Maximizing Yield While Minimizing Nitrate Loss

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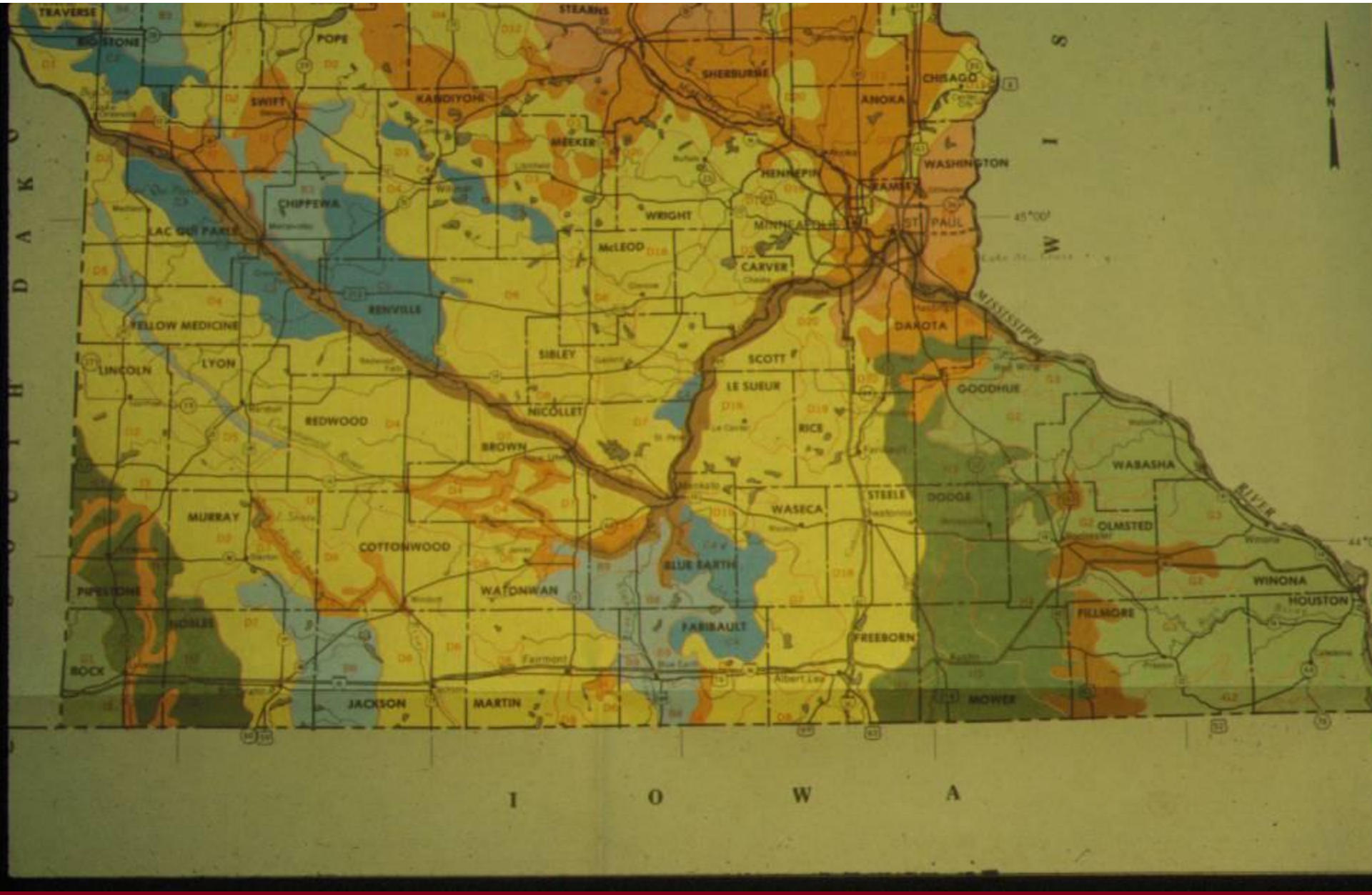
Nitrogen

- Required at higher rates than any other nutrient for optimizing corn yield and profitability
- More than 600,000 tons of N are applied for corn each year in Minnesota.

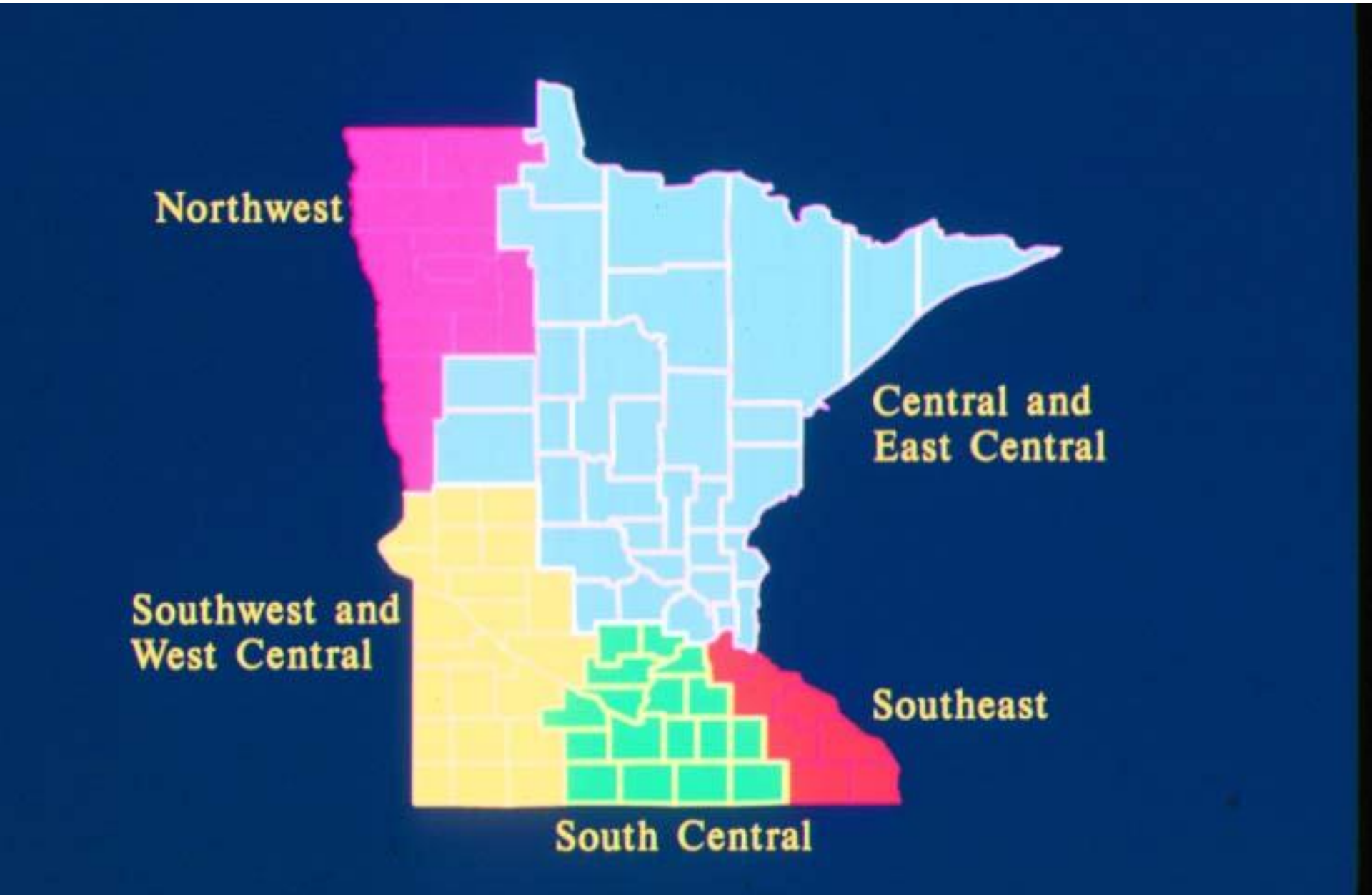

TRAVERSE
BIG STONE
POPE
STEARNS
SHERBURNE
CHISAGO
ANOKA
SWIFT
KANDIYOHI
MEEKER
WASHINGTON
HENNEPIN
RAMSEY
CHIPPEWA
WRIGHT
MINNEAPOLIS
ST. PAUL
LAC QUI PARLE
McLEOD
CARVER
RENVILLE
YELLOW MEDICINE
DAKOTA
MISSISSIPPI
SIBLEY
SCOTT
LINCOLN
LYON
LE SUEUR
GOODHUE
NICOLLET
REDWOOD
RICE
BROWN
WABASHA
STEELE
DODGE
WASECA
MURRAY
OLMSTED
COTTONWOOD
BLUE EARTH
WINONA
PIPESTONE
WATONWAN
HOUSTON
NOBLES
FARIBAULT
FILLMORE
FREEBORN
ROCK
JACKSON
MARTIN
MOWER
RIVER
I O W A


Randall


Lynn Betts, NRCS


Randall

Region Specific BMPs for N



BMP's
(Best Management Practices)

Three management categories

- Recommended
- Acceptable, but with risk
- Not recommended

RISK

Economic and Environmental

Management Practices

1. Cropping system
2. Rate of N application
3. Time of N application
4. Nitrification inhibitors
5. Source of N (Fert. & Manure)
6. Cover Crops
7. Tillage (have data, not presented here)

Effect of CROPPING SYSTEM on drainage volume, NO_3-N concentration, and N loss in subsurface tile drainage during a 4-yr period (1990-93) in MN.

