R. Khosla, Dr. M.M., Alley, P.H. Davis, Dr. D.E. Brann

High Residual Soil Mineral-N Impedes Response

Virginia researchers find increased residual N accumulations in soil from drought and changing crop practices can sharply reduce crop response to additional N applications.

Summary: *Three years (1995-1997) of research work with fertilizer management on grain sorghum production in Coastal Virginia has demonstrated that it would be unwise to ignore residual soil mineral-N present in the profile at planting. Increased frequency of drought in Virginia over the last two decades, coupled with changes in crop production systems from conventional-till to reduced-till to no-till, suggests the possibility of residual N accumulations. Both drought years (1995 and 1997) showed agronomically significant levels of soil mineral-N, ranging from 67 lbs/A to 134 lbs/A of N at grain sorghum planting time. During these two years, grain sorghum had no significant response to N fertilizer application. Sufficient levels of mineral-N already existed in the soil profile and lack of moisture limited grain yields.*

Grain sorghum is a relatively new crop in Virginia. Being more drought tolerant, it is an acceptable alternative to corn whose yields have been reduced by frequent droughts during the last 15 years in Virginia. Sorghum is grown on about 15,000 to 25,000 acres, mostly under no-till conditions for erosion control and more efficient use of available water. However, acreage has not increased over the years because adequate production practices to increase yields on no-till systems have been lacking. Growers also have not had access to adequate, equitable markets for grain sorghum, which are now available.

Efficient fertilizer management, especially N, continues to be a challenge in high-residue (no-till) farming systems, especially on sandy soils having low organic matter. No-till systems often produce lower yields because of N availability, slower mineralization, greater immobilization, denitrification, and volatilization. This complexity with N management suggests that more research is needed if we are to achieve more efficient management of N fertilizer.

Since data are lacking, research is also needed to determine if phosphorus and sulfur applications on soils testing high in phosphorus, and on soils with variable sulfur levels, will produce more vigorous stands that result in higher grain yields.

Our objectives in these studies were to:

- measure rate of banded N starters needed to optimize sorghum yields in combination with sidedress N
- determine if preplant broadcast N is as efficient as banded plus sidedressed N
- measure grain sorghum yield response to banded phosphorus
- measure yield response to broadcast sulfur at planting.

The data in this report are from our 1997 findings, the last year of our study.

Climate

Field observations during the growing season revealed signs of water stress. Visual symptoms (rolling of leaves, adventitious roots at the basal node of plants) were evident at both locations, even during the vegetative growth stage.

Soil mineral-N

An NPS analysis of profile soil samples taken at the Henrico site at planting is shown in Figure 1. Data from the New Kent site were similar. Though surface organic matter content was less than 2 percent at the Henrico site, note that the soil had significant amounts of soil profile mineral-N. These residual mineral-N levels reflect the nitrogen that probably mineralized from the previous soybean crop. The amounts in the deeper horizons could only have come from previous nitrogen applications. These agronomically significant levels of soil profile mineral- N of 100 lbs/A warrant consideration in developing more efficient N fertilizer recommendations for grain sorghum production on the sandy soils of Virginia.

Objectives 1 and 2

There was no significant yield response to N fertilization treatments banded at either location. This lack of response is reasonable in light of substantial residual mineral-N levels present at the time of planting, coupled with lack of moisture during the growing season.

Leaching losses during the growing season would also be expected to be insignificant because of low rainfall and high evapotranspiration due to high temperatures.

