EFFECT OF SULFUR ON CORN YIELD AND AGRONOMIC NITROGEN USE EFFICIENCY

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ABSTRACT

- It is well documented that, (1) Adequate sulfur (S) is vital to maximize corn yield, (2) Yield response to S is more likely on sandy soils with low SOM
- Steinke et al. (2015) reported that, when N is adequate, corn yield may not increase significantly from S applied on fine texture soil if SOM ≥ 2.8%, and soil S is ≥ 8 ppm
- Low grain market prices raised farmers' interest in understanding the efficiency of their S and N fertilizer rates on yields
- In order to investigate the effect of S on yields and the agronomic efficiency (AE) of S and N, two main objectives were set

OBJECTIVES

- To assess the magnitude of yield impact of S on corn in loam soils with high SOM
- To verify if agronomic efficiency (AE) of N and S is improved by S fertilization

MATERIALS AND METHODS

- Trial sites were Forman (2016, 2017) and Carrington (2017), North Dakota on loam soil
- Forman site treatments:
  - 2016 : N rates: 105, 210 lbs/ac.
    S rates: 0, 10, 20, 30, 40 lbs/ac at both N rates + a check of 0 lbs N with 0 lbs S
  - 2017: N rates: 0, 60, 120, 180, 240 lbs/ac
    S rates: 0, 10, 20 lbs/ac at all N rates
- Carrington (CREC) site treatments:
  - N rates: 0, 73, 128, 155 lbs (were 0, 50, 100, and 125% of recommended N rates, respectively)
    S Rates: 0, 10, 20 lbs/ac at all N rates
- Previous crop was soybeans
- Strip-till at Forman, conventional at CREC
- RCBD with 5 reps at Forman, and 4 reps at CREC
- Data was analyzed using the mixed model Means were compared using Tukey's method at 95% probability level
- Yield response curve was used to estimate N rate to maximize yield
- Statistical effects were analyzed at Forman in 2016 only under adequate N (210 lb N/ac)

Table 1. Pre-plant soil analysis by site and year

Site	Depth	N	P	S	K	Ca	Mg	Zn	pH	SOM
	in	ppm								%
Forman 2016	0-6	5.5	13	14	156	5038	532	1	7.9	3.9
	6-24	3.5		50						
Forman 2017	0-6	3.0	16	10	292	5011	576	2	7.3	4.5
	6-24	1.5		5					8.0	
CREC 2017	0-6	4.0	9	16	236	2978	346	1	7.1	3.1
	6-24	6.0		8					8.0	0.5

RESULTS

- Only the results from Forman are reported because yields did not respond to N and S at the CREC.

Forman, 2016

- S improved yields significantly (*p=0.049*) at 210 lbs N (Fig.1), but not at 110 lbs
- Yields were numerically greater for all S fertilized plots (Fig 2.)
- More bushels were produced per pound of S (AE of S, Fig 3) under adequate N (210 lbs). AE of S declined as S levels increased.

Fig 1. Effect of S rates on corn yield (Forman, 2016)

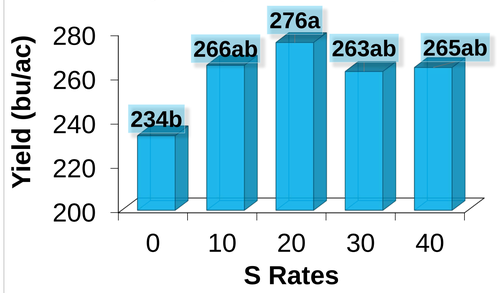


Fig 2. Corn yield response to N at five S rates (Forman, 2016)

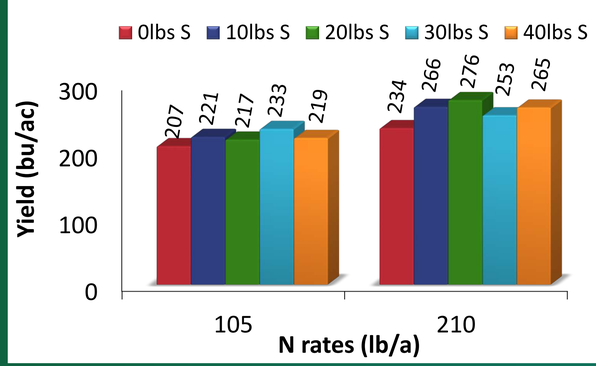


Fig 3. Agronomic efficiency of S for corn at two N rates (Forman, 2016)

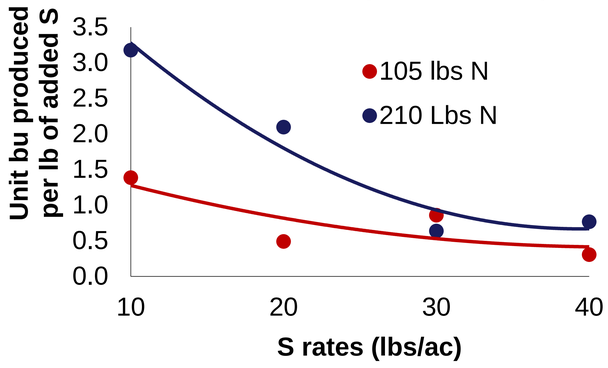


Table 2. Effect of N and S rates on corn performance (Forman, 2017)

