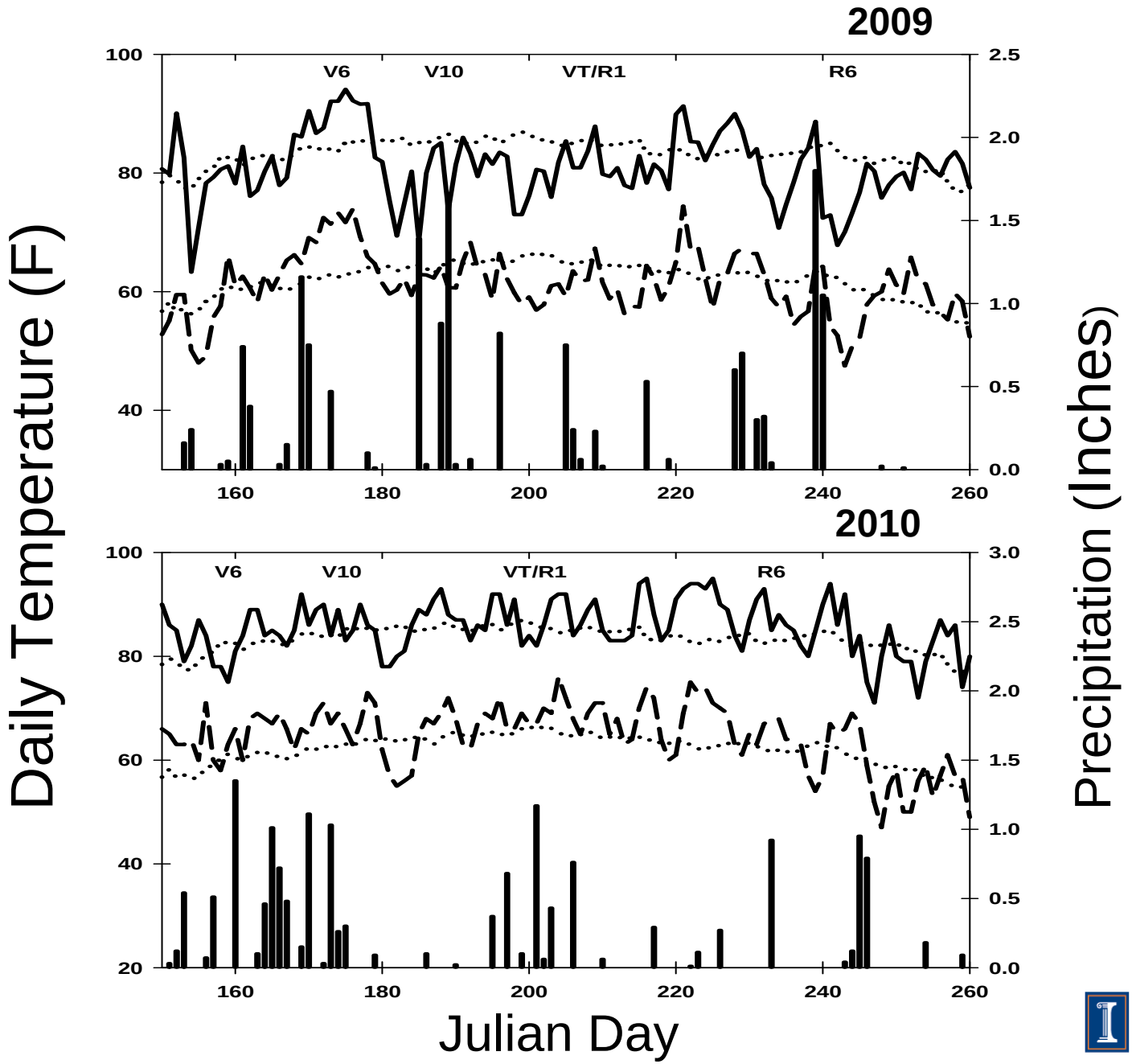
- Medium to high soil P & K
- 200 kg base N as UAN
- DKC 61-19 or 61-22
- Soybean as previous crop
- Conventional tillage

