Efficient Management of Water and Nutrient Resources: Assessing the Potential for Drip Irrigation Fertigation

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The Corn Yield Gap

- US average corn yield of about 160 bushels per acre
- All 18 National Corn Growers Contest winners in 2014 exceeded 300 bushels, 6 exceeded 400 bushels
- New World Record of 503.7190 bushels per acre

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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

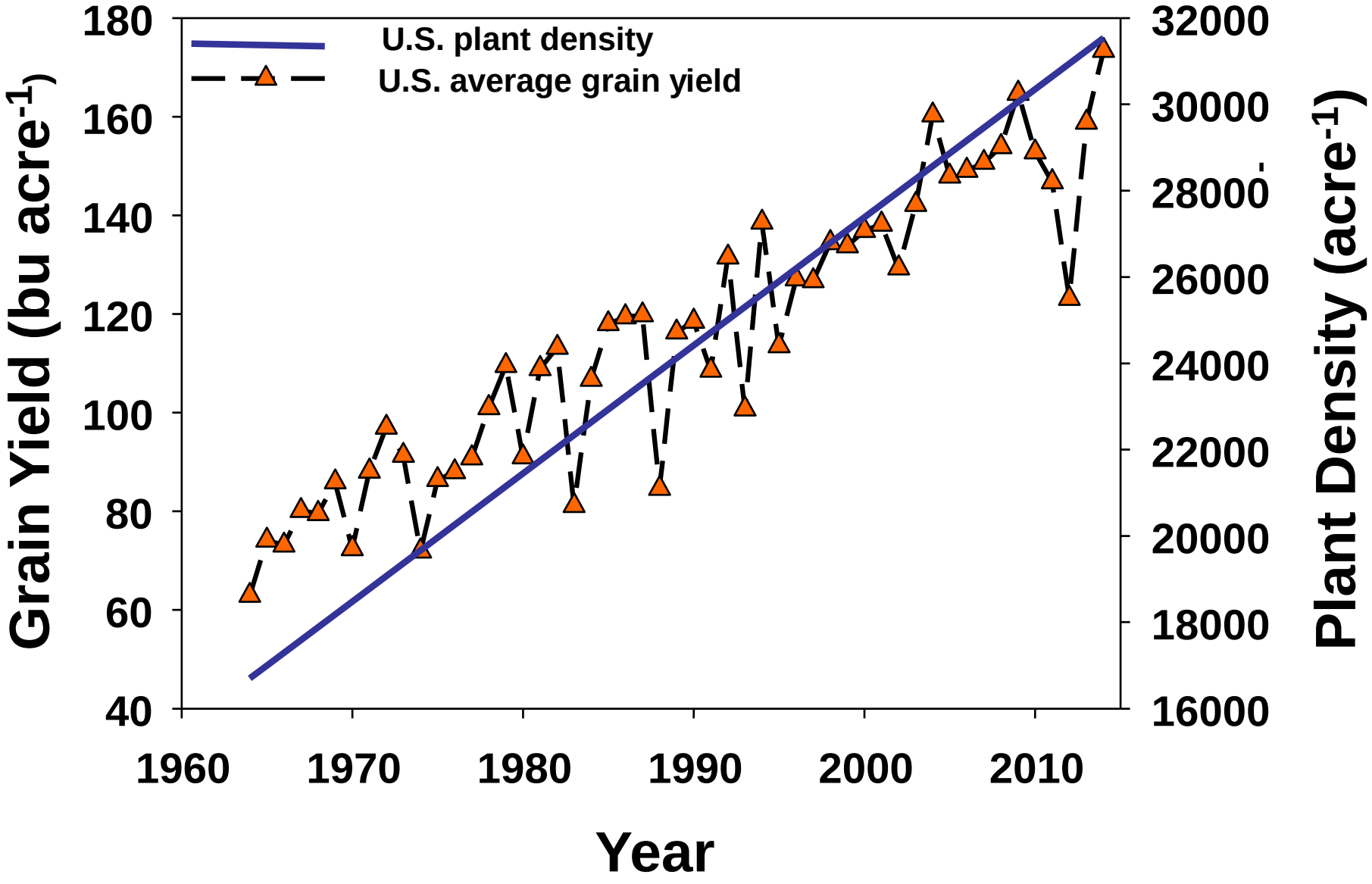
200 bushels =
32,000 plants/ac x 550 kernels/plant x 250 mg/kernel

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

Kernel weight expressed at 0% and yield at 15% moisture

How Have Corn Yields Increased?



Source USDA

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High Plant Density = Smaller Roots