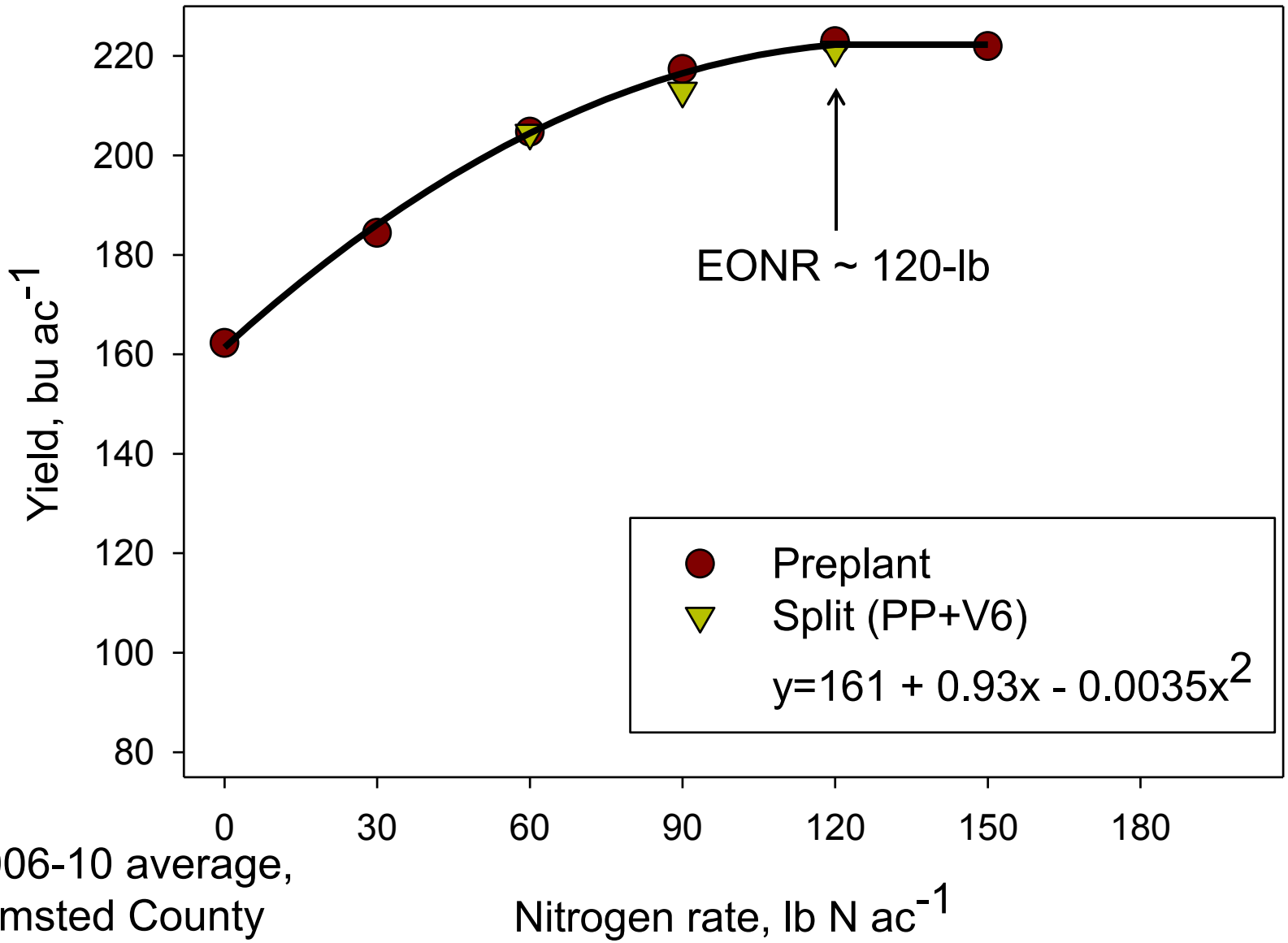
Cropping System	Total discharge	Nitrate-N	
		Conc.	Loss
	Inches	ppm	lb/A
Continuous corn	30.4	28	194
Corn – soybean	35.5	23	182
Soybean – corn	35.4	22	180
Alfalfa	16.4	1.6	6
CRP	25.2	0.7	4

Conclusions

- Cropping system has greater effect on hydrology and nitrate losses than any other management factor! (RISK)
- Perennial crops (alfalfa and grasses) compared to row crops (corn and soybean) reduce
  - Drainage volume by 25 to 50%
  - Nitrate loss by > 95%

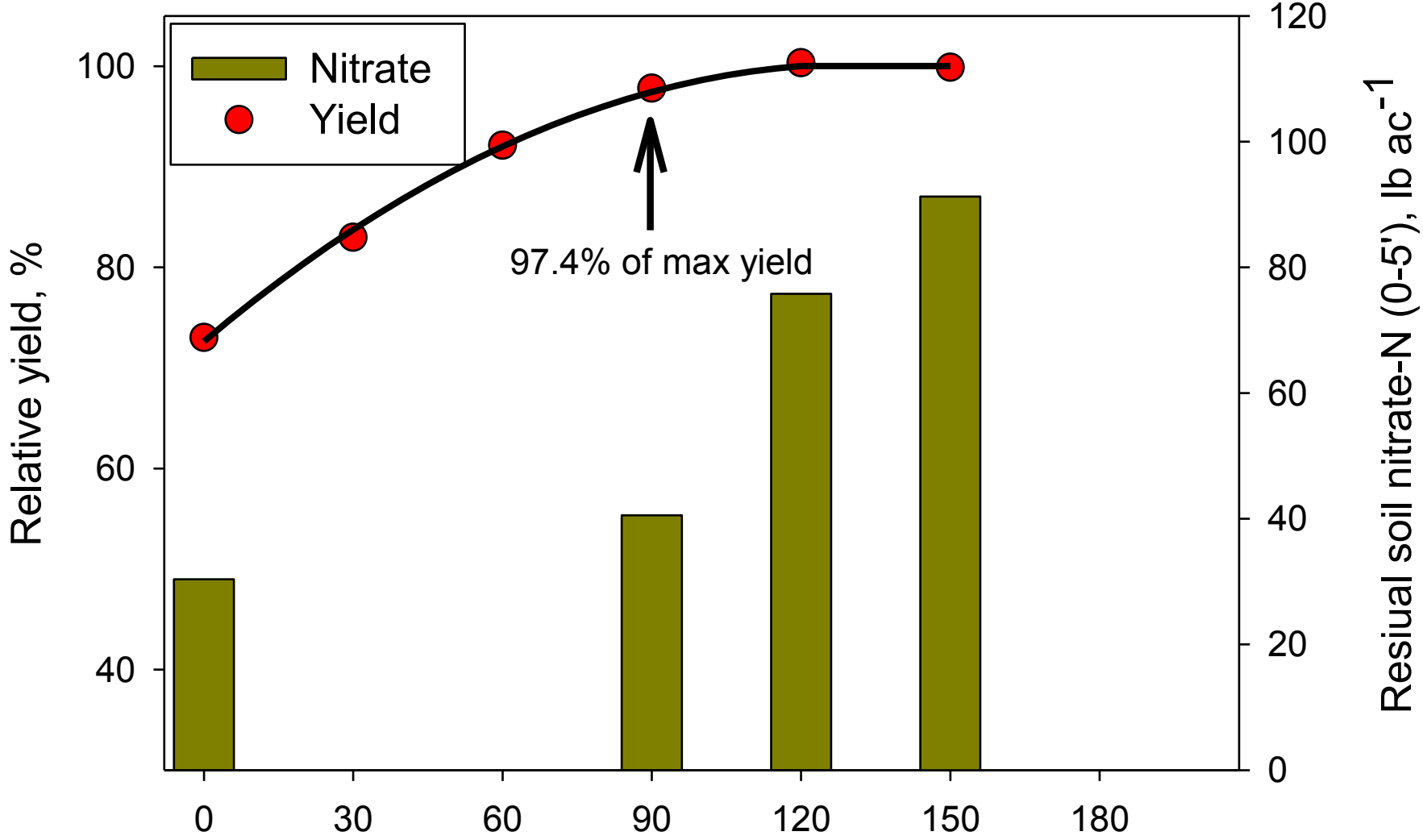
Rate and Time of N Application

Corn grain yield following soybean as affected by N rate and application timing (Port Byron sil)