Treatments	Yield	TWT	Protein	Ear leaf N	Ear leaf S	N/S ratio
N (lb/a)	bu/ac	lb/bu	%			
0	168c	55.0	7.48	2.692c	0.170b	15.9b
60	195b	55.5	7.69	2.983b	0.182ab	16.4ab
120	212a	55.8	7.79	3.058b	0.185ab	16.5ab
180	217a	55.4	8.21	3.100ab	0.188ab	16.5ab
240	222a	55.4	8.39	3.333a	0.193a	17.4a
S (lb/a)						
0	196b	55.1	8.05	2.950	0.175b	16.9
10	208a	55.5	7.86	3.095	0.187ab	16.6
20	208a	55.6	7.84	3.055	0.189a	16.1
Effects	Pr > F					
N	<.0001	0.1121	0.0063	<.0001	0.0207	0.0051
S	0.003	0.0501	0.5484	0.1425	0.0159	0.0542
N x S	0.309	0.9045	0.2836	0.4888	0.3893	0.3391

Means with different letter(s) in a column are significantly different, P≤0.05

Fig 4. Corn yield response to N at three S levels (Forman, 2017)

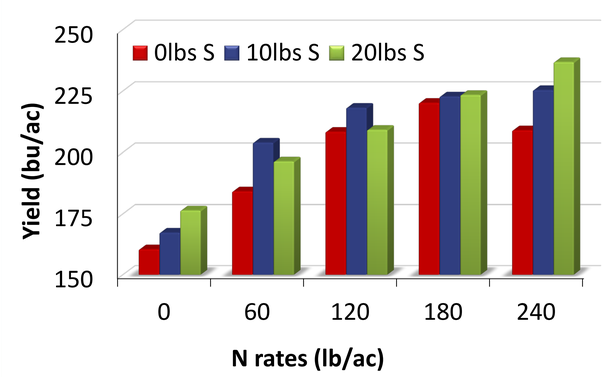
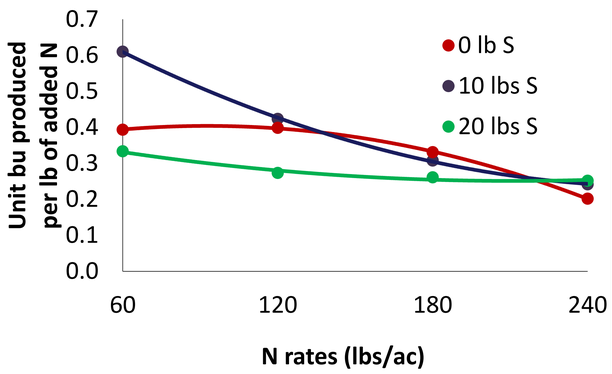


Figure 5. Agronomic efficiency of N in corn at three S rates (Forman, 2017)



Forman, 2017

- N * S interaction was not significant. S and N improved yields significantly (Table 2)
- S improved yields by 6% (12 bu/ac)
- Yields were greater with S application than without S at all N rates (Fig 4)
- AE of N was greatest at 10 lbs S (Fig 5)
- N rate estimated to maximize yield was 191 lbs N to produce 217 bu at 0 lbs S and 198 lbs N to produce 228 bu with 10 lbs S There was no maximum point at 20 lbs S
- To maximize yield at N = 191 lbs (0 lb S) and 198 lbs (10 lbs S), AE for N was estimated at 0.32 at 0 lbs S, and 0.274 at 10 lbs S.

DISCUSSIONS

- Large variability in response explained why S effects were statistically marginal in 2016
- With adequate rainfall, yield potential and crop nutrient demand were high, which is probably why S effect was not significant for the under-fertilized crop at 105 lbs N/ac
- In 2017, yields were maximized when S was applied at 120 lbs N (+15 lbs residual N and 40 lbs previous crop credit).
- Yields improved with increasing N rate. AE declined. AE of N at 10 lbs S was > at 0 lbs S until just past 120 lbs N, the most likely agronomic recommended for this study.
- At 120 lbs N, yield estimates from the regression curves with 10 lbs S and without suggest 10 bu yield advantage at 10 lbs S

CONCLUSIONS

- Corn yields can be significantly impacted by S even in high SOM soils (Table 1, 2).
- These results highlight the magnitude of influence S can have on yields of corn in high yielding environments.
- Agronomic efficiency of N is likely improved with applied S only to a point where added N does not statistically improve yields

REFERENCES

Steinke, K, J. Rutan, and L. Thurgood. Corn response to nitrogen and multiple sulfur rates. Agron. J. 107:1347-1354.

ACKNOWLEDGEMENTS

North Dakota Corn Council
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