Inorganic Nutrient Management for Cotton Production in Mississippi

MISSISSIPPI STATE UNIVERSITY EXTENSION

Lime and fertilizer management are significant costs in cotton production. Consider these five points in making your nutrient management decisions:

1. What nutrients do you need?
2. How much of each nutrient do you need?
3. What source of fertilizer should you use?
4. How should they be applied?
5. When should they be applied?

Soil Testing

Lime, phosphorus, and potassium requirements and rates are best determined by soil testing. It is a cost-effective best management practice. Samples must be properly collected in order to yield accurate results and recommendations. Information on soil sampling is available in MSU Extension Information Sheet 346 *Soil Testing for the Farmer*.

It is best to collect soil samples in the fall. Collecting samples and getting results in the fall allows time to plan and implement a proper soil fertility program for each field. Fall sampling and lime application also allows time for the lime to react fully with the soil and produce optimum pH changes before the growing season.

Lime

Cotton grows best in soil with a pH between 5.8 and 7.0. Yield decreases usually are not severe until the soil pH drops below 5.5 on sandy loam and silt loam soils and below 5.2 on clay loam soils.

When the soil pH falls below these levels, lime is recommended. For best results, incorporate lime into the soil several months before planting. Lime is beneficial when applied anytime before planting, but it is most effective 5 to 6 months after application.

Two types of hard limestone are widely available in Mississippi. Calcitic limestone, or calcite, is calcareous rock made of calcium carbonate. Dolomitic limestone, or dolomite, is calcareous rock containing both calcium and magnesium carbonates, and it has at least 6 percent magnesium content. A softer material mined within the state, "marl" (or "chalk") is granular or loosely consolidated earthy material that is largely composed of sea shell fragments and calcium carbonate. Where soil test levels of magnesium are low or medium, consider using dolomitic lime. Where soil test levels of magnesium are high, base your choice of lime on price and availability.

Limestone's properties differ considerably, and these differences influence its ability to neutralize soil acidity. Effectiveness depends on the purity of the liming material and how finely it is ground. Purity is assessed by calcium carbonate equivalent (CCE) ratings. Pure calcitic limestone has a CCE of 100. Lime is not soluble in water, so particles must be finely ground to neutralize soil acidity in a reasonable time. Time required for dissolving individual limestone particles increases dramatically with relatively small increases in the diameter of the particle.

Each quarry selling lime in Mississippi submits samples annually for CCE and particle size analysis to the Mississippi State Chemical Laboratory for registration with the Bureau of Plant Industry. Since 2006, lime vendors are required to provide buyers with a calculated relative neutralizing value (RNV) based on this analysis. Recommended application rates should be adjusted to reflect the RNV of the material applied. More information on RNV is available in Extension Information Sheet 1587 *Agricultural Limestone's Neutralizing Value*.

Nitrogen

Nitrogen fertilization of cotton involves a variety of factors, including yield potential, soil type, weather, sources of nitrogen, and timing of application.

Nitrogen fertilizer rates vary from farm to farm and from field to field within a farm. Nitrogen application rates on cotton should be based on yield potential, history of rank growth in a field, soil type, and level of management.

As a general guideline, approximately 50 to 60 pounds of nitrogen fertilizer are needed to produce a bale of cotton on light-textured soils; 60 to 70 pounds of nitrogen fertilizer are needed to produce a bale of cotton on medium-textured soils; and 70 to 80 pounds of nitrogen are needed to produce a bale of cotton on clay and clay-loam soils. If a medium-textured soil (CEC = 15) has a yield potential of two bales per acre, 120 to140 pounds of actual nitrogen should be applied per planted acre. The general recommendation in Mississippi is not to credit residual soil nitrogen (and reduce nitrogen application rates to the subsequent crop) following soybean production.

Weather, particularly rainfall amount and timing, influences the efficiency of applied nitrogen fertilizers. Nitrogen losses can occur through leaching and denitrification. Nitrogen loss by leaching occurs when water moves nitrogen downward in the soil profile by water and possibly out of the effective rooting zone. Denitrification occurs in water-saturated soils where bacteria break down nitrate and release the nitrogen into the atmosphere as nitrogen gas. Heavy and prolonged periods of rainfall can result in severe nitrogen losses and require additional nitrogen applications to correct potential deficiencies.

