

ADVANCES IN NUTRIENT MANAGEMENT

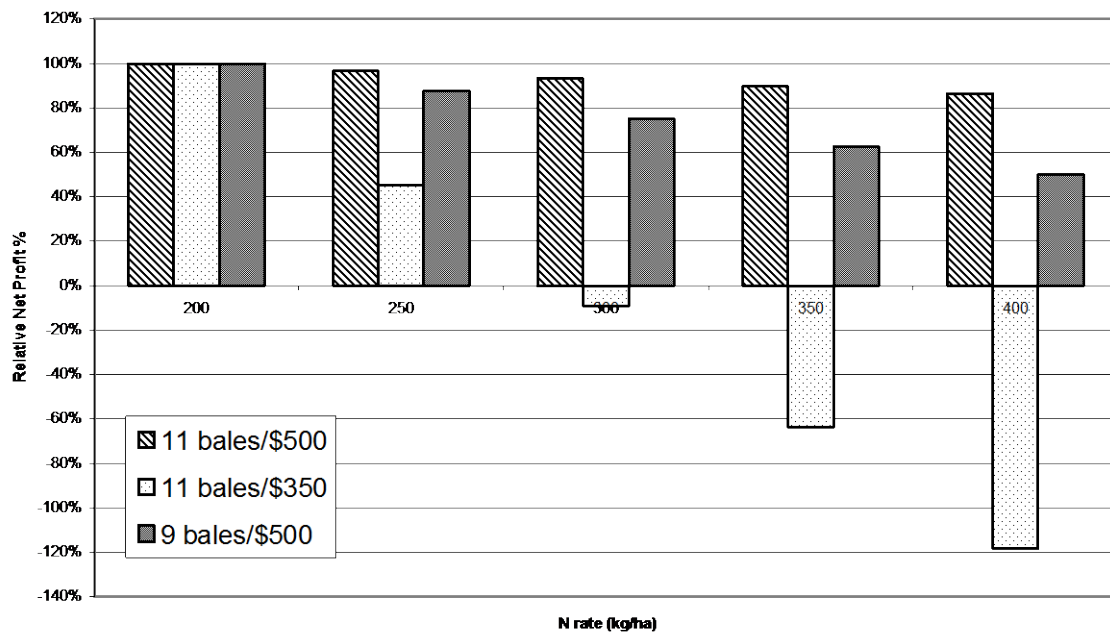
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With the recent stepwise increase in cotton yield, it is timely to reflect on the possible implications of this gain, in particular, on crop nutrition and soil fertility, and nutrient use efficiency.

Achievable paddock yields now frequently overreach the science and yields upon which our current crop nutrition practices are based. To date managing high yield cotton has been done with a lack of verifiable evidence based strategies but more based on seasonal tactics. In the current atmosphere of high yield expectations, increasing nutrient prices, and varying cotton prices, continuation of the increasing nutrient addition approach poses risks both to the stability of production and the environment. Increasing rates of nutrients applied must be done in a considered and balance approach with nutrient use efficiency keeping pace with increasing yield. A large divergence in this relationship can be an early symptom of increase environmental risk and potential increase in volatility of production economics (Fig 1).

Figure 1 Effect of N rate, lint yield and crop price on relative profitability in irrigated cotton.



(Based on N price 120c/kgN, other variable costs \$2500/ha and fixed cost \$100/ha)

Over-fertilisation chasing yield has a smaller economic impact when yields are high and prices strong but are more problematic when either yields or prices decline.

It is reasonable to expect that a small extrapolation from our current nutrition research base is unlikely to derail yield gains or overly increase risk however the closer we push cotton to its physiological limits without clearly defined strategies we may increase yield volatility, nutrient use inefficiency and resource use rundown.

Management Strategies for High Yield Crops

A major challenge facing production of high yield is in developing a workable strategy that looks after the current crop as well as the potential of future crops. In developing a management programme for cotton nutrition it is important that there is a clear process in of reviewing soil capability and ensuring the strategy and tactics are manageable and appropriate.

A soil fertility management strategy is a longer-term plan that defines nutrients and soil properties that are of concern, their priority for management and how they are to be managed.

Nutrient Management Strategy

Some key components of developing a nutrient management strategy include;

- Knowing your soils limitations – chemical, physical, biological
- Modify limitations where profitable
- Manage within soil limitation
- Understand strengths and weakness of soil nutrient supply capacity
- Benchmark soil nutrient characteristics both surface and subsoil
- Rank the importance of each nutrient
- Rank your ability to manage the nutrient
- Develop a nutrient strategy for important manageable nutrients and other soil chemical parameters – buildup, maintain, replace, rundown, optimize (profit, environment)
- Develop a strategy performance-monitoring plan – crop, soil, efficiency (NUE, WUE), test-strips and on-farm replicated experiments.

Tactics are the plans that are derived from the strategy that define how the nutrients are managed in any season.

