Proceedings of the 4th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference

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Impact of Nitrogen Management on NUE and Water Quality

Fabián G. Fernández
Department of Soil, Water, and Climate
fabiangf@umn.edu

4th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference
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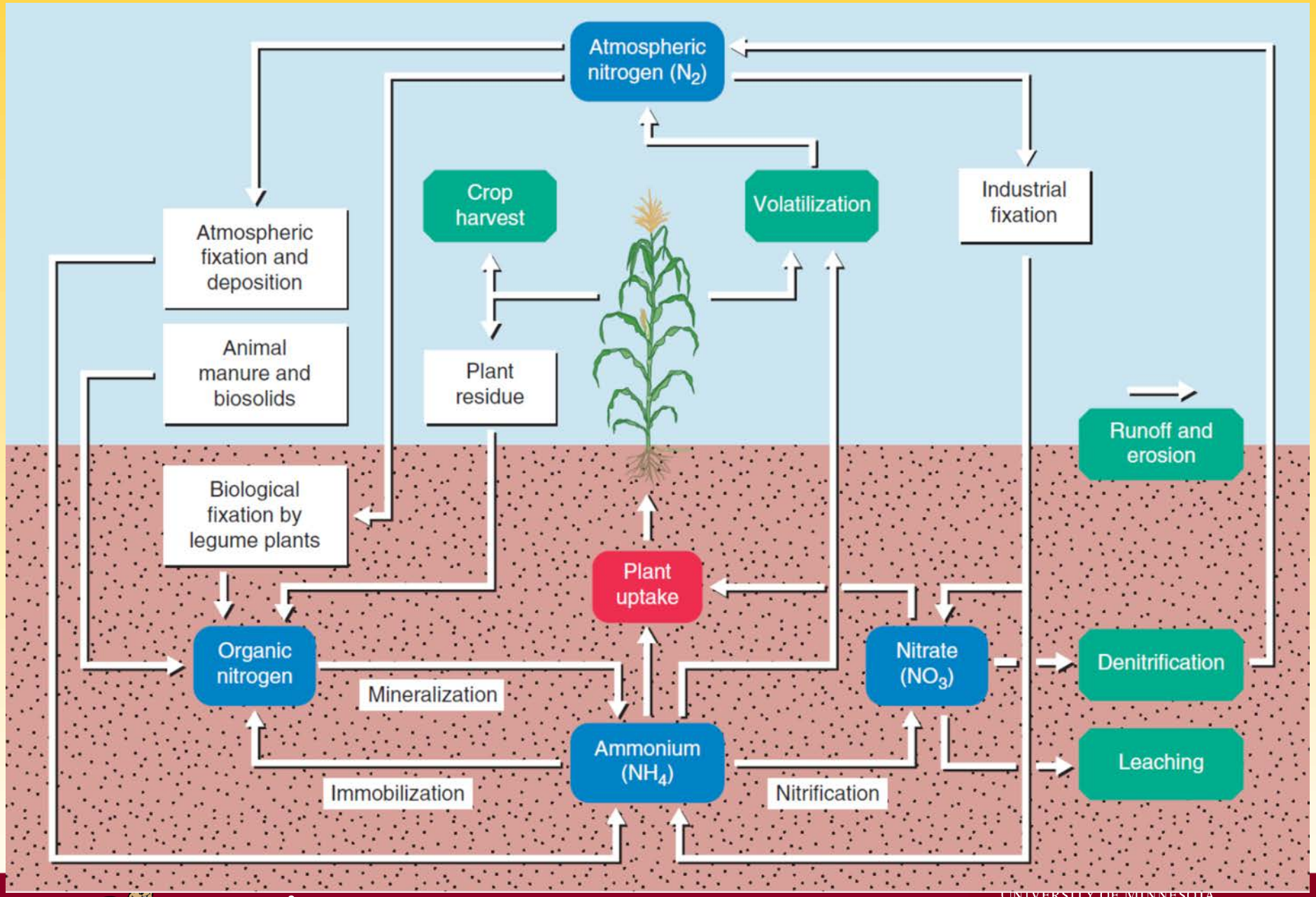

Nutrient Management

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EXTENSION
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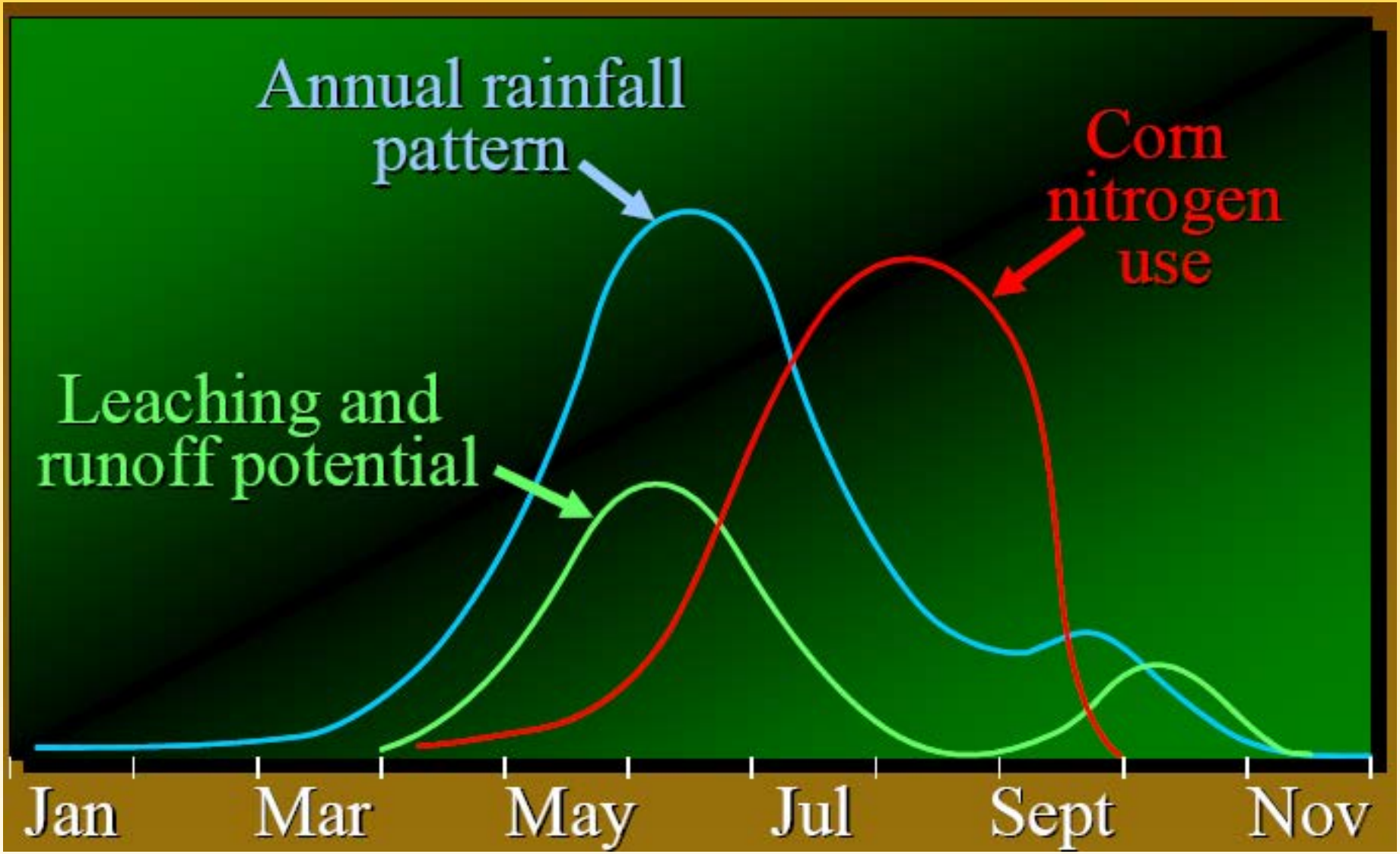
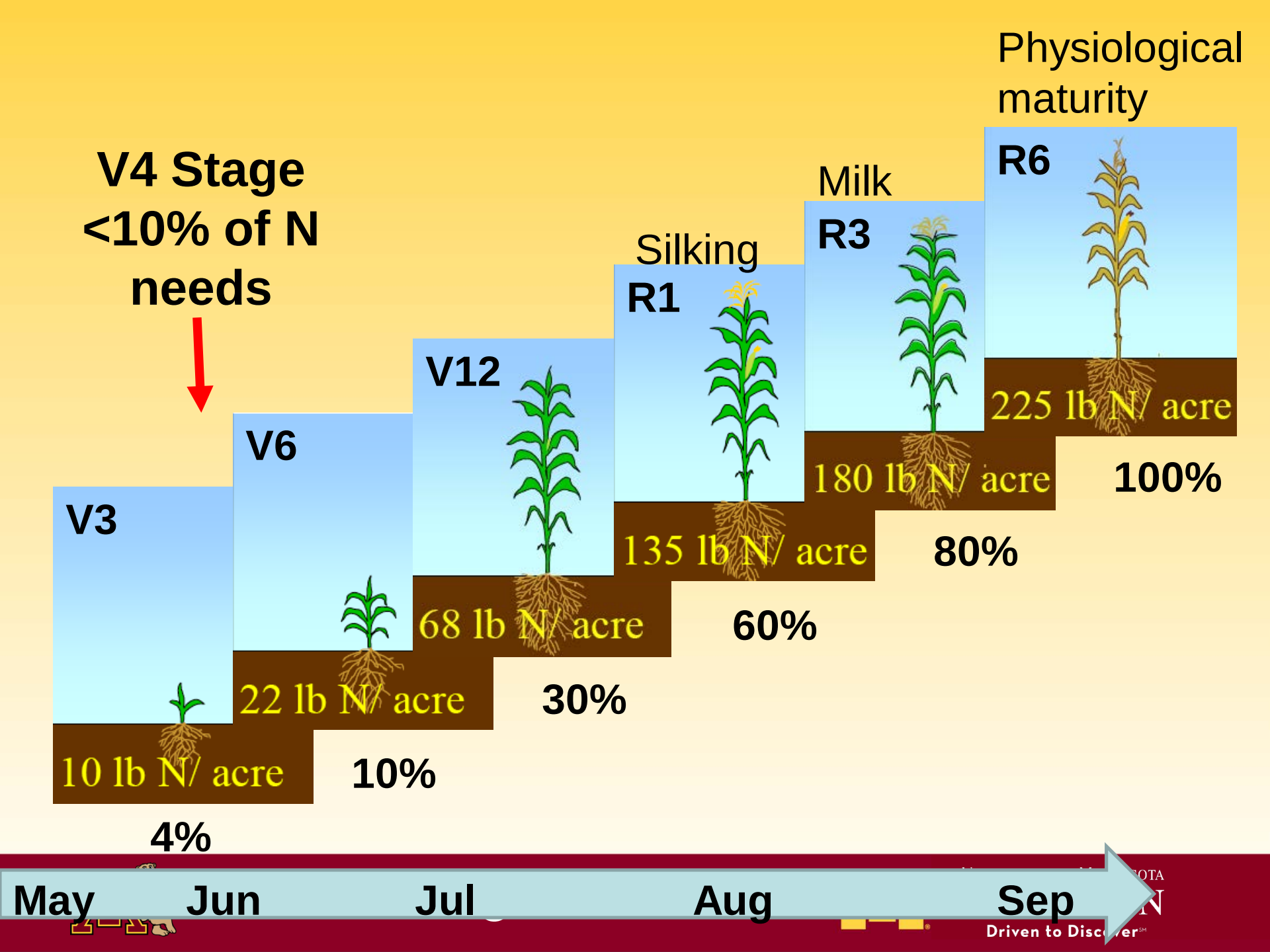
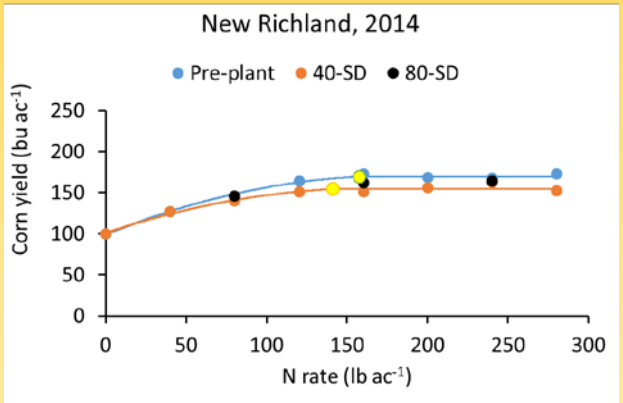
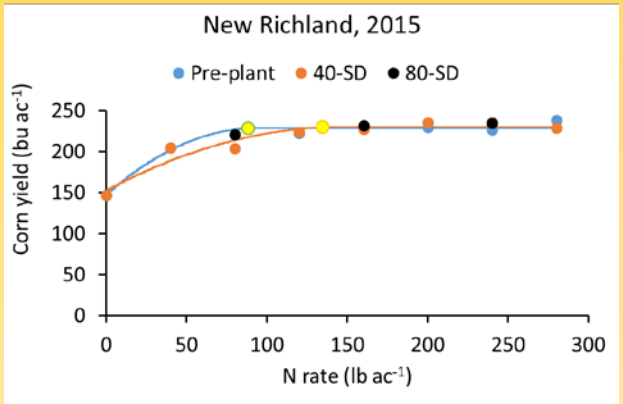
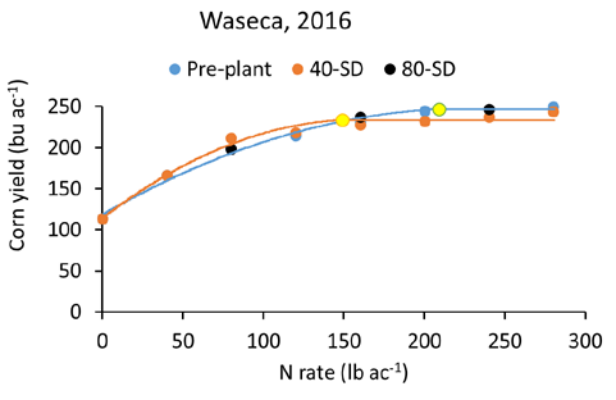
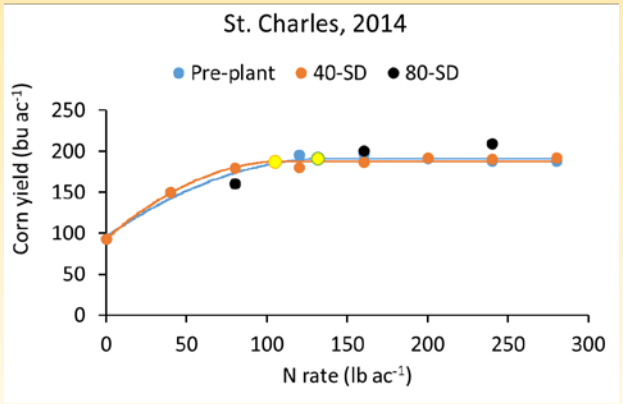