Normal Population
32,000 plants/acre

High Population
45,000 plants/acre

Champaign, IL 2012

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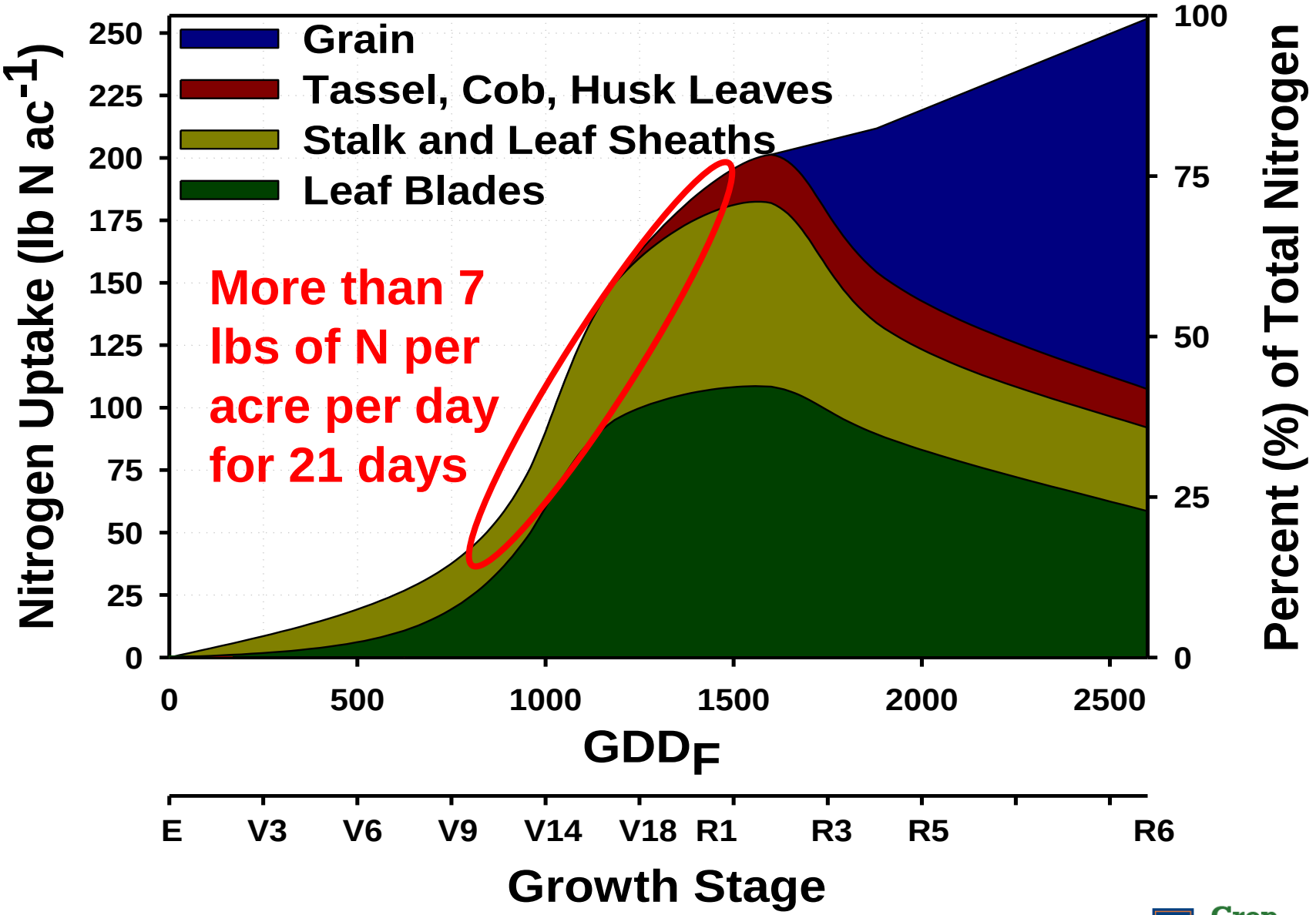
N Uptake & Partitioning for 230 Bushel Corn



Average of 6 hybrids in Champaign and DeKalb IL in 2010

Agron. J. 105:161-170 (2013)

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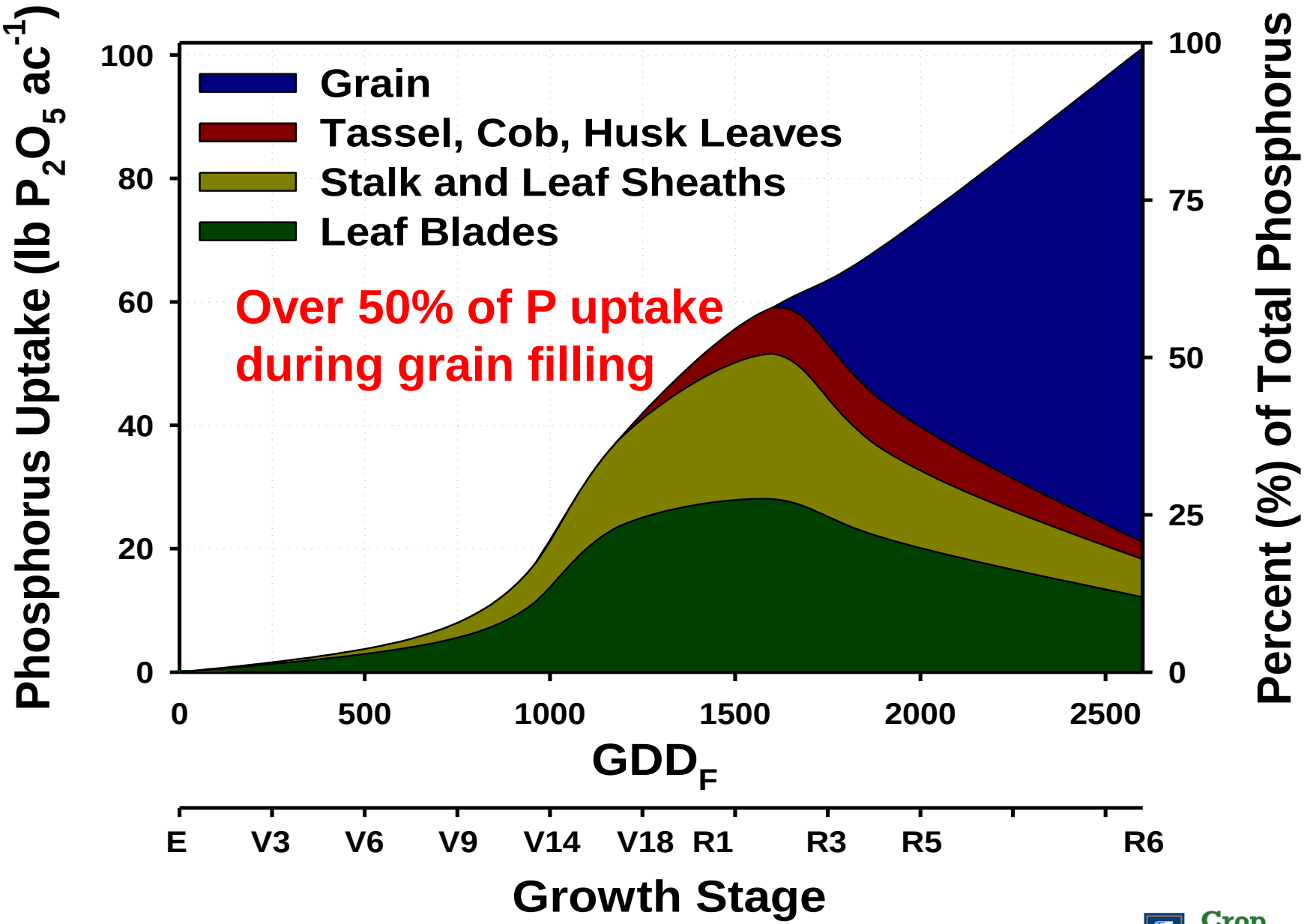
P Uptake & Partitioning for 230 Bushel Corn



