FERTILISER INPUTS - RATIONALISING COSTS

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Several factors influence the nitrogen demands of a cotton crop and the ability of the soil and fertiliser to satisfy these demands. Some of these factors (eg weather) are beyond the control of a cotton grower. One of the skills of cotton growing is having agronomy, especially fertiliser application strategies, that are least penalised by adverse conditions. Additionally, and especially during times of low prices, no grower can afford to miss any yield. This article outlines key principles arising from nutrition experiments and describes the options when deciding on fertiliser rates.

Stage of crop growth

Cotton seedlings grow relatively slowly, consequently in very N deficient soils the location of fertiliser can be important. For this reason, banding N fertiliser in the hill before sowing is the best all round application method.

Once a cotton crop has a full boll load, the ability of the roots to take N from the soil is reduced, regardless of how much N has been applied. This effect can be demonstrated with N uptake by drip irrigated cotton at Narrabri (Fig 1). N fertiliser was applied to drip irrigation treatments in the water during November, December and January. For furrow irrigation treatments the same total rate was applied before sowing. It is clear from these data that N applied through the drip system during January was not used until late in the season. There have been no

instances in these experiments when late N uptake (February) has contributed to yield. The consequence is that at least half of the nitrogen should be applied before sowing and the remainder should be applied before boll filling (mid January).

Crop requirement

N budgets and measurements of N uptake indicate that net plant uptake of about 110 kg N/ha is sufficient for maximum yield. This relationship is shown in Figure 2. Maximum "physiological efficiency" of N is achieved at about 110 kg N uptake. These data are for the Namoi Valley and cover DP61, DP90 and Siokra at yield levels from 5 to 10 bales per hectare. The relationship shows little increases in yield for crop N uptake in excess of 110 kg N/ha. Soils high in N may need application of only 50 kg N/ha to achieve this uptake; but very deficient soils may require fertiliser rates in excess of 180 kg N/ha.

Once sufficient N has been, or can be taken up, the key issue is the ability of the cotton crop to utilise N. This relies on having ideal conditions of aeration, water, pest control, etc. If yield is limited by poor soil structure for example, high N rates will not help.

Fertiliser recovery ("efficiency of uptake") is the proportion of applied N fertiliser that is taken up by the crop. Measured values rarely exceed .50 (range .14 - .80). Recovery is greatest with pre-sowing banding, and least with broadcasting or late sidedressing. Poor soil structural condition, water stress and waterlogging all reduce fertiliser recovery. It stands to reason that high fertiliser recovery is the most important

component of getting a high return from money spent on fertiliser.

Sidedressing

Consideration should be given to Figure 1 when deciding on date of sidedressing. Given that peak requirement occurs before peak bollfilling (about mid January) and that there are up to 3 weeks delay between N application and effective N utilisation; then the ideal time to sidedress is before flowering (mid December or earlier). There have been instances of slight yield increases with sidedressing (compared to all of the N being applied presowing). These instances have always been for situations where total N rates in excess of 140 kg/ha were required. Examples of the range of results obtained with sidedressing are shown in the following table:

Site	Nitrogen applied (kgN/ha) Before sowing	Sidedressed	Lint yield % of maximum
A	0	0	29
	100	0	75
	50	50	76
	200	0	89
	150	50	100
B	0	0	86
	0	146	100
	50	73	100
	100	0	100
	100	73	96

A = Second year cotton, compacted soil, waterlogged at irrigation
B = Wheat fallow, good structure, no waterlogging

Fertiliser recovery from sidedressed N has been equally affected by seasonal conditions, but recovery was more reliable from N

applied before sowing (range .28 - .56) than from sidedressing (range .19 - .48).

Foliar application

A short-term N deficiency in cotton is commonly associated with waterlogging. During waterlogging, roots lose the ability to absorb N from the soil. Additionally, waterlogging encourages denitrification of soil N. Experiments at Narrabri by Arthur Hodgson, have shown heavier yields of cotton when foliar N was applied one day before irrigations that induced waterlogging.

