NITROGEN RATES FOR COTTON IN ALABAMA'S LONG-TERM EXPERIMENTS

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Abstract

In order to verify standard N rates for cotton in Alabama soils, long-term soil fertility experiments with N rate variables on cotton at five locations were summarized from 1992 through 1998. The results support the current standard N recommendations used on soil test reports. For most sandy and loamy Alabama soils, the standard recommendation is a total of 90 (±30) pounds N per acre during the growing season; 60 (±30) pounds N per acre is standard for the deep, red, silt and clay loams of the limestone valleys of North Alabama. Cotton following a good soybean or peanut crop will benefit from some residual N but predicting this response is difficult. While N recommendations based on a yield goal may apply for some crops, this clearly is not the case with non-irrigated cotton in Alabama. A comparison of a Bollgard® variety (Deltapine NuCotn 35B) and a similar conventional variety (Deltapine DP5690) at one location for 3 years resulted in 85 pounds lint/acre/year higher yields for the Bollgard® variety. Producers should follow the standard N recommendation on new fields and make adjustments as experience and cropping systems dictate.

Introduction

Although nitrogen (N) is the most difficult nutrient to manage in cotton production, it has more impact on yields, earliness, and lint quality than any other primary plant nutrient. It is also the most costly plant nutrient applied per acre. Potential nitrate-N leaching into ground waters is a driving force behind water quality issues and nutrient management planning policies. Because N is a primary constituent in all protein, easily transforms into several chemical forms, is biologically active, and can be mobile in the environment, we have problems managing it in cotton production.

Some techniques growers use to try and optimize N use efficiency in cotton include:

- Split or multiple N applications
- Starter fertilizers
- N fertilizer placement
- Foliar urea (46-0-0) applications during bloom
- Petiole monitoring
- Plant leaf analyses
- Water management (irrigation timing)
- Plant growth regulators (e.g., Pix Plus®)
- Cover crops
- Computer programs and plant growth models (e.g., Gossym-Comax®, NLEAP®, EPIC®, COTMAN®)

Soils in Alabama's Long-term Soil Fertility Experiments with Cotton

Brewton Experiment Field: Benndale loamy sand (*coarse-loamy, siliceous, thermic Typic Paleudults*)

Wiregrass Research & Extension Center: Dothan sandy loam (*fine-loamy, siliceous, thermic Plinthic Kandiudults*)

Monroeville Experiment Field: Lucedale fine sandy loam (*fine-loamy, siliceous, thermic Rhodic Paleudults*)

Prattville Experiment Field: Lucedale sandy clay loam (*fine-loamy, siliceous, thermic Rhodic Paleudults*)

Tennessee Valley Research & Extension Center: Decatur silt loam (*clayey, kaolinitic, thermic Rhodic Paleudults*)

Long-Term N-Rate Experiments

Since its beginning in 1883, the Alabama Agricultural Experiment Station has been studying N on cotton in an attempt to help Alabama growers better manage this nutrient. The oldest, continuous cotton experiment in the world, Alabama's Old Rotation (circa 1896) at Auburn University, focuses on N management by rotating cotton with other crops and planting winter legumes (Mitchell et al., 1996). The Alabama Agricultural Experiment Station also maintains thirteen other long-term experiments at seven Alabama locations. These also have included N rates on cotton periodically since 1929 (Cope, 1970; 1984). These are called the "Two-year Rotation" (c. 1928) and the "Rates of N-P-K" (c. 1954) experiments. Since 1992, the "Two-year Rotation" has been in a cotton-soybean rotation and the "Rates of N-P-K" has been in annual cotton production at five locations. In addition to other soil fertility variables, each test includes variable rates of N on cotton. All sites are non-irrigated and conventionally tilled. Plots are 21 x 69.2 feet in the "Two-year Rotation" and 21 x 34.6 feet in the "Rates of N-P-K". Nitrogen rates are split applictions with half applied at planting and half as a sidedress at or near early squaring. The source of N at all locations is ammonium nitrate (34-0-0).

