

Sulfur Fertilization of Corn

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Sulfur in corn, alfalfa and small grains:

- Plant available form of sulfur is (SO_4^{2-}) it's mobile in soil, like nitrate
- Sulfur is immobile in plants
 - Deficiency symptoms appear at the top of corn plant – newest growth
- Frequently mistaken for nitrogen deficiency
- Needed for proteins, chlorophyll and photosynthesis



Background on S response in MN

- Old data: S needed only on low OM, coarse texture soils
- What's changed? Deposition, higher yields
- Liming study at Waseca (1998-2005) yield response to gypsum (S) on a Nicollet soil.
 - Very high rate of gypsum (400 lb/A annually)
- NPKS fluid starter study (2004-06) at Waseca (Randall and Vetsch).
 - 8 bu/ac response to sulfur (3-yr avg)
 - 2x0 (surface dribble band) equal to 2x2

June 21, 2010 Waseca

193 bu/A, 21%

0 gal/A 10-34-0
0 gal/A UAN
0 gal/A ATS

209 bu/A, 16%

4 gal/A 10-34-0 In-
8 gal/A UAN S. ba
4 gal/A ATS S. ba

3
0
7

2010 Waseca sulfur source, rate, and timing study (methods and measurements)

- Waseca (Nicollet-Webster clay loam) corn on corn
- OM=5.8%, Bray P=24, K=167, pH=6.2
- Planted corn (DKC 52-43) at 35K/A on May 3
- Urea preplant-incorporated to bring all plots up to 180 lb N/A
- Whole plant samples at V6
- Ear leaf samples at R1-2
- Relative leaf chlorophyll readings at VT-R1



Corn grain moisture and yield as affected by S source, rate, and timing at Waseca in 2010.

Nutrient management					Grain	Grain
Sulfur Source	S timing	S rate	Placement	APP rate	H ₂ O	Yield
		per acre		per acre	%	bu/A
Control	none	none	none	no	21.0	181
APP Control	planting	none	In-furrow	4 gal	19.9	183
ATS (2.8-lb)	planting	1 gal	In-furrow	4 gal	18.2	188
ATS (5.6-lb)	planting	2 gal	In-fur.&SB	4 gal	16.9	205
AMS/Gypsum	PP	10-lb	Broadcast	no	16.4	210
AMS/Gypsum	PP	20-lb	Broadcast	no	16.0	226
Gypsum	V5	10-lb	Broadcast	no	18.1	222
Gypsum	V5	20-lb	Broadcast	no	17.2	224
ATS (10-lb)	V5	3.5 gal	Injected	no	17.3	209
LSD (0.10):					1.5	18



2011 Waseca sulfur source, rate, and timing study (methods and measurements)

- Sources: gypsum, AMS, elemental and ATS (plant)
- Timing: fall vs preplant (spring) for dry sources.
- Waseca (Nicollet-Webster clay loam) corn on corn
- OM=5.1%, Bray P=32, K=182, pH=6.7
- Planted corn (DKC 52-43) at 35K/A on May 17
- Urea preplant-incorporated to bring all plots up to 180 lb N/A
- Plant heights at V9
- Ear leaf samples at R1
- Relative leaf chlorophyll readings at VT-R1



2011 Waseca sulfur source, rate, and timing study (RESULTS)

- NO SIGNIFICANT DIFFERENCES IN CORN YIELD
- Greater [S] and relative chlorophyll content in the ear leaf at R1 with preplant S fertilization compared with fall applied.



