

Proceedings of the 11th Nutrient Management Conference



11th Annual

NUTRIENT MANAGEMENT CONFERENCE

Tuesday, February 19, 2019



BEST WESTERN KELLY INN ST. CLOUD

11th Annual

NUTRIENT MANAGEMENT CONFERENCE

Sessions 9:05 a.m.-3:40 p.m.

■ GENERAL SESSION

8:15 a.m.	<i>Registration</i>	
9:00 a.m.	<i>Welcome</i> Tom Rothman	University of Minnesota
9:05 a.m.	<i>Lessons Learned in 2018, Opportunities for 2019</i> Brad Carlson Dave Nicolai Gary Prescher	
9:55 a.m.	<i>Phosphorus Management Challenges Confronting the US</i> Dr. Heidi Peterson	University of Minnesota Extension University of Minnesota Extension Minnesota Corn Research & Promotion Council
10:50 a.m.	<i>Break</i>	
11:05 a.m.	<i>Get the Most Out of Sulfur Application by Applying at Right Time</i> Dr. Dan Kaiser	University of Minnesota
12:00	<i>Lunch</i>	

■ BREAKOUT SESSION #1

1:00 p.m.	<i>Residue Management and Potential Effects on P Availability in a Continuous Corn System</i> Dr. Paulo Pagliari	
1:55 p.m.	<i>Phosphorus Management and Water Quality</i> Dr. Lindsay Pease	
2:50 p.m.	<i>Lessons Learned from Spring Creek Farms</i> Tim Radatz	

■ BREAKOUT SESSION #2

1:00 p.m.	<i>Evaluation of the Haney Soil Health Test as a Corn Nitrogen Management Tool</i> Dr. Matt Yost	
1:55 p.m.	<i>Irrigation and Nitrogen Management</i> Dr. Vasudha Sharma	
2:50 p.m.	<i>Managing Micronutrients for Soybeans</i> Dr. Dorivar Ruiz-Diaz	
3:40 p.m.	<i>Adjourn</i>	

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Getting the Most from Sulfur by Applying at the Right Time



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2019
Nutrient Management
Conference



Soil Fertility



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Sulfur – What we Know

- Organic matter provides a large storehouse of S in the soil
 - 80% or more of the S needed by crops can be supplied by SOM
 - 3-5 lb S/ac/yr mineralized from SOM
- Sulfate is mobile in the soil
 - Sulfate is a divalent anion and is not as mobile as nitrate
 - Mobility depends on soil textural class

