SOIL FERTILITY MANAGEMENT and COTTON NUTRITION

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Growers need to monitor soil and plant nutrient status, on a field-by field basis in order to manage soil fertility and avoid nutritional stress to their cotton crops. By regular soil and plant tissue testing, they can build a substantial bank of data to assist in managing soil fertility and planning a fertiliser program where this is required.

Only in this way will growers be able to identify soil problems (eg high pH, low organic matter, high sodicity (ESP) salinity (EC) or chloride) that can limit production. Similarly, regular analysis of leaf blades can help identify nutrient imbalances, deficiencies and toxicities in a more precise way than soil testing.

Soil analysis

Sampling is best done from May to August. Depth is important. 0-30 cm depth is ideal for all nutrients, especially N, P and K, as well as salinity and sodicity indicators. Micronutrients are more accurately assessed by leaf blade analysis than soil analysis, although some indication is given by soil testing. Sampling the subsoil (30-100 cm) for ESP, EC, nitrate and chloride should be done from time to time and changes noted. Consult the NutriLOGIC program or the CRC website tool for interpretation of the nitrate results.

Petiole analysis

Sampling is best done at ~600, 750, 900 day degrees from sowing; three samplings, about 10 days apart give an indication of the rate of decrease in nitrate-N in the petioles. Remove the petiole from the 5^{th} topmost leaf. Importantly, remove the leaf blade. Petioles are ideal for monitoring nitrate-N and potassium concentrations around flowering. Of the other nutrients, petioles normally contain about half the concentrations found in the leaf blade.

Leaf analysis

Sampling at two times (flowering and cut-out) produces the most useful information. Take the blade of the fifth topmost leaf. Remove the petiole! The leaf blade is ideal for monitoring all nutrients, especially micronutrients. Nutrient concentrations may increase (eg calcium, sodium, sulfur, boron) or decrease (eg nitrate, potassium) over the season, but the critical concentration for most nutrients remains steady during the season. NUTRIpak provides the concentrations of all nutrients required for optimal growth of cotton.

Soil sodicity

Research over the past three years has indicated the importance of soil sodium (Na) upon cotton nutrition. Most of our cotton-growing soils are at least slightly sodic at their surface and sodium levels normally increase with depth. Sodium impacts on soil structural stability, such that at high exchangeable sodium percentage (ESP), soils tend to disperse, and water infiltration and drainage are slowed. Subsoil sodicity can therefore reduce deep drainage.

However, as cotton roots grow into more highly sodic soil, the crop accumulates sodium and this reduces its ability to take up important nutrients, including phosphorus (P) and potassium (K). This is shown in Figure 1 below, where high sodium concentrations in the leaf are associated with low (deficient) levels of P and K in the leaf. The horizontal lines indicate the critical levels for each nutrient. Current research is aimed to assess various ways to improve P and K uptake by cotton growing in sodic soils.

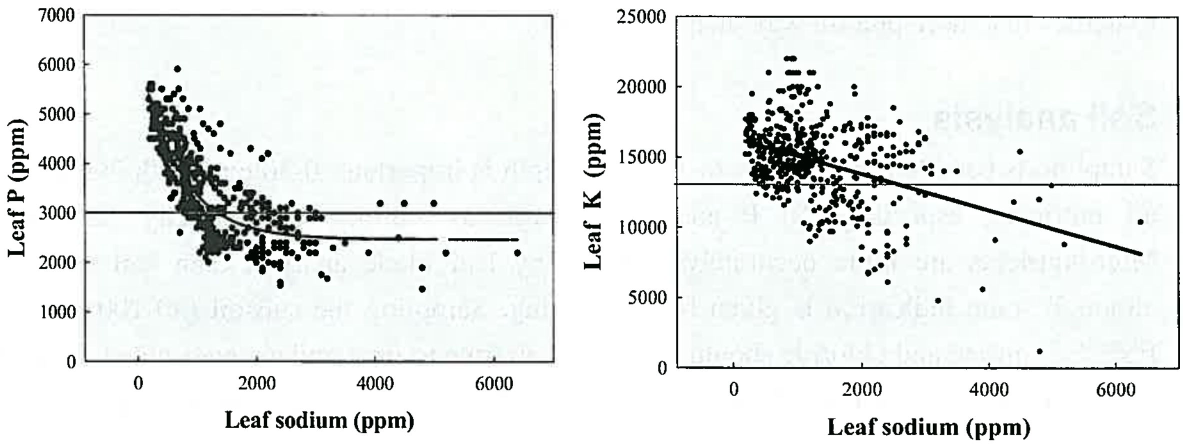

Figure 1. Deficiencies of P and K are often associated with high levels of sodium uptake.

