Proceedings of the 5th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference

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Urea Fertilizers Do's and Don'ts

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5th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference

5 Feb. 2019, Minneapolis, MN

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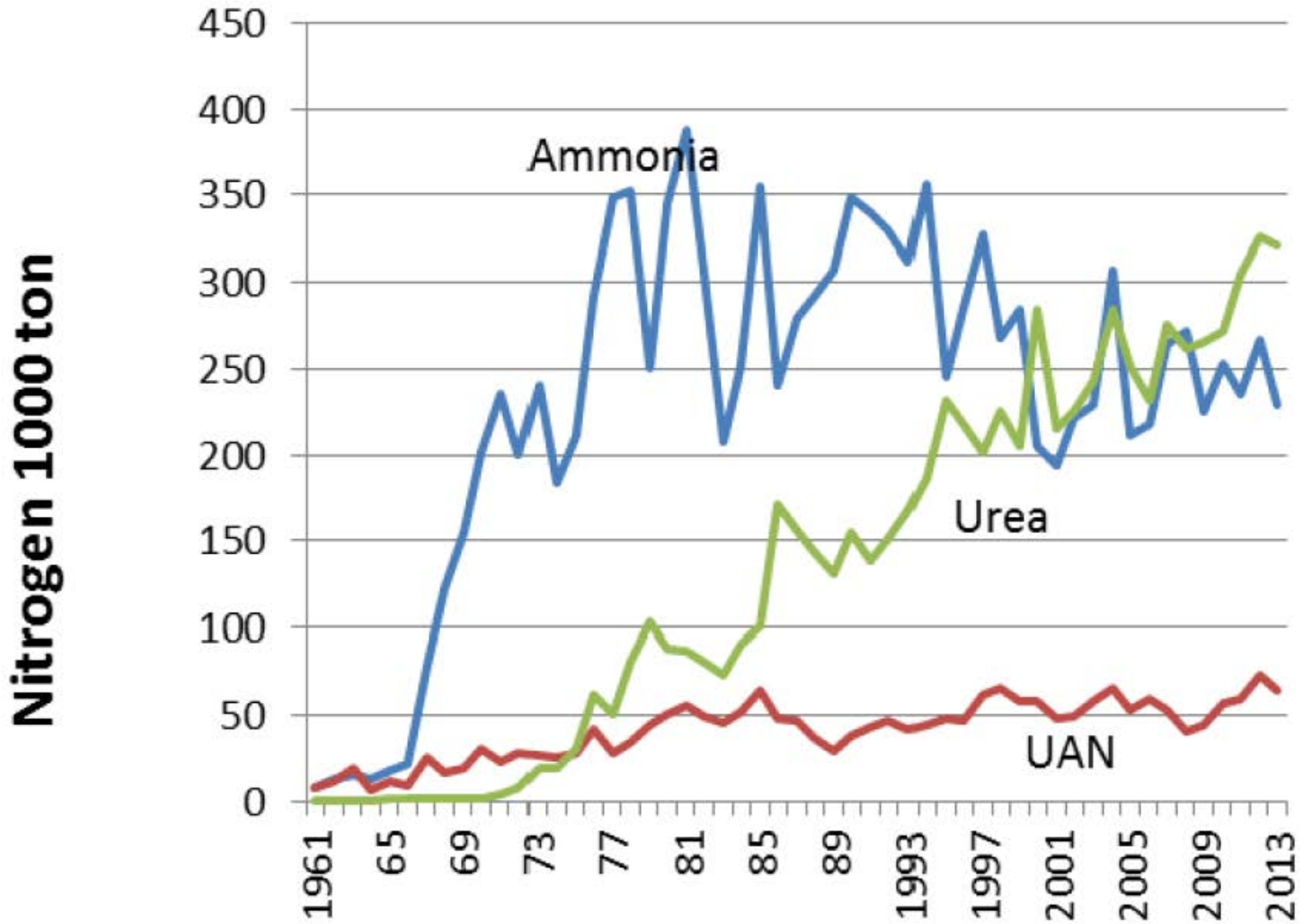
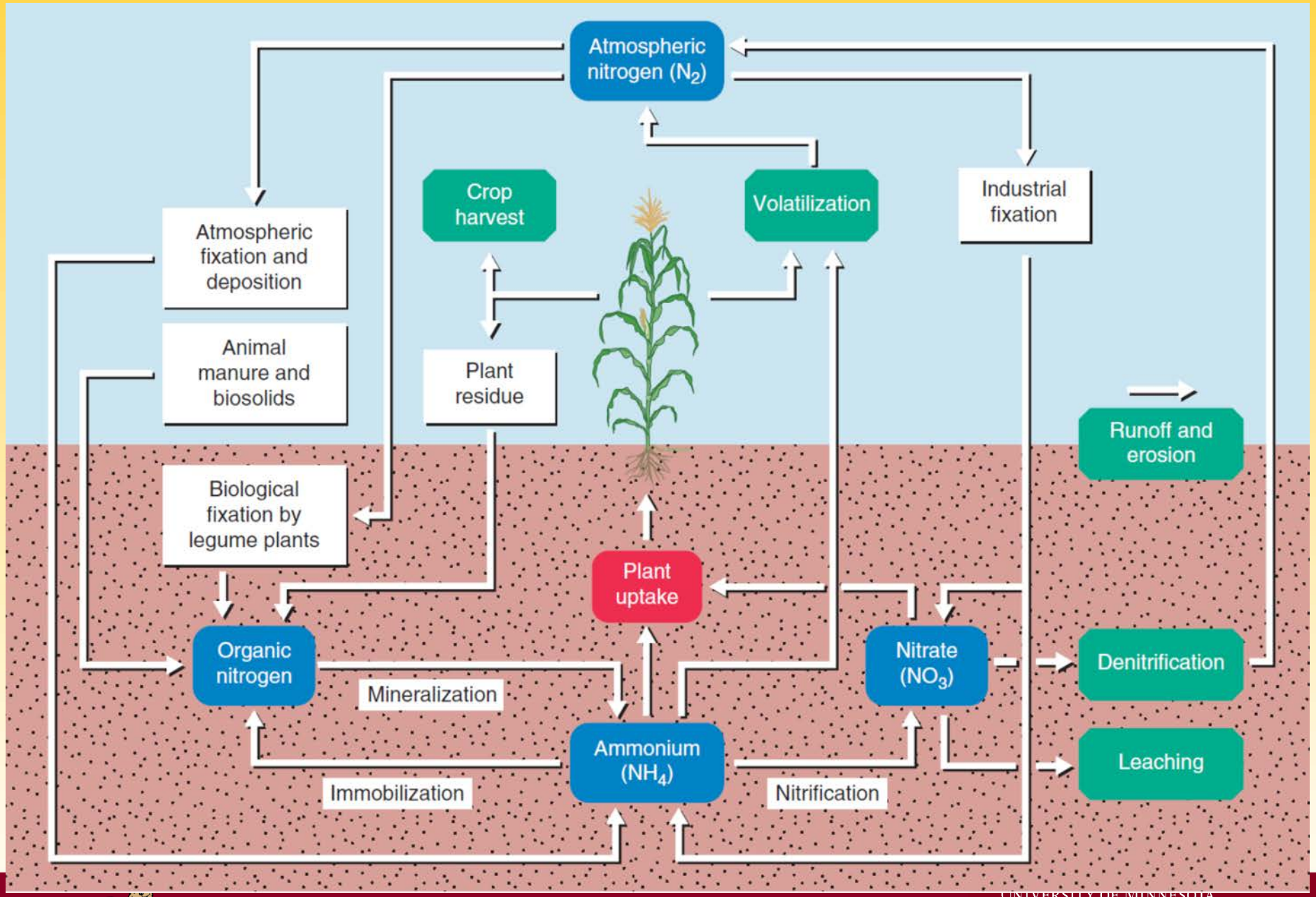
Driven to Discover℠

