Nitrogen Management for Older versus Modern Corn Hybrids

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Purdue University

Presentation to Fluid Technology Roundup
In Council Bluffs, Iowa, on December 6, 2016

Research Context:

On-going Experiments with Strip-Till and No-till Corn and Associated Management Options:

1. Nutrient Placement, Rate, Timing, and Source

2. Corn Management (hybrid, plant density, rotation)

3. Greenhouse gas emissions from different N managements

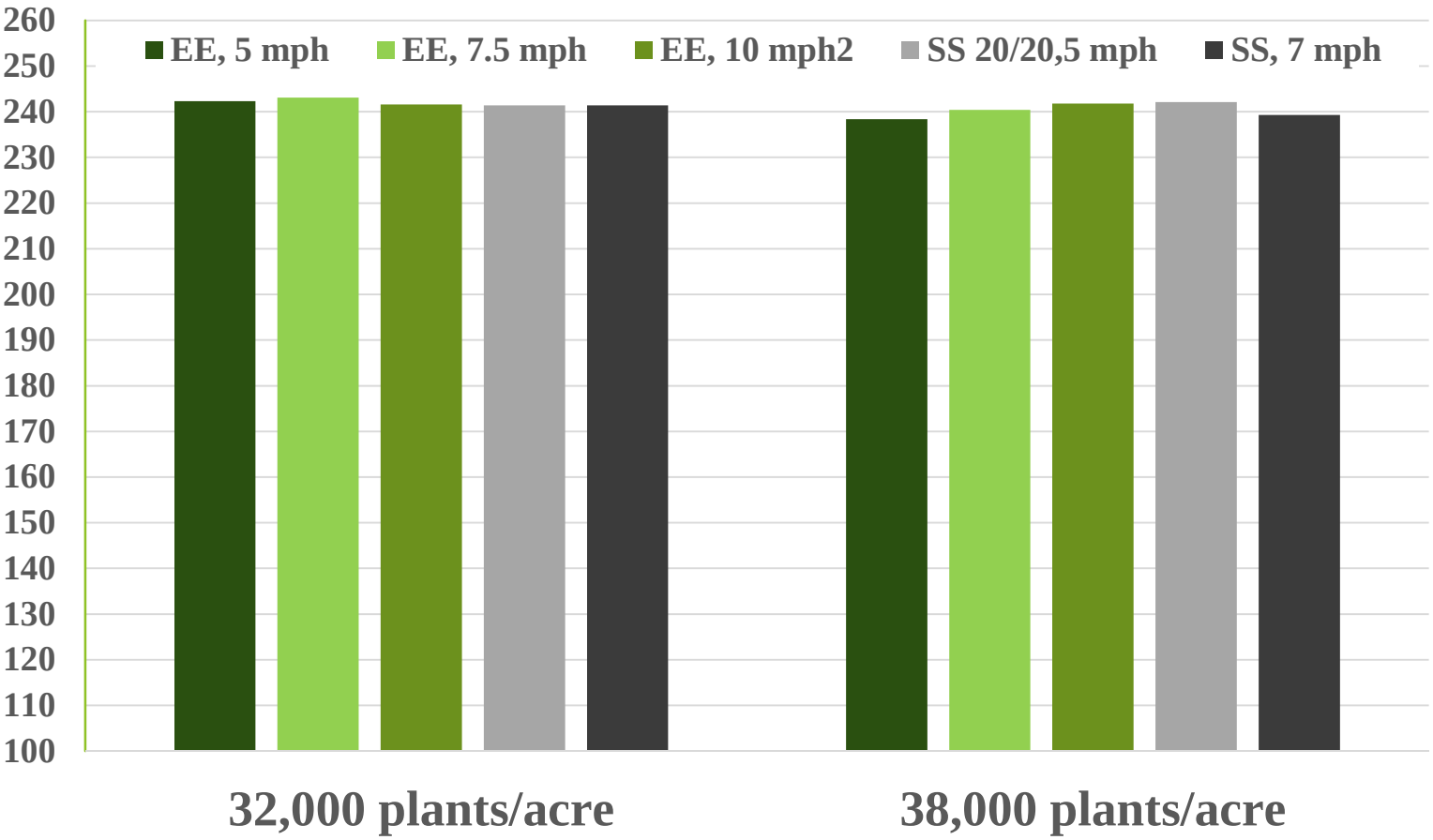
Cooperative Planting Speed Studies with Deere at Purdue (ExactEmerge) in 2015 and 2016 (Comparison of 5, 7.5 and 10 mph)

2016 ExactEmerge Trial

Cooperator: Greg Gilbert, Romney, IN

24-row 30” ExactEmerge vs. JD 1770 Precision SS 20/20 at 2-3 speeds and 2 populations

2016 ExactEmerge Trial
Cooperator: Greg Gilbert, Romney, IN



Avg. grain yield = 241.4 bu/acre

Modern Hybrids, Stress Tolerance and N + H_2O Management?

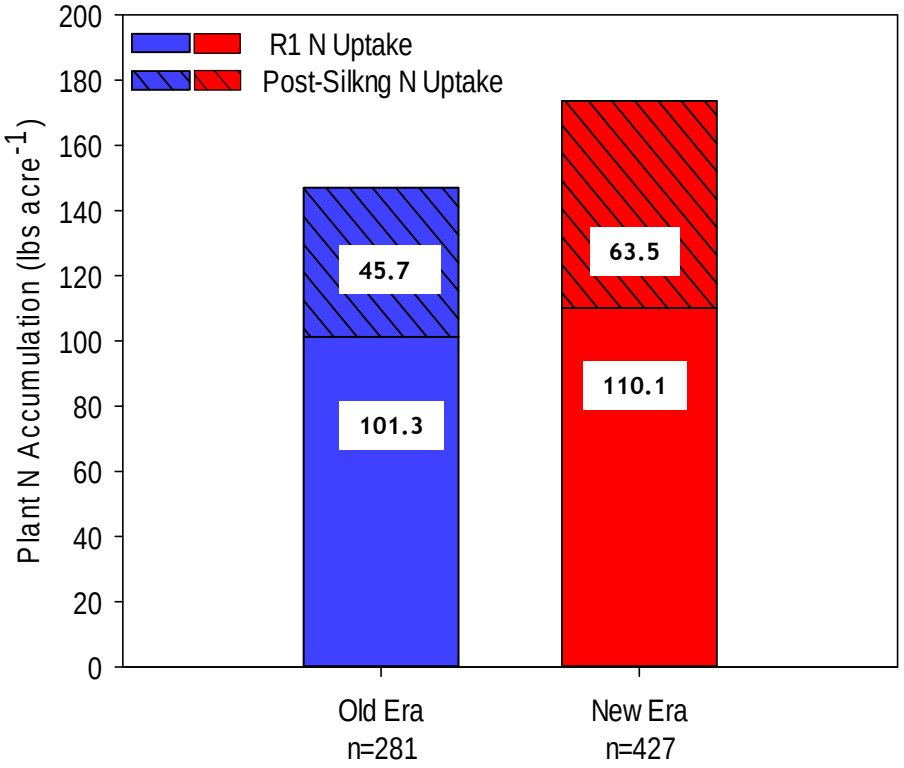
Whole-plant, grain, cob and stover nutrient (macro- and micro-) determination at maturity

Summary of Corn Hybrid Changes Over Time

Measured Parameter	Old Era 1942-1990 (mean=1984)	New Era 1991-2011 (mean=2001)
Mean N Rate (lb/Acre)	126	125
Plant Density/Acre	22,800	28,800
Yield (bu/acre)	115	144
N Use Efficiency (PFP)	58	66
N Internal Efficiency (NIE)	49.7	56.0
Grain Harvest Index (HI)	47.6	49.8
N Harvest Index (NHI)	63.1	63.8
Grain N %	1.33	1.20

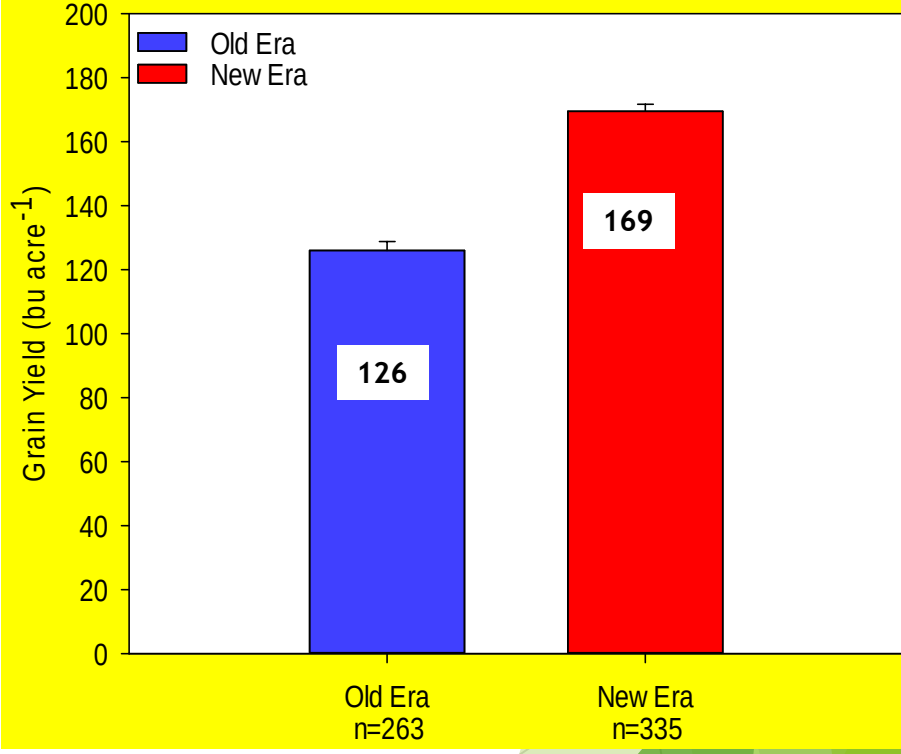
Ciampitti and Vyn (2012, Review Paper, Field Crops Research 133: 48-67)

Higher and Later N Uptake in Modern Corn Hybrids



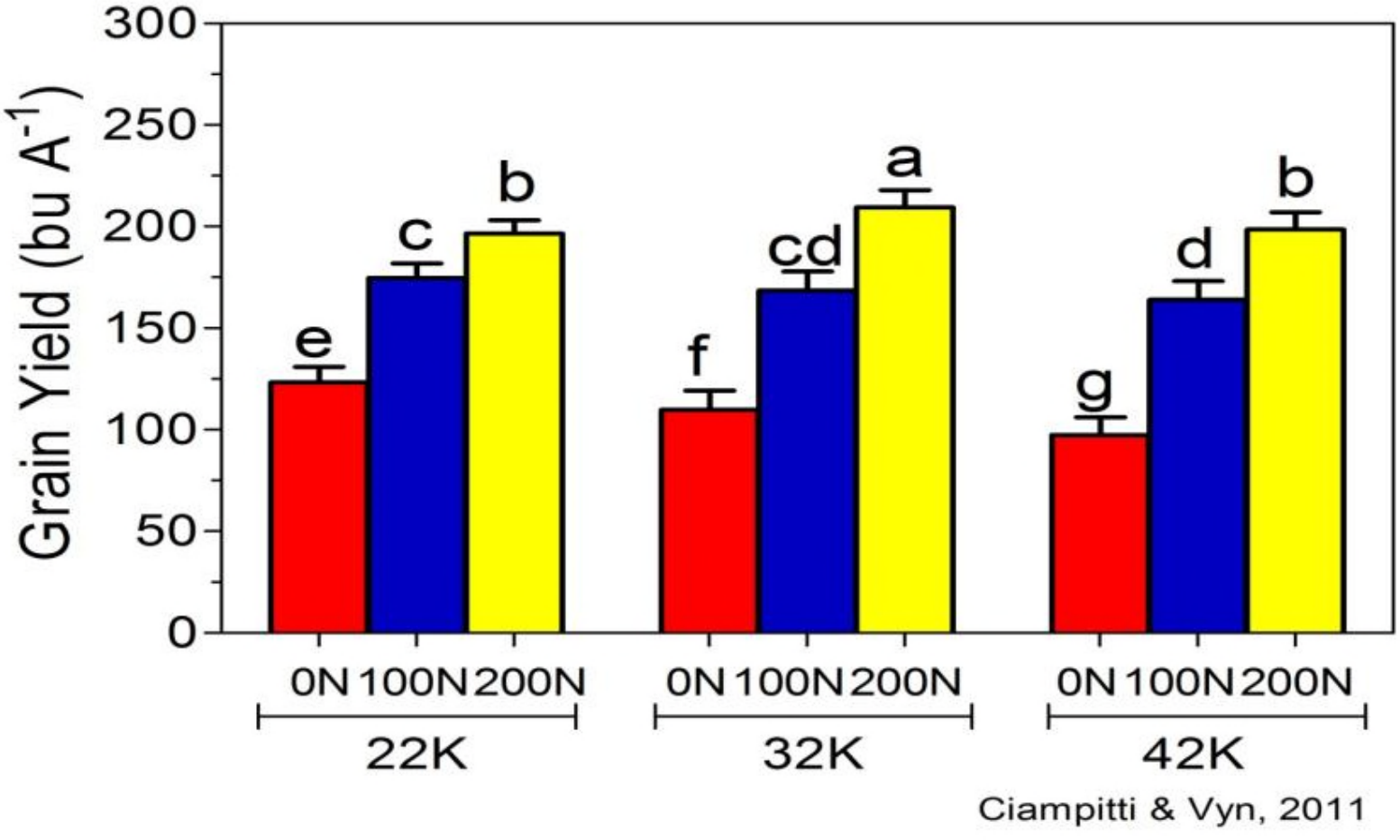
Mean N rates in lbs N acre^{-1}:

