# Nutrient Management for Texas High Plains Cotton Production

## Soil Sampling and Testing

Soil testing is the first step in fertilizer management, for all nutrients. We recommend the following depths and scheduling of soil sampling and testing for irrigated and dryland cotton fields in the High Plains:

Table 1. Soil sampling schedule

| Soil test | Irrigated | Dryland |
|---|---|---|
| Nitrate-nitrogen (0-24 inches) | Every year | Every 2-3 years |
| Phosphorus, Potassium, and micronutrients (0- 6 inches) | Every 2-3 years | Every 2-3 years |

## Nitrogen

Nitrogen (N) is important in rapid growth and fruiting. It is contained in plant proteins and is a part of the chlorophyll molecule.

•Urea ammonium nitrate (32-0-0) is the most common liquid N fertilizer. It is convenient for fertigation in center-pivots or drip systems. If applied with a ground rig, it is best to knife-in 32-0-0. Dribbling 32-0-0 is also a sound practice, although there may be some ammonia loss. Do not spray-apply 32-0-0. Solid urea (46-0-0) is becoming more popular. Few producers have equipment to apply 46-0-0 in bands. It is best to broadcast urea just prior to re-listing beds to avoid ammonia loss, which can be substantial with 46-0-0. Alternatively, spray irrigation with a center pivot is effective in moving 46-0-0 into the soil.

•Nitrate ($NO_3^-$), a negatively charged "anion," is the main nitrogen form in soils. It is subject to leaching from heavy rain or over-irrigating.

•Soil testing for nitrate should be to a depth of 24 inches. This is because the clayey subsoils on the High Plains hold substantial amounts of nitrate.

•Indicate on the soil test form that the sample is for the 24-inch depth.

•Soil testing for other nutrients like phosphorus (P), potassium (K), and zinc (Zn), only requires the typical 6-inch sample.

Table 2 can be used to determine your N fertilizer requirements, simply: 1) choose a yield goal, 2) soil test to 24 inches for nitrate-nitrogen and multiply results in ppm by 8 to convert to lb N/ac, 3) subtract soil test value from number in column two.

Table 2. Cotton nitrogen requirements for various yield goals.

| Yield goal | Nitrogen requirement[1] |
|---|---|
| bales/acre | N/acre |
| 0.5 | 25 |
| 1.0 | 50 |
| 1.5 | 75 |
| 2.0 | 100 |
| 2.5 | 125 |
| 3.0 | 150 |
| 3.5 | 175 |
| 4.0 | 200 |

[1]Nitrogen fertilizer plus 0-24 inch soil nitrate (in lb N/acre)

*Example*: A 0-24 inch soil test nitrate-nitrogen result is 3.8 ppm. Multiply this by the unit conversion factor 8 = 30 lb nitrate-nitrogen/ac. If your yield goal is 2.0 bales/acre then Table 2 says your total nitrogen requirement is 100. Subtract the soil test value as:

100 lb N/ac – 30 lb N/ac = 70 lb N fertilizer/acre needed

or from start to finish:

100 lb N/ac – (3.8 ppm X 8) = 70 lb N fertilizer/acre needed

Timing of Nitrogen Fertilizer Application

•In dryland, if you have access to a ground rig applicator that can band apply, wait until two weeks after emergence, then knife-in entire dose several inches off the seed row

using 32-0-0 (urea-ammonium nitrate) alone or with 10-34-0 (ammonium polyphosphate) if P is needed. If you have a broadcast applicator, apply urea (46-0-0) alone or with 11-52-0 (monoammonium phosphate) or 18-46-0 (diammonium phosphate) if P is needed before disking in herbicides and or re-listing operations.

•For row watering, use same strategy as above. For center pivots and subsurface drip, ground apply 30 lb N/ac pre-plant if soil test nitrate in 0-6 inches < 4 ppm, and/or heavy sorghum or other residue is present. Apply remainder of N requirement through center pivot in 30 lb N/ac doses starting at first square and no later than early bloom. For drip systems apply balance of N between first square and early bloom in daily drip irrigations.

**Phosphorus**

Phosphorus (P) is important in promoting early rooting. It is involved in plant energy storage and transfer.

•Soil test (0-6 in.) is step one

•P fertilizer (either dry 11-52-0, 18-46-0 or liquid 10-34-0) is best band-applied preplant.

•Banding P fertilizer is more efficient than broadcasting. This is because the calcium carbonates in our soils bind or "fix" most of the phosphorus (as calcium phosphate) when it is broadcasted (incorporation does not help).

•Liquid P fertilizer (either phosphoric acid or 10-34-0) can be injected into the drip system.

•10-34-0 salts out easily in "hard" (high calcium and magnesium salts) irrigation water unless acidified to pH 6.0 (it is best to acidify with urea/sulfuric acid mix like N-pHURIC). However, we do not routinely recommend this practice.

•Before deciding to acidify a drip or center-pivot irrigation system and fertilize at the same time with phosphoric acid, consider that phosphoric acid is twice the cost of 10-34-0 in $ per lb of $P_2O_5$.