Weather

- Wet spring in both years
- Abnormally cool in 2009
- Abnormally hot in 2010



Different Weather Between Years- Champaign, IL



Crop Physiology

High-Yield Omissions Study, 2009-2010

High Technology Package

Standard Practice

Ears from 1/1000 of an acre

Crop Physiology

Omission Plot Experimental Design

		FACTORS				
	TREATMENT	Fertility	Nitrogen	Genetics	Population	Fungicide
	HIGH TECH	MESZ	Base + Slow release	Triple stack	45,000	Strobilurin
Remove Technology	Fertility	No P & K	Base + Slow release	Triple stack	45,000	Strobilurin
	Nitrogen	MESZ	Base	Triple stack	45,000	Strobilurin
	Genetics	MESZ	Base + Slow release	Refuge	45,000	Strobilurin
	Population	MESZ	Base + Slow release	Triple stack	32,000	Strobilurin
	Fungicide	MESZ	Base + Slow release	Triple stack	45,000	none
	STANDARD	No P & K	Base	Refuge	32,000	none
Add Technology	Fertility	MESZ	Base	Refuge	32,000	none
	Nitrogen	No P & K	Base + Slow release	Refuge	32,000	none
	Genetics	No P & K	Base	Triple stack	32,000	none
	Population	No P & K	Base	Refuge	45,000	none
	Fungicide	No P & K	Base	Refuge	32,000	Strobilurin

Standard vs High-Tech 2009

	Standard		High Tech	
Factor	Yield	Δ	Yield	Δ
	bu acre^{-1}			
None or All	198		260	
Fertility	202	+ 4	248	-12
Nitrogen	206	+ 8	240	-20
Genetics	208	+10	235	-25
Population	185	-13	250	-10
Fungicide	198	0	242	-18

LSD ($p<0.10$) = 7

Data from Champaign and Dixon Springs

Crop Physiology

Standard vs High-Tech 2010

	Standard		High Tech	
Factor	Yield	Δ	Yield	Δ
	bu acre^{-1}			
None or All	188		230	
Fertility	192	+ 4	225	- 5
Nitrogen	190	+ 2	225	- 5
Genetics	196	+ 8	215	-15
Population	190	+ 2	226	- 4
Fungicide	199	+11	195	-35

LSD ($p<0.10$) = 7

Data from Champaign and Dixon Springs

Crop Physiology

Standard vs High-Tech Two Years

	Standard		High Tech	
Factor	Yield	Δ	Yield	Δ
	bu acre^{-1}			
None or All	193		245	
Fertility	197	+ 4	236	- 9
Nitrogen	198	+ 5	232	-13
Genetics	202	+ 9	225	-20
Population	187	- 6	238	- 7
Fungicide	198	+ 5	218	-27

LSD ($p<0.10$) = 6

Data from Champaign and Dixon Springs

Crop Physiology

Standard vs High Tech Package 2009-10

Fertility

No P or K based on soil test

100 lbs P_2O_5 as MESZ (N, P, S, & Zn)

Nitrogen

180 lbs pre-plant as UAN

100 lbs extra N sidedress as Super-U

Genetics

RR Refuge Hybrid (DKC 61-22)

Triple stack Hybrid (DKC 61-19)

Both with soil insecticide at planting

Population

32,000 plants/ac vs 45,000 plants/ac

Both in 30 inch rows and twin rows in 2010

Fungicide

No Fungicide

Headline or Quilt-Xcel (@ R1)