Annual rainfall pattern
Corn nitrogen use
Leaching and runoff potential
Jan
Mar
May
Jul
Sept
Nov

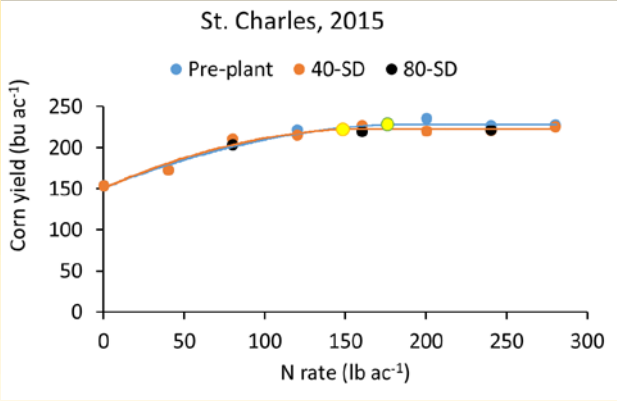

Physiological maturity
V4 Stage <10% of N needs
V3
V6
V12
Silking
R1
Milk
R3
R6
10 lb N/ acre
22 lb N/ acre
68 lb N/ acre
135 lb N/ acre
180 lb N/ acre
225 lb N/ acre
4%
10%
30%
60%
80%
100%
May
Jun
Jul
Aug
Sep

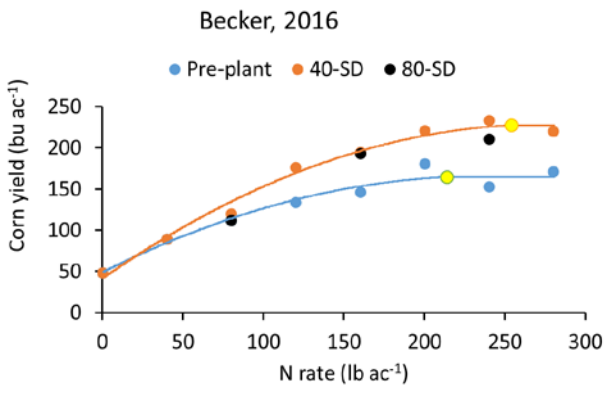

New Richland, 2014
Pre-plant
40-SD
80-SD
Corn yield (bu ac-1)
N rate (lb ac-1)


New Richland, 2015
Pre-plant
40-SD
80-SD
Corn yield (bu ac-1)
N rate (lb ac-1)


Waseca, 2016
Pre-plant
40-SD
80-SD
Corn yield (bu ac-1)
N rate (lb ac-1)

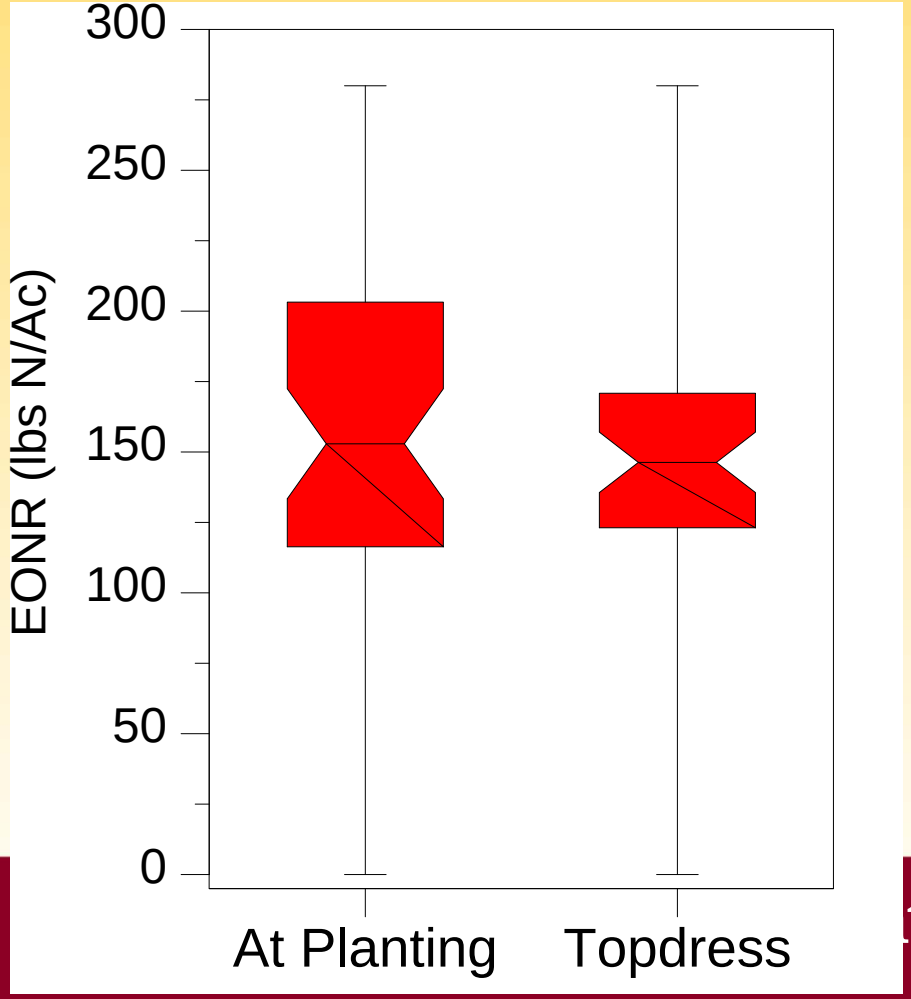

St. Charles, 2014
Pre-plant
40-SD
80-SD
Corn yield (bu ac-1)
N rate (lb ac-1)

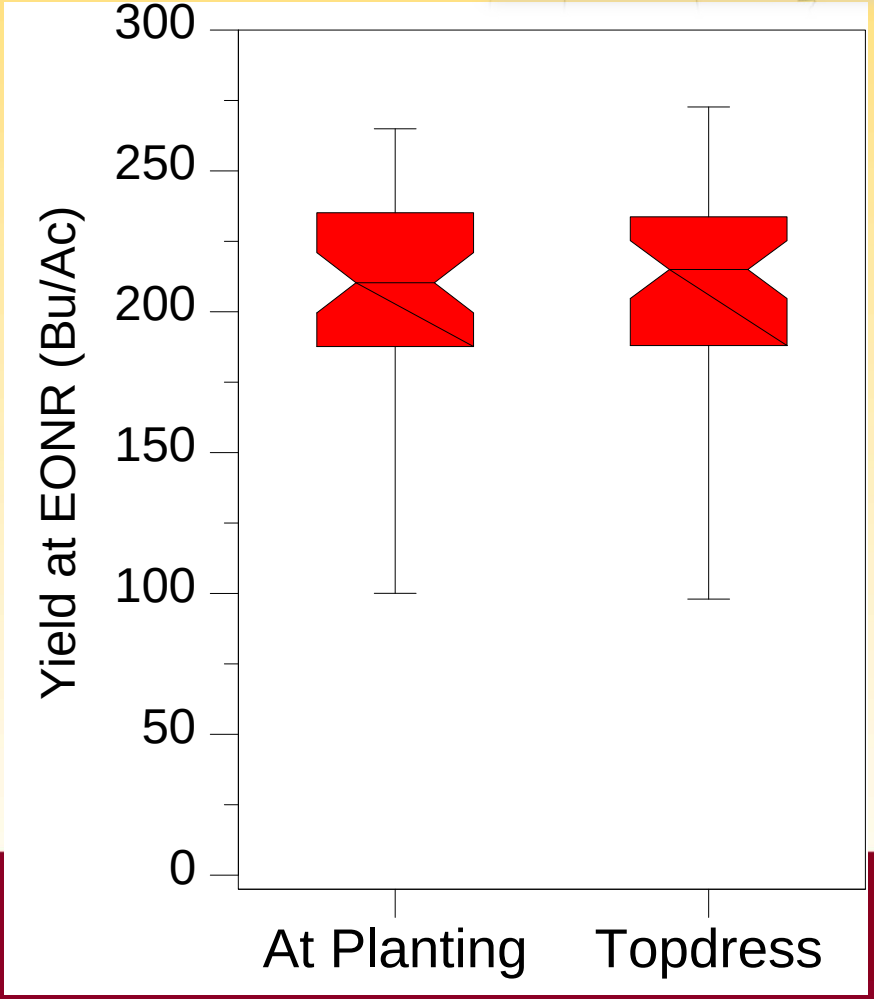

St. Charles, 2015
Pre-plant
40-SD
80-SD
Corn yield (bu ac-1)
N rate (lb ac-1)


Becker, 2016
Pre-plant
40-SD
80-SD
Corn yield (bu ac-1)
N rate (lb ac-1)

EONR and Yield at EONR

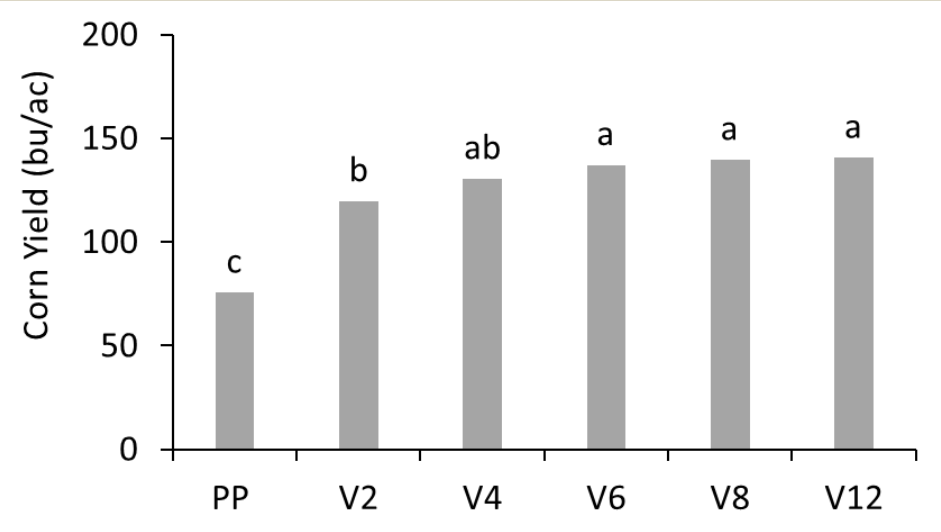
(49 site-years)