2012 Waseca sulfur source, rate, and timing study (methods and measurements)

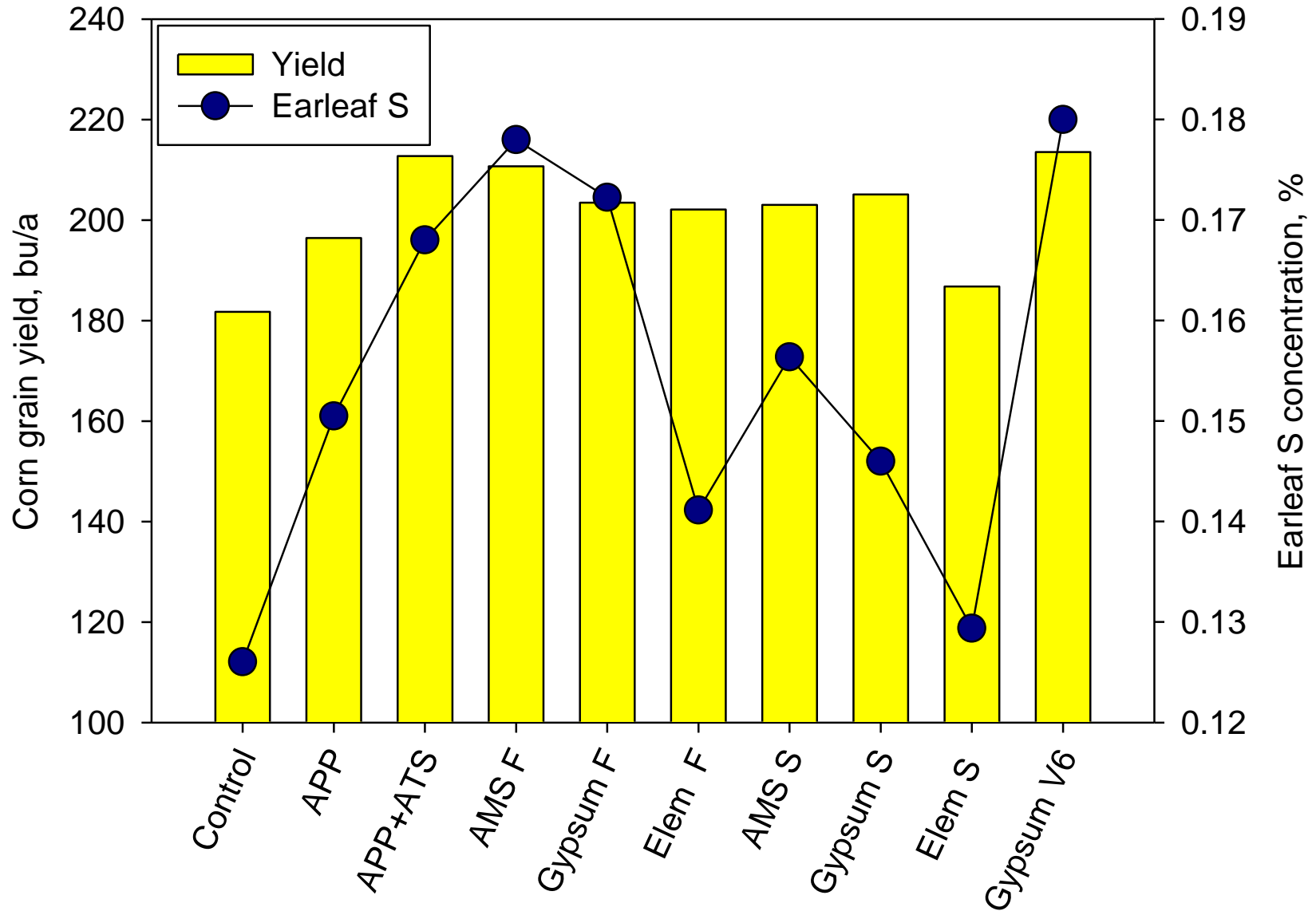
- Webster-Glencoe-Canisteo clay loam
- Corn after corn
- OM=5.8%, Bray P=23, K=192, pH=6.2
- Planted corn (DKC 52-43VT3) at 35K/A on May 10
- Urea preplant-incorporated to bring all plots up to 180 lb N/A
- Ear leaf samples at R2
- Relative leaf chlorophyll readings at VT-R1



Corn yield, ear leaf [N] and [S] and RLC as affected by S source, timing and rate in 2012.

