Improved Productivity with In-Season Nitrogen Management

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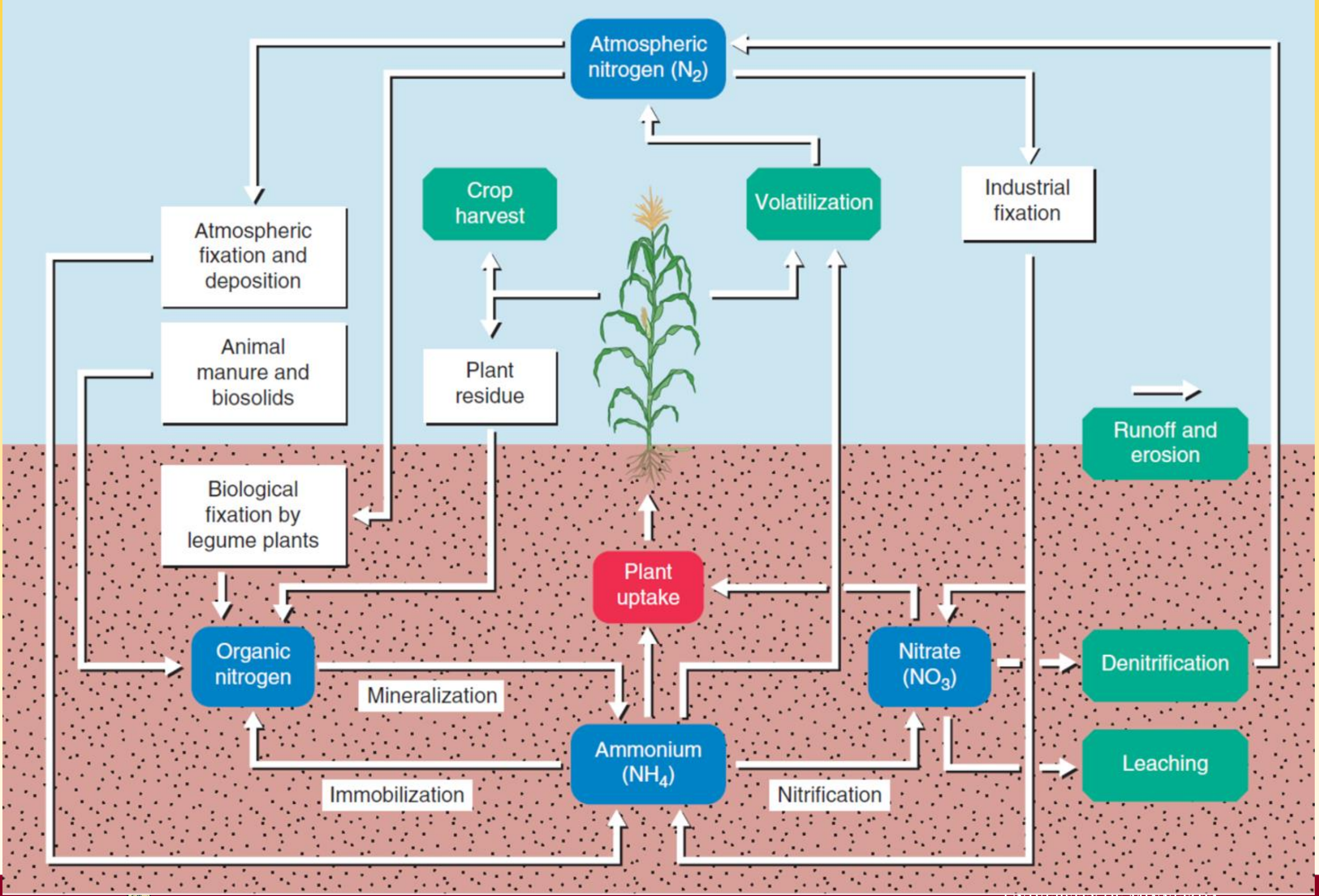
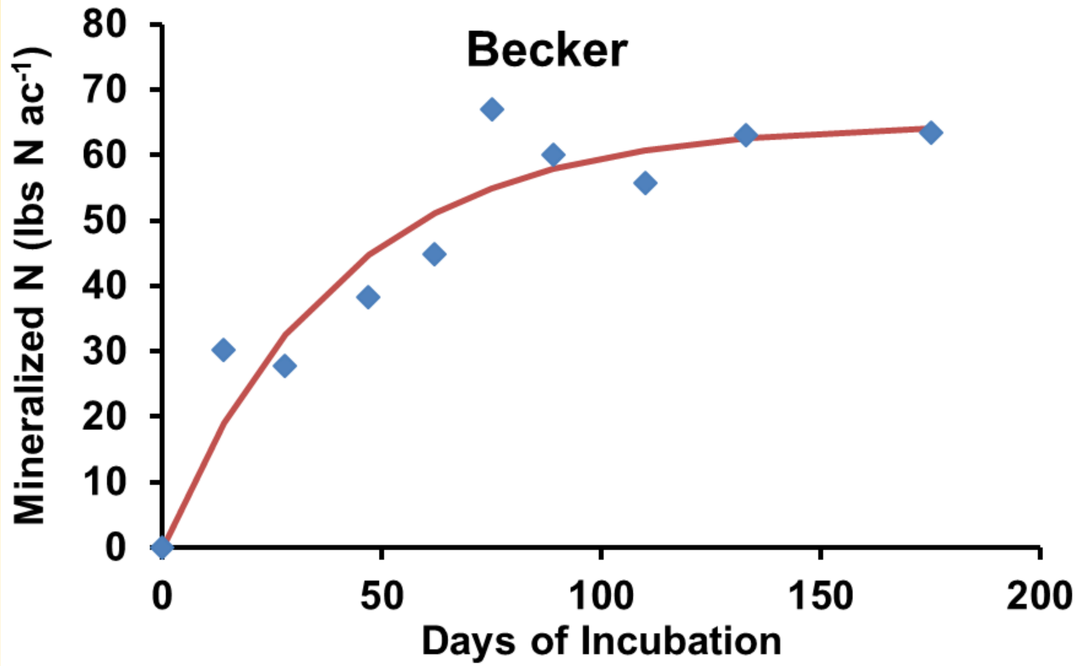
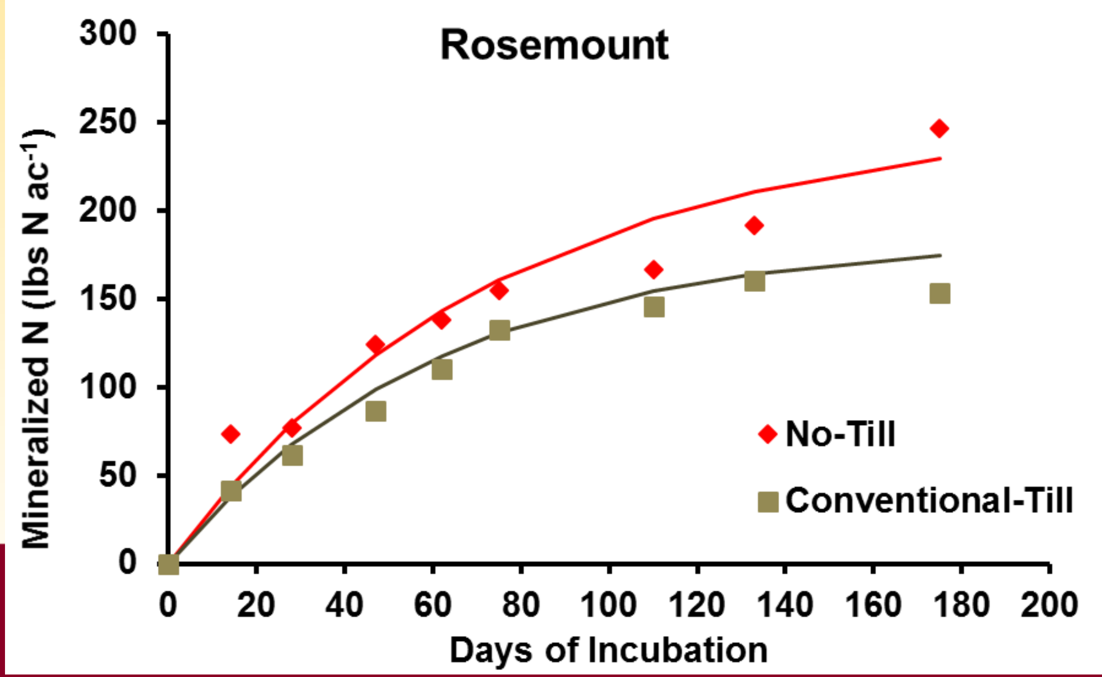