151 153



Source: S. M. Mueller and T.J. Vyn 2016 (Frontiers in Plant Science)

Plant Density and N Rate Impacts on Grain Yield (average of 2 hybrids, 2 locations and 2010-2011)



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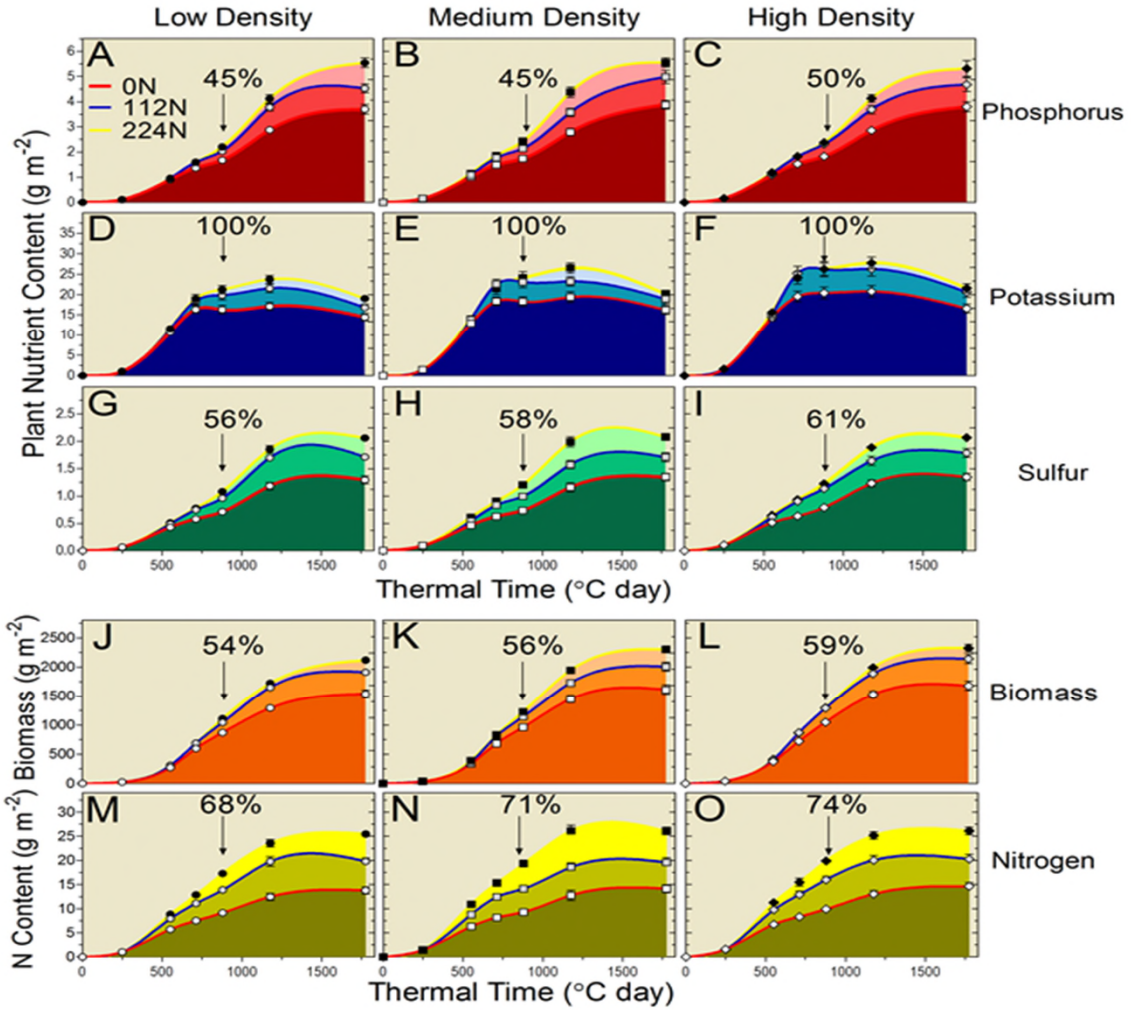
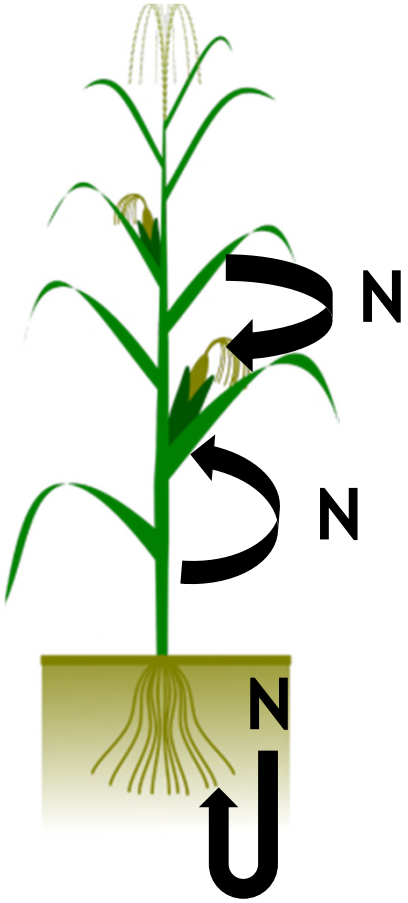
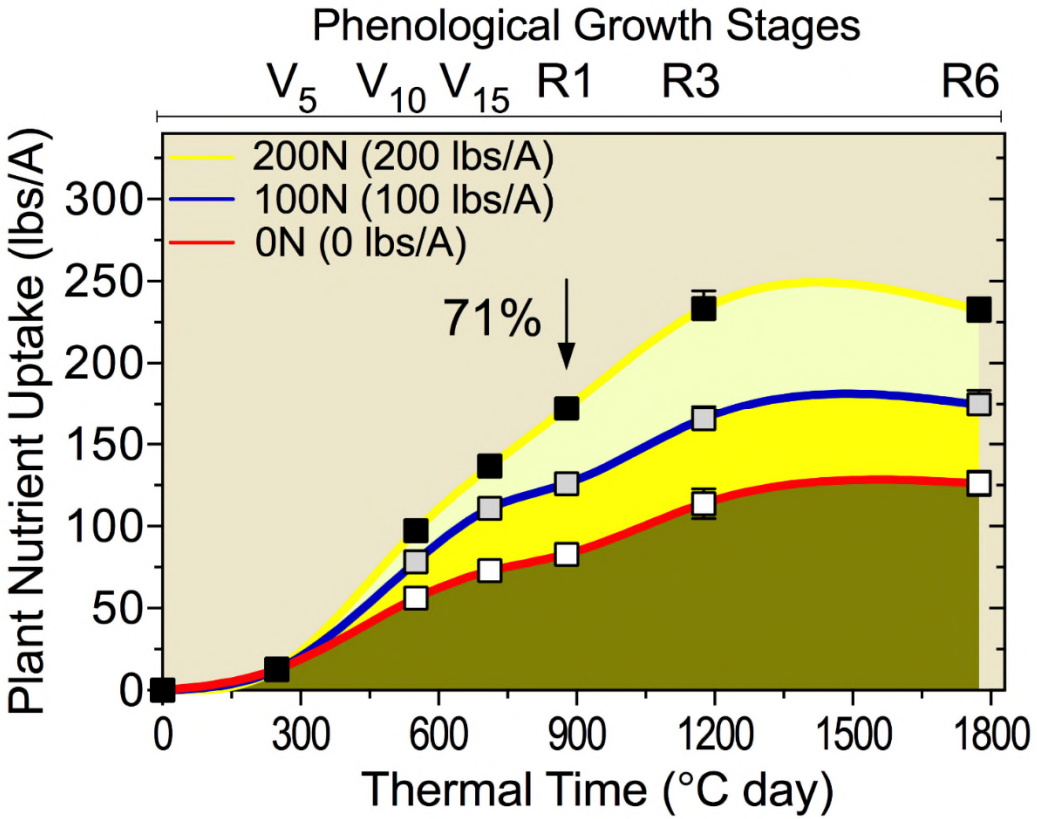
Post-flowering uptake of N,P, K, S in response to plant density and N rates



Source: Ciampitti et al., 2013. Agron. J.