Main Effect	Grain	Earleaf Conc		R1 Leaf
	Yield	N	S	Chloro
	bu/ac	%	%	%
Source				
AMS	207	2.70	0.167	95.8
Gypsum	204	2.66	0.159	95.8
Elemental S	194	2.48	0.135	90.9
Average LSD (0.10):	10	0.13	0.008	1.6
Time of application				
Fall	205	2.71	0.164	95.7
Spring	198	2.52	0.144	92.6
P > F:	0.1295	0.0039	0.0001	0.0005
Rate of application				
10-lb of S	202	2.57	0.149	93.6
20-lb of S	202	2.66	0.159	94.7
P > F:	0.9182	0.1381	0.0156	0.1683

Corn yield and ear leaf [S] as affected by S treatments at Waseca in 2012.



2013 Waseca sulfur source, rate, and timing study (methods and measurements)

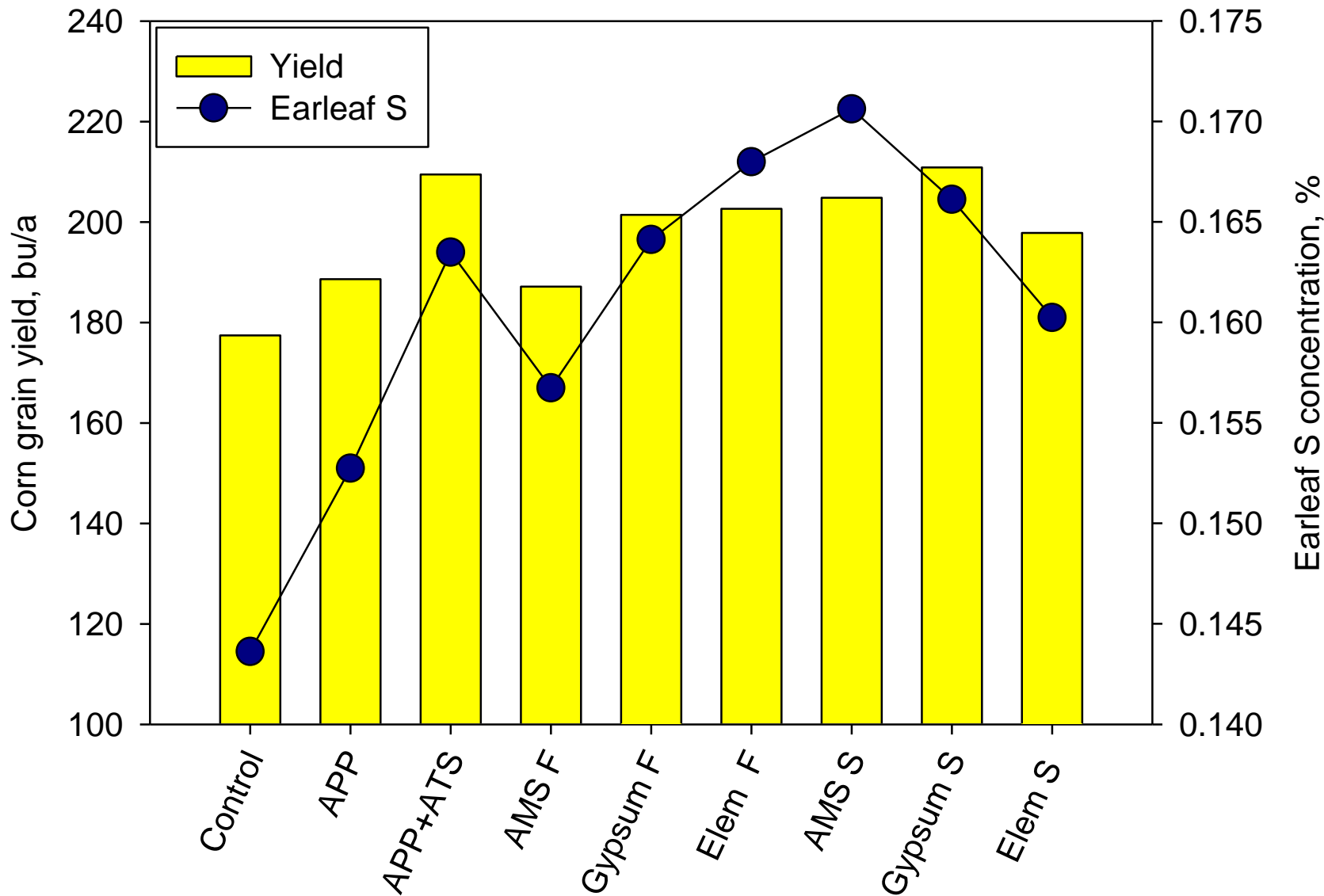
- Waseca (Nicollet-Webster clay loam) corn on corn
- OM=6.9%, Bray P=37, K=245, pH=7.1
- Planted corn (DKC 53-56 RIB) at 35K/A on May 15
- Urea preplant-incorporated to bring all plots up to 180 lb N/A
- Ear leaf samples at R2
- Relative leaf chlorophyll readings at VT-R1



