Nitrogen and Phosphorus Management to Increase Nutrient Use Efficiency and Corn Grain Yield

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2019 Fluid Fertilizer Forum
Scottsdale, AZ February 19th, 2019

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Brad Bernhard Loves Corn

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Average Soil Analysis at Crop Physiology Laboratory Research Sites

	Location		
	Yorkville	Champaign	Harrisburg
OM (%)	4.5	3.6	2.2
pH	6.3	6.3	6.6
CEC	21.9	19.6	13.2
P (ppm)†	45	38	26
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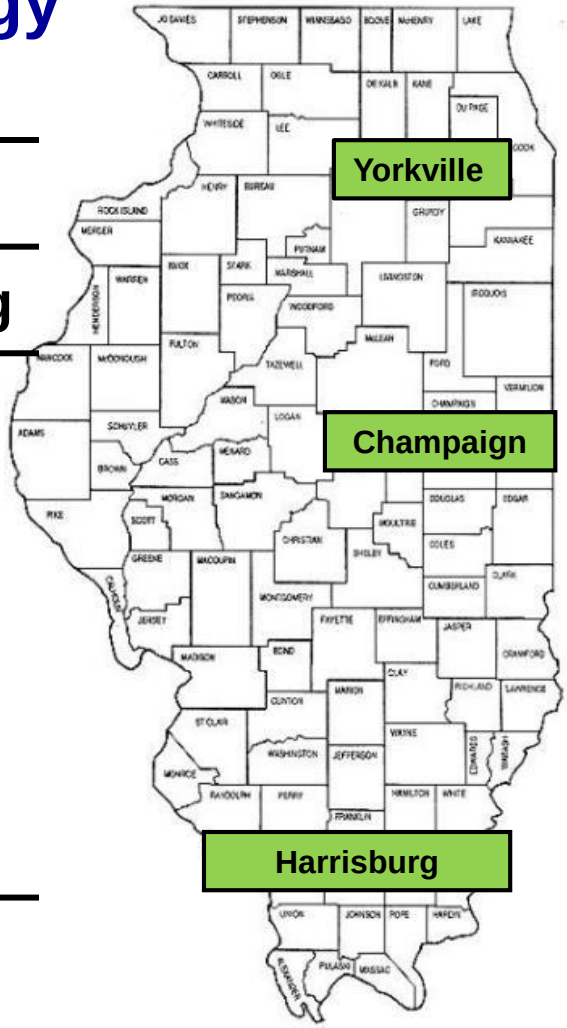
† Mehlich 3 extraction

All soils are silt loams or silty clay loams



Test Your Knowledge of Agriculture and US Politics

- **Which crop does President Trump like better, Corn or Soybean?**

President Trump Likes Corn

Test Your Knowledge of High Yield Corn

- **What is the world record corn yield and what is the corn yield gap?**

The Corn Yield Gap

- **World Record yield of 542.2740 bushels per acre in 2017**
- **US average yield of 178 bushels per acre in 2018**
- **Yield Gap = Record Yield – Average Yield = 364 bushels**

The NCGA Corn Yield Contest

- 6 categories that include: state corn area (A & AA), irrigated, non-irrigated, conservation tillage with 3 winners in each category
- All 18 contest winners in 2017 exceeded 300, 5 exceeded 400, and 3 exceeded 500 bushels; while in 2018 only 16 exceeded 300, and only one exceeded 400 bushels

2018 National Corn Growers Contest Winners
Winners From I States

Kevin Kalb, Indiana @ 388.1
Mike Moyle, Idaho @ 351.2
Jerry Reinhart, Illinois @ 345.6
Nikia Kalb, Indiana @ 343.2
Shawn Kalb, Indiana @ 343.0
John Ruff, Iowa @ 333.1
Brad Wehr, Indiana @ 331.1

Strategy for Winning the NCGA Corn Yield Contest

- Feed (better plant nutrition) and protect a much higher density of the best 'racehorse' hybrids
- Make sure the crop is never stressed

Banding Fertilizer 4-6 Inches Deep Directly Under the Future Crop Row

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Seeding Corn Crop 2 Inches Deep Directly Over the Fertilizer Band

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Improved Growth with Banded Fertility

250 lbs/acre MicroEssentials = 30 N, 100 P_2O_5, 25 S, and 2.5 Zn

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Improved Growth with Banded Fertility

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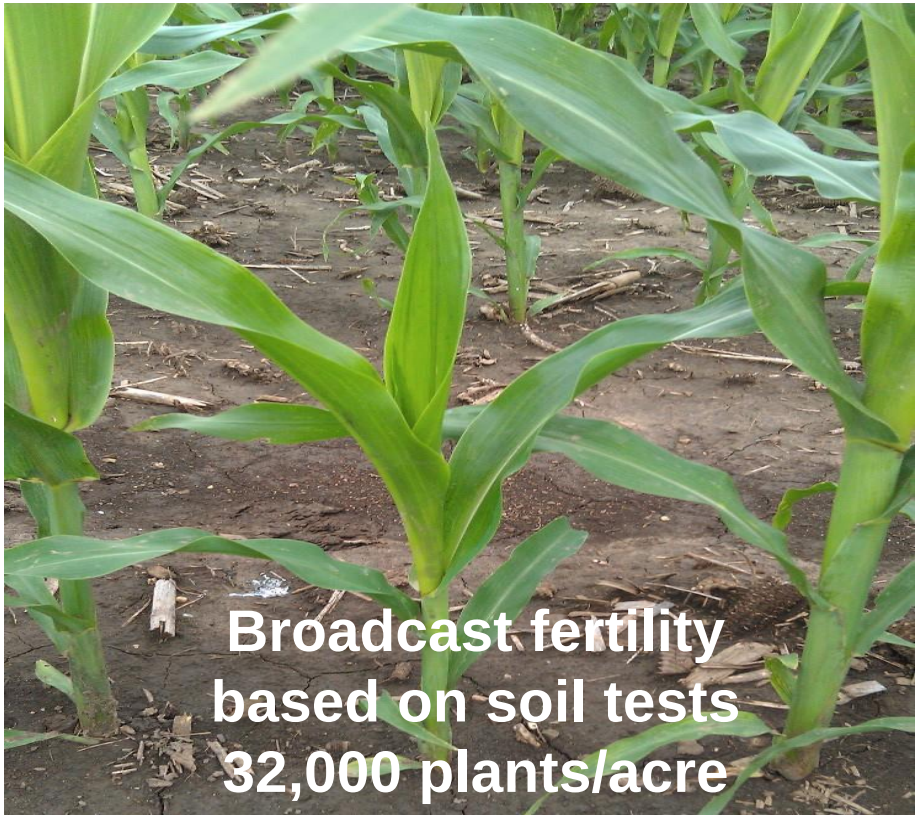
No Corn Plant Left Behind