Nutrient Management

Potential Mineralizable N

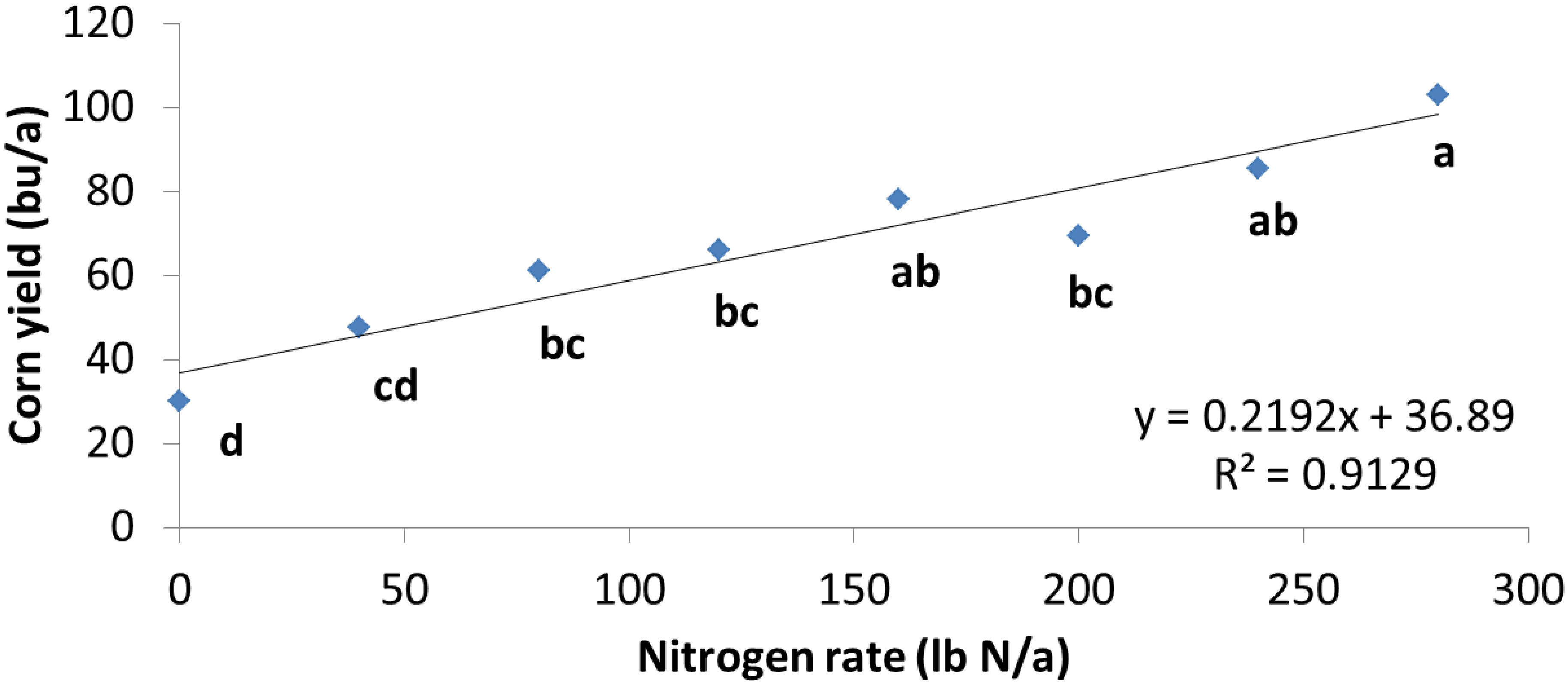


Waukegan silt-loam over sand: 4.8% OM CEC 15.7 meq/100g, (22% sand, 51% silt, 27% Clay), pH 6.6



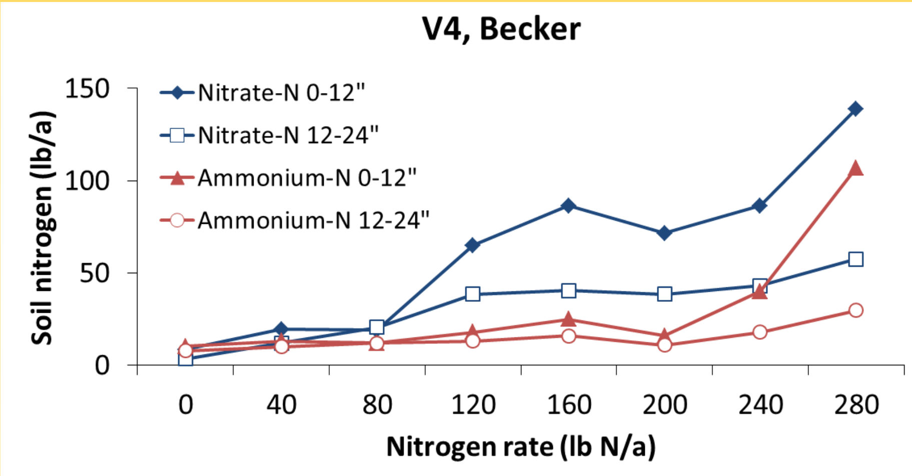
Hubbard loamy sand: 1.5% OM, CEC 7.6 meq/100g, (90% sand, 5% silt, 5% Clay), pH 7.2