2006-10 average,
Olmsted County

Relative corn yield following soybean & residual soil NO_3 (0-5' depth) as affected by N rate (Port Byron)



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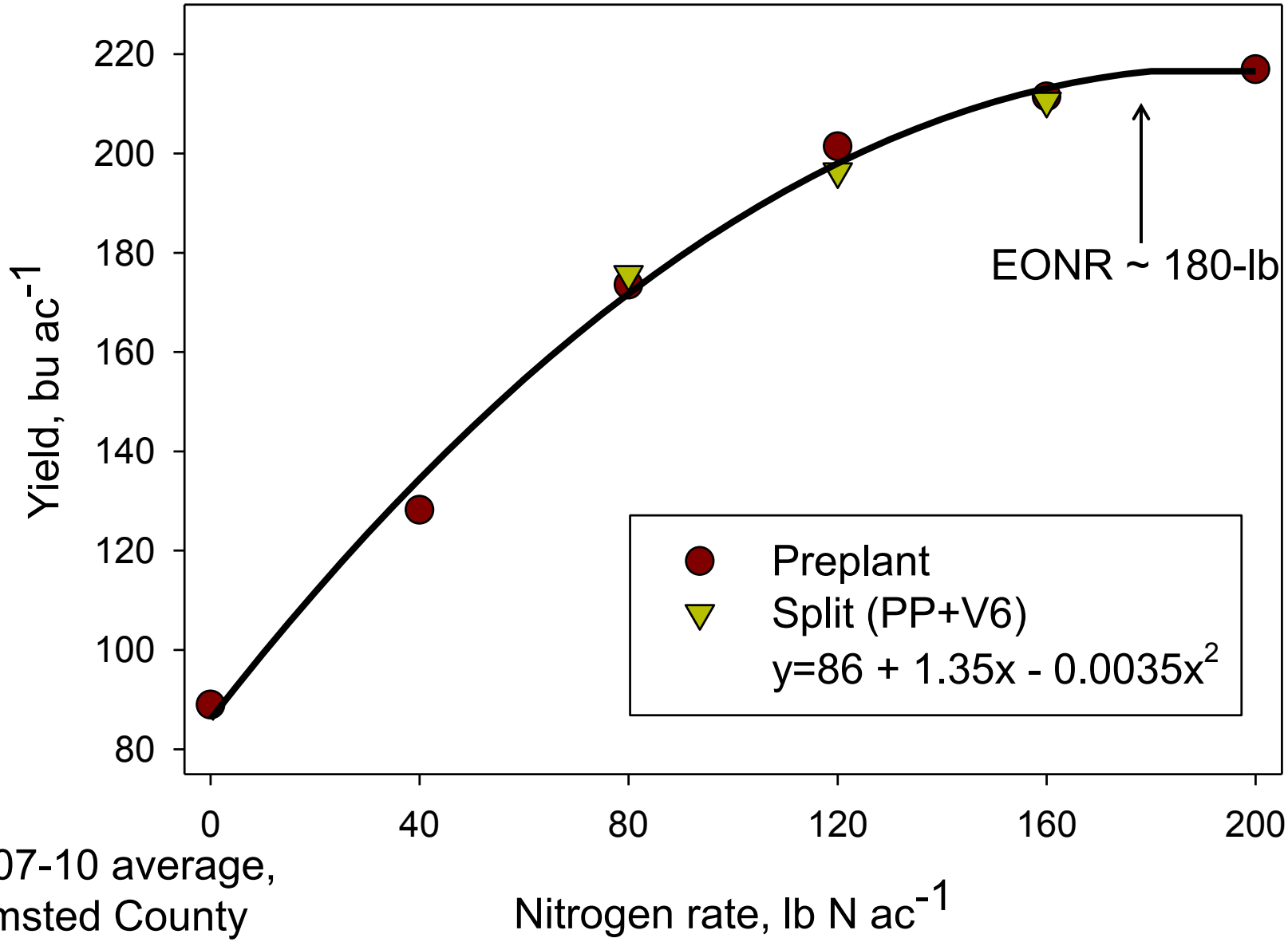
Corn grain yield following corn as affected by N rate and application timing (Port Byron sil)