Nutrient Management Tactics

Must be aligned with the objectives of the strategy and include plans for seasonal nutrient management such as;

- Rotations
- Products – fertilisers, animal manure, green manure

- Application Timing – presowing, sowing, squaring, 10 % flower, mid boll fill
- Placement – centre line in bed, side of hill, foliar
- Method of Application - broadcast, band, water run, aerial spread
- Develop tactic performance monitoring plans – crop, soil, efficiency (NUE, WUE)
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You Can't Manage What you don't Measure

The Australian cotton industry has generally had the good fortune of being based on highly fertile soils and of reasonable to good physical structure and stability. While it is a valid strategy during the development of the industry to run down the soil nutrient capital, there must also be some thought as to when to intervene and halt the decline. The intervention strategy must be timed carefully to ensure that productivity is not sacrificed as the soils decline and crops slip quietly into the “hidden hunger” zone disguised by all manner of seasonal and management factors that blur the nutrient effects. It is not uncommon for yield losses of 10 – 20 % to not be visible as deficiency symptoms.

To be able to detect the approach of the “hidden hunger” zone it is important that an appropriately designed soil or plant tissue-testing programme is put in place as part of the nutrient management strategy or tactics.

Taming Sampling Variability

Monitoring of soil and plant nutrient status is highly recommended on a field by field basis to manage soil productivity and to avoid nutritional stress of cotton crops as well as identifying soil problems that could limit production. However, interpretation of soil or plant tissue analyses viewed in a poor light due to confusion about sampling methodologies or locations as well as testing laboratories, that leads to uncontrolled variability in results. Information to help reduce the variability associated with sampling and laboratory analysis has recently been published by the Cotton Catchment Communities CRC, “Nutrient sampling guidelines for cotton”, to increase the value and reliability of these vital nutrient management tools.

Well thought out sampling regimes based on knowledge of soil and crop growth characteristics and how the information is to be used provide vital information in developing and monitoring sampling and nutrient management strategies.

The cost of analysis in this type of programme can be made attractive by only testing nutrients after a period of time or after significant events that would indicate that the soil nutrient concentration would have increase or declined to the extent that it can be distinguished from sampling and laboratory error. For low mobility nutrients such as P, K and Zn, and organic carbon this may be 5 to 7 years where the nutrient is applied at a rate in moderate excess of removal or is removed at a moderate rate in excess of addition.

Trends in Cotton Nutrient Management

Nutrient management of high yield irrigated cotton in recent years has evolved on a "trial and error basis" for the most part. Generally there has been a greater focus on a more balanced nutrient program with more frequent inclusion of phosphorus, and potassium and in some areas use of sulfur and a range of trace elements. Rates of addition of P and K are generally related to nutrient removal calculate from yield. A disturbing trend however is the anecdotal reports of some of the nitrogen fertiliser rates being applied in the quest for the high yields. It is widely recognized the nitrogen is a key component in high yielding crops but it is also the nutrient that is most prone to overuse. It is vital that N efficiency is maintained at the highest possible level to avoid crop management problems associate with end of the season high N and possible offsite environmental issues.

It is as yet unclear that the breadth of the applied nitrogen rates reported, 200 – 400 kg/ha N to growth 13 bales/ha, is warranted as these rates are not reported in the light of the total N supply to the crops.

The data in table 1 suggest that to produce 13 bales/ha N deficits in the range 230 – 315 kg/ha are likely to indicate maintenance of current rates of N use efficiency, however the total amount of N required to be available to the crop to produce yields in this range may need to be as high as 525 kg/ha at current levels of inefficiency and loss. Clearly there is a need for better definition of the total N supply rather than the rate of fertiliser applied.

Table 1 Theoretical nitrogen balance for irrigated cotton producing 13 bales/ha back to back.

| Demand (kg/ha) | Typical | Minimum | Source |
|------------------------------|----------------|----------------|------------------------------------|
| Uptake into Tops | 300 | 250 | Rochester 2006 pers. comm. |
| Roots | 75 | 75 | ~30 % of tops |
| Soil residual | 60 | 60 | Remaining in the soil post harvest |
| Leaching | 20 | 20 | Hulugalle et al 2002 |
| Denitrification | 70 | 40 | Grace 2006 pers. comm. |
| Total | 525 | 440 | |
| Supply (kg/ha) | | | |
| Soil Residual Mineral N | 60 | 60 | |
| Mineralisation from base OC | 50 | 50 | 1% OC, 4 - 5% mineralized, BD 1.2 |
| Mineralisation from fresh OM | 100 | 100 | 10 t@1.75% N, 60% turnover |
| Total | 210 | 210 | |
| <i>Deficit</i> | <i>315</i> | <i>230</i> | |

Areas of management that may be managed to increase N efficiency include -

- Decrease losses by control of water i.e. deep drainage and denitrification (waterlogging hours).

- Avoiding losses by decreasing the period of exposure of high soil supply and lower crop demand with split application
- Improved soil physical properties
- Know your soil N supply power in the root zone before adding fertiliser N.
- Ensure that other nutrients are not limiting
- If water running N and recirculating water, know what N rate is applied in the water
e.g. 50 mg/L NO₃-N = 50 kg N/ML.

The Future

It is difficult to move ahead in the management of nutrients use efficiency if the information about current practice is uncertain. In an attempt increase the efficiency and effectiveness of nutrient use a new project funded through the Cotton Catchment Communities CRC has the broad objectives of -

- Reviewing current knowledge and practice
- Manage knowledge gap,
- Increasing training available for nutrient related issues
- Produce new standardised nutrient DSS to be available to all

Some more specific information may include -

- Better defined N requirement in high yield and efficiency
- Better define "action" limits for P and K in rundown
- Better understanding of nutrient uptake intensity and root activity in high yielding crops