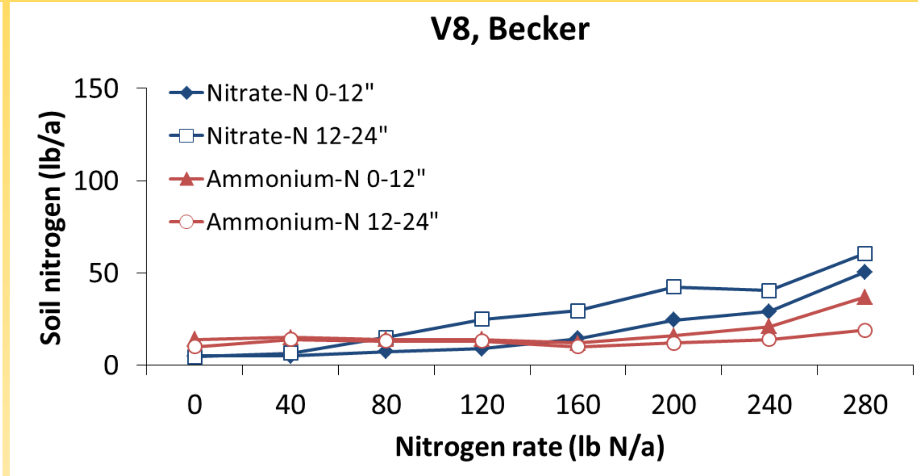
Becker, Yield



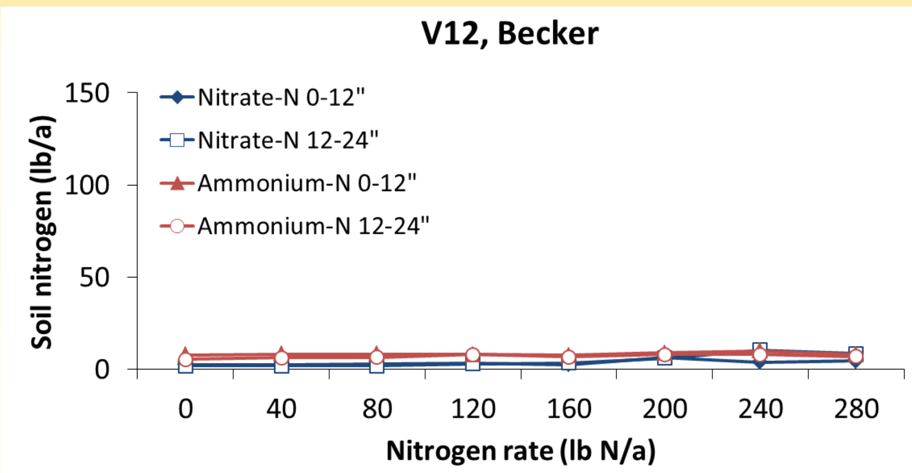
Hubbard loamy sand

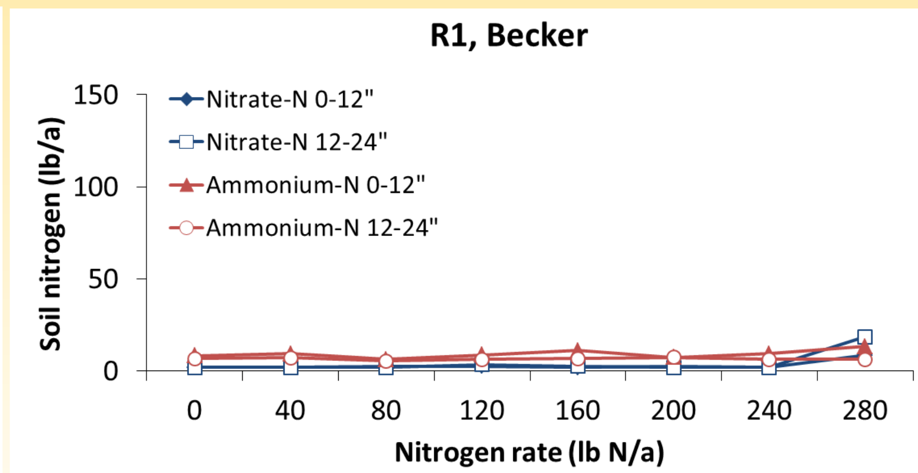
Soil N with Pre-plant Applications



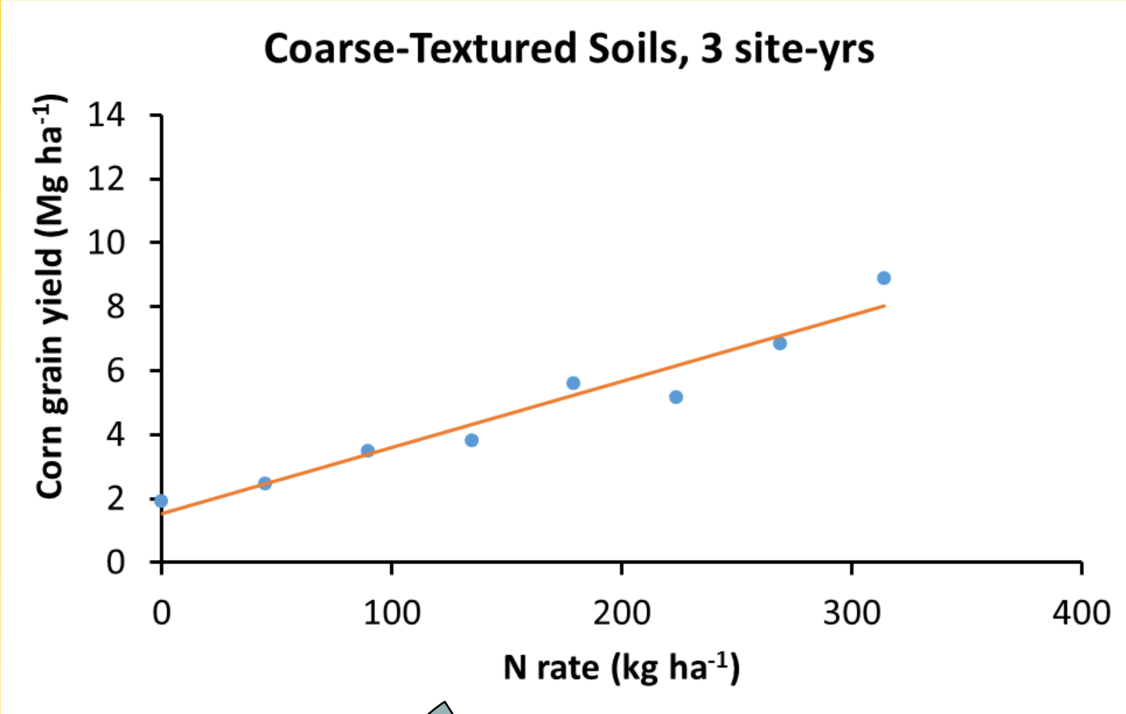


Soil with 1.6% OM, CEC 8 meq/100g

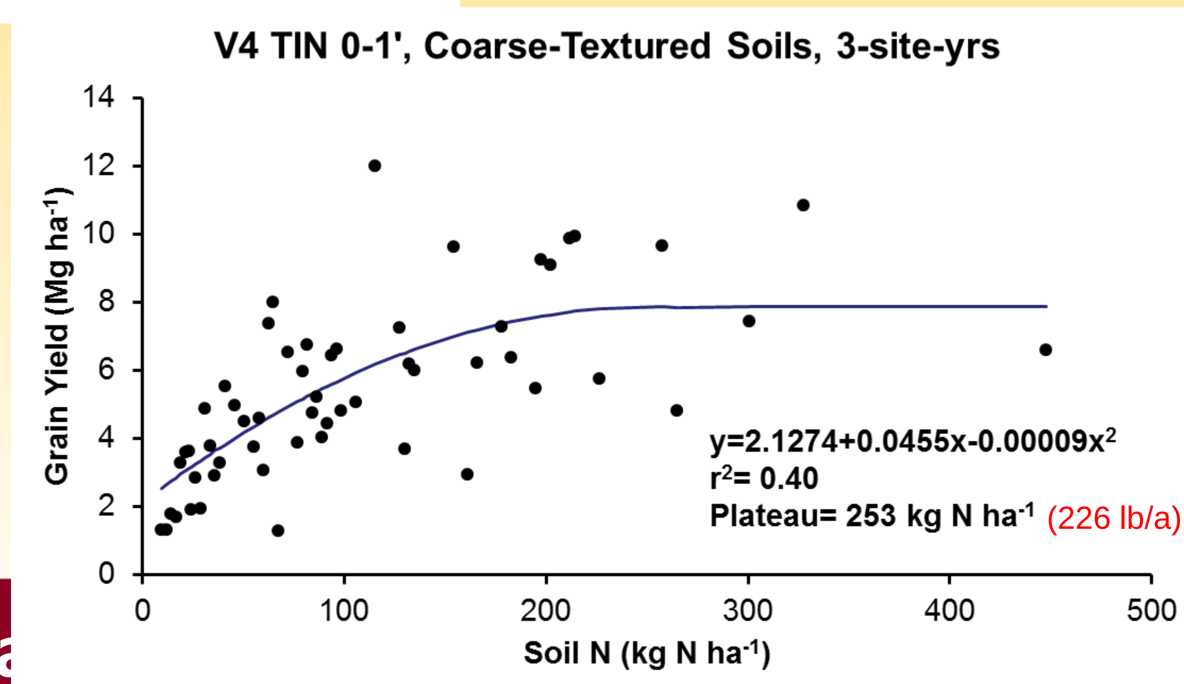




Hubbard loamy sand



Coarse-Textured Soils, 3 site-yrs
Corn grain yield (Mg ha-1)
0
2
4
6
8
10
12
14
0
100
200
300
400
N rate (kg ha-1)



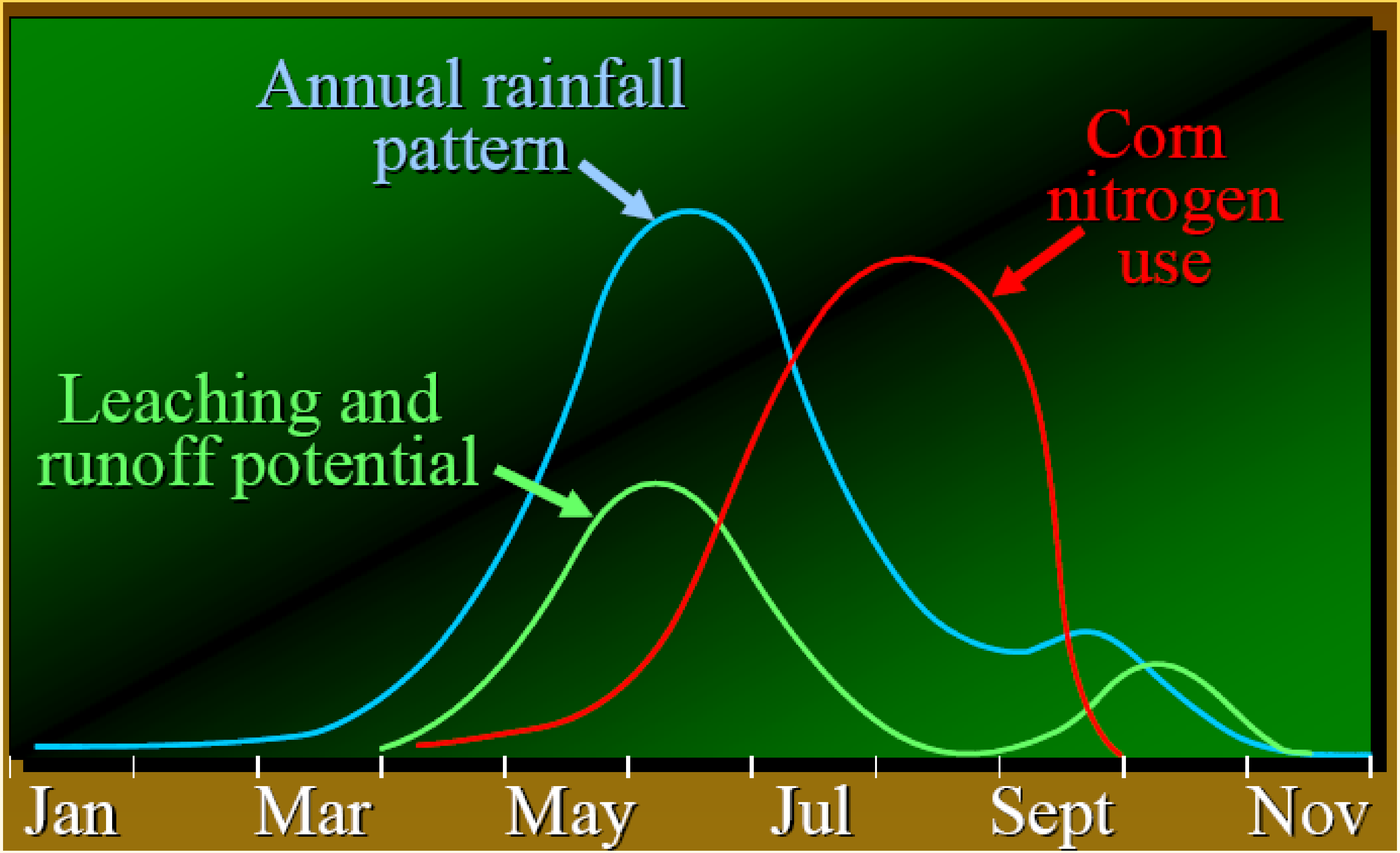
V4 TIN 0-1', Coarse-Textured Soils, 3-site-yrs
Grain Yield (Mg ha-1)
0
2
4
6
8
10
12
14
0
100
200
300
400
500
Soil N (kg N ha-1)
y=2.1274+0.0455x-0.00009x2
r2= 0.40
Plateau= 253 kg N ha-1 (226 lb/a)

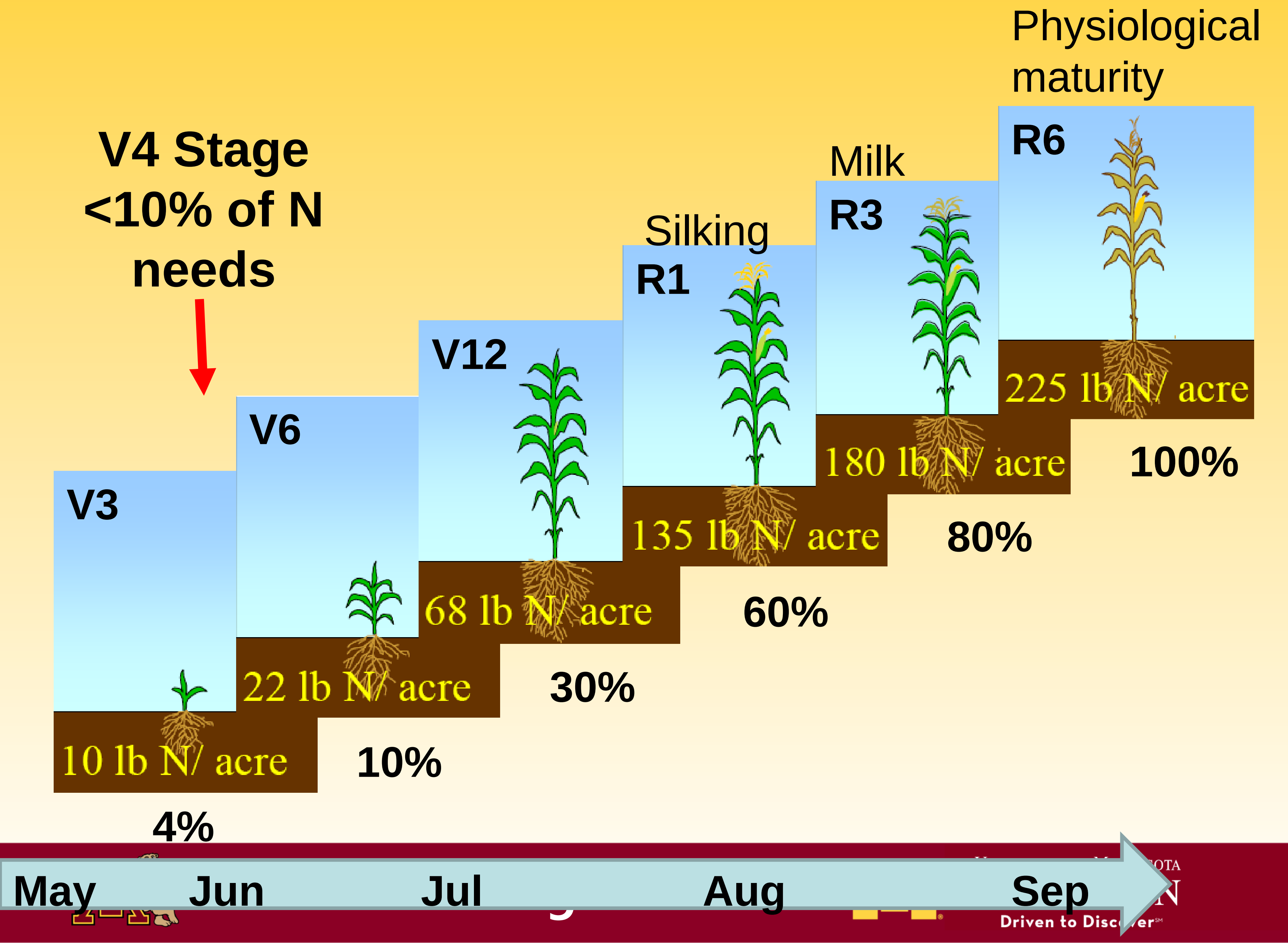
V4 soil N (lb ac^{-1}) corn yield prediction