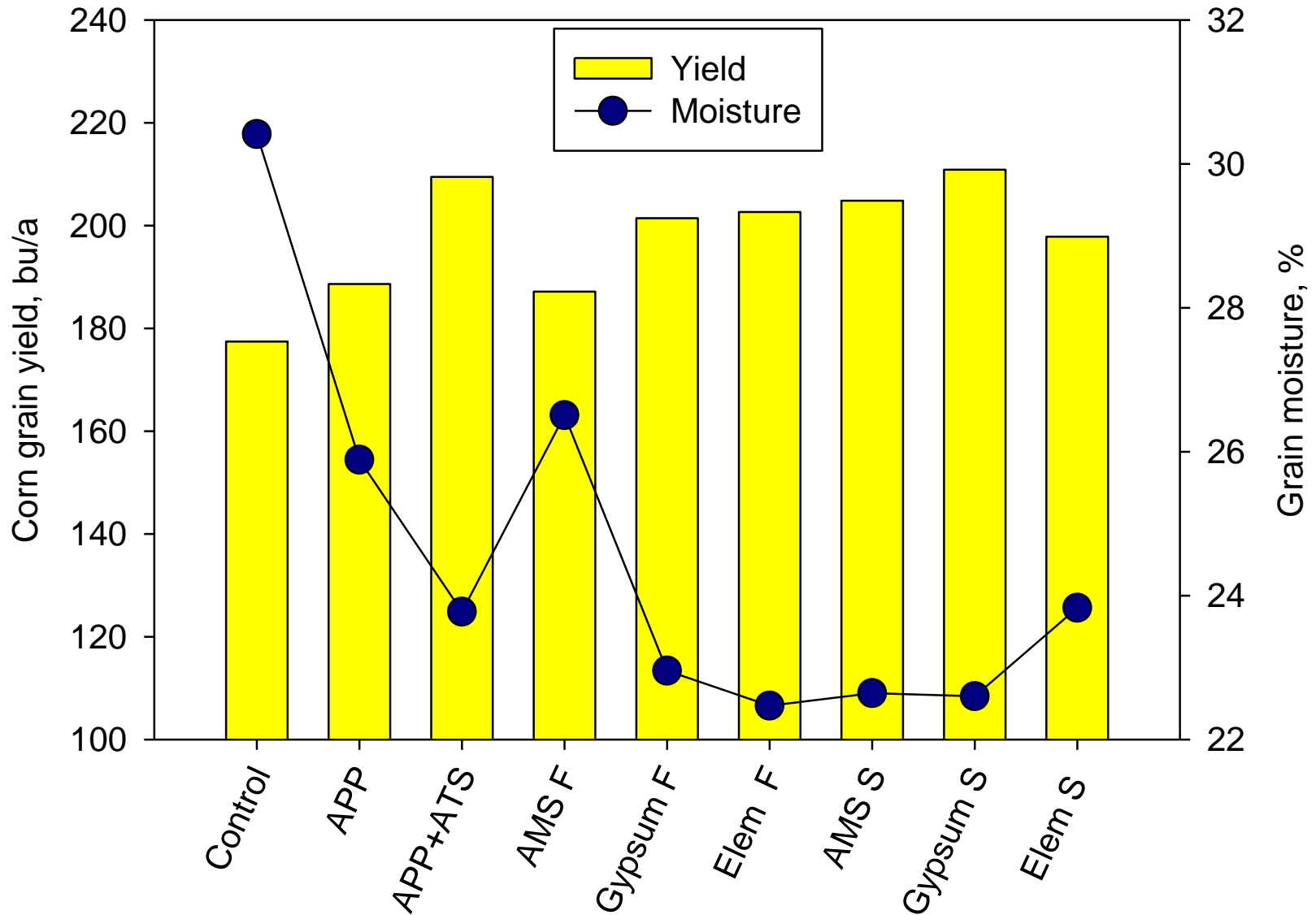
Corn yield, ear leaf [N] and [S] and RLC as affected by S source, timing and rate in 2013.