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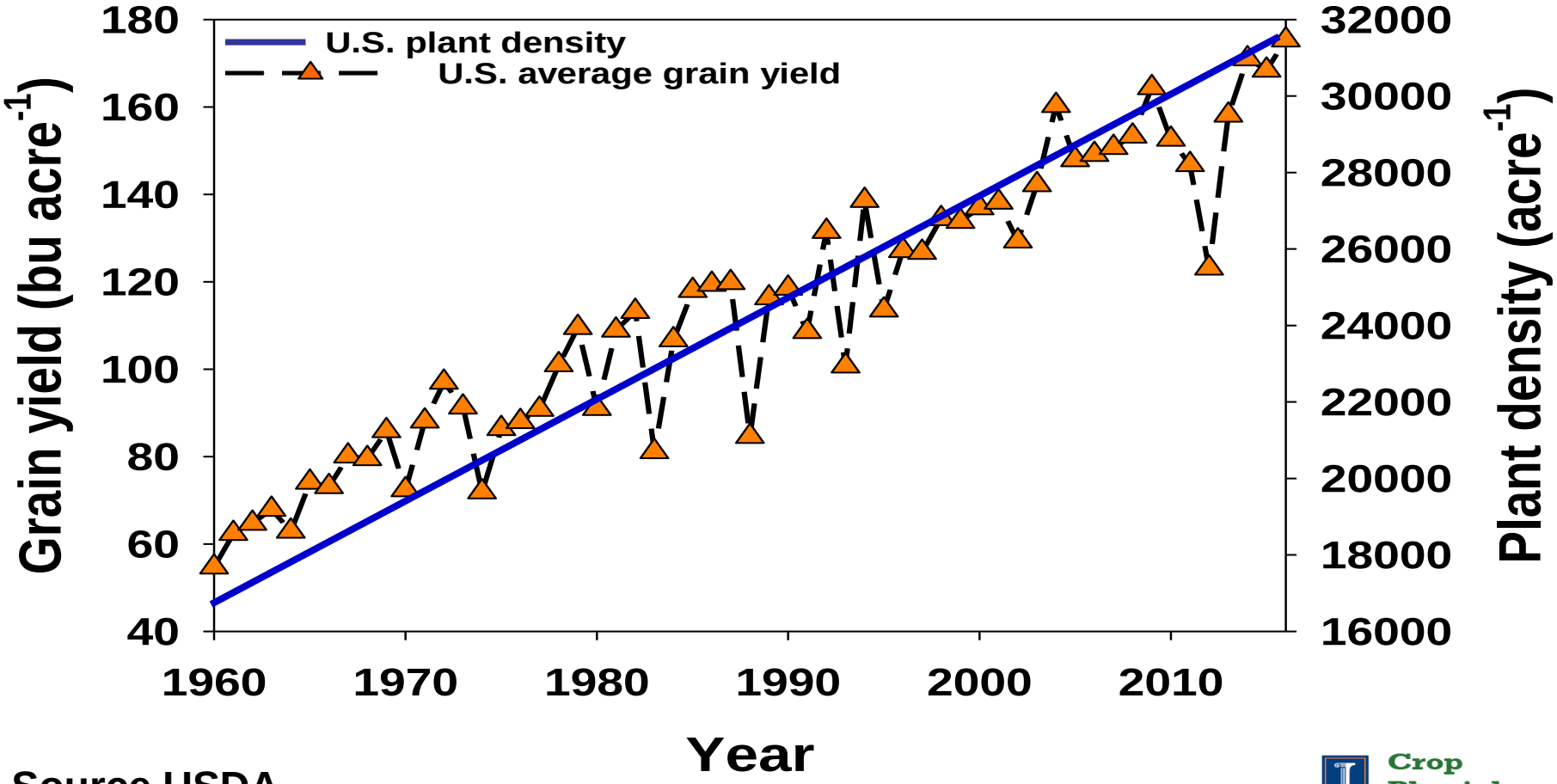
How Have Corn Yields Increased?



Source USDA

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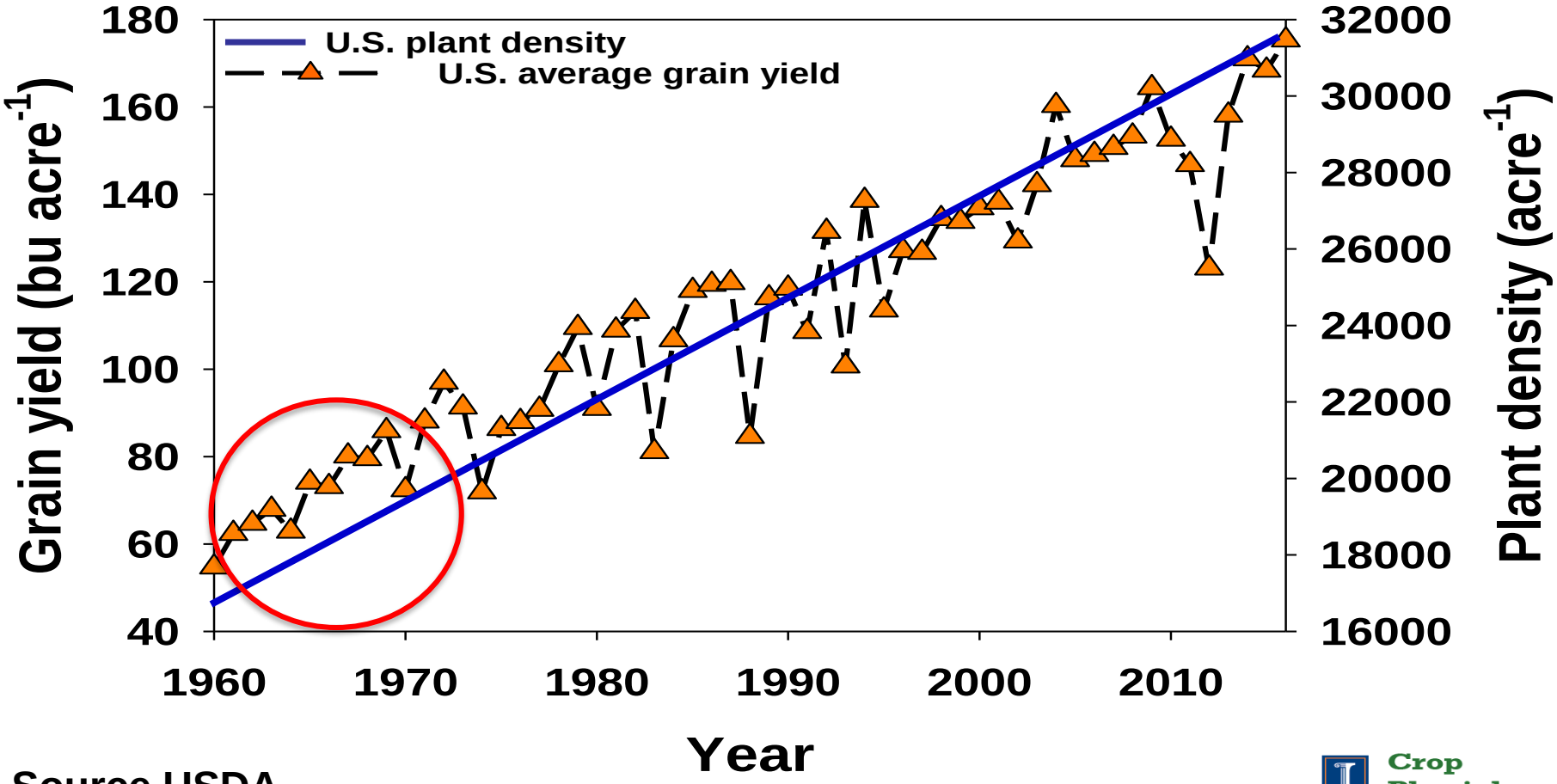
Test Your Knowledge of High Yield Corn

