Cotton Catchment Communities CRC
Queensland Government

COTTON *TALES*

Central Queensland

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2010/11
No.4
06/10/10

Nutrient Uptake

By Duncan Weir; Thanks to Phil Moody, DERM

There is little crop demand for nutrients until about 1 month after sowing. During this establishment period, soil water in the surface 10cm is likely to be adequate for active root growth, & starter fertiliser will be available for crop uptake. However, as the season progresses, the surface soil dries out, & most root activity will be in the 10-30cm zone. As the plants grow & develop, nutrient demand accelerates. This demand must be met by high uptake rates through the root system.

Plants absorb water through their root cell walls & cell membranes. There are specific sites where nutrient forms such as nitrate, ammonium, phosphate and potassium are bound onto "carrier" molecules & transported across the cell membrane into the cell. The absorbed nutrients are then transported from cell to cell into the internal plumbing system of the plant ('xylem') where they are then transported to the stem and leaves.

Organic forms of N & P are too large to be absorbed through the root cells and must be broken down into simple forms. This occurs in the rhizosphere, the soil area immediately surrounding the root. This area has a very dense population of microorganisms. Enzymes secreted by the microorganisms and root cells break down the organic forms of nutrients into simple forms which are then available to be taken up by the plant and the microorganisms.

How do Plants Find Their Nutrients?

Plant roots grow extensively throughout the soil profile in search of water and nutrients. Root interception of nutrients accounts for only 1-2% of the total N, P, and K needed by the plant. The major processes transporting plant nutrients to the root surface are mass flow and diffusion.

Mass flow is when nutrient is swept along in the flow of water moving to the root from the soil as a result of plant demand for water. This is the main transport process for nitrate-N. Nitrate is almost entirely in the soil solution and does not interact with soil surface.

Diffusion is the movement of nutrients as a result of concentration gradients of nutrients within the soil solution. Plant uptake of nutrients lowers the concentration around the root surface. Nutrients move from the areas of higher concentration into the areas of lower concentration around the root. Diffusion is the main transport process for P (about 90%) and K (about 80%).

Implications for Nutrient Management

Mass Flow -

- Maintain high soil solution concentrations of N during periods of high crop demand by applying fertilisers in accord with crop growth. In practice this means split application of N fertilisers rather than putting it all up front.
- Enrich as much of the active rooting zone with fertiliser as possible. This may mean deep placement of N (& K) fertilisers in soils where crops need to access subsoil moisture (dryland cropping)
- Minimise the risk of nitrate loss by denitrification (e.g., maintain good drainage in the active root zone) and leaching and runoff (e.g. manage irrigation effectively by monitoring soil water status/scheduling/irrigation)

Diffusion (P and K)

- Apply fertilisers in the active rooting zone to ensure zones of high nutrient concentration. This may mean deep placement of P & K fertilisers in soils where crops need to access subsoil moisture. In Vertosols (cracking clay soils) P uptake will be more efficient from spreading and incorporation or multiple bands rather than a single band per row, simply because more roots will have access to nutrient-enriched soil.
- Maximise the opportunity for root systems to become mycorrhizal by minimum tillage and not having long bare fallows
- Maximise the opportunity for roots to encounter residual fertiliser bands by adopting GPS guidance and off-setting the position of fresh fertiliser bands from previous bands.

Wet spring

Given the unusually wet spring there are some additional issues that should be considered:

- With each rain event it is possible that highly mobile nutrients such as N & S have been leached. The amount of leaching is difficult to estimate however it should not necessarily be assumed that additional fertilizer will be required. If the majority of fertilizer has already been applied, monitoring nutrition through leaf analysis at key times during the season will help detect deficiencies. Cotton CRC website has fact sheets on tissue testing and Nutrilogic can help with interpretation.
- Improved prices & planting moisture may tempt growers into fields not originally marked for cotton. Consider previous crop history including previous use of residuals. Cotton CRC has an interesting new publication on the hidden cost of residuals.
- Compacted or smeared soils prevent the exploration of plant roots in the soils & hence the plants ability to access nutrients & moisture. Timing of planting and planter setup should account for this risk.

The new 2010 Australian Cotton Production Manual has some great tips on planting in the Crop establishment chapter (p35-39), including planter set up, planting depth and tips for planting on rain moisture. Haven't got a copy? Access this document via the Cotton CRC website or contact Susan Maas.