Crop Physiology

Standard vs High Tech Package - 2011

Fertility

No or fall P or K based on soil test

100 lbs P_2O_5 as MESZ (N,P, S, & Zn) banded 4-6” directly under row at planting

Nitrogen

180 lbs pre-plant as urea

180 lbs pre-plant SuperU + 60 lbs sidedress urea with Agrotain

Genetics

Low Management Yield Potential

High Management Yield Potential

Both triple-stack with soil insecticide at planting

Population

32,000 plants/ac vs 45,000 plants/ac

Both final stand in 30 inch and twin rows

Fungicide

No Fungicide

Headline-Amp or Quilt-Xcel @ R1

Crop Physiology

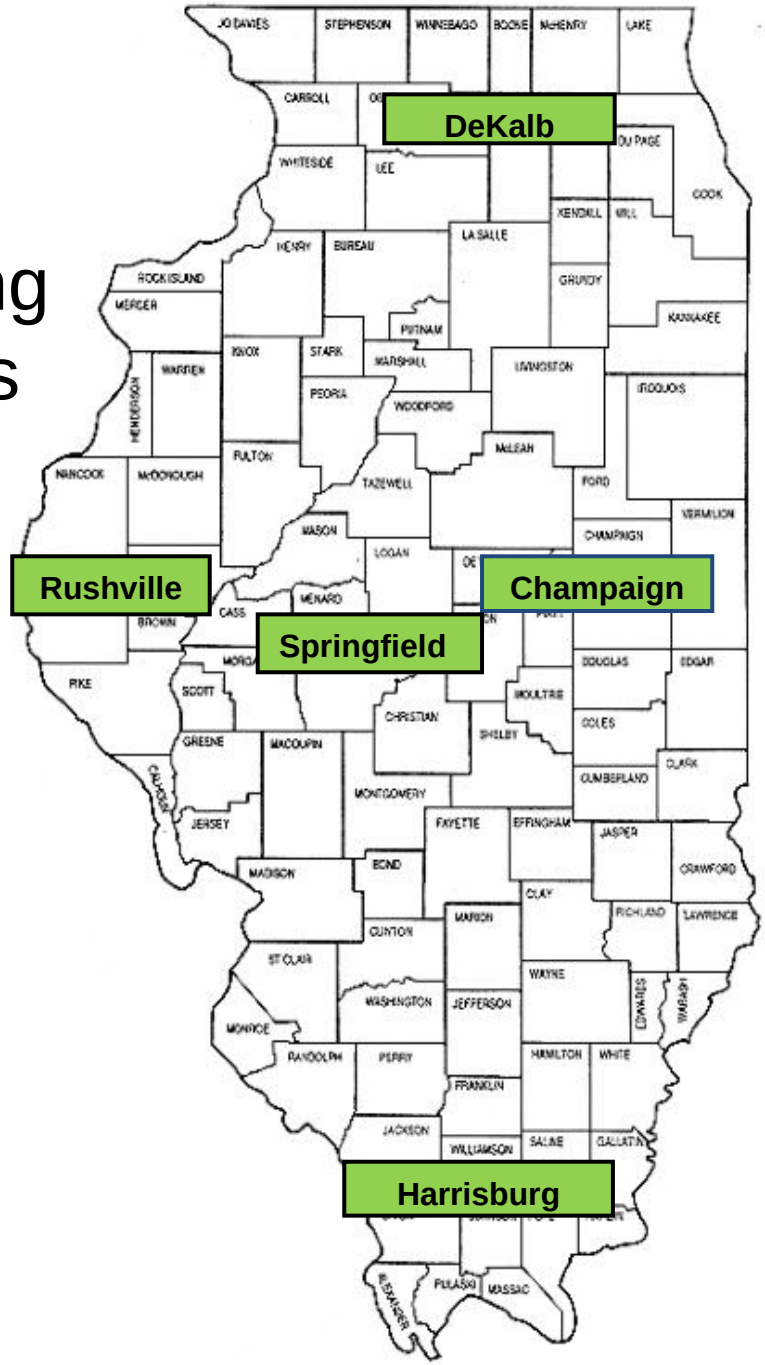
Omission Plots 2011

14 plots at 5 main sites with

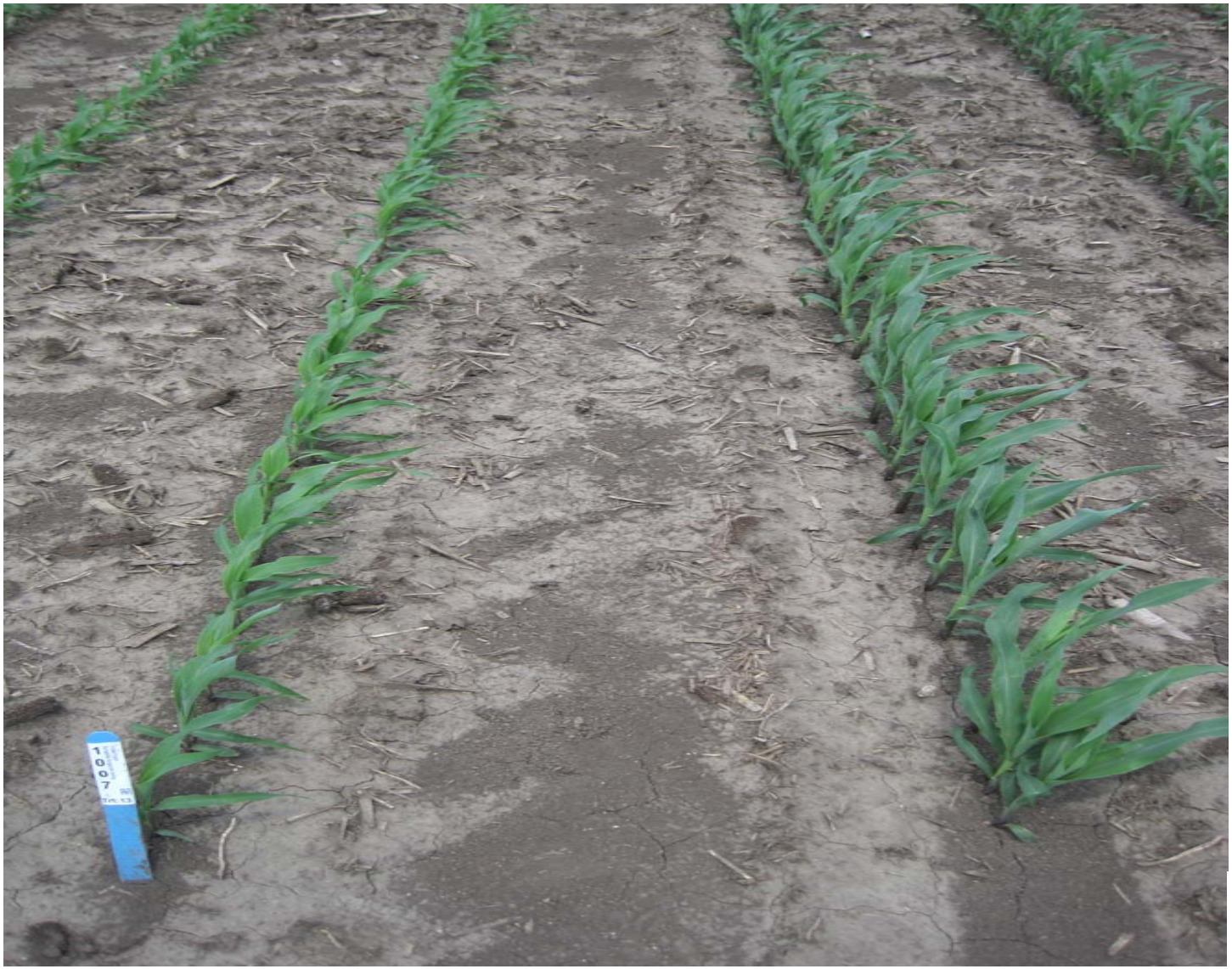
- Banded/broadcast P at planting
- Different N protection methods
- Hybrid/trait comparisons
- Twin rows vs 30 inch
- Different fungicides
- Farm Progress Show

