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Cotton Insights Newsletter

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Update

The 2023 planting season is around the corner, and drought is still a significant challenge in much of our geography. Inputs are expensive, and cotton lint prices are lower than expectations. Although we are still quite a ways out from planting, the overall moisture situation is difficult. This is going to be another year to watch inputs. We will cover some of these critical components of cotton production in the next few newsletters.

Fertility Management Considerations

Even though fertilizer prices have dropped, they remain higher than desired. Essential nutrients can be a place to scrutinize for input cost reduction in a belt-tightening year. We don't want to "throw the baby out with the bath water" though. Remember that soil testing can pay. Many times, we may have had an outstanding fertilizer management program on a specific farm. Other farms may have had less than desirable soil fertility management. The best way to determine which farms require higher expenditure of fertilizer dollars is simply by checking the soil fertility status by using soil testing.

A one bale cotton crop will remove from the field about 40 lbs of actual nitrogen (N) per acre in the seed cotton at harvest. However, the total above ground biomass is likely to take up about 60 lbs of N/bale. The crop residue will return to the soil and recycle the remaining nutrients. This same yield will remove about 20 lb of phosphate per acre.

The table below was reproduced from a vintage Cotton Physiology Today article covering cotton plant nutrition which can be downloaded here:

http://www.cotton.org/tech/physiology/cpt/upload/CPT-Jan91-v2-3.pdf

Typical Nutrient Content
(Pounds of Nutrient Per Bale)

Nutrient	Above ground plant (leaves, stems, fruit)	Seed cotton	Lint
Nitrogen (N)	62	35-40	1
Phosphate (P_2O_5)	22	13-20	0.3
Potash (K_2O)	61	15	3
Calcium (Ca)	27-62	1	0.2
Magnesium (Mg)	11-27	5	0.3
Sulfur (S)	8-16	1-2	trace

Nitrogen

The main form of nitrogen (N) that cotton roots take up is nitrate (NO_3^{-1}). Nitrate-N is considered mobile in the soil, so N in the nitrate-N form is susceptible to leaching under the high rainfall and saturated soil conditions. If a previous crop was reasonably well fertilized and yielded poorly or failed due to drought, as we experienced across considerable acreage in 2022, then it is very likely that residual nitrate-N will be present in the soil profile. In our region, determination of the amount of residual nitrate-N in the upper 18 to 24 inches of the soil profile can result in reduction in N fertilizer requirement. This is typically more noted in crop rotations with corn for grain.

Over the years, in my opinion, my eyes have probably seen more cotton negatively impacted by excess N than by N deficiency, at least in irrigated fields. There are always exceptions, but as a gross generality, I am fine with stating that observation. Note that excess N can perhaps increase Verticillium wilt disease pressure, and perhaps increase cotton aphid populations. Excess N can also:

- Increase plant growth and thus plant growth regulator need, especially under high moisture conditions and modern high growth potential varieties.
- Delay maturity, decrease gin turnout, and challenge harvest aid performance.
- Ultimately negatively impact fiber quality (e.g. micronaire; possibly bark and color and leaf grade). This could result in cotton production losses, or unnecessarily high expenses or both.

Texas A&M AgriLife Extension Service and others recommend 50 lbs N/acre/bale of yield goal. This N requirement must be adjusted for residual nitrate-N in the soil and for any contributions of N from organic manure or compost and from high nitrate-N irrigation water.

I am of the opinion that this should be reduced to about 40 lbs N/acre/bale of yield goal due to changes in varieties over the past 20 years or so. It now requires fewer lbs of seed to produce a 500 lb bale of lint. If we assume the N concentration in that seed has remained constant over years, this would indicate about 20-25% lower crop N removal per bale with many smaller seeded cotton varieties.