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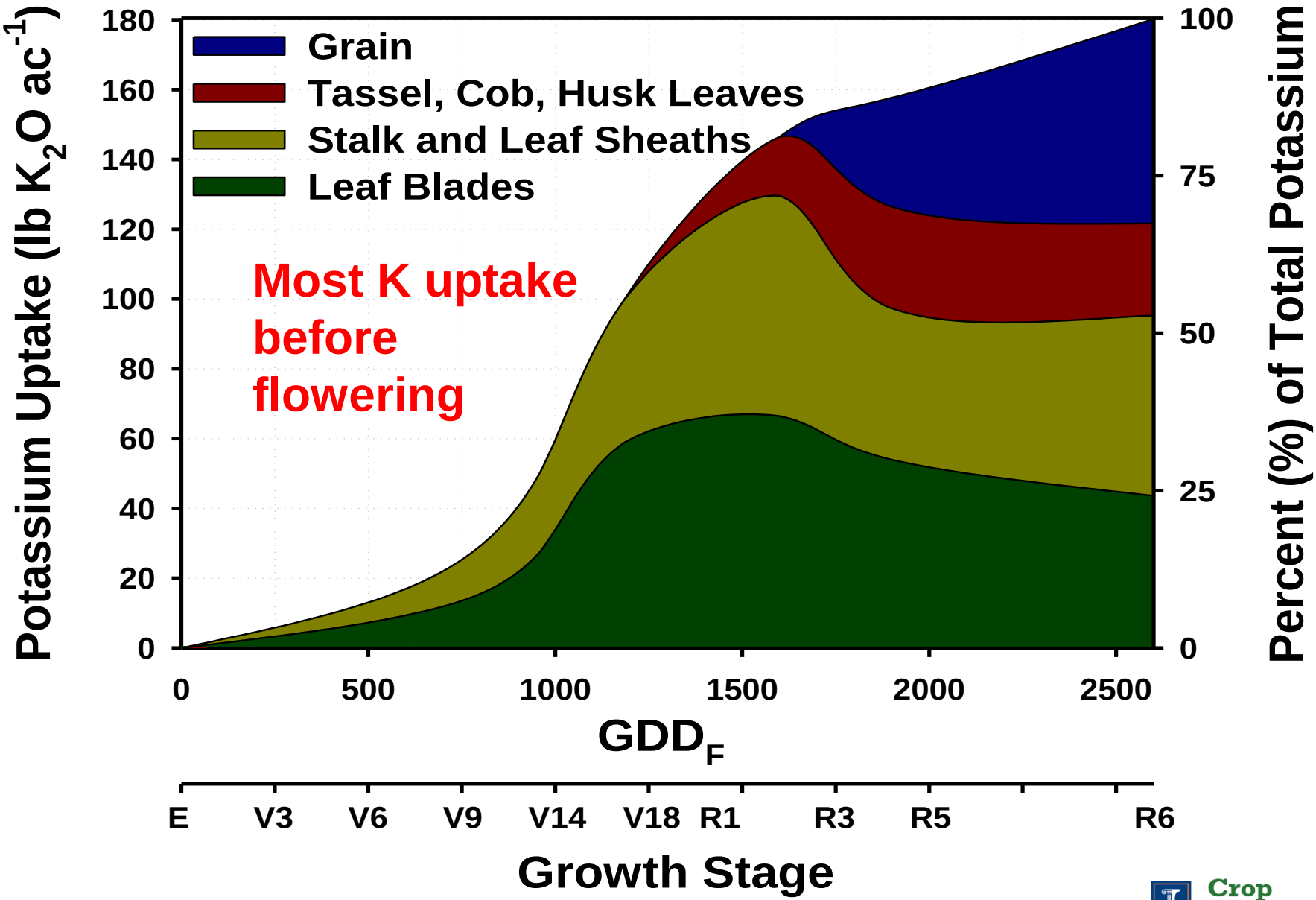
K Uptake & Partitioning for 230 Bushel Corn