All sources of nitrogen are considered equal in their ability to provide nitrogen to cotton. No one form or source of nitrogen is better than another if applied correctly. Base your nitrogen choices on price, availability, and ease of application.

Solid urea requires special consideration when applications are made to cotton. If you apply dry urea to the soil surface in hot, dry weather, the rate of nitrogen loss can be high unless it is incorporated into the soil by tillage, rainfall, or irrigation within 2 to 3 days. If urea is incorporated into the soil by any of these methods within 2 to 3 days or if the temperature is less than 75°F, losses are minimal. When left on the soil surface during midsummer for 5 to 7 days, 50 percent or more of the nitrogen within the urea can be lost in the most severe cases. Losses of more than 30 percent in these situations are more common. Some commercial products slow the rate of urea volatilization and may apply in some situations.

Nitrogen application rates greater than 100 pounds of actual nitrogen per acre should be split to reduce danger of salt damage. Splits of one-half preplant, one-half sidedress, or two-thirds preplant, one-third sidedress can be used, depending on the situation. But note that daily use rate of nitrogen is relatively low until squaring. During square set, daily use rates of nitrogen increase and maximize during bloom and boll fill (if there is adequate moisture available for uptake and respiration). Split nitrogen applications are designed to provide adequate nitrogen to meet crop demands, depending on physiological requirements.

Another option for irrigated cotton is to apply one-third of the total nitrogen at planting, one-third at late square-early bloom, and one-third at near-peak bloom. This late application must be aerially applied and used only where irrigation is available.

If you plan to use less than 100 pounds nitrogen per acre, applying all desired nitrogen preplant is as effective as split applications in most cases. Rates greater than 100 pounds nitrogen per acre should be split between preplant, with the remainder applied between first square and first bloom. Where preplant nitrogen is applied, broadcast before rows are formed; apply no more than 40 pounds of actual nitrogen because of potential for salt injury. Apply the remainder as a sidedress.

Avoid applying excess nitrogen because of increased cost, potential for delayed maturity, increased attractiveness to insect pests, and increased potential for hardlock and boll rot incidence.

Potassium

Potassium is essential in the growth and development of the cotton plant. It is essential for many of the enzyme systems in the plant, plays a role in reducing the incidence and severity of wilt disease, increases water efficiency, affects the speed of almost all plant biological systems, and affects fiber properties such as micronaire, length, and strength. Uptake of potassium increases during early boll set, with some 70 percent of total uptake occurring after first bloom.

Potassium deficiency symptoms are often confused with various disease symptoms, since K-deficient plants have more susceptibility to various diseases. Researchers (Raja et al, 2000) traced the progress of potassium deficiency in cotton in the absence of disease organisms as follows:

- early evidence is downward curling or cupping of upper leaves;
- mild mottling followed by severe interveinal chlorosis;
- necrotic areas at leaf margins appeared in extremely low K conditions after an extended period; and
- severely deficient leaves have nearly yellow interveinal areas with pale green veins, and often have brown margins.

The most common source of potassium is muriate of potash (0-0-60). Other sources include potassium sulfate and potassium nitrate.

Follow Mississippi State University Extension Service soil test recommendations where yield potential is less than two bales per acre. If a field has a realistic yield goal of two bales or more, increase the potash rates by 50 percent over the recommendation given by the Extension Service Soil Testing Laboratory.

In some areas of the Delta bordering the brown loam hills, some soils have historically tested low in potassium, regardless of past use rates. Cotton grown on these soils tends to have wilt problems or problems with premature cutout and premature leaf senescence. Increasing potassium application rates by an additional 50 percent over and above Extension soil test recommendations and splitting material into two applications may be beneficial.