Urea a Major N Source in MN





Nutrient Management

UNIVERSITY OF MINNESOTA
EXTENSION
Driven to Discover℠

$$(NH_2)_2CO + 2H_2O \xrightarrow[\text{Urease}]{\text{Soil}} (NH_4)_2CO_3$$

Urea Water Ammonium Carbonate

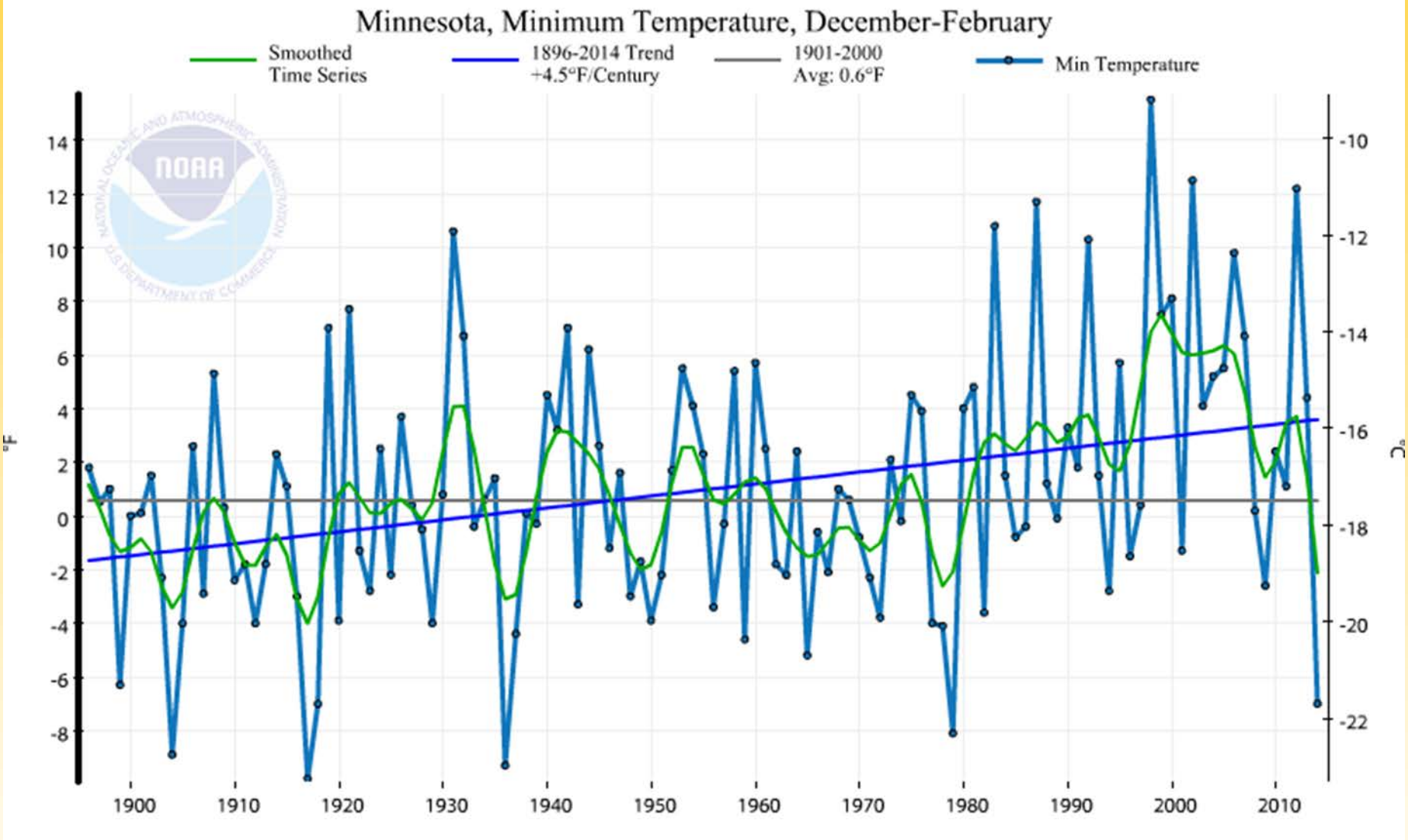
$$(NH_4)_2CO_3 + 2H^+ \longrightarrow 2NH_4^+ + CO_2\uparrow + H_2O$$

Ammonium Carbonate Ammonium Carbon Dioxide (gas) Water

$$NH_4^+ + OH^- \rightleftharpoons NH_3\uparrow + H_2O$$

Ammonium Hydroxyl Ammonia Water

- -28° F at point of release freezes everything it contacts
- Soil pH is temporarily high (9.5-10) in the injection zone creating toxic condition.


Minnesota, Minimum Temperature, December-February
Smoothed Time Series
1896-2014 Trend +4.5°F/Century
1901-2000 Avg: 0.6°F
Min Temperature
°F
°C
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
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1900
1910
1920
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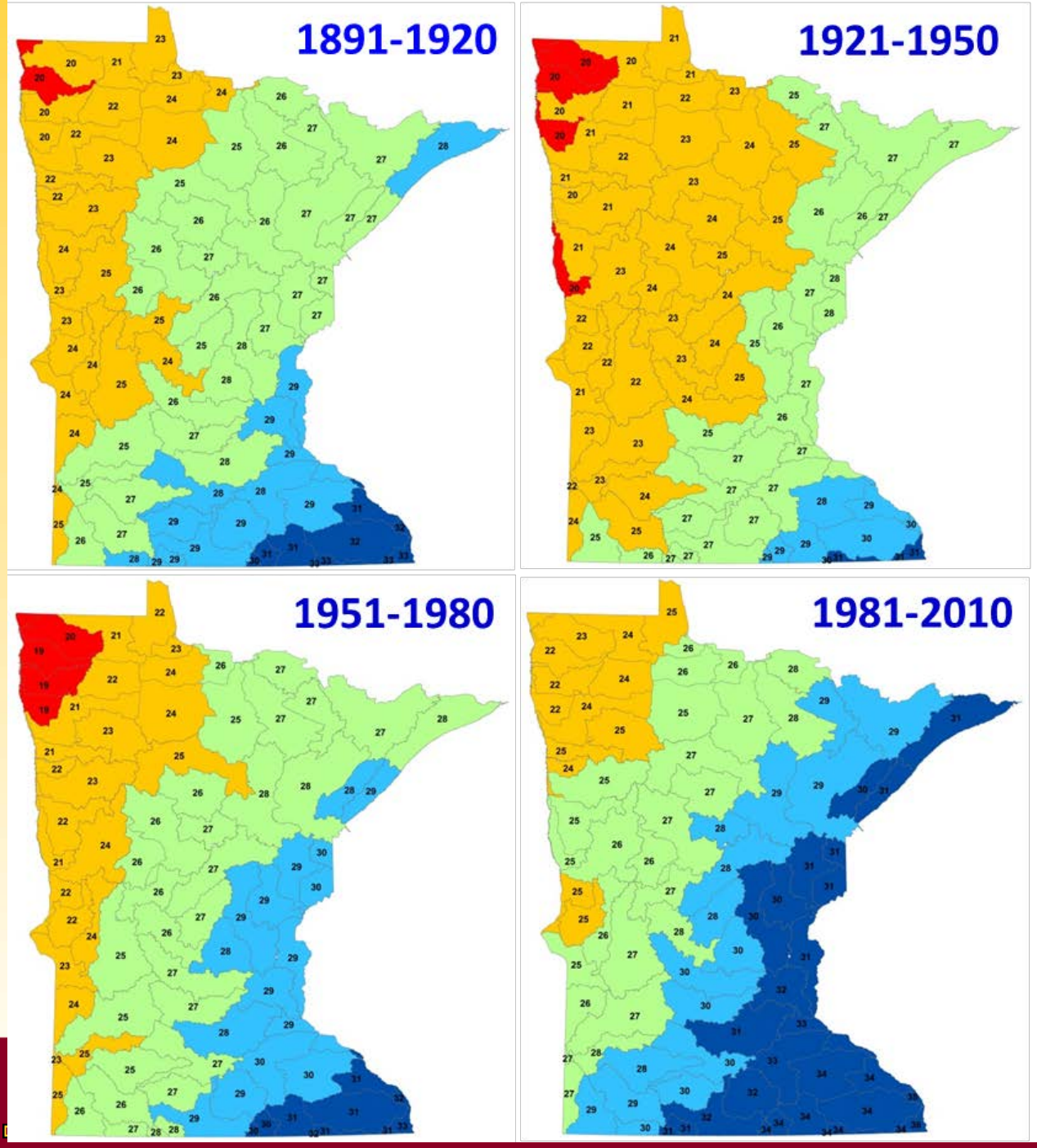