- **When were soil test values calibrated to corn yields?**

In the 60's and Early 70's

Soil Test Values Calibrated to Yield in the 60's and 70's



Source USDA

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Test Your Knowledge of High Yield Corn

- **What happens to the size of each plant's root system as the plant population is increased?**

It Gets Smaller

Root Digging/ Washing

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High Plant Density = Smaller Roots

Standard Population 32,000 plants/acre	High Population 44,000 plants/acre
	

Champaign, IL 2016

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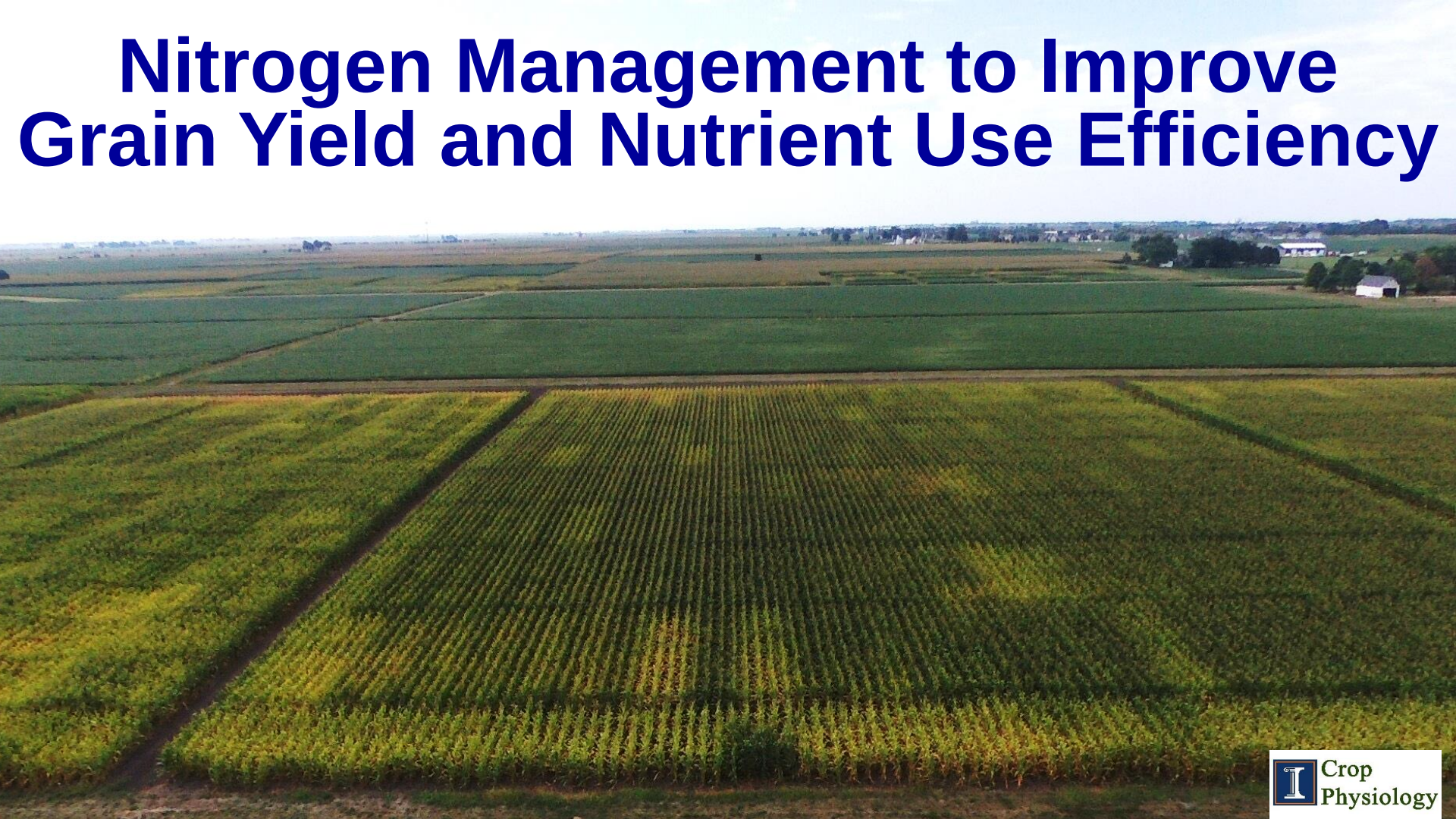
Fertility Needs for Corn Based on Soil Test Data

- **Soil test values calibrated to yield in the 60's and 70's**
- **Do higher plant populations and more productive germplasm necessitate better fertilization strategies for corn?**

Corn Fertility Recommendations

- **Current = N based on expected yield and P and K on soil tests**
- **Future = Use application and fertilizer technologies to supply required crop nutrition**

Nitrogen Management to Improve Grain Yield and Nutrient Use Efficiency



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Test Your Knowledge of High Yield Corn

- **Does weather impact nitrogen availability?**

Weather Induced Nitrogen Loss

Test Your Knowledge of High Yield Corn

- **Does nitrogen predominately move vertically (down) or horizontally (to the side) in the soil?**

Nitrogen Deficiency to the Row Due to Vertical Soil Movement

180 lbs N preplant (Left) vs 180 lbs preplant + 80 lbs sidedress (Right)

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In-Season Y-Drop N Application

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Research Y-Drop Applicator
Courtesy of Yield 360

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Mechanical Y-Drop Reseach Applicator