Timing and Source of N Uptake by Plants and Grain

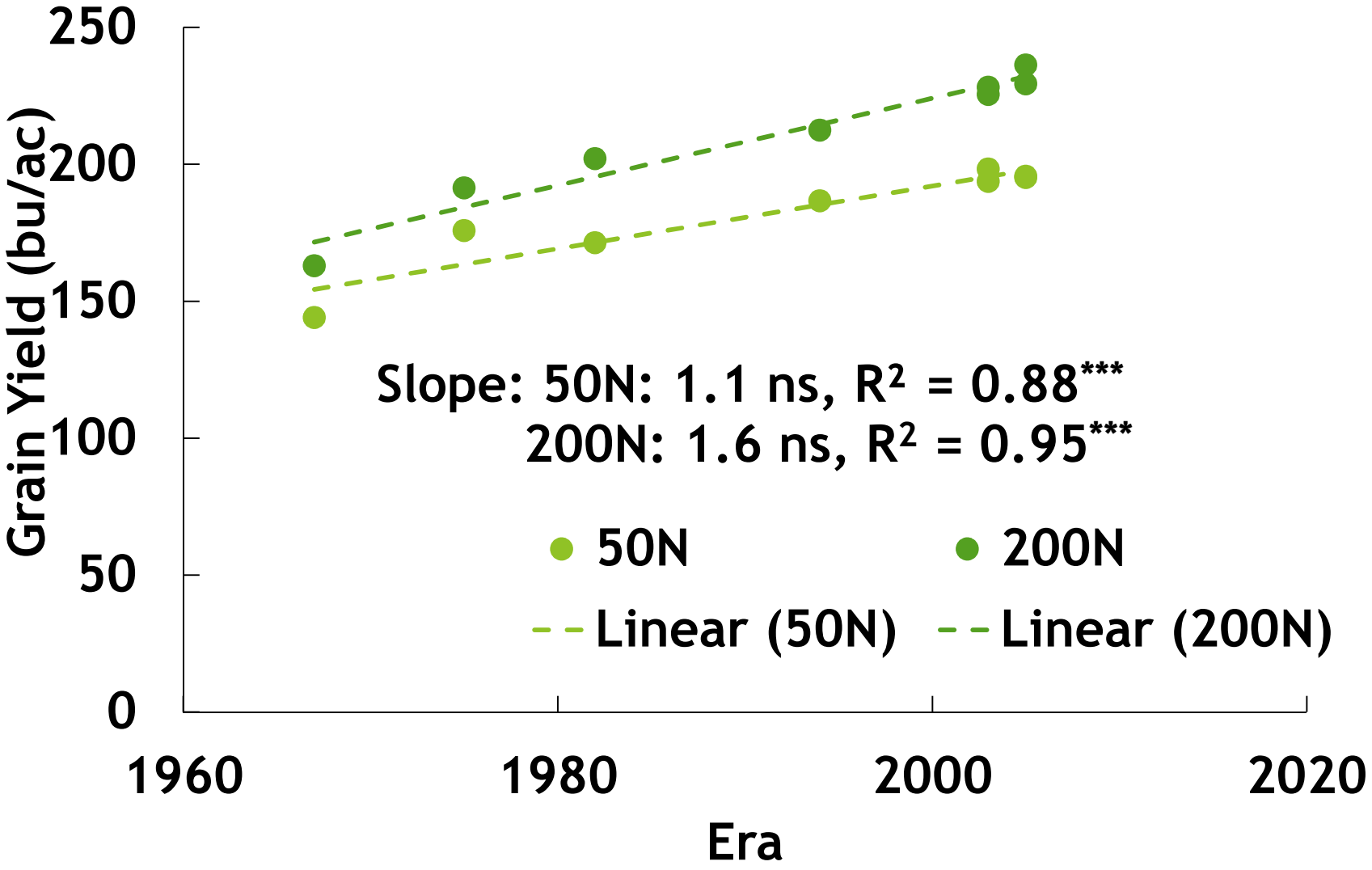




Ciampitti et al., 2013 Agronomy Journal

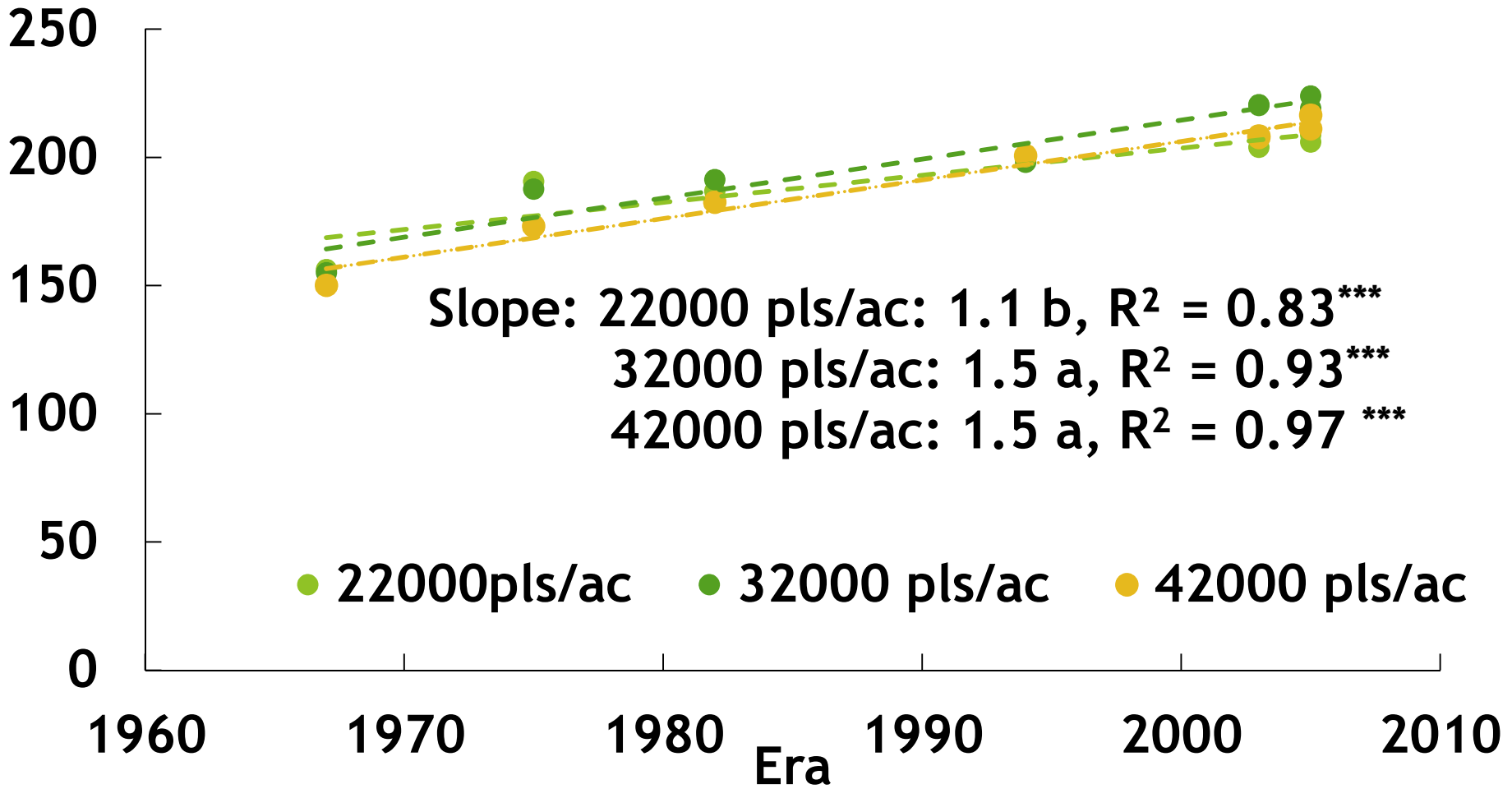
Study of Dekalb Hybrids from 1967 to 2005 and Their Response Changes to Nitrogen and Plant Density Management (2012-2014)

West Lafayette, IN, N rate effect (2013-2014)



Source: Keru Chen et al., Field Crops Research, 2016

West Lafayette, IN, density effect on grain yield response to Dekalb hybrid era (2013-2014)



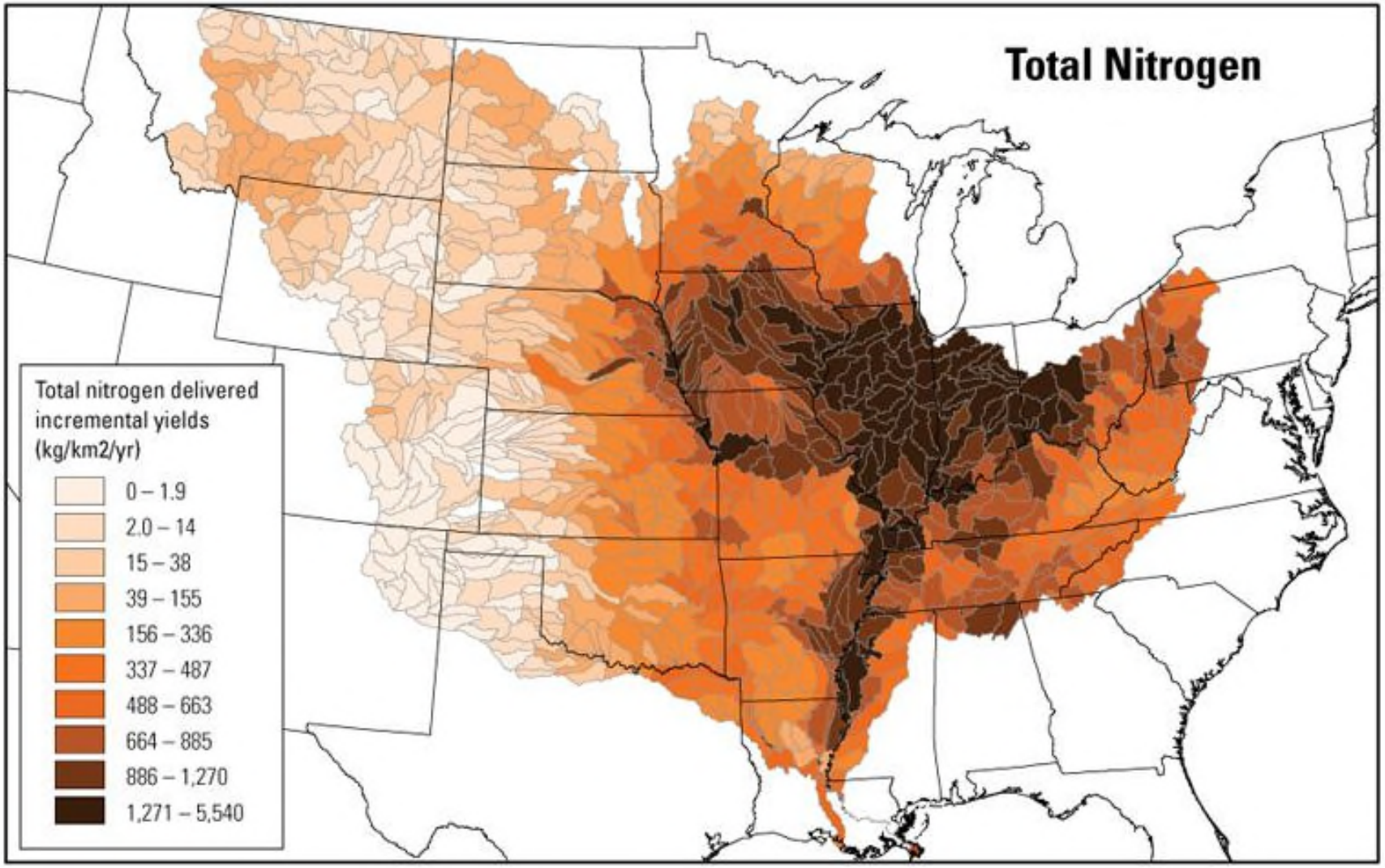
Source: Keru Chen et al., Field Crops Research, 2016

Effects of two "modern" hybrids (2005) versus a common older hybrid (1975) on corn grain yield, total N uptake, and post-flowering stage N uptake when N rate = 200 pounds N/acre

(mean of 3 plant populations from 22,000 to 42,000/acre and 3 site-years in NW + NC Indiana in 2012-2013).

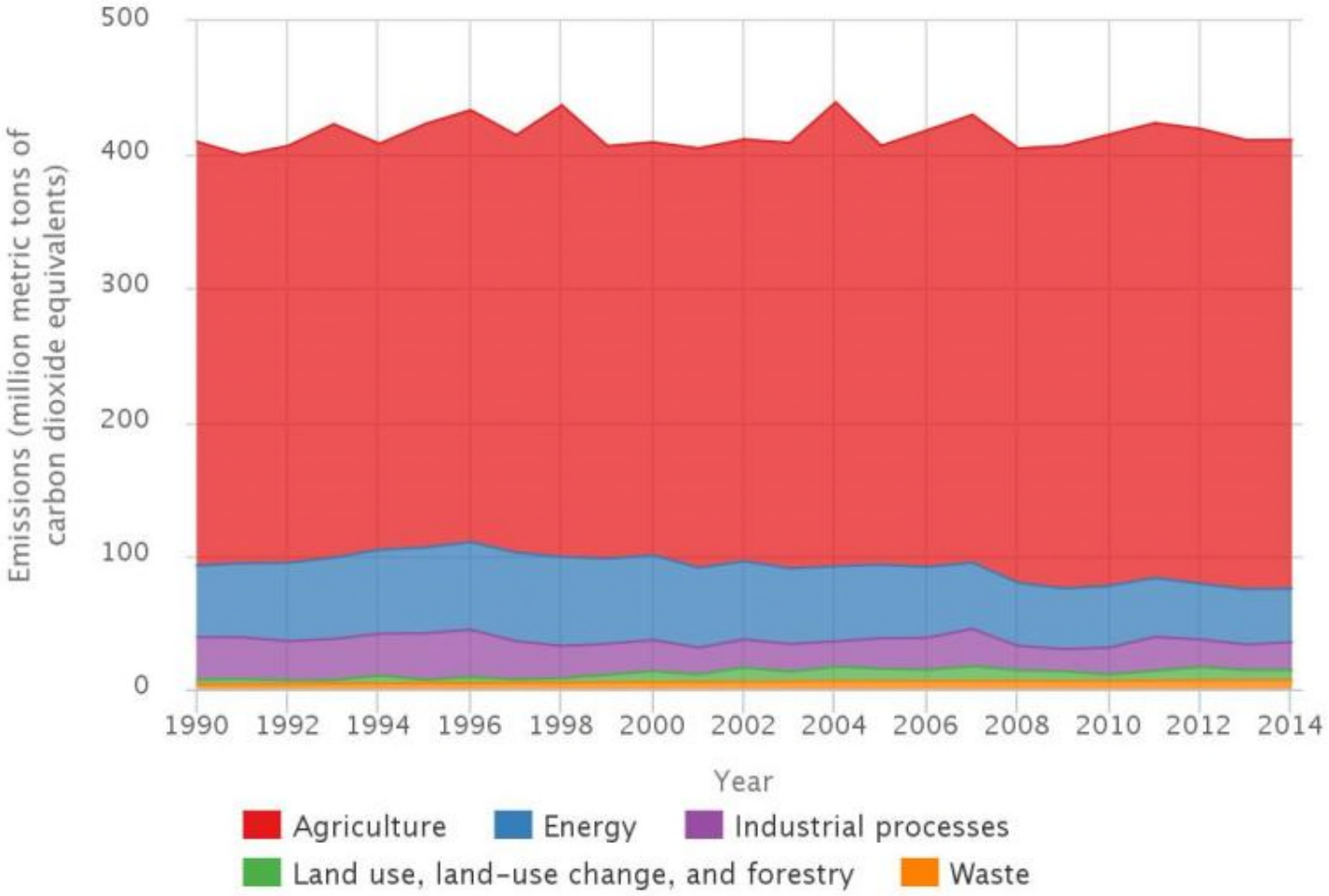
Data Source: K. Chen (Ph.D. Student) & T.J. Vyn

Hybrid (commercial release year)	Grain Yield (bushels/acre)	Total Plant N Uptake (pounds/ac)	Post-silk Plant N Uptake (% of final total uptake)
DKC61-69VT3 (2005)	226	240	37
DKC61-72RR (2005)	225	244	38
DKC XL72AA (1975)	189	203	30



