Cotton Yield Goal - Nitrogen Rate Recommendation

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Nitrogen in the Crop

Nitrogen (N) is the most limiting mineral nutrient in cotton production. It plays an integral role as a building block for proteins and chlorophyll synthesis. Cotton lint is actually an extension of the cell wall of the seed. Therefore, if seed is not produced, then neither will lint. Unlike cereal grains, cotton can be impacted by both under- and over-fertilization. Under-fertilization can result in reduced fruiting site development, lead to boll abortion, reduce lint yield, and potentially reduce fiber length and strength. Over-fertilization can result in excessive vegetative growth (rank growth), higher plant growth regulator requirements to check the unwanted growth, decreased lint turnout, possibly increased *Verticillium* wilt disease incidence, maturity delay resulting in immature fiber (low micronaire), negative effects on harvest aid chemical treatment efficacy, and ultimately reduced lint yield and fiber quality (Main et al. 2010; Main et al. 2011).

Historic Trends and New Data

The past fifty years have brought great changes in Oklahoma cotton production. During that time, the average lint yield in Oklahoma has nearly tripled (Figure 1), while the amount of cotton seed required to produce a 480-lb bale of lint has decreased by about 100 lbs (Figure 2). This decrease was from about 800 lbs seed per bale of lint in the early to mid-1990s to about 700 lbs seed per bale of lint in more recent years. This indicates that the amount of lint produced per lb of seed has increased. Overall, this leads to a reduction in N removal per bale of lint. If we assume that seed N concentrations were relatively constant during these years, the amount of N removed by 100 lbs fewer seed per bale would represent about 12.5 percent less N per bale with modern transgenic cultivars when compared to 20 years ago.

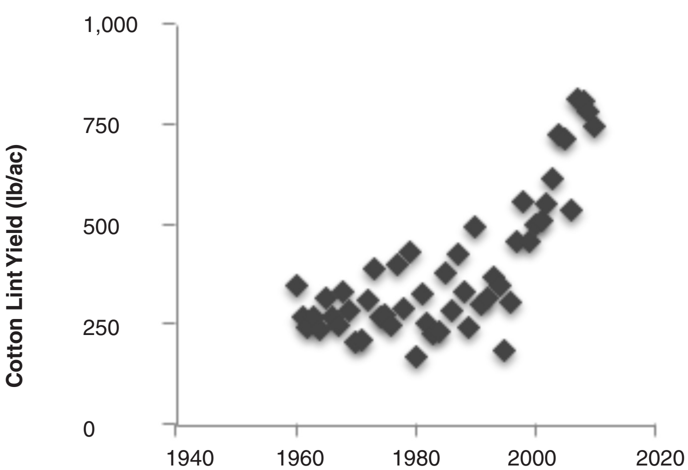

Figure 1. Average Oklahoma cotton lint yield (for irrigated and non-irrigated combined) from 1960 to 2010. Data retrieved from NASS.

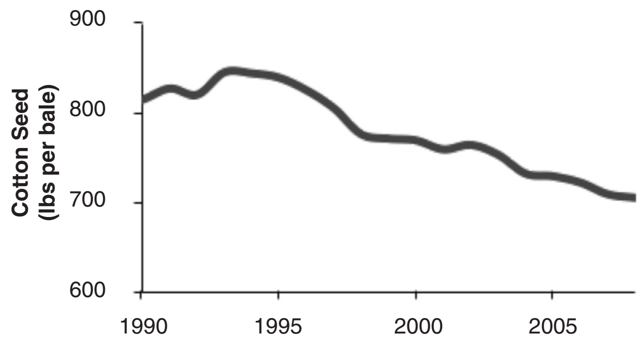

Figure 2. Average pounds of cotton seed required to produce one bale of lint from 1990 to 2010. Data shows a 5-yr smoothed average. Data retrieved from NASS.

A review of data from a long-term cotton fertility experiment conducted at the OSU Southwest Research and Extension Center near Altus indicated that since the early 1990s, maximum yield has essentially doubled and the total amount of N to meet the needs of the higher yielding crop has increased. However, N required per bale of lint has decreased. Several factors are involved in these tremendous productivity gains, including boll weevil eradication, Bt transgenic cultivars resistant to many caterpillar pests, transgenic weed control traits and herbicide systems that provide excellent control of weeds, and overall breeding improvements in cotton cultivars in terms of yield and quality. On average, the newer cultivars reached three bales per acre yields with just 120 lbs of N when all other nutrients were sufficient (Girma et al. 2007). The conclusion of the paper was that when P and K were adequate and held constant across N rates, all cultivars attained maximum lint yield with application of 120 lbs/ac N (Figure 3).