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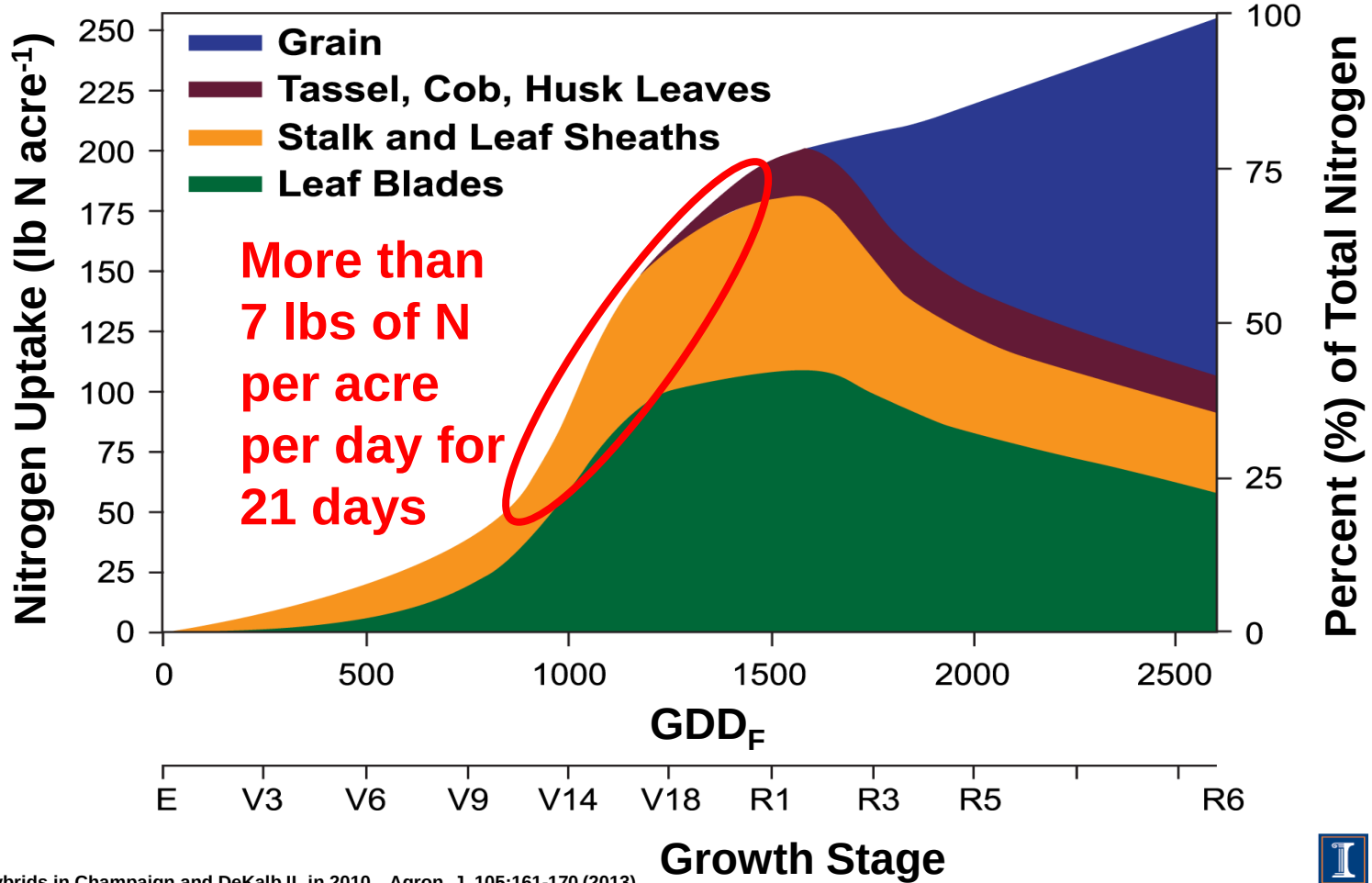
Test Your Knowledge of High Yield Corn

- **Are split applications of N better than applying all the N upfront at preplant?**

Test Your Knowledge of High Yield Corn

- **When does N need to be available for maximum N uptake and grain yield?**

Nitrogen Uptake and Partitioning for 230 Bushel Corn



Average of 6 hybrids in Champaign and DeKalb IL in 2010 Agron. J. 105:161-170 (2013)

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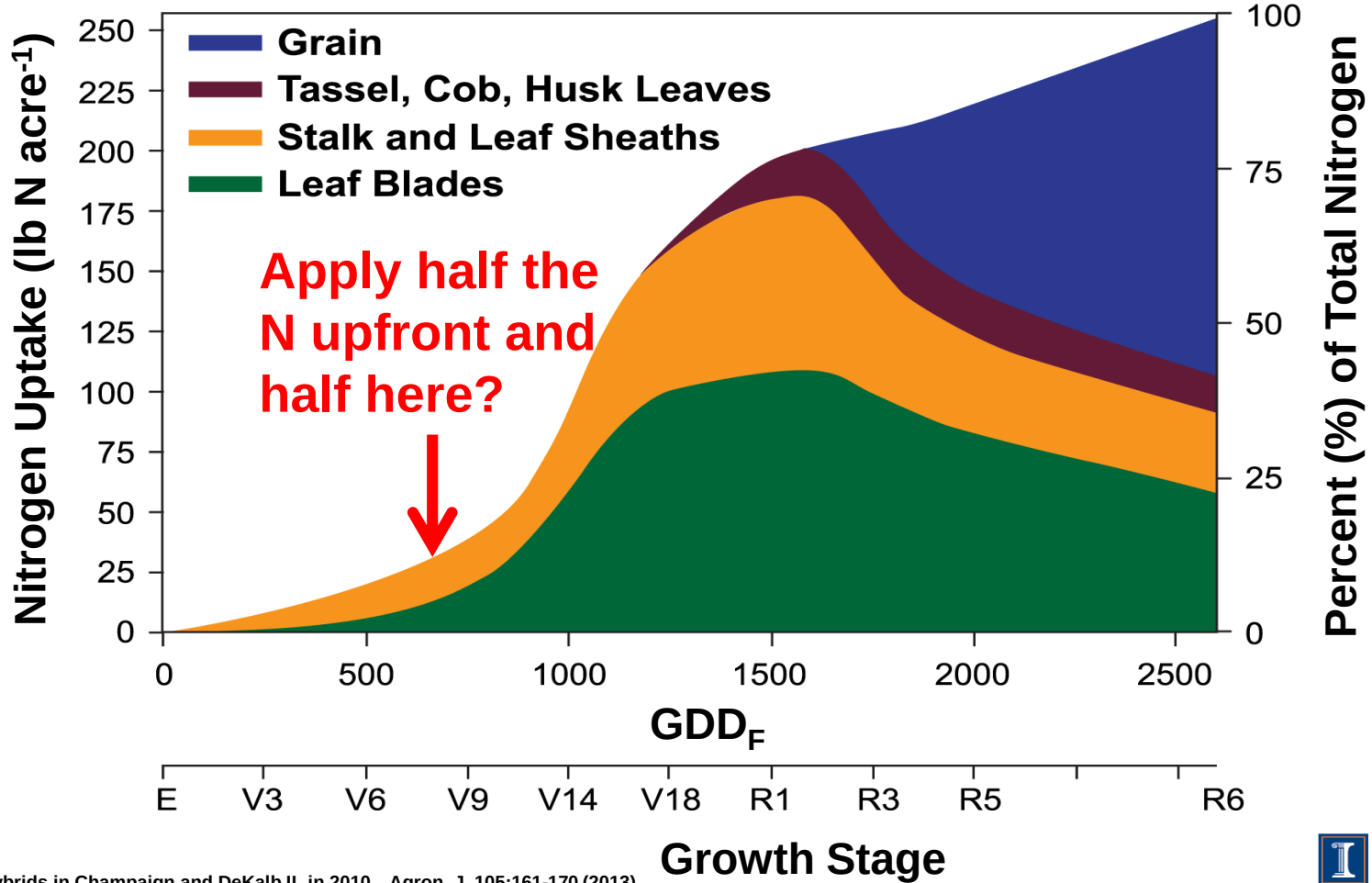
Are Split Applications of Nitrogen Better?