Sparrow Model - USGS

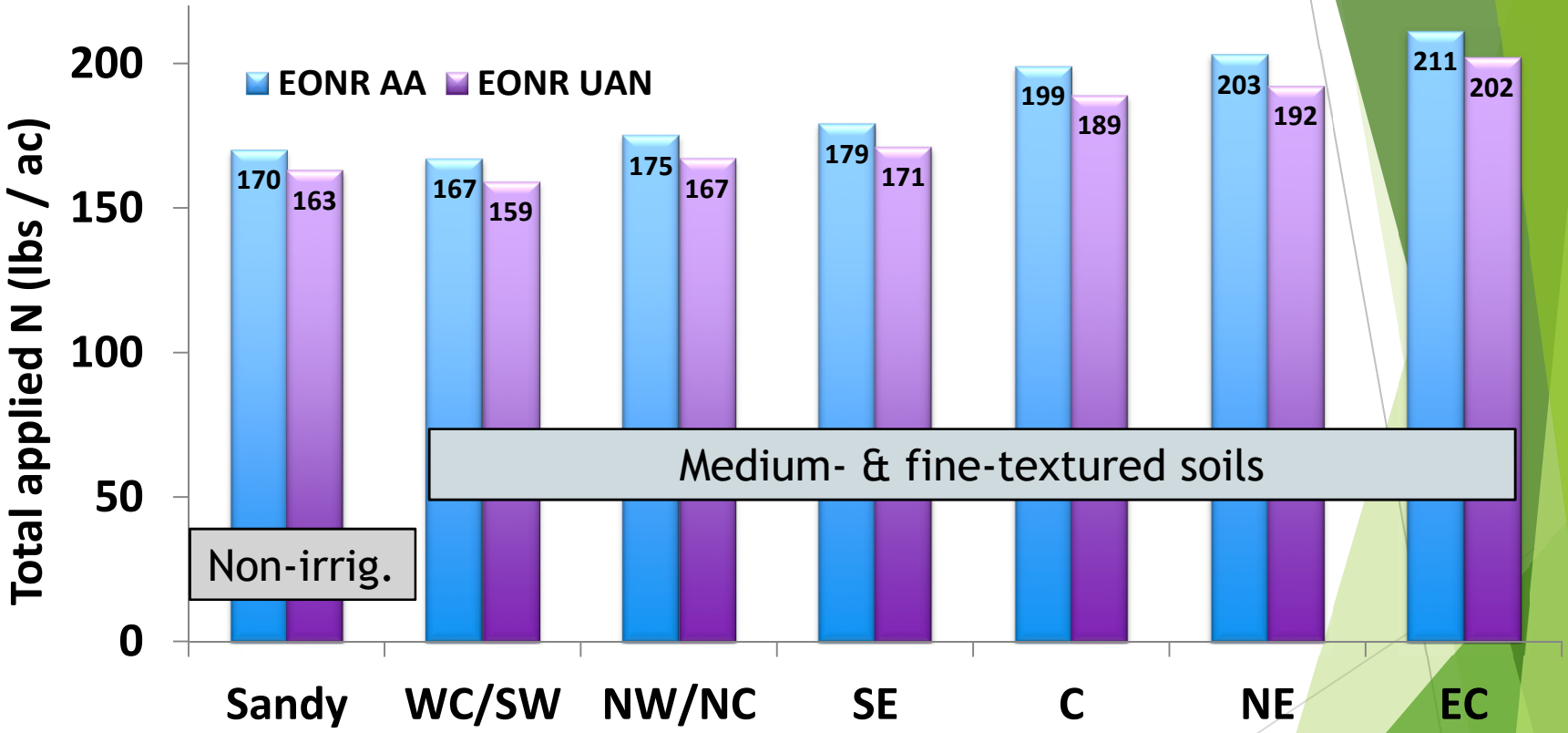
U.S. Emissions of Nitrous Oxide by Inventory Sector, 1990–2014



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2014.
http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

Economic Optimum N Rates for Corn after Soybean in Indiana (Late-spring timing)

Assumptions: AA $565/t or UAN $270/t and $3.50/bu corn



Source: J. Camberato & R. Nielsen, Purdue, ~ 180 trials statewide, 2006 – 2014

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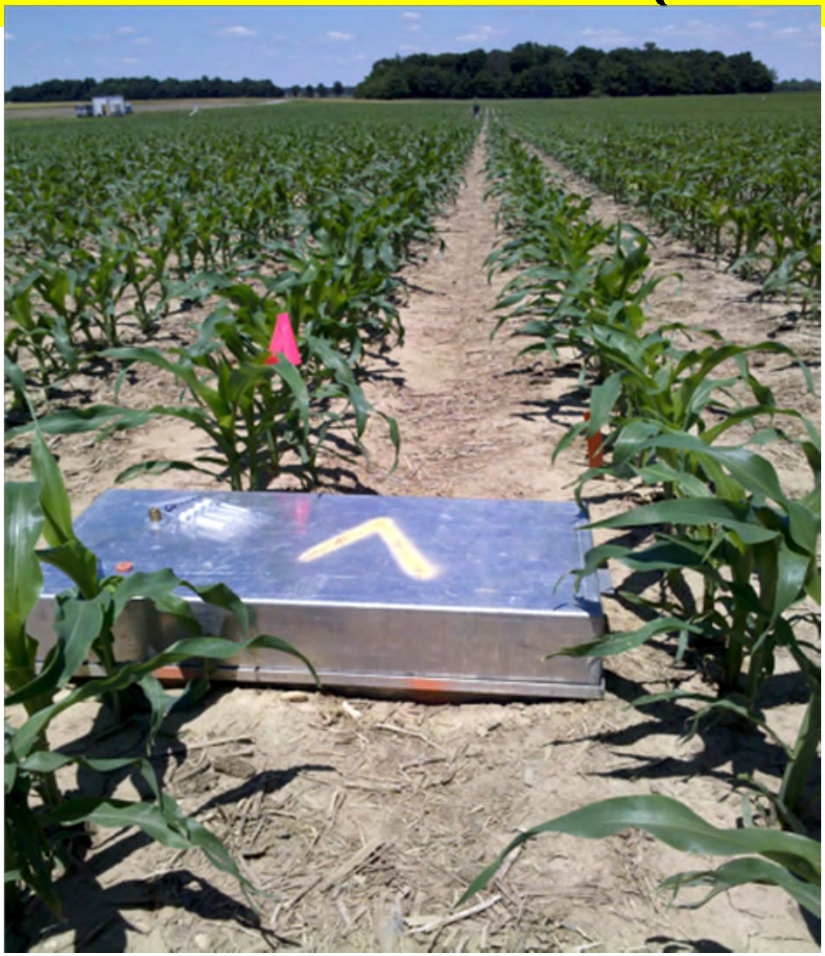
Sidedress UAN and Instinct™ Application (2010-2016)



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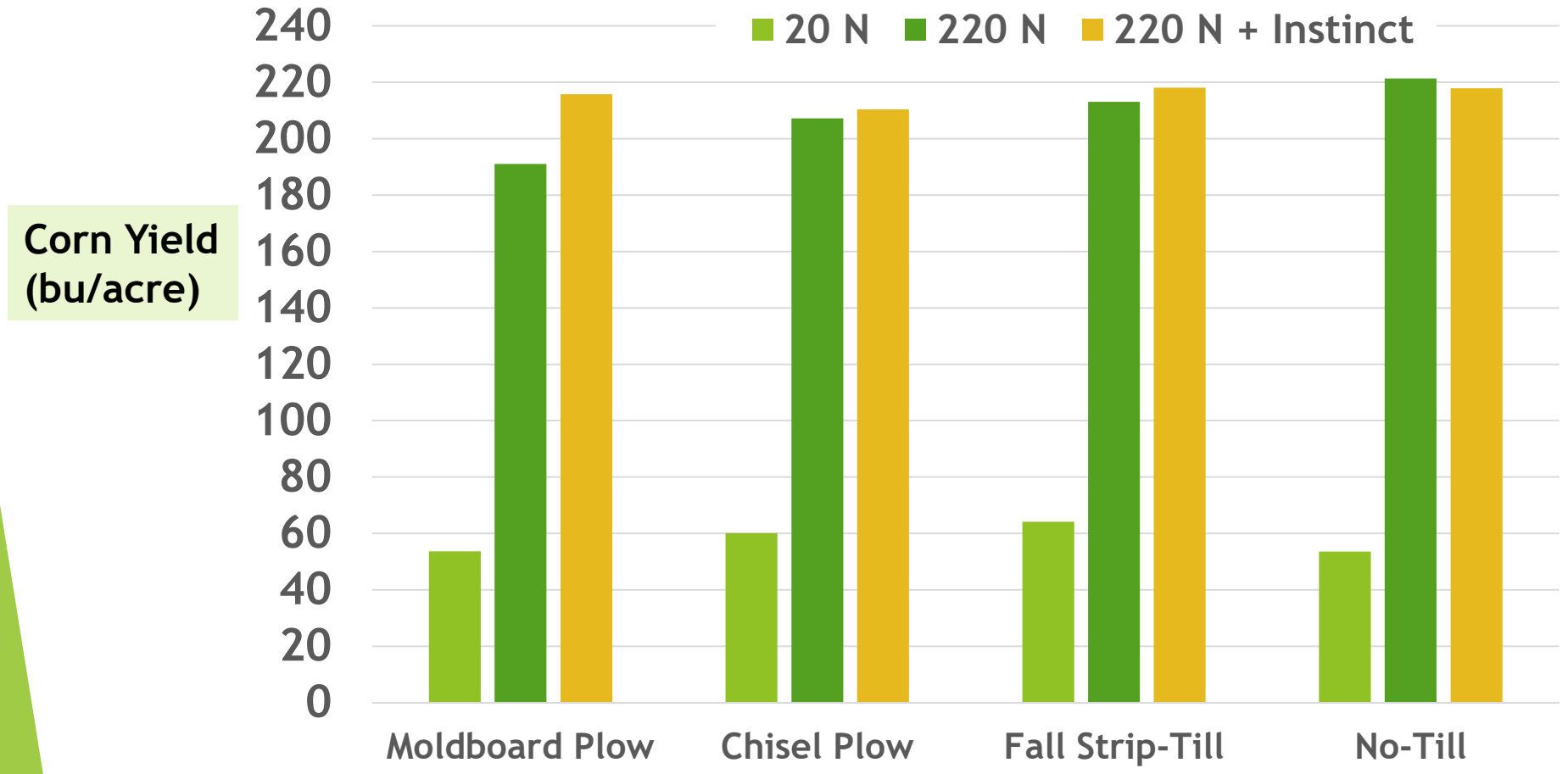
USDA United States Department of Agriculture National Institute of Food and Agriculture

2015 Corn Yield Response to N Rate and Nitrification Inhibitor in 42nd Year of Tillage Systems for a Corn-soybean Rotation (West Lafayette, IN)



2016 Corn Yield Response to N Rate and Nitrification Inhibitor in 43rd Year of Tillage Systems for a Corn-soybean Rotation (West Lafayette, IN)

Global Maize Trial to Compare "Farmer Practice" versus "Ecological Intensification" (2012 – 2016)

1. Farmer Practice + 0 N
2. Farmer Practice + 100 N
3. Farmer Practice + 160 N

(all at 31,000 plants/acre)

1. Ecological Intensification + 0 N
2. Ecological Intensification + 160 N
3. Ecological Intensification + 160 + 60 N

(all at 38,000 plants/acre, plus Instinct®II nitrification inhibitor and ThioSul since 2012, and Aspire® in 2015-2016)

