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 2011 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. Excessive heat during silking and pollination caused significant problems with kernel fill and reduced yields. A significant positive effect was seen when S was combined with AN, but not with UAN and both yields were similar to Sulf-N26. This project should be repeated another site-year under normal growing conditions to further investigate S and N fertility in Mid-Atlantic sweet corn production.

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, 2011). 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 2011 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

Overall, 2011 was a detrimental year for crop production throughout the Eastern Shore of Virginia. Initially the growing season was below average for rainfall (Figure 1), but a large high intensity rainfall event occurred in mid-June that significantly increased the yearly average (Figure 2). This high intensity rainfall (5-inches in two hours) occurred soon after the second split of N and S was applied, with 2 more inches of rain occurring within the next three days. We speculate that low yields were partially due to excessive leaching and possible denitrification of fertilizer sources. Secondly, we experienced excessive heat units during the growing season with temperatures during pollination exceeding 95 degrees F for an extended period of time. Excessive heat likely reduced pollen viability and caused excessive silk desiccation, both of which were responsible for poor kernel fill and resulted in all ears being considered culls for this site year.

Comparing the data subset that had 120 lbs N/A applied and 65 lbs S/A, S additions to AN (1870 lbs./A) did significantly increase yields compared to AN with no sulfur (1183 lbs./A) (Table 1). However, this S response was not seen with UAN and we caution the use of this data at low yield expectations. The N source × N rate interaction was not significant and only main effects will be discussed. UAN had higher yields than SULF-N26 (1974 vs. 1507 lbs./A, respectively) with all fertilized plots having higher yields than the 0-N control (871 lbs./A) (Table 2), averaged across N rates. Nitrogen rates indicated that 60 lbs. N/A (1824 lbs./A) was sufficient for highest yields in a difficult growing season as seen in 2011 (Table 3).

CONCLUSION

In conclusion, 2011 data is marginal due to difficulties with weather. Yields were low and similar to other yields seen across the Virginia Eastern Shore. A significant trend was seen with higher yields with both N and S fertility; however, we caution the use of this data in a poor growing season. This trial should be repeated another site-year to further investigate N and S fertility in Virginia sweet corn production.

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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 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	27 b†	0	871 d	0
Ammonium nitrate	45 a	0	1183 cd	0
Ammonium nitrate + Sulfur	28 b	0	1870 a	0
Sulf-N26	37 ab	0	1474 abc	0
Urea ammonium nitrate	39 ab	0	1793 ab	0
Urea ammonium nitrate + Sulfur	41 a	0	1318 bcd	0
$LSD_{0.10}$	12	0	514	0

†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	27 b†	0	871 c	0
Ammonium nitrate	41 a	0	1565 ab	0
Sulf-N26	39 a	0	1507 b	0
Urea ammonium nitrate	41 a	0	1974 a	0
$LSD_{0.10}$	7	0	460	0

†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 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	27 b†	0	871 b	0
60	42 a	0	1824 a	0
120	40 a	0	1484 a	0
180	39 a	0	1738 a	0
$LSD_{0.10}$	7	0	460	0

†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.

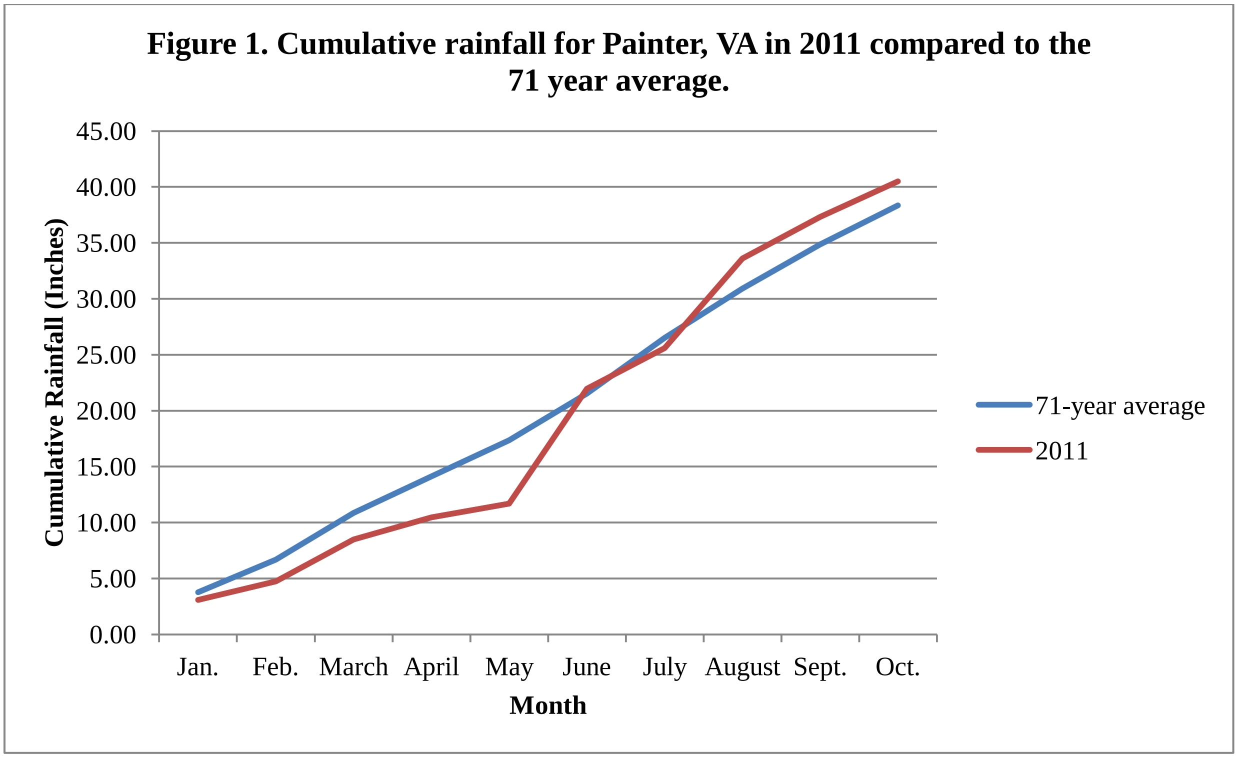
Figure 1. Cumulative rainfall for Painter, VA in 2011 compared to the 71 year average.
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Cumulative Rainfall (Inches)
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Month
71-year average
2011