In order to take a new look at the effects of N rates on new cotton varieties with higher yield potentials, seven years of cotton yield data from these experiments were summarized. Since 1996, Bollgard® and Roundup Ready® varieties have been used at most locations.

Standard N Recommendations

Alabama's current standard N recommendations were

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developed from these and other experiments in the 1950s and 60s, modified in the 1970s and refined in the 1980s (Scarsbrook and Cope, 1957; Cope, 1970, 1984; Touchton et al., 1981). Therefore, if cotton responds to N rates differently today, we would expect this to be a reflection of improved varieties, higher yields, and different management. This is not the case, however. The standard N recommendations are still appropriate for maximum relative yields in these tests (Fig. 1).

Standard N Recommendations (lb/acre) for Cotton in the Southeastern U.S.

Alabama: 90±30 in split application for all soils except Limestone Valley soils; 60±30 in Limestone Valley soils
Florida: 60 in split applications
Georgia: 60 to 105 in split applications based on realistic yield goals of 750 to 1500 lb. lint/acre.
Mississippi: 50 to 60 per bale on "light-textured soils"; 60-70 per bale on "medium-textured soils"; split applications if over 100 lb N per acre applied.
North Carolina: 50 to 70 in split applications
South Carolina: 70±30 in split applications
Virginia: 60 to 90
Tennessee: 30 to 60 on bottom soils; 60 to 80 on upland soils

Data in Fig. 1 is compilation of mean relative yields for N rates at each location and year. Relative yield is the percentage yield of each treatment compared to the standard N rates of 90 pounds per acre. Cotton on Coastal Plain soils appear to respond to N similarly and are combined into one curve with a near maximum yield at 90 pounds N per acre. Cotton on the finer textured soils of the Tennessee Valley (Decatur silty clay loam) reach a near maximum yield at 60 pounds N per acre, probably due to less leaching loss and some N retention.

Cotton Following Soybean or Peanut

The comment with current recommendations recognizes that residue from a good soybean or peanut crop may contribute 20 to 30 pounds N per acre to the following cotton crop (Adams et al., 1994). Because as many as 6 months could elapse between soybean/peanut harvest in the fall and cotton planting the following April or May, much of the residual N may be lost from the soil. Data from N-rate treatments on the "Two-Year Rotation" at 5 locations verify the variable nature of residual N from legumes (Fig. 1). Since 1992, cotton on this experiment has always followed soybean or peanut. Clearly, cotton response to N rates was highly variable following a legume. At some locations (e.g. Monroeville) the residual N from soybean produced nearly 100% yields even where no fertilizer N was applied. At Brewton on a much sandier Benndale loamy sand, yields were so variable that only the standard recommendation consistently produced maximum yields on this experiment.

Yields Goals

Promoters of fertilizer use have often espoused the concept of recommendations based on "yield goals". This is a particularly popular and reasonable practice with grain crops such as corn, wheat and sorghum and forages. These crop remove large quantities of N in the harvested portion of the crop. However, Alabama's long-term N experiments do not support this practice for cotton under the conditions of these experiments (Fig. 2). In a disaster year when cotton yields are less than a bale per acre, very little if any N fertilizer is needed. No farmer plans on a disaster year and never fertilizes for these situations. But even in outstanding production years when yields far exceed anticipated yield goals (e.g., 3+ bales per acre), data from Alabama's research stations support the "standard" recommendation plus or minus about 30 pounds N per acre.

Due to the boll weevil eradication program in Alabama, boll weevils have not been an economic factor for Alabama cotton farmers since 1996. With the weevil out of the way, cotton has the potential to set more late-season cotton bolls increasing yields and the demand for more N. However, data from these long-term experiments have not indicated that boll weevil eradication nor the new, genetically modified varieties have had any effect on cotton yield response to N rates since 1996. In fact, highest yields were produced in 1992 or 1993 at all sites except the Brewton Experiment Field.