Nitrogen Requirement

With the changes in cultivars, lint yield potential, and other factors, Oklahoma State University has noted a need

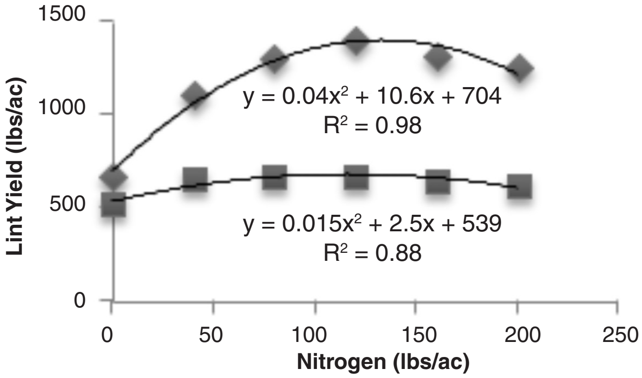

Figure 3. Nitrogen response curves when P and K were adequate from the long-term cotton fertility trial located at the OSU Southwest Research and Extension Center near Altus. Yield data for bottom regression line are Paymaster 145 cultivar from 1989-1994; whereas top regression line data are Paymaster 2326BG/RR cultivar from 2001 to 2004. Figure derived from Desta et al. 2007.

to adjust the N rate recommendation for cotton production in Oklahoma, which has been 60 lbs N/bale for many years. The amount of N needed for all crops is directly related to the yield goal of the field. Oklahoma State University now recommends that cotton requires 50 lbs of N per expected bale of lint (Table 1). This amount of N per bale of yield goal should be appropriate for most soils. It should be noted that the amount of N mineralized during the growing season is unknown for most soils, but it is obvious that contributions from atmospheric N deposition, and organic residue mineralization can be adequate in some irrigated soils to produce more than a bale of lint per acre (see Figure 3, 0-N rate yields).

Yield goals can be determined by one of two methods: a) the average of the three highest yields from the past five years, or b) the five-year average plus 20 percent. The total amount of N applied should be the yield goal rate (Table 1) minus soil test N, and any contributions of NO_3-N from irrigation water (if applied). Since cotton is a tap rooted crop it is recommended that both top soil (0 to 6 inches) and sub-soil (6 to 18 inches) samples should be collected and analyzed for

Table 1. Nitrogen requirement for cotton production in Oklahoma (actual N needed is the amount listed in the table less soil and irrigation water test N).

Yield Goal (bales /ac)	N requirement (lbs /ac)
1	50
1.5	75
2	100
2.5	125
3	150
3.5 and greater	175

residual nitrate (NO_3-N). The amount of NO_3-N found in subsoil can be significant and therefore can result in substantial fertilizer savings in terms of reduced N application.

In some areas of Oklahoma, irrigation water contains sufficient NO_3-N that should be credited toward the cotton N requirement. To determine if irrigation water contains significant NO_3-N, a water sample must be collected and submitted to a testing laboratory. For every one ppm of NO_3-N in irrigation water, 0.23 lb per acre of N will be added to the soil with each acre-inch of water applied. Thus, one acre-foot (12 acre-inches) of 10 ppm NO_3-N irrigation water would supply about 27 pounds of N per acre. This can be calculated using the following:

ppm of NO_3-N in water x 0.23 x inches of water applied = lbs of N per acre added.

As an example, suppose 15 inches of irrigation water is applied and the water test indicates 10 ppm for NO_3-N. Based on the above formula, an additional 34.5 lbs of N per acre will be applied during the growing season (10 ppm x 0.23 x 15 inches = 34.5 lbs N/acre).

Total N (soil test plus irrigation and fertilizer N) of 175 lbs per acre should be adequate for lint yields of 3.5 bales per acre and greater. This maximum rate may need to be reassessed in the future due to differences in N use efficiency among irrigation delivery systems, newer transgenic traits, or if yield otherwise increases to new record high levels. The total N requirement for cotton can be calculated using the following equation if soil and irrigation water (if available) are tested:

N (lbs/ac) = Yield goal N – {top soil NO_3-N + sub-soil NO_3-N + irrigation water NO_3-N}

In no-till fields with a large amount of crop residue the N rate should be increased by 20 to 30 lbs of N per acre when fertilizer is surface applied. This will compensate for the N tied up in the residue due to immobilization.

Citations

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