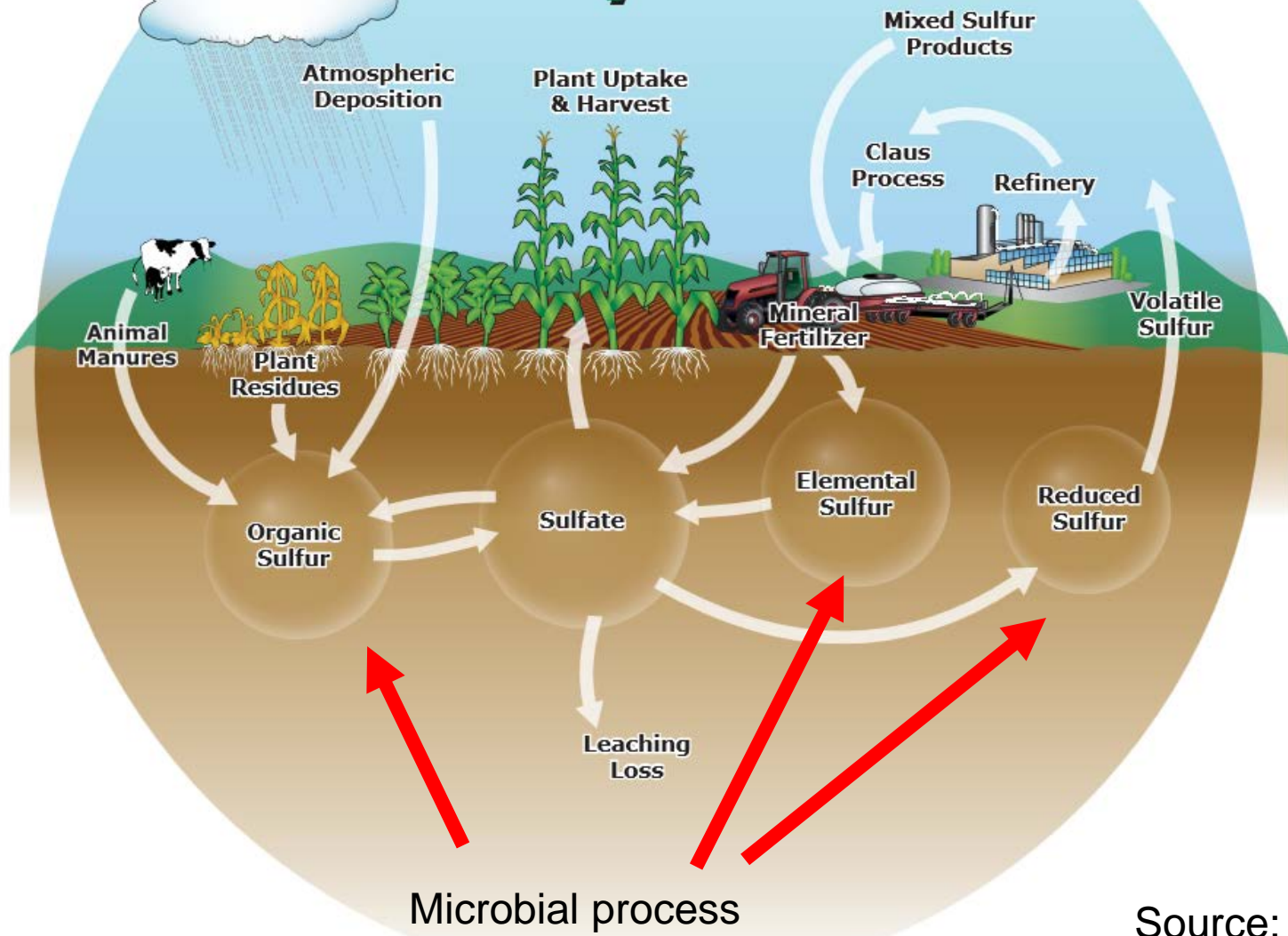


Sulfur – What we Know

- Sulfate is the form of sulfur taken up by plants
 - Uptake occurs by mass flow (with water)
 - Sulfate forms will provide immediately available S
- Elemental sulfur is made available through oxidation
 - Oxidation is generally slow and depends on many factors

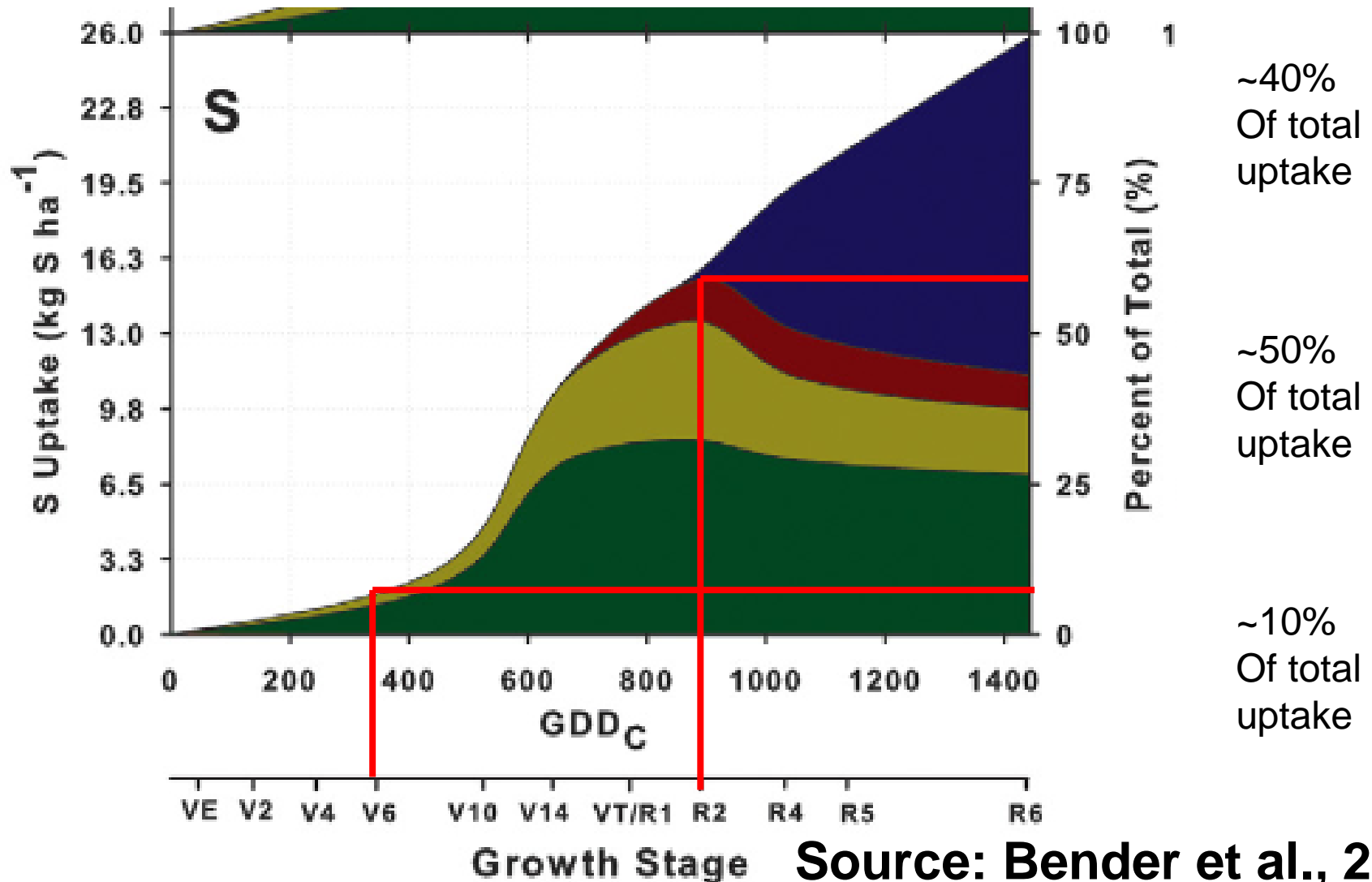


The Sulfur Cycle



Source: IPNI

Key Growth Stages for Sulfur Uptake in Corn



Sulfur is Immobile in Plants



Soil Sulfur Response Scenarios

1: Low S supply capacity

- Response is dictated by supply capacity of soil
 - i.e. organic matter
- Temp. and moisture are still factors
- If deficient, S uptake will be limited throughout the growing season
- Plant analysis should provide useful data

2: Temporary deficiency

- Response is dictated by availability of S at key growth stages
- Greater impact of temp. and moisture
 - Start and end of season
- Plant may green up if S supply increases
 - Plant tissue analysis would be less reliable