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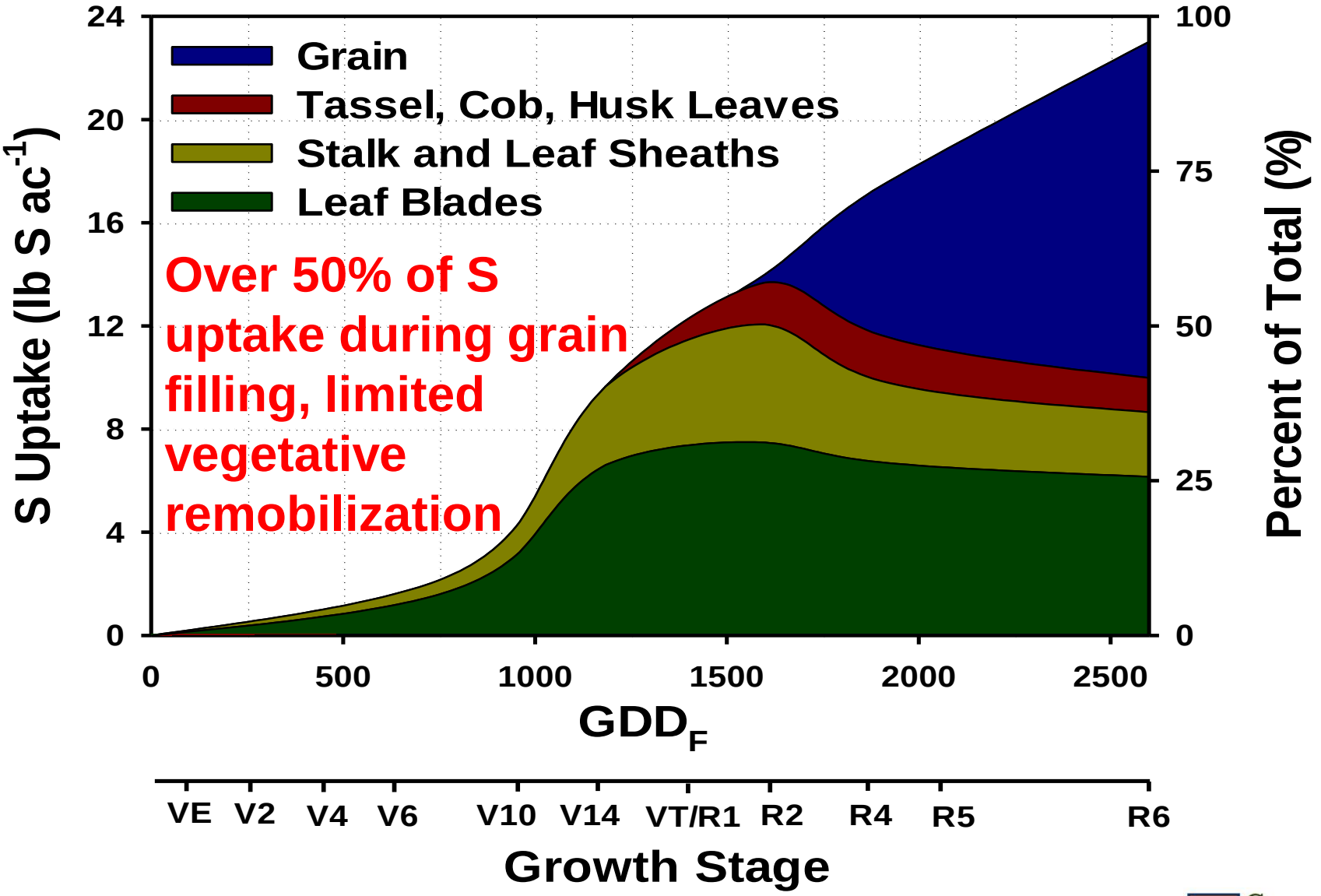

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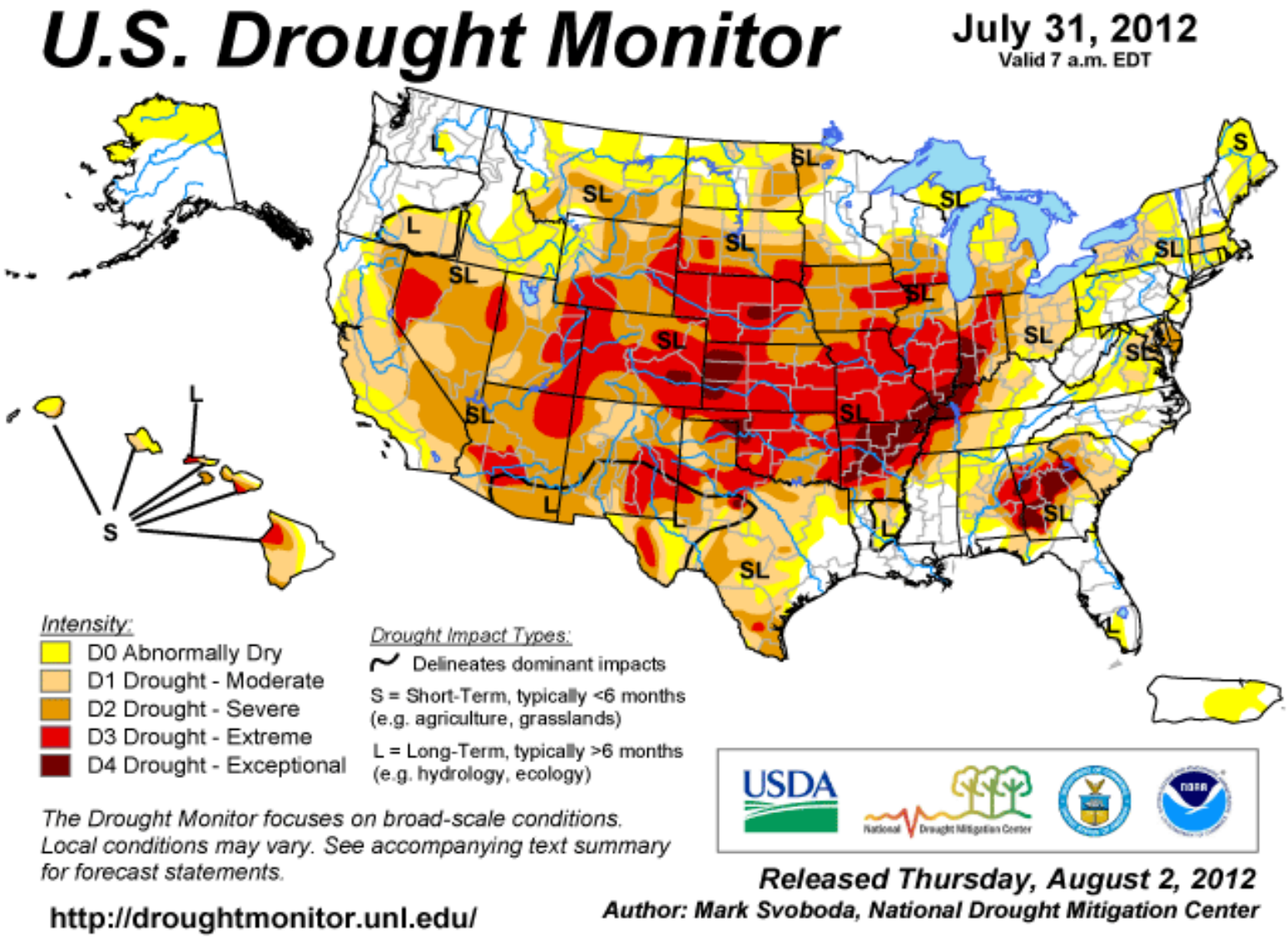
Exceptional Drought in 2012



