Evaluation of Ammonium Sulfate Nitrate in Virginia Sweet Corn Production

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INTERPRETIVE SUMMARY

Virginia farmers produce over 3,500 commercial acres of fresh market sweet corn (*Zea mays*) yielding 32 cwt/A and valued in excess of 2.8 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 2012 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. A significant positive effect was seen when N was added, regardless of N source. Treatments receiving 180 lbs. N/A had highest yields, but only 60 lbs. N/A was needed to achieve highest marketable yields. No benefit was seen to S fertilizer additions. In conclusion, Sulf-N26 is an acceptable N fertilizer source for sweet corn on sandy loam soils and plants may benefit from S additions in years when S additions are warranted.

INTRODUCTION

The Mid-Atlantic region of the United States produces significant acreage of commercial fresh market sweet corn. Virginia ranks eighteenth out of the 26 states with reportable commercial fresh market sweet corn production (USDA-NASS, 2013). On average, Virginia farmers produce over 3,500 commercial acres of fresh market sweet corn yielding 32 cwt/A and valued in excess of 2.8 million dollars (5-year average; USDA-NASS, 2013). 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 2012 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 (Freeman et. al., 2012). 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

Overall, the lowest yielding (0-N control; 6373 lbs./A) plots yielded 1.4 times more than the 2012 Virginia marketable yield average of 4400 lbs./A (USDA-NASS, 2013). The N rate × N source interaction was not significant; therefore, all data is discussed as main effects and averaged over the other parameter. For total yield, 180 lbs. N/acre yielded more than 0 and 60 lbs. N/A (10218, 8499, and 9075 lbs./A, respectively) (Table 1), averaged across N sources. However, statistically highest marketable yield and percent of total yield that was marketable was achieved by applying 60 lbs. N/A (7921 lbs./A and 83% marketable ears) (Table 1), averaged across N sources. High yields from the 0-N treatment was also seen in an adjacent plot study where we measured ~20 ppm groundwater NO_3 (4-ft. deep well) throughout the dry growing season. This high groundwater/soil N from non-leached soils combined with ~35 lbs. N/A deposited from air deposition and irrigation likely aided in high yields when no N fertilizer was applied and possible lowered overall chemical fertilizer needs (Fleming, 2013). All three fertilizer sources (AN, Sulf-N26, and UAN) had higher average marketable yields than the 0-N control (6373 vs. 7842, 8305, and 8077 lbs./A, respectively) (Table 2), averaged across N rates. However, no difference was seen between fertilizer sources.

Comparing the data subset that had 120 lbs N/A applied and 65 lbs. S/A, no yield differences were observed between treatments with and without sulfur for the same N fertilizer source (Table 3). This was similar to data seen in Table 2 when comparing Sulf-N26 to non-S containing fertilizer sources.

CONCLUSION

In conclusion, 2012 yields were higher than the Virginia state average. Nitrogen rates of 180 lbs. N/A had highest total yields, but only 60 lbs. N/A was necessary to achieve highest marketable yields. No yield benefits were seen when S was added into the system; which was similar to other crops in 2012.

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TABLES AND FIGURES

Table 1. Average sweet corn ear weight, marketable yield, total yield, and percent of yield that was marketable for various nitrogen rates on the Eastern Shore of Virginia on a Bojac sandy loam, averaged across N sources.

Nitrogen Rate	Ear Weight	Marketable Yield	Total Yield	Marketable
	---grams---	---------------lbs./A---------------		----%----
0	233 a	6373 b	8499 b	76 b
60	208 b	7921 a	9075 b	83 ab
120	239 a	7518 ab	9323 ab	78 ab
180	229 ab	8784 a	10218 a	85 a
$LSD_{0.10}$	24	1274	1116	10

†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. Average sweet corn ear weight, marketable yield, total yield, and percent of yield that was marketable for various nitrogen sources on the Eastern Shore of Virginia on a Bojac sandy loam, averaged across N rates.

Nitrogen Source	Ear Weight	Marketable Yield	Total Yield	Marketable
	---grams---	----------------lbs/A----------------		----%----
Control	233 a†	6373 b	8499 b	76 a
Ammonium nitrate	227 a	7842 a	9250 ab	83 a
Sulf-N26	222 a	8305 a	9921 a	80 a
Urea ammonium nitrate	227 a	8077 a	9556 ab	83 a
$LSD_{0.10}$	24	1274	1116	10

†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. Average sweet corn ear weight, marketable yield, total yield, and percent of yield that was marketable 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	Ear Weight	Marketable Yield	Total Yield	Marketable
	---grams---	---------------lbs./A---------------		----%----
Control	233 a†	6373 bc	8499 ab	76 ab
Ammonium nitrate	230 a	5844 c	8097 b	69 b
Ammonium nitrate + Sulfur	220 a	7622 abc	9612 ab	75 ab
Sulf-N26	246 a	8105 abc	9981 ab	81 ab
Urea ammonium nitrate	242 a	8605 ab	9891 ab	85 ab
Urea ammonium nitrate + Sulfur	217 a	9219 a	10271 a	89 a
$LSD_{0.10}$	38	2302	2057	18

†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.