Main Effect	Grain	Ear leaf Conc		R1 Leaf
	Yield	N	S	Chloro
	bu/ac	%	%	%
Source				
AMS	196	2.71	0.164	94.3
Gypsum	206	2.76	0.165	97.0
Elemental S	200	2.73	0.164	96.7
Average LSD (0.10):	6	NS	NS	1.6
Time of application				
Fall	199	2.75	0.163	95.5
Spring	204	2.71	0.163	96.1
P > F:	0.031	0.324	0.952	0.401
Rate of application				
10-lb of S	200	2.69	0.159	95.2
20-lb of S	204	2.77	0.167	96.5
P > F:	0.095	0.097	0.002	0.055

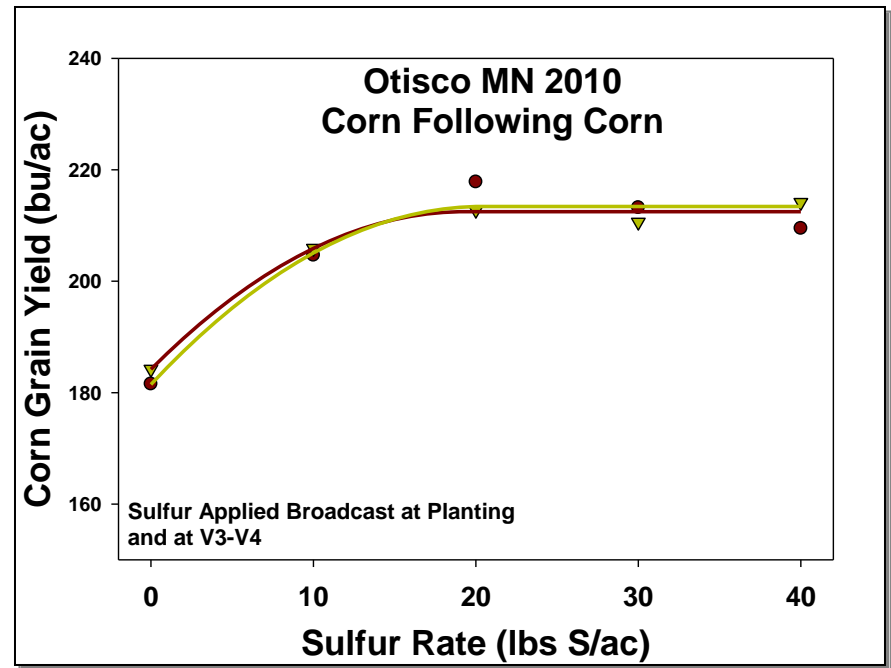
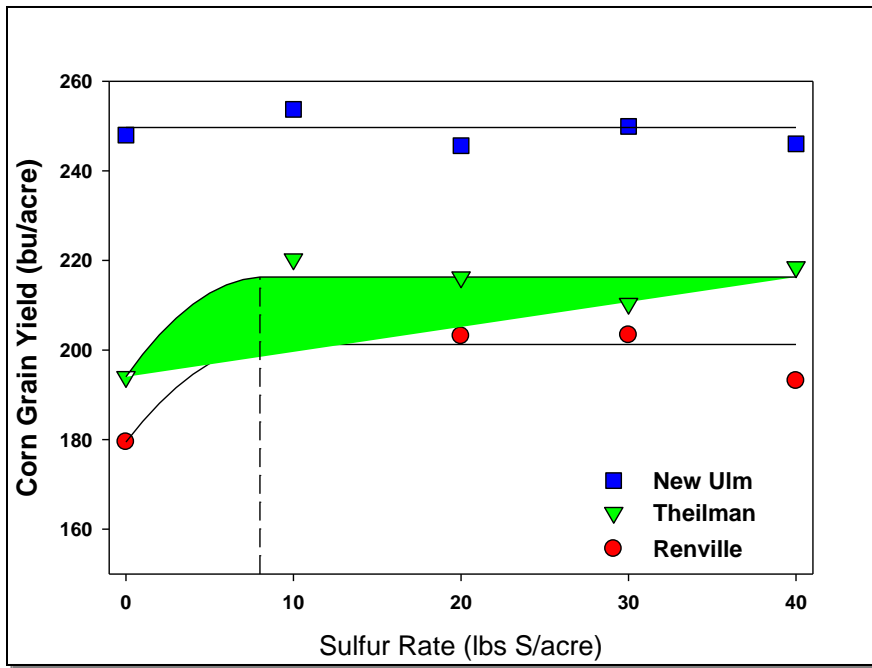
Corn yield and ear leaf [S] as affected by S treatments at Waseca in 2013.



Corn yield and moisture as affected by S treatments at Waseca in 2013.



Sulfur Timing and Rate Study 2009-2010



- Timing is less critical than rate as long as S is applied early (by V5)
- Most rate data indicates that 10 lbs of S is sufficient
- Some fields may respond to higher rates
 - Due to lower organic matter or more residue?

Rotation and Tillage study at Lamberton, (Pagliari, 2012)

- Positive response to S in 67% of treatments

S	Corn-Corn			
	2008	2009	2010	2011
	Corn Grain Yield (Bu / A)			
0	104	177	177	150
25	114	182	178	160
S	Corn – Soybean			
	Corn Grain Yield (Bu / A)			
0	---	185	---	170
25	---	191	---	174

Differences in yield greater than 6 Bu / A are significantly different (P-level 0.10)

Summary: Sulfur fertilization of corn

- Greatest yield responses found with corn after corn in conservation tillage (high residue situations).
- Sources
 - AMS, gypsum and ATS (sulfate) are best, elemental acceptable if fall applied, may require a rate adjustment
- Timing
 - Interactions with time of application, source, and environment (weather); avoid spring application of elemental.
 - Sidedress applications before V6 work in most trials
- Rates for corn after corn
 - 10 lb S banded near row, 15-20 lb broadcast



Proposed Corn Sulfur Guidelines for Southern Minnesota

Broadcast sulfur to apply (lbs S per acre)				
		0-6" Soil Organic Matter		
Rotation		0-2	2-4	>4%
Corn-Corn		15-25??	10-20??	10-15
Corn-Soybean		10-20??	10-15	0
Sandy Soils		25	15-25	10-25??

** ??, denotes where we have limited data on response and need more data.

Thanks Questions

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OR

[http://www.extension.umn.edu/
nutrient-management/](http://www.extension.umn.edu/nutrient-management/)



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