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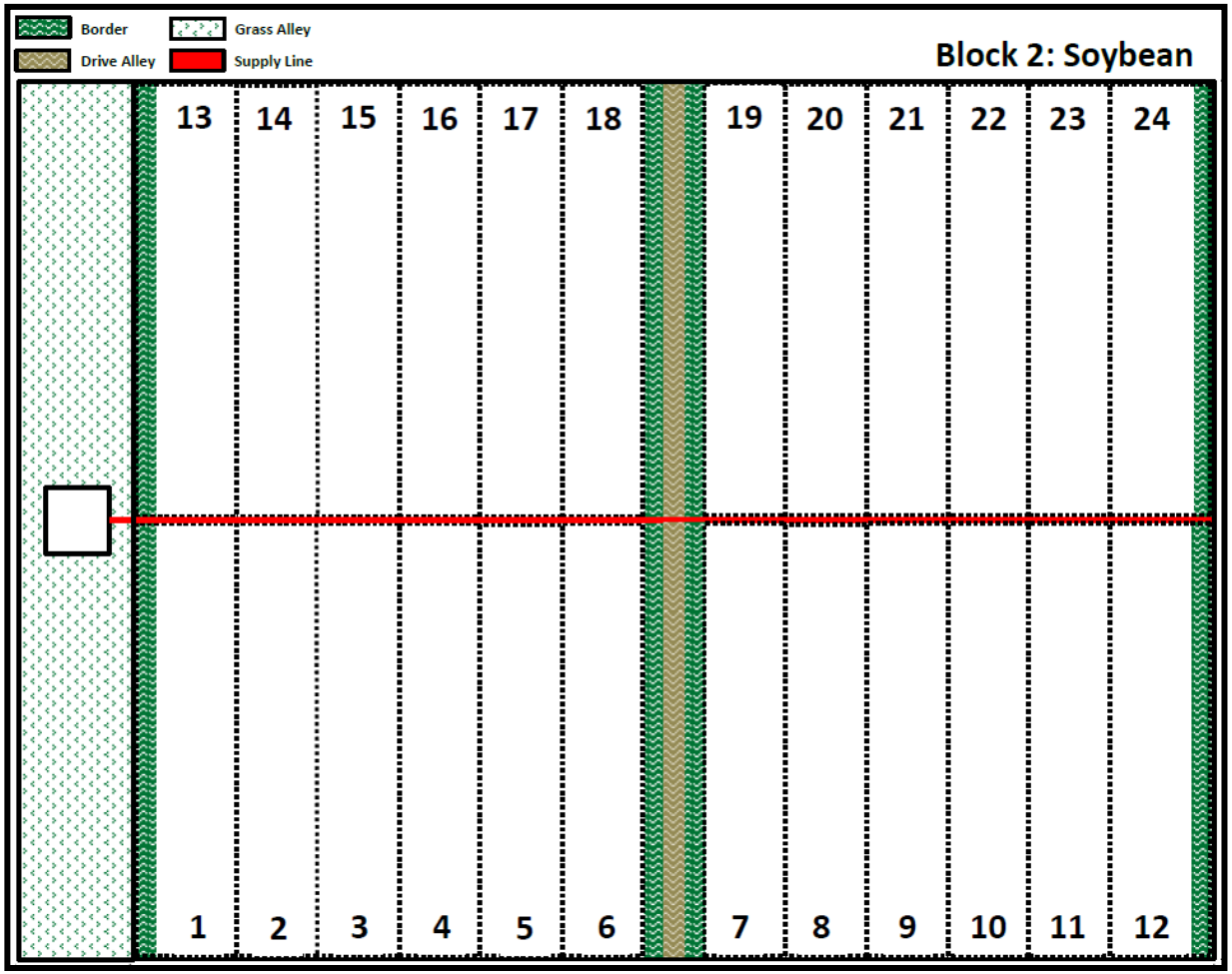
What innovative technologies exist to maintain season-long nutrient availability and alleviate plant stress?
We’re exploring a new solution with SDI!