Avg. Annual PPT, in

- < 20
- 21 - 25
- 26 - 28
- 29 - 30
- > 30

Source: MN-SCO

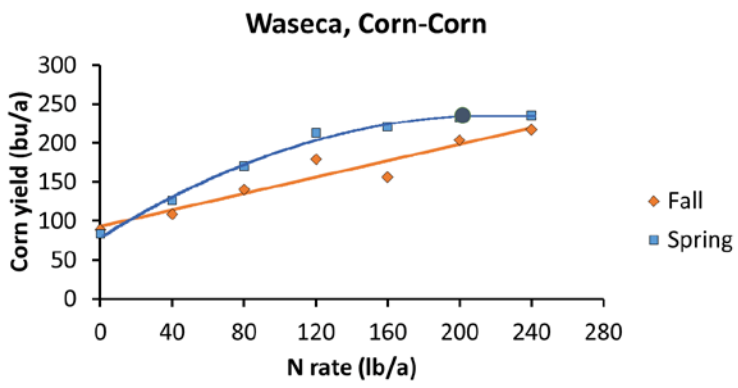
Re-evaluate BMPs

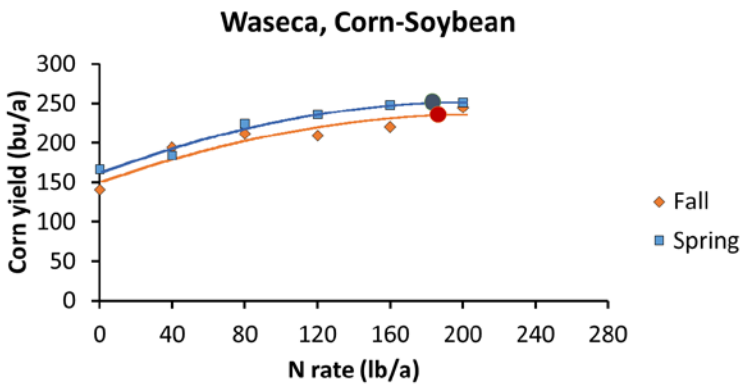
Questions to investigate

1) What are the differences between fall and spring urea?
2) Can we improve nitrogen management by subsurface banding instead of broadcasting and incorporating urea?
3) Are there benefits using a nitrification inhibitor or other N sources?

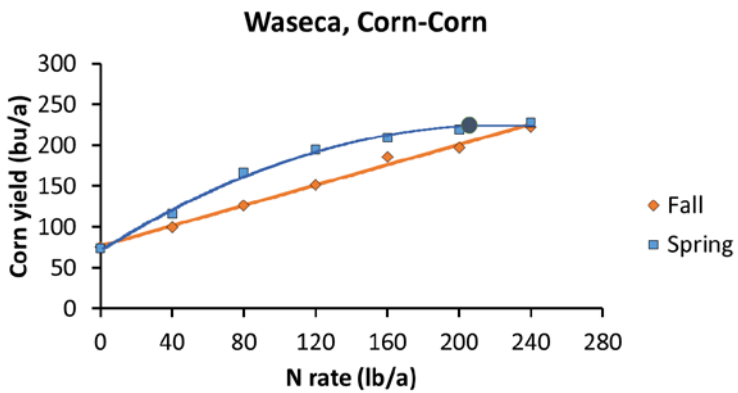
Product	Placement method	Time	CC rate (lb N/ac)	CSb rate (lb N/ac)
check	check	Fall	0	0
Urea	BI	Fall	40	40
Urea	BI	Fall	80	80
Urea	BI	Fall	120	120
Urea	BI	Fall	160	160
Urea	BI	Fall	200	200
Urea	BI	Fall	240	x
check	check	Spring Pre Plant	0	0
Urea	BI	Spring Pre Plant	40	40
Urea	BI	Spring Pre Plant	80	80
Urea	BI	Spring Pre Plant	120	120
Urea	BI	Spring Pre Plant	160	160
Urea	BI	Spring Pre Plant	200	200
Urea	BI	Spring Pre Plant	240	x
AA+Nserve	Injected	Fall	120	120
Urea	SSB	Fall	120	80
Urea+Instinct	BI	Fall	120	80
Urea+Instinct	SSB	Fall	120	80
ESN	BI	Fall	120	80
AA	Injected	Spring Pre Plant	120	120
Urea	SSB	Spring Pre Plant	120	80
Urea+Instinct	BI	Spring Pre Plant	120	80
Urea+Instinct	SSB	Spring Pre Plant	120	80
ESN	BI	Spring Pre Plant	120	80

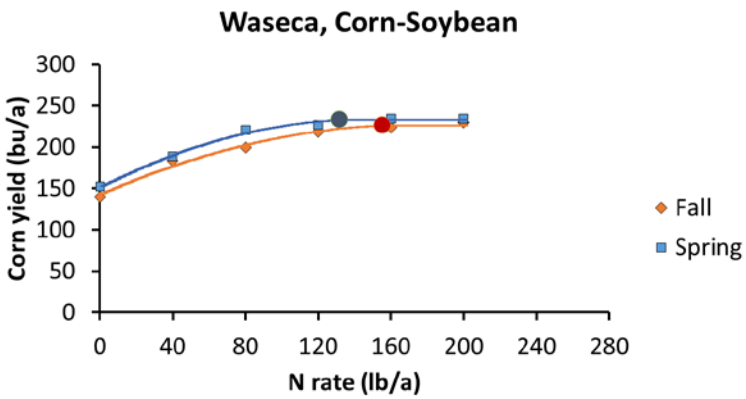
2016



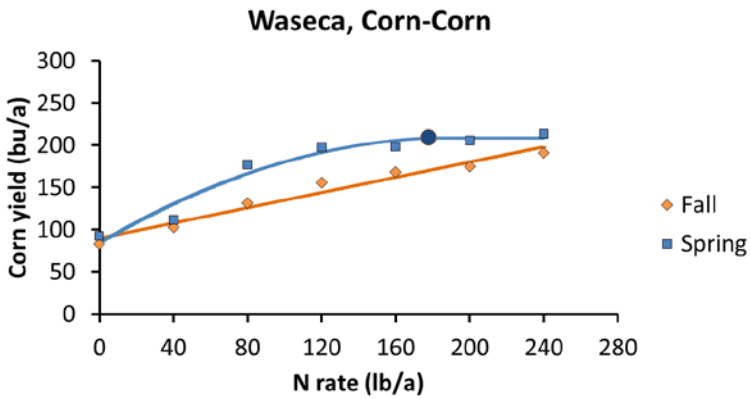


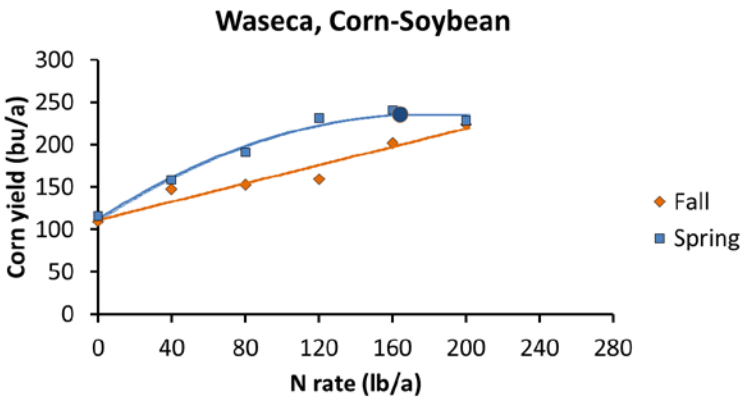
2017





2018





SROC	Rotation	Time	Response to N	EONR	EONR Yield
				lb N/ac	bu/ac
2016	CC	Fall	Linear	240	220
	CC	Spring	Quadratic plateau	202	234
	CSb	Fall	Quadratic plateau	187	235
	CSb	Spring	Quadratic plateau	183	251
2017	CC	Fall	Linear	240	222
	CC	Spring	Quadratic plateau	206	224
	CSb	Fall	Quadratic plateau	156	226
	CSb	Spring	Quadratic plateau	132	233
2018	CC	Fall	Linear	240	191
	CC	Spring	Quadratic plateau	178	208
	CSb	Fall	Linear	200	224
	CSb	Spring	Quadratic plateau	164	235
Difference	CC			45	-11
	CSb			21	-11
	Overall			33	-11