- It is best to deep sample cotton fields, especially those following corn for grain, in order to determine the amount of residual nitrate-N in the soil profile. This will likely have to be done with hydraulic soil probes. Samples from as deep as 18 to 24 inches should be considered. The surface 6 inches can be separated and have routine analyses performed for pH, N, P, K, and micronutrients. The remaining depth (6-18 inches or 6-24 inches) can be analyzed for nitrate-N only. This profile nitrate-N can be directly credited against the N requirement for the yield goal.
- *Note that cotton roots do not grow through dry zones in the soil, so if we expect the plant roots to explore the profile for residual fertility, we need to have a moist, unimpeded soil profile and a good root system.*
- High rainfall can leach nitrate-N from the upper profile before crop uptake (more problematic on sandy soils), or water saturated soils may experience denitrification (more problematic if moisture saturation of soil occurs for an extended period).
- Another important question needs to be asked, and that is "how much nitrate-N will be mineralized by the soil organic N pool" during the growing season.
- Fields with a history of excellent N fertilization over a period of years – especially grain corn/cotton rotations, will likely be able to mineralize or "churn out" more nitrate-N during the growing season from this typically unmeasured, and mostly ignored organic pool of N.
- *Note that preplant nitrate-N sampling and testing does not indicate what will be mineralized from the "organic N pool" during the growing season. It only measures what is present as nitrate-N on the day you sample.*

Phosphorus

Cotton is a very good scavenger of soil phosphorus (P), due to its taproot, assuming a robust root system is developed. P forms taken up by plant are $H_2PO_4^{-1}$ and HPO_4^{-2}, and both are immobile in soil. Reductions in P fertilizer availability will occur over time due to reactions with calcium and other soil constituents, and soil testing should be used to determine the "plant available" amount. Since P is considered an immobile nutrient in the soil, there is minimal movement away from the initial fertilizer placement site.

Fertilization is generally recommended when these soil test P extract methods show:

- Olsen test < 10 ppm (best used in soils with high soil $CaCO_3$)
- Bray test < 30 ppm (not recommended for pH > 7.6)
- Mehlich III
  - < 50 ppm Texas A&M-ICP
  - many other labs use this extract
- P_2O_5 fertilizer recommendation rates depend upon lab, method and soil test calibration data. For Texas A&M AgriLife Extension recommendations, see the table below.

Placement to get the most from P fertilizers:

- Concentrating highly soluble ammonium phosphates in bands will extend solubility in soil.
- Band where possible as banding P fertilizer is more efficient than broadcasting. This is because the calcium carbonates in our soils bind or "fix" most of the P (as calcium phosphate) when it is broadcasted (incorporation does not help). Knife into the soil away from seeding zone.
- *The Texas A&M AgriLife Extension Service Lab suggests: "P fertilizer rates can be reduced by 40-50% if banded using 4 inch x 4 inch (4 inches to the side x 4 and inches deep) or 6x6 inch placement from seed."*

Texas A&M AgriLife P_2O_5/Acre Rate Recommendations

Scenario	---------- ppm Mehlich III P by ICP ----------					
	0	10	20	30	40	50
1 bale/acre (dryland)	55	40	30	20	10	0
2 bales/acre	105	80	60	40	20	0
3 bales/acre	120	95	70	45	20	0
4 bales/acre	130	100	75	50	25	0

Source: http://soiltesting.tamu.edu/webpages/recommendations.html

Potassium

Potassium (K) is taken up by plants as the K^+ ion, and it is considered immobile in the soil, but it typically has somewhat higher mobility than P, and much less than nitrate-N.

- Bolls are major sinks for K, and uptake may peak at an excess of 3 lbs K_2O/acre/day during boll development.
- A very high percentage of total K uptake occurs after first bloom.
- K deficiency negatively affects quality (micronaire, length, and strength).
- Many times, K soil tests indicate adequate amounts for cotton in our region.
- However, certain exceptions noted are intensively managed sandy soils with high yields (high capacity pivots and drip).
- Fertilization is generally recommended for a soil test level < 125 ppm extractable K. For Texas A&M AgriLife Extension Service recommendations, see the table below.
- *Currently there is discussion of raising the K soil test critical value above 125 ppm due to various issues. These include newer varieties that produce exceptionally high yields. Sometimes deficiency symptoms are found in fields with high soil test K values – but many times this is when compromised root systems are encountered.*