Corn Yield Response to S

Year	Location	Control	MOP	MOP+S	Poly	Poly/MOP	P>F
		-----bu ac ⁻¹ -----					
2017	Becker	205	206	209	214	214	0.94
	Lamberton	184b	189b	200a	196ab	191b	0.08
	St Charles	182b	218a	204b	209ab	217a	0.04
	Staples	188	194	186	194	194	0.72
	Waseca	192b	192b	206a	196ab	205a	0.10
2018	Becker	226	228	232	235	228	0.59
	Lamberton	216bc	210c	226a	226ab	227ab	0.08
	Rosemount	235	233	236	236	234	0.18
	St Charles	211b	204b	226a	247a	225a	0.02
	Waseca	191c	193bc	202a	199ab	206a	<0.01

MOP – Muriate of potash (0-0-60), Poly – Polyhalite (0-0-14-19S-6Mg-19Ca)

Lamberton and Waseca sites were C-C, remaining sites were C-Sb

MOP+S and Poly/MOP treatments applied 25 lbs S

Poly treatment was based on K rate and applied > 25 lbs S/ac



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Soybean Yield Response to S

Year	Location	Control	MOP	MOP+S	Poly	Poly/MOP	P>F
		-----bu ac ⁻¹ -----					
2017	Becker	64.0	64.4	65.3	63.2	63.8	0.73
	Delavan	60.1	57.8	59.4	62.1	61.1	0.43
	Staples	43.9b	42.6b	48.3a	45.6a	48.5a	0.01
2018	Lamberton	49.3	49.6	51.0	50.1	50.2	0.85
	Rosemount	57.3a	53.0a	53.0ab	55.3ab	52.9b	0.05
	Staples	51.0b	53.2ab	56.1a	57.2a	54.4a	0.10

MOP – Muriate of potash (0-0-60), Poly – Polyhalite (0-0-14-19S-6Mg-19Ca)

MOP=S and Poly/MOP treatments applied 20 lbs S

Poly treatment was based on K rate and applied > 20 lbs S/ac

- Soybean response to S has occurred at Staples which is irrigated but the total amount of S applied through irrigation has been low (5 lb S or less per year)
- No response to S at other sites



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Apply S When a Response is Likely

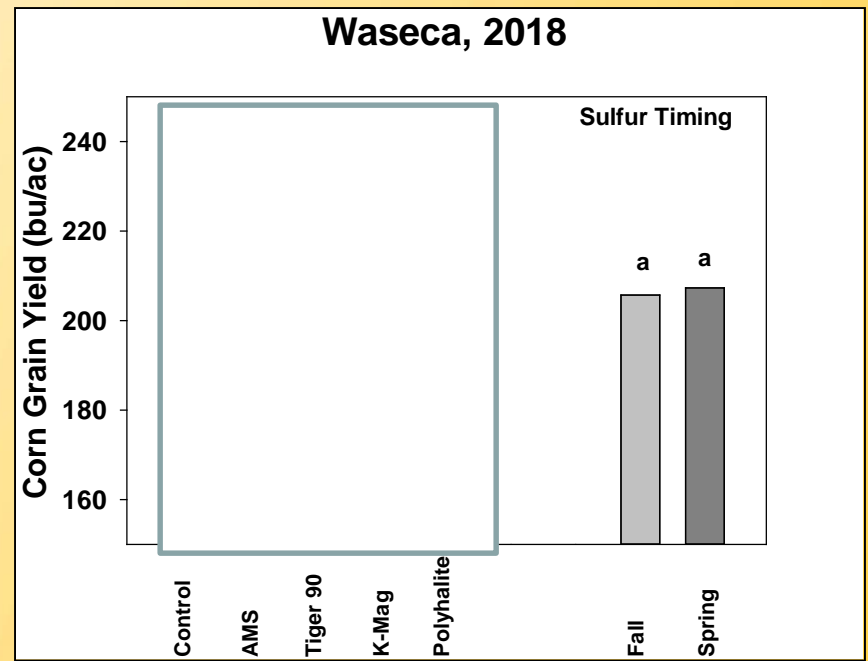
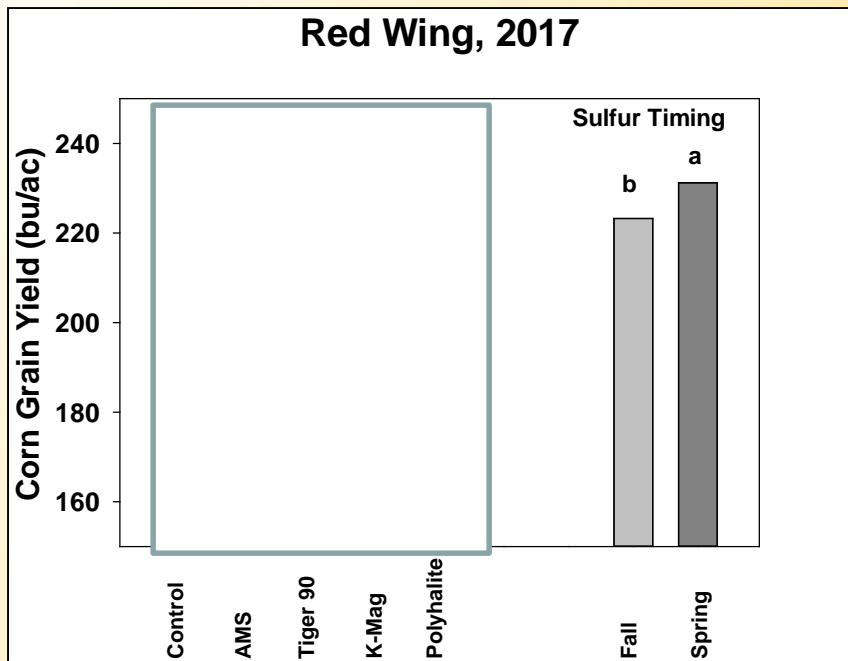
- Alfalfa, corn, and canola are more likely to show a strong response to S
- Small grain crops may respond on eroded ground with the best responses on sandy low organic matter fields
- Apply to corn/corn fields
- I would avoid direct application to soybean
 - N + P + S can stimulate vegetative growth
- Sulfur can deplete over time in deficient soils – responses may get greater