Bollgard® Versus Standard Varieties

Because of the rapid adoption of the new, genetically modified cotton varieties, there have been few opportunities to evaluate their response to soil fertility variables. In 1996, the first year Bollgard® varieties were available to Alabama producers, the "Rates of N-P-K" experiment on a Lucedale s.c.l. at the Prattville Experiment Field was modified to determine if any differences existed in response to soil fertility variables between two varieties of similar genetic backgrounds. All plots were split and a Bollgard® variety, 'Deltapine NuCotn 35B' (DP35B), was planted on half of each plot (3 , 40-inch rows, 25 feet long) and a conventional variety of similar genetics, 'Deltapine DP 5690' (DP5690), was planted on the other half of each plot. The center and inside row in each subplot was harvested for yield. This was repeated in 1997 and 1998.

There were significant differences ($P<0.05$) due to N rate and variety each year. The 'DP35B' yielded an average of 85 pounds more lint per acre per year than the conventional variety over all N rates. Although in 1996 and 1998, there were significant N rate x variety interactions, these

differences do not affect standard N rate recommendations (Fig. 3).

Summary

Long-term, N-rate research at several Alabama locations since 1992 support the current standard N recommendations used on soil test reports (Adams et al., 1994). For most sandy and loamy Alabama soils, the standard recommendation is a total of 90 (±30) pounds N per acre during the growing season; 60 (±30) pounds N per acre is standard for the deep, red, silt and clay loams of the limestone valleys of North Alabama. Cotton following a good soybean or peanut crop will benefit from some residual N but predicting this response has been difficult. While N recommendations based on a yield goal may apply for some crops, this clearly is not the case with non-irrigated cotton in Alabama. Producers should follow the standard N recommendation on new fields and make adjustments as experience and cropping systems dictate. Nitrogen rates do not need to be adjusted for the newer, genetically modified cotton varieties.

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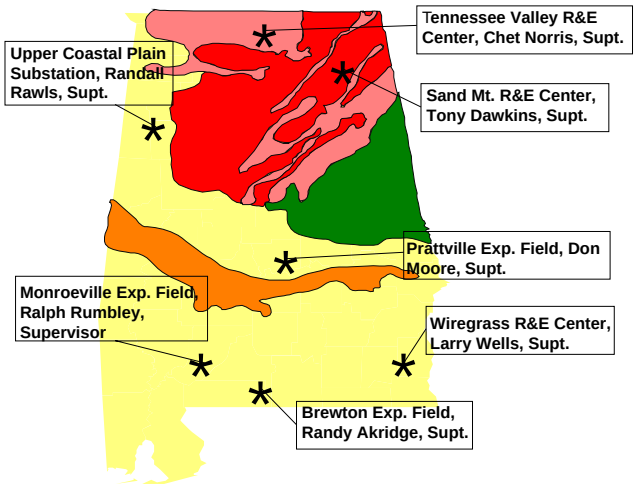
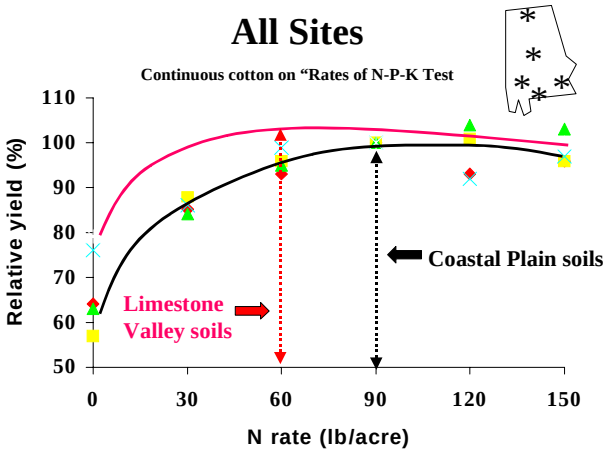
Acknowledgements

These long-term experiments are the basis for Alabama's research-based soil test interpretations and recommendations. They continue to exist because of the support of the Alabama Agricultural Experiment Station and the dedication and hard work of the superintendents and staff of Alabama's outlying research units. The "Rates of N-P-K Test" and the "Two-year Rotation" are identified in the following map and are maintained by the respective superintendents. The experiments at Sand Mountain Research and Education Center and at the Upper Coastal Plain Substation have been converted to forage crops while the others remain in cotton production. In recent years, producer checkoff funds have also helped support these experiments.