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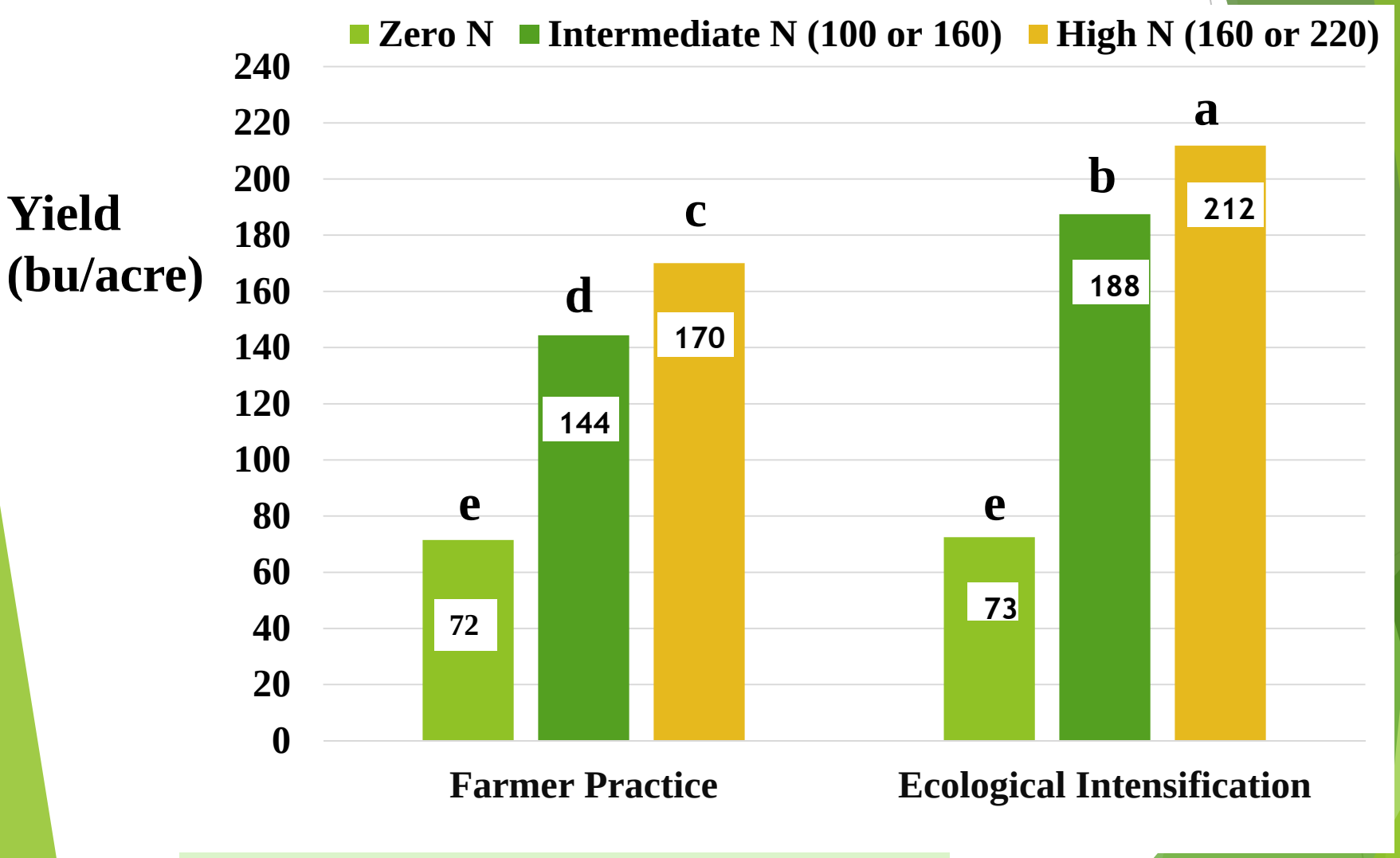
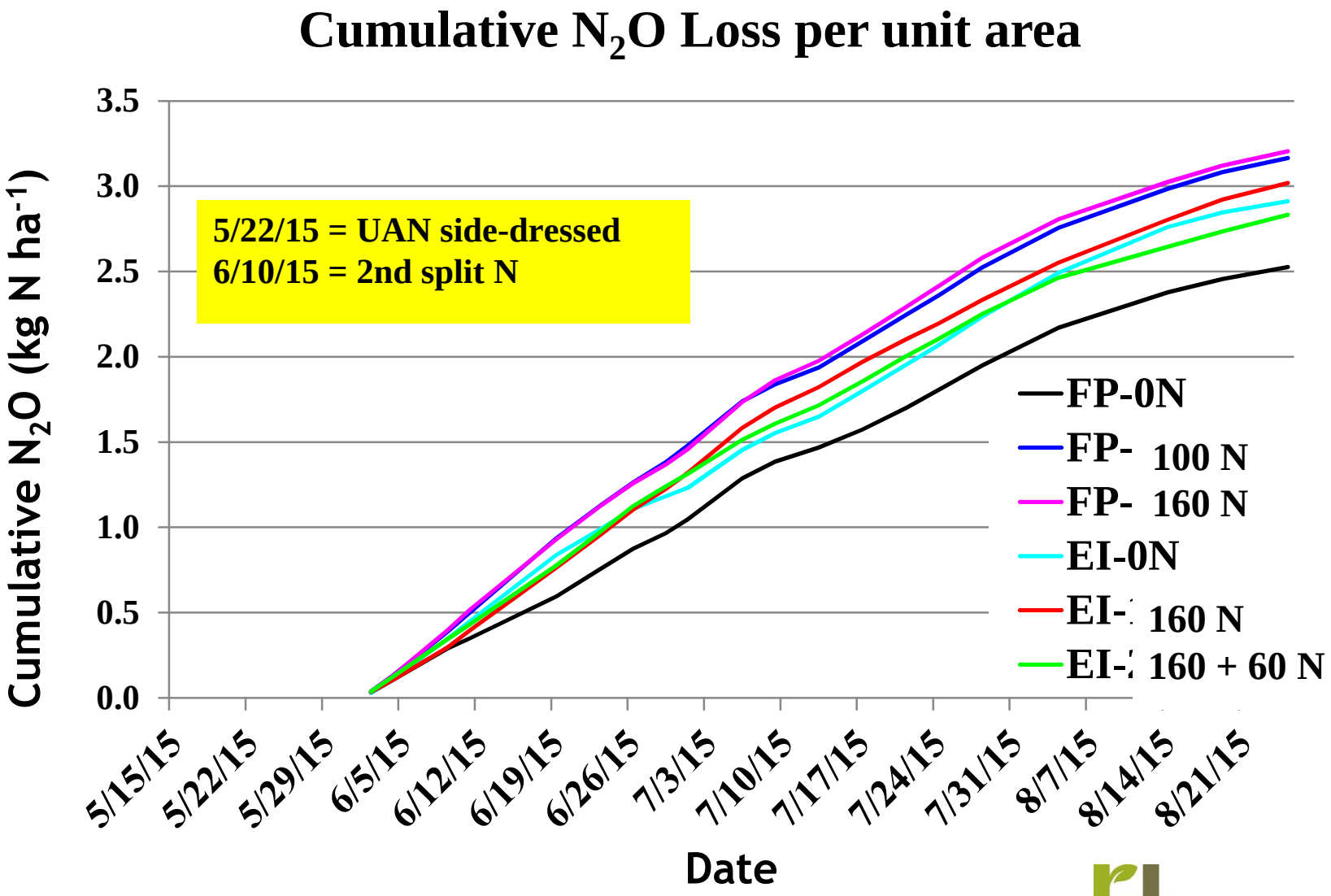
Grain Yield Response to Ecological Intensification Management in 2015 (West Lafayette, IN)



Source: Vyn, West and Omonode, 2016, unpublished

Cumulative Seasonal N_2O Loss from E.I. Approach to Corn Management in 2015 (West Lafayette, IN)



Source: Omonode and Vyn, 2016, unpublished

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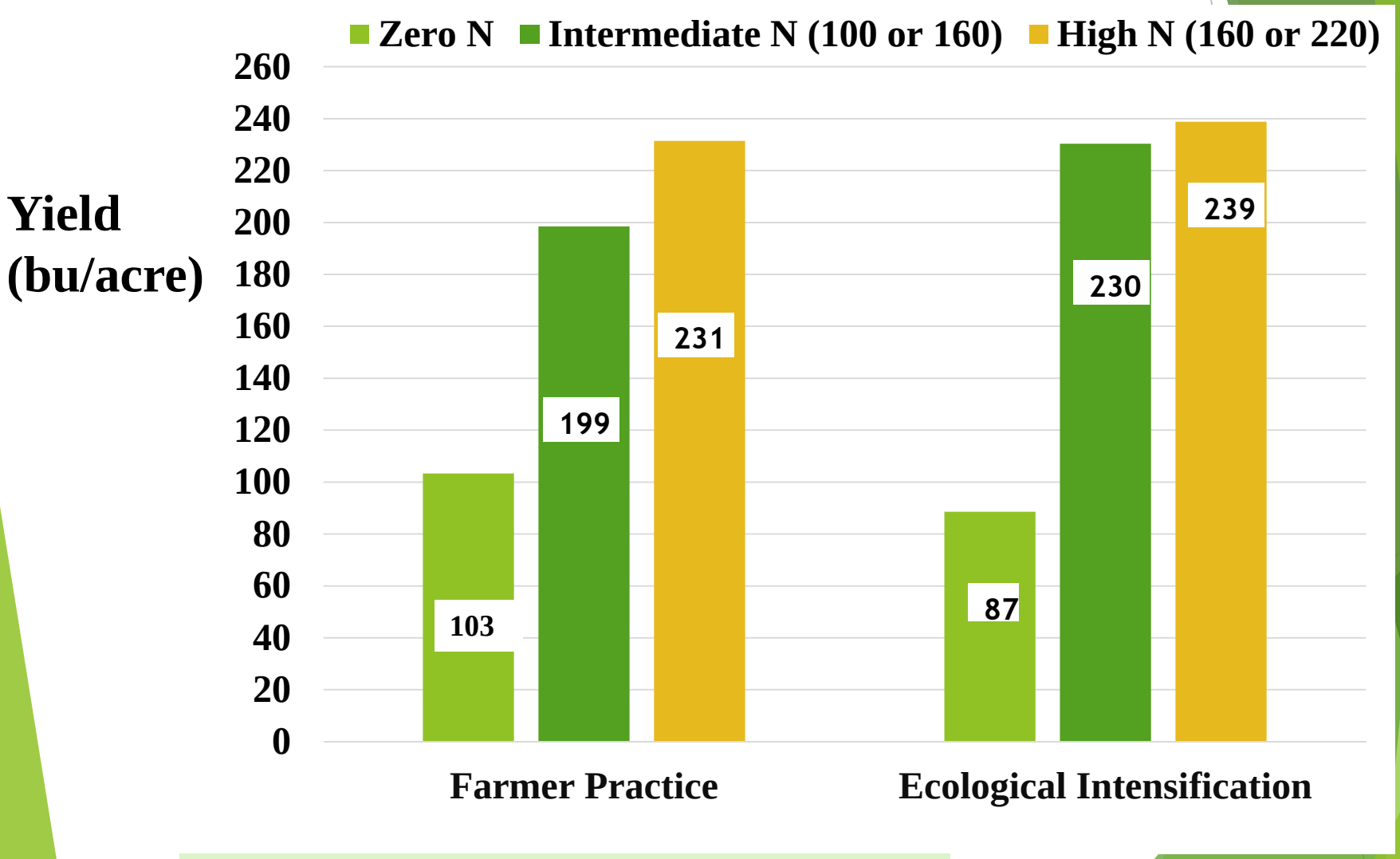
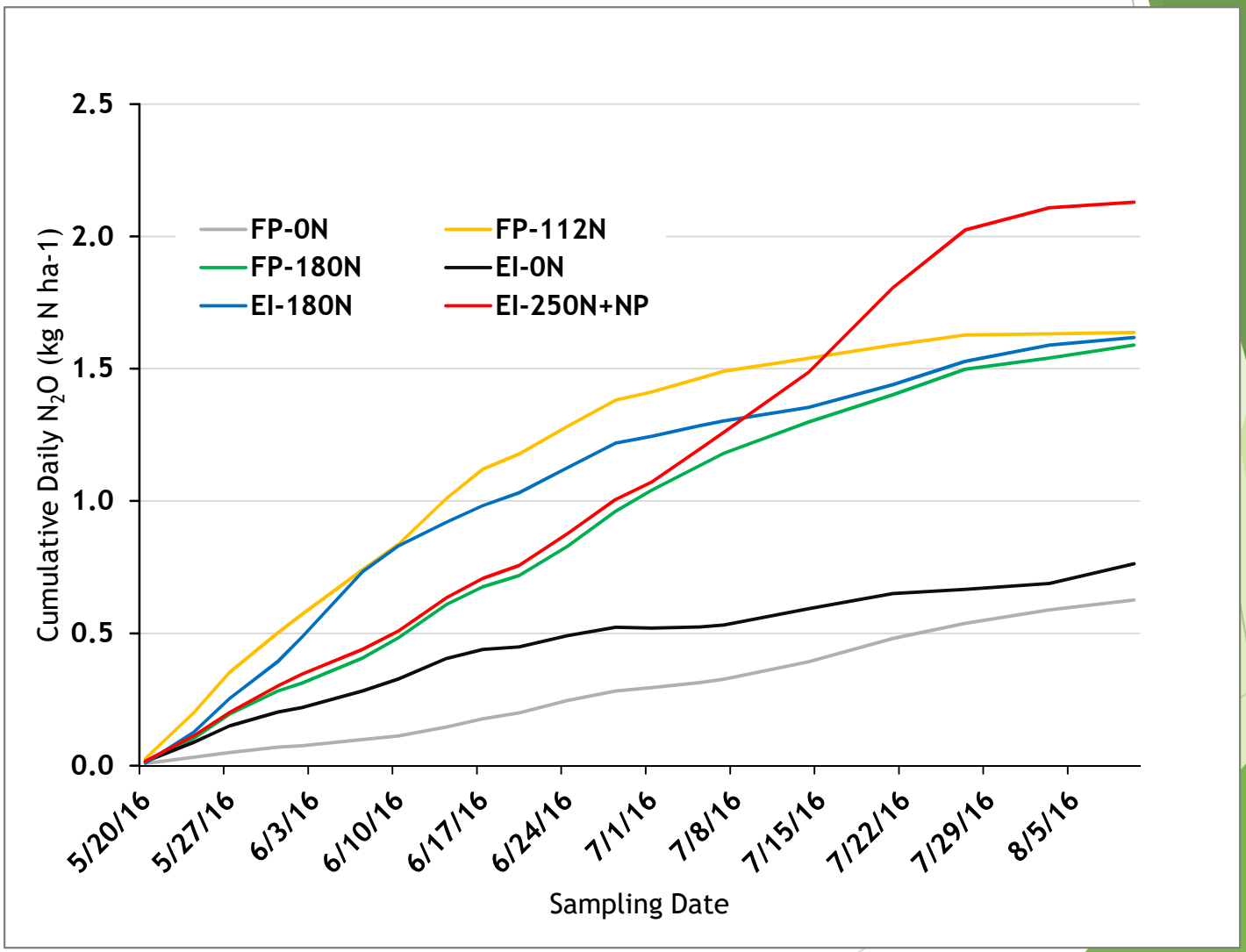
Grain Yield Response to Ecological Intensification Management in 2016 (West Lafayette, IN)