2007-10 average,
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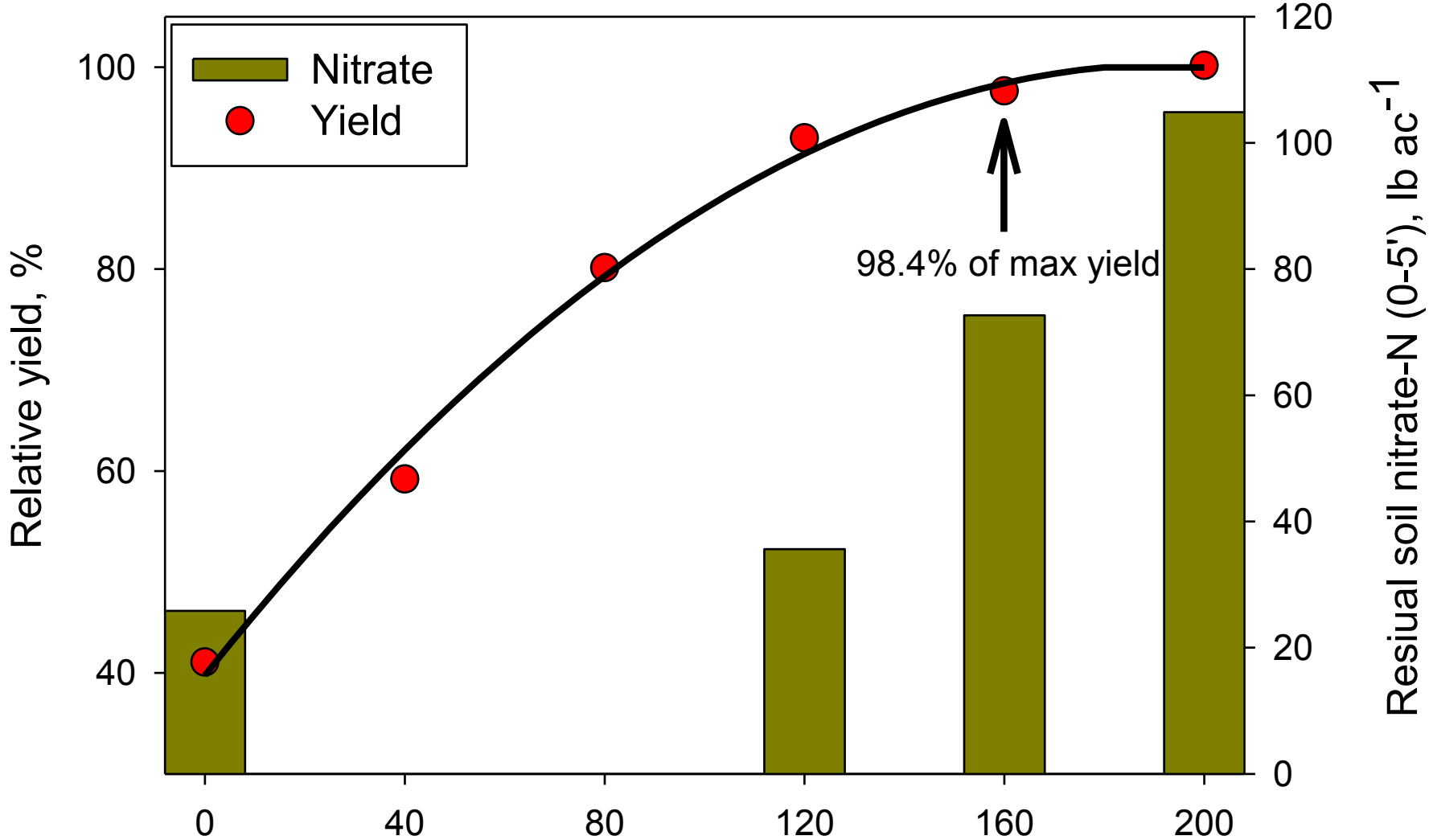
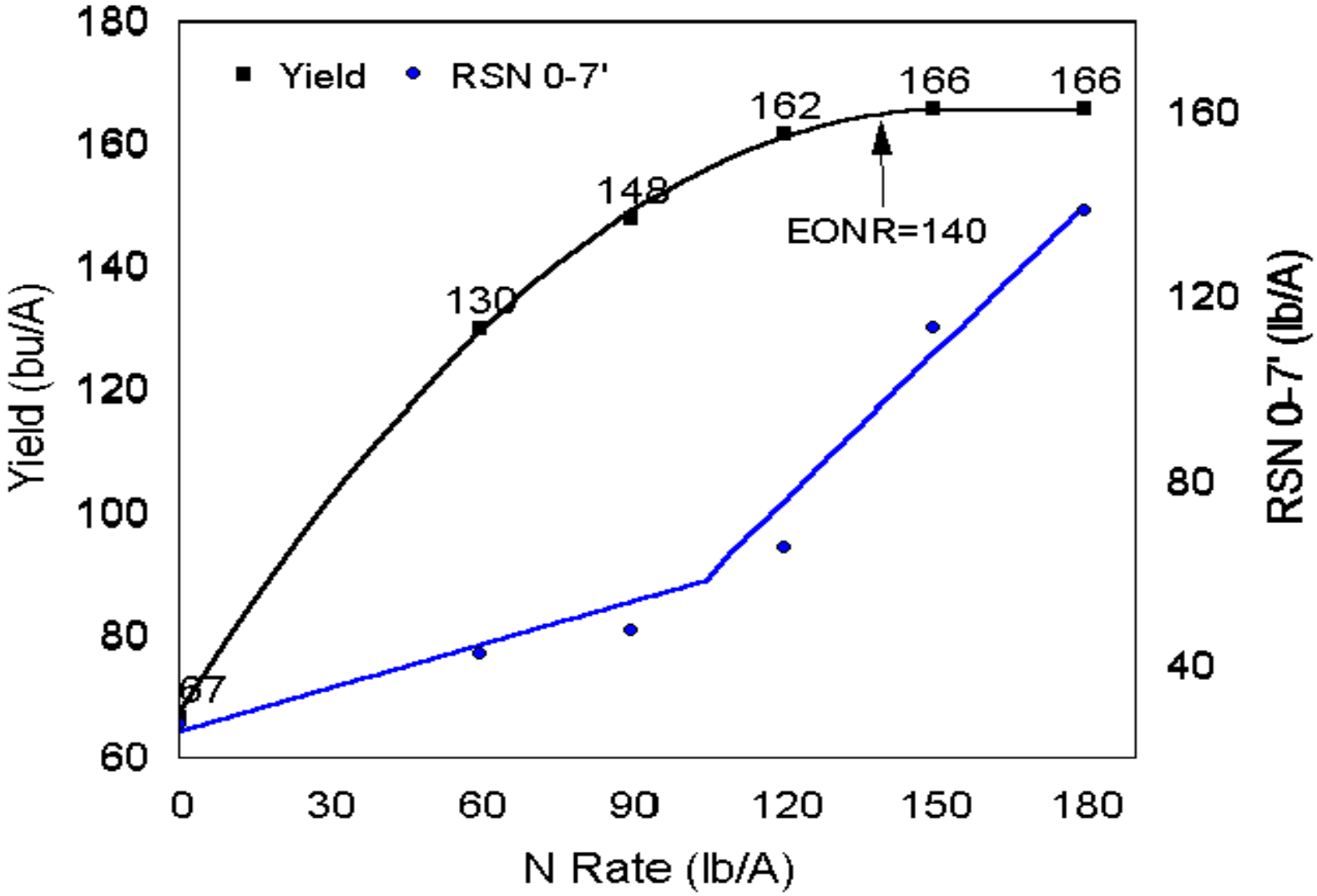
Relative corn yield following corn & residual soil NO_3 (0-5' depth) as affected by N rate (Port Byron sil)