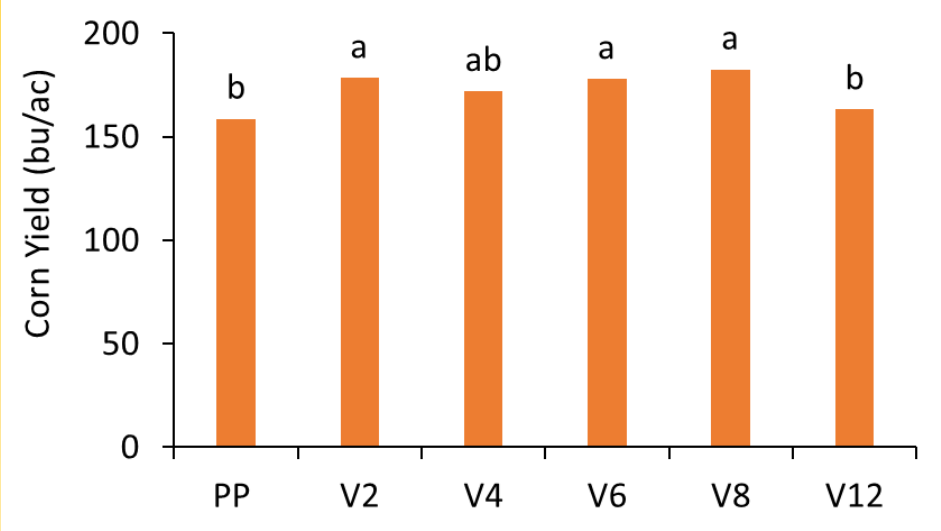


When to Side-dress

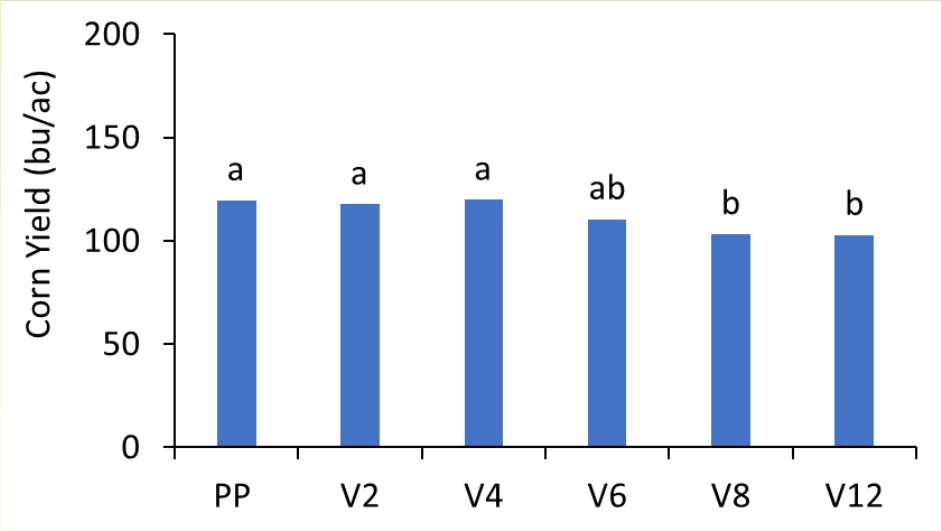
Group 1



Group 2



Group 3



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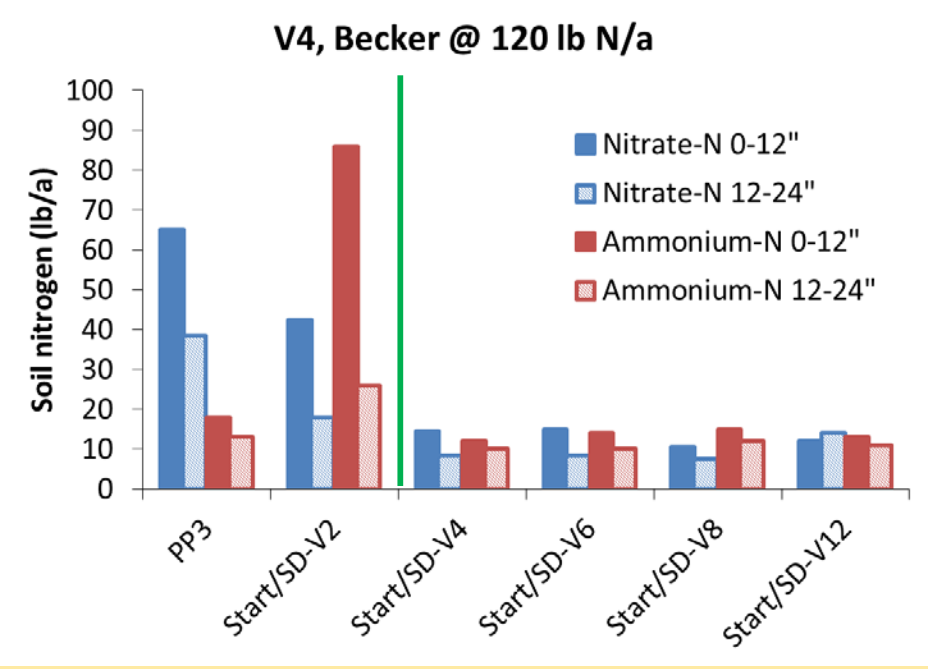
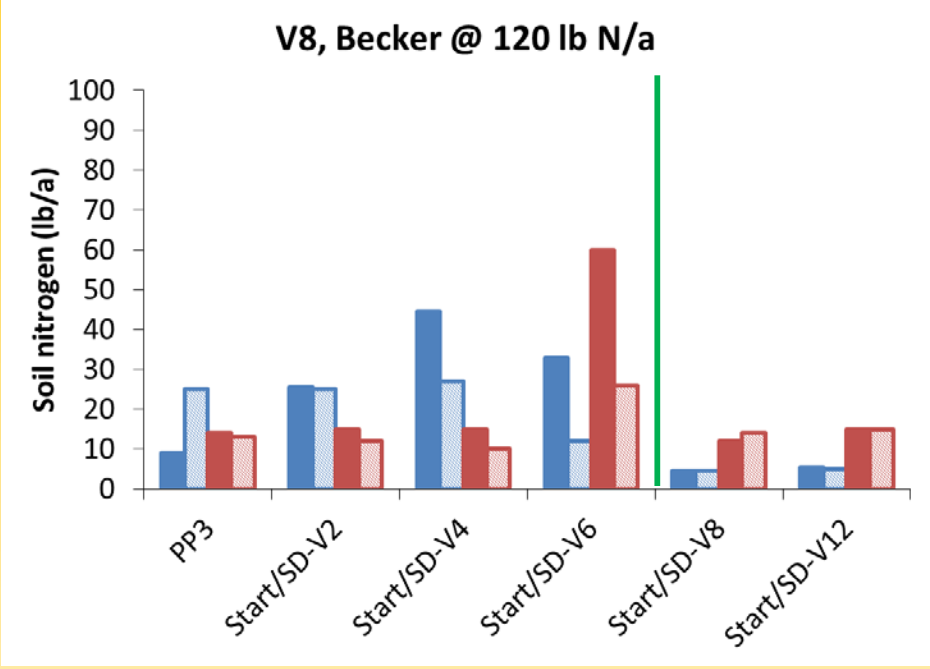
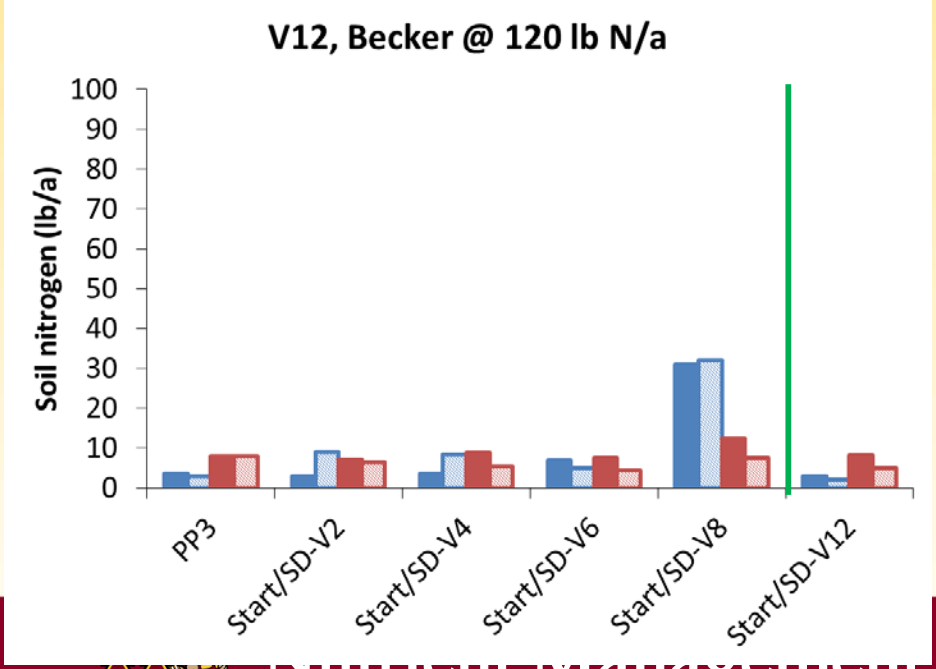
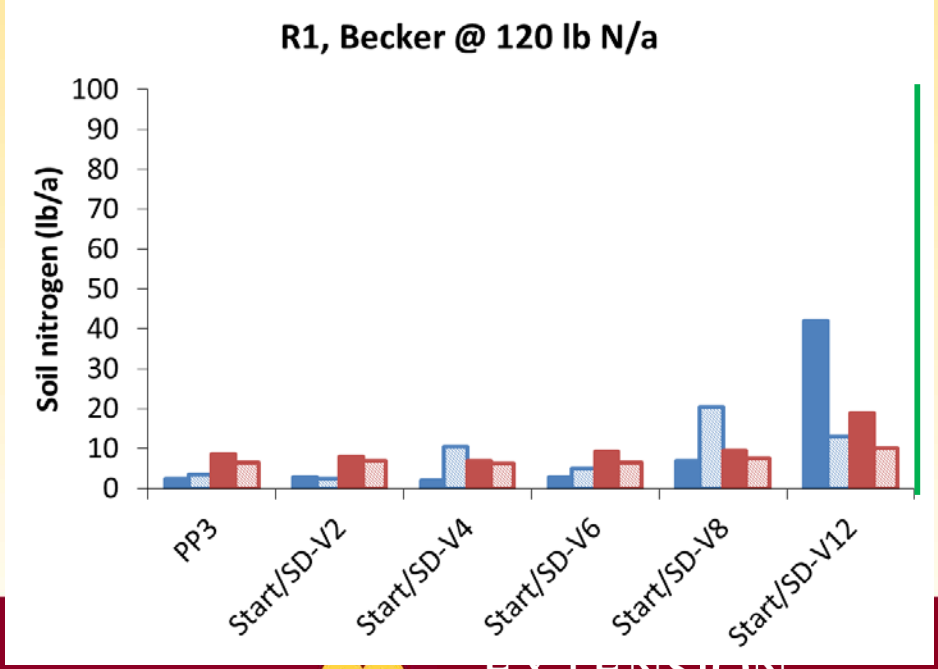
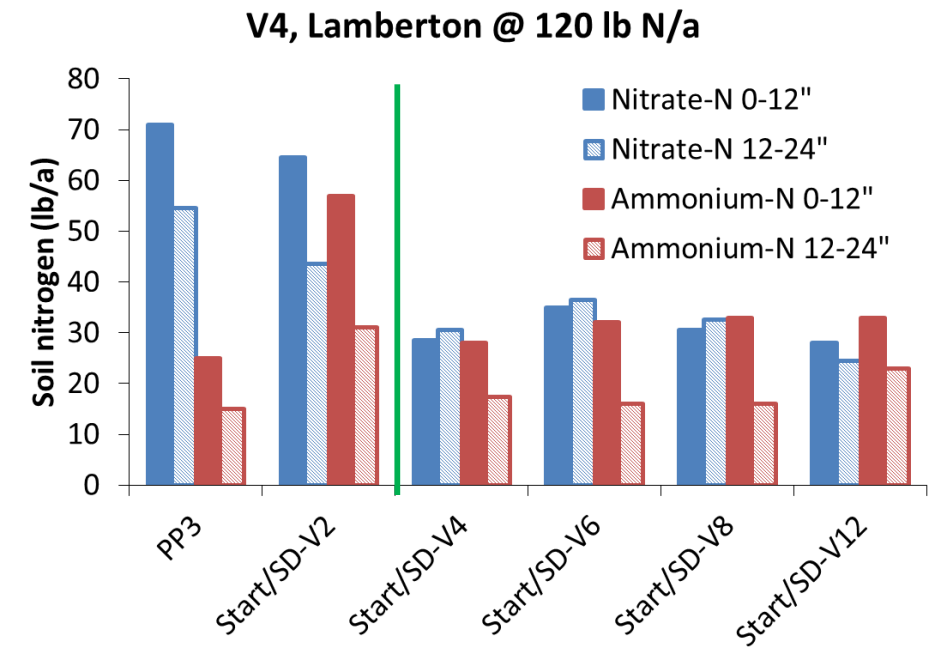
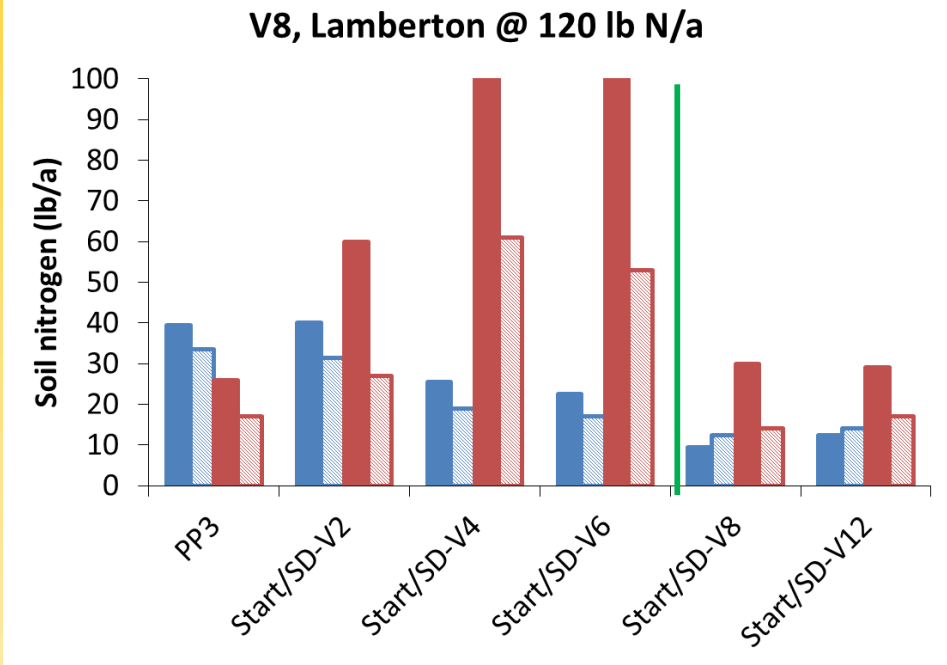

V4, Becker @ 120 lb N/a
Soil nitrogen (lb/a)
100
90
80
70
60
50
40
30
20
10
0
Nitrate-N 0-12"
Nitrate-N 12-24"
Ammonium-N 0-12"
Ammonium-N 12-24"
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12

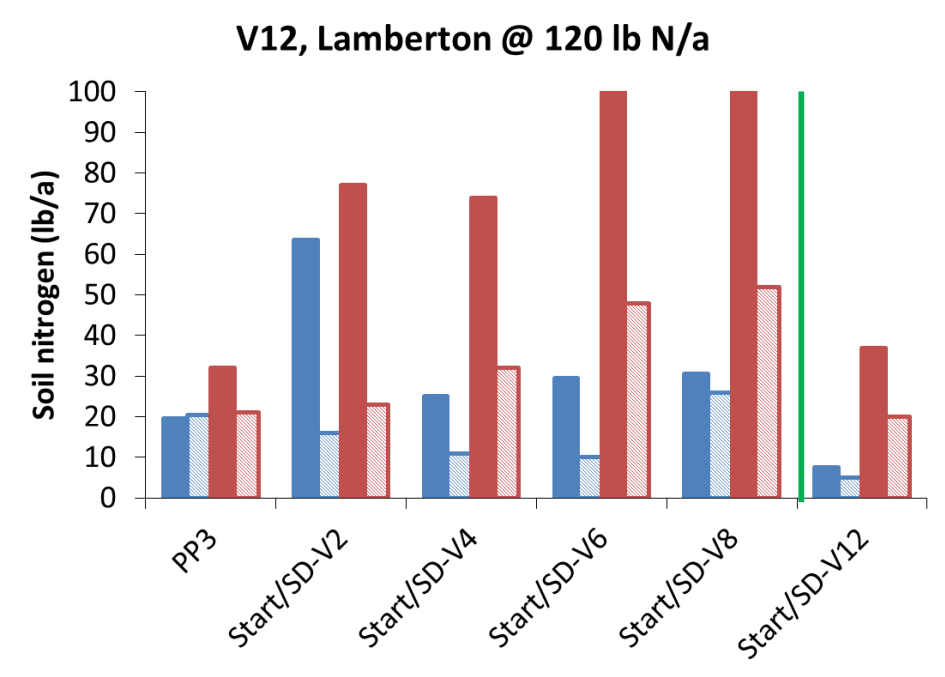

V8, Becker @ 120 lb N/a
Soil nitrogen (lb/a)
100
90
80
70
60
50
40
30
20
10
0
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12