Soil	Grouping	NO_3				TIN			
		0-1'		0-2'		0-1'		0-2'	
		R^2	Plateau	R^2	Plateau	R^2	Plateau	R^2	Plateau
Coarse-Textured	3 Site-yrs	0.31	113	0.38	269	0.40	226	0.36	---
Fine-Textured	5 Site-yrs	0.69	124	0.69	191	0.63	154	0.66	---
	3 Site-yrs	0.27	109	0.33	121	0.20	145	0.26	168
	1 Site-yrs	0.06	74	0.15	120	0.12	85	0.13	142

V8 soil N (lb ac^{-1}) corn yield prediction

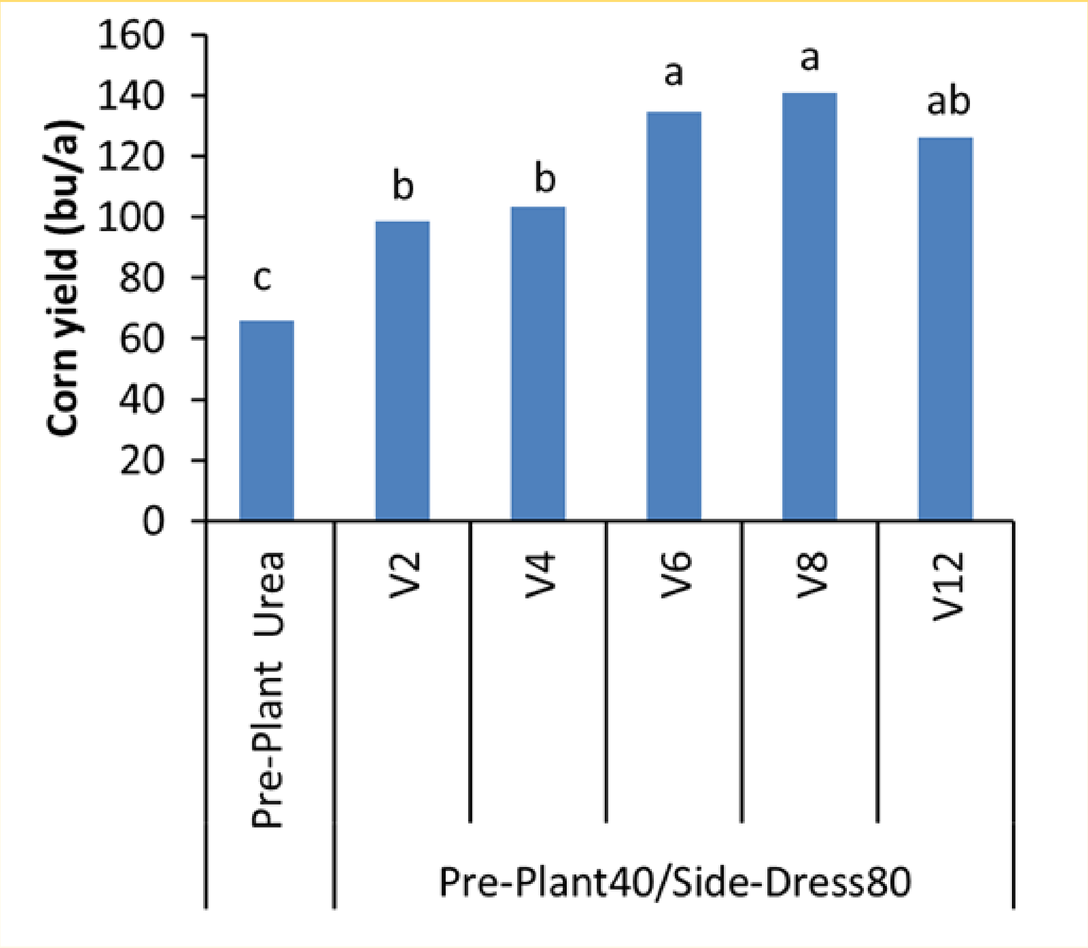
Soil	Grouping	NO_3				TIN			
		0-1'		0-2'		0-1'		0-2'	
		R^2	Plateau	R^2	Plateau	R^2	Plateau	R^2	Plateau
Coarse-Textured	3 Site-yrs	0.32	58	0.42	---	0.30	119	0.40	---
Fine-Textured	5 Site-yrs	0.25	54	0.40	100	0.16	103	0.27	173
	3 Site-yrs	0.20	62	0.25	84	0.14	92	0.19	121
	1 Site-yrs	0.12	---	0.13	---	0.26	---	0.38	---


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

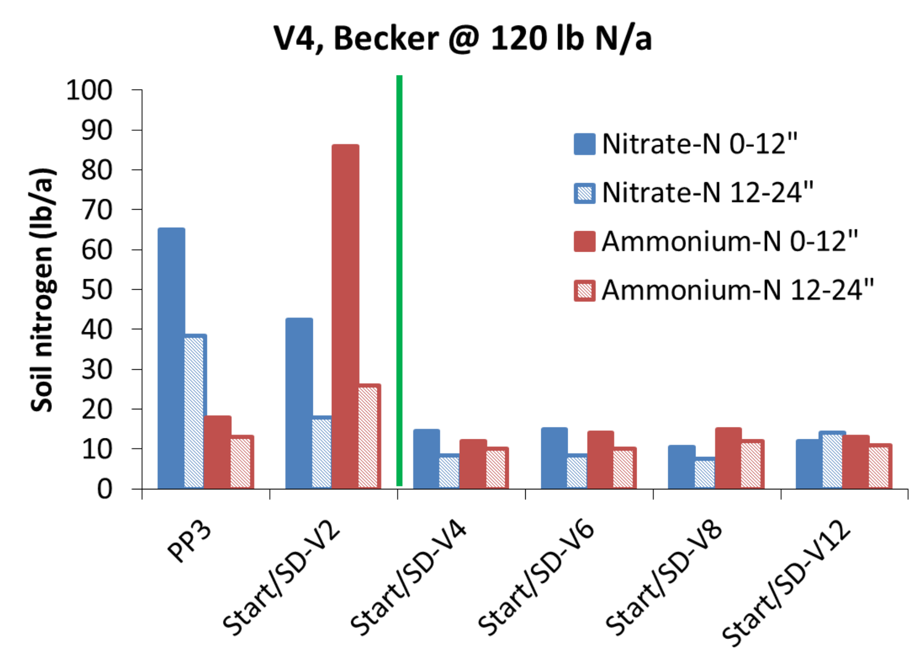


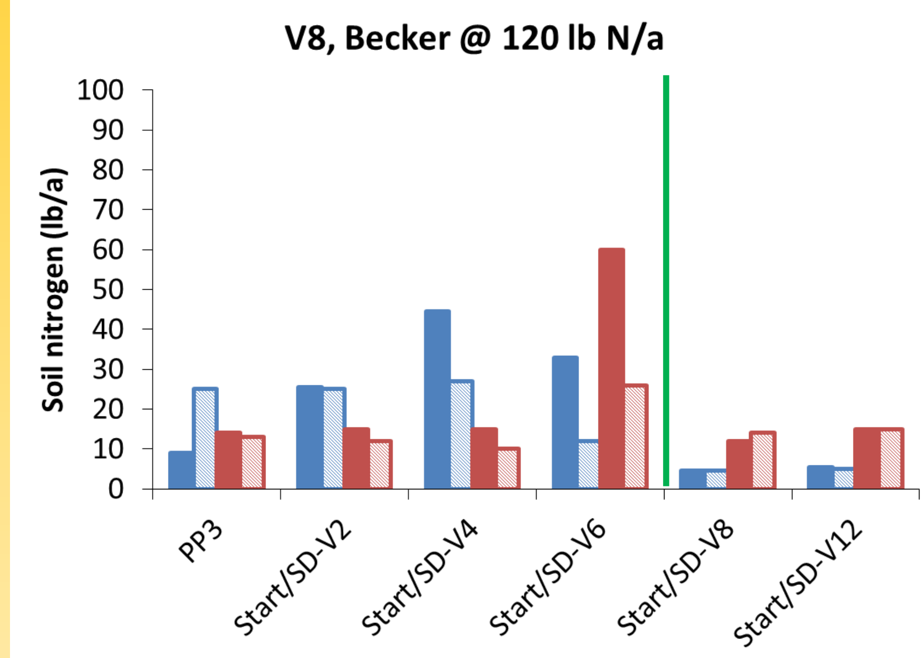
V4 Stage
<10% of N
needs
V3
10 lb N/ acre
4%
V6
22 lb N/ acre
10%
V12
68 lb N/ acre
30%
Silking
R1
135 lb N/ acre
60%
Milk
R3
180 lb N/ acre
80%
Physiological
maturity
R6
225 lb N/ acre
100%
May
Jun
Jul
Aug
Sep