Can Sulfur be Applied in Fall



Timing of Sulfur Application



Sulfur was applied at 5 and 15 lbs S per acre (broadcast)

Source results are averaged across the two rates

Red Wing – Silt loam soil < 3.0% SOM C-Sb

Waseca – Clay loam soil > 4.0% SOM C-C



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Leaching of Sulfur

- The rate of S leaching depends on soil texture
 - Sandy soils are more likely to require annual applications
- Sulfate-S can remain in the upper soil profile for 1 or more years
 - Fall application of sulfate may be okay in high clay soils
- Leaching of sulfate-S is not fast enough to warrant split application of S



Notes on Fall Application

- Soil texture plays an important role in whether S will remain from fall application
 - Western MN – risk for over winter or early spring loss are low
 - What we do not know is whether fertilizer sulfate reduction occurs in soils
- Elemental S is not more likely to result in more available sulfate in May than sulfate-S



**Should Only Elemental S be
used in the fall?**



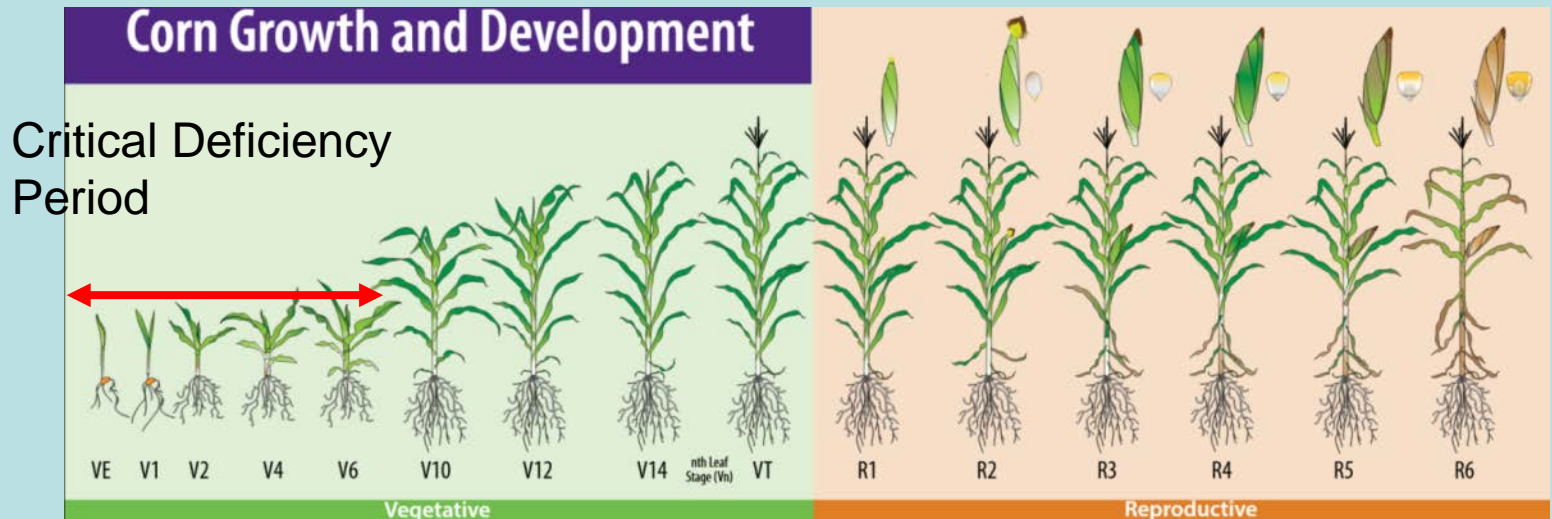
Elemental Sulfur Availability

- Elemental S is hydrophobic and not soluble in Water
- Microbial mitigated process
 - Bacteria and Fungi
- Soil temperature and moisture affect oxidation of S to SO_4^{2-}
 - Optimum around 80-90°F
- Oxidation is limited by the surface area of the fertilizer source
 - Larger particles oxidize slower