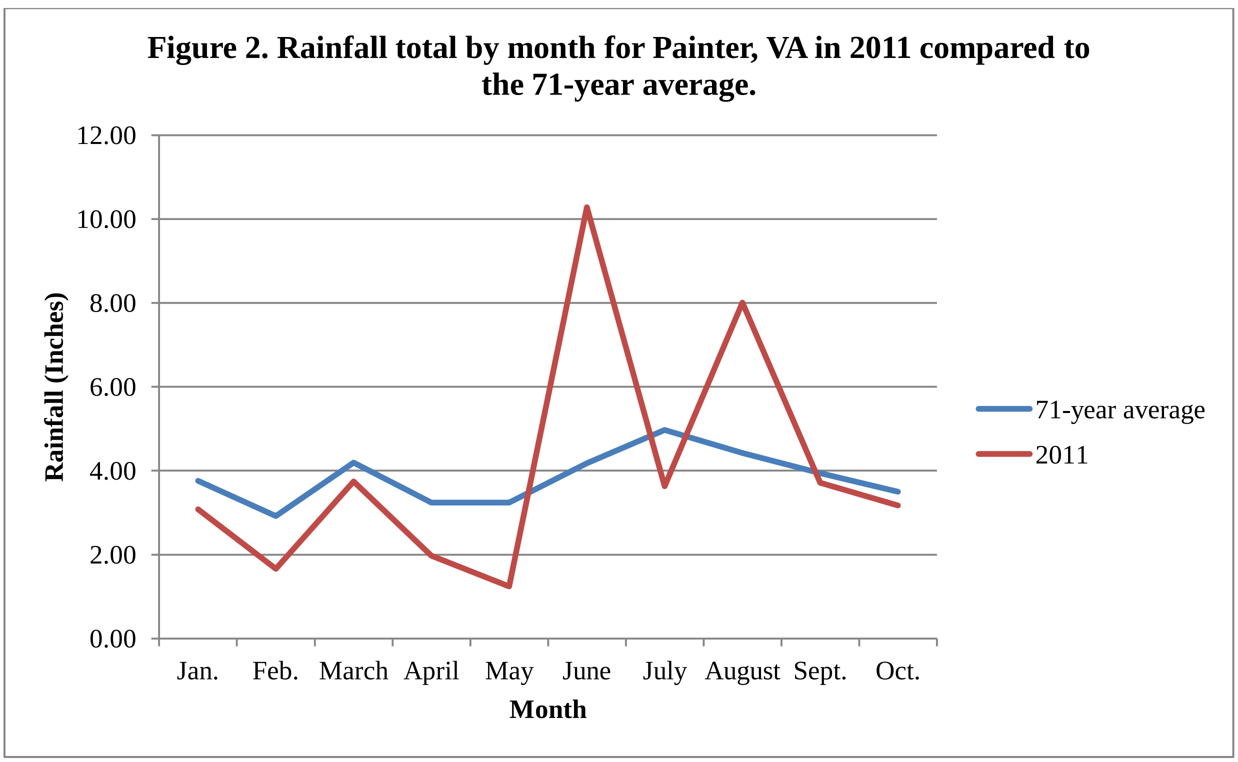
Figure 2. Rainfall total by month for Painter, VA in 2011 compared to the 71-year average.
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Rainfall (Inches)
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Month
71-year average
2011