Evaluation of Ammonium Sulfate Nitrate in Virginia Sweet Corn Production

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INTERPRETIVE SUMMARY

Virginia farmers produce over 3,000 commercial acres of fresh market sweet corn (*Zea mays*) yielding 35 cwt/A and valued in excess of 2.5 million dollars. Fertilizer costs are now a major crop input and farmers are interested in ways to increase their fertilizer use efficiency. Research plots were established at the Virginia Tech Eastern Shore Agricultural Research and Extension Center near Painter, Virginia in Spring 2009 on a Bojac sandy loam (Coarse-loamy, mixed, semiactive, thermic Typic Hapludults). The experiment was arranged as a factorial arrangement of 3 N rates (60, 120, and 180 lbs N/acre) × 3 nitrogen (N) sources [liquid urea-ammonium nitrate (UAN, 30% N), ammonium nitrate (AN, 34% N), and ammonium sulfate nitrate [Sulf-N26, 26% N and 14% sulfur (S)], plus a 0-N control. Two additional treatments were applied and analyzed separately to test for S response. Sulfur as gypsum was applied at Sulf-N26 equivalent rates for 120 lbs N/A (65 lbs S/A) to additional plots fertilized using UAN (UAN + S = UANS) and AN (AN + S = ANS). Yield and ear quality parameters were measured. Sulf-N26 had a quadratic relationship with N rate and yielded highest (14,858 lbs/A) with 117 lbs N/A. Ammonium nitrate had highest yields using 125 lbs N/A while UAN peaked at 110 lbs N/A (13,230 and 13,329 lbs corn/A, respectively). Overall, Sulf-N26 is an acceptable fertilizer source for Mid-Atlantic sweet corn production and may offer yield advantages over traditional fertilizer sources. However, we cannot say conclusively yield advantages were due to S fertilization. More research is necessary to further quantify appropriate N rates for various N sources and to determine S fertilizer needs in the Mid-Atlantic.

INTRODUCTION

The Mid-Atlantic region of the United States produces significant acreage of commercial fresh market sweet corn. Virginia ranks twentieth out of the 26 states with reportable commercial fresh market sweet corn production (USDA-NASS, 2010). On average, Virginia farmers produce over 3,000 commercial acres of fresh market sweet corn yielding 35 cwt/A and valued in excess of 2.5 million dollars (USDA-NASS, 2010). Similar to most vegetable crops, most commercial production occurs in the Chesapeake Bay watershed on the Eastern Shore of Virginia; which is similar to other large vegetable producing states in the Mid-Atlantic. Farmers are cognizant of the environmental and financial consequences of poor fertilizer use efficiency and are always looking for improved fertilizer sources and methods to increase their overall yield and profit.

Nitrogen (N) and sulfur (S) fertilizers are difficult nutrients to manage in crop production systems because they can be leached below the effective root zone with rainfall or irrigation. Plant uptake and utilization of N and S fertilizers are major concerns to farmers because they impact fertilizer use efficiency. Adjusting for inflation, we are experiencing increased fertilizer prices compared to historic values where most fertilizer recommendations were made (USDA-NASS, 2009). Fertilizer costs have increased to the point where they are now a major crop input and farmers no longer have the luxury to over-apply as “insurance” for top yields and are looking for ways to increase their fertilizer use efficiency and profits.

Sulfur may be added to fertilizer sources since S is used in large quantities by sweet corn and readily leaches through the soil profile out of the effective root zone. Varying results have been obtained regarding S fertilization in the Mid-Atlantic. For instance, Kline and coworkers (1989) found that S fertilizer usually increased plant tissue concentrations but rarely increased yields (3 out of 12 site-years). However, when S fertilizer was beneficial, Reneau (1983) found that up to 31 lbs S/A was necessary to achieve 90% maximum yield. The objective of this study is to determine if S containing fertilizers or fertilizers with varying amounts of ammonium or nitrate will increase sweet corn yields in Mid-Atlantic production systems grown using sandy loam soils.