Elemental S Oxidation – Long Term

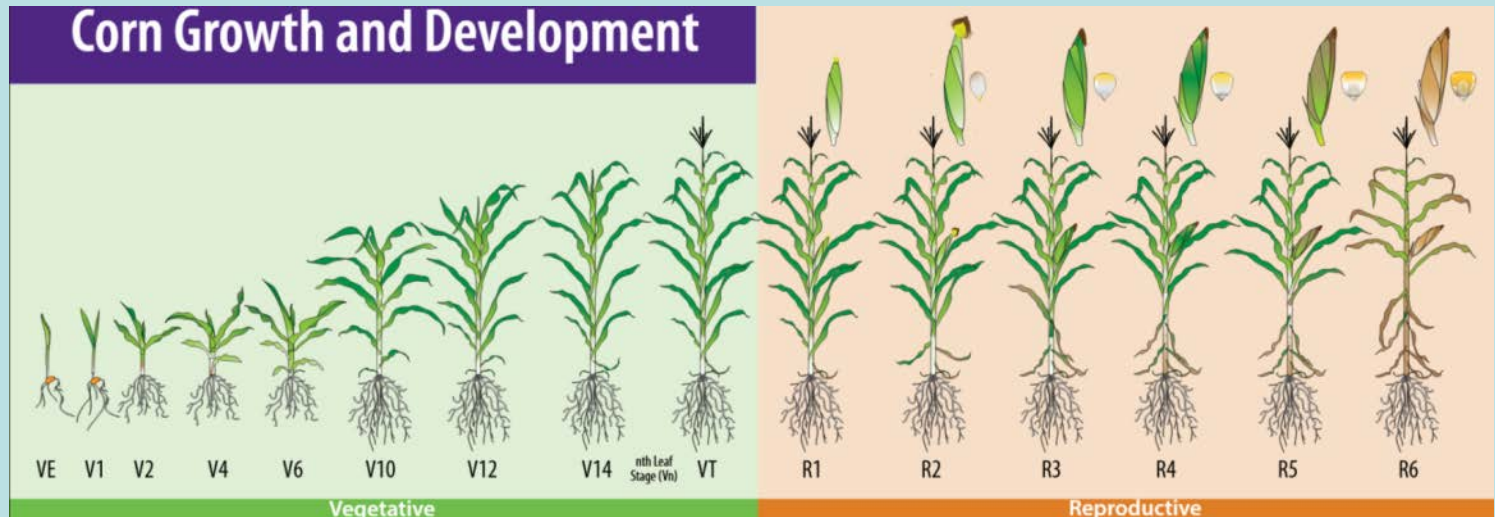
Year 1



Application of Elemental S

Mineralization increases
Oxidation increases

Year 2



↑
Soil $\text{SO}_4\text{-S}$

Application of Elemental S
Carried over Sulfate-S

Mineralization increases
Oxidation increases

2-Year Average Yield

Fall vs Spring: Elemental & Sulfate-S

S Rate (lb/ac)	Yield (bu/ac)
0	232b
5	235a
10	236a
20	236a

Summary – 4 locations in Western MN

- No evidence of an effect of Fall vs Spring application on yield
- No difference between sources
- Rate was significant with 5 lbs S producing the maximum yield



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Micronized Elemental S

Timing	NPK	Phos. MST SGF	Phos. MST WS	MES 15	Potash MST	Potash + AMS	Liquid MST	ATS	Mean
	-----Yield (bushels/ac @15.5%)-----								
Fall	168	222	209	222	225	230	219	225	215
Spring	164	221	214	217	224	228	219	227	214
Mean	166d	222ab	211c	219bc	224ab	229a	219bc	226ab	

- Rosemount, MN 2018 – C-SB – Slightly eroded silt loam soil
- MST – 100% elemental sulfur – Micronized
- All S applied at 15 lbs S/ac
- Fall S applied before freeze up, lightly incorporated
- Liquid MST and ATS applied with a hand boom streamed beside the row
- Potash + AMS had the greatest yield potential
- No difference between fall and spring application

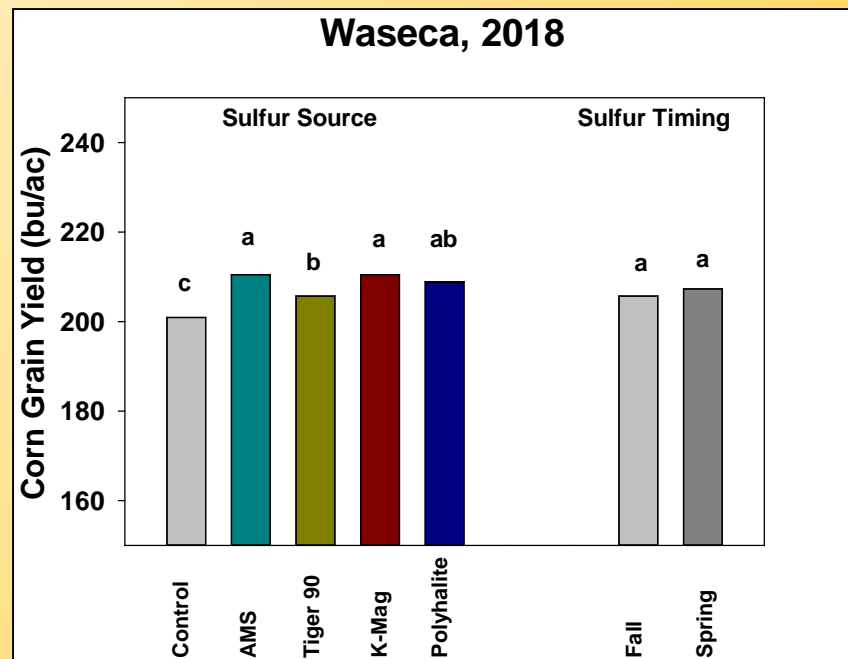
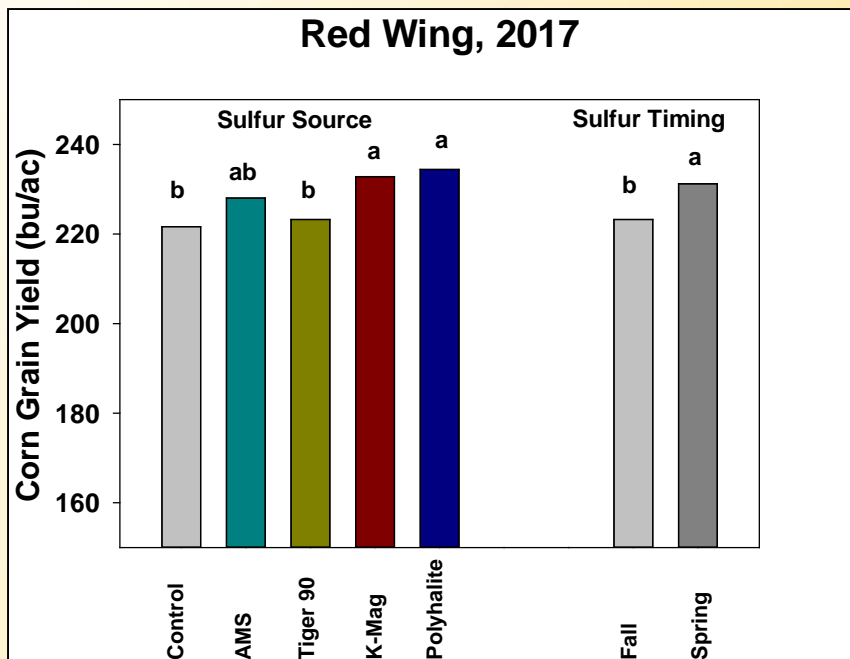