Residual mineral nitrogen levels were

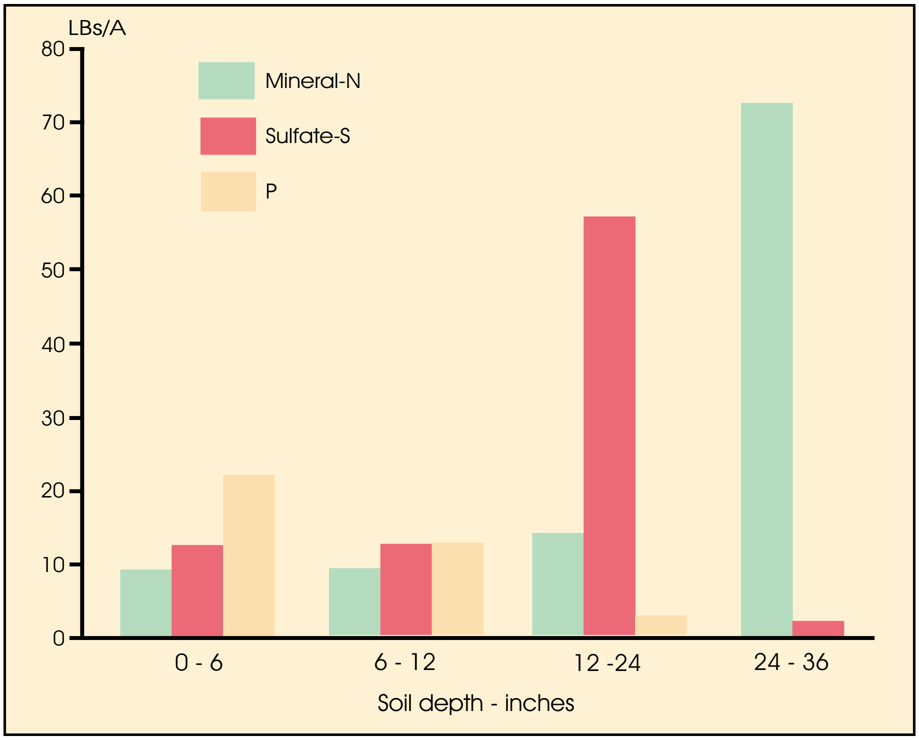

Figure 1. Mineral-N, SO_4-S, and P analysis taken at planting, Henrico County, Khosla, et al., 1997.

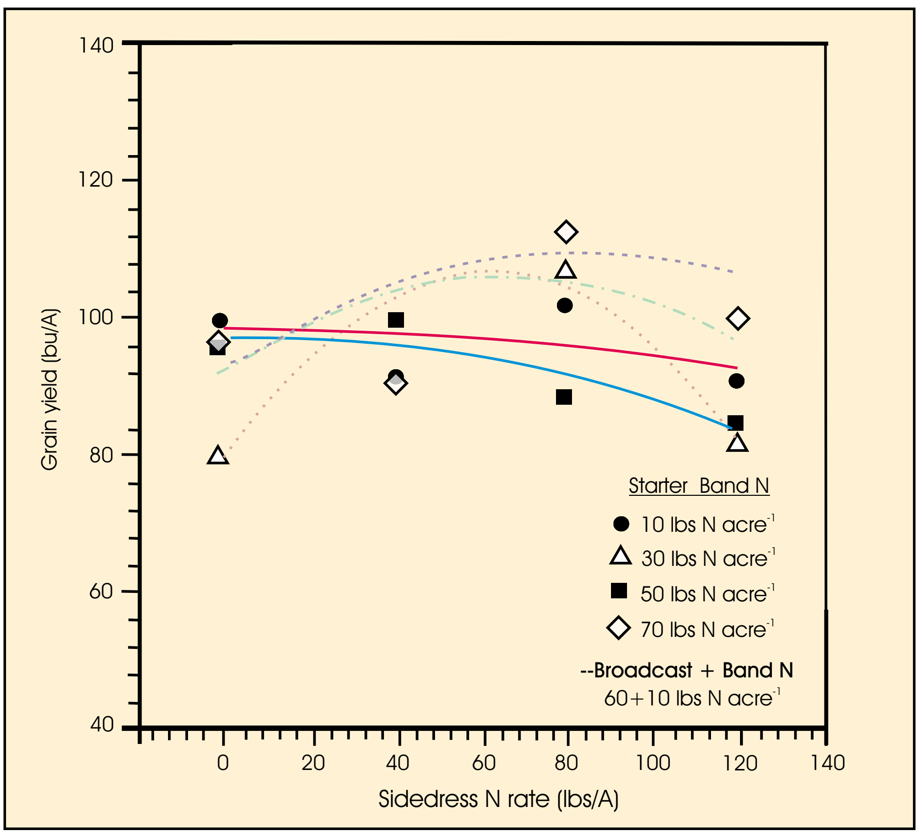

Figure 2. Yield response to sidedress N applications on no-till grain sorghum, New Kent County, Khosla, et al., 1997.

adequate to supply grain sorghum with nitrogen needed to produce yields that were limited by low rainfall.