How to identify potential sodicity problems:

High soil sodium can pose a major limitation to cotton nutrition. Soil testing can indicate where this is likely to occur (ie where the exchangeable sodium percentage (ESP) exceeds 6% in the surface 0-30 cm of soil). Higher sodium levels normally occur in the subsoil, but where the ESP exceeds 10%, cotton nutrition may be significantly affected.

Where cotton leaves are analysed, the sodium concentration should be less than 2000 mg/kg, but less is better. Less than 1000 mg/kg is ideal for cotton leaves and can be achieved on soils where the surface ESP is less than 5%. Most commonly, low P and/or K concentrations or deficiencies are associated with high sodium concentrations in leaves.

Nutrition of Bollgard® II cotton

Bollgard II nutrition was assessed in the 2003/04 season at ACRI (Table 1). The conventional cultivars Sicot 189, Sicot 71 and Sicot 80 were compared with the Bollgard II and Bollgard RoundupReady® versions of each cultivar.

Table 1. Comparison of Bollgard II and conventional cultivars in their capacity to take up nutrients and produce lint.

Cultivar	Dry matter (t/ha)	P uptake (kg/ha)	K uptake (kg/ha)	Na uptake (kg/ha)	Yield (b/ha)
Sicot 189	7.1	20	164	5.3	5.7 **
Sicot 289B	6.9	21	163	4.6	7.6
Sicot 289BR	8.2	22	174	8.1	7.6
Sicot 71	7.5	25	164	5.2	7.7
Sicot 71B	6.8	21	153	5.6	8.0
Sicot 71BR	6.9	20	146	3.7	8.1
Sicot 80	7.5	22	174	5.0	6.4 *
Sicot 80B	7.7	25	167	4.7	7.6
Sicot 80BR	8.1	24	170	6.2	7.3
lsd	*ns*	*ns*	*ns*	*1.8*	*0.8*

While Sicot 189 and Sicot 80 yielded significantly less than Sicot 71 and the transgenic lines, there was no significant difference in crop growth (DM), nitrogen (not reported), phosphorus or potassium uptake between the nine cultivars. Importantly, the highest yielding cultivar took up the least amount of sodium (Na). Bollgard should not require significantly higher amounts of N, P or K fertiliser than Ingard cotton. Growers should aim to apply sufficient fertiliser to satisfy the crop nutrient requirement and optimise yield.

Potassium

The response of Bollgard II cotton to potassium fertilisers was assessed in 2003/04 at ACRI (Table 2). Soil-applied sulfate of potash (SOP) and muriate of potash (MOP) fertilisers were applied at 200 kg K/ha presowing; foliar KNO_3 was applied at 10 kg K/ha on each of four occasions. No significant responses were evident. K uptake was adequate and petiole K was high in all treatments in mid January. The cultivar was Sicot 289BR. As with Ingard cotton, it is wise to grow Bollgard cotton on your most productive and fertile fields. So, care must be taken to ensure adequate nutrients are supplied to Bollgard cotton where nutrient status is known to be marginal or low.

Table 2. Application of various forma of potassium fertilisers did not affect Bollgard II cotton with respect to potassium uptake, lint yield or fibre quality.

	K uptake (kg/ha)	K in petiole (mg/kg)	Yield (b/ha)	Fibre quality		
				length	strength	micronaire
Control	197	62,200	8.81	1.16	31.5	5.3
Foliar KNO_3	209	-	8.97	1.16	31.0	5.2
MOP	212	61,500	9.05	1.17	32.0	5.2
SOP	182	62,000	8.69	1.15	31.0	5.3

Cropping system

The introduction of legumes into the cotton production system can make profound differences on the nutrition of cotton crops. Vetch crops grown in the fallows of traditional systems can reduce the reliance on chemical fertilisers by making nutrients more available in the soil. Soil fertility is improved and soil organic matter increased. Hence, the cotton crops grown under this system are better able to take up nutrients (Table 3), and therefore, have the potential to produce more lint.

Table 3. Significantly greater uptake (kg/ha) of major nutrients by cotton was observed growing in systems that rely on the use of vetch crops that are green manured prior to sowing cotton compared with those that rely on winter fallows.

Nutrient	Winter fallow	Vetch	% increase
N	126	164	30
P	19	22	16
K	114	130	14
Ca	127	148	17
Mg	30	36	20
S	35	40	14

Two recent publications further describe the benefits of rotating cotton with legumes:

Ian Rochester, Grant Roberts, Mark Peoples, David Kelly and David Nehl 2001 The benefits of vetch cropping in cotton systems. *Australian cottongrower* 22(6), 22-27.

Ian Rochester 2004 Vetch improves the productivity of irrigated cotton. *Australian cottongrower* (April-May) Vol 25(2) pp 58-61.