University of Illinois SDI System

- 48 equally sized zones
  - 960 to 3840 corn or soybean plots
- Zones regulated for differential application of irrigation, fertigation, or chemigation.
- Completed May, 2014



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Drip Tape Installation: Fall, 2013

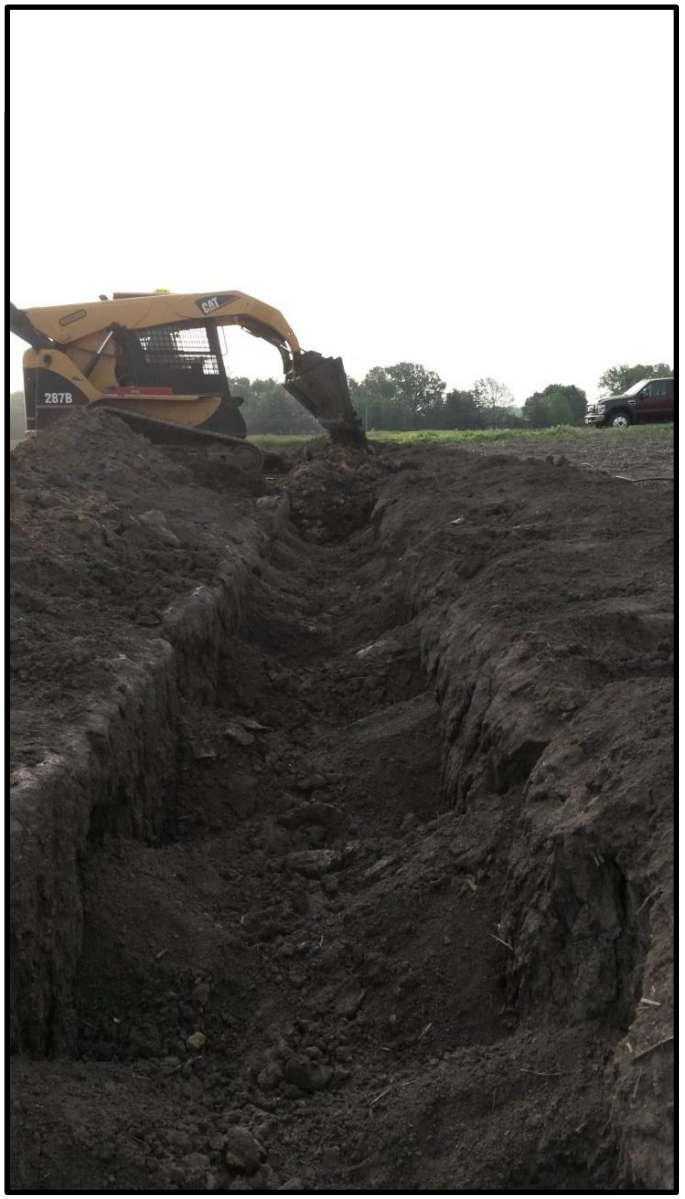
- Dripperline spaced every 30” buried ~14-16” below ground
- Thinwall dripperline: Typhoon 630 series of 13 mil thickness with emitters every 24”
- Net flow rate = 0.08”/hr

A Network of PVC Fittings

- Distribution and collection manifolds trenched in at 24”
- “Autodrains” installed to “winterize” the system after each use
- 92 fittings, 1320’ of PVC and 205’ of dripperline from start to finish

Backfilling Trenches

- **Manual backfilling used to protect elbows and dripperline fittings**
- **Mechanical excavation to fill in remaining trenches**



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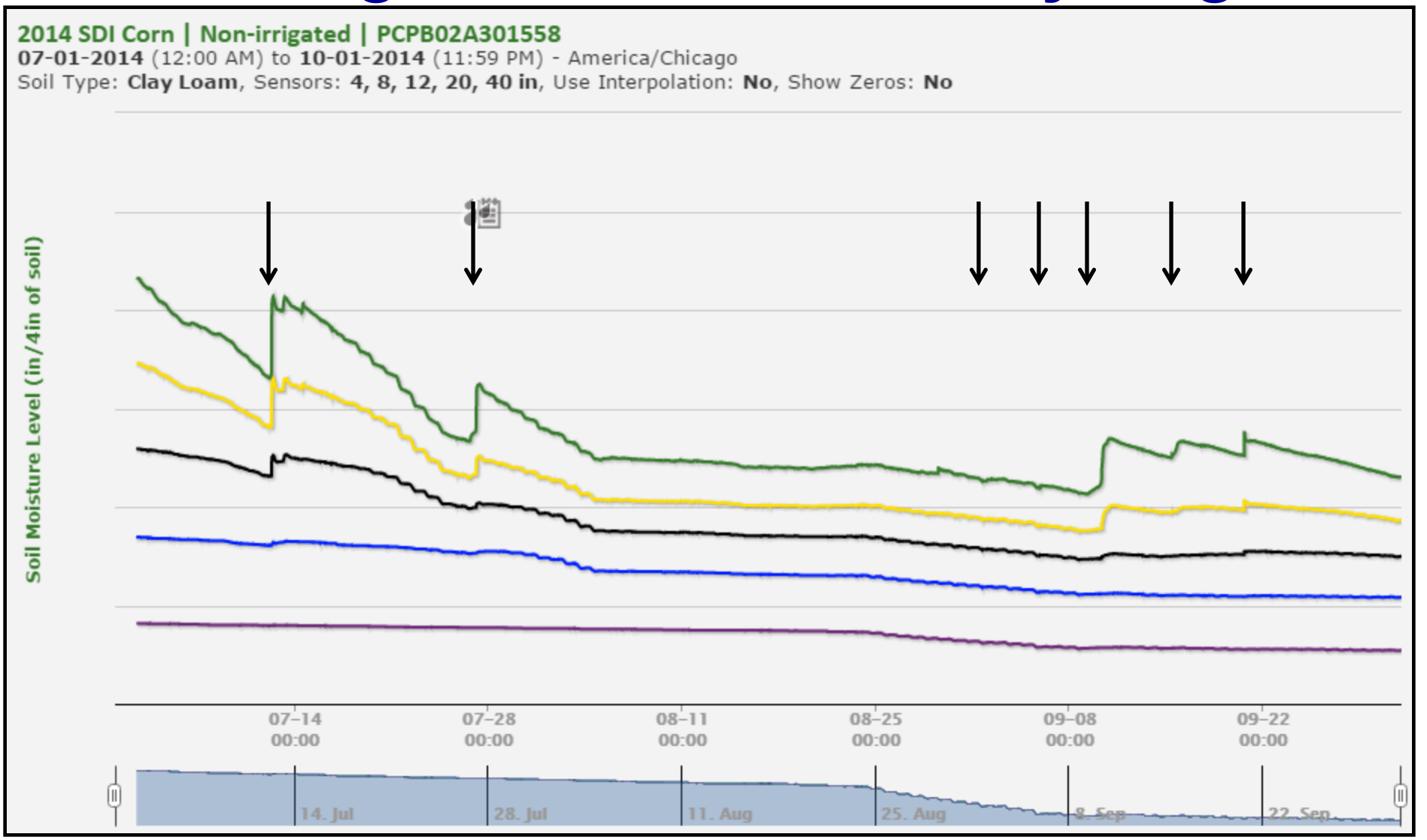
SDI Equipment