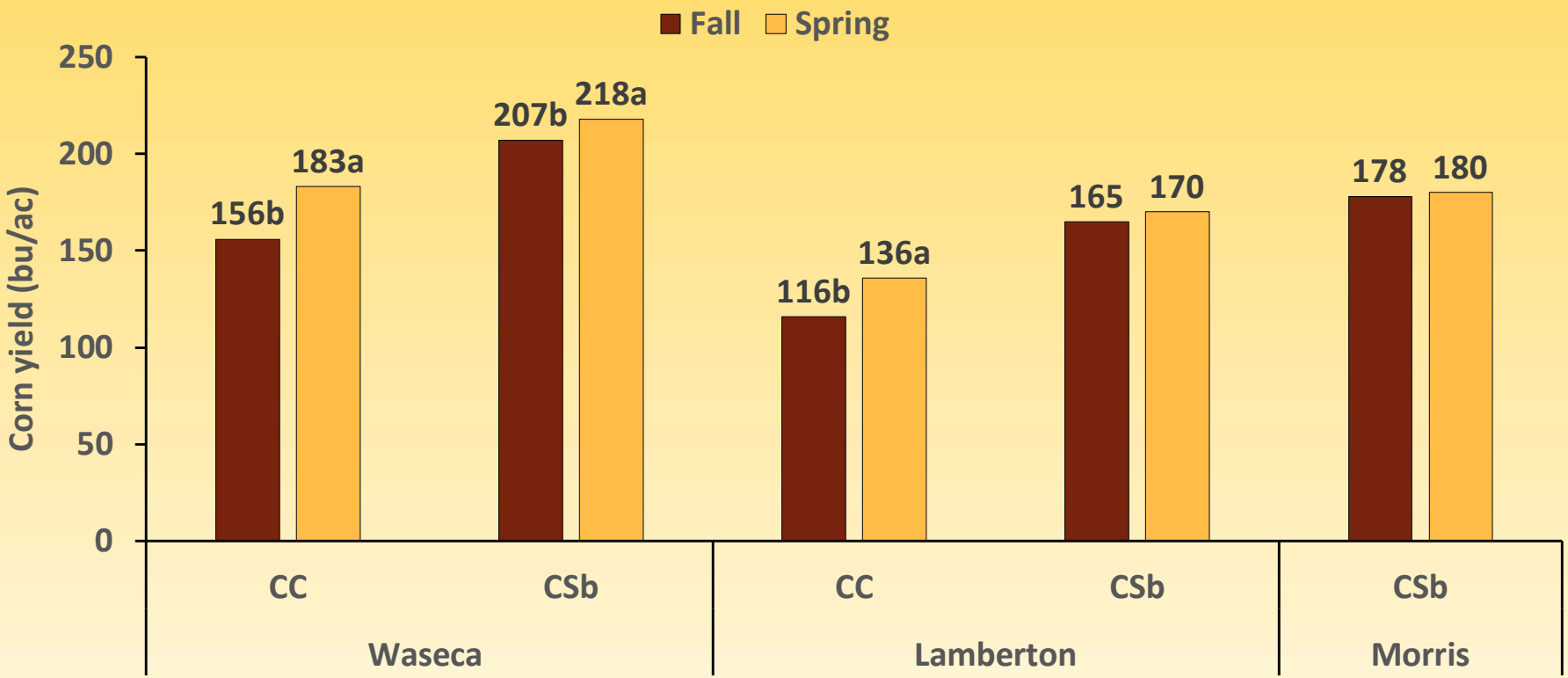
SWROC	Rotation	Time	Response to N	EONR	EONR Yield
				lb N/ac	bu/ac
2016	CC	Fall	Linear	240	155
	CC	Spring	Linear	240	186
	CSb	Fall	Linear	200	214
	CSb	Spring	Quadratic plateau	146	194
2017	CC	Fall	Linear	240	207
	CC	Spring	Quadratic plateau*	240	204
	CSb	Fall	Quadratic plateau	170	183
	CSb	Spring	Quadratic plateau*	200	204
2018	CC	Fall	Linear	240	122
	CC	Spring	Linear	240	183
	CSb	Fall	Linear	200	187
	CSb	Spring	Linear	200	177
Difference	CC			0	-30
	CSb			8	3
	Overall			4	-13

WCROC	RotationTime		Response to N	EONR	EONR Yield
				lb N/ac	bu/ac
2016	CSb	Fall	Quadratic plateau	181	203
	CSb	Spring	Quadratic plateau	107	193
2017	CC	Fall	Linear	240	144
	CC	Spring	Linear	240	186
2018	CC	Fall	Linear	240	157
	CC	Spring	Quadratic plateau	190	160
	CSb	Fall	No N response	0/200	196/163
	CSb	Spring	No N response	0/200	161/193
Difference	CC			25	-23
	CSb			74	10
	Overall			41	-12

NWROC	Rotation	Time	Response to N	EONR	EONR Yield
				lb N/ac	bu/ac
2017	CWh	Fall	Quadratic plateau	182	157
	CWh	Spring	Quadratic plateau	111	155
	CSb	Fall	No N response	0/200	149/148
	CSb	Spring	No N response	0/200	176/170
2018	CWh	Fall	No N response	0/200	119/135
	CWh	Spring	Quadratic	86	133
	CSb	Fall	No N response	0/200	149/149
	CSb	Spring	No N response	0/200	138/161

Location	Rotation	Time	EONR lb/ac	EONR Yield bu/ac	
Waseca	CC	Fall	240	212	33 lb N/ac -11 bu/ac
	CC	Spring	195	222	
	CSb	Fall	181	228	
	CSb	Spring	160	240	
Lamberton	CC	Fall	240	161	4 lb N/ac -14 bu/ac
	CC	Spring	240	191	
	CSb	Fall	190	195	
	CSb	Spring	182	192	
Morris	CC	Fall	240	151	50 lb N/ac -6 bu/ac
	CC	Spring	215	173	
	CSb	Fall	181	203	
	CSb	Spring	107	193	
Crookston	CWh	Fall	182	157	
	CWh	Spring	99	144	
	CSb	Fall	NR	149	
	CSb	Spring	NR	161	
Mean		Fall	208	187	
		Spring	171	193	
		Diff	37	-6	