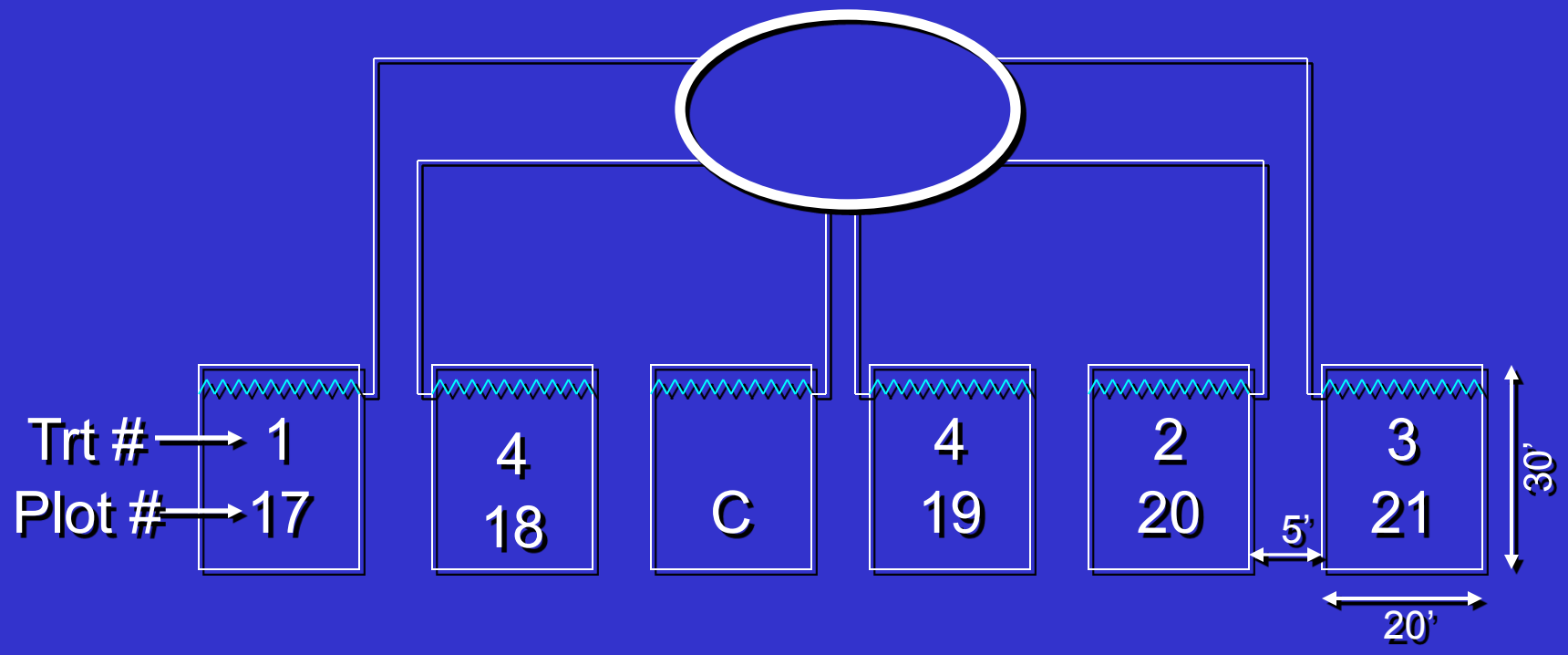


2007-10 average,
Olmsted County

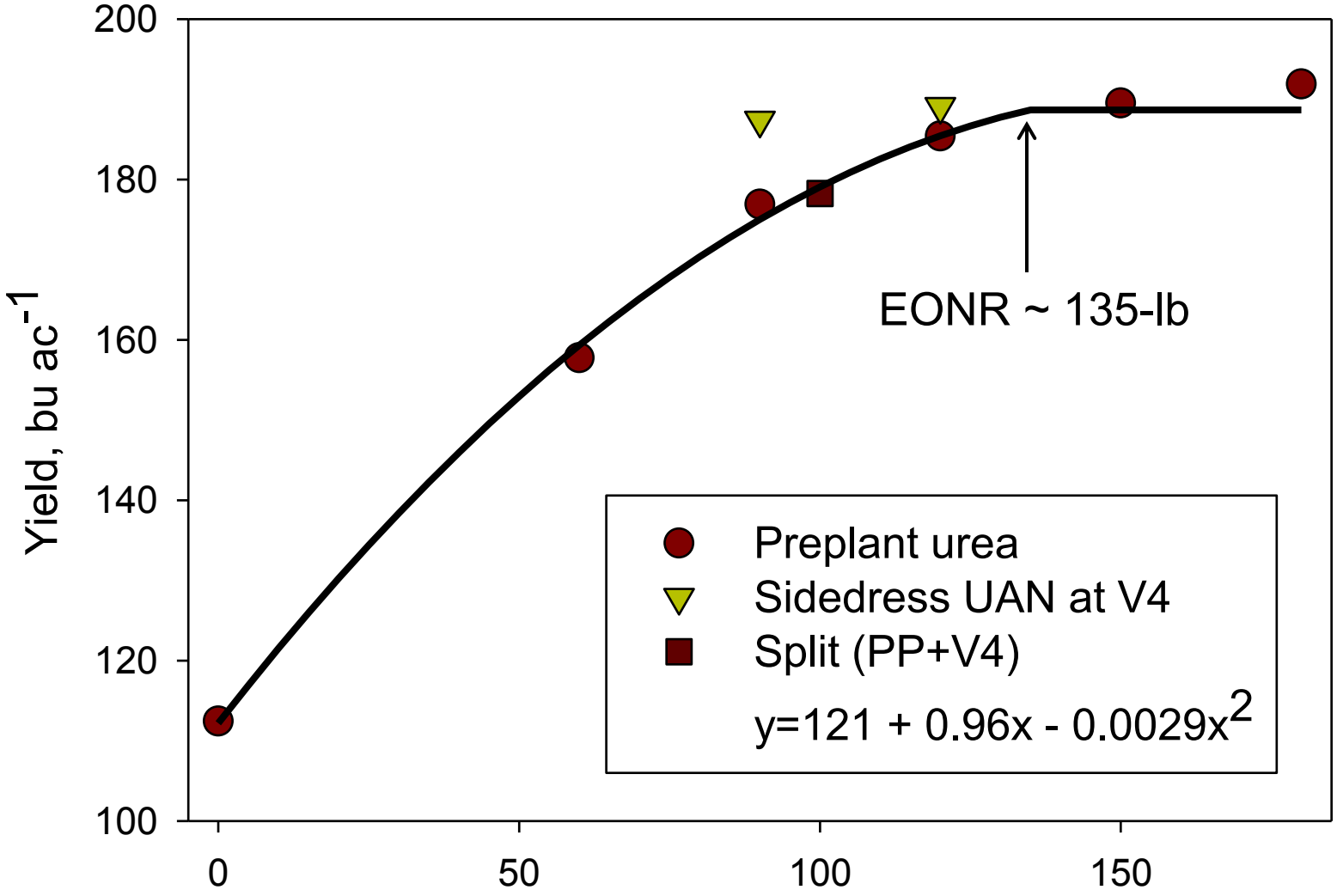
Continuous Corn, 2001–03 Olmsted Co.



Corn-Soybean Rotation Drainage Study, Waseca



Corn grain yield following soybean as affected by N rate and application timing (Webster cl)



2008-10 avg., Waseca

Nitrogen rate, lb N ac^{-1}

Nitrogen products and their purpose

Chemical or Compound	Common Product Names	Process Affected
Dicyandiamide (DCD)	Guardian®	Nitrification
Nitrapyrin	N-Serve®, Instinct®	Nitrification
NBPT	Agrotain®	N volatilization
NBPT + DCD	Agrotain®Plus, SuperU®	Nitrification, N volatilization
ATS (0.1% by volume)	Ammonium thiosulfate	N Volatilization
Polymer-coated urea (PCU)	ESN®, Polyon®, Duration®	N release
Malic+itaconic acid co-polymer	Nutrisphere®	Nitrification, N volatilization

adapted from Hergert et al.

http://cpc.unl.edu/includes2011/pdf/EnhancedEfficiencyFertilizers.pdf?exampleSessionId=1229904069000&exampleUserLabel=Your%20Name

Time and Rate of N Application and Nitrification Inhibitors (N-Serve)

Effect of time of AA application and N-Serve on corn yields after soybean from 1987-2001 at Waseca

Parameter	Time of N Application		
	Fall	Fall+N-Serve	Spring
15-Yr Avg. Yield (bu/A)	144	153	156
15-Yr Avg. FW NO_3-N Conc. (mg/L)	14.1	12.2	12.0
15-Yr N recovery in grain (%)	38	46	47
*7-Yr Avg. Yield (bu/A)**	*131*	*146*	*158*

* Seven years when statistically significant differences occurred.

Conclusions

- Adding a nitrification inhibitor (N-Serve™) to fall-applied anhydrous increased corn yield and NUE, while reducing nitrate concentration in tile drainage.
- A preplant application of anhydrous increased yield an average of 12 bu/ac in 7 of 15 years (wet springs) at Waseca.

Nitrate-N concentrations and losses in tile water as affected by rate and time of N application at Waseca.

N application			FW	2000-2003		
			NO_3-N	NO_3-N Lost		
Rate	Time	N-Serve	Conc.	C	Sb	Total
lb N/A			mg/L	-- lb/A/4 cycles - -		
80	Fall	Yes	11.5	115	90	205
120	Fall	Yes	13.2	121	99	220
160	Fall	Yes	18.1	142	139	281
120	Spr.	No	13.7	121	98	219

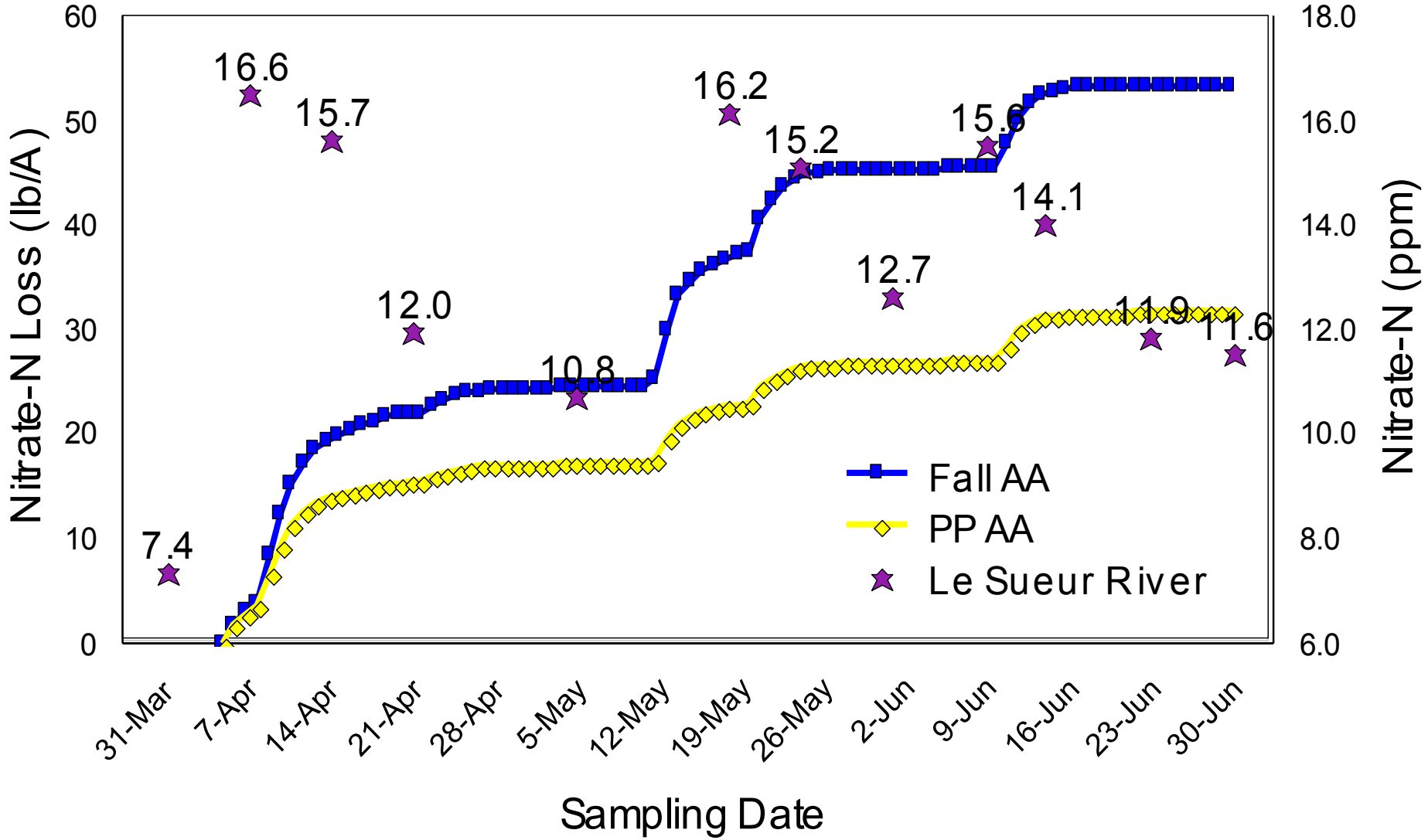
Effect of N rate on yield of corn after soybean, net return to fertilizer N, and nitrate-N concentration in tile drainage at Waseca (2000–2003).