- Electronic pressure reducer, flow meters
- NMC-Pro: Controls 64 relays (zones/injectors/ reducers)
- (3) injectors ranging in capacity from 0.10 to 10 gal/hr
- Electronic celenoid & reducers for each zone
- John Deere CropSense probes monitor soil moisture throughout the profile

2014 Registered Rainfall: Dry August



Rainfall

Irrigation

Sensor Depth: 4 in | 8 in | 12 in | 20 in | 40 in

Courtesy of John Deere Crop Sense moisture sensing technology

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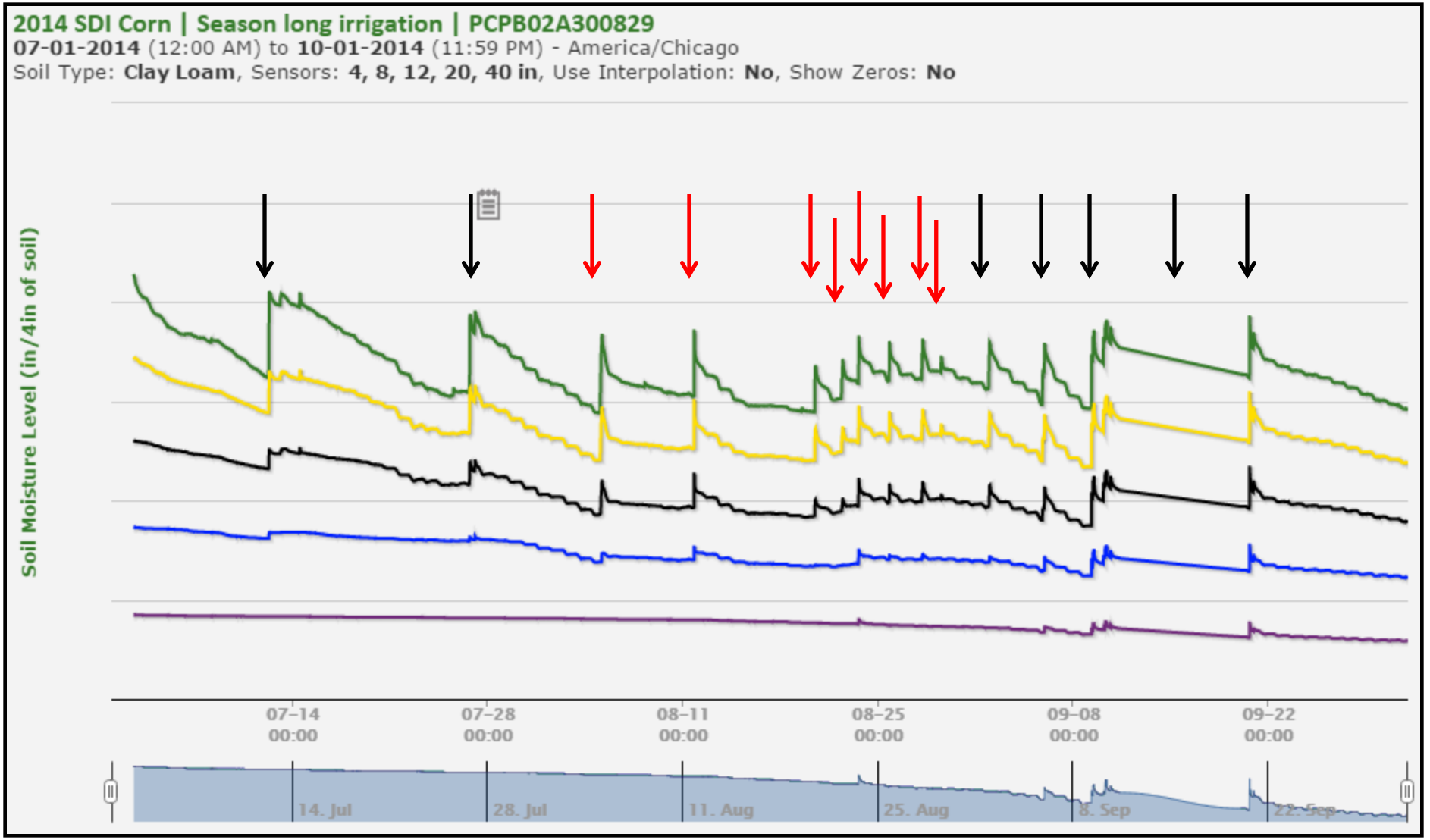
Supplemental Irrigation During Dry Periods