MATERIALS AND METHODS

Research plots were established at the Virginia Tech Eastern Shore Agricultural Research and Extension Center near Painter, Virginia in Spring 2009 on a Bojac sandy loam (Coarse-loamy, mixed, semiactive, thermic Typic Hapludults; surface horizon = 65% sand, 25% silt, 10% clay, and 0.75% organic matter). Painter, Virginia averages 43 inches of precipitation per year, has a mean annual temperature of 59°F and 210 frost free days per year.

The experiment was arranged as a factorial arrangement of 3 N rates (60, 120, and 180 lbs N/acre) × 3 N sources [liquid urea-ammonium nitrate (UAN, 30% N), ammonium nitrate (AN, 34% N), and ammonium sulfate nitrate (Sulf-N26, 26% N and 14% S), plus a 0-N control. Two additional treatments were applied and analyzed separately to test for S response. Sulfur as gypsum was applied at Sulf-N26 equivalent rates for 120 lbs N/A (65 lbs S/A) to additional plots fertilized using UAN (UAN + S = UANS) and AN (AN + S = ANS). Sulf-N26, AN, ANS, and gypsum were weighed and broadcast applied by hand to plots. Liquid UAN and UANS were applied with a calibrated backpack CO_2 sprayer. All N treatments were 50-50% split applied between at-planting (broadcast applied and incorporated) and knee high (~18 inches tall; band applied to soil surface). Phosphorus, potassium, other macro and micronutrients, and production practices were based on Virginia Cooperative Extension Recommendations (Kuhar et. al., 2010). Conventionally tilled ‘Devotion’ sweet corn was planted in 4 row plots that were 30 ft long and set on a 30” row spacing. The middle two rows of each plot were harvested by hand. Corn ear diameter, ear length, and percentage kernel fill were measured from 5 ears from each plot. The experiment was arranged in a randomized complete block design and replicated four times in a factorial arrangement of 3 N sources × 3 N rates + 2 S comparisons + a 0-N/S control. Data were analyzed using the SAS system and means separated using Fisher’s protected least significant difference test (LSD) at $p = 0.10$ that was established *a priori*.

RESULTS AND DISCUSSION

Regression equations were established for each N source used and graphed against N rate applied (Fig. 1). Overall, all N sources reacted in a quadratic fashion as N rates increased. Sulf-N26 yielded highest (14,858 lbs/A) at 117 lbs N/A. Ammonium nitrate had highest yields at 125 lbs N/A while UAN peaked at 110 lbs N/A (13,230 and 13,329 lbs corn/A, respectively) (Fig. 1). Overall, Sulf-N26 had the highest agronomic efficiency of the three N sources by producing 127 lbs corn per lb N fertilizer (106 and 121 lbs corn/lb N for AN and UAN, respectively). Comparing the data subset that had 120 lbs N/A applied and 65 lbs S/A, it is not possible to say conclusively that the corn was S deficient due to large variation among plots (Table 1). However, it is clear that N fertilizer benefited corn as control plots had lower marketable yields and higher cull yields than N fertilized plots (Table 1). We contribute variation to extremely wet weather conditions with above normal rainfall during the growing season (Fig. 2).

Nitrogen source and N rate main effects were significant for corn ear quality measurements (Tables 2 and 3). For the N source main effect, 0-N control plots had slightly thinner and a higher percentage of kernel fill than N fertilized plots, averaged across N rates (Table 2). The N rate main effect was similar to the N source main effect as N fertilized plots generally had thicker diameter ears and lower kernel fill than the 0-N control plots (Table 3).

CONCLUSION

In conclusion, Sulf-N26 is an acceptable fertilizer source for Mid-Atlantic sweet corn production. Yield was increased over AN and UAN fertilizer sources, but we cannot say it was necessarily due to S since they S comparison treatments at 120 lb N/A was not significant. Producers applying Sulf-N26 in the Mid-Atlantic will achieve maximum yields at 117 lbs N/A. More research is necessary to further quantify appropriate N rates for various N sources and to determine S fertilizer needs in the Mid-Atlantic.