Foliar N is unlikely to help plants waterlogged in wet, cloudy weather because the utilisation of N within the plant requires warm sunny weather.

As stated earlier, the poor response to N applied during boll filling was due to the reduced ability of roots to take up N. The hypothesis is that at this time the plant uses most of its resources to grow bolls, so roots function less efficiently for the active process of soil N extraction. If this hypothesis were true it could explain the greater responsiveness to foliar N than to soil N during boll filling. Precise data on this aspect is lacking, but the consequences are that foliar N application, although most important early in the season, may be still effective during boll filling particularly in situations where waterlogging is expected.

Decisions on N rates

With the variability in soil types and seasons, it is impossible to be exact about N rates for cotton. Guides to the choice of N rate include soil type, cropping history and length

of season. Soil nitrate tests can also be used as a guide to confirm or modify a decision. During crop growth, petiole nitrate tests can be performed on the growing crop to determine if a sidedressing is required.

Rule of thumb

The following table can be used to calculate the approximate N rate.

Previous crop	N rate
Sorghum or second year cotton	140 kg/ha
Third year cotton	165
Soybean	90
Wheat	80
Fallow	65

Factors which increase N rate	Factors which decrease N rate
Long growing season	Short season
Compacted soil	Excellent soil condition
Heavy flat country	River loam

Soil nitrate test

This test measures the content of N in the nitrate form in soil. The test does not measure the content of other N forms which may already be available, or which may subsequently become available. Similarly, sampling date can affect the soil nitrate value : it is common for soil nitrate to halve between autumn and spring. Sampling depth can also affect soil nitrate values since the surface soil usually has a higher nitrate content than sub soil. Tests from soil that has been recently fertilised are of little value. This is because it is difficult to sample uniformly from where fertiliser has been banded, and misleading results are obtained. For these reasons, care has to be exercised in interpreting soil nitrate tests.

We have standardised on soil nitrate tests taken in September to a depth of 30 cm. On farms where N is applied before this date, a nil strip should be left to take soil samples from. In this case the soil test will be a check on whether the rate already applied was enough; and indicate the rate required at sidedressing. The relationship between the soil nitrate test and crop nitrogen uptake by an unfertilised cotton crop in the same soil is shown in Figure 3. These data cover a wide range of seasons, varieties and agronomy but the general relationship is quite good, indicating the test is helpful in identifying high and low N status soils. In general, soil nitrate tests over 20-25 ppm would indicate that no fertiliser N would be required.

Petiole nitrate test

This test measures the content of nitrate N in the petiole (leaf stalk). The test therefore measures how much nitrate is being taken up by the plant at that time. It does not measure how much N the crop has already extracted. The test is also affected by stage of crop growth, crop agronomy (water status, plant spacing etc), variety and weather conditions. Within these limitations, the test can be used as a guide to whether additional N is required, so long as there is time to effectively add N (refer to the section on date of N application).

The critical petiole nitrate value at first flowering is 14,000 to 19,000 ppm. Below this value, N applications might be necessary. The critical value decreases by about 2,800 ppm per week, so that the critical value is 10,000 to 14,000 ppm two weeks after first flowering.

One approach to petiole nitrate testing is to take at least three samples one week apart, starting in mid to late November. If the values obtained stay below the critical value for the growth stage, or point to values below below the critical value in the future, then N application is justified. This approach allows time for N application before boll filling.