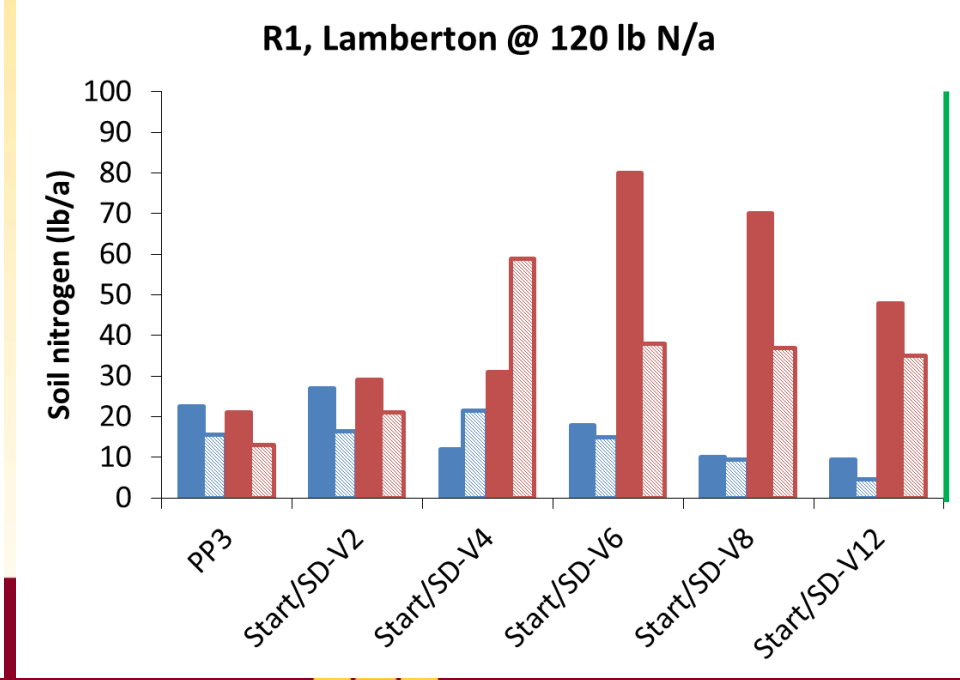

V12, Becker @ 120 lb N/a
Soil nitrogen (lb/a)
100
90
80
70
60
50
40
30
20
10
0
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12

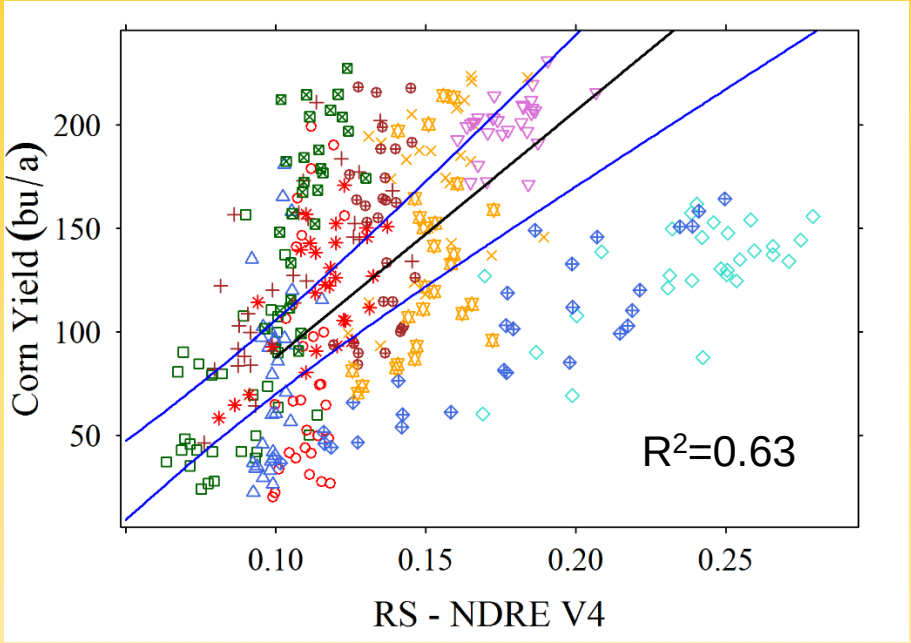

R1, Becker @ 120 lb N/a
Soil nitrogen (lb/a)
100
90
80
70
60
50
40
30
20
10
0
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12

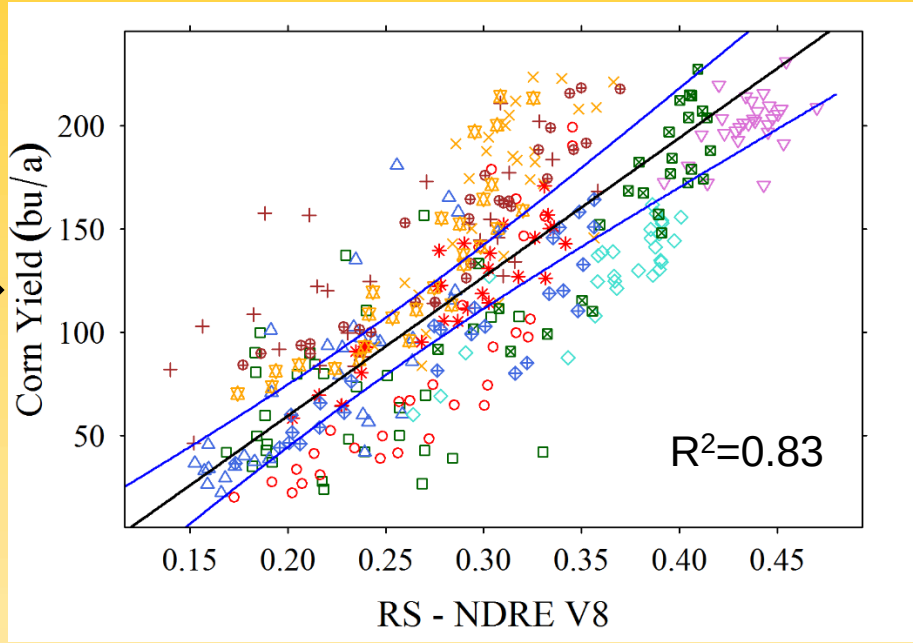

V4, Lamberton @ 120 lb N/a
Soil nitrogen (lb/a)
0
10
20
30
40
50
60
70
80
Nitrate-N 0-12"
Nitrate-N 12-24"
Ammonium-N 0-12"
Ammonium-N 12-24"
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12

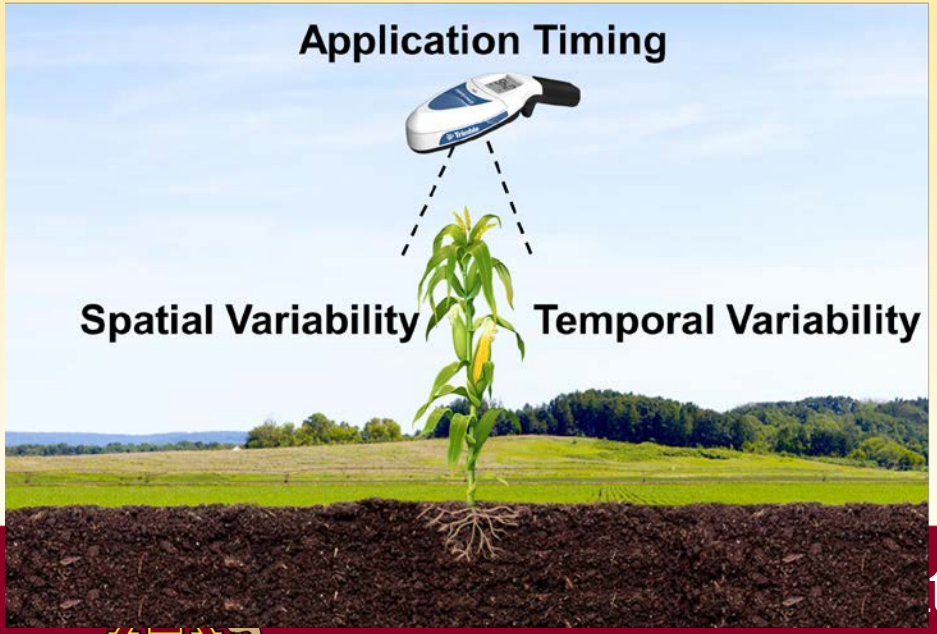

V8, Lamberton @ 120 lb N/a
Soil nitrogen (lb/a)
0
10
20
30
40
50
60
70
80
90
100
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12

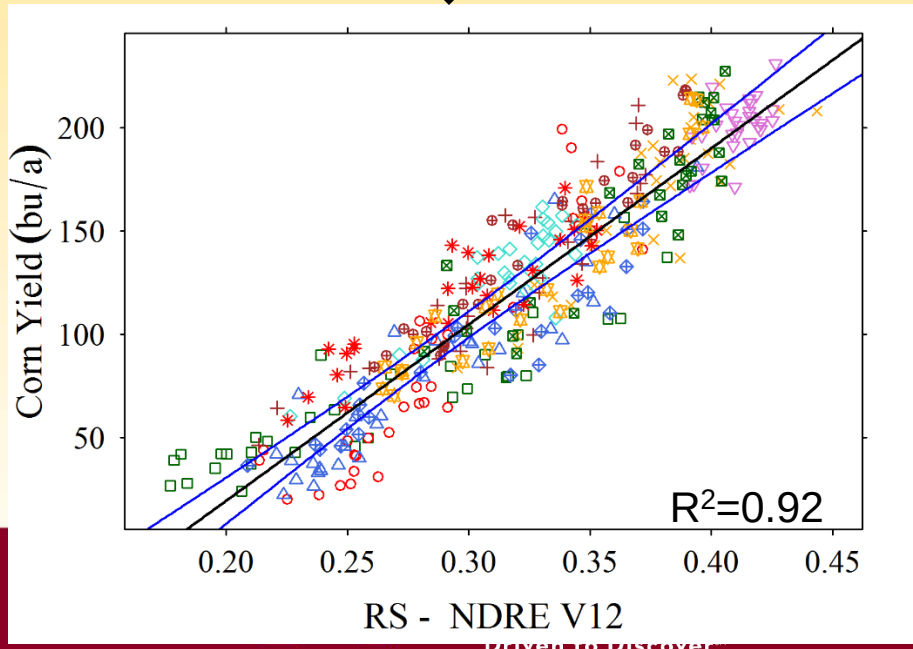

V12, Lamberton @ 120 lb N/a
Soil nitrogen (lb/a)
0
10
20
30
40
50
60
70
80
90
100
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12


R1, Lamberton @ 120 lb N/a
Soil nitrogen (lb/a)
0
10
20
30
40
50
60
70
80
90
100
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12

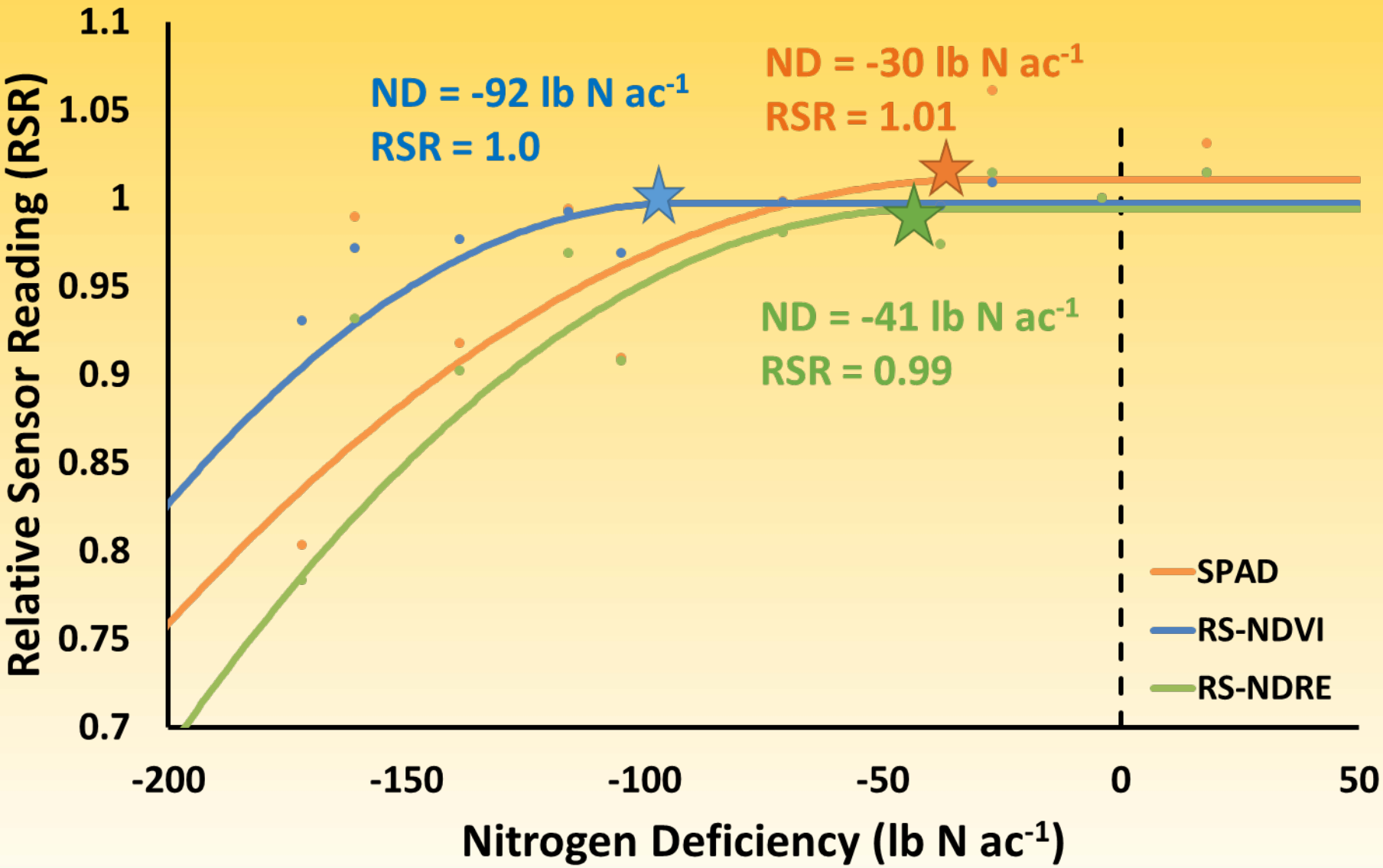

Corn Yield (bu/a)
200
150
100
50
0.10
0.15
0.20
0.25
RS - NDRE V4
R²=0.63


Corn Yield (bu/a)
200
150
100
50
0.15
0.20
0.25
0.30
0.35
0.40
0.45
RS - NDRE V8
R²=0.83

