MANAGING COTTON NUTRITION

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While the cotton industry relies on large inputs of Nitrogen fertilizer, most growers are confident that their management of this input is satisfactory. Even so, substantial improvement can often be made on the most efficient of farms. Also, many growers are now becoming more aware of other nutritional problems. Increasingly, phosphorus, potassium and soil sodicity are creating concern for growers.

Some of these problems have been created over a long period of time and hence identification and awareness of impending problems is imperative before they can be addressed. Often, the solution is not immediate. Hence, monitoring the availability of nutrients in the soil is critical, as is monitoring of nutrient uptake by the crop using leaf analysis. This will provide data to ensure deficiencies are recognised before they affect productivity and longer-term problems (eg soil sodicity) are addressed.

The NUTRIpak manual was published in 2001 and delivers a detailed coverage and background to nutritional problems encountered in cotton production. It can be used to help interpret laboratory analysis to determine deficiencies, toxicities and imbalances between nutrients. The most important issues related to cotton nutrition are summarised below.

Nutrition problems commonly observed in cotton crops

Zinc (Zn) is commonly a problem in alkaline soils. Zinc concentrations less that 0.4 mg/kg (DTPA test) in the soil or 20 mg/kg (ppm) in the leaf tissue indicate that Zn may be deficient. Annual applications of zinc sulfate can be combined with other operations (herbicide applications or cultivation).

Phosphorus (P) deficiency has been identified in many regions. Soil P levels should be above 10 ppm (Colwell bicarbonate test). For soil P between 6 and 10 ppm, a maintenance application of 20 kg P/ha should made prior to each cotton crop. For soil P concentrations below 6 ppm, apply 40 kg P/ha to increase P levels. Ideally, leaf P levels should be greater than 0.3%. P deficiency is indicated by dark green foliage early in the season, but leaves may turn purplish as the bolls mature.

Potassium (K) deficiency is becoming more widespread in the cotton industry. Potassium nutrition of cotton has been researched for some time now but research is continuing to examine interactions with other nutrients and to better understand the K cycle. While the vast majority of cotton soils indicate adequate levels of K from testing (ie greater than 0.4 meq K/100g soil or 150 ppm), the majority of cotton crops grown on these soils during the 2001/2002 season displayed symptoms of K deficiency, particularly at the end of the season. It is often worthwhile to determine the relative abundance of K, relative to the other cations in the soil. Simply divide the K concentration (meq/100g) by the cation exchange capacity (CEC) and multiply by 100 to give a percentage. Ideally, K should occupy 5-6% of the CEC. In reality, cotton soils which rarely show K deficiency contain about 4% K, while fields low in K and showing K deficiency symptoms with every crop can have levels less than 1% of the CEC. Concentrations in the soil maybe well over the critical value mentioned above. Further, many cotton-growing soils are also high in magnesium; levels higher than 10% of CEC can interfere with K nutrition. High levels of sodium have a similar effect.

Symptoms of K deficiency appear as yellowing of leaves followed by dead spots between the leaf veins and margins; leaves may also appear rusted or bronzed. Later in the season, K deficiency may resemble P deficiency, with dark red/purplish leaves. It is therefore difficult to distinguish between P and K deficiencies in cotton late in the season. There is an interaction between these two nutrients; low concentrations of one will usually concur with low levels of the other in the plant and vice versa (see Fig. 1 below).

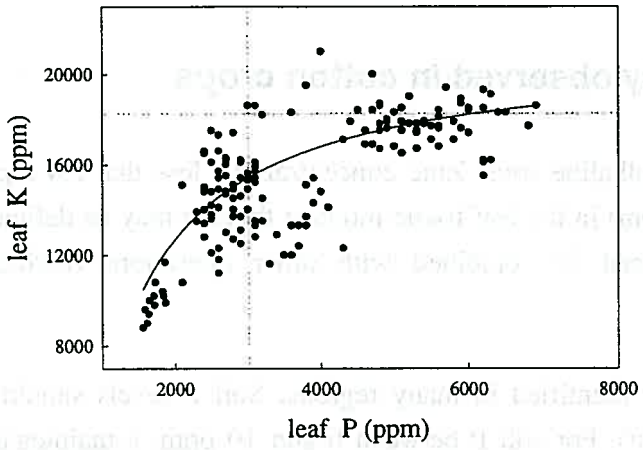

Fig. 1. The relationship between Phosphorus (P) and Potassium (K) observed in cotton leaves collected between squaring and flowering

The concentration of potassium in cotton leaves declines during the season. Cotton growing in soils of high K-fertility generally has values in excess of 18,000 ppm (1.8% K) and decline to values of greater than 10,000 ppm (1% K) at the end of the season (see Fig. 2).