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Strategy for use of Elemental S

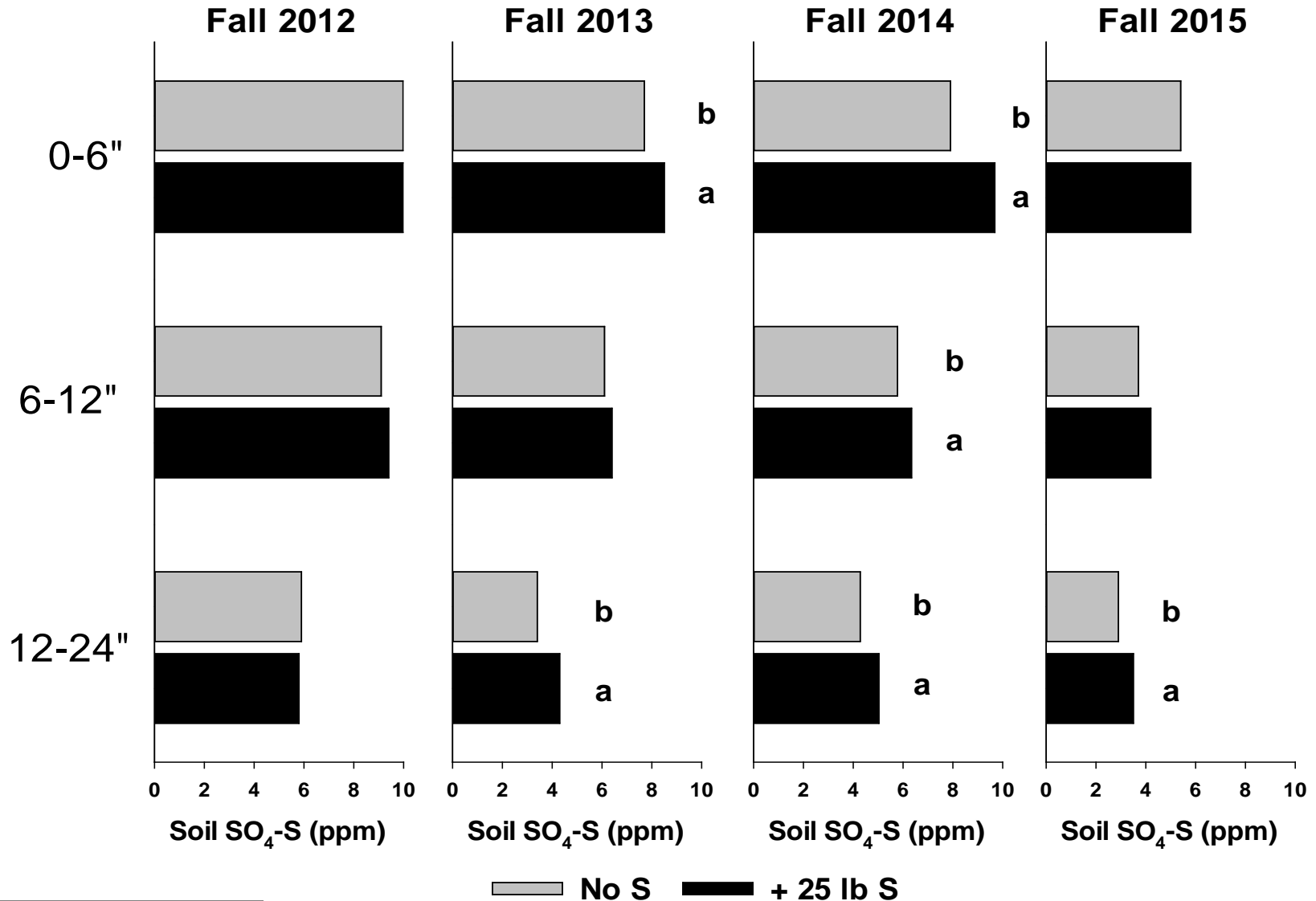
- Elemental S products like Tiger 90 have two issues
 - High % S content results in poor distribution of S
 - Oxidation is not guaranteed
- Elemental S may not provide any available in the early growing season following a spring or fall application
 - This would include MES-10, MES-15, and MEZ which the elemental S is more finely ground (micronized S)
- Repeated application of elemental S may supply plant available S due to sulfate carried over from one year to the next
- Add sulfate with elemental S for early season availability
 - ATS is a good option



Are Split Applications of S Needed?