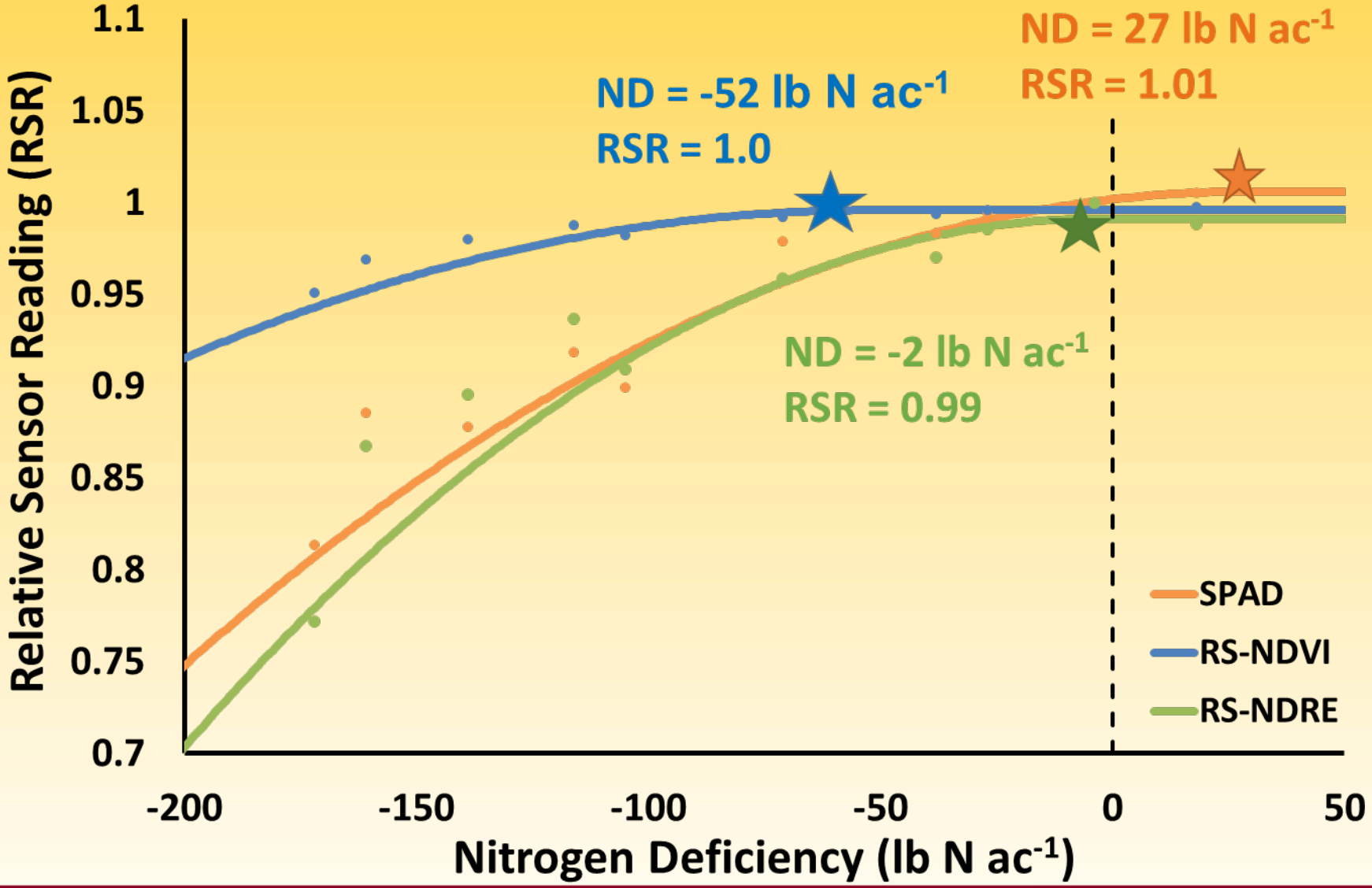

Application Timing
Spatial Variability
Temporal Variability


Corn Yield (bu/a)
200
150
100
50
0.20
0.25
0.30
0.35
0.40
0.45
RS - NDRE V12
R²=0.92

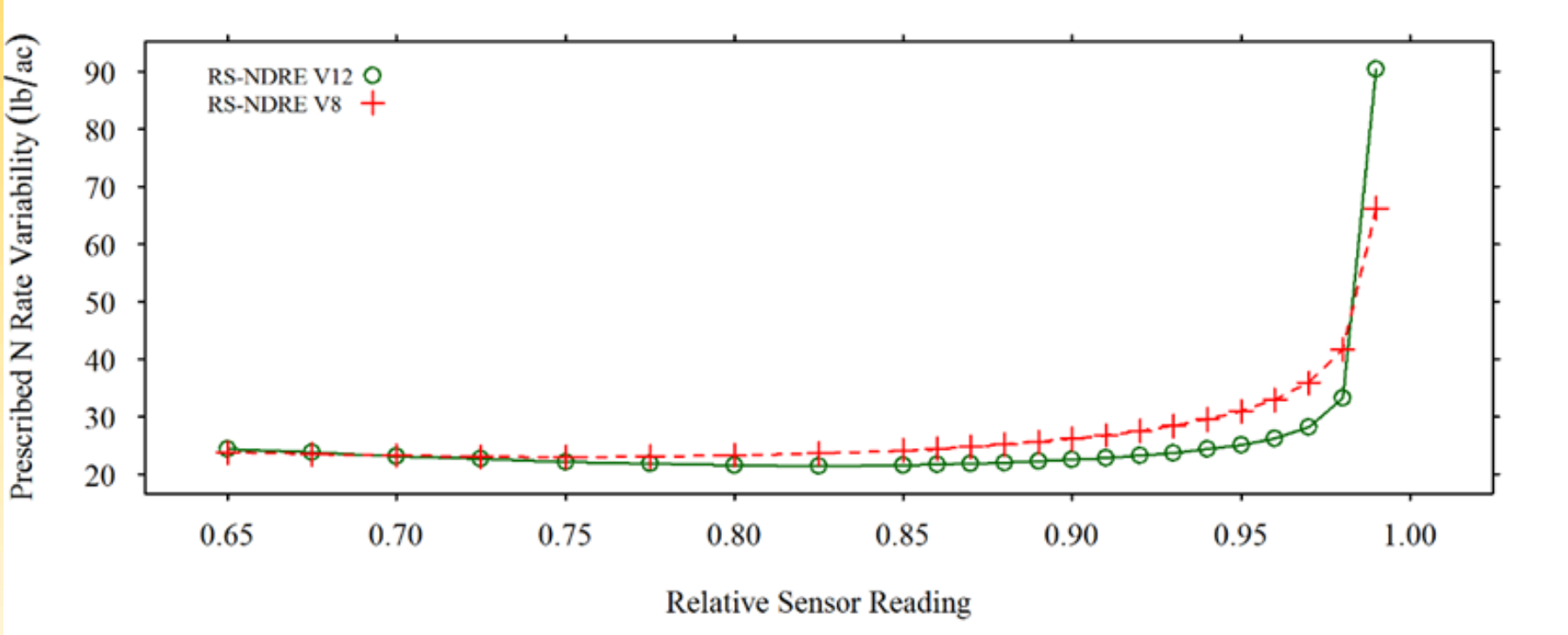
N Deficiency Determination – Sensor only –QPLoc – V8