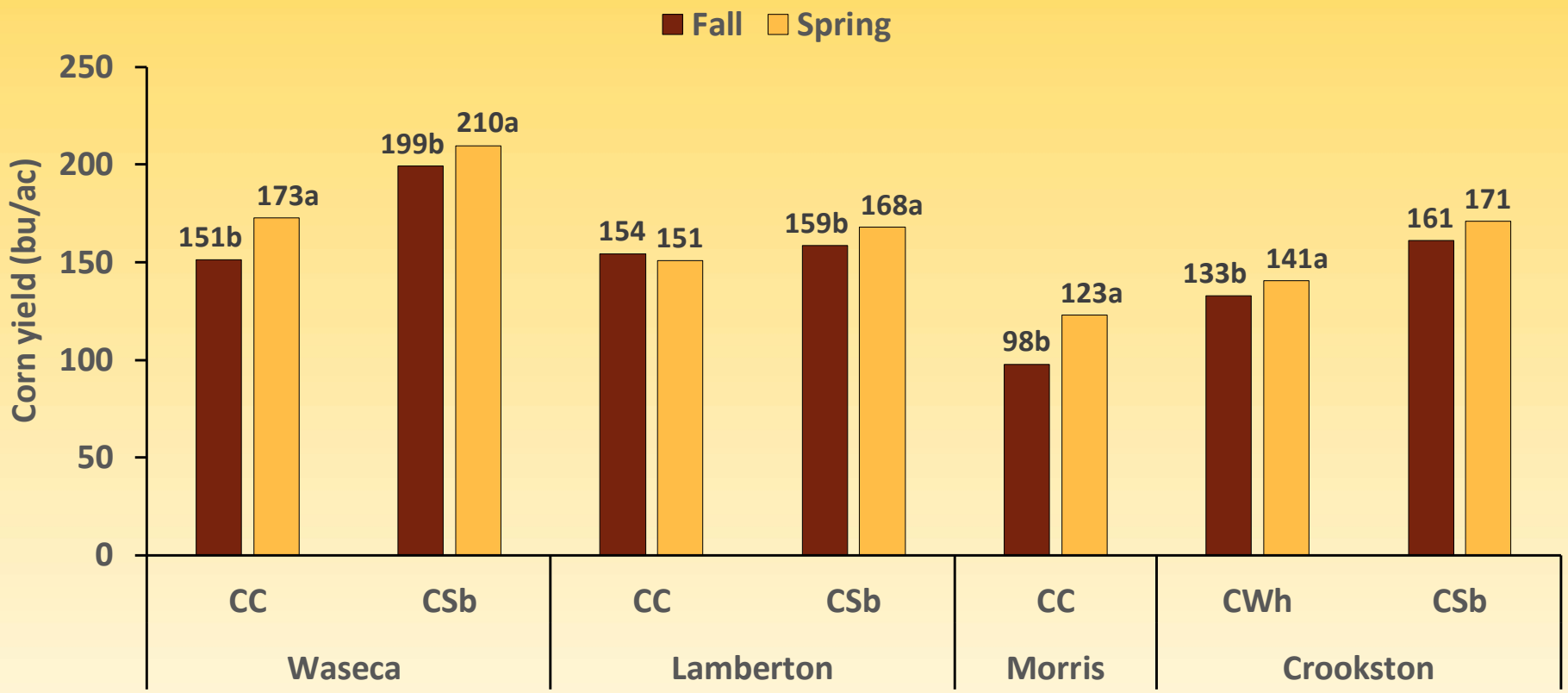
Averaged Across Rates, 2016



164 bu/ac Fall
177 bu/ac Spring

13 bu/ac more
with Spring

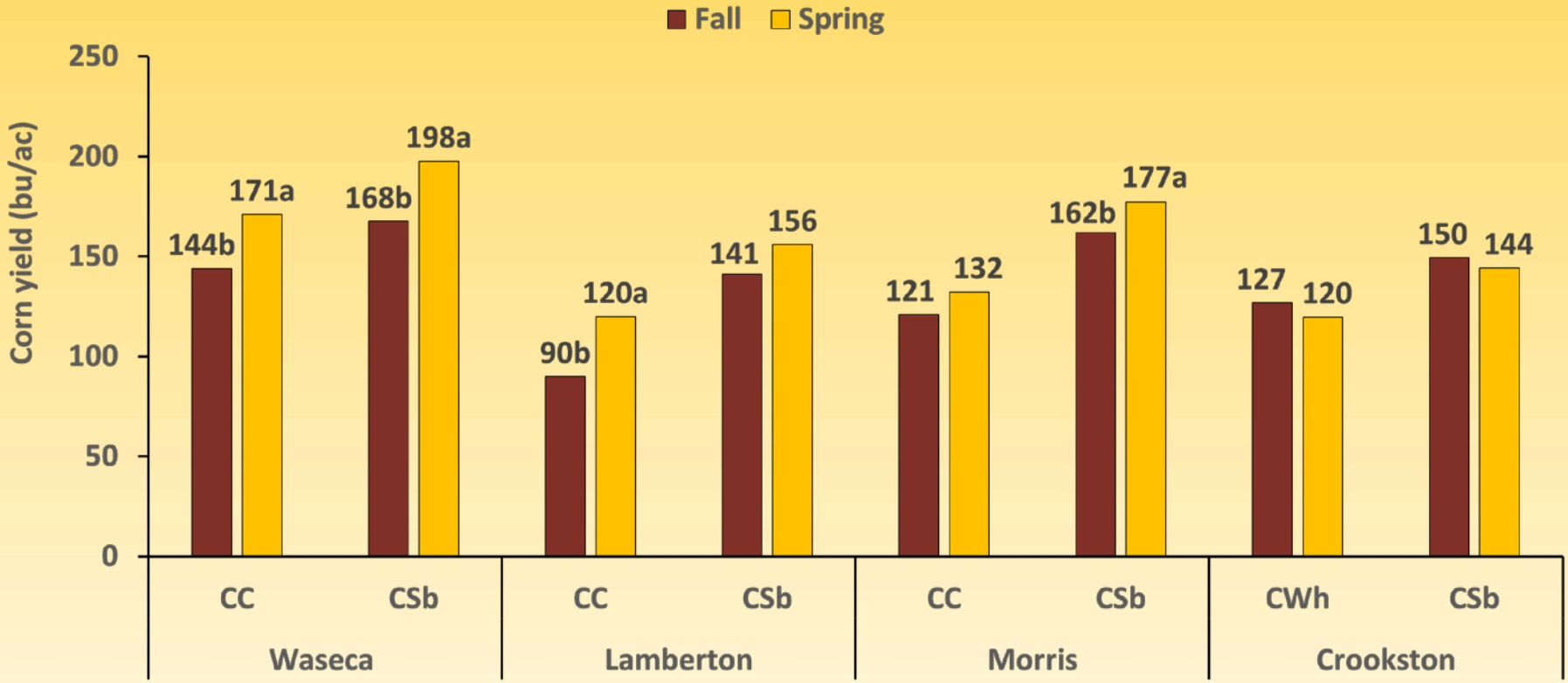
Averaged Across Rates, 2017



151 bu/ac Fall
162 bu/ac Spring

11 bu/ac more
with Spring

Averaged Across Rates, 2018



138 bu/ac Fall
152 bu/ac Spring

14 bu/ac more
with Spring

Lack of Drainage Generally Results in Greater Pre-plant Optimum N Needs and Similar Optimum Yields in Conventional Tillage

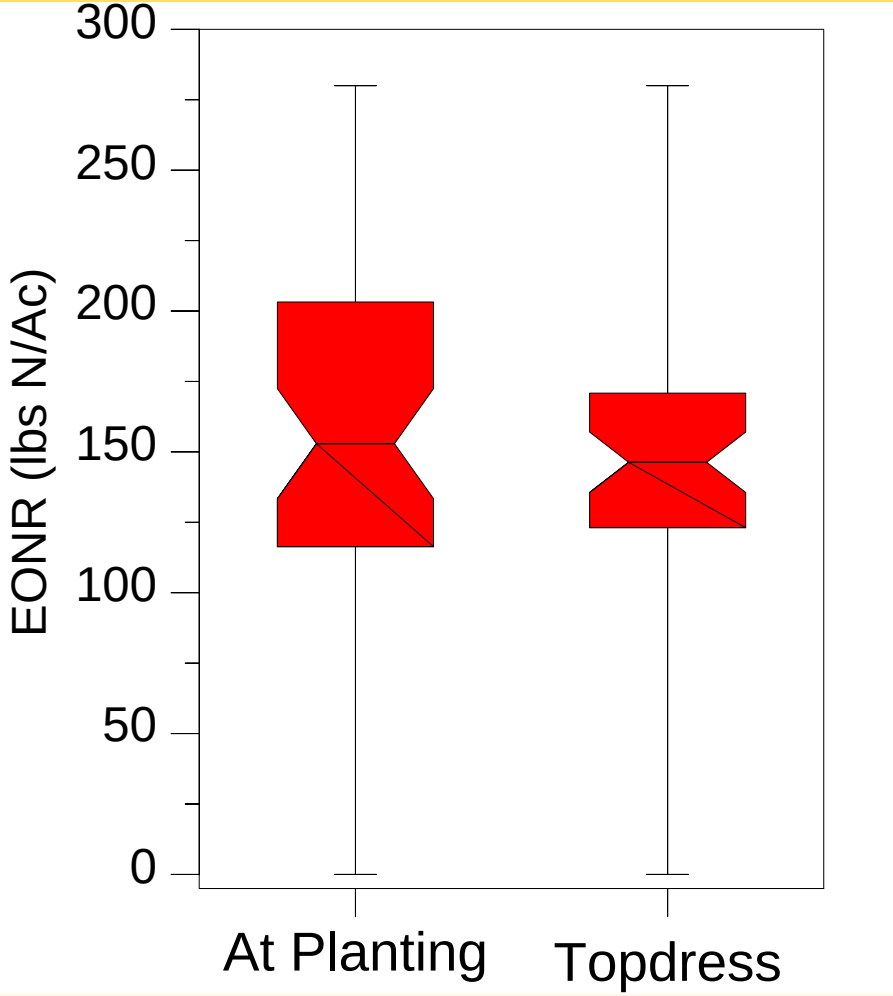
Year	Drained	Undrained	Drained	Undrained
	Yield (bu/ac)		N rate (lb/ac)	
2014	187	187	148	127
2015	212	211	108	200
2016	216	222	91	121
2017	216	214	154	200
2018	234	201	200	200
Average	**213**	**207**	**140**	**170**