•Table 3 shows P fertilizer rates for various soil test values and extracts. This approach does not depend on yield goal, or whether cotton is dryland or irrigated. The Bray P extract is not appropriate where soil pH > 7.6. Mehlich 3 or Olsen is the best soil test P extract for West Texas. Although we recommend soil sampling
and testing for P every 2-3 years (because soil test P doesn't change rapidly like nitrate-nitrogen does), you should P fertilize every year according to the table below.

Table 3. Phosphorus fertilizer rates based on soil test values.

| Mehlich 3 | Olsen | P fertilizer rate |
|---|---|---|
| ---------- ppm ---------- | | lb $P_2O_5$/ac |
| 0 –5 | 0 – 2.5 | 100 |
| 5 – 10 | 2.5 – 5.0 | 90 |
| 10 – 20 | 5.0 – 10.0 | 70 |
| 20 – 30 | 10 – 15 | 50 |
| 30 – 40 | 15 – 20 | 30 |
| 40+ | 20+ | 0 |

For maintenance of adequate soil test P levels, 30 lb $P_2O_5$/ac can be applied for Mehlich 3 tests of 30-40 ppm (15-20 ppm Olsen P). This may not be an economical practice for dryland farms. It is not necessary to apply P if Mehlich 3 P is > 40 ppm (20 ppm Olsen P). Adjust your P program every 2-3 years based on soil sampling and testing.

**Potassium**

Potassium (K) is important in plant water relations, energy relations, and in enzyme activation.

•Generally one does not need to apply fertilizer K where the soil test K is > 150 ppm. Adequate soil test K (> 150 ppm) is common in West Texas (and western USA). One could consider maintenance fertilizer K applications of 30-40 lb $K_2O$/ac if soil test K is between 150 and 200 ppm K. High-yield producers (e.g. subsurface drip) can adopt the "replacement philosophy" of adding as much K as they remove in cottonseed (about 1.8 % $K_2O$) to avoid long-term "K mining" if soil test K is between 150 and 200 ppm. We do not recommend maintenance or replacement K fertilizer applications if soil test K > 200 ppm. Cotton burrs are high in K (about 2.5 % $K_2O$), and therefore "burr extractors" on stripper harvesters help maintain K soil fertility

•Potassium chloride (KCl) (0-0-63) is the most common K fertilizer. It mixes with water for fertigation or ground application.

•Potassium hydroxide (KOH), or caustic potash (0-0-37) a caustic liquid, or potassium thiosulfate ($K_2S_2O_3$) can be used for high chloride ($Cl^-$) irrigation water

**Zinc**

Zinc (Zn) is important in plant enzymes, which catalyze reactions.

•Soil testing from 0-6 inches is step one. Zinc is not needed when soil > 0.28 ppm Zn.

•Zn fertilizer comes in liquid chelates (eg. 10 % Zn as Zn-EDTA) or dry zinc sulfate ($ZnSO_4.H_2O$, 34 % Zn) .

•Chelated Zn stays more available to plants as the calcium carbonate in our soils "fixes" Zn from Zn sulfate. ("Chelate" is Greek for "claw" and describes a ring structure with the Zn ion bonded in the center).

•Zn-EDTA mixes easily with either 32-0-0 or 10-34-0 (same caution for 10-34-0 in hard irrigation water).

•Therefore Zn-EDTA can be banded pre-plant with 10-34-0 or injected in-season with 32-0-0.

•$ZnSO_4.H_2O$ is cheaper than Zn-EDTA (but is fixed by $CaCO_3$ in our soils). •The following table shows Zn fertilizer recommendations (not dependent on yield goal).

Table 4. Zinc fertilizer rates based on soil test zinc concentrations.

| DTPA Zn ppm | lb Zn/ac |
|---|---|
| 0 – 0.19 | 4 |
| 0.19 – 0.28 | 2 |
| 0.28 + | 0 |

**Sulfur**

Sulfur (S) is an important component of many plant amino acids.

•S plant requirements are 1/20 of N requirements.

•Atmospheric S deposition onto West Texas soils is decreasing as coal-fired power plants "clean up." Therefore S soil fertility may become more of an issue.

•The main form in soil is the sulfate anion ($SO_4^{=}$). It is common in West Texas soils as part of calcium and magnesium sulfate.

•Sulfate is generally low in sandy surface soils, but accumulates in our clayey subsoils, like nitrate does. To soil test for sulfate therefore, you should request this analysis on the 24-inch samples you take for nitrate-nitrogen.

•The only soils in West Texas that might need S fertilization are deep sands (eg. Tivoli soil) or the Brownfield loamy sand soils that have 20 inch sandy surface horizons.

•Solid S sources are ammonium sulfate (dry) (21-0-0-24S), gypsum (calcium sulfate, $CaSO_4$-$H_2O$ is 16 – 18 % S), sulfuric acid ($H_2SO_4$), urea-$H_2SO_4$ liquid (N-pHURIC).

•Potassium thiosulfate, $K_2S_2O_3$ (0-0-25-17S), and ammonium thiosulfate $(NH_4)_2S_2O_3$ (12-0-0-26S) are fluid S sources.

For more information contact:
Kevin Bronson, Professor of Soil Fertility and Nutrient Management
(Phone: 806-747-4013, email: k-bronson@tamu.edu)
Randy Boman, Professor Extension Agronomist-Cotton
(Phone: 806-746-4049, email: r-boman@tamu.edu).

Revised, February, 2009