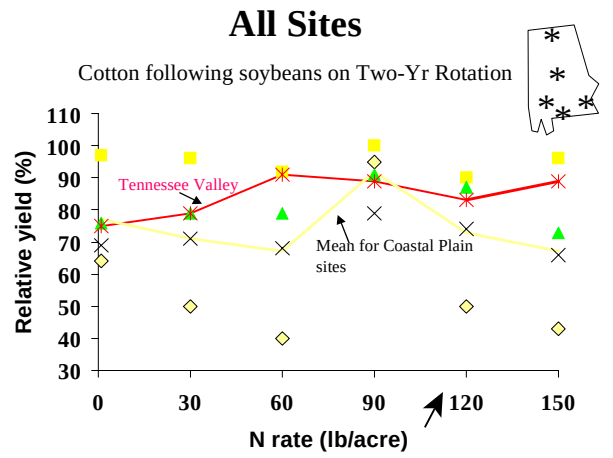
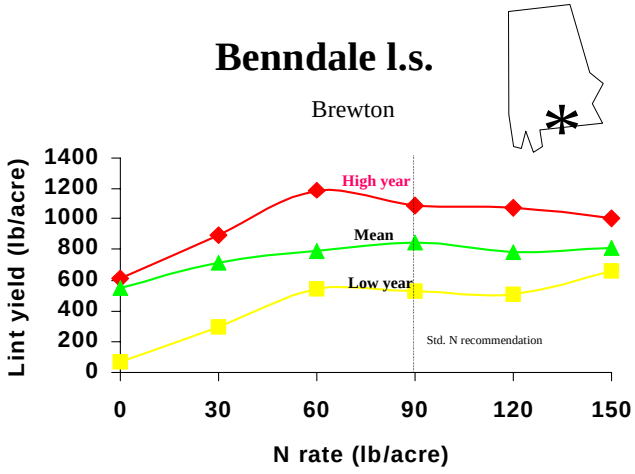
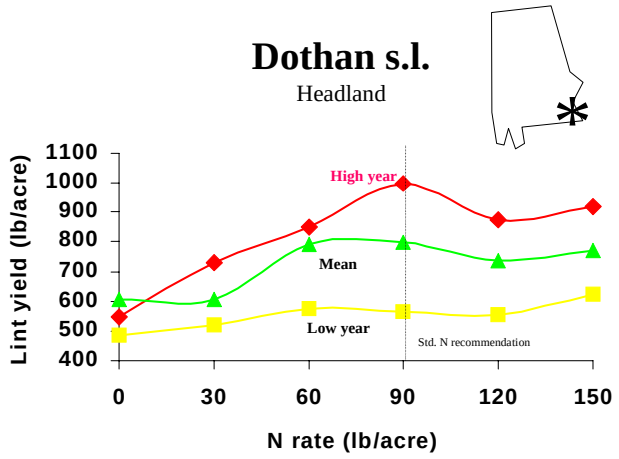


Figure 1. Nitrogen rates where cotton is planted every year ("Rates of N-P-K Test") and cotton following soybean ("Two-Year Rotation Experiment") at five Alabama locations, 1992-1998. Relative yield is the lint yield compared to the lint yield of a treatment receiving 90 pounds N per acre. All N is applied in split applications.