N Treatment			4-Yr Yield	4-Yr FW
Time	Rate	N-Serve	Avg.	NO_3-N conc.
	lb /A		bu/A	mg/L
---	0	---	111	---
Fall	80	Yes	144	11.5
Fall	120	Yes	166	13.2
Fall	160	Yes	172	18.1
Spr.	120	No	180	13.7

Conclusions

- Nitrate losses were reduced 27% by decreasing the application rate from 160 lb N/A to the recommended rate of 120 lb N/A for corn after soybean without reducing yield.
- Nitrate losses were reduced 14% by decreasing the application rate to 80 lb N/A from the recommended 120-lb rate BUT yields were reduced by 17%.

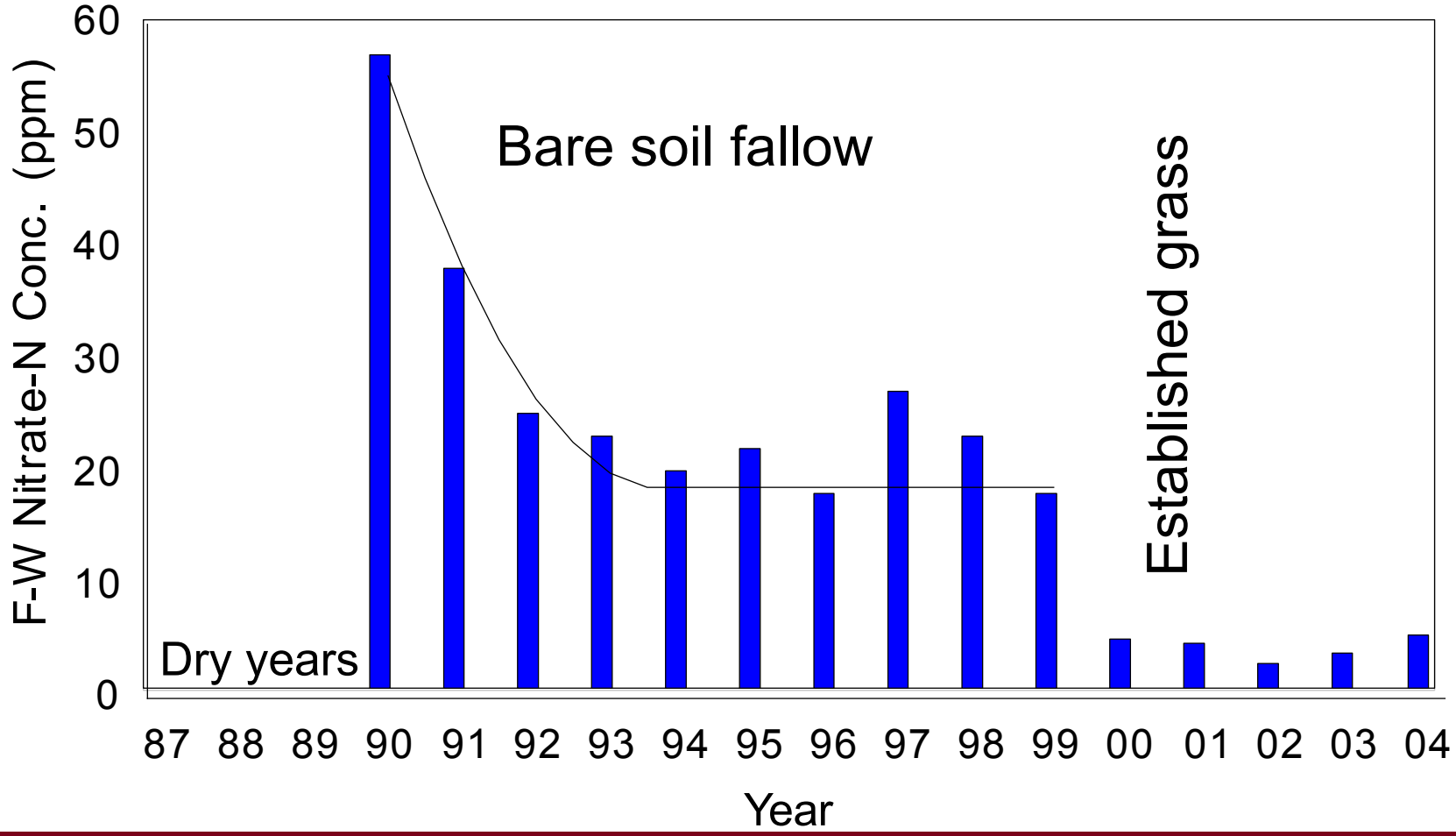
1999 tile water NO_3-N loading at Waseca vs. NO_3-N concentrations in the Le Sueur River 2.3 miles from Mankato.



Management Practices

1. Cropping system
2. **Rate of N application**
3. **Time of N application**
4. **Nitrification inhibitors**
5. Source of N (Fert. & Manure)
6. Cover Crops
7. Tillage (have data, not presented here)

Nitrate losses in tile drainage water from soil mineralization.



Source of N

- Fertilizer N vs. manure

Results for Instinct™ Applications with Manure

2011 Methods for manure study

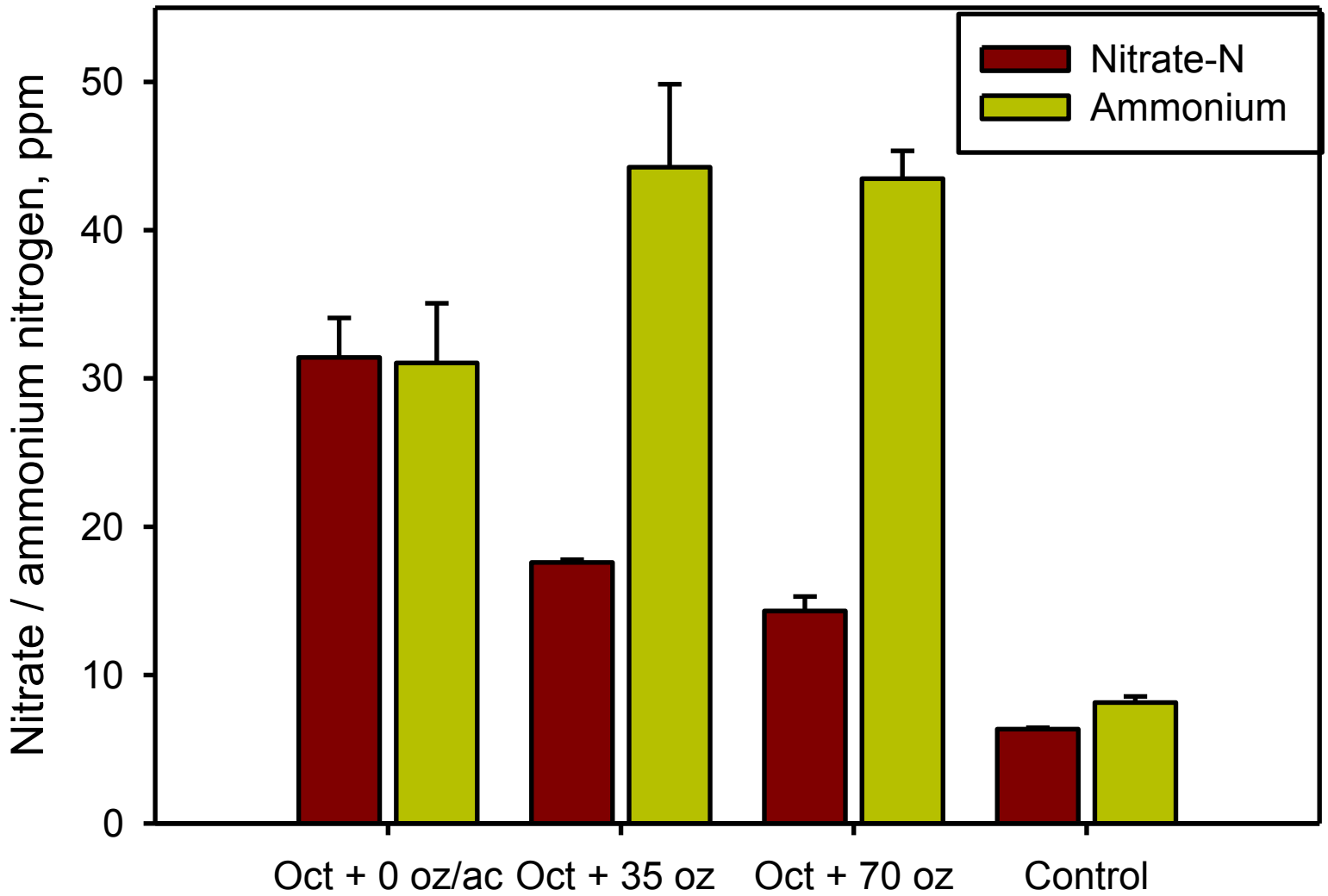
- Treatments (8)
  - Two manure application timings: Oct. 5 & Nov. 5 of 2010.
    - Manure rate [2440 (Oct) & 2700 gal/ac (Nov)] was adjusted based on the manure analysis from each application timing to give 120 lb of available N/ac based on 80% availability if sweep injected.
  - Three rates of Instinct (0, 35, and 70 oz./ac)
  - 120 lb N/ac as AA w/N-Serve on Nov. 5
  - Control (zero N)