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Are Split Applications of N Better than all at Planting?

Fertilizer Source

Urea and UAN

Application Timing

Upfront: All N applied at preplant

50/50 Split: 50% N at planting
50% N sidedressed at V8

*** Total of 180 lbs of N / acre**

Application Method

Planting
Broadcasted

V8 Growth Stage
Broadcasted
Center of Row
Y-Drop

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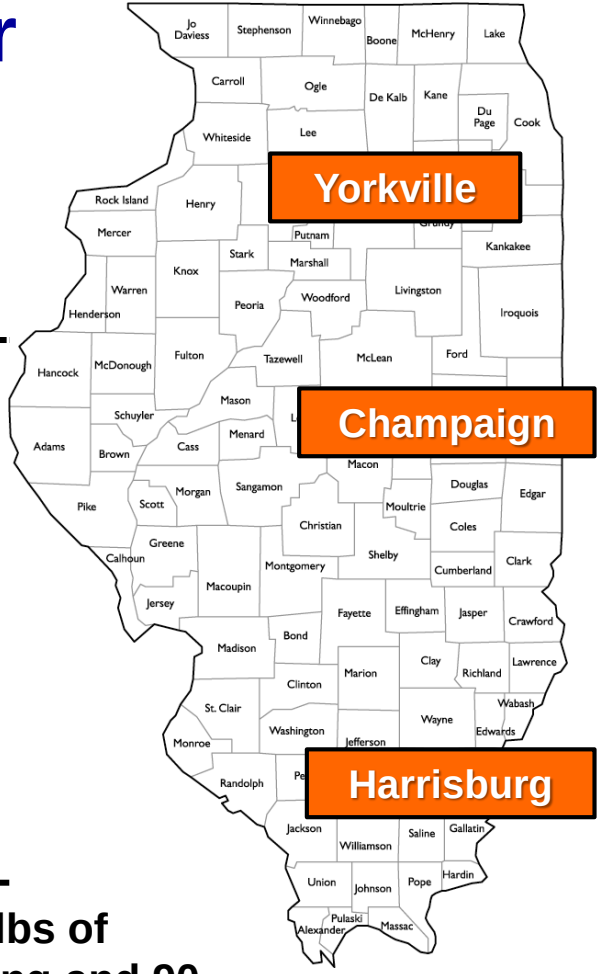
Are Split Applications of N Better than all N at Planting?

Planting	Sidedress
No Nitrogen	-
Urea Broadcast	-
Urea Broadcast	Urea Broadcast
Urea Broadcast	UAN Mid-Row
Urea Broadcast	UAN Y-Drop



All treatments (except the no N control) received a total of 180 lbs of N/acre. Split applications received 90 lbs of N just before planting and 90 lbs of N/acre at the V8 growth stage. Two years 2017 and 2018.

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Urea Broadcast

UAN Center of Row

UAN Y-Drop

Crop Physiology

Are Split Applications of N Better than all N at Planting?

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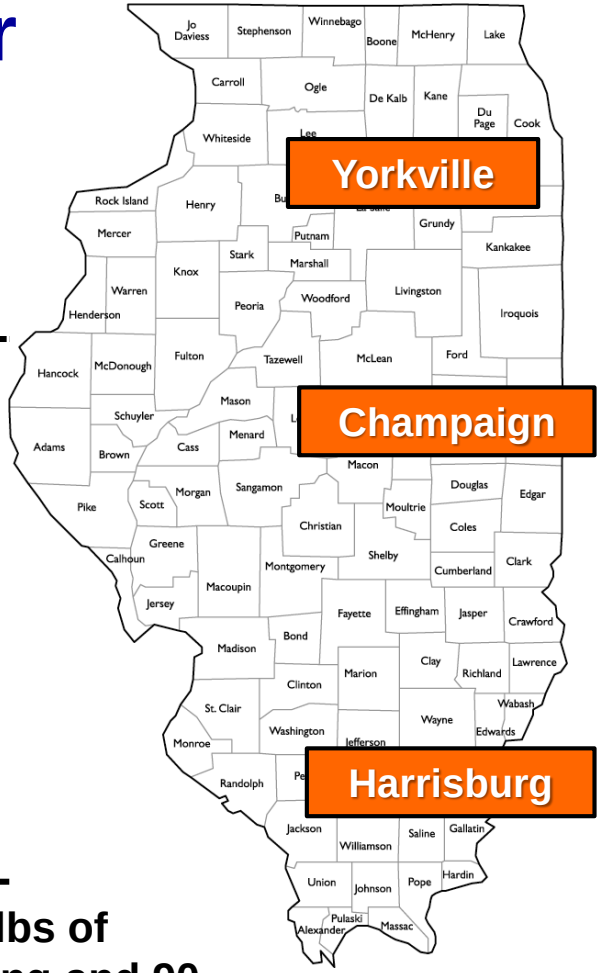

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Differences in Check Plot Yield Per Site

Year and Location	Check Plot Yield
	bushels/acre
2018 Harrisburg	97
2018 Champaign	103
2017 Champaign	184
2018 Yorkville	195
2017 Yorkville	208
2017 Harrisburg	224

Check Plot is yield without any N fertilizer application; what the soil supplies

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2017 Yorkville	208
2017 Harrisburg	224

Check Plot is yield without any N fertilizer application; what the soil supplies

Yield Difference from all N Applied Upfront and Sidedress with Different Placements

Check Plot Rank	Upfront Urea Broadcast	Placement of 90 lbs N Sidedress†		
		Broadcast	Center Row	Y-Drop
	bu/acre	Δ bu/acre		
18HB	190	-7	-2	9
18CU	222	-8	-17*	6
17CU	256	-3	-25*	-11
18YV	232	3	9	15*
17YV	265	7	0	13
17HB	265	8	9	11

† Split application received 90 lbs N as broadcast urea upfront

* Nitrogen treatment significantly different than Upfront Urea Broadcast at α=0.05

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Key Takeaways

- **When the N supplied from the soil was low (as indicated by a low check plot yield), more N is needed at preplant**

Key Takeaways

- **Split applications of N increased yield in years and fields with high initial soil N, and the Y-drop method was the best way to sidedress N**

What About Banding of Nitrogen?