Texas A&M AgriLife K_2O/Acre Rate Recommendations

Scenario	---------- ppm Mehlich III K by ICP ----------					
	0	30	60	90	120	150
1 bale/acre (dryland)	30	20	15	5	0	0
2 bales/acre	120	90	60	30	0	0
3 bales/acre	150	120	90	60	30	0
4 bales/acre	150	120	90	60	30	0

Source: http://soiltesting.tamu.edu/webpages/recommendations.html

Sulfur

Sulfate (SO_4^{-2}) is the sulfur (S) form taken up by cotton and it is mobile in soil, so it can be leached in the soil profile under the same conditions as nitrate-N.

- S requirement is related to N:S ratio, with the suggested ratio of 10-20:1 (for every 10-20 lb N, 1 lb S needed).
- About 5-15 pounds of S per acre can generally meet the needs of most crop species.
- SO_4^{-2} is mineralized from soil organic matter and crop residues.
- A considerable SO_4^{-2} concentration is many times found in irrigation water and can be credited against the S requirement. This is often overlooked by growers.
- Severe deficiencies are not generally encountered in our region, but are more likely to occur in sandy soils that have high production and where leaching may occur.

Zinc

Zn^{+2} is the zinc (Zn) form taken up by plants and it is immobile in the soil. Typically, growers who have been following a good fertilizer management program for corn should be in good shape for cotton with respect to this nutrient.

- Cotton is generally mildly sensitive to Zn deficiencies.
- Potential problem areas are:
  - sandy soils
  - cut / fill areas
  - induced deficiency by high soil P concentrations (perhaps from several years of manure or compost applications)
- Fertilization is generally recommended for a soil test level < 0.28 ppm. For Texas A&M AgriLife Extension Service recommendations, see the table below.
- If > 0.28 ppm diethylene triamine pentaacetic acid (DTPA) extractable Zn is present (Texas A&M AgriLife Extension Service) then an economic response to applied Zn fertilizer is not likely to occur.
- Based on my observations, foliar applications of Zn can successfully address deficiencies if caught early enough through visual symptomology and then confirmation by tissue testing. For best response to foliar Zn, the application should probably be made not later than the early to mid-square stage. Follow application rates suggested on the product label.

Texas A&M AgriLife
Zinc Fertilizer Recommendations

- Not dependent on yield goal
- Fertilizer rates are based on soil test Zn concentrations

DTPA Zn (ppm)	Lb Zn/acre
0 - 0.19	4
0.19 – 0.27	2
0.28+	0

Fertilizer Cost Cutting

Cutting fertilizer rates in tough years can be considered. However, it's always best to have a good soil test report in hand. This test report must come from a sample that was properly obtained, and from a lab with which you have a high comfort level. Good sampling technique, tracking, and reliable soil analysis are all keys to success. The grower must have faith in all steps involved.

For an excellent publication on collecting and sending soil samples to the Texas A&M AgriLife Extension lab, click on the following link:

http://soiltesting.tamu.edu/publications/E-534.pdf

Numerous publications related to soil sampling and testing are available at the Texas A&M AgriLife Extension website. To view these documents, click on the following link:

http://soiltesting.tamu.edu/webpages/publications.html

In MY OPINION the order of importance - for most fields which have had good fertilization programs over the past several years:

- N is most important (check the soil).
  - Don't cut here unless you find high residual amounts, and watch closely in corn grain/cotton rotations.
- P may be high (check the soil).
  - Cut here if soil test concentrations indicate very high amounts, or amounts close to the critical level for the soil test P extract used for your test.
- K may be high (check the soil).
  - Definitely cut here if soil test indicates very high amounts.
  - Many soils in our region have high enough K concentrations to produce high yields assuming a quality root system is developed.
- Zn (check the soil)
  - I have found some deficiencies in some fields over the years.