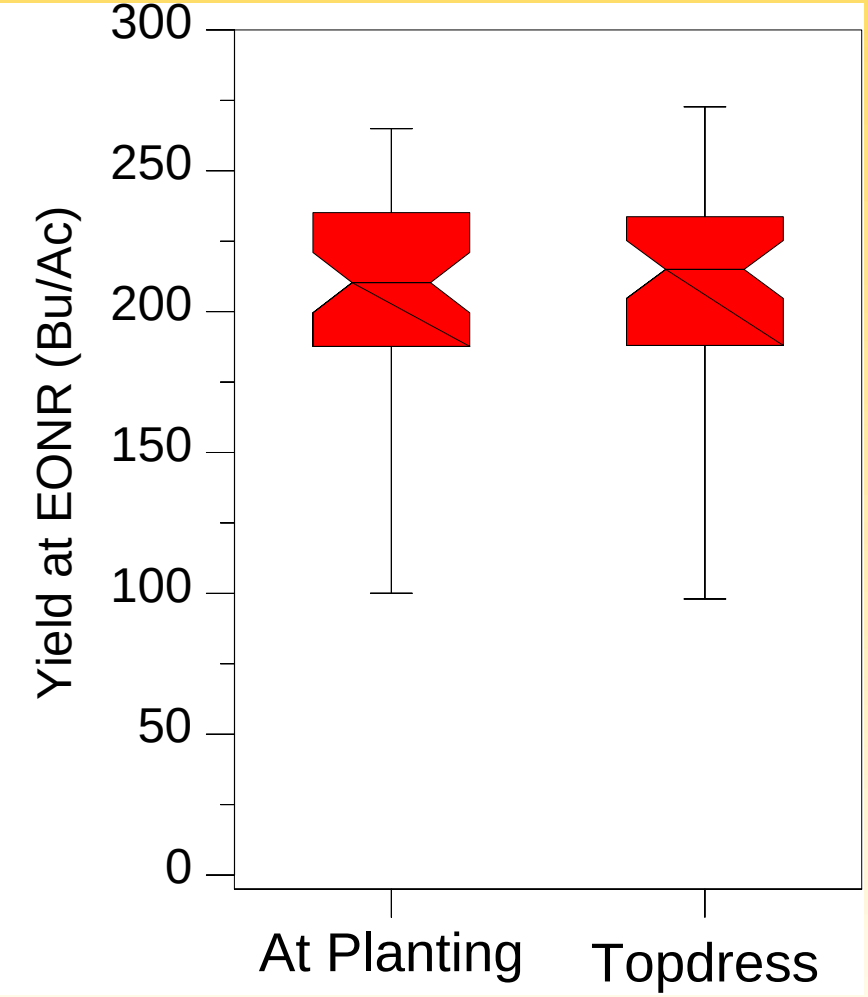
34 lb N/ac

Is There a Role for Splitting N

Treatment	EONR			
	2017		2018	
	PPT	PPT/V6	PPT	PPT/V8
Drained-CT	154	197	200	174
Drained-NT	171	200	200	156
Drained-ST	147	158	200	184
Undrained-CT	200	200	200	167
Undrained-NT	187	171	200	200
Undrained-ST	173	200	200	189

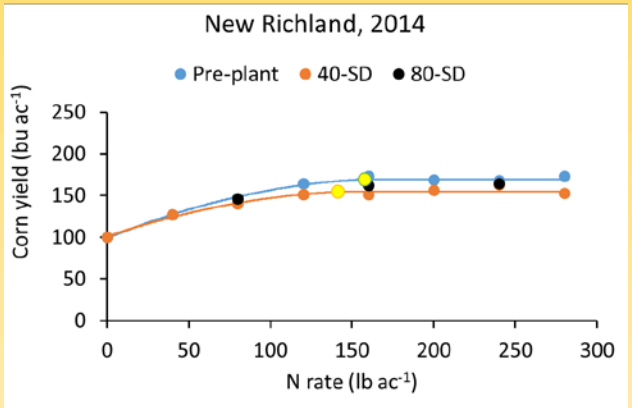
Is split better than single pre-plant?
(49 PRNT sites)

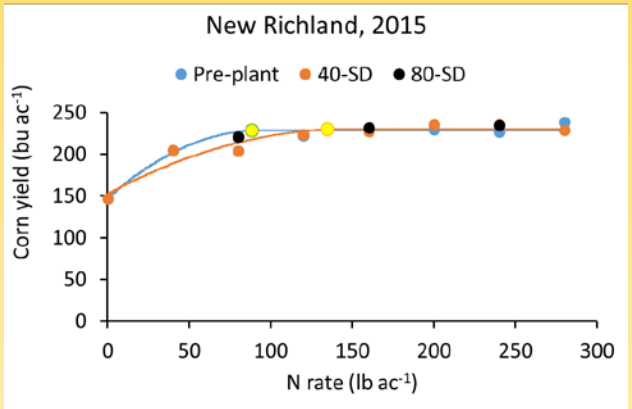


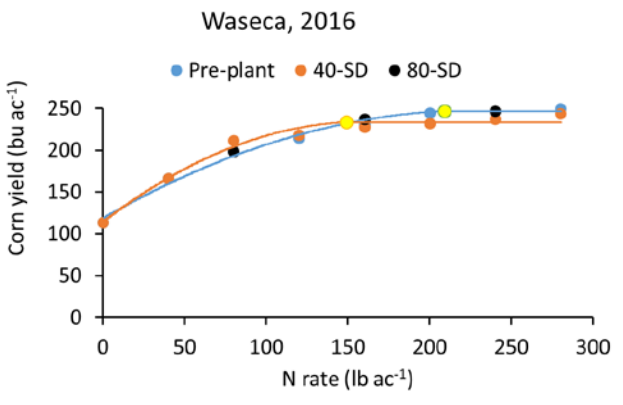


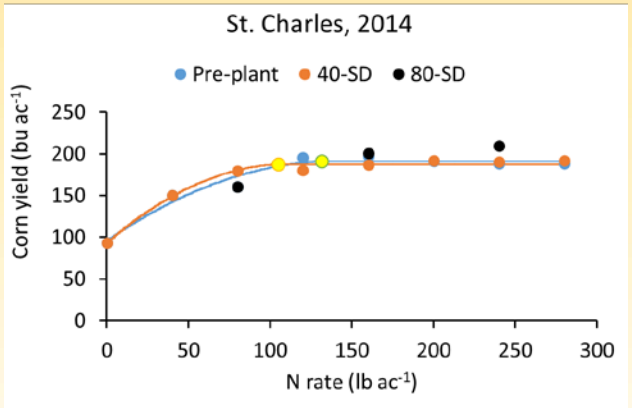
Slide from N. Kitchen

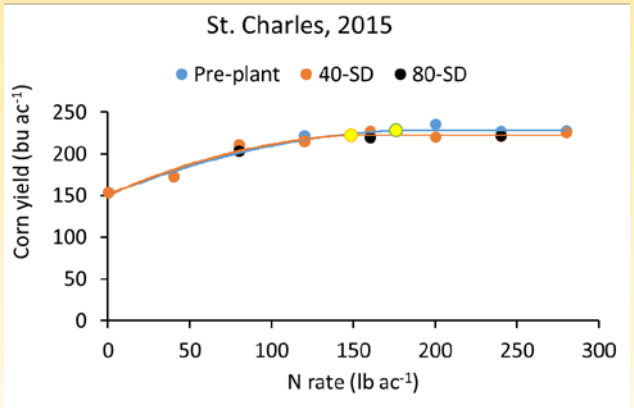
When splitting, how much N would you need at pre-plant?