Weather

- Different planting dates
- Different growing conditions



Improved Growth with Spring-Banded MESZ



Champaign, IL 2011

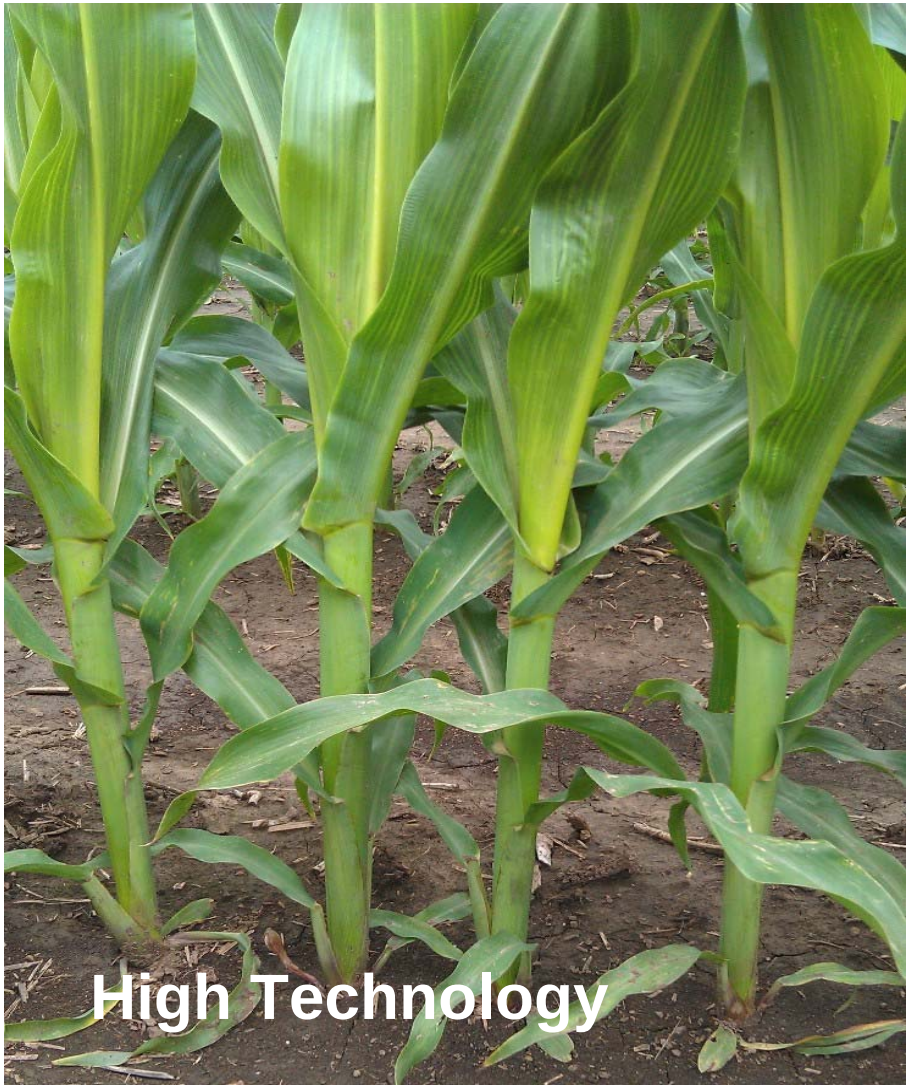
Crop Physiology

Banded vs Broadcast MESZ

Champaign, IL 2011

Crop Physiology

No Corn Plant Left Behind



Champaign, IL 2011

Crop Physiology

Conclusions

- **Big yield gains are possible from crop management that provides better Fertility along with packages of optimized Yield Wonders (High-Tech)**

- **The High-Tech system either protects or pushes yield depending on the weather**

Crop Physiology

Conclusions

- **The yield value of an individual factor is magnified in the High-Tech system**

- **Increasing plant population may be the foundation for pushing higher yields, but it must be managed with the other Yield Wonders**

Acknowledgements

Personnel

- Brad Bandy
- Tom Boas
- Ryan Becker
- Ross Bender
- Fernando Cantao
- Laura Gentry
- Jason Haegele
- Mark Harrison
- Cole Hendrix
- Adam Henninger
- Jim Kleiss
- Bianca Moura
- Matías Ruffo
- Juliann Seebauer
- Martín Uribelarrea
- Mike Vincent
- Kyle Vogelzang
- Wendy White

Financial Support

- AGCO
- AgroFresh
- AgroTain
- BASF
- Dawn Equipment
- Dow AgroSciences
- GrowMark
- Honeywell
- Illinois Corn Marketing Board
- Illinois Fertilizer Research Council
- Monsanto
- Mosaic
- Orthman
- Pioneer
- Rosen's Inc.
- Syngenta
- Valent BioSciences
- WinField Solutions

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