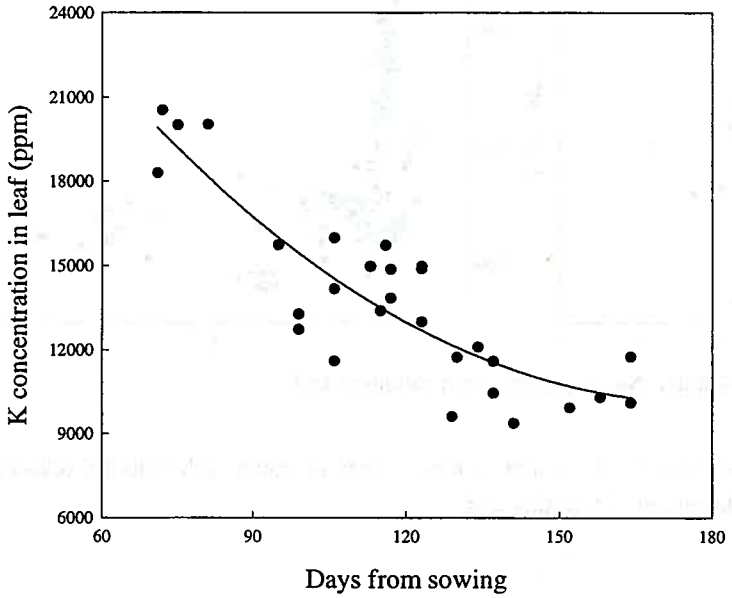

Fig. 2. Potassium (K) concentration in the youngest mature leaf of cotton declines over time, even in crops well supplied with potassium.

Sodium (Na) is excessive in many of our soils. High levels of sodium reduce plant growth through impaired soil structure and interactions with nutrients. High levels of sodium in the subsoil help reduce rates of water movement through the soil profile, but sodium can impede root growth.

Where sodium exceeds 4% of the cations in cotton leaves, P and K concentration is depressed. The percentage of cations as sodium in the leaves roughly corresponds with the soil ESP (ie percentage of cations as sodium found in the soil). So moderate amounts of soil sodium can have a significant bearing on P and K and other nutrients (Fig. 3).

Remediation of highly sodic soils has traditionally been through the displacement of sodium with calcium by applying high rates of gypsum (and/or lime). Managing crop stubble, tillage, rotation crops and fallows to maintain and hopefully improve soil organic matter content can help to reduce the effects of high sodium levels in the soil. Some crops (particularly legumes) are more sensitive to sodium than cotton and will not thrive under these conditions.

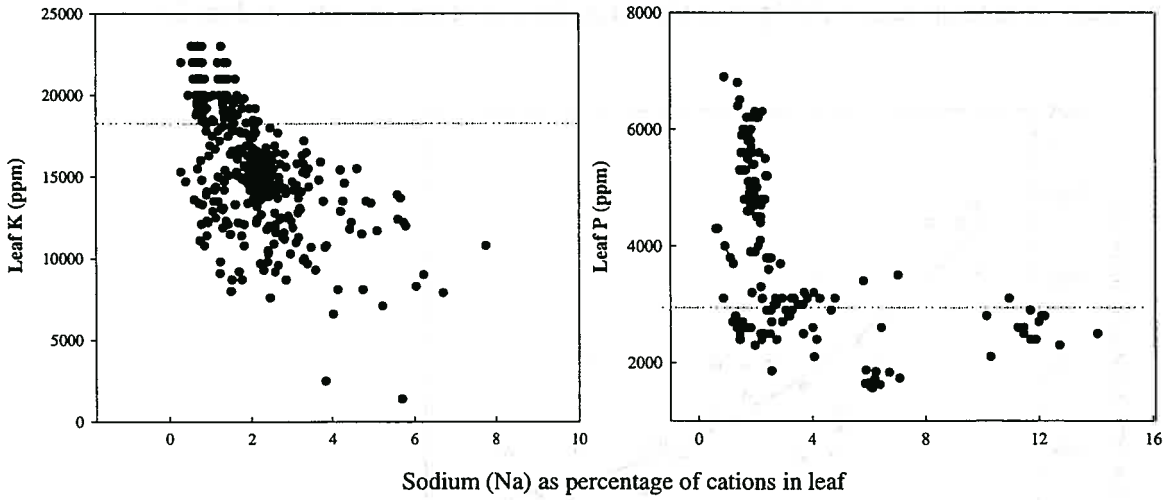

Fig. 3. Increasing concentration of sodium in the youngest mature leaf of cotton substantially reduces the concentrations of potassium (K) and phosphorus (P) in that leaf.