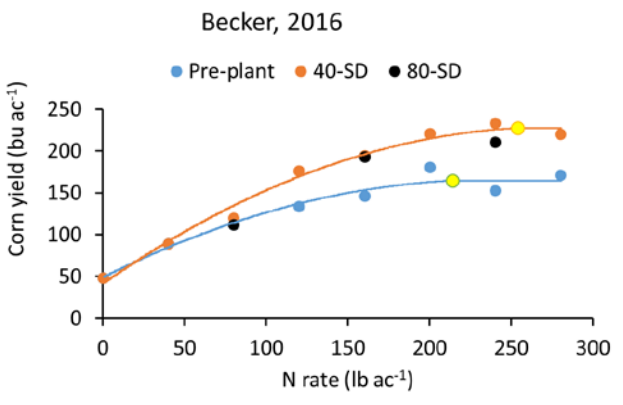






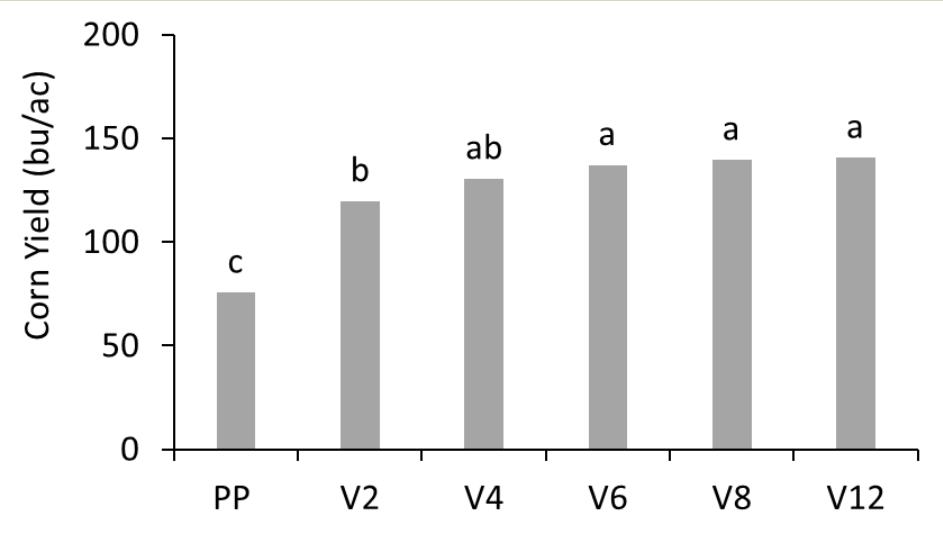




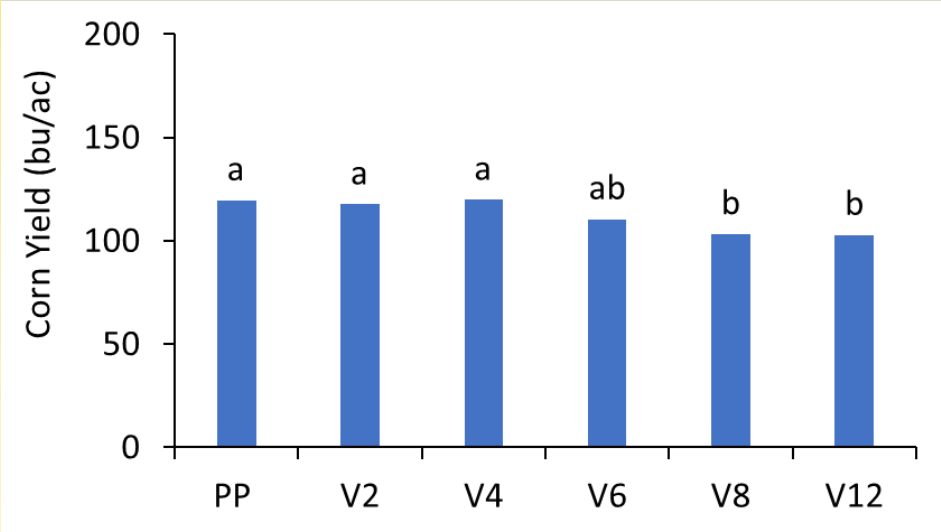


If splitting, what is the best time to apply the split?