Phosphorus

Phosphorus uptake is most critical early in the growing season because it is necessary to stimulate early root development and early fruiting. The presence of phosphorus is essential for such processes as photosynthesis, synthesis and break down of carbohydrates, and transfer of energy in the plant. It is involved in cell division and transfer of hereditary characteristics. Phosphorus stimulates blooming, promotes seed formation, and is the primary form of stored energy in the seed. Phosphorus also hastens maturity in some cases.

Phosphorus deficiency in cotton is characterized by leaves that are reduced in size but remain dark green. The most striking symptom of phosphorus deficiency is decidedly dwarfed plants within a given area. Delayed fruiting and maturity may also occur in cotton suffering from phosphorus deficiency.

Determine phosphorus needs by soil testing. Phosphorus can be broadcast in the fall if the soil pH is between 6.0 and 7.0, and the CEC is greater than 8. If the pH is outside this range, apply phosphorus as close to planting as possible.

Sulfur

Sulfur deficiencies have become more common as atmospheric deposition of S has decreased in recent years. Sulfur deficiency is sometimes observed on sandy soils with low organic matter levels. Sulfur deficiencies look much like nitrogen deficiencies being characterized by pale-green leaves on the upper part of the plant. But sulfur deficiency appears on new growth first; whereas nitrogen deficiency appears on older leaves first.

Mississippi State University Extension specialists recommend 8 to 12 pounds of sulfur per acre annually in the hill section of the state and in the Delta section that borders the hills. Sulfur deficiencies are less common in the western Delta but may be found in very sandy soils with low organic matter.

Soil test reports from the Extension Soil Testing Laboratory contain an estimated sulfur level based on soil organic matter levels. The laboratory does not perform a chemical test for sulfur. So if the organic matter is very low, the sulfur level reported will be low even if you have been applying large amounts of sulfur fertilizer.

Sulfur must be in the sulfate form for plants to use it. Some common sources of sulfur are granulated fertilizers containing sulfur, ammonium sulfate, ammonium thiosulfate (12-0-0-26), liquid nitrogen with sulfur (28-0-0-4 or 28-0-0-5), and gypsum. Use the sulfur source that is cheapest and most convenient.

Boron

Boron is required in only trace amounts and plays an important role in the reproductive process of the cotton plant. Boron also influences conversion of nitrogen and carbohydrates into more complex substances such as protein, affects the transfer of sugars within the plant, exerts marked influence on cell division, and aids in the formation of certain membranes.

Boron-deficiency symptoms frequently appear in the terminal growth of the plant first. The terminal bud often dies, resulting in development of many lateral branches. Young leaves of boron-deficient cotton are yellowish-green. In addition, flower buds become chlorotic, and bracts flare open. Many of the fruiting forms become dried out and may be shed from the plant. Bolls that survive often are deformed, presenting a flat-sided or hook-billed appearance. (Heat damage may cause this same symptom.) A dark discoloration may also appear inside the boll and boll petioles.

Boron deficiencies are usually found in sandy soils with low organic matter, particularly for 1 to 2 years after liming. MSU Extension specialists recommend one-third to one-half pound boron annually in the hill section of the state and in the Delta section that borders the hills.

Boron probably won't provide a yield increase for cotton grown on heavier soils or soils that have more than 1.5 percent organic matter.

Common forms of boron fertilizer include granulated fertilizer containing boron, borax (11 percent boron), sodium tetraborate (14 to 20 percent boron), and solubor (20 percent boron).

Boron may be soil-applied or foliar-applied. All forms of boron fertilizer listed previously are equal in value if soil applied. Apply boron at one-third to one-half pound actual boron per acre.

Other Micronutrients

There is no reason at this time to expect positive yield responses following iron, copper, manganese, zinc, or other combinations of nonrecommended micronutrient applications. These mixtures can be expensive, and research has not shown any positive yield responses on cotton in Mississippi to nutrients other than nitrogen, phosphorus, potassium, magnesium (where soil test is low or medium), sulfur (where needed), and boron (where needed).

References

Reddy K.R., Hodges H.F., Varco J.J. (2000). Potassium nutrition of cotton. Mississippi Agriculture and Forestry Experiment Station Bulletin 1094. Mississippi State, MS. pp. 10.

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