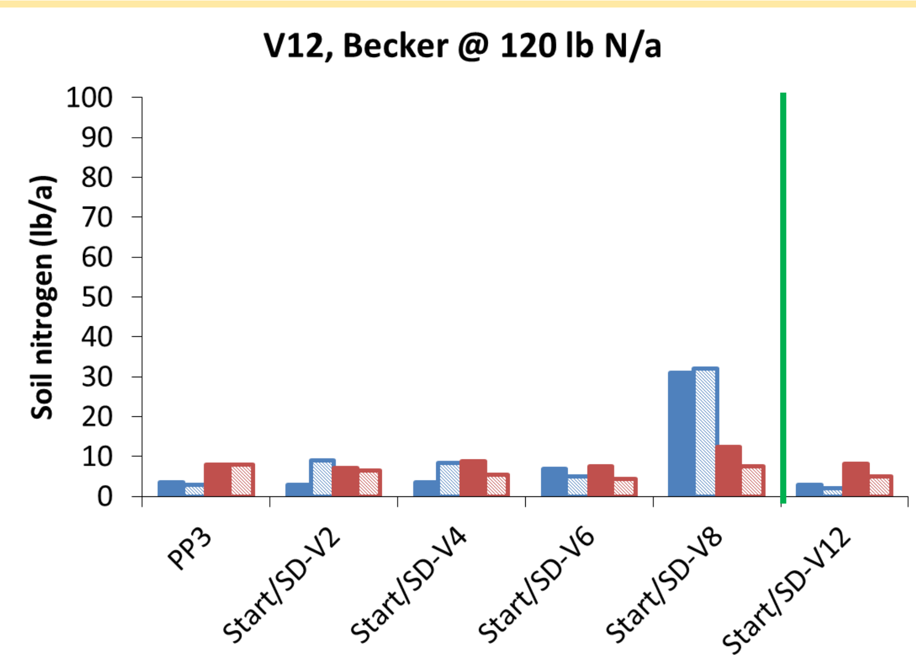
Becker, C-C at 120 lb N/a

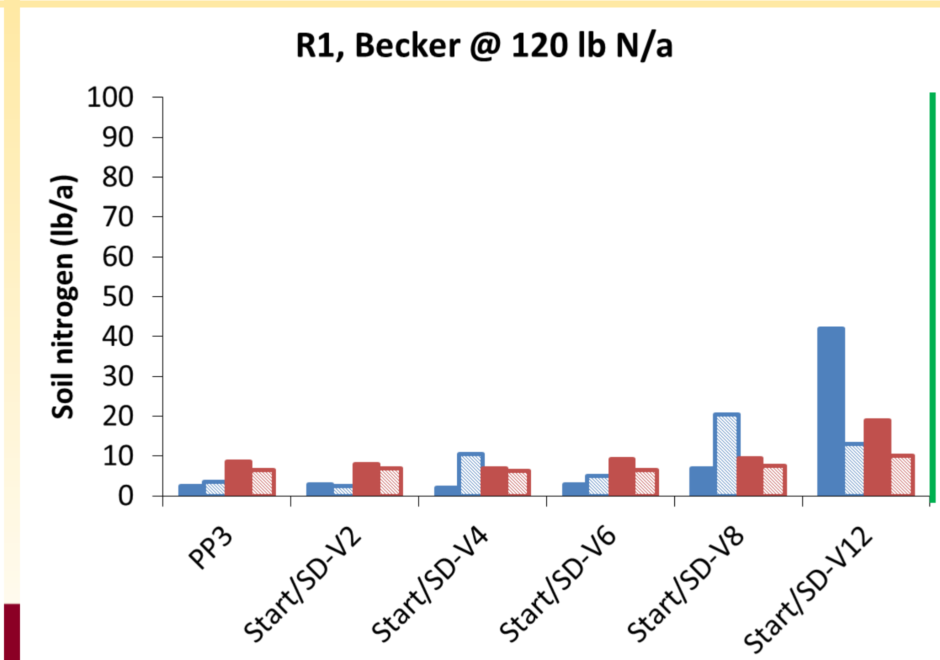


Hubbard loamy sand

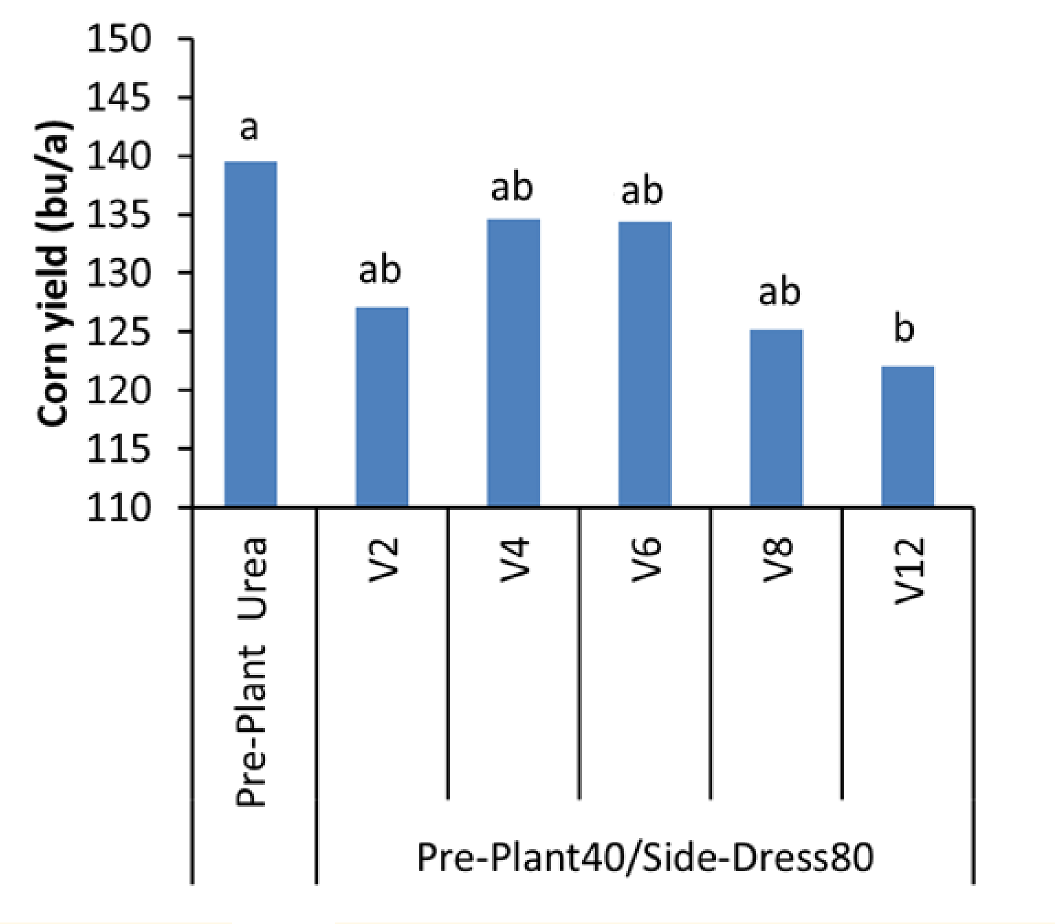

V4, Becker @ 120 lb N/a
Soil nitrogen (lb/a)
100
90
80
70
60
50
40
30
20
10
0
Nitrate-N 0-12"
Nitrate-N 12-24"
Ammonium-N 0-12"
Ammonium-N 12-24"
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12

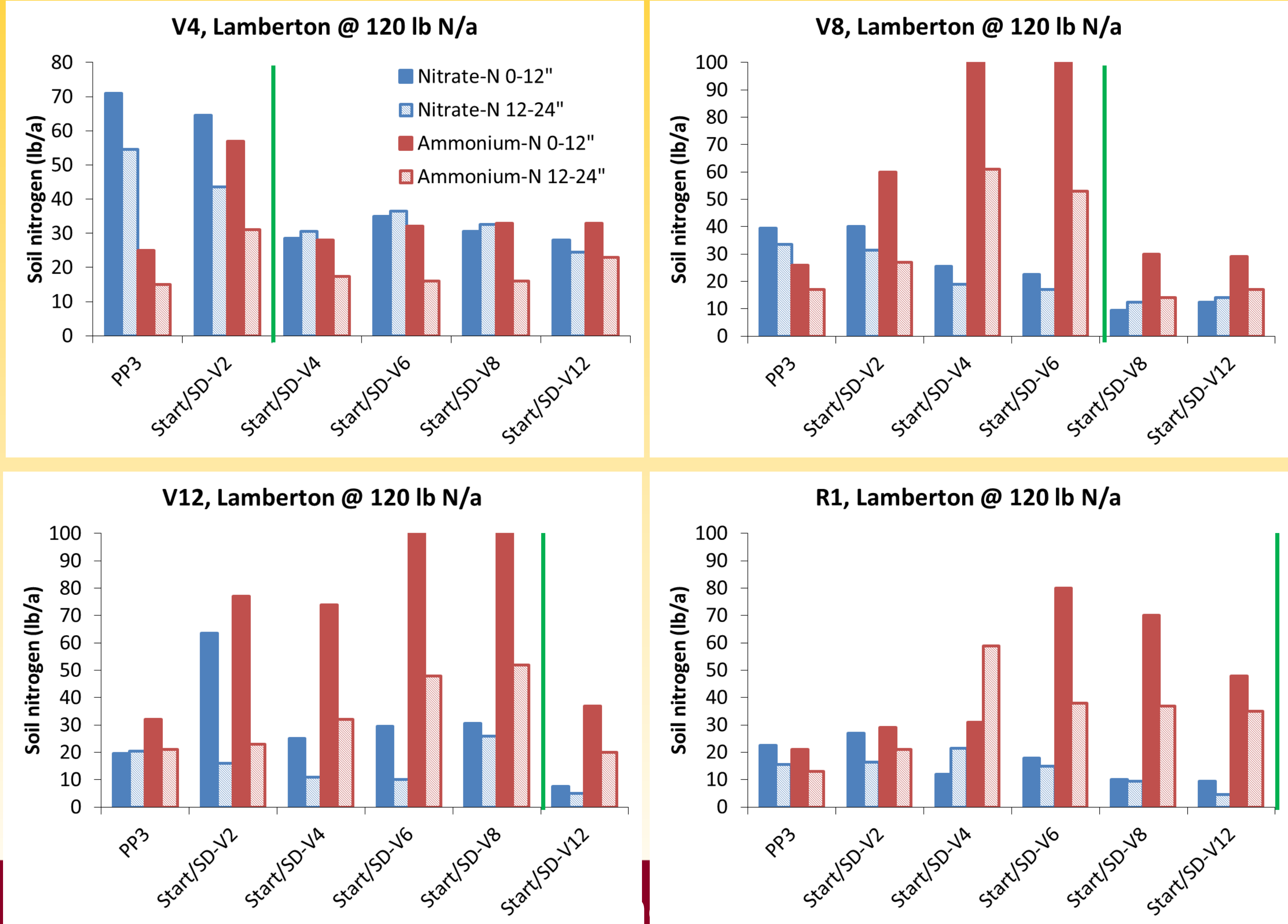

V8, Becker @ 120 lb N/a
Soil nitrogen (lb/a)
100
90
80
70
60
50
40
30
20
10
0
PP3
Start/SD-V2
Start/SD-V4
Start/SD-V6
Start/SD-V8
Start/SD-V12