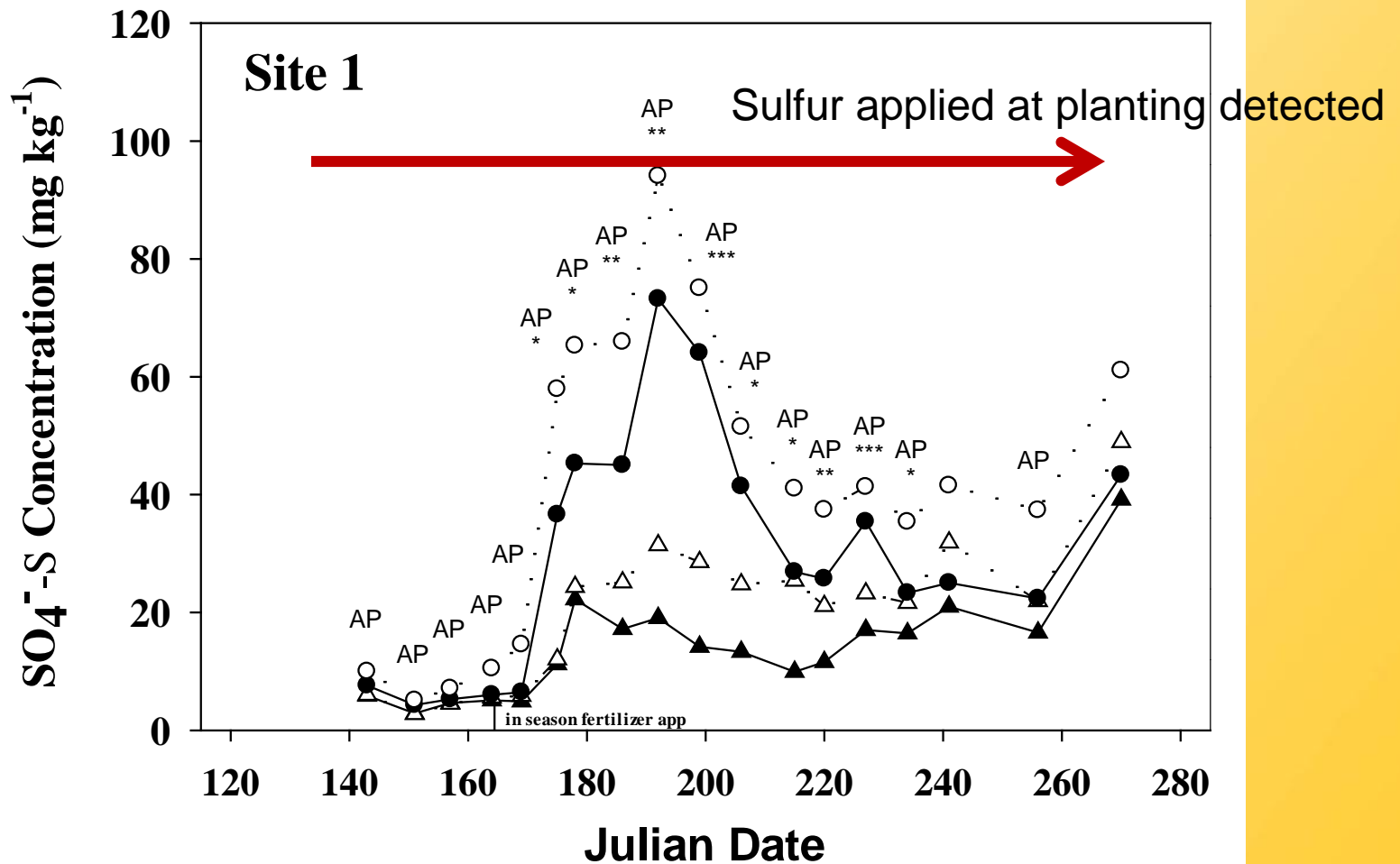


Lamberton, MN



Tracking S availability with a soil test is difficult

Leaching of S

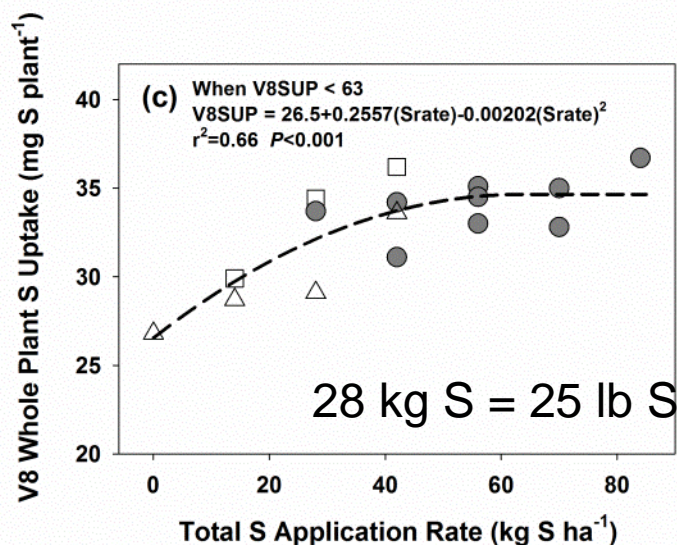
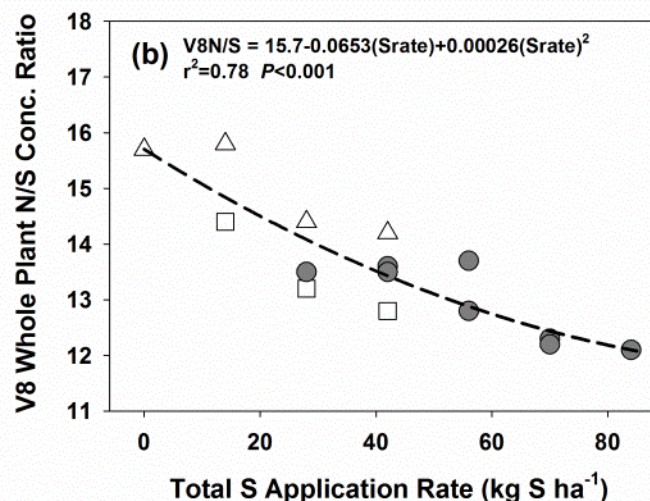
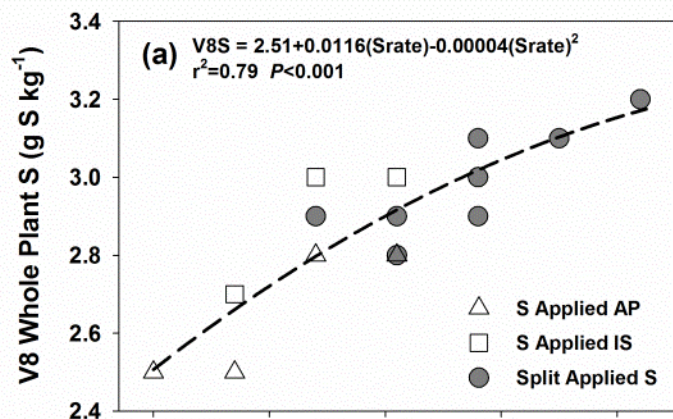