→ Rainfall

→ Irrigation

Sensor Depth: — 4 in — 8 in — 12 in — 20 in — 40 in

Courtesy of John Deere Crop Sense moisture sensing technology

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Installation Challenges

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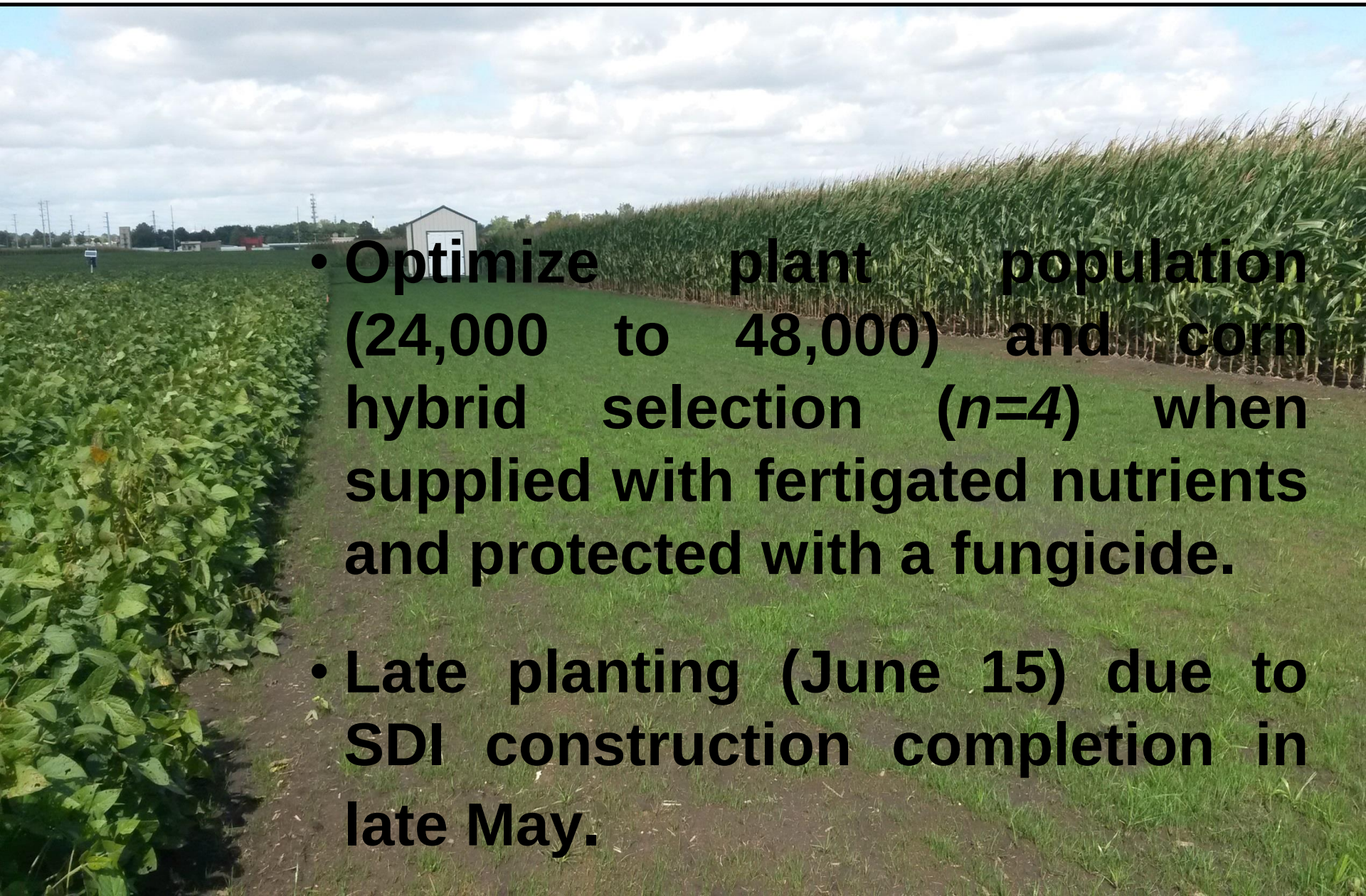
Challenges

Our Progress

2014 SDI Research Objectives



- Optimize plant population (24,000 to 48,000) and corn hybrid selection (*n=4*) when supplied with fertigated nutrients and protected with a fungicide.
- Late planting (June 15) due to SDI construction completion in late May.

Nutrient Fertigation in Corn - 2014

- **Evaluated four hybrids ranging in population from 24,000 to 48,000 plants/acre**
- **Nutrients N, K, and S were fertigated (No P during 2014) based on known patterns of nutrient accumulation**
- **Control Treatment: 180 lbs N/acre at V4**
- **Fertigated Treatment: Applied (80 – 0 – 70 – 14S) between V6 and R2**

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Visual Fertigation Response

All treatments balanced for water. Champaign, 2014.

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Fertigation Improved Yield Over Base Fertility

Population	Irrigated	Fertigated	Δ
plants acre^{-1}	bushels acre^{-1}		
24,000	174	191	+17*
30,000	182	197	+15*
36,000	181	198	+17*
42,000	175	197	+22*
48,000	176	194	+18*
Average	175	195	+17*

* Significantly greater than zero at α=0.10.

- All treatments balanced for water and received base N rate (180 lbs)
- Fertigated treatments received (80-0-70-14S), Champaign, 2014.

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Fertigation during key Growth Periods Improves Nutrient Recovery in Corn

Treatment, Parameter	Nutrient accumulation at R6			
	N	P_2O_5	K_2O	S
	lbs acre^{-1}			
Irrigation	176	54.6	113	14.1
Fertigation	210*	58.6*	144*	16.4*
Amount Applied	80	0	70	14
Recovery (%)	42	-	44	16

* Significantly greater than control at α=0.10.
• All treatments balanced for water with base N rate (180 lbs).

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Conclusions

- **Very responsive year to crop management, especially fertility.**
- **Very promising results from SDI site given the field conditions and delayed planting. We believe greater responses to fertigated nutrients will be obtained with a more timely planting date and with fertigated P.**

Acknowledgements

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For more information:

Crop Physiology Laboratory at the University of Illinois

http://cropphysiology.cropsci.illinois.edu

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