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

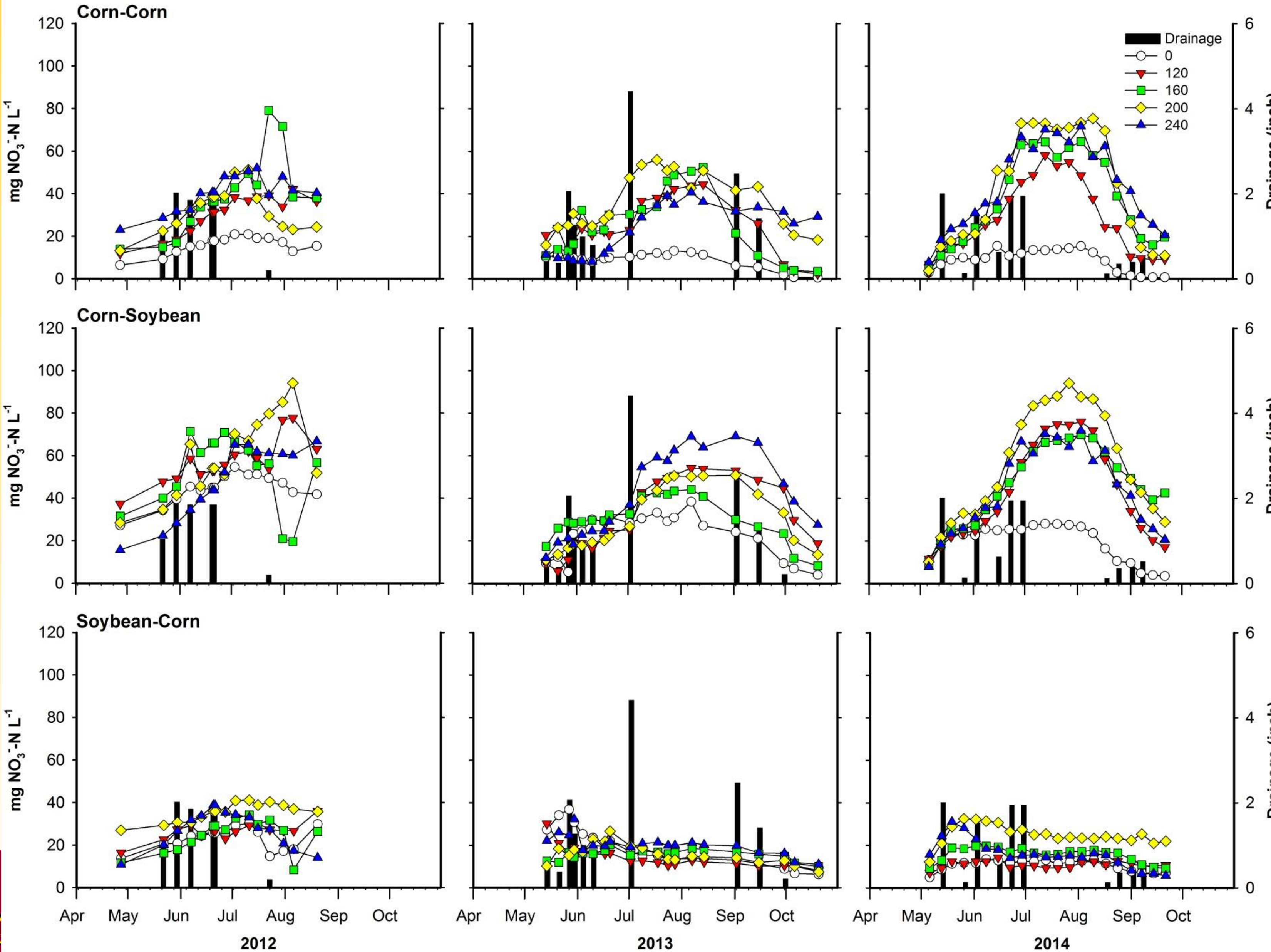
Lamberton, C-C at 120 lb N/a




V4, Lamberton @ 120 lb N/a
V8, Lamberton @ 120 lb N/a
V12, Lamberton @ 120 lb N/a
R1, Lamberton @ 120 lb N/a
Soil nitrogen (lb/a)
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

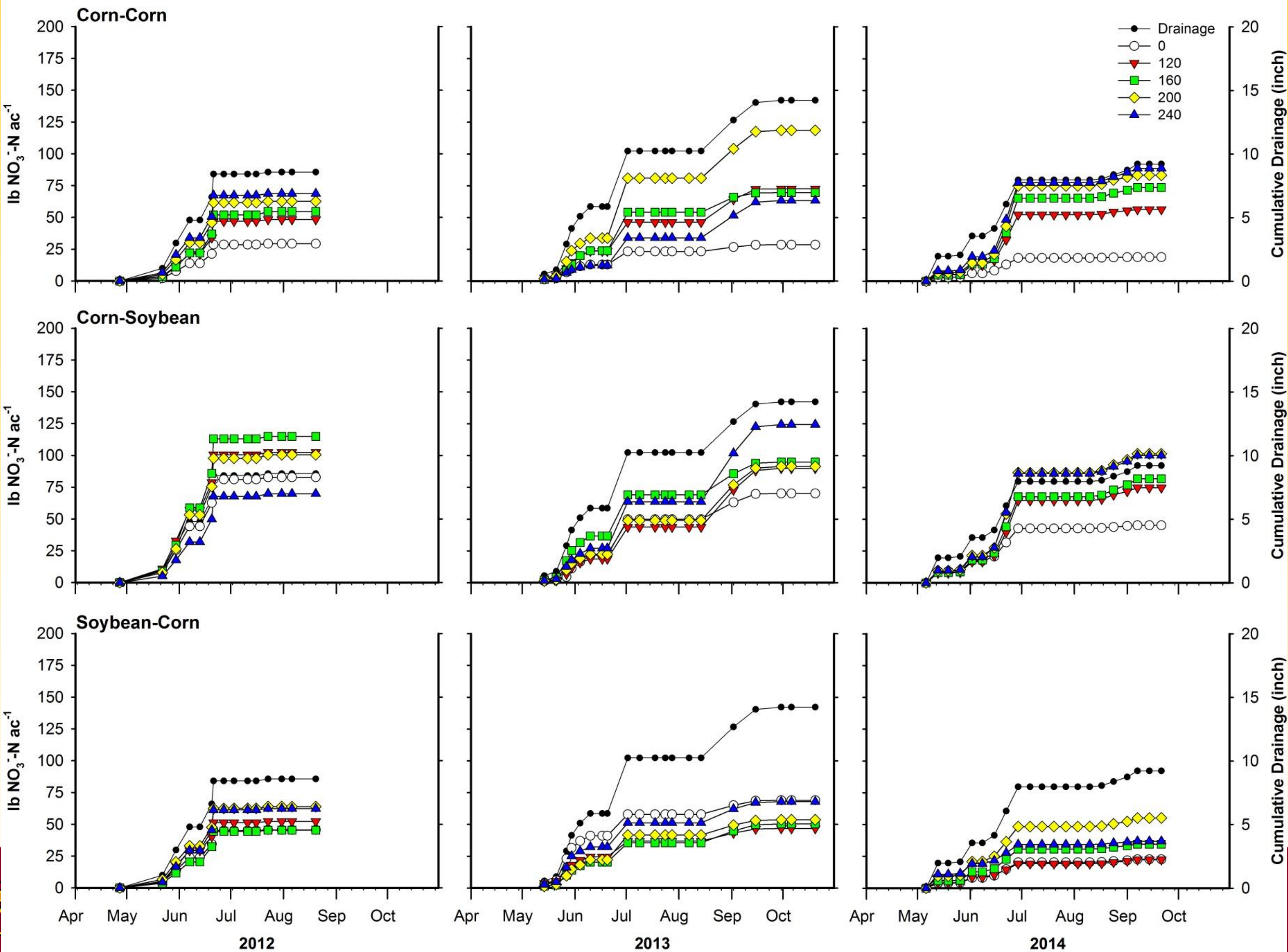
May-June 75% of drainage, 25 mg L^{-1} July-Aug 39 mg L^{-1}

98% drainage 41% drainage 86% drainage



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

98% load | 34% load | 88% load



Season-long (2012-2014) nitrate leached below the root-zone

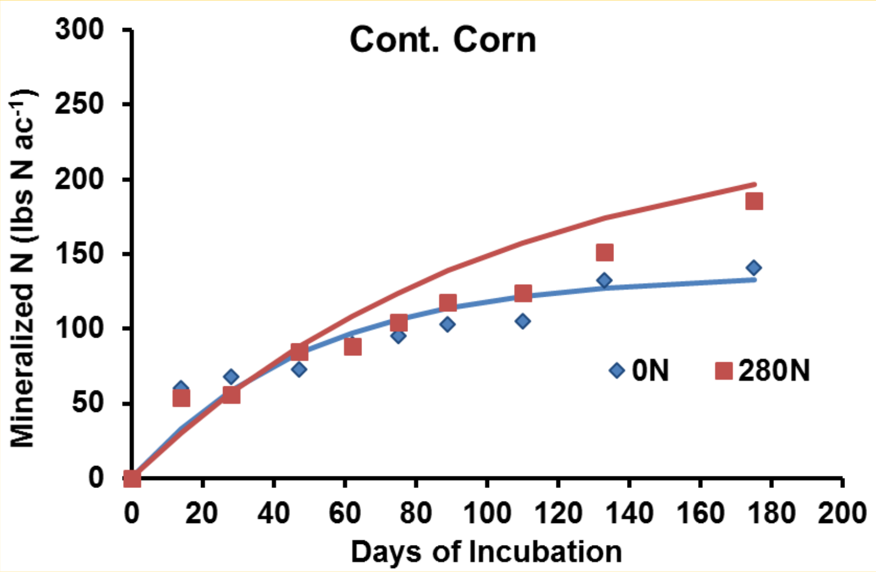
N Rate	CC	CSb	SbC	CC	CSb	SbC
lb ac^{-1}	mg NO_3^--N L^{-1}			lb NO_3^--N ac^{-1}		
0	11.2c	29.4a	17.8a	26c	65a	46a
120	28.4b	43.8a	16.5a	55b	88a	35a
160	30.3b	43.6a	18.8a	63b	96a	44a
200	38.0a	45.8a	25.4a	86a	93a	58a
240	35.7ab	47.6a	21.1a	73ab	98a	55a
Mean	28.7B	42.0A	19.9C	61B	88A	47C