Precipitation and temperature (air and soil) departures from normal.

Parameter	Sep	Oct	Nov	Apr	May	Jun	Jul	Aug	Sep
		-------- Departures from normal ---------							
Precip. inch	9.5	-1.5	0.1	1.2	0.7	1.0	2.7	-3.7	-2.3
Air temp. F	-1.3	3.3	1.8	-1.1	-1.4	0.8	5.0	1.1	-0.6
4” soil temp.	-2.7	4.9	1.4	0.5	-3.6	-0.3	3.5	3.8	1.5

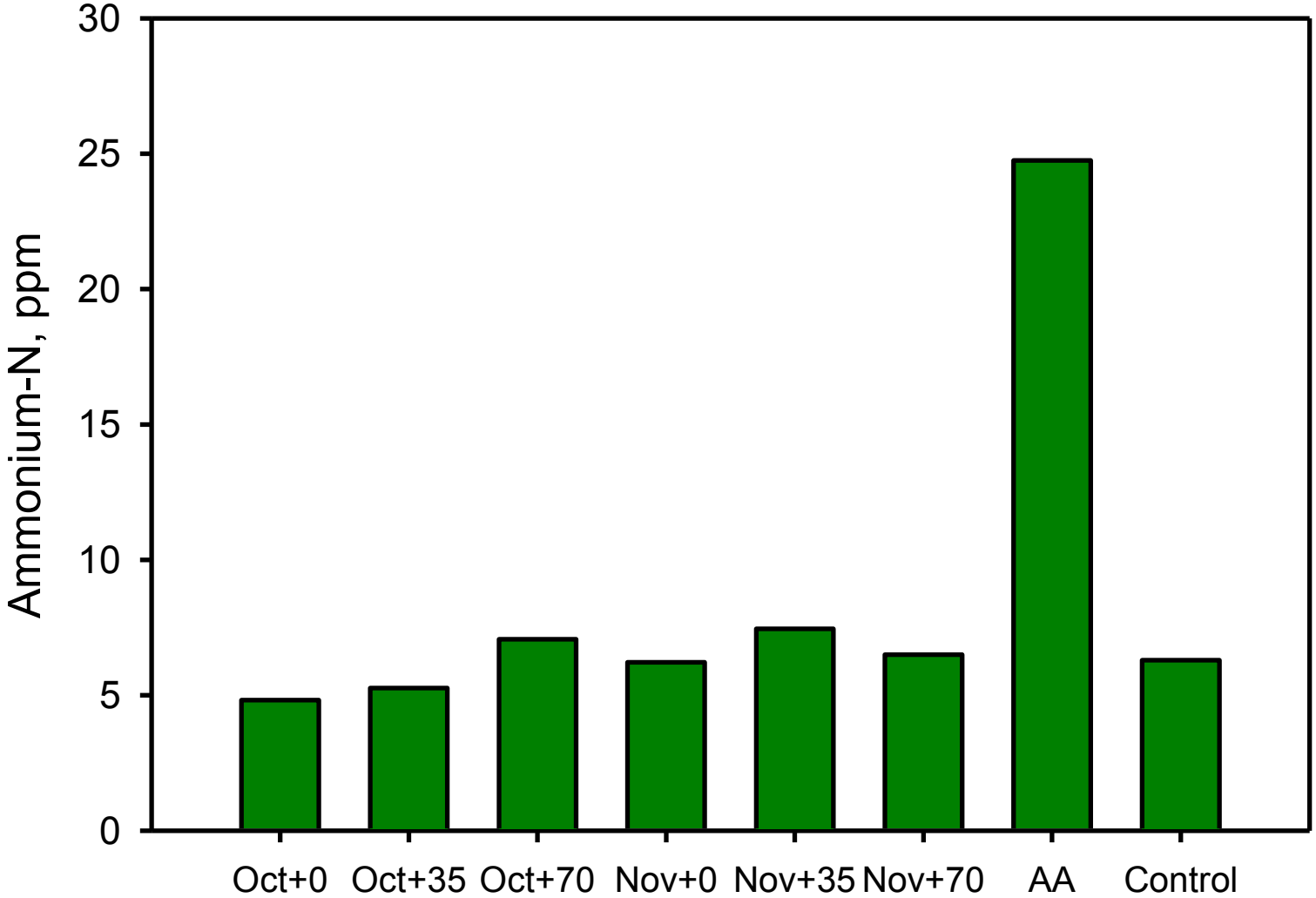
Deep snowpack resulted in 3-4” of tile drainage in March.

Soil NO_3-N and NH_4-N as affected by October swine manure application and Instinct™ rate.



Nov. 8, 2010 sampling.
0-1 ft depth sample

Soil NH_4-N on June 1, 2011 as affected by manure application timing and Instinct™ rate.



0-1 ft depth sample

Corn grain yield as affected by manure application timing and Instinct™ rate.