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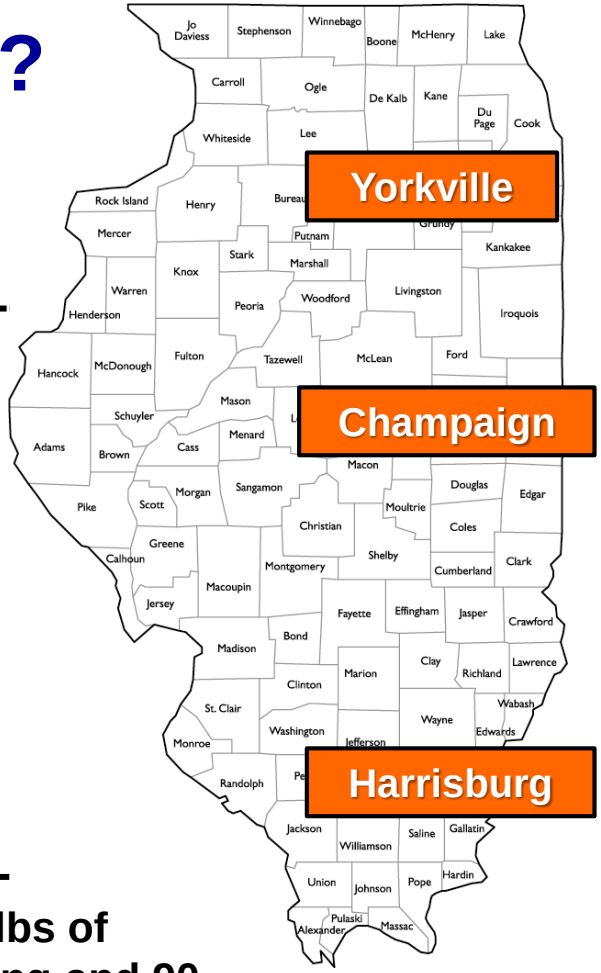
Is Banding Better than Broadcast?

Planting	Sidedress
No Nitrogen	-
Urea Broadcast	-
Urea Branded	Urea Broadcast
ESN Banded	-



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Yield Difference from all N Applied Upfront as Urea or Split Application with Some or all N Banded

Check Plot Rank	Upfront Urea Broadcast	90 lbs Banded Urea at Planting and 90 lbs Broadcast Urea at V8	180 lbs Banded ESN at Planting
	bu/acre	Δ bu/acre	
18HB	190	9	14*
18CU	222	-5	18*
17CU	256	18	30*
18YV	232	9	17*
17YV	265	14	10
17HB	265	17*	12*

* Nitrogen treatment significantly different than Upfront Urea Broadcast at α=0.05

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Key Takeaways

- **Banded ESN directly under the crop row at planting, acted as both a preplant and a sidedress and was the best source and application method, especially when the check plot was low**

Phosphorus Management to Improve Grain Yield

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Research Objective

- **Investigate different P fertilizer application methods, timings, and the use of Humic Acid to improve P availability and increase grain yield**

Research Questions

- **How much 10-34-0 can be put in furrow?**
- **Will sidedressing 10-34-0 with Y-drops at V8 increase late season P uptake?**
- **Can a humic acid improve P availability?**

Effect of Properly Placed Fertilizer

3 gal 10-34-0 In Furrow

No Starter

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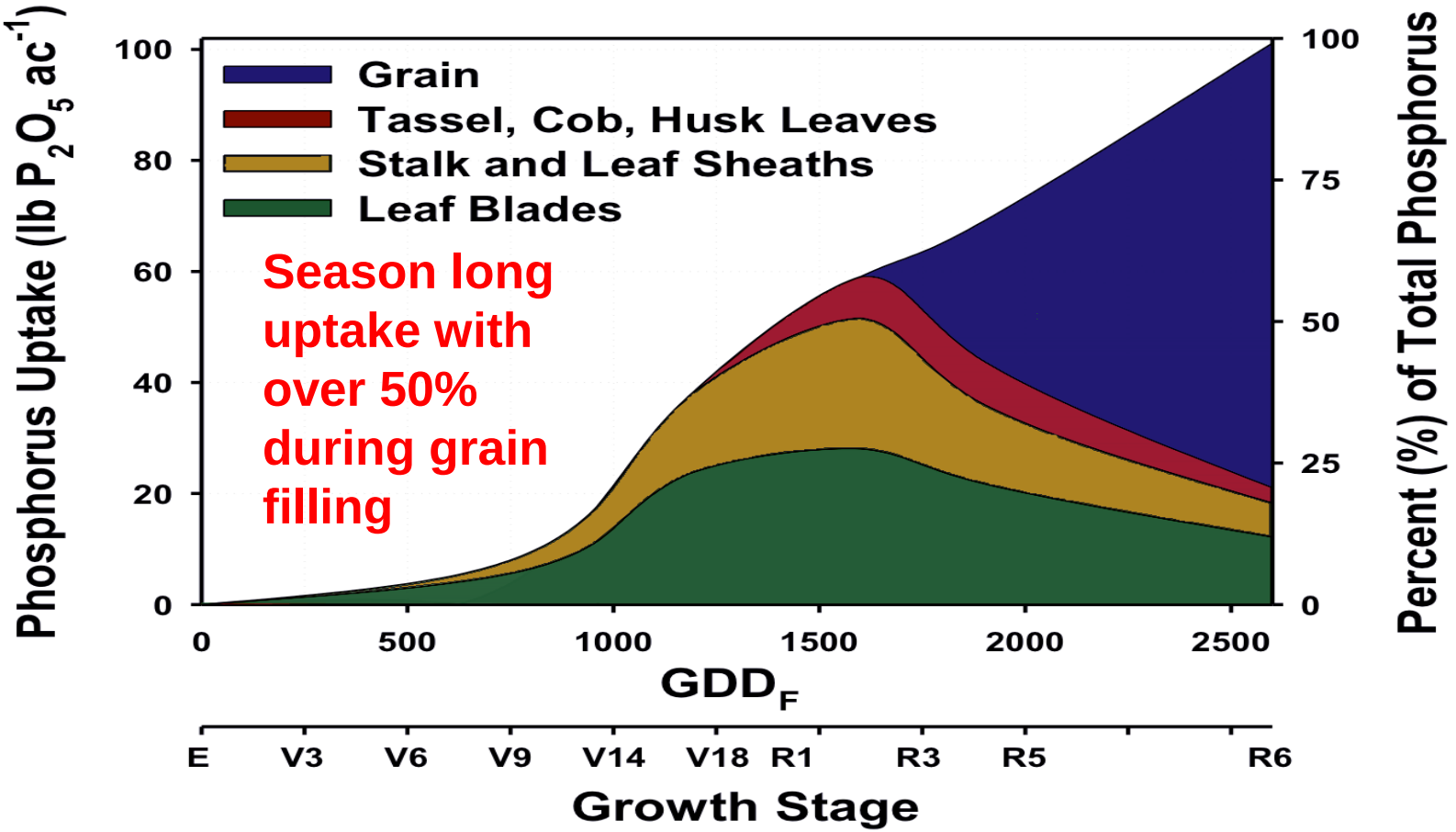
P Uptake & Partitioning for 230 Bushel Corn