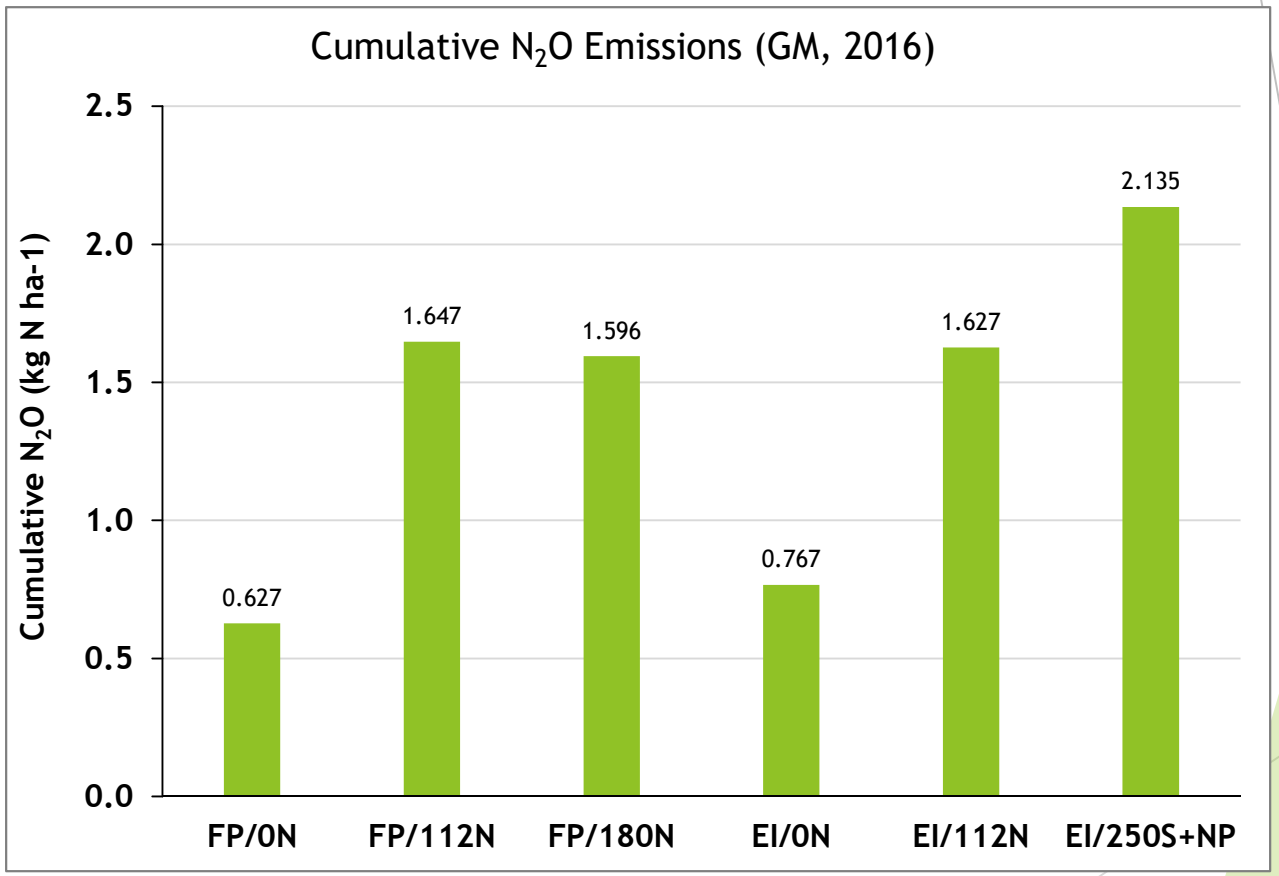


Source: Vyn, West and Omonode, 2016, unpublished

Time trend in accumulating N_2O losses in 2016



Cumulative N_2O Losses to date in 2016



What About Late-Season N?


Photo by Mike Shuter, 2014

Are there greater yield and economic benefits from “late” nutrient applications with modern hybrids and higher plant densities?

“Rescue N” versus “Late-Split N”

- **Rescue N means adding more N fertilizer after the entire N rate has already been applied because of excessive N loss**

- **Late-split N means intentionally delaying application of the last 20-30% of total N to after the V10 stage, but usually before R1 stage. It may be variable rate applied.**

Late-Split N Applications with Older versus "Modern" Pioneer Hybrids (2014-2016)

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Methodology

Main Treatment: N rates

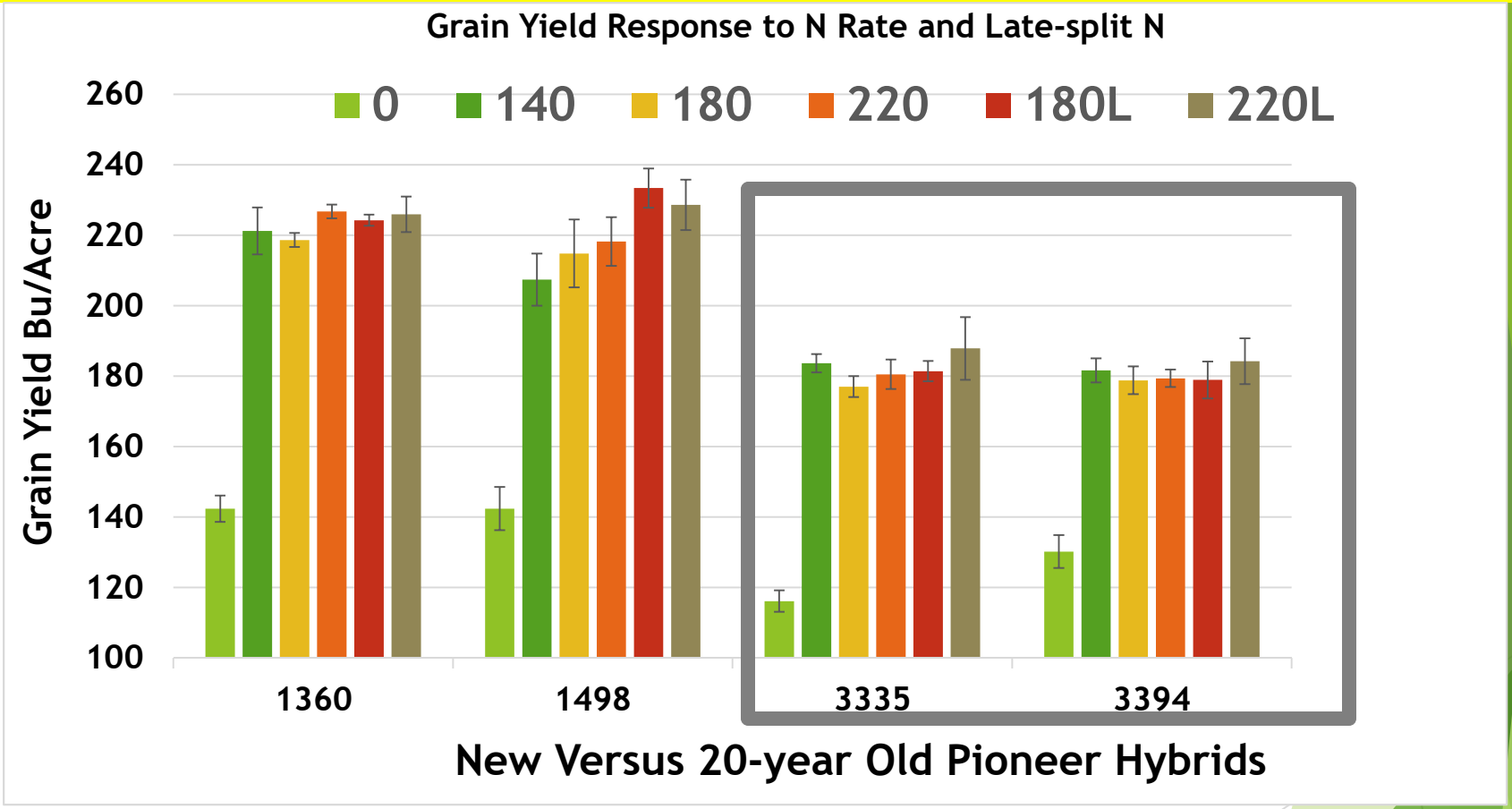
Treat. Name	Lbs N V3-V4	Lbs N V12-V14
0	0	
140	140	
180	180	
220	220	
180S	140	40
220S	180	40

Sub-Treatment: Hybrid (Release year)

1. Pioneer 3394 (1991)
2. Pioneer 3335 (1995)
3. Pioneer 1498 HR (2012)
4. Pioneer 1360 HR (2014)


Miller

Corn Yield Response to N Rate and Late-Split N in 2014 (Wanatah, IN)



32,500 plants/acre

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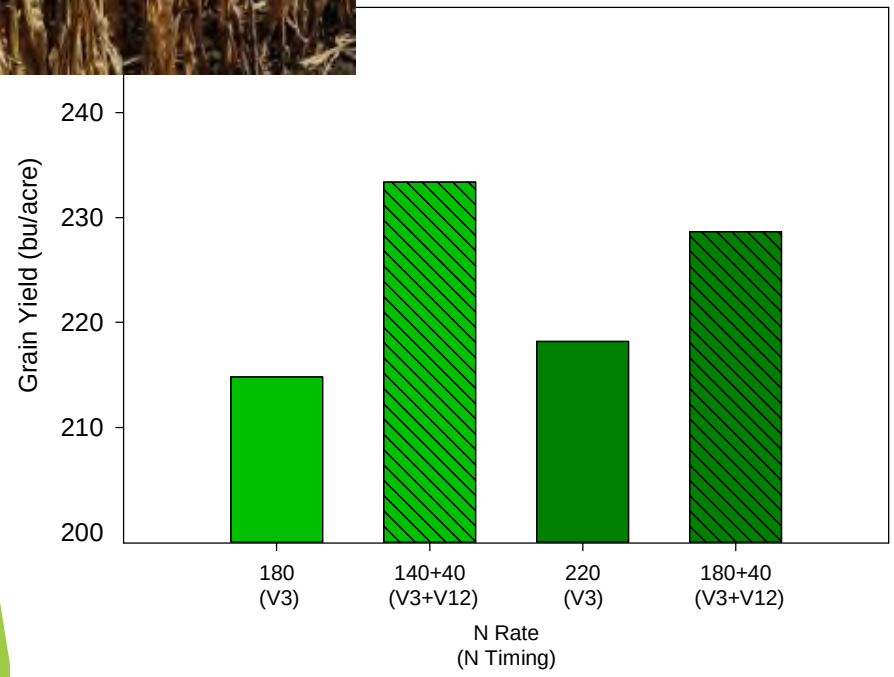
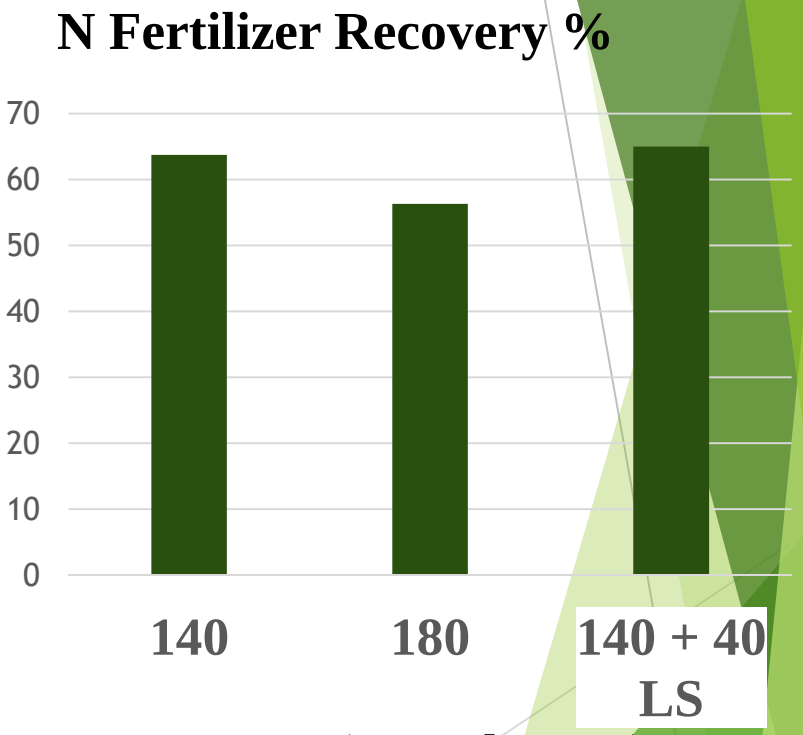
Preliminary Corn Yield and N Uptake Responses to Late-Split N in 2014-2015