Lack of response to N fertilization prevented any assessment of efficiency of the fertilizer placement methods.

Although yield responses to N fertilizer treatments were not significant at the 10 percent probability level, sorghum grain yields showed trends in yield response to N fertilizer applications on the Kempville loamy fine sand at the New Kent site (Figure 2). The crop reached its maximum yield (112 bu/A) at an N starter band rate of 70 lbs/A in combination with sidedressed N at 80 lbs/A. Beyond this rate, grain yield decreased for all sidedress applications greater or less than 80 lbs/A.

Review of grain yield response data (Figure 1) and calculation of grain yields for all starter/band treatments using regression equations, showed that 93 percent of the maximum grain yield was achieved at a much lower rate of starter N and sidedressed N. For example, a starter N rate of 44 lbs/A in combination with 30 lbs/A of sidedress N produced 104 bu/A. Such a rate is advisable when rainfall is highly variable and below average, and when there are agronomically significant levels of soil profile mineral N.

Rapid growth and nutrient uptake by sorghum plants normally occur about 35 days after emergence, at the 8-leaf stage. Sidedress application at this stage is practically feasible and could be beneficial for the crop.

Objectives 3 and 4

Figures 3 and 4 show yield responses of grain sorghum to varying applications of phosphorus and sulfur. At the Henrico site, grain yield averaged 73 bu/A for P, and 72 bu/A for S. At New Kent, grain yield averaged 108 bu/A for P, and 105 bu/A for S.

Mehlich I extractable phosphorus levels were 22 and 60 ppm for the Atlee and Kempsville soils, respectively, which are calibrated as medium to very

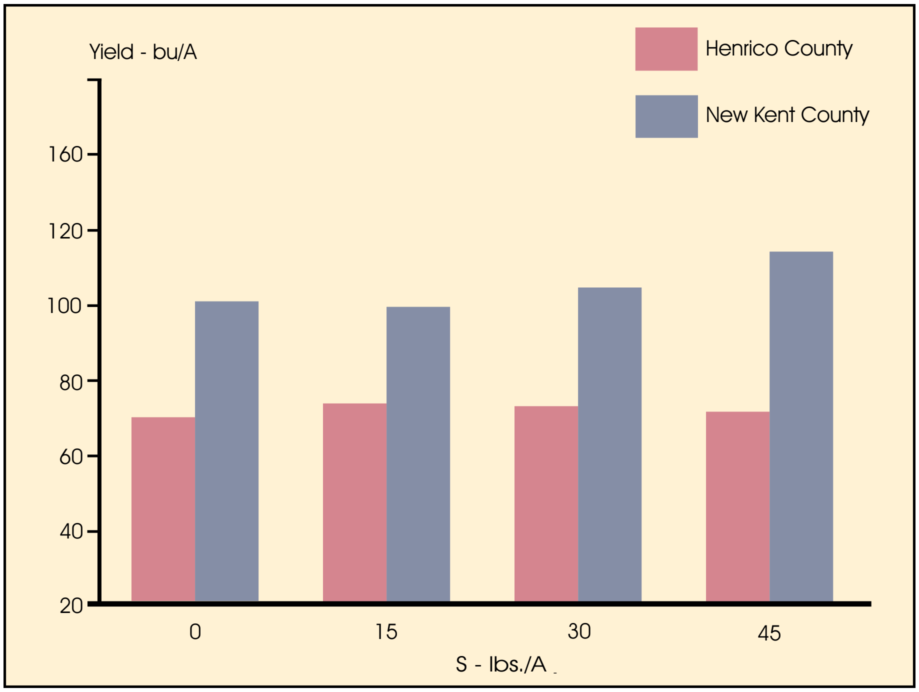

Figure 3. Grain yield response to variable rate preplant broadcast of P_2O_5, N starter constant at 40 lbs/A, Henrico and New Kent counties, Khosla, et al., 1997.