Average of 6 hybrids in Champaign and DeKalb IL in 2010

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Evaluations

Application Timing/Rate of 10-34-0

Planting	5 gallons/acre
	10 gallons/acre
V8 Sidedress	15 gallons/acre

Application Method

Planting: In-furrow

V8 Sidedress: Y-dropped

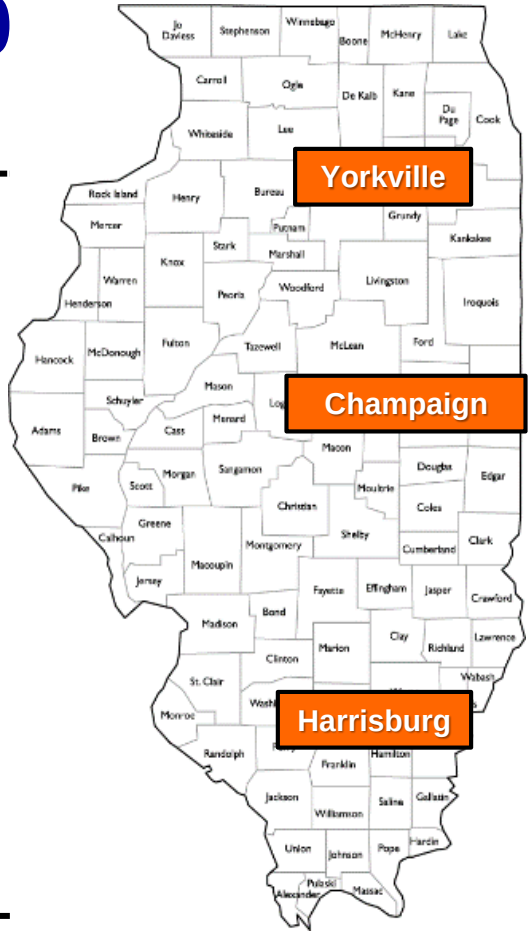
Fertilizer Additives

With/Without Hydra-Hume

In-Furrow Application Capabilities

Treatments Gallons of 10-34-0

In Furrow @ Planting	Sidedress @ V8
Control (0)	-
5	-
5 + HH	-
10	-
15	-
-	10
5	10
5	10 + HH
5 + HH	10 + HH
-	15



Base rate of 180 lbs N/acre before preplant
Hydra-Hume application rate was 1gal/10gal of 10-34-0

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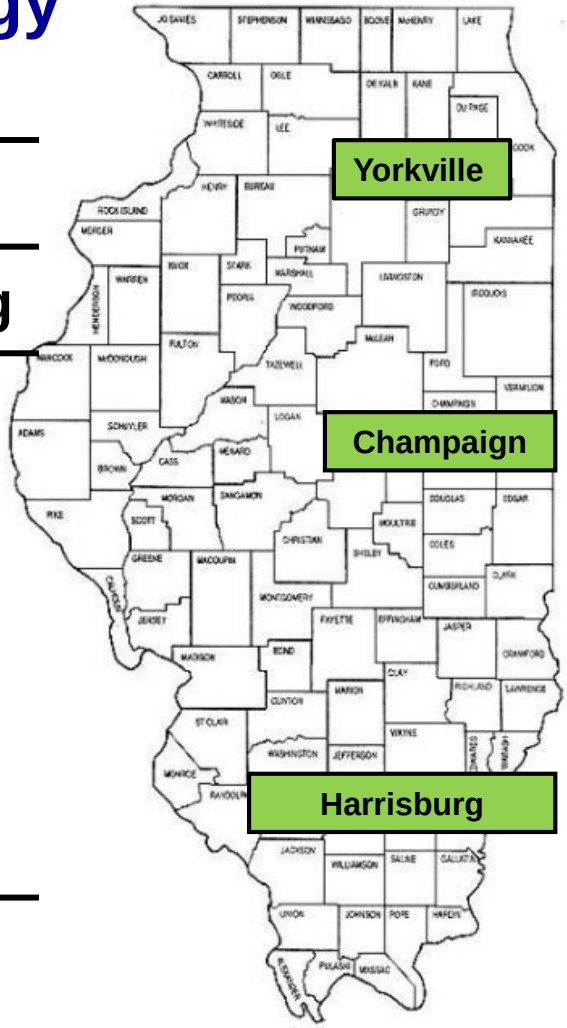

Treatments Gallons of 10-34-0

In Furrow @ Planting	Sidedress @ V8
Control (0)	-
5	-
5 + HH	-
10	-
15	-
-	10
5	10
5	10 + HH
5 + HH	10 + HH
-	15

Base rate of 180 lbs N/acre before preplant
Hydra-Hume application rate was 1gal/10gal of 10-34-0

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Untreated
5 gallons 10-34-0
Crop Physiology


15 Gallons 10-34-0
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Yield Difference From In Furrow 10-34-0

Treatment		Location			
In-Furrow	Sidedress	Harrisburg	Champaign	Yorkville	All
gallons 10-34-0		Δ bushels/acre			
5	-	+5	+10	+5	+7*
5 + HH	-	+5	+5	+8	+7*
10	-	-2	+3	+6	+3
15		-5	-5	-5	-5

Control Yields (bu/acre) 250 in Harrisburg, 250 in Champaign, 291 in Yorkville
*Significant at (α = 0.10)

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Treatments Gallons of 10-34-0

In Furrow @ Planting	Sidedress @ V8
Control (0)	-
5	-
5 + HH	-
10	-
15	-
-	10
5	10
5	10 + HH
5 + HH	10 + HH
-	15