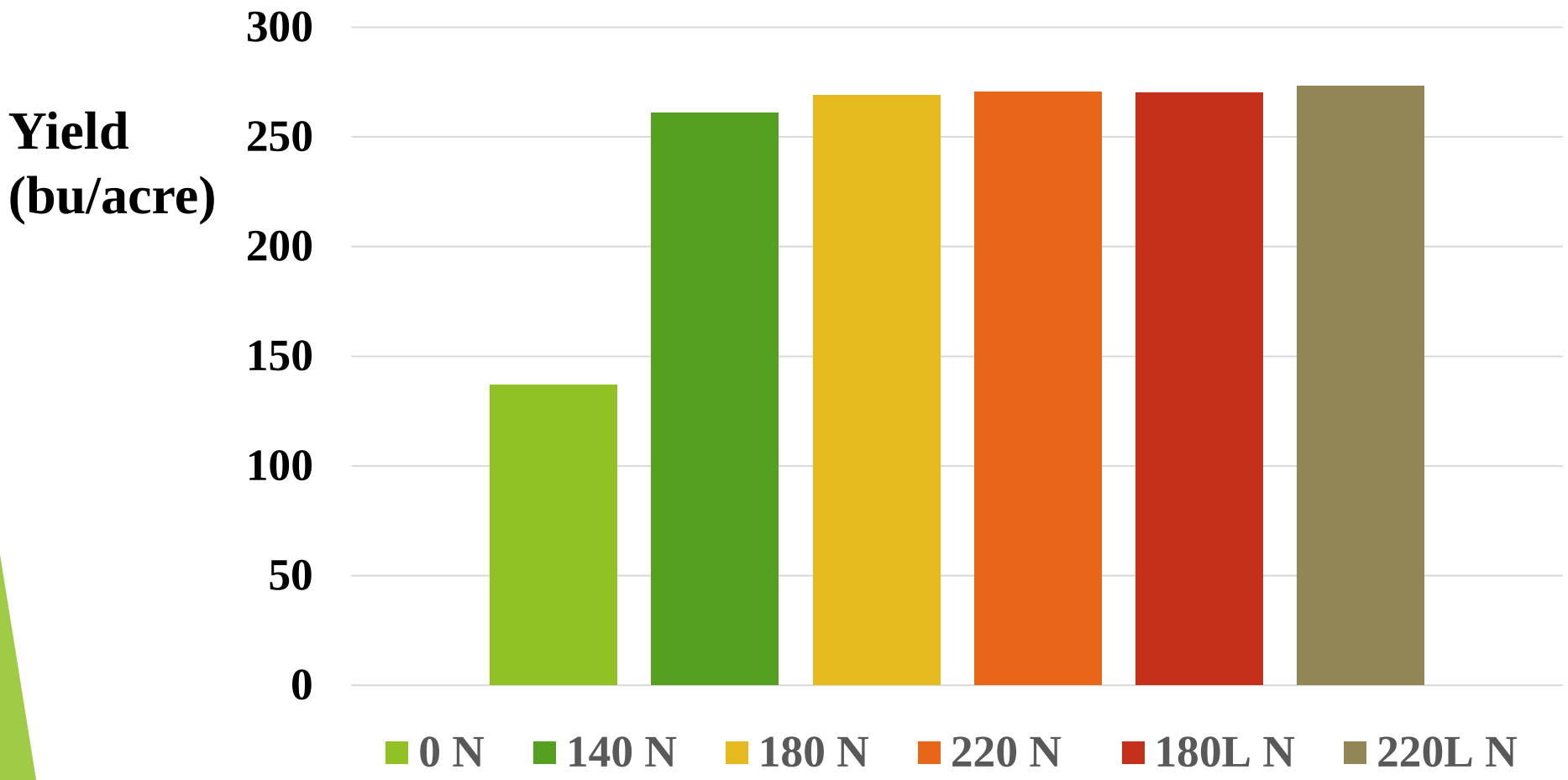


S.M. Brooks and T. J. Vyn, 2014, unpublished
1 hybrid (P1498), 1 location



S.M. Brooks and T. J. Vyn, 2016, unpublished
Average of 4 hybrids

“Late-split N” Response with Pioneer 1360 in 2015



Hybrid Recovery of Late-Season N Applications?

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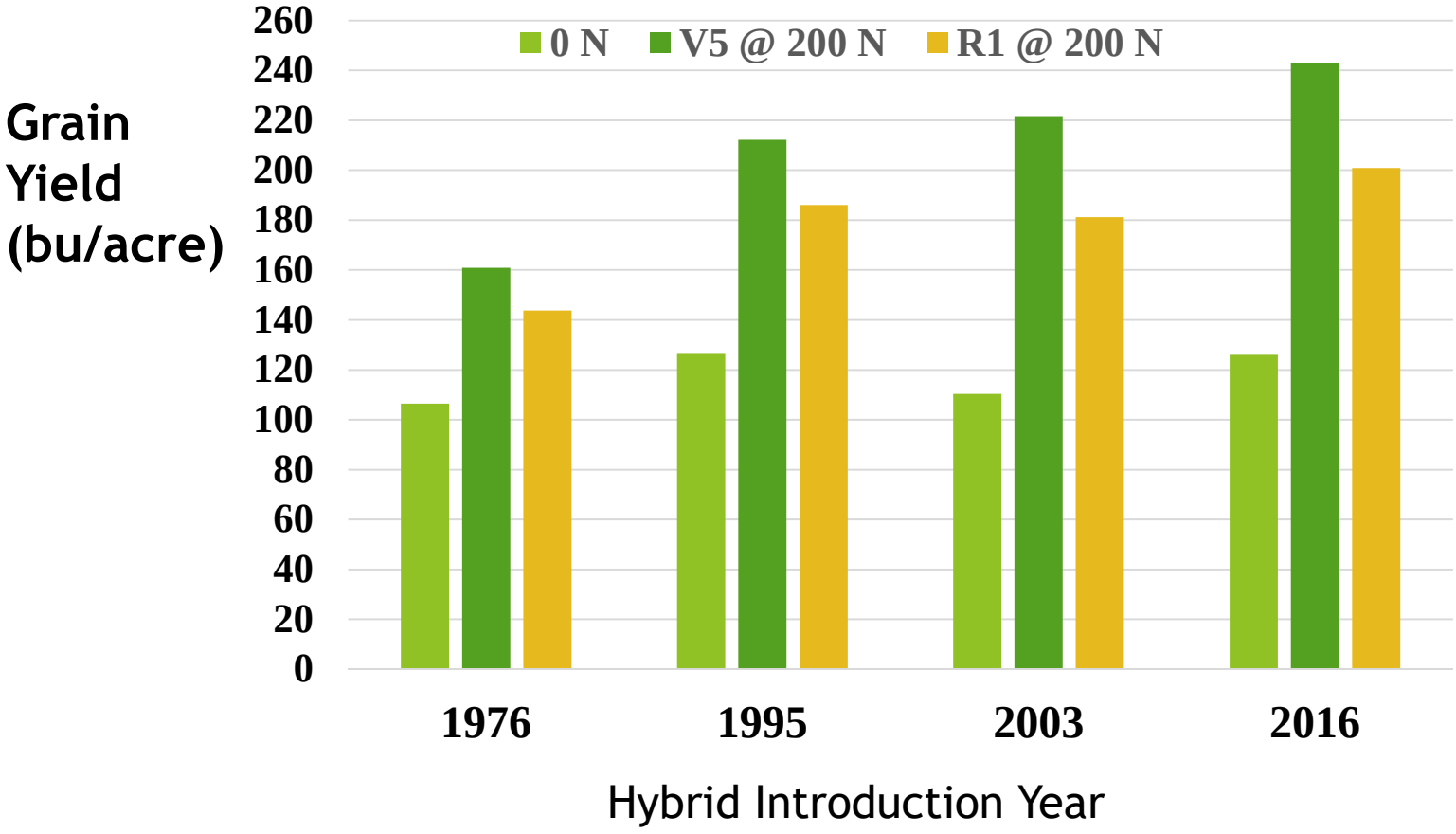
Pioneer Hybrid Yield Resiliency in Response to UAN applied at the R1 stage versus the V5 stage (West Lafayette, 2016)

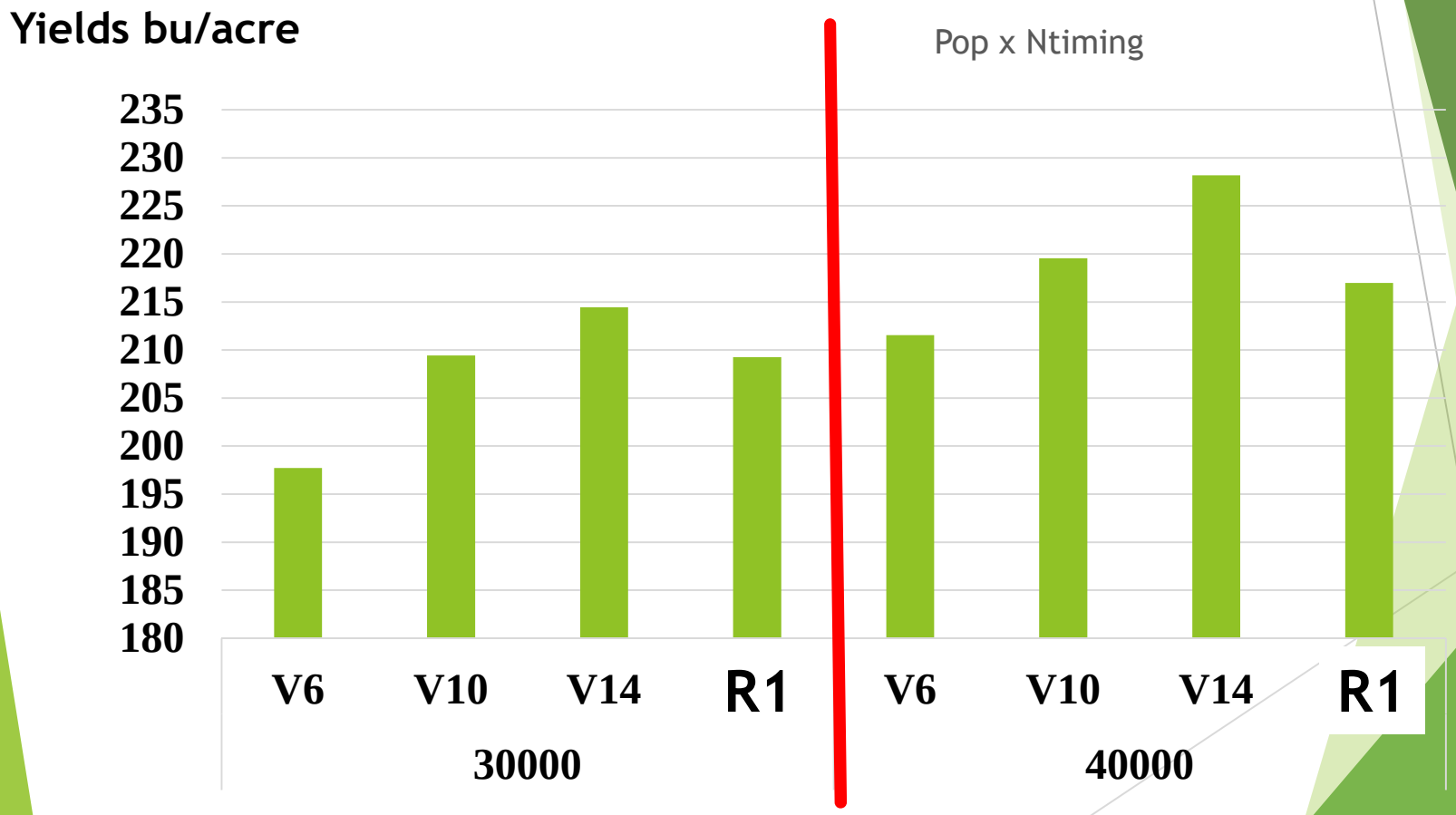


Source: Mueller and Vyn, unpublished, 2016

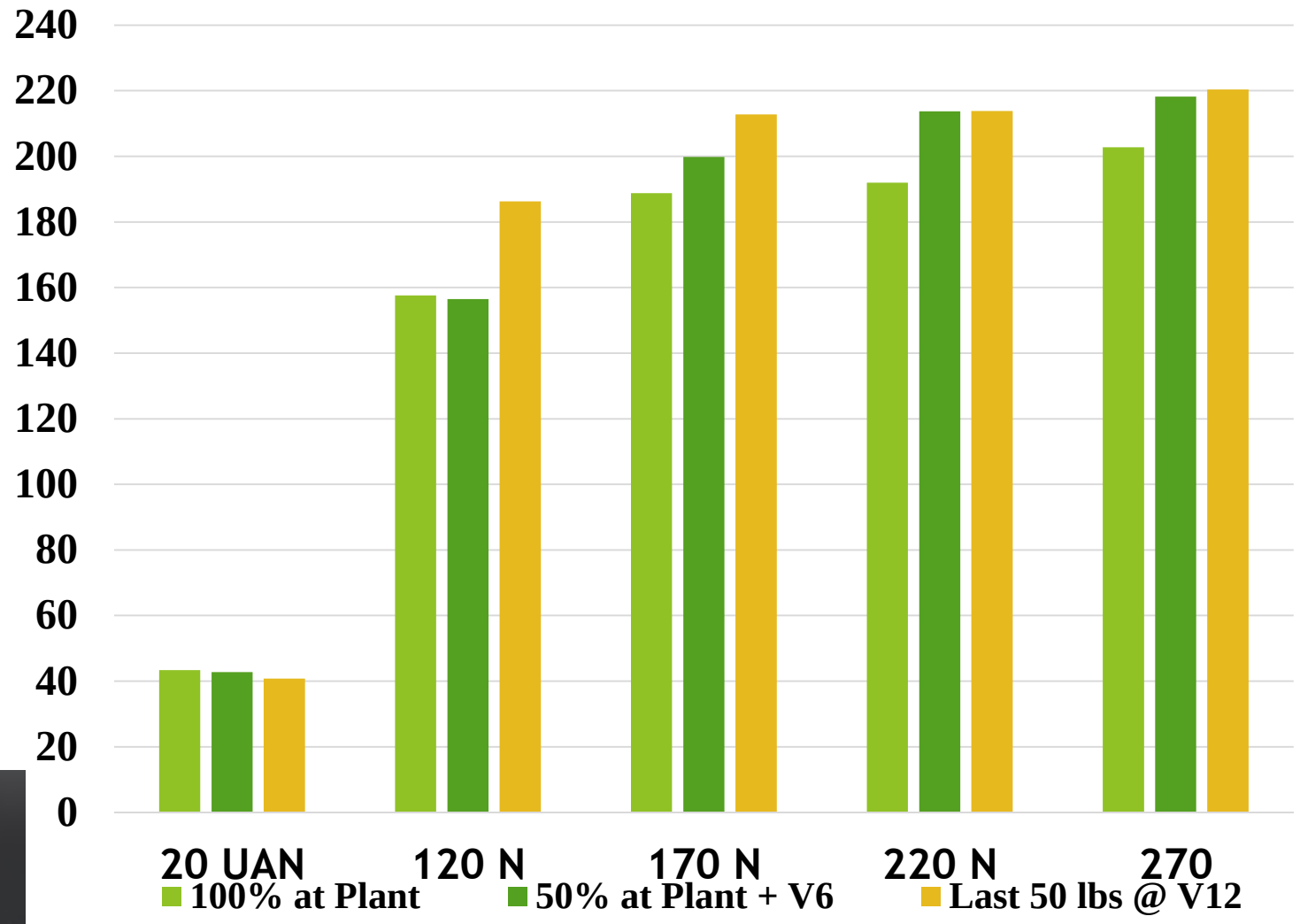
Fertigation N Opportunities?

