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Managing Nitrogen Fertilization in cotton

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To be profitable, cotton producers in Texas must manage fertilization and other agronomic practices very efficiently. Nitrogen (N) is the nutrient most frequently applied in cotton production, and usually the most expensive. It is also the most difficult nutrient to manage. Nitrogen deficiency can reduce leaf size, number of fruiting nodes, fruit retention, yield, and fiber quality. Deficiency also can limit water and nutrient uptake and cause excessively early cutout. Excess nitrogen can delay maturity, cause excessive vegetative growth, decrease boll retention, lower fiber quality, increase pest problems, hinder defoliation, and pollute ground and surface water.

Accurately predicting the nitrogen a crop needs is difficult because nitrogen can undergo chemical changes that influence its retention and mobility in the soil, as well as its availability to plants. Nitrogen leaching, denitrification (conversion to a gas), ammonia volatilization, and mineralization and immobilization (release and tie-up of N by soil microbes) are processes that can quickly alter the amount of nitrogen available to plants.

Nitrogen Requirements of Cotton

The amount of N cotton needs depends on yield. The total quantity of available N required to produce a given yield, as determined by previous research in Texas, is presented in Table 1. Texas Cooperative Extension recommends that a total of 50 pounds of N per acre, from all sources, be available for each bale of lint produced.

Table 1. Nitrogen recommendations for various yields of cotton in Texas.

Yield (bales/acre)	N recommendation* (lbs./acre)
½ bale	25
1 bale	50
1 ½ bales	75
2 bales	100
2 ½ bales	125

*Recommended amount should be reduced by the amount of residual NO_3 in the soil.

Crops obtain N from applied fertilizer, from residual fertilizer in the soil (chiefly NO_3), and from N released (mineralized) from decaying organic matter. Of these sources, only the amount of N applied in fertilizer is accurately known. Residual N in the soil is highly dynamic, and the amount of N slowly released by organic matter is influenced by soil and climatic factors. Thus, soil should be tested for NO_3 as near the time of planting and crop demand as possible because a soil test gives only a point-in-time estimate of the amount of N available.

To improve the efficiency of N fertilization, a 5-year study was conducted to develop and evaluate a rapid procedure for estimating the amount of N being released from organic matter. With an estimate of mineralizable N and a test for residual NO_3, N fertilizer recommendations can become more accurate.

In this study, nitrogen application rates ranged from 0 to 150 pounds per acre in 50-pound-per-acre increments. Results were difficult to assess because only 8 of the 39 sites studied responded to additional fertilizer N (Table 2). Residual soil nitrate, measured to a depth of 4 feet, exceeded 100 pounds per acre on 22 of the sites and supplied the N necessary for optimum crop yields at those locations.

As this study clearly shows, residual NO_3 must be accounted for when determining how much fertilizer to apply. The study also showed that soil samples for testing should be taken to a depth of 4 feet to be most accurate. If this is not feasible, soil should be sampled to at least 2 feet and the amount of residual NO_3 subtracted from the typical N recommendation. Any NO_3 that will be added in irrigation water (as determined by water testing) also should be credited.

Table 2. Summary of the 5-year project.

Years	Rainfall	Sites		
		Total	Residual N >100 lbs./acre	Response to N
1998	10% of normal	6	1	3†
1999	normal	7	5	1
2000	less than normal	7	5	0
2001	less than normal	10	6	2
2002	normal	9	5	2
Total		39	22 (56% of sites)	8 (20% of sites)

† Indicates a significant increase in lint yield from added fertilizer nitrogen.

Other studies have shown that 2 feet is the optimum depth for sampling residual NO_3. Our study showed that the prediction of lint yield using available N (residual NO_3 + added fertilizer N) significantly improves with increasing sampling depth. This study also showed that sampling soil to a depth of 2 feet, as compared to the currently recommended 6 inches, would reduce the recommended N application amount for a yield goal of two bales of lint per acre by an average of about 30 percent (Table 3). These calculations were based on the recommended 50 pounds of N per bale and credits for residual NO_3 at these two depths. The greatest absolute and percentage changes in recommended fertilizer rates between sampling depths occurred when residual soil NO_3 at the 2-foot depth was nearly adequate to achieve the yield goal.

Table 3. Amounts of fertilizer N recommended for a two-bale-per-acre yield based on soil testing for residual NO_3 at 6- and 24-inch depths.