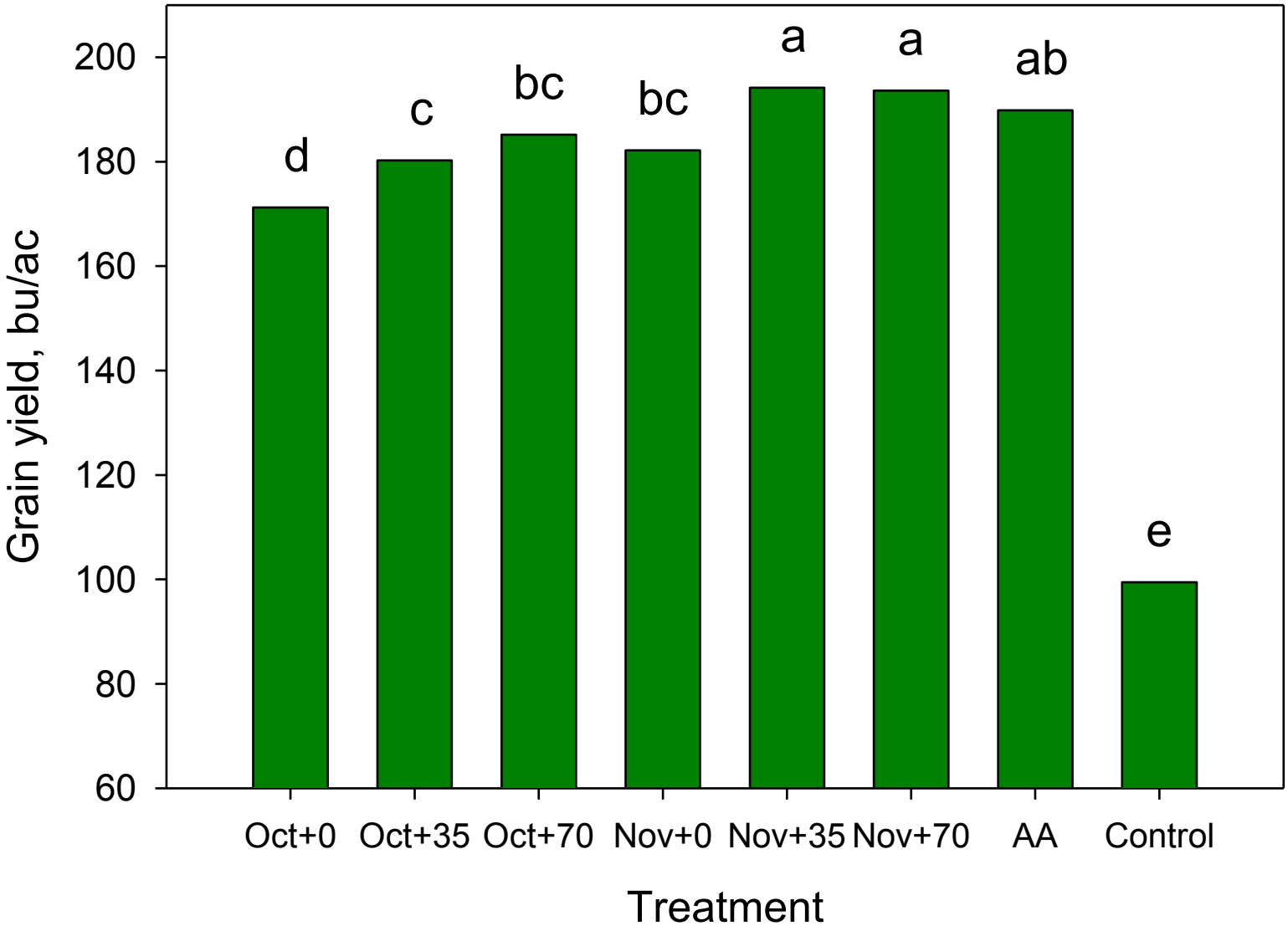


Table 1. Corn grain moisture and yield as affected by swine manure application timing and Instinct rate at Waseca.

Trt	Manure Timing	Manure Rate	Instinct™ Rate	Avail. N Rate*	Grain H_2O		Grain Yield	
#		gal/ac	oz/ac	lb N/ac	%		bu/ac	
1	Oct	2700	0	120	25.4		171	
2	Oct	2700	35	120	23.6		180	
3	Oct	2700	70	120	23.4		185	
4	Nov	2440	0	120	24.2		182	
5	Nov	2440	35	120	23.6		194	
6	Nov	2440	70	120	23.4		194	
Manure application timing								
October 5					24.1	*a*	179	*b*
November 5					23.7	*a*	190	*a*
Instinct rate								
Zero					24.8	*a*	177	*b*
35 oz/ac					23.6	*b*	187	*a*
70 oz/ac					23.4	*b*	189	*a*
Interactions (P > F)								
Manure timing × Instinct rate					0.429		0.762	

* Manure rate equals 120 lb of available N/acre, based on 80% availability for sweep injected swine finishing manure.

Observations: Yield data

- Delaying application of manure from October to November increased corn grain yields 11 bu/ac in this warmer than normal fall/year.
- The addition of Instinct to fall-applied swine manure increased yields from 10 to 12 bu/ac and decreased corn grain moisture.
- November application of swine manure with Instinct produced similar yields as fall-applied anhydrous ammonia with N-Serve.

Acknowledgement

• Funding for Instinct research projects at the Univ. of Minnesota SROC was provided by Dow AgroSciences and is appreciated by the author.

Manure and Cover Crops


CASE INTERNATIONAL
5300

Oat cover crop dry matter yield and N uptake in oat forage in 2007 and 2008 at Waseca.

Oat Planting Date	Manure Application Date	DM Yield 2007	DM Yield 2008	N Uptake 2007	N Uptake 2008
- - target dates - -		- - ton/acre - -		- lb N/acre -	
8/1	None	1.63	0.68	97	36
“	8/1	1.98	0.78	129	57
9/1	None	0.58	0.22	45	16
“	9/1	0.94	0.23	76	14

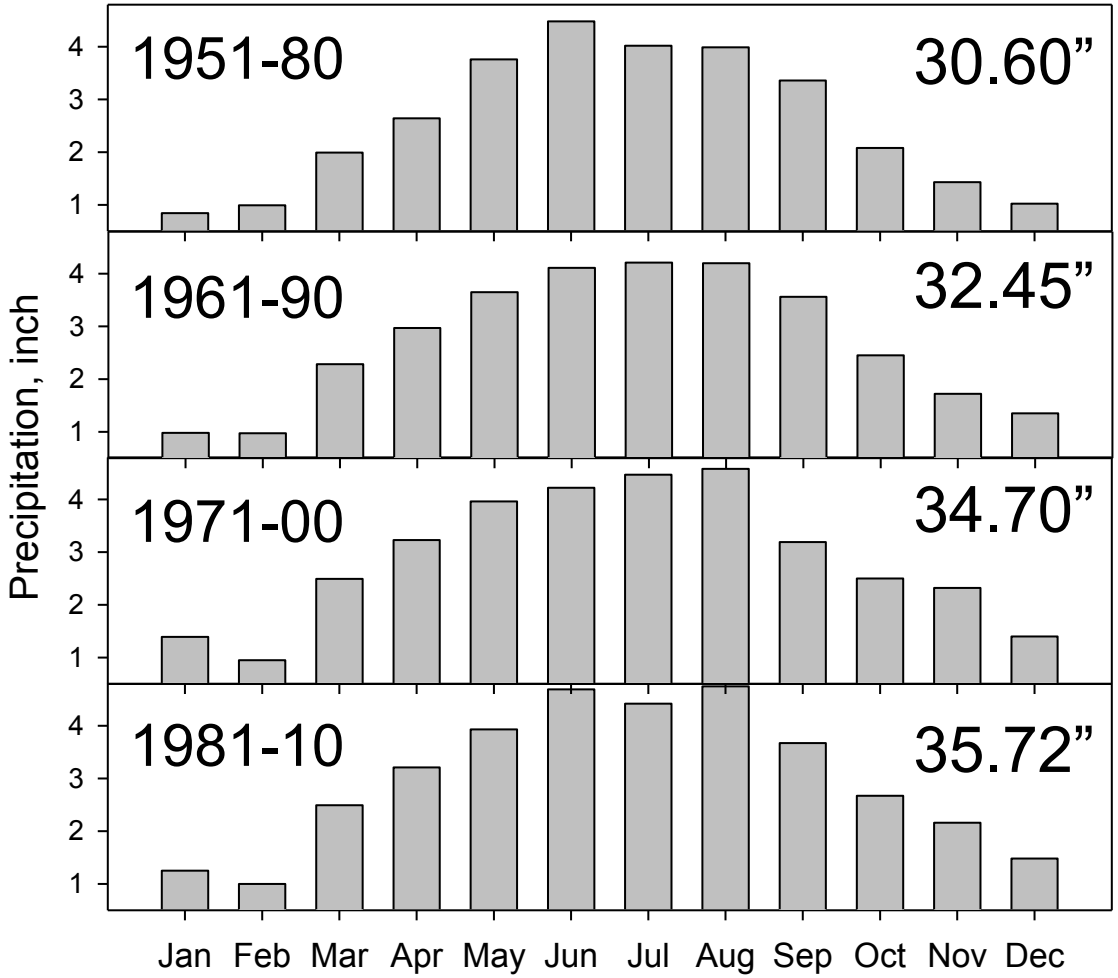
Corn grain yield as influenced by time of hog manure application and oats as a fall cover crop at Waseca.

Time of Application	Cover Crop	Grain Yield 2008	Grain Yield 2009
		- - - - - bu/A - - - - -	
Aug. 1	No	207	211
“	Aug. seed	173	140
Sept. 1	No	213	212
“	Sept. seed	205	182
Oct. 1	No	223	223
Nov. 1	No	213	(202)
Apr. 15	No	223	219
Zero-N control	No	179	158
“	Aug.	146	88
“	Sept.	164	104
120 lb N/A	No	226	214

Conclusions

- Cover crop establishment, growth, N uptake, and subsequent N release to following crop were unpredictable (highly weather dependent). RISKY
- Risk of a yield penalty for next crop (corn).
- Benefits included: uptake (tie-up) of N from summer manure applications (environmental) and improved soil quality (tilth).

Precipitation patterns are changing and N management may need to change too.



- April and May rainfall hasn’t changed, much.
- June still one of the wettest months
  - Past N management like preplant application & inhibitors can be effective (too wet to sidedress)
- Frequency of 2”+ rains
- July and August are significantly wetter
  - Past N management practices less effective.

Thanks

Questions?

Jeff Vetsch

http://sroc.cfans.umn.edu

http://sroc.cfans.umn.edu/People/Staff/JeffreyVetsch/index.htm