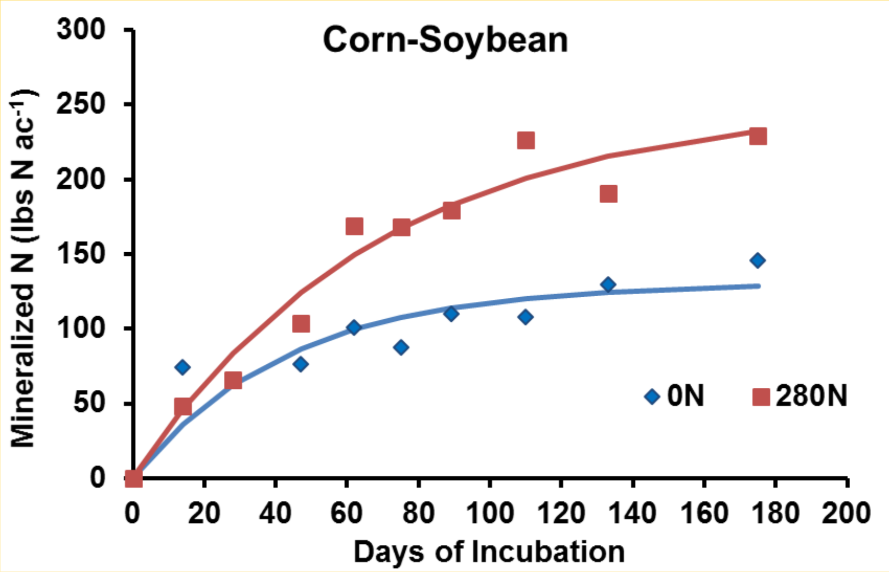
Measurements After 4 Years

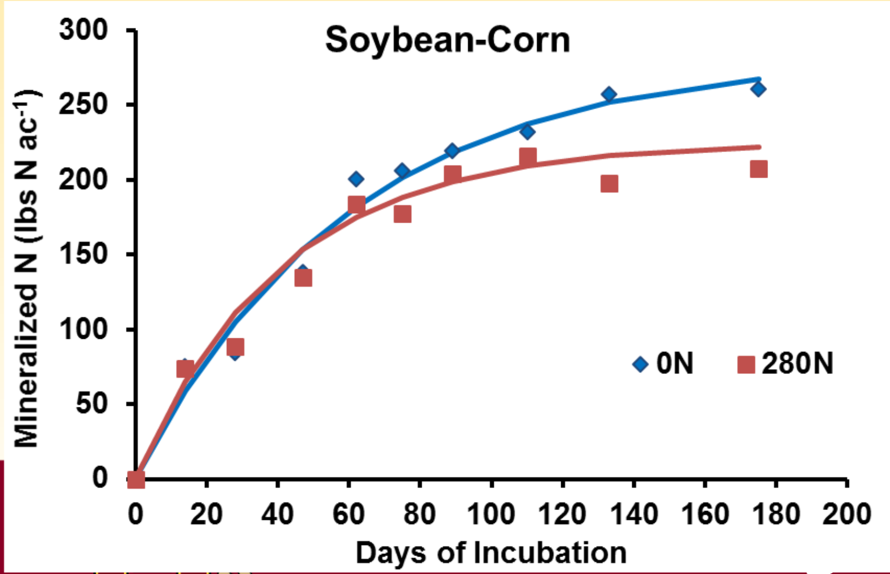
N Rate	Year	CC	CSb	SbC
lb ac^{-1}		mg NO_3^--N L^{-1} (SEM)		
0		8.8d (1.0)	19.7d (1.2)	10.6c (0.7)
120		28.2c (2.5)	42.9c (3.0)	10.9c (0.5)
160		37.2b (3.0)	46.6bc (2.8)	15.6b (1.4)
200		42.7ab (3.7)	55.8a (4.0)	25.0a (1.8)
240		44.3a (3.1)	53.6ab (3.2)	15.8b (1.4)
Mean		32.2 (1.4)	43.7 (1.5)	15.6 (0.6)

N Rate	Year	CC	CSb	SbC
lb ac^{-1}		lb NO_3^--N ac^{-1}		
0		19b	45c	23
120		57ab	75b	22
160		74a	82ab	35
200		83a	101a	55
240		89a	100a	37
Mean		64A	81A	34B

Potential Mineralizable N







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

ment

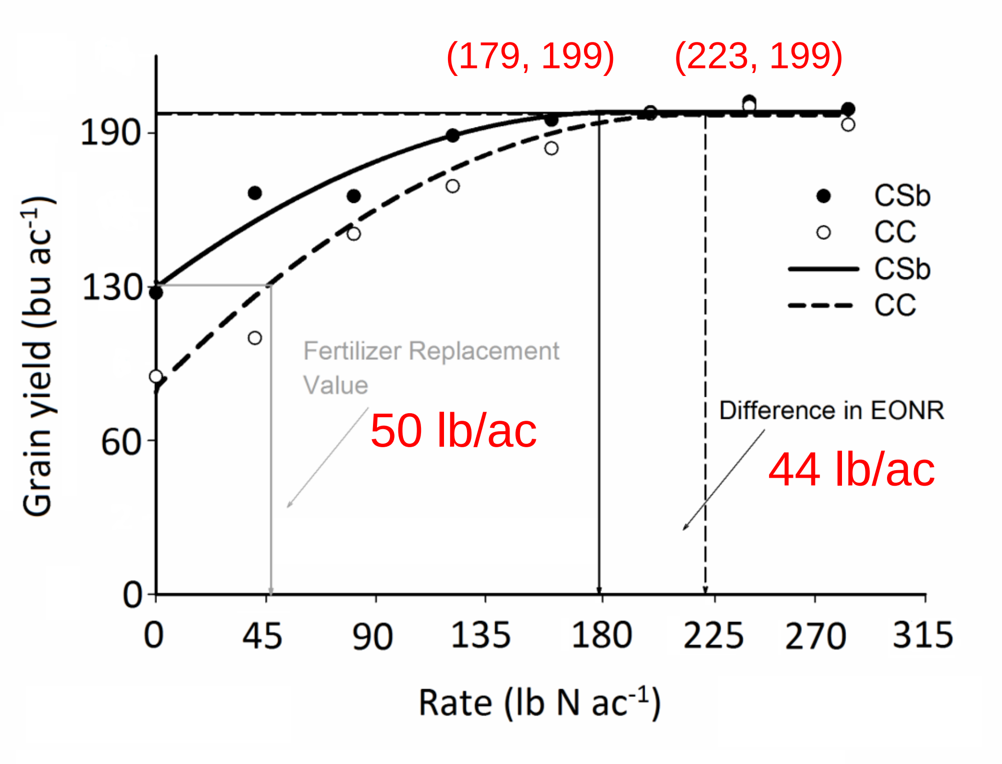


Table 1. Guidelines for use of N fertilizer for corn after corn grown on irrigated sandy soils.		
N price/Crop value ratio	MRTN	Acceptable range
	------------- lb N/acre -------------	
0.05	233	214 – 252
0.10	209	192 – 225
0.15	191	177 – 206
0.20	177	164 - 190

UNIVERSITY OF MINNESOTA EXTENSION

NUTRIENT MANAGEMENT

AG-NM-1501 (2015)

Fertilizing Corn Grown on Irrigated Sandy Soils

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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

Reduction Scenarios

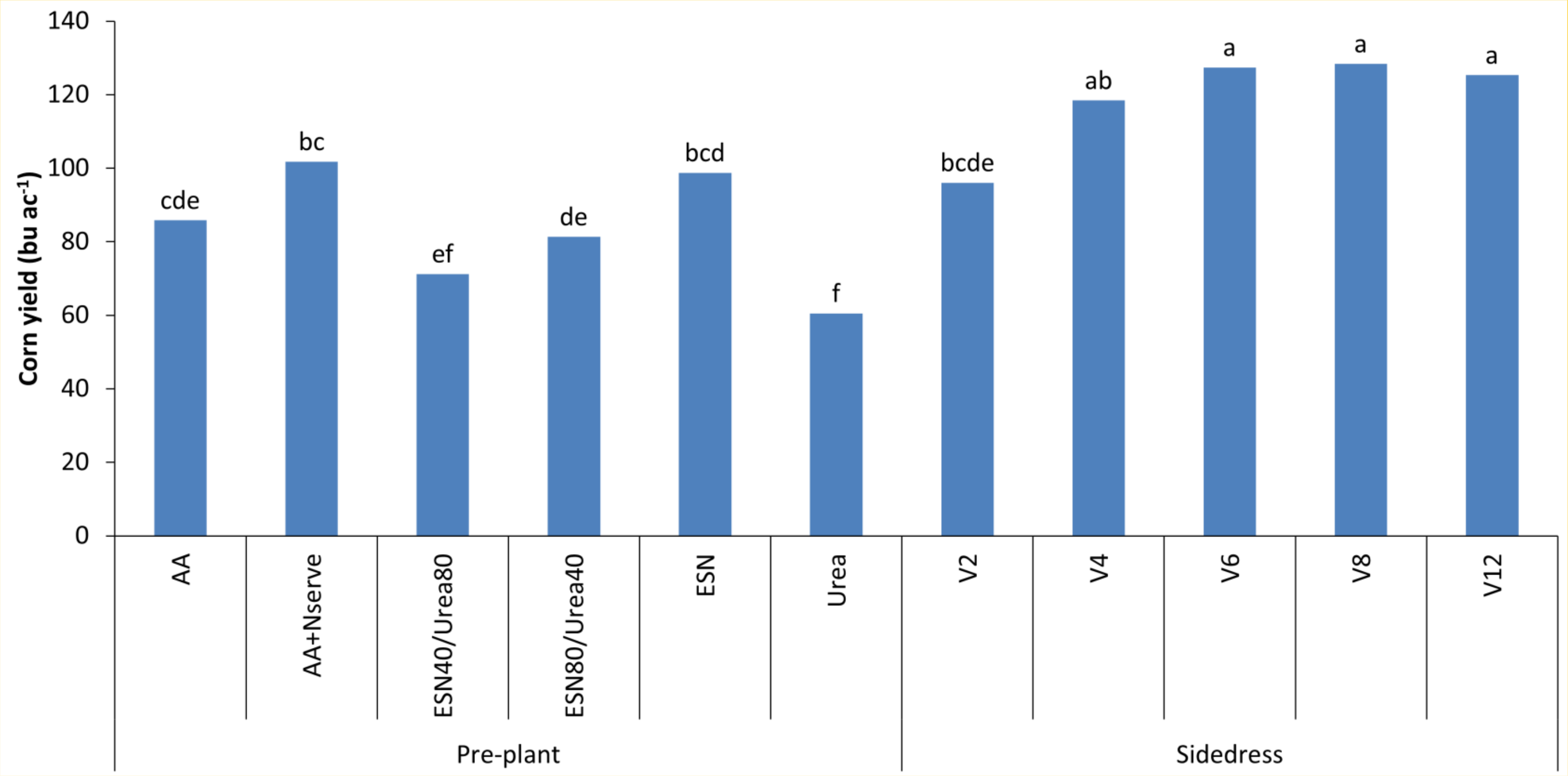
	CC			CSb		
	N rate	Grain yield	NO_3^--N Leached	N rate	Grain yield	NO_3^--N Leached
	lb ac^{-1}	bu ac^{-1}	lb ac^{-1}	lb ac^{-1}	bu ac^{-1}	lb ac^{-1}
EONR	223	199	77	179	199	95
20% Reduction	179	191	70	144	194	91
25% Reduction	167	188	68	135	193	90