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TABLES AND FIGURES

Table 1. Marketable, cull and total yields for various nitrogen sources applied at 120 lbs N/A on the Eastern Shore of Virginia on a Bojac sandy loam. Sulfur containing sources had 65 lbs S/A applied.

Nitrogen Source	Marketable Yield	Cull Yield	Total Yield
	--------------------------lbs/A--------------------------		
Control	8320 b†	3006 a	11326 a
Ammonium nitrate	9642 a	2338 b	11979 a
Ammonium nitrate + Sulfur	10796 a	1779 b	12575 a
Sulf-N26	12495 a	2011 b	14506 a
Urea ammonium nitrate	10360 a	2766 b	13126 a
Urea ammonium nitrate + Sulfur	10201 a	1880 b	12081 a

†Within each column, means followed by different letters are significantly different at *p*=0.10 and were separated using Fisher's protected least significant difference tests.

Table 2. Ear diameter, length, and percent fill of various nitrogen sources applied to sweet corn on the Eastern Shore of Virginia on a Bojac sandy loam, averaged across N rates.

Nitrogen Source	Diameter	Length	Fill
	------mm------	------cm------	------%------
Control	42.4 c†	19.2 b	100 a
Ammonium nitrate	44.9 b	19.5 ab	96 b
Sulf-N26	45.8 ab	19.2 b	95 b
Urea ammonium nitrate	46.2 a	19.8 a	97 b

†Within each column, means followed by different letters are significantly different at *p*=0.10 and were separated using Fisher's protected least significant difference tests.

Table 3. Ear diameter, length, and percent fill for various nitrogen rates applied to sweet corn on the Eastern Shore of Virginia on a Bojac sandy loam, averaged across N sources.

Nitrogen Rate	Diameter	Length	Fill
	------mm------	------cm------	------%------
0	42.4 c†	19.2 b	100 a
60	44.7 b	19.5 ab	96 b
120	45.3 b	19.2 b	95 b
180	47.0 a	19.8 a	97 b

†Within each column, means followed by different letters are significantly different at *p*=0.10 and were separated using Fisher's protected least significant difference tests.

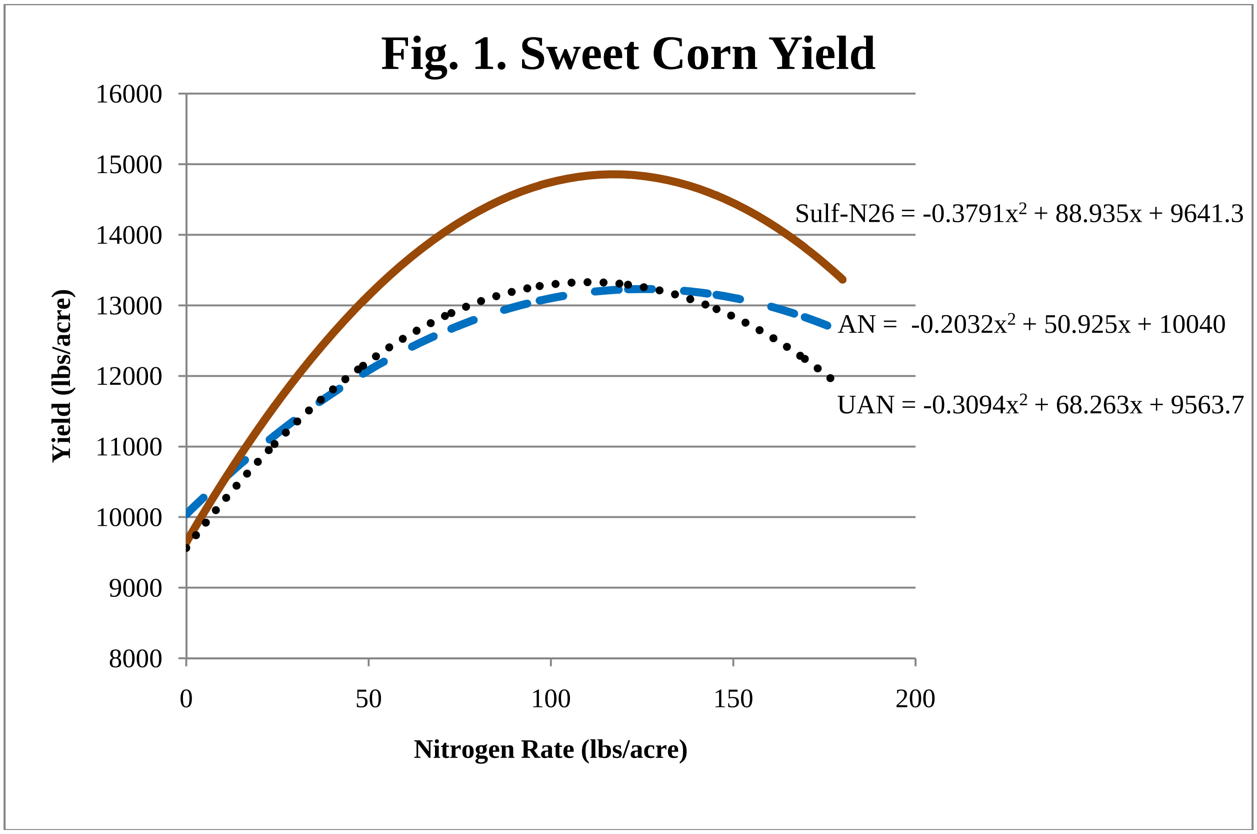
Fig. 1. Sweet Corn Yield
16000
15000
14000
13000
12000
11000
10000
9000
8000
Yield (lbs/acre)
0
50
100
150
200
Nitrogen Rate (lbs/acre)
Sulf-N26 = -0.3791x2 + 88.935x + 9641.3
AN = -0.2032x2 + 50.925x + 10040
UAN = -0.3094x2 + 68.263x + 9563.7