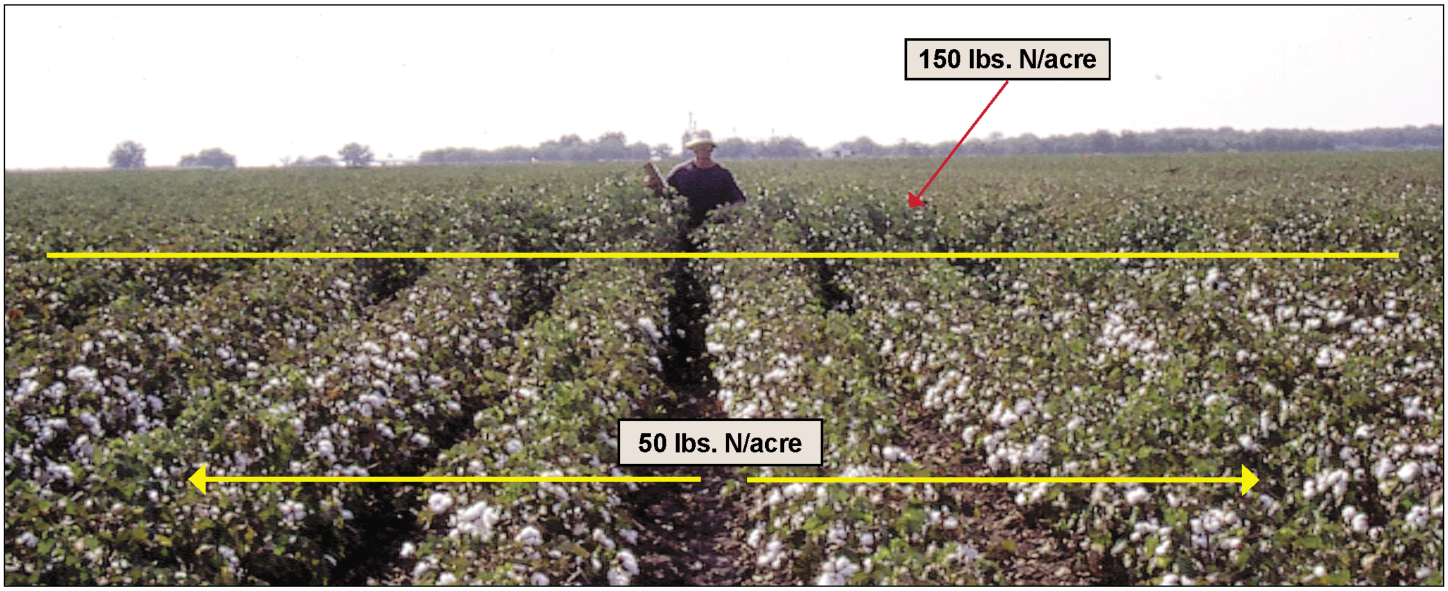
Site	Fertilizer N recommended lbs. N/acre		Difference lbs. N/acre	Reduction %
	0-6 inches	0-24 inches		
1	90	76	14	15.6
2	85	68	17	20.0
3	75	55	20	26.7
4	68	46	22	32.4
5	57	27	30	52.6
6	36	3	33	91.7