N Deficiency Determination – Sensor only – QPLoc – V12

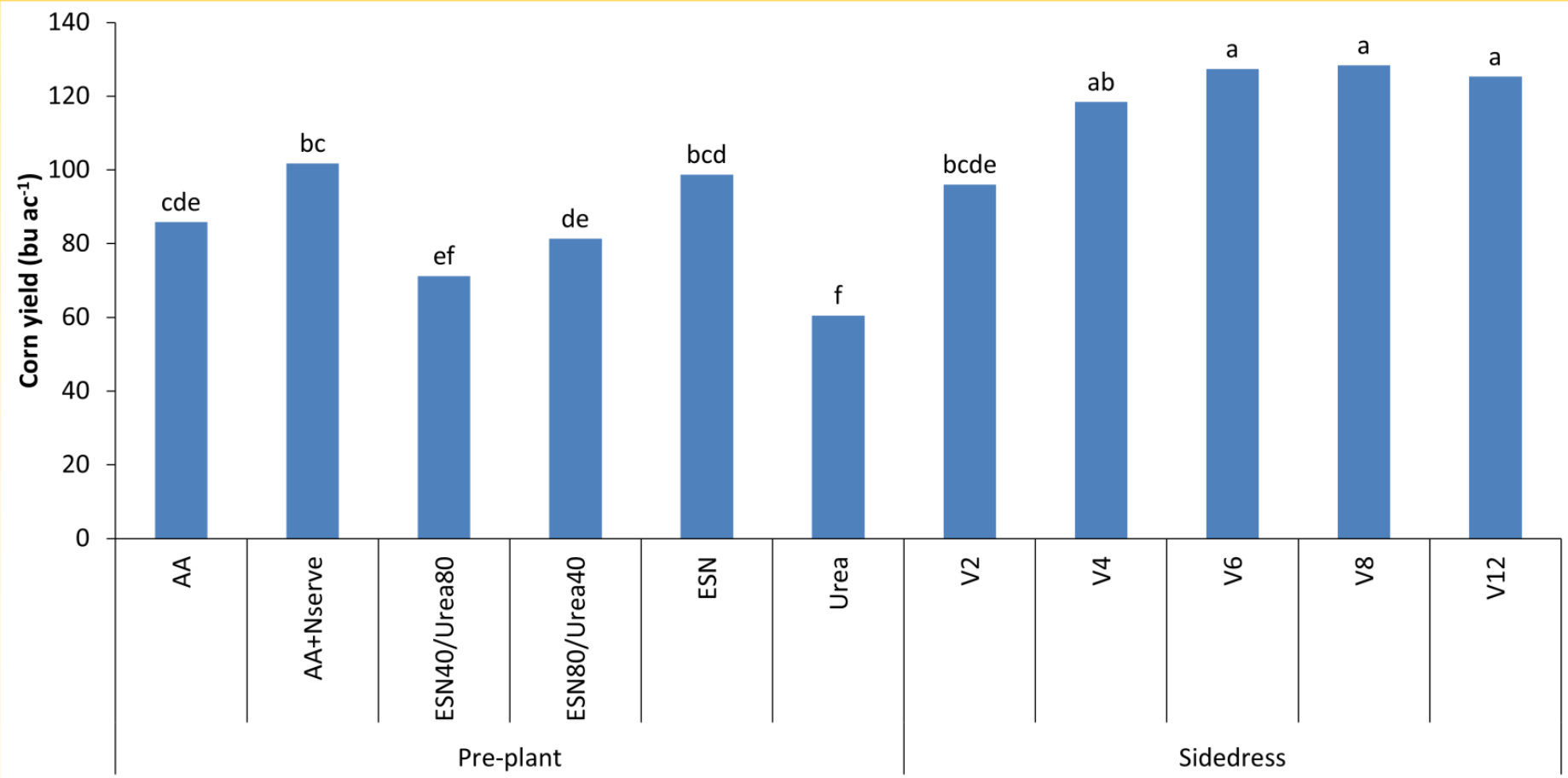


N Deficiency Determination – Sensor only – QPLoc

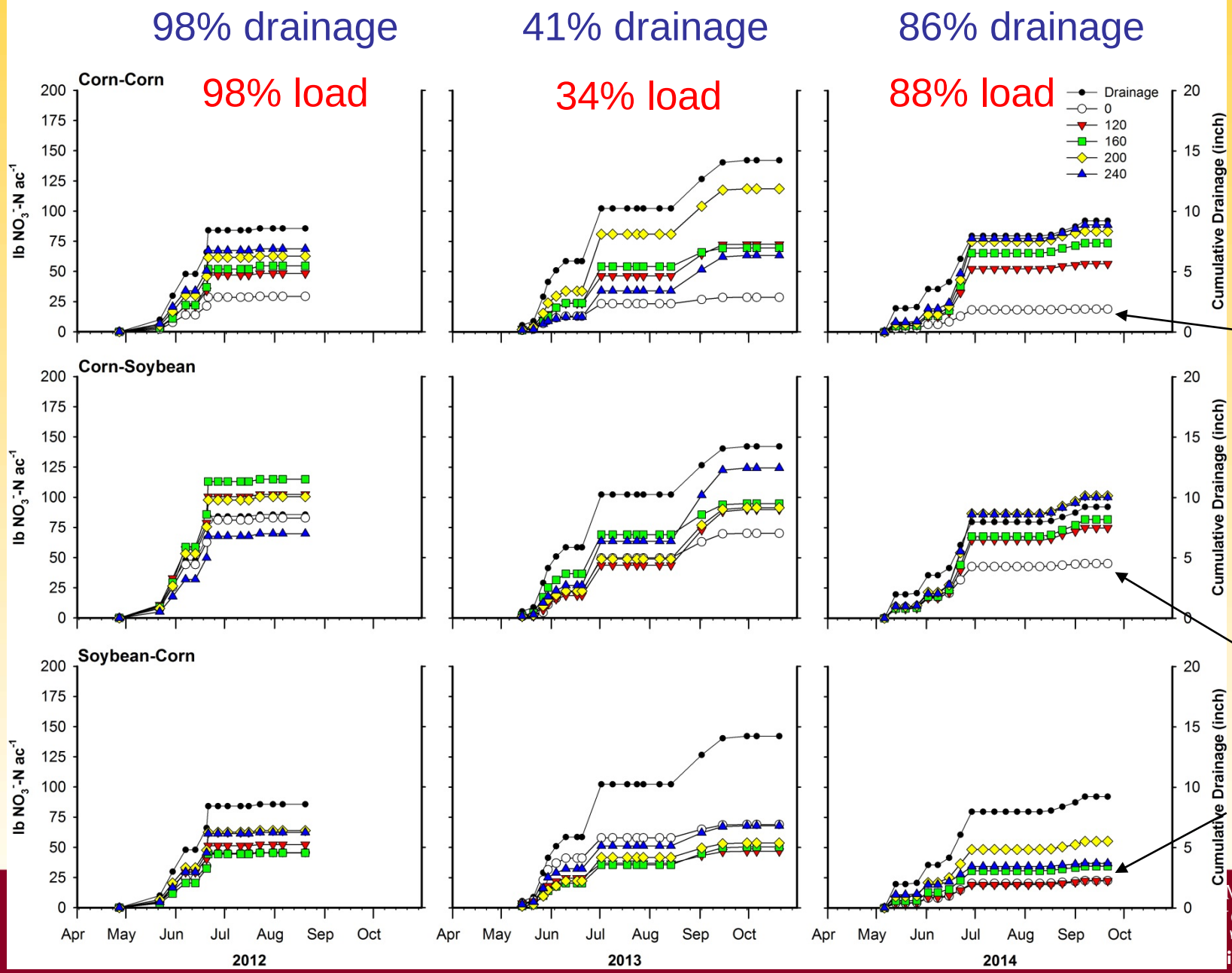


Corn yield (bu/ac) for Pre-Plant N Applications

Group1 (n=3) Linear response		Group3 (n=3) Q+P response	
AA	86AB	AA	166A
AAI	102A	AAI	179A
ESN	99A	ESN	167A
ESN-Urea 2:1	81ABC	ESN-Urea 2:1	183A
ESN-Urea 1:2	70BC	ESN-Urea 1:2	174A
Urea	61C	Urea	159A
Group2 (n=5) linear response		**Group4 (n=1) no response**	
AA	108C	AA	215A
AAI	115C	AAI	215A
ESN	140AB	ESN	206A
ESN-Urea 2:1	148A	ESN-Urea 2:1	209A
ESN-Urea 1:2	142A	ESN-Urea 1:2	204A
Urea	120BC	Urea	198A


Corn yield (bu ac-1)
140
120
100
80
60
40
20
0
cde
bc
ef
de
bcd
f
bcde
ab
a
a
a
AA
AA+Nserve
ESN40/Urea80
ESN80/Urea40
ESN
Urea
V2
V4
V6
V8
V12
Pre-plant
Sidedress

May-June 75% of drainage and 73% of load



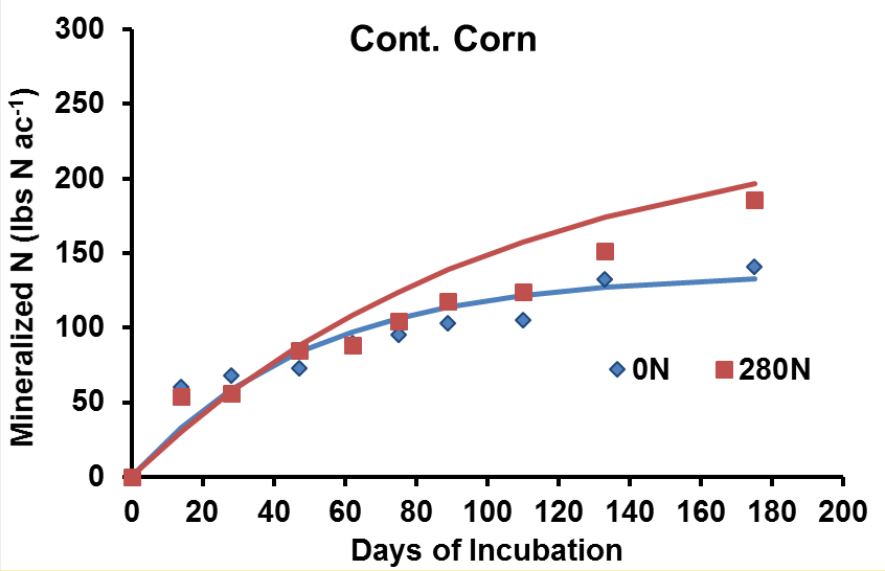
19 lb/a
8.8 mg/kg

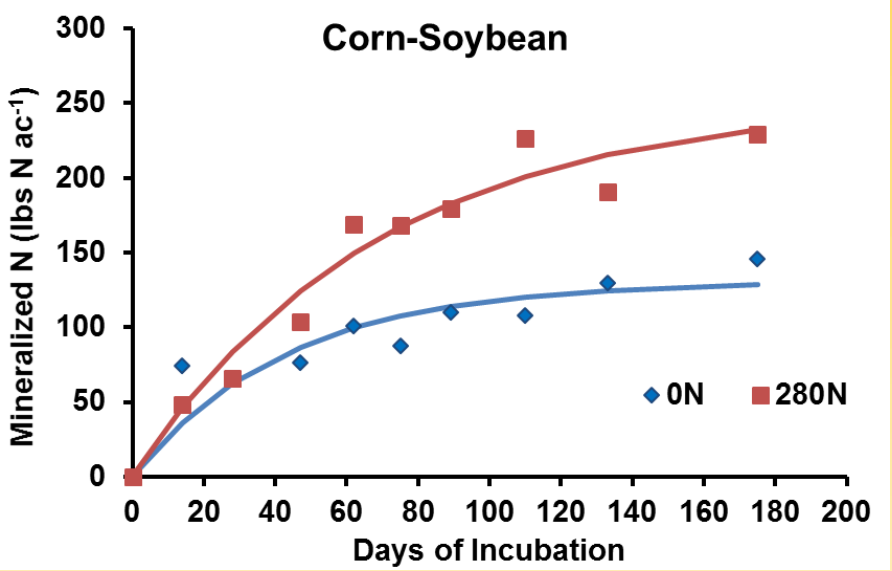
45 lb/a
19.7 mg/kg

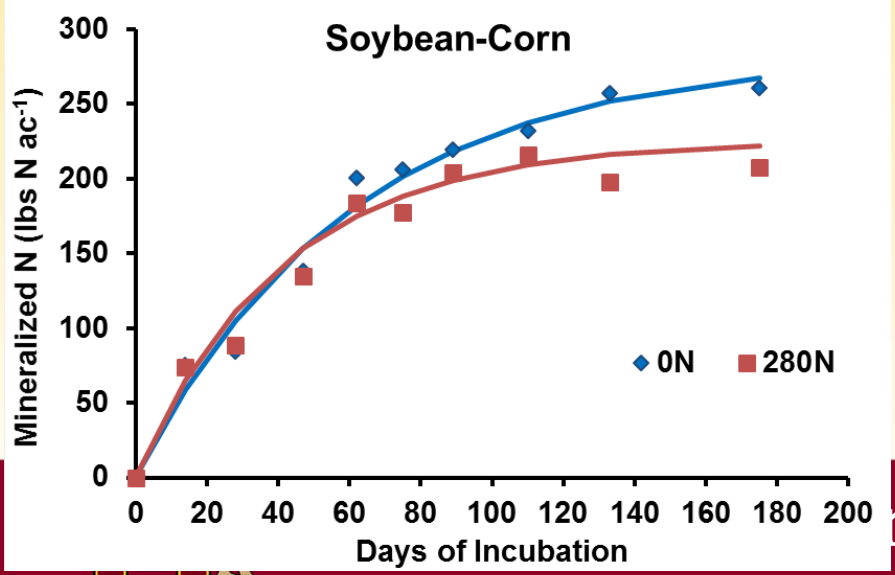
23 lb/a
10.6 mg/kg

MINNESOTA
SION
iscover℠

Potential Mineralizable N







Arvilla sandy loam: 4.6% OM CEC 16.1 meq/100g, (70% sand, 17% silt, 13% Clay), pH 7.1

N Rate Reduction is Not a Solution

	CC			CSb		
	N rate	Grain yield	NO_3^--N Leached	N rate	Grain yield	NO_3^--N Leached
	lb ac^{-1}	bu ac^{-1}	lb ac^{-1}	lb ac^{-1}	bu ac^{-1}	lb ac^{-1}
EONR	223	199	77	179	199	95
20% Reduction	179	191	70	144	194	91
25% Reduction	167	188	68	135	193	90

20% reduction reduced yield by 4% and NO_3-N leaching by 9%.
25% reduction reduced yield by 6% and NO_3-N leaching by 11%

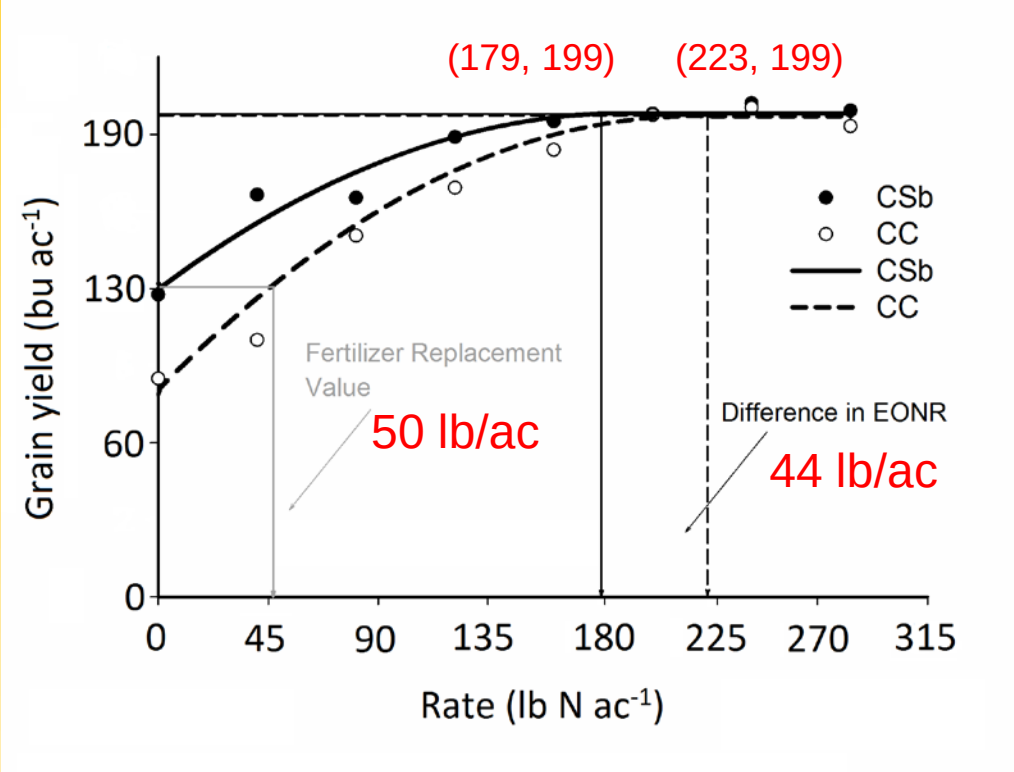


Table 1. Guidelines for use of N fertilizer for corn after corn grown on irrigated sandy soils.

N price/Crop value ratio	MRTN	Acceptable range
	---------- lb N/acre ----------	
0.05	233	214 – 252
0.10	209	192 – 225
0.15	191	177 – 206
0.20	177	164 - 190

UNIVERSITY OF MINNESOTA EXTENSION

NUTRIENT MANAGEMENT

AG-NM-1501 (2015)

Fertilizing Corn Grown on Irrigated Sandy Soils

John A. Lamb, Nutrient Management Specialist
Carl J. Rosen, Nutrient Management Specialist
Phyllis M. Bongard, Educational Content Development & Communications Specialist
Daniel E. Kaiser, Nutrient Management Specialist
Fabian G. Fernandez, Nutrient Management Specialist
Brian L. Barber, Director, Soil Testing Laboratory

Most irrigated corn grown in Minnesota is on soils derived from sand and gravel outwash deposits. Sub-soils are sandy while the surface soil's textures can range from sand to silty clay loam. With irrigation, these soils are very productive but nutrient application is necessary to get the most economical production from them. These soils also require high levels of management to control nutrient loss and related environmental degradation and profitability concerns.

NITROGEN BEST MANAGEMENT PRACTICES

Currently, the use of best management practices (BMPs) for nitrogen (N) is voluntary. Corn growers on irrigated sandy soils should implement BMPs to optimize N use efficiency, profit, and protect against increased losses of nitrate-N to groundwater aquifers. The focus of this publication is to present recent findings for N fertilizer use, especially related to rate of application and time of application. For more detailed discussion on time of application, selection of N source, placement of fertilizer N, and decisions regarding the use of nitrification inhibitors please see Extension publications listed under Related Publications.