Nitrogen nutrition is generally well understood by most growers. There are a few points to remember:

- Nitrogen fertilizer is used more efficiently when applied a few weeks prior to sowing and especially prior to flowering
- Broadcast N fertilizers must be incorporated quickly or watered in
- Much N fertilizer is lost through denitrification, especially under prolong waterlogging
- Water-run urea (not anhydrous ammonia) is an effective means of applying N
- N fertilizer rates can be more accurately determined with soil testing
- Crop N status can be monitored with leaf or petiole analyses or SPAD meters
- Following legume crops, N fertilizer requirement may be significantly reduced
- Over fertilizing with N is inefficient (delayed maturity, defoliation difficulties, waste of fertilizer, increase in disease (boll rot), rank cotton producing less yield, leaf trash in lint
- Rates over 250 kg N/ha can be considered excessive – these crops are generally difficult to defoliate

Identification of nutritional problems in cotton

Soil testing

Soil testing is one means of assessing the chemical fertility of the soil. Soil is normally collected during the autumn/winter prior to sowing. Where soil nitrate analysis is required to determine N fertilizer requirement of a field, soil can be collected up to three months prior to sowing cotton; this must be from an unfertilised area for irrigated cotton. Sampling from 0 to 30 cm depth is fine, as this allows several cores to be bulked and subsampled after careful mixing. Deeper soil sampling will give an indication of nutrient concentrations in the subsoil, especially for dryland systems, as well as factors that may impede root growth (eg sodicity). The NutriLOGIC program (in CottonLOGIC) can be used to indicate the optimum N fertilizer rate required to maximise lint yield in most situations, using soil nitrate concentration. The program takes account of soil type and time of soil sampling. It can also be used to interpret petiole nitrate analyses. These procedures are explained in detail in NUTRIpak.

Plant tissue testing

Leaf analysis can be used to indicate crop nutrition problems. Leaf analysis can be particularly useful for diagnosing deficiencies of micronutrients (eg zinc, boron, iron) as the plant normally concentrates these nutrients far in excess of the levels determined the soil analyses, making detection and prediction of deficiency or excess easier. The youngest mature leaf (normally the fifth unfurled leaf from the top of the plant) is collected and either dried at low temperature or dispatched to a laboratory quickly. Appropriate levels of nutrients are given in NUTRIpak. Nitrogen and potassium levels decline through the season

Petiole nitrate analysis can be a reliable means of indicating crop N nutrition, and indicate where further N application is required. At least 50 petioles are collected from the youngest mature leaf from an area within a field – weekly petiole collections will indicate the rate of decline in petiole nitrate, starting at squaring. Petiole nitrate levels fluctuate and are affected by environmental stresses (eg cold shock or waterlogging/drought). The NutriLOGIC program will indicate whether further N fertilizer is required.

SPAD meter. These instruments measure the green colour of leaves, which is related to its N content. The meter is clamped over each leaf (youngest mature leaf) to be measured and the mean of 30 readings recorded. As with petiole nitrate sampling, several readings taken over 2-3 weeks will give a better indication of crop N status. Calibration of this meter is continuing and variation between cotton varieties has been researched. Because growth regulators

preclude the use of these meters, as they tend to thicken and darken leaves. This technology will enable N fertilizer management decisions to be made in the field, without the need for sample collection and laboratory analysis.

Do your own trial

Having identified a potential nutritional problem, you may want to investigate whether application of that nutrient as a fertilizer will overcome the problem. If low levels of a particular nutrient are identified, a marginal deficiency may be assessed using a strip trial. Simply apply a fertilizer containing the nutrient in strips leaving untreated (control) areas between them, making sure to record where these strips have been placed.

Where more serious deficiency problems are identified, whole fields should be treated and a small control (untreated) area left to assess the effect of the fertilizer. In this situation, it is be easy to assess if doubling the rate of the fertilizer has an additional benefit, simply by traveling over the same area twice with the fertilizer rig, again noting where these treatments have been installed.

Many growers should be experimenting strip trials of phosphorus and potassium fertilizers, as these nutrients appear marginal to highly deficient in soil and plant tissue tests from all cotton-growing regions.

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