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Comparison of Two Nitrogen Fertilizer Sources for Highbush Blueberries

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Abstract. **Highbush blueberries (*Vaccinium corymbosum* L.) were fertilized with equal amounts of nitrogen from ammonium sulfate (AMS) or sulfur-coated urea (SCU) for 6 years. The plots treated with SCU yielded significantly more than the AMS plots three out of the five harvest years. Except for plant size in 1984, treatments did not significantly affect berry size, plant survival, and other vegetative characteristics. Soil pH after 5 years was significantly lower on the AMS treatments than on the SCU-treated plots (5.4 vs. 5.7). The nutrient content of the leaf tissue did not differ significantly by fertilizer source. At the rate used in this study, SCU would be an acceptable nitrogen source for blueberries compared to AMS, but SCU is less effective in maintaining low soil pH.**

Optimum highbush blueberry production requires the maintenance of a lower soil pH than commonly occurs in many upland soils. Because of this management constraint, ammonium sulfate (AMS), an acid-forming nitrogen source, commonly is recommended for blueberry production (2, 7). AMS is not readily available in this area. Therefore, an alternate acid-forming nitrogen source would be desirable. The Tennessee Valley Authority (TVA) was evaluating the use of sulfur-coated urea (SCU) as a nitrogen source for a variety of crops. SCU could become readily available. The purpose of this study was to compare the effects of SCU and AMS on blueberry growth, yield, soil pH, and nutrient availability.

One-year-old plants of eight highbush blueberry cultivars (Berkley, Bluecrop, Blueray, Collins, Darrow, Earliblue, Jersey, and Patriot) were established in May 1979 on a Crider silt loam (Typic Paleudalf, fine-silty, mixed mesic) at the Univ. of Kentucky College of Agriculture Research and Education Center, Princeton. Prior to planting, the soil was fertilized based on a soil test and amended with finely ground elemental sulfur (95% passed through a 325-mesh screen) to adjust the pH to 4.5 (2, 4). Prior to planting, 3.8 liters of wet peatmoss was incorporated in each planting hole. Plants were spaced 1.2 m apart with 3.0 m between rows, about 2700 plants/ha. A fresh hardwood sawdust mulch was applied annually to renew the mulch to a depth of 10 cm, and the planting was irrigated by trickle irrigation as needed. Finely ground elemental sulfur was applied to all plots at the rate of 167 $g \cdot m^{-2}$ in Winter 1983. This treatment reduced the soil pH of the planting from 6.1 in 1983 to 5.4 in 1984.

Each plot consisted of one cultivar. Eight four-plant plots per block were split in half to form two two-plant subplots per plot, in each of two blocks, for a total of 32 subplots. The two fertilizer treatments were 92 $kg \cdot ha^{-1} \cdot year^{-1}$ of N as AMS (20% N) or SCU (36.1% N). Each fertilizer was broadcast in two equal applications—the first week of May (at bloom) and 6 weeks later in June. Treatments were started in 1980, and the N rates were increased to 138 and 207 $kg \cdot ha^{-1} \cdot year^{-1}$ in 1983 and 1985, respectively. These adjustments were made to maintain optimum foliar nitrogen levels (5) and were in accordance with commercial recommendations (2, 7). Applications of P and K were not made in this study.

Fruit were hand-harvested beginning with the 1981 season, and the yield per plant was recorded. All vegetative growth measurements were made during the fall/winter season following the summer harvests. The number of new canes arising within the area from the mulch surface to 20 cm above it was recorded. A growth index was calculated annually by dividing the sum of the maximum height plus maximum width by 2 (3). In 1985, the average weight per berry was calculated based on a 25-fruit harvest. Soil and leaf samples were collected from each treatment-replication combination on 22 July 1985. Soil and leaf samples collected in previous years were used solely to monitor the general soil and nutritional status of the planting and were inappropriate for statistical analysis. The means of each two-plant subplot for each variable (except percent survival) were analyzed statistically using the SAS GLM procedure. Treatment effects on plant survival were analyzed by collapsing across replications and cultivars and using the χ^2 test.

Fertilizer source had a significant effect on yield 3 out of 5 years (Table 1). In every year, yield for plants receiving SCU was as great as or greater than those receiving AMS. Berry size in 1985 averaged 1.7 g/berry for both fertilizer treatments. Plant survival at the end of 1985 (69.4% and 75.0% for SCU and AMS, respectively) was also not significantly different for the two treatments. Top growth and number of 1-year-old canes for SCU-treated plants were as high as or higher than the AMS-treated ones (Table 1). Plants treated with SCU in 1984 were significantly larger than those treated with AMS. No significant differences between the two fertilizer treatments were observed in soil and leaf nutrient levels (Table 2). However, the pH was higher in soil fertilized with SCU than that treated with AMS.