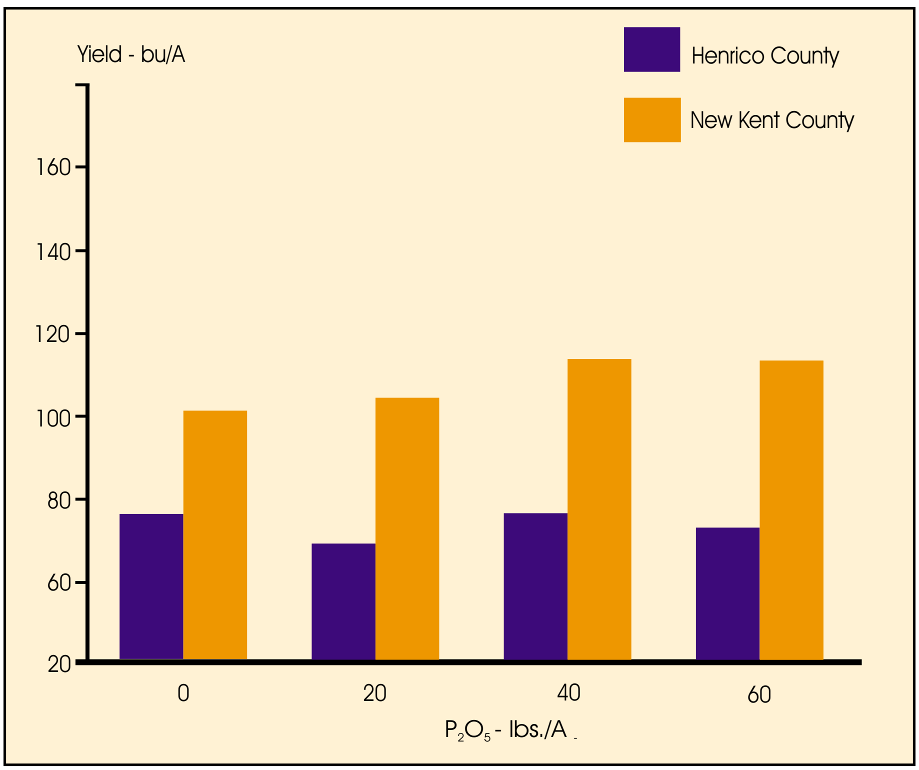

Figure 4. Grain yield response to variable rate preplant application of sulfur, N starter constant at 40 lbs/A, Henrico and New Kent counties, Khosla, et al., 1997.

high. Lack of sorghum response to phosphorus fertilization confirmed that the calibrations were correct.

Previous application of ammonium sulfate and release of S from soil organic matter and crop residues apparently provided sufficient levels of sulfur for grain sorghum growth under these conditions.

Shows potential

Grain sorghum performed fairly well under both normal and subnormal rainfall to demonstrate its acceptability as an alternative to corn. A grain yield level of 71 bu/A in extremely dry years, as reported in this study, to 160 bu/A in a good rainfall year like 1996 is encouraging. Research has shown it has a much higher yield potential under drought conditions than corn.

Incorporation of soil profile mineral N as an integral part of the fertilizer N recommendation system would increase N-use efficiency and profitability, and enhance environmental quality.

Residual mineral N does contribute to crop yields in these humid-region soils. This concept has not been readily accepted and used.

Soil test first

High levels of P and adequate levels of S already in the soil dampened any crop response to applications of these two nutrients. Soil sampling, therefore, using surface sample testing for P and deep samples for nitrates and sulfur, offers a means to improve fertilizer-use efficiency in grain sorghum production.

Methodology

Location. Field experiments were conducted during the summer of 1997 in the Central Coastal region of Virginia.

Soils were an Atlee very fine sandy loam (fine-loamy, mixed, thermic Typic Fragiudults) and Kempsville fine loamy sand (fine-loamy siliceous, thermic Typic Hapludults). These soils have less than 3 percent slopes and are typical of those widely used for grain sorghum production in Virginia.

Plots consisted of eight 15-inch wide rows, 25 feet in length. Plots were laid out in a randomized complete block design with four replications of each treatment.

Samples were taken to a depth of 36 inches at planting time. A “JMC Backsaver” probe was used to collect soil samples. Sixteen cores for each depth increment were composited.

Hybrid. Pioneer Brand 8310 was planted no-till into the previous crop residue.

Seeding rate was 80,000 plants/A.

Khosla is research associate, Dr. Alley is professor, Davis is agricultural extension agent, and Dr. Brann is extension grains specialist at Virginia Polytechnic Institute and State University.