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%

Product	CC	CSb	SbC	CC	CSb	SbC
	mg NO_3^--N L^{-1}			lb NO_3^--N ac^{-1}		
Urea	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

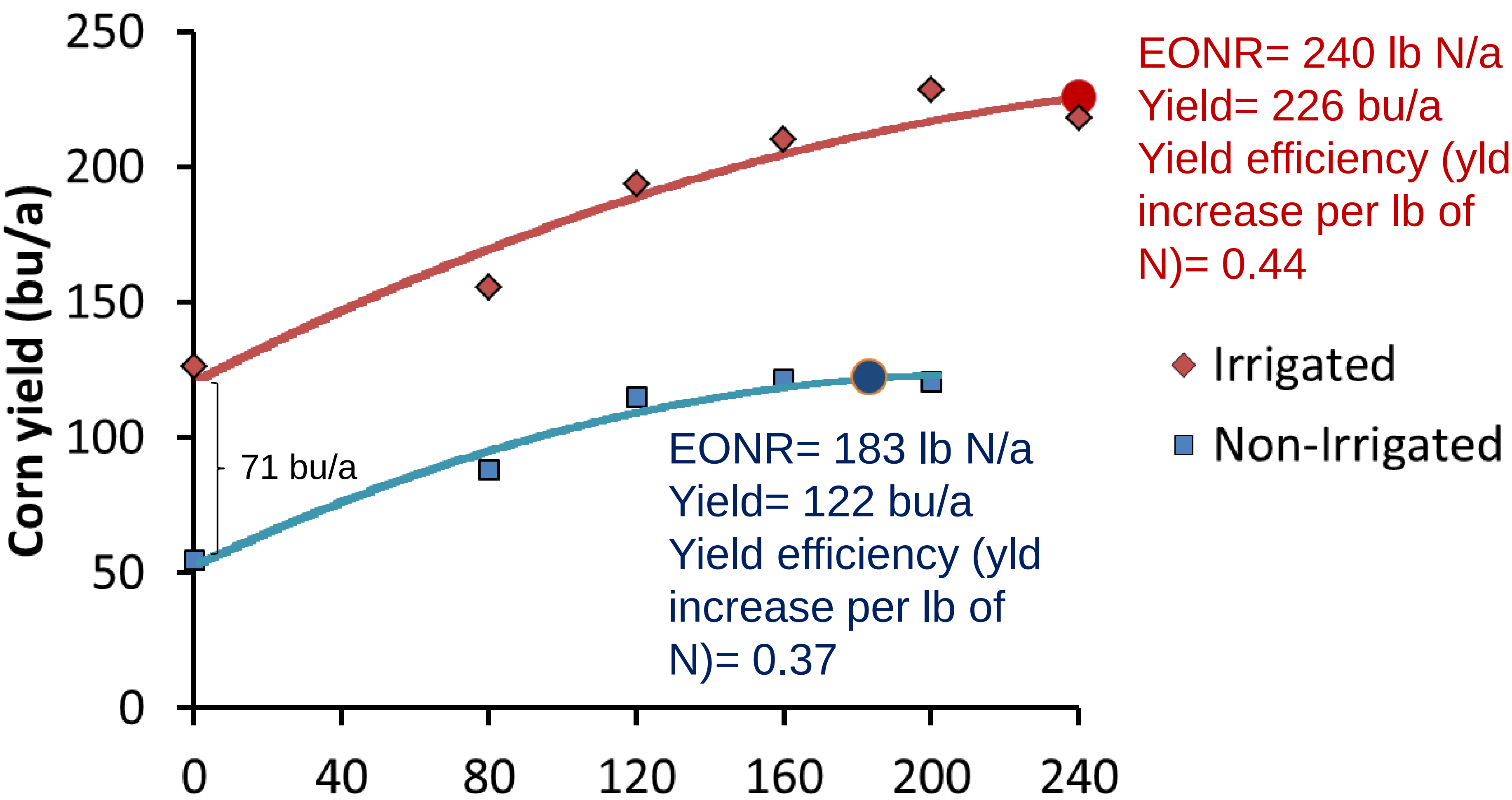
Source	Rate	Yield	Grain N	Tot. uptake	Basal Stalk N	RSN	PFP	AE
	lb ac^{-1}	bu ac^{-1}	%	lb N ac^{-1}	ppm	lb ac^{-1}		
Urea	160	198a	0.11	196	983	19	62a	29a
ESN		190b	0.11	184	677	19	59b	26b
SuperU		188b	0.11	192	1320	21	58b	26b
ESN/Urea	80/80	185b	0.11	175	448	21	58b	25b
Urea	200	206	0.12	208	1763	22	51	25
ESN		202	0.11	208	1661	24	50	24

Residual Soil Nitrogen top 2’; Partial Factor Productivity = $Yield_{(rate)}$ / N rate
Agronomic Efficiency = $Yield_{(rate)}$ - $Yield_{(control)}$ / N rate
Data averaged for Pope CC, CSb & Dakota Co. CC

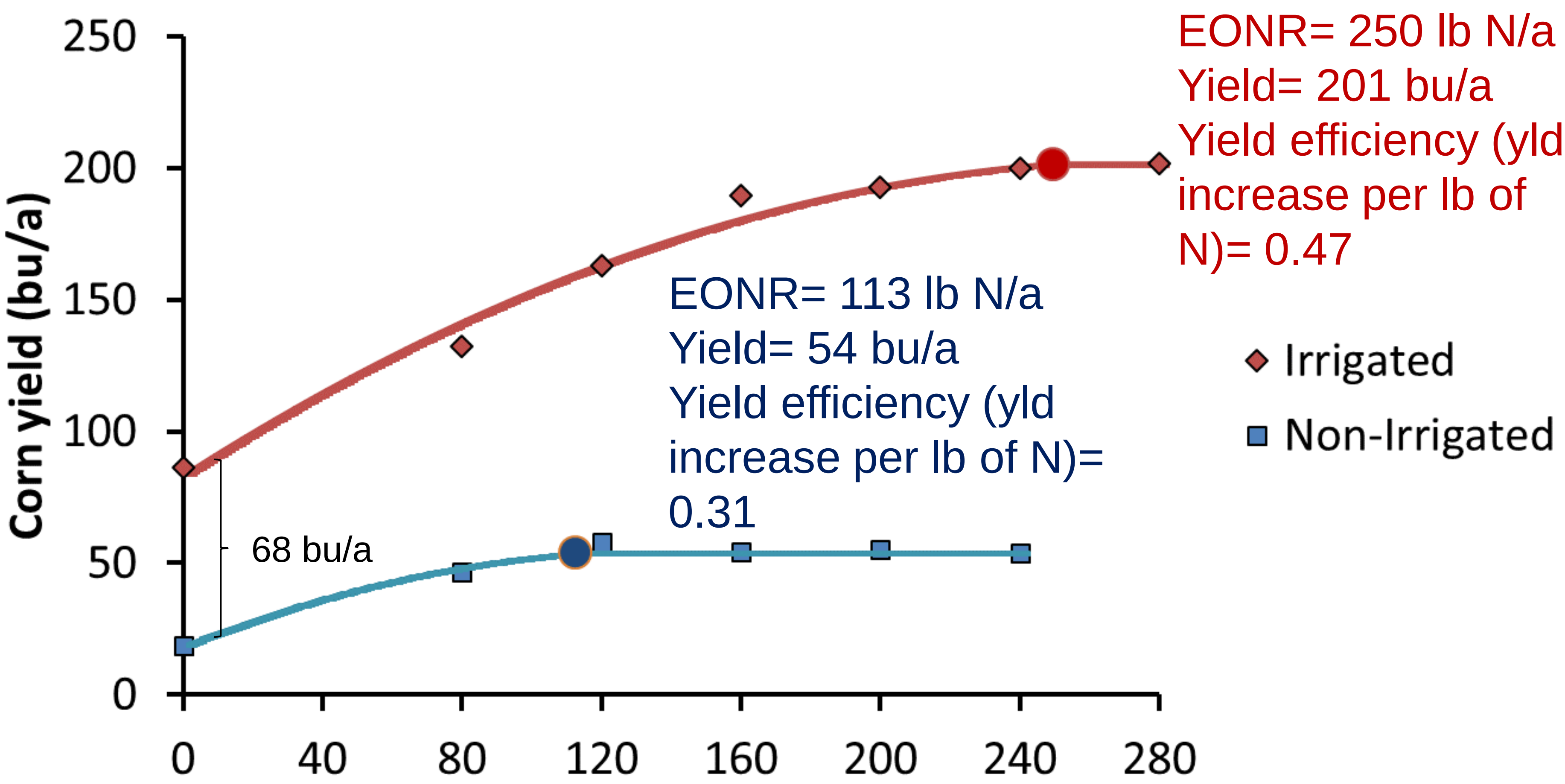


Corn yield (bu ac-1)
140
120
100
80
60
40
20
0
cde
bc
ef
de
bcd
f
bcde
ab
a
a
a
AA
AA+Nserve
ESN40/Urea80
ESN80/Urea40
ESN
Urea
V2
V4
V6
V8
V12
Pre-plant
Sidedress

2015


Corn yield (bu/a)
250
200
150
100
50
0
0
40
80
120
160
200
240
71 bu/a
EONR= 240 lb N/a
Yield= 226 bu/a
Yield efficiency (yld increase per lb of N)= 0.44
EONR= 183 lb N/a
Yield= 122 bu/a
Yield efficiency (yld increase per lb of N)= 0.37
Irrigated
Non-Irrigated

2016



EONR= 250 lb N/a
Yield= 201 bu/a
Yield efficiency (yld increase per lb of N)= 0.47
EONR= 113 lb N/a
Yield= 54 bu/a
Yield efficiency (yld increase per lb of N)= 0.31
68 bu/a
Irrigated
Non-Irrigated
Corn yield (bu/a)
0
50
100
150
200
250
0
40
80
120
160
200
240
280

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Questions

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THANK YOU

Students, Field Crew, Farmers, Research Centers

Minnesota Department of Agriculture

Minnesota Soybean Research & Promotion Council

MinnesotaCorn GROWERS ASSOCIATION

AFREC Agricultural Fertilizer Research & Education Council