Base rate of 180 lbs N/acre before preplant
Hydra-Hume application rate was 1gal/10gal of 10-34-0

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Yield Difference From In Furrow plus Sidedress

Treatment		Location			
In-Furrow	Sidedress	Harrisburg	Champaign	Yorkville	All
gallons 10-34-0		Δ bushels/acre			
	10	+7	+14*	+9	+10*
5	10	+11*	+14*	+8	+11*
5	10 + HH	+15*	+20*	+9	+15*
5 + HH	10 + HH	+8	+13*	+11*	+11*
	15	+6	+17*	+8	+11*

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Key Takeaways – In Furrow

- **5 gallons of 10-34-0 in furrow was the best rate for increasing yield, but it was not enhanced by humic acid**

- **10 or 15 gallons of 10-34-0 in-furrow resulted in crop damage and reduced grain yield**

Key Takeaways – Sidedress

- **Y-drop applications of 10-34-0 at V8 consistently increased yield**
- **Combinations of in-furrow plus sidedress were not consistently better than sidedress alone**
- **Humic acid with the Y-drop applications tended to produce the highest yields**

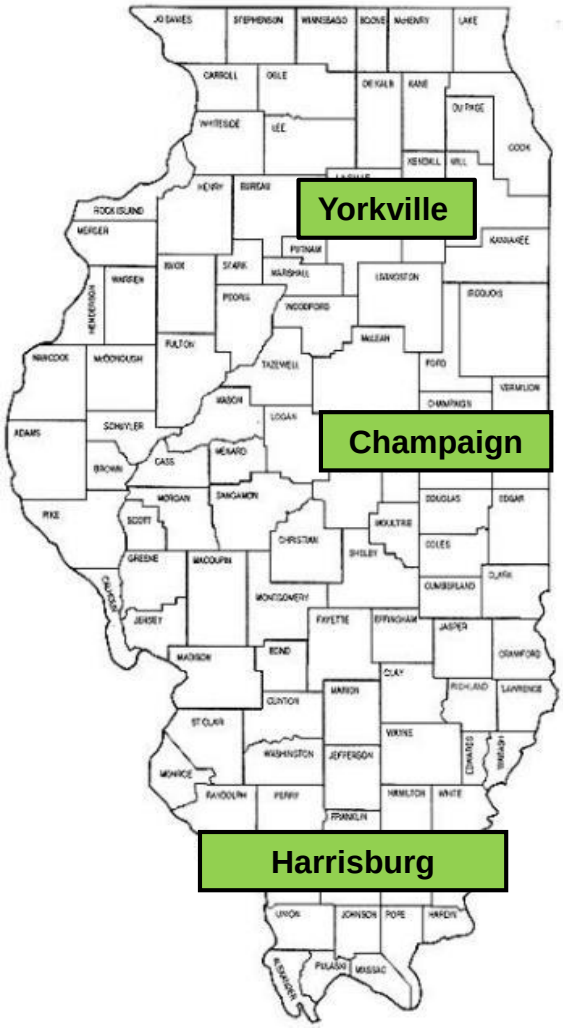
Crop Physiology 2018 Research Team

Crop Physiology Lab Research Sites & Farm Cooperators

Yorkville - Bob Stewart, Stewart Farms

Champaign - UI Research Farm

Harrisburg - Scott Berry, Berry Farms



The Crop Physiology Laboratory
Financial and Product Support for 2018

- AdvanSix
- Agrinos
- Agricen
- Agrocete
- Asilomar
- Avunia
- Balchem
- BASF
- Bayer
- Calmer Corn Heads
- Compass Minerals
- Crystal Green Fertilizer
- Fluid Fertilizer Foundation
- Helena
- ISA
- Illini FS
- Italpollina
- John Deere
- Mosaic
- Montag Mfg
- Netafim
- Nutrien
- Sipcam Agro
- Sirius Minerals
- Solvay
- Syngenta
- Tessenderlo Kerley
- United Prairie
- United Soybean Board
- Valent
- Verdesian
- West Central
- WinField United

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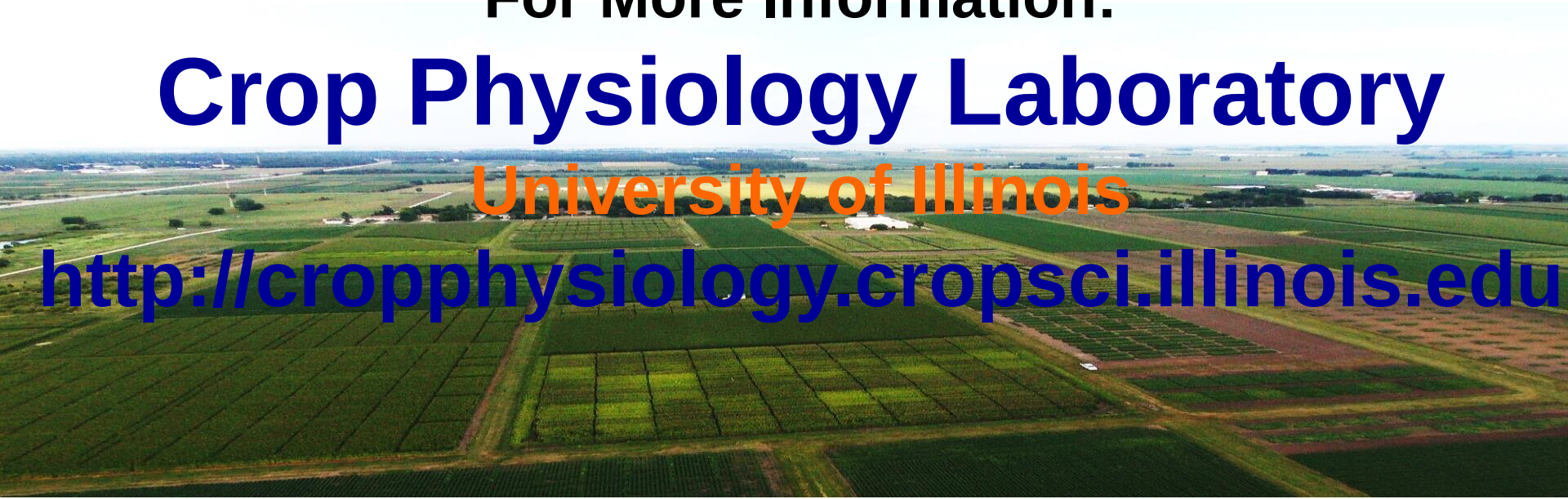
Special Thanks to Fluid Fertilizer Foundation

For More Information:

Crop Physiology Laboratory

University of Illinois

http://cropphysiology.cropsci.illinois.edu



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