The SCU treatment resulted in a 34%, 31%, 74%, 60%, and 13% greater yield than those receiving AMS in 1981 through 1985, respectively. The greatest difference in yield

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Table 1. Effect of fertilizer treatments on fruit yield and vegetative growth of highbush blueberry[z]

Fertilizer treatment	1981	1982	Year 1983	1984	1985
			Yield (t·ha⁻¹)[y]		
SCU	0.75	1.40	3.34	6.80	6.38
AMS	0.56	1.07	1.92	4.25	5.64
Significance	*	NS	*	*	NS
			No. 1-year-old canes/plant		
SCU	---[x]	4.3	4.6	14.0	5.0
AMS	---	3.2	4.5	9.6	3.9
Significance	---	NS	NS	NS	NS
			Growth index[w]		
SCU	---	---	86	97	102
AMS	---	---	77	86	92
Significance	---	---	NS	*	NS

[z]Values are least squares means obtained by using the SAS GLM procedure.
[y]Based on 2691 plants/ha.
[x]Data not collected.
[w]One-half the sum of the plant height (cm) and the width (cm).
NS,*Not significant or significant at the 5% level, respectively.

between treatments occurred in the 2 years when the application rate was 138 kg·ha^{-1}·year^{-1} of N. This rate is comparable to the 136 kg·ha^{-1}·year^{-1} of N rate recommended by Scott et al. (7) when mulching is used as a cultural practice in blueberry production. The lowest percent difference in yield (13%) between sources was observed in 1985 when the rate of N was increased to 207 kg·ha^{-1}·year^{-1} N. This response suggests that the beneficial effects from a gradual release of N (6) may be negated as the N rate per plant is increased. Blueberries are reported to grow better with NH_4-N than with NO_3-N (3). Ammonium sulfate is highly soluble and would be immediately available in the soil solution. The availability of the urea in the SCU is affected by the thickness of the sulfur coating and particle size (6), but 20% to 30% of the urea becomes available during the first week and is quickly converted to the NH_4-N form. Neither Smagula and Hepler (8) nor Blatt (1) reported significant differences in yield and vegetative growth of lowbush blueberries when comparing urea and SCU.

SCU is ≈36% N and 14% to 18% elemental sulfur (S) by weight. AMS is ≈20% N and 24% S by weight. Since 1.7 times the weight of AMS is required to provide an equivalent weight of N from SCU, 2.3 to 2.9 times more S is applied when AMS is used as the N source. Acidification of the soil occurs when sulfur is converted to sulfuric acid. Then, basic cations, such as Ca and Mg, are displaced from soil colloids by hydrogen and leached from the soil. However, the soil in this study was buffered by residual limestone from lime applied prior to initiation of the study. This residual contributed to the lack of significant differences in the basic cations from soil samples taken from the two fertilizer treatments. The lower pH of soil fertilized with AMS was attributed to the higher rate of sulfate applied to those plots.

SCU performed adequately as a N source in our conditions as measured by plant response. However, it was not as effective as AMS in maintaining the soil pH; therefore, plots fertilized with SCU may require more frequent amendments of the soil pH than plots fertilized with AMS.

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Table 2. Effect of fertilizer treatments on soil pH, soil nutrient levels, and leaf tissue levels in 1985

Fertilizer treatment	pH	Nutrient N	P	K	Ca	Mg	Mn	Fe	B	Cu	Zn
					Soil (kg·ha⁻¹)[z]						
AMS	5.4	---[y]	14.0	264	2732	251	---	---	---	---	---
SCU	5.7	---	11.3	279	2816	270	---	---	---	---	---
Significance[z]	*		NS	NS	NS	NS	---	---	---	---	---
					Leaf tissue[x]						
AMS	---	1.59	0.053	0.42	0.53	0.19	207	45	58	1.8	11
SCU	---	1.46	0.058	0.39	0.56	0.19	169	38	56	2.0	11
Significance		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z]Extraction by phosphorus by Bray 1, 1 N neutral ammonium acetate used for cation exchange.
[y]Value not determined.
[x]Foliar analysis by Univ. of Georgia Lab. Macronutrient values in percent dry weight. Micronutrient values in ppm.
NS,*Not significant or significant at the 5% level, respectively.