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Split Application Efficiency?



- Similar tissue concentration values for the same rate regardless of split % and timing



Soil Fertility



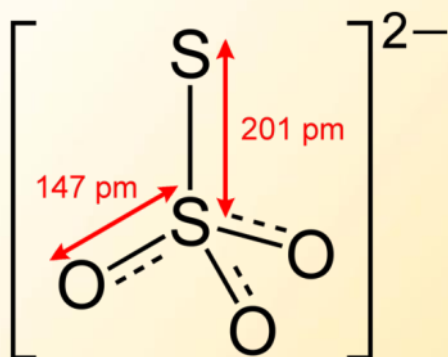
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What Source is the Best

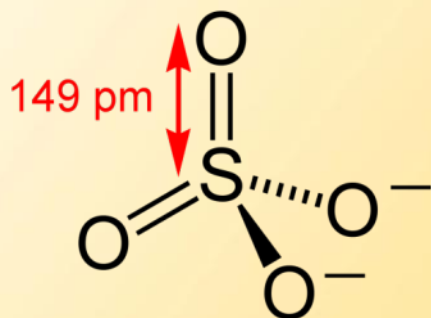
- Sulfate sources are immediately available
 - AMS, Gypsum, K-Mag, K-sulfate should supply S somewhat equally
 - Can be some differences in solubility with gypsum sources
- Elemental sulfur sources must be oxidized
 - Tiger 90 – mixed with bentonite, high % S
 - Microessential – micronized elemental S with AMS
- Manure ~65% S available but depends on source (dry sources probably greater avail.)
- Ammonium thiosulfate



Sources of Sulfur



Thiosulfate Ion
Not Plant Available
Dissociates into elemental S
And Sulfate



Sulfate Ion
Plant Available



Corn Grain Yield Data By Soil Organic Matter Level



	Low (<4.0% SOM)				High (>4.0% SOM)			
S Rate	AMS-Br	ATS-Br	ATS-Ba	Avg.‡	AMS-Br	ATS-Br	ATS-Ba	Avg.‡
-lb S/ac-	-----bu/ac-----							
0	227	226	229	227b	212	211	209	211c
2.5	230	231	221	227b	214	213	216	215bc
5.0	231	228	232	230ab	221	215	217	217ab
10.0	231	233	231	231ab	215	221	212	216b
20.0	231	237	228	232a	224	216	223	221a
Avg.‡	230ab	231a	228b		217	215	216	

† Sulfur source: ATS-Ba, Ammonium thiosulfate banded; ATS-Br, ammonium thiosulfate broadcast; AMS-Br, ammonium sulfate broadcast.

‡ Avg., treatment mean; within rows and columns, numbers followed by the same letter are not significantly different at the $P \leq 0.05$ probability level.



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Wrap Up

- I don't think sulfate leaching is a serious issue to warrant only applying elemental S in fall
 - Similar assessment where split application do not seem to be needed in highly leached situations
- Soil and plant tissue tests for S are not reliable for determining where a response will occur
- Some striping can occur on plants early in the growing season which may not affect grain yield
 - Depends on when it occurs and how long it lasts



Are Responses to S Increasing?

- The answer depends on early season rainfall and soil temperature
 - 2017 and 2018 – greater S deficiency
- Atmospheric S has decreased but the relative impact in an individual year is low
 - May compound over a number of years
- Mineralization of S from soil organic matter is still an important source of S
 - Rate depends on soil temp and moisture
- Drainage may also impact S availability



When to Apply S

- Sulfate can carry over in soils so the question of Fall versus Spring application is less important for Western, MN
- Should you apply sulfur across all acres?
 - Probably not needed in all circumstances but a low rate may be warranted
 - No justification to apply over 20 lbs on medium to fine textured soils (5-10 lbs is likely enough)
 - Increased rates when elemental S is used
- Apply to low organic matter or highly leached soils
 - Spring or SD application for high leaching situations
- Poorly drained soils may also warrant application
 - Responses may be limited to highly alkali areas
 - Trust your eyes, not the soil test



A photograph of a cornfield with rows of young corn plants. The leaves are green and show some signs of stress or damage, with some yellowing and wilting visible. The soil is brown and appears to be a mix of dirt and organic matter.

Thank You Questions?

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