Avoid Over-Fertilization with Nitrogen

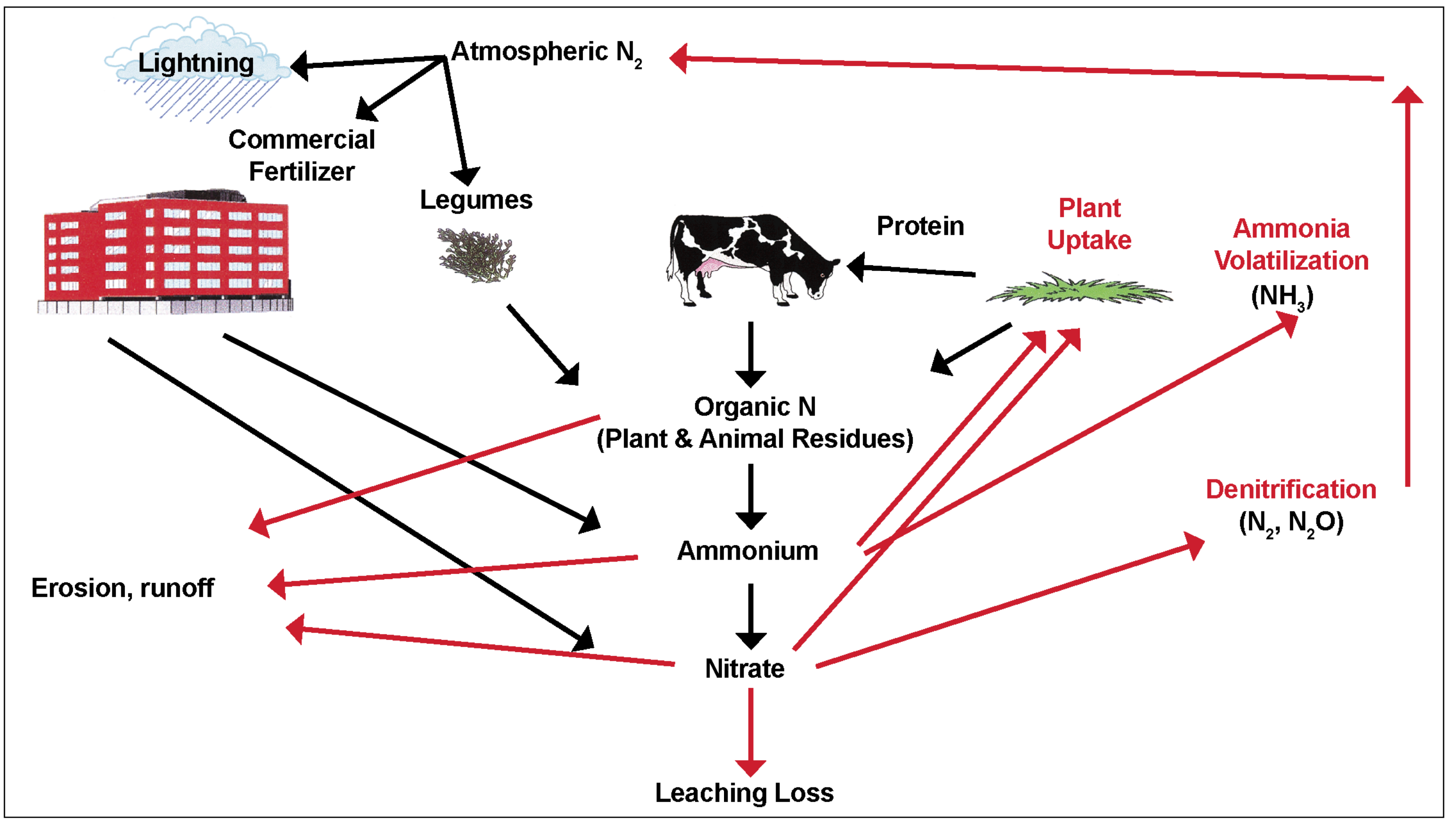
There can be several reasons for high levels of residual NO_3 in soil, including crop failure, over-fertilization because of unrealistic yield goals, preplant N application, and failure to monitor residual NO_3 by testing soil regularly. Producers should:

Establish achievable yield goals and fertilize accordingly: Unrealistically high yield goals result in overapplication of N. For example, if the long-term average yield is 1 or 1 ½ bales per acre, there is no reason to routinely fertilize for 2 or 2 ½ bales per acre. Additional N can be applied in-season, if conditions warrant. This same principle should be applied to all crops in the rotation.

Determine soil NO_3 levels and reduce N fertilizer accordingly: To prevent NO_3 buildup, soil should be tested annually to a depth of 2 feet if possible, and the fertilizer N recommendation reduced by the amount of residual NO_3 in the soil. Nitrate also may



Excessive nitrogen promotes vegetative growth, boll rot and insect attack, while decreasing boll retention, fiber quality, and defoliation effectiveness.



The nitrogen cycle, including most inputs, losses and transformations. Red arrows indicate potential losses from soils, while black arrows indicate inputs or transformations.

build up over several years of drought if crops have been fertilized for normally expected yields. Soil testing will detect this increase and enable fertilizer N recommendations to be reduced accordingly.

Apply N when the crop can use it: If all the N fertilizer is applied before planting, some may be lost because of leaching and denitrification. It is inappropriate to make up for this loss by applying even more N fertilizer before planting because this can contribute to excessive residual NO_3 in the soil. It is better to split the N application—applying one-third to one-half the recommended amount preplant or at planting and sidedressing the remainder between first square and first bloom. Splitting N applications can significantly improve N use efficiency and protect against the accumulation of excess N and/or the leaching of N from the soil, especially in coarse-textured soils.

Recommendations

Improving the accuracy of N fertilizer recommendations for cotton and other crops is important to profitability and environmental sustainability.

The amount of N fertilizer applied annually for cotton should be based on the following:

- A *realistic* yield goal
- A soil test for residual NO_3 to a depth of 2 feet (if possible) *every* year
- A soil test for other essential plant nutrients at least every other year
- Split N applications to improve efficiency, especially on sandy soils

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