Timing of last N application (50 pounds/acre) in Irrigated Corn

(mean of P1498 and P1360 at 2 populations in 2015)



Nitrogen Timing in Continuous Corn on Irrigated Sandy Soil (LaCrosse, IN) with DKC66-42 in 2016



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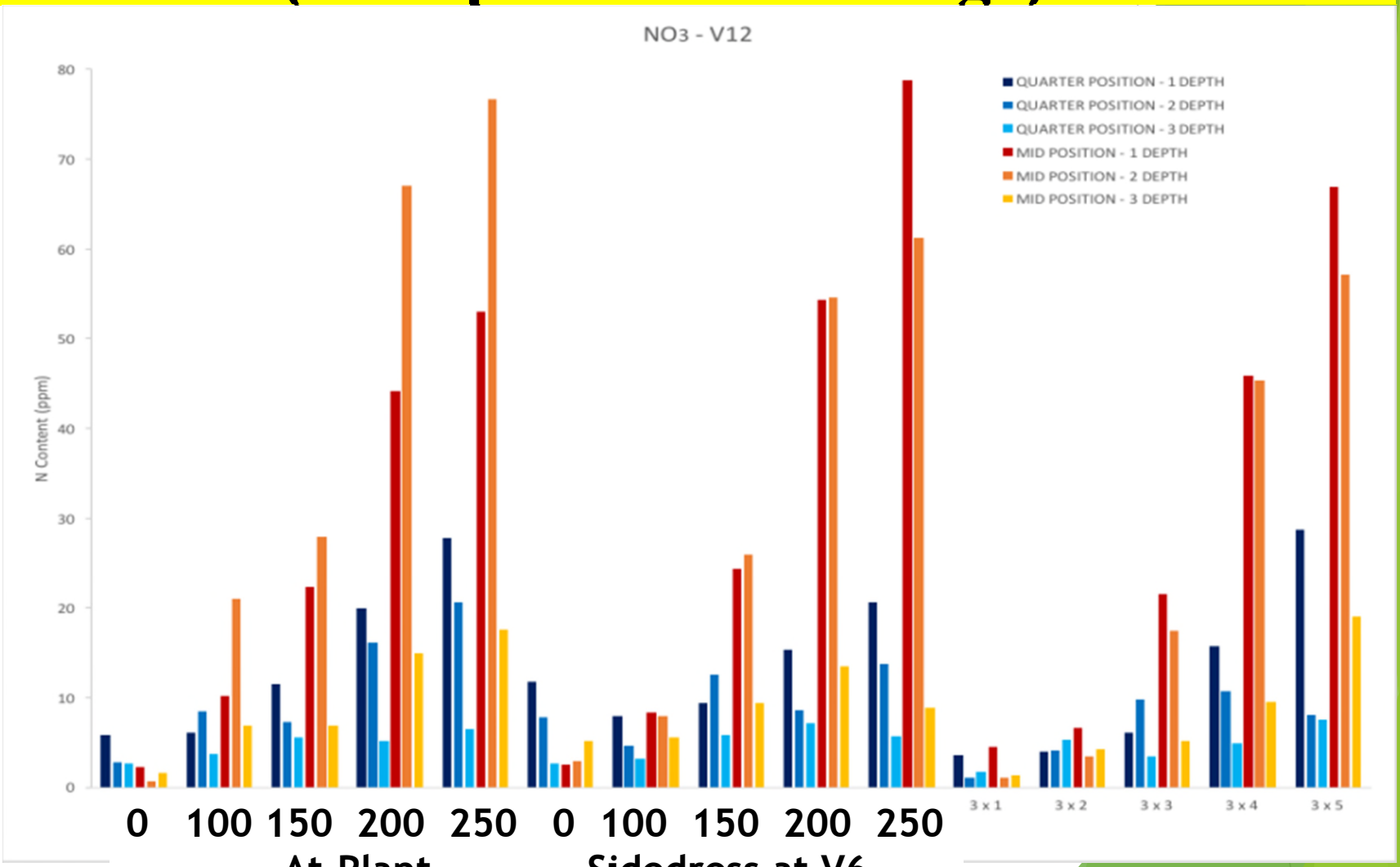
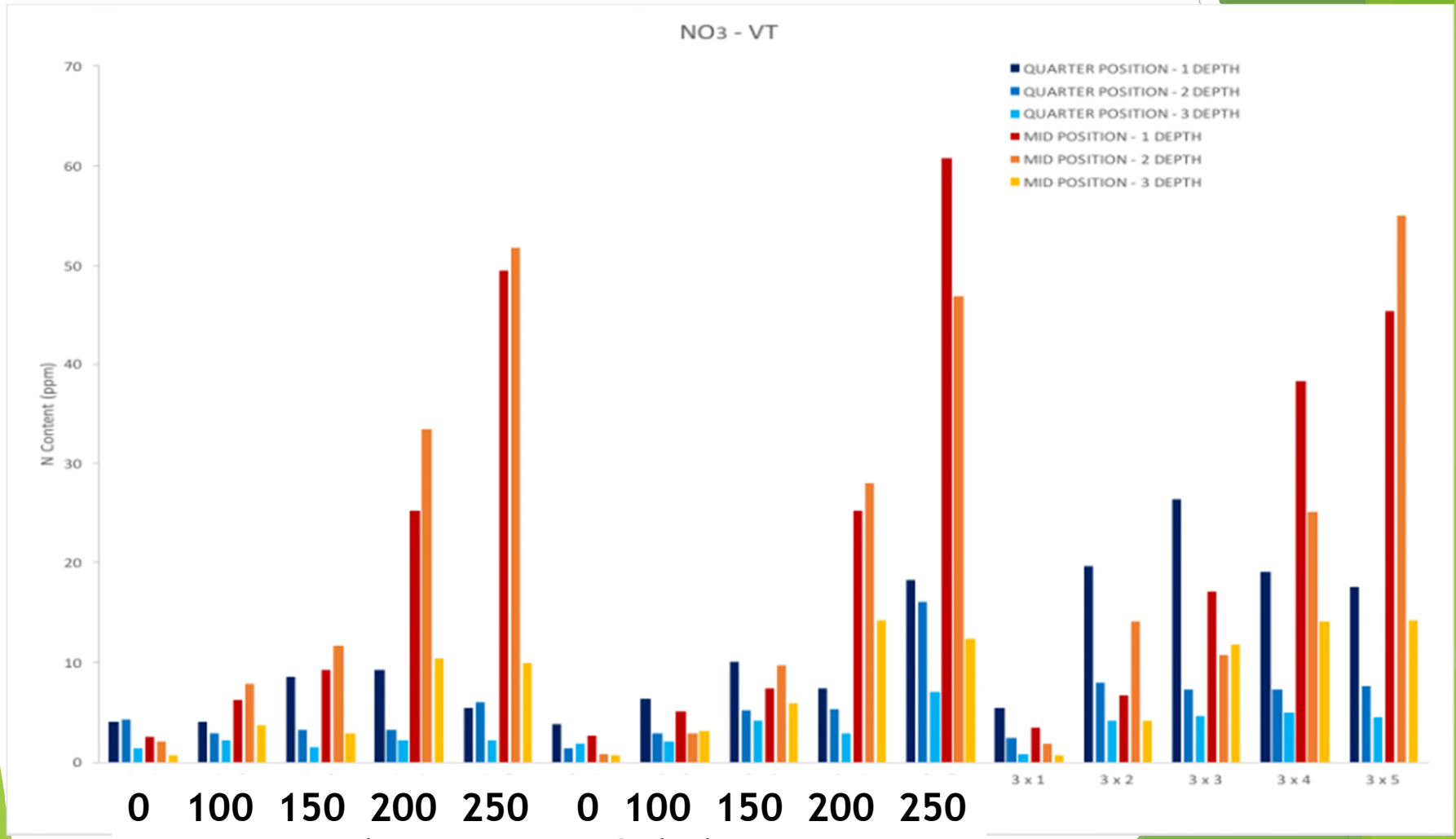
In-season Soil Sampling for NO_3 and NH_4 after banded N applications virtually impossible! (example from V12 stage)



In-season Soil Sampling for NO_3 and NH_4 after banded N applications virtually impossible! (example from VT stage)



On-farm Studies with Intentional Late-Season N applications of 30 to 50 pounds

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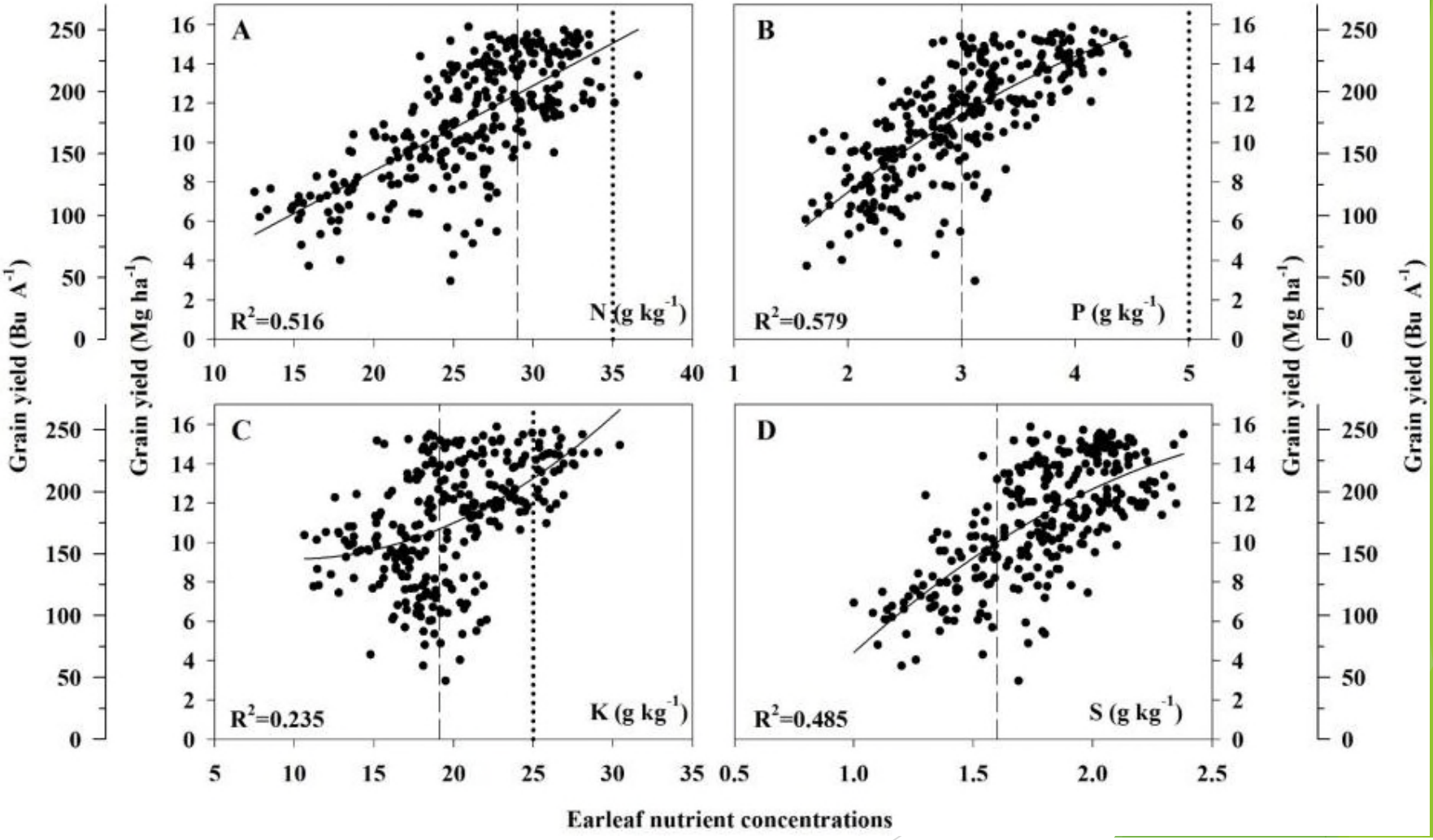
Recent Corn Yields Relative to Ear-leaf Sufficiency Levels for N, P, K, and S



P. Kovacs and Vyn, unpublished

Conclusions

- **Modern hybrids take up more total N at the same N rates, and more post-silking than old hybrids, so there could be more yield and N efficiencies to gain with late split N.**
- **More rate/timing etc. research needed on intentional late-split N applications and multiple-position nutrient placement to increase nutrient availability over the critical uptake periods.**
- **We need more research focus on plant nutrient availability in soil to late season corn growth (nutrient rate, efficiencies, timing, ...).**

Acknowledgments

Funding:

Indiana Corn Marketing Council
Dupont-Pioneer
Dow AgroSciences (2009-)
4R Nutrient Stewardship
The Mosaic Company
Monsanto Company

Equipment:

John Deere Cropping Systems Unit

Seed:

Pioneer Hi-Bred, Int'l.
Monsanto
Dow AgroSciences


Questions?