No-Till Plus Poultry Litter Raises Cotton Yields in Drought

STEPHEN AUSMUS (D314-8)

In a conventionally tilled field near Watkinsville, Georgia, agricultural engineer Dinku Endale (foreground) and technician Stephen Norris use a capacitance probe to measure soil water.

Drought is one of the environmental conditions farmers must contend with—sometimes periodically and sometimes for years. In 2002 the southeastern United States emerged from a 4-year drought during which cotton production was suppressed. Researchers at the ARS J. Phil Campbell, Sr., Natural Resource Conservation Center in Watkinsville, Georgia, were evaluating response of cotton in a Cecil soil—a type of soil common in the Southern Piedmont—and were able to contrast the crop's responses in drought and nondrought years.

No-Till Improves Hardpans

Nonirrigated cotton in the Southeast, which is how most of it is grown, relies on timely rainfall in April and May for establishing good stands and in the summer months to sustain fruiting. Drought during these periods can be disastrous for growers. Unfortunately, such droughts are not uncommon in the region, despite its mean annual rainfall of more than 44 inches. The Federal Crop Insurance Corporation rates drought as the greatest cause of disasters of cotton and other crops in the Southeast. Even in years that are not particularly dry, the spring and summer rains may not be adequate for optimal nonirrigated cotton production, say agricultural engineer Dinku Endale and agroecosystems ecologist Harry Schomberg, both with the conservation center.

Cotton production has returned to the Southeast in a big way after a successful boll weevil eradication program. According to the Conservation Technology Information Center, cotton acreage increased by 1.9 million in the region in the last decade, with 5.2 million acres planted in 2002. But soils there present some problems for cotton farmers.

"Many soils in the Southeast have low water-holding capacity and form hardpans, or nearly impervious layers, which restrict root growth," says Endale. "If roots can't penetrate deeply enough to access soil water reserves, the drought effect is worsened. The soil surface also crusts, which forces rainwater to run off rather than seep in."

STEPHEN AUSMUS (D318-12)

Technicians Stephen Norris and Robin Woodroof observe an application of poultry litter on a tarp used in catching and measuring output for calibration of the precision poultry litter applicator.

Many growers manage their cotton with conventional tillage methods such as disking and harrowing, which disturb the soil surface. But this may not create the best soil conditions for cotton, because excessive tillage destroys organic matter needed to maintain good soil structure. Conservation tillage, on the other hand, protects the soil surface and allows more rainwater to penetrate it. Long-term use of practices such as no-till allows crop residue to accumulate on soil surfaces. That added organic matter builds soil structure, increases rainwater infiltration, reduces evaporation, and increases the biological activity that helps improve nutrient cycling.

The net effect is larger soil water reserves and greater nutrient availability, which are crucial for crop growth and sustenance during drought, say Endale and Schomberg.

STEPHEN AUSMUS (D316-37)

Agroecologist Harry Schomberg uses a chlorophyll meter to determine leaf color before collecting cotton plants for evaluating plant growth and nutrient uptake.

STEPHEN AUSMUS (D317-10)

Stephen Norris (foreground) and Dinku Endale calibrate a 6-inch flume and subsampling system used for determining runoff and sediment loss.

Add Litter To Boost Yield

Cotton growers may want to combine no-till with applications of poultry litter fertilizer to reap even greater yields, say the researchers.

The poultry industry continues to be a major source of income for producers in the South—and it generates vast amounts of litter. In Georgia, more than 100 counties have farm cash receipts that exceed $1 million each, with the total value of the poultry industry exceeding $13 billion annually. Poultry litter provides nitrogen, potassium, and other beneficial nutrients to the cotton crop—but at a slower rate than conventional fertilizers. The drawback is that care must be taken not to apply so much that soil phosphorus levels build up and contribute to water-quality problems.

During the 5-year study, from 1996 to 2000, the scientists found that, indeed, no-till cotton fertilized with poultry litter yielded more than conventionally tilled cotton fertilized with ammonium nitrate.

The scientists also looked at use of ammonium nitrate in no-till farming. "Our analysis shows that no-till was the main reason for the yield differences, while poultry litter contributed to a lesser degree," says Endale. "The study showed that just changing to no-till increased yield by 33 percent over conventional tillage. But changing to no-till plus poultry litter fertilizer increased yield by 42 percent."

Conventional fertilizer and poultry litter were applied at a rate of 60 pounds of nitrogen per acre. This nitrogen application rate required 2 tons of poultry litter per acre. Annual rainfall totals were: 49 inches in 1996, 61 inches in 1997, 49 inches in 1998, 41 inches in 1999 (the 17th driest in 67 years), and 33 inches in 2000 (the driest in 67 years).

Yields from no-till cotton fertilized with poultry litter increased by an average of 42 percent during the first 3 years. In the fourth year, a 35-day period of almost no rainfall occurred during the critical blooming period, and yields were severely reduced in all tillage and fertilizer regimens.

In the fifth year, conditions were very dry during planting and early establishment, which caused severe stress and required replanting in some rows in the conventionally tilled cotton. No-till cotton, on the other hand, was able to capitalize on carry-over soil water reserves to fare better during establishment, which helped it survive better into blooming. The blooming period was dry, though not as dry as the previous year. The early and blooming-period water stress proved too severe for the conventionally tilled cotton, and so yield stayed the same as the previous year. No-till cotton—better positioned to use the limited rainfall—did much better. As a result, average cotton yield for the 2 dry years surpassed that from conventionally tilled and fertilized cotton by 42 percent. The combination of no-till and poultry litter clearly outyielded conventional tillage and commercial fertilizer in 4 of the 5 years.

"Cotton producers in the southeastern United States would benefit from managing cotton production under no-till and poultry litter fertilization, because these practices make more soil water and nutrients available to the crop," says Endale.—By **Sharon Durham,** ARS.

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Dinku Endale and Harry Schomberg are with the USDA-ARS J. Phil Campbell, Sr., Natural Resource Conservation Center, 1420 Experiment Station Rd., Watkinsville, GA 30677; phone (706) 769-5631, fax (706) 769-8962, e-mail dendale@uga.edu, hhs1@uga.edu. ✷