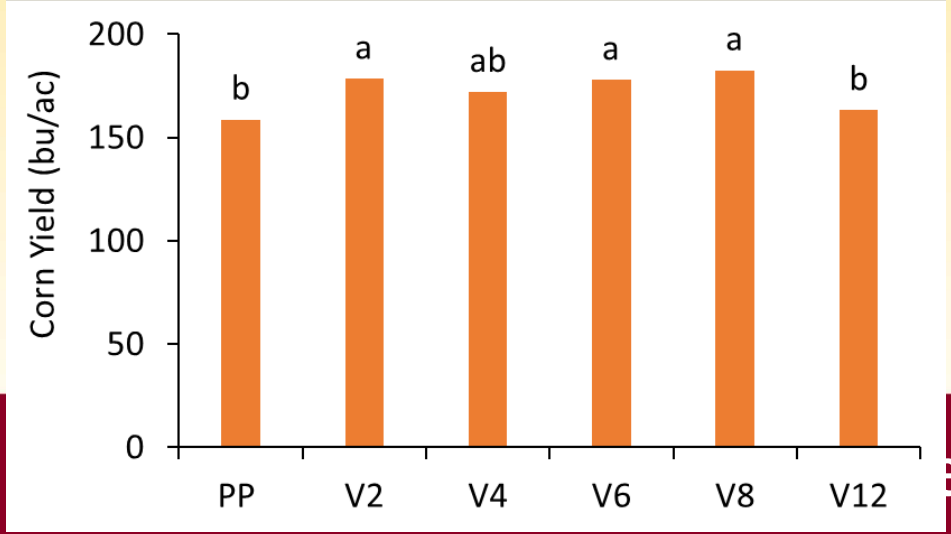
High spring N loss potential



Dry Summer



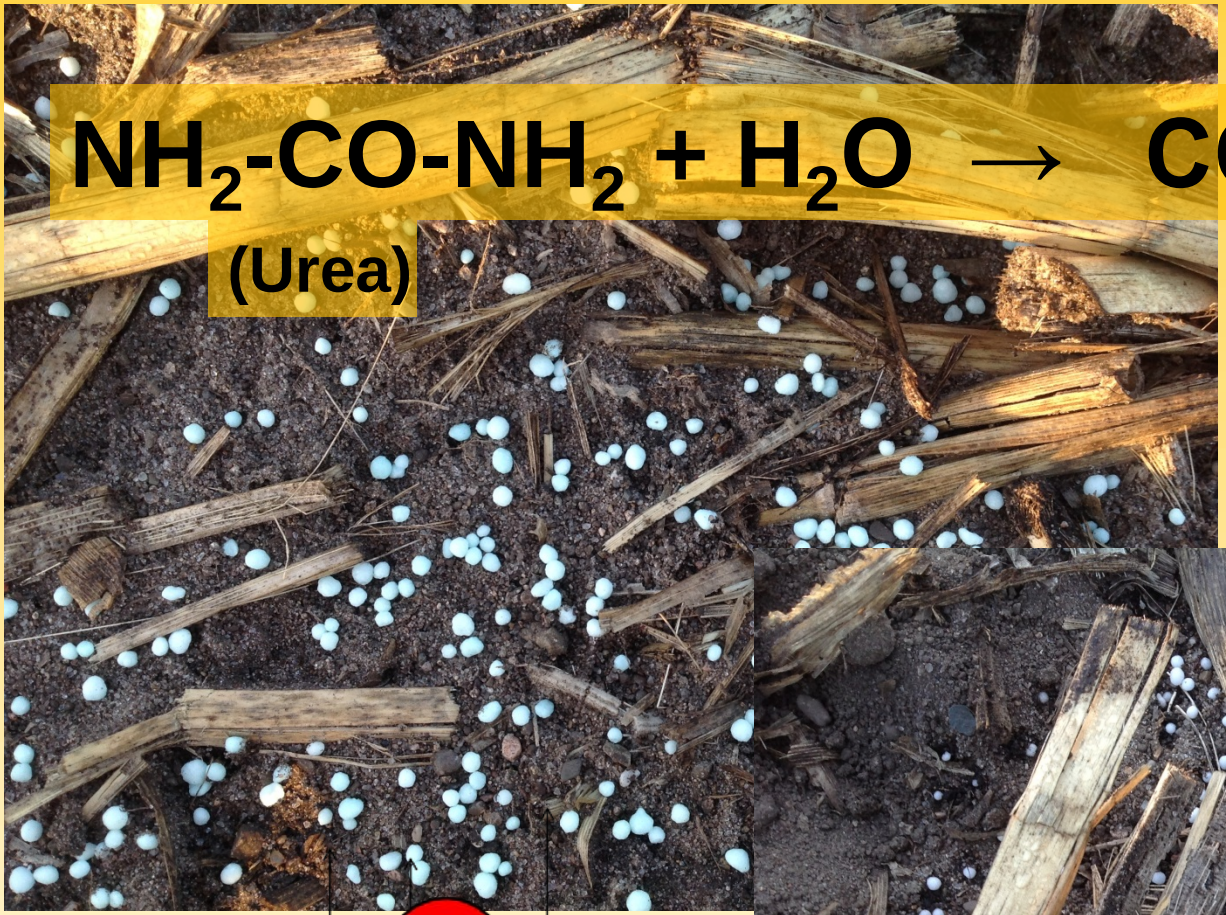
Low spring N loss potential

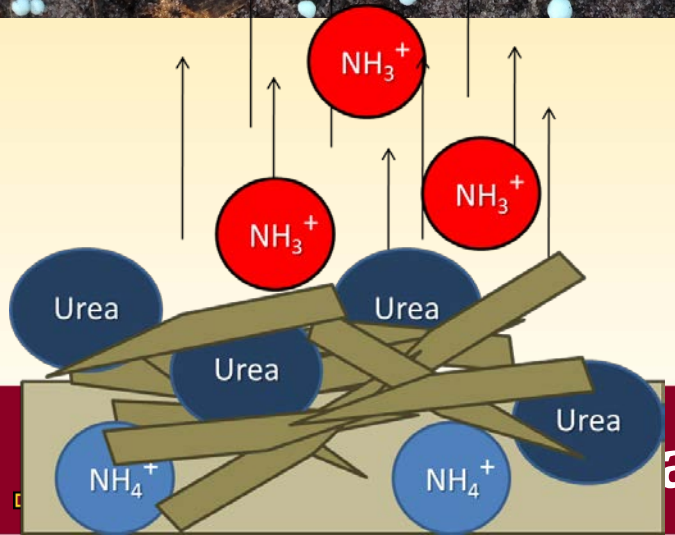


alpha=0.1

$$NH_2\text{-}CO\text{-}NH_2 + H_2O \rightarrow CO_2 \uparrow + 2\ NH_3 \uparrow$$

(Urea)





Time	Product	Placement	SROC		SWROC		WCROC
2016			CC	CSb	CC	CSb	CSb
			bu ac^{-1}				
Fall	AA+Nserve	INJ	191ab	229a*	201a	213a*	180a*
	Urea	BI	179bc	211a	106b	135c	164a
	Urea	SSB	176bc	206a	124b	164b	172a
	Urea+Instinct	BI	155c	205a	105b	156bc	181a
	Urea+Instinct	SSB	216a	221a	131b	174b	167a
Spring	AA	INJ	196a	239a*	186a	210a*	198a*
	Urea	BI	213a	224ab	121c	163b	175a
	Urea	SSB	196a	218b	160ab	171b	177a
	Urea+Instinct	BI	207a	225ab	141bc	170b	178a
	Urea+Instinct	SSB	198a	212b	161ab	171b	172a

N-Serve 32 oz/ac; Instinct II 37 oz/ac; *anhydrous ammonia applied at 120 vs all others at 80 lb N/ac

Time	Source	Placement	SROC		SWROC		WCROC	NWROC	
2017			CSb	CC	CSb	CC	CC	CSb	CWh
			bu ac^{-1}						
Fall	AA+Nserve	INJ	223a*	168a	203a*	195a	157a		
	ESN	BI	204b	154a	190ab	194a	139a	164a	144a
	Urea	BI	199b	151a	141d	170bc	86b	168a	134a
	Urea	SSB	194b	155a	185b	182ab	143a	-	-
	Urea+Instinct	BI	195b	175a	169c	160c	101b	148a	132a
	Urea+Instinct	SSB	202b	176a	177bc	182ab	135a	-	-
Spring	AA	INJ	227a*	184c	200a*	208a	125a	-	-
	ESN	BI	226a	214b	198ab	198a	121a	173a	150a
	Urea	BI	221a	195c	163d	166bc	130a	169a	148a
	Urea	SSB	228a	238a	183bc	178b	135a	-	-
	Urea+Instinct	BI	224a	191c	180c	156c	123a	158a	150a
	Urea+Instinct	SSB	217a	228a	181c	158c	118a	-	-

N-Serve 32 oz/ac; Instinct II 37 oz/ac; *anhydrous ammonia applied at 120 vs all others at 80 lb N/ac

Time	Source	Placement	SROC		SWROC		WCROC		NWROC	
2018			CSb	CC	CSb	CC	CSb	CC	CSb	CWh
			bu ac^{-1}							
Fall	AA+Nserve	INJ	186*a	147 a	192*a	157a	181*	168a	-	-
	ESN	BI	185a	171ab	158b	106b	164	141b	159a	127a
	Urea	BI	154b	156ab	117c	76b	164	130b	153a	133a
	Urea	SSB	187a	193a	145bc	104b	169	133b	-	-
	Urea+Instinct	BI	142b	130b	120c	75b	158	121b	163a	133a
	Urea+Instinct	SSB	193a	191a	140bc	96b	174	126b	-	-
Spring	AA	INJ	224*a	169c	201*a	182a	174*	162a	-	-
	ESN	BI	210ab	196ab	183ab	168ab	186	163a	153a	124a
	Urea	BI	191bc	198a	153cd	116cd	173	155a	144a	129a
	Urea	SSB	169cd	177bc	170bc	147bc	171	134b	-	-
	Urea+Instinct	BI	203ab	181abc	146d	101d	167	131b	167a	138a
	Urea+Instinct	SSB	157d	147d	168bcd	174ab	177	144ab	-	-

N-Serve 32 oz/ac; Instinct HL 24 oz/ac; *anhydrous ammonia applied at 120 vs all others at 80 lb N/ac

Comparison	Time	Occurrence
Urea SSB > Urea BI	Fall	9/32
(mean across w & w/o inhibitor)	Spring	5/32; 4/32*
Instinct > No Instinct	Fall	2/36
(mean across BI & SSB)	Spring	1/36; 3/36*
ESN > Urea BI	Fall	4/15
	Spring	4/15
ESN > AA	Fall	0/6; 2/6*
	Spring	2/6
AA > Urea BI	Fall	12/16
(mean across w & w/o inhibitor)	Spring	7/16; 1/16*
AA > Urea SSB	Fall	6/16
(mean across w & w/o inhibitor)	Spring	5/16; 2/16*

*Reverse response. All other comparisons were non significant

Questions

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THANK YOU

MinnesotaCorn GROWERS ASSOCIATION

Minnesota Soybean Research & Promotion Council

AFREC
Agricultural Fertilizer Research & Education Council