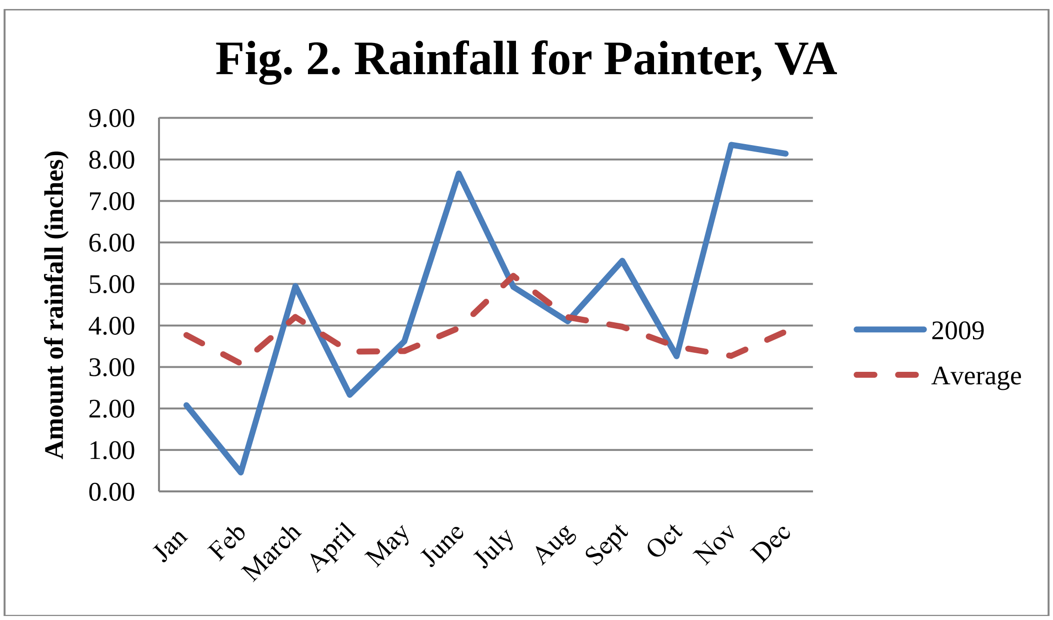
Fig. 2. Rainfall for Painter, VA
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Amount of rainfall (inches)
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec
2009
Average