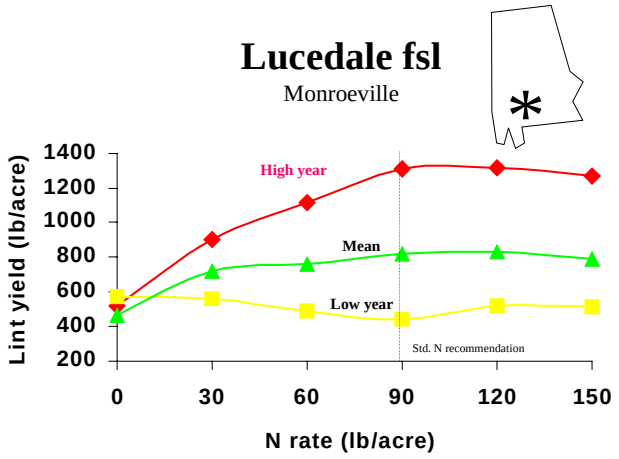
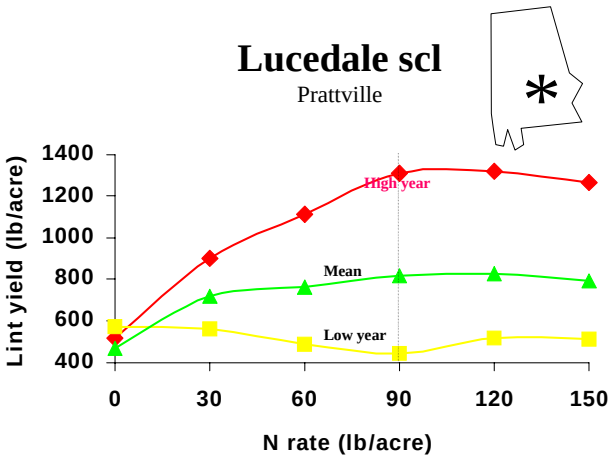
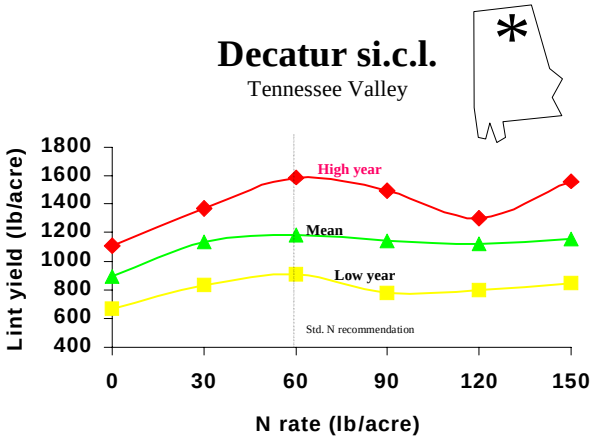


Figure 2. Cotton yield response to nitrogen rates on the "Rates of N-P-K Test" (c. 1954) , 1992-1998, at five Alabama locations. Lines represent the highest yielding year, the lowest yielding year, and the mean of 7 years (continued).





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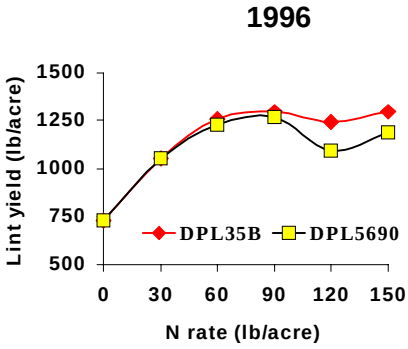

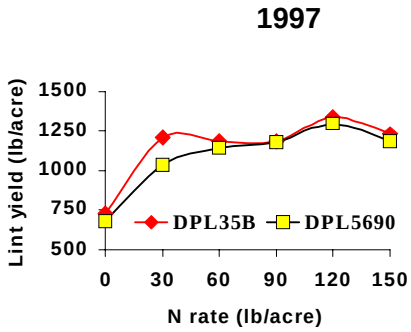

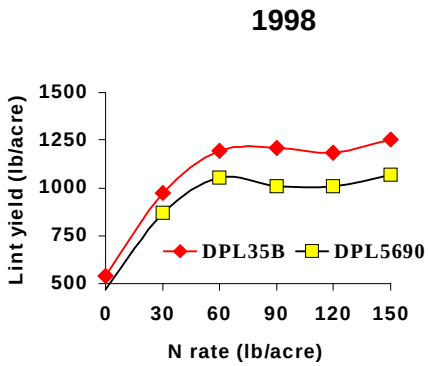

Figure 3. Effect of N rates on two similar cultivars of cotton on a Lucedale s.c.l. at the Prattville Experiment Field in Central Alabama, 1996-1998. A significant ($P<0.05$) N rate x variety interaction was found in 1996 and 1998.