Rate of N Application

Because of environmental risks and profitability concerns, N is the most important nutrient input for irrigated corn. The corn fertilizer guidelines established in 2006 were based on the use of the Maximum Return To Nitrogen (MRTN) concept. This concept incorporates the productivity of the soil, the cost of N fertilizer, the price received for corn, and the grower's attitude towards risk associated with insufficient N for the crop and risk of environmental degradation.

When the MRTN concept was developed, there was relatively little current information for corn N response on irrigated sandy soils. A decision was made to use data from highly productive fine-textured soils for the irrigated sandy soils until an adequate amount of data was collected under irrigation. Here we discuss N rates based on field research conducted since 2007 on irrigated sandy soils. The corn market and fertilizer costs do affect the economic optimum N rate. To account for this, the ratio of the price of N fertilizer per pound to the value of a bushel of corn is used in the N rate decision. An example calculation of the price/value ratio is if N fertilizer costs $0.50 per lb N or $830 per ton of anhydrous ammonia, and corn is valued at $5.00 per bushel, the ratio would be 0.50/5.00 = 0.10. Once the soil productivity, in this case irrigated sandy soils, and price/value ratio have been determined, a producer's attitude towards risk must be factored into the

Product	CC	CSb	SbC	CC	CSb	SbC
	mg NO_3^--N L^{-1}			lb NO_3^--N ac^{-1}		
Urea (Split)	30.3a	43.6a	18.8a	63a	95a	43a
ESN	27.1a	42.0a	19.2a	64a	85a	47a
ESN/Urea	28.2a	45.5a	21.6a	60a	99a	46a
SuperU	33.2a	52.4a	21.2a	67a	104a	52a

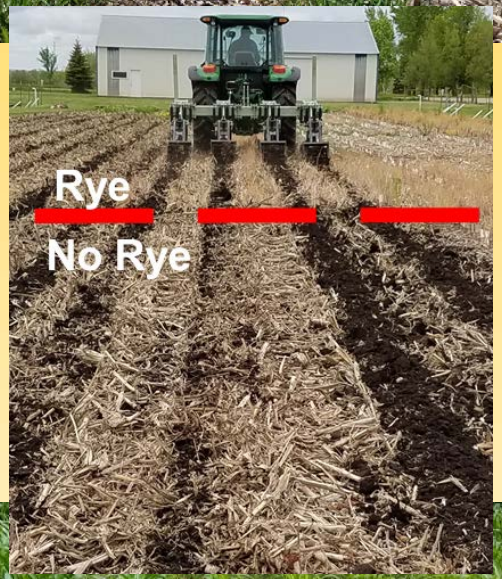
Source	Rate	Yield	PFP	AE
	lb ac^{-1}	bu ac^{-1}		
Urea (Split)	160	198a	62a	29a
ESN		190b	59b	26b
SuperU		188b	58b	26b
ESN/Urea	80/80	185b	58b	25b

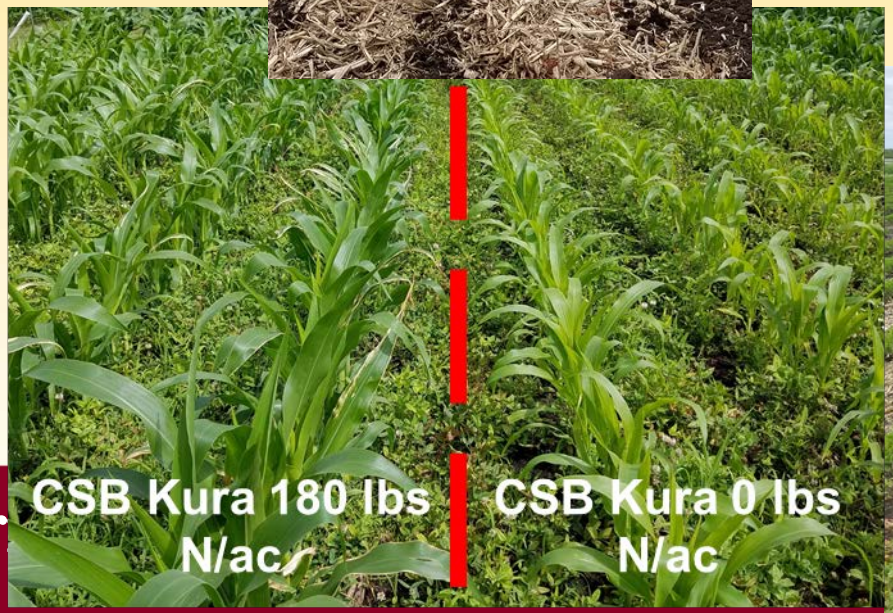
Partial Factor Productivity = $Yield_{(rate)}$ / N rate
Agronomic Efficiency = $Yield_{(rate)}$ - $Yield_{(control)}$ / N rate
Data averaged for Pope CC, CSb & Dakota Co. CC

Rye in CC
fall 2016

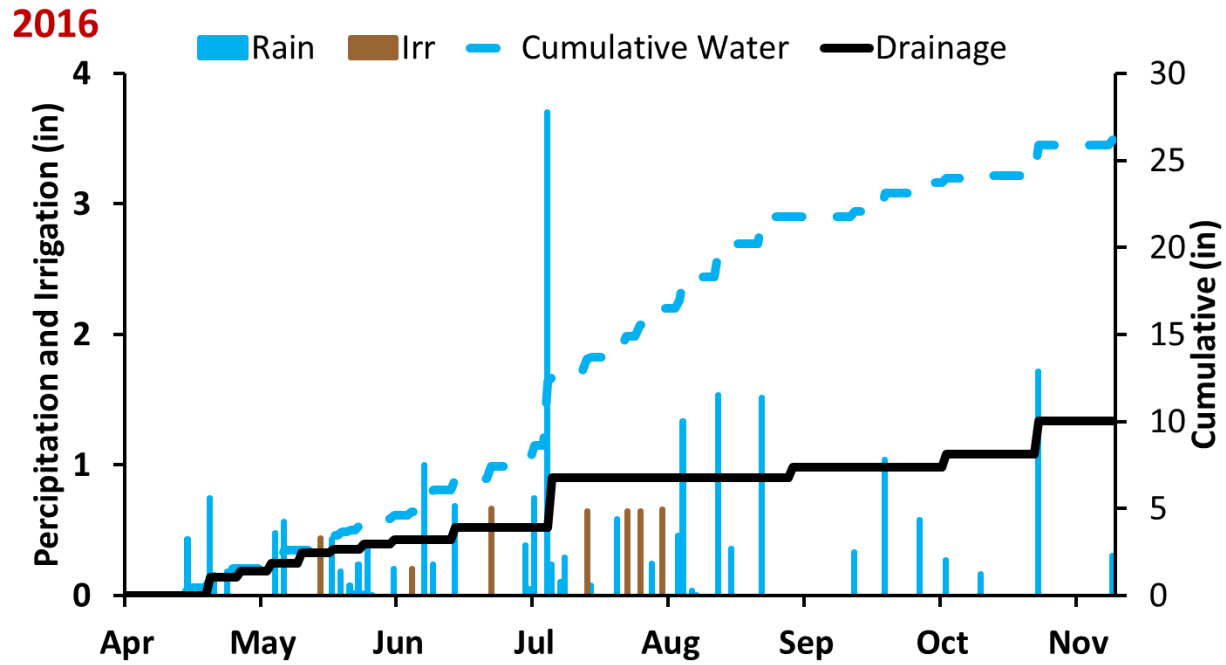
Rye spring 2017

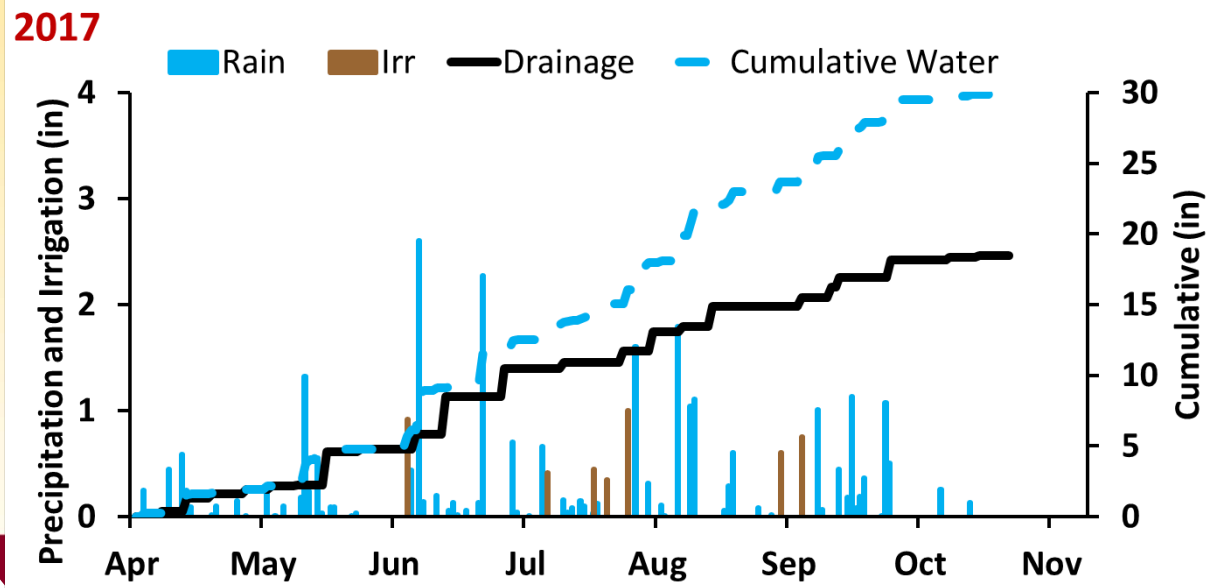
Mechanical Suppression 2017

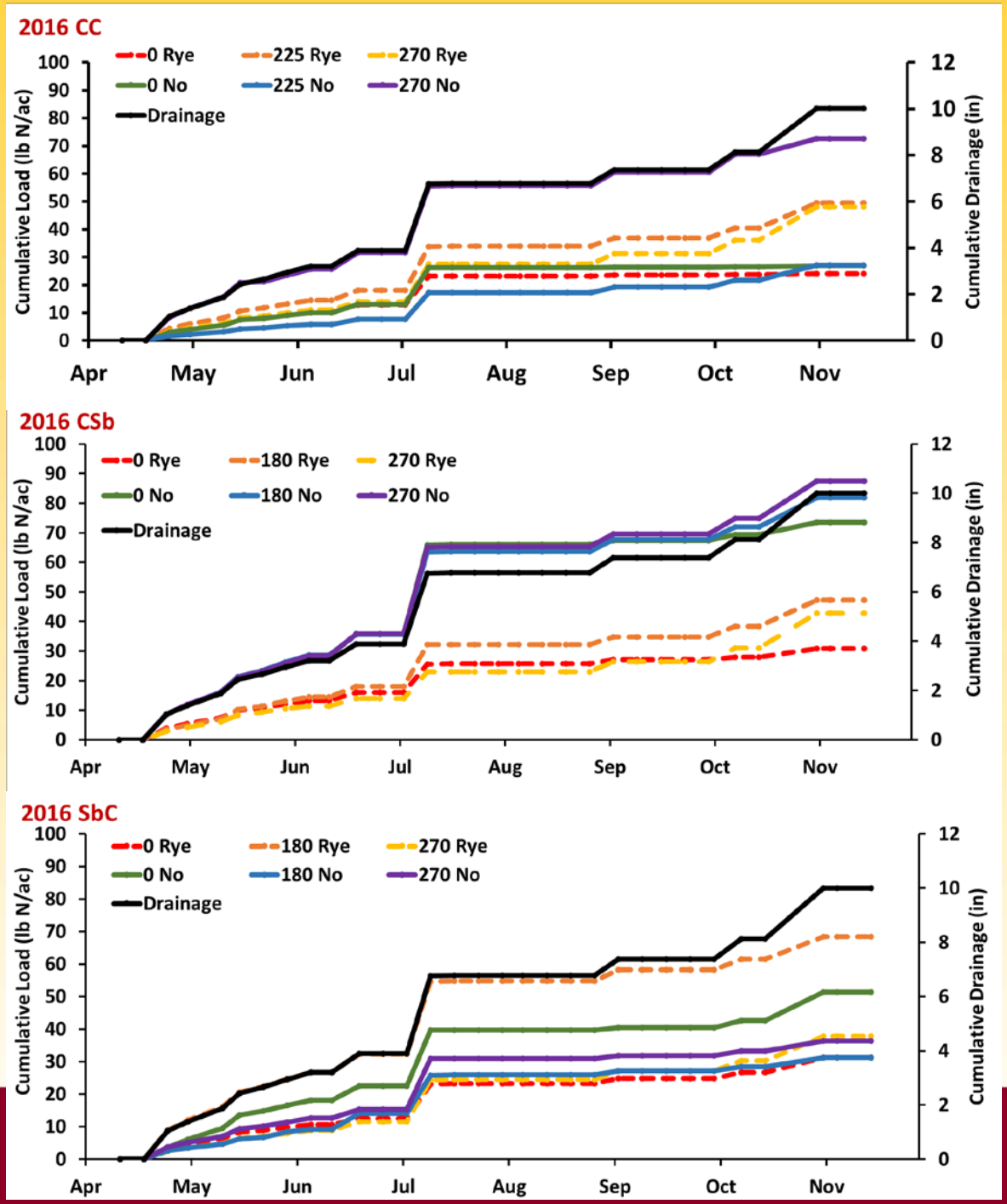

Rye
No Rye


CSB Kura 180 lbs
N/ac
CSB Kura 0 lbs
N/ac

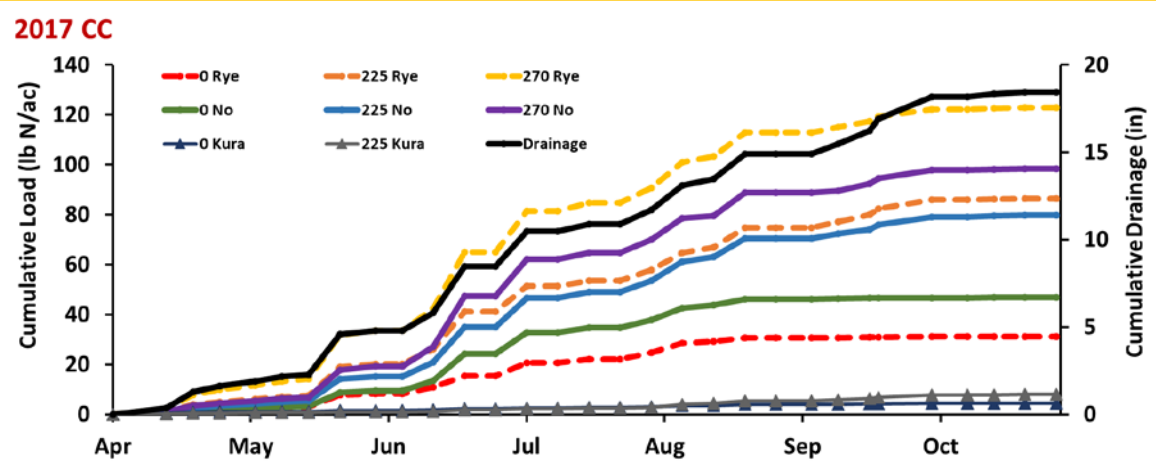
Soybeans in Kura 2017

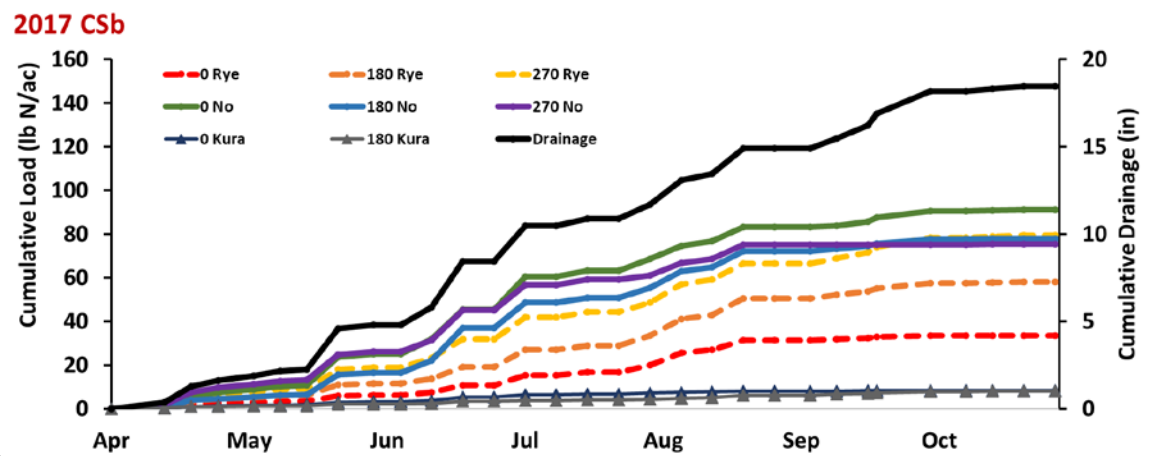

2016
Rain
Irr
Cumulative Water
Drainage
Percipitation and Irrigation (in)
Cumulative (in)
0
1
2
3
4
0
5
10
15
20
25
30
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov

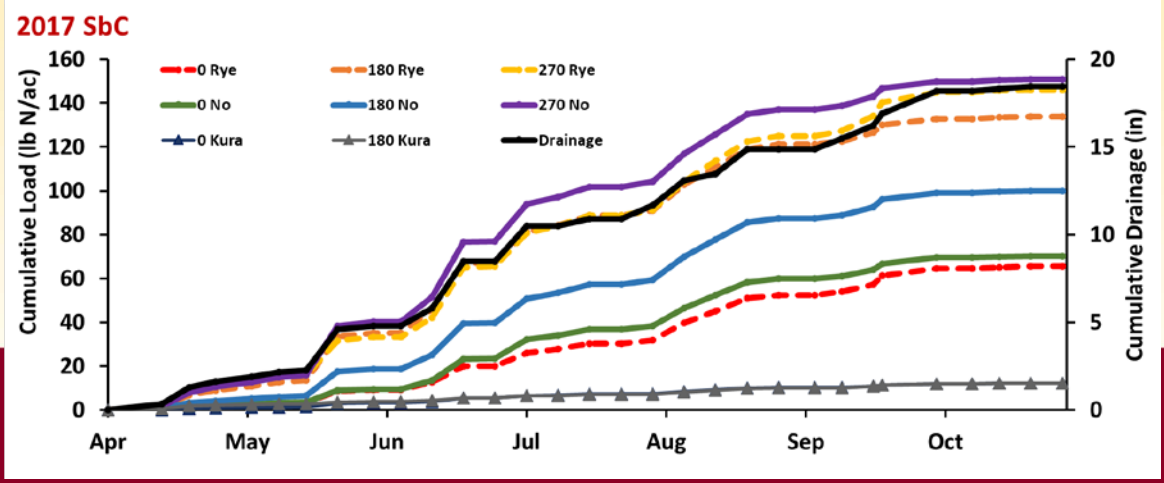

2017
Rain
Irr
Drainage
Cumulative Water
Precipitation and Irrigation (in)
Cumulative (in)
0
1
2
3
4
0
5
10
15
20
25
30
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov



Spring 2016, Rye biomass			
	lbs/ac	% N	lb N/ac
CC	391	2.9	11
CSb	2573	2.4	62
SbC	518	3.2	17

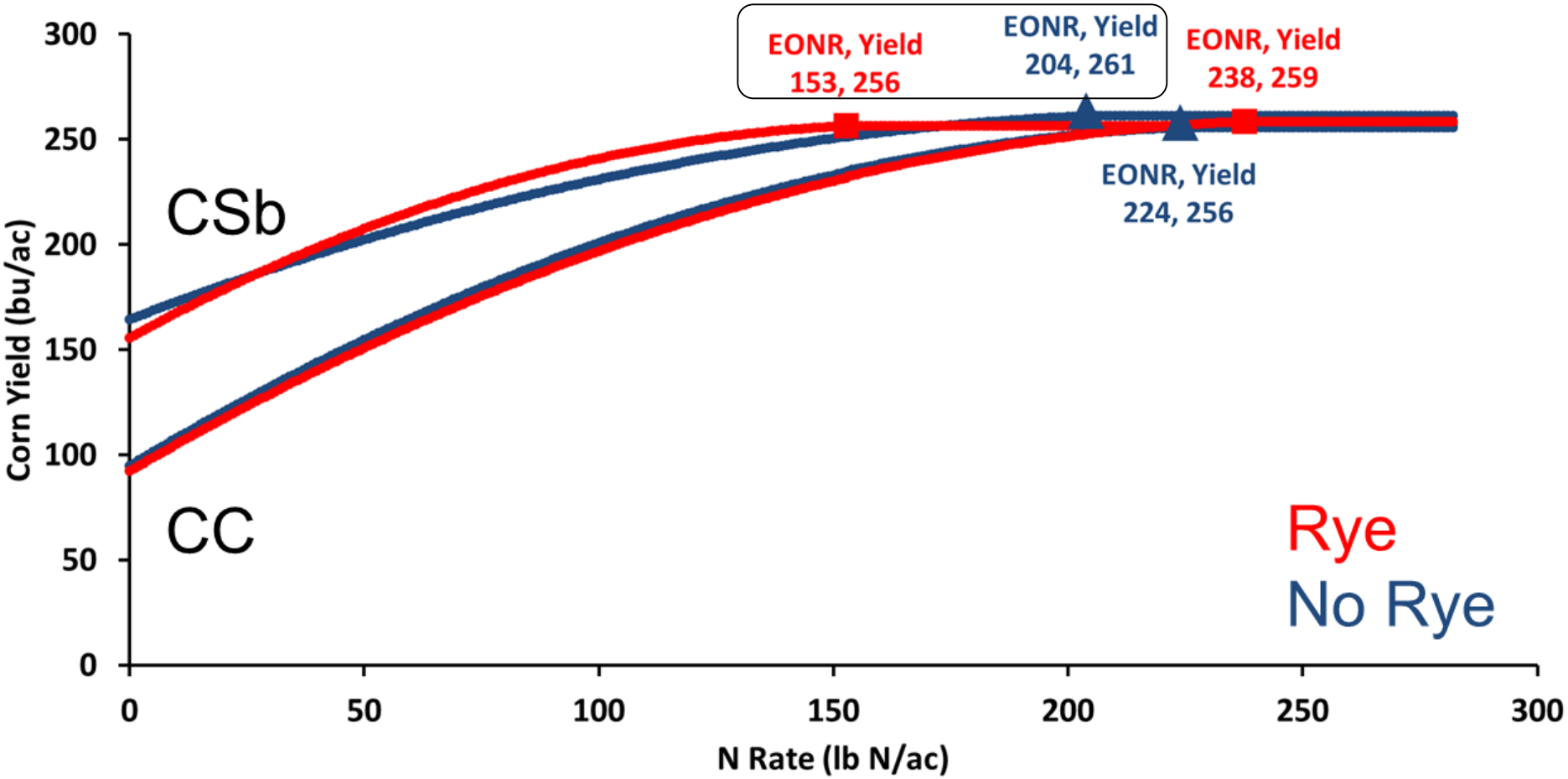




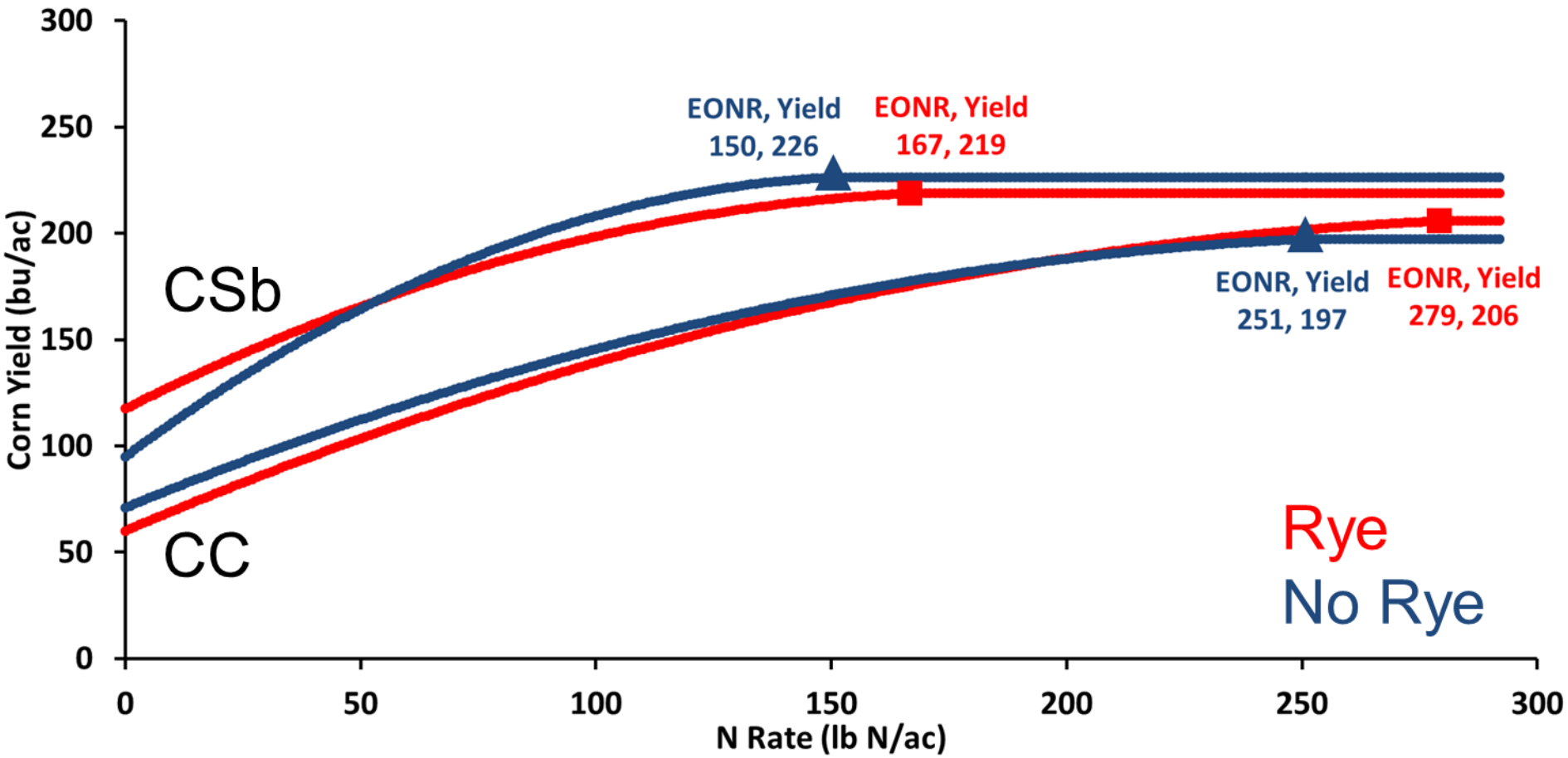


Rye biomass		
	Fall 2016	Spring 2017
	lb/ac	
CC	100	327
CSb	152	1358
SbC	334	327

2016


EONR, Yield
153, 256
EONR, Yield
204, 261
EONR, Yield
238, 259
EONR, Yield
224, 256
CSb
CC
Rye
No Rye
Corn Yield (bu/ac)
N Rate (lb N/ac)
0
50
100
150
200
250
300

2017


300
250
200
150
100
50
0
Corn Yield (bu/ac)
0
50
100
150
200
250
300
N Rate (lb N/ac)
EONR, Yield
150, 226
EONR, Yield
167, 219
EONR, Yield
251, 197
EONR, Yield
279, 206
CSb
CC
Rye
No Rye

mawrc.org/events/

Questions

Fabián Fernández
fabiangf@umn.edu

THANK YOU

Minnesota Department of Agriculture

Minnesota Soybean Research & Promotion Council

MinnesotaCorn GROWERS ASSOCIATION

AFREC
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