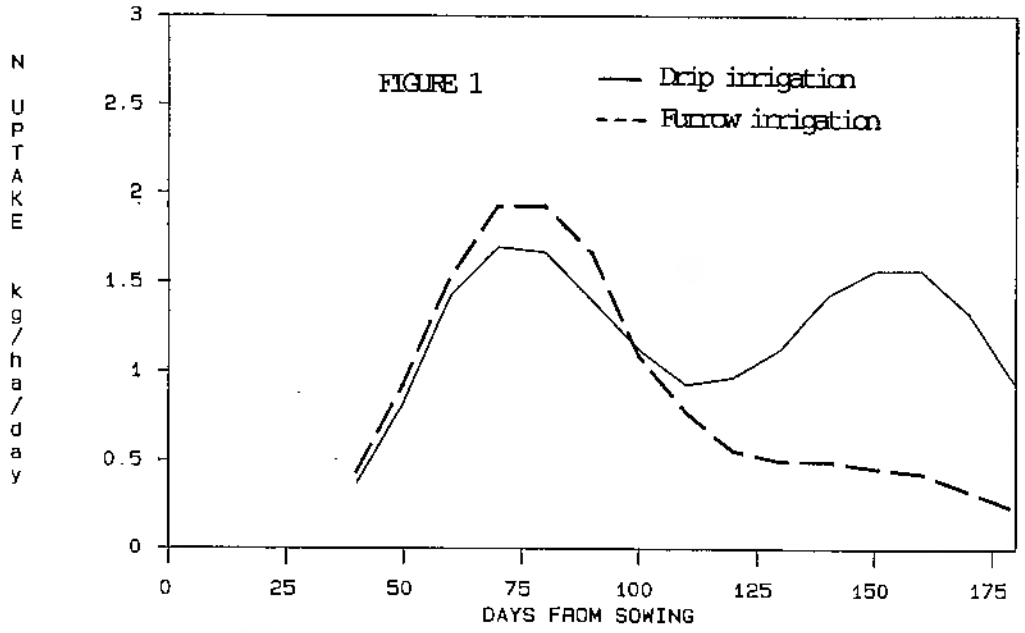
FIGURE 1
Drip irrigation
Furrow irrigation
N UPTAKE kg/ha/day
3
2.5
2
1.5
1
0.5
0
0
25
50
75
100
125
150
175
DAYS FROM SOWING

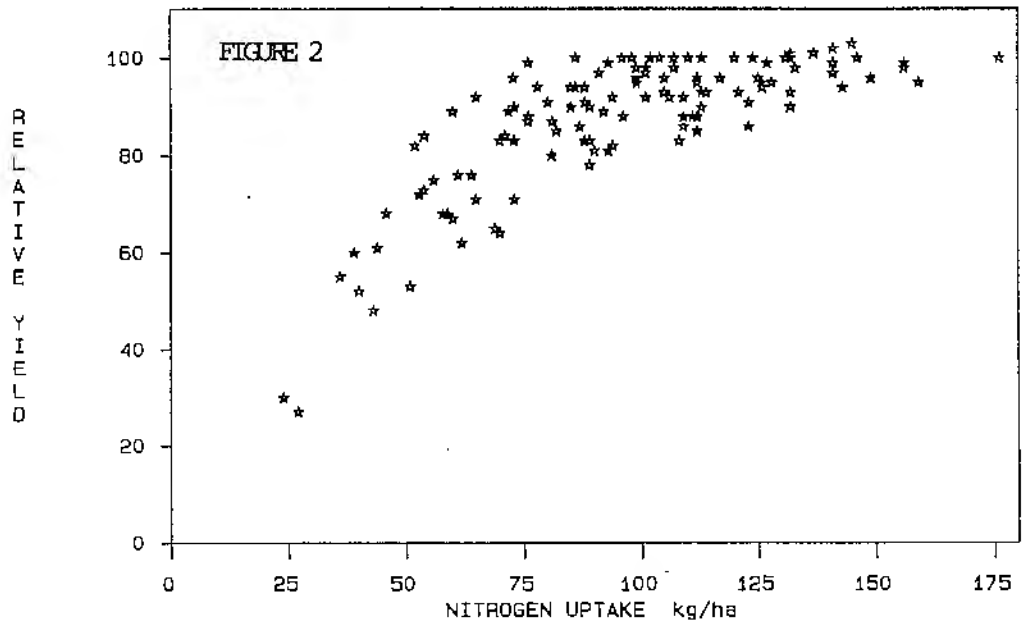
FIGURE 2
RELATIVE YIELD
100
80
60
40
20
0
0
25
50
75
100
125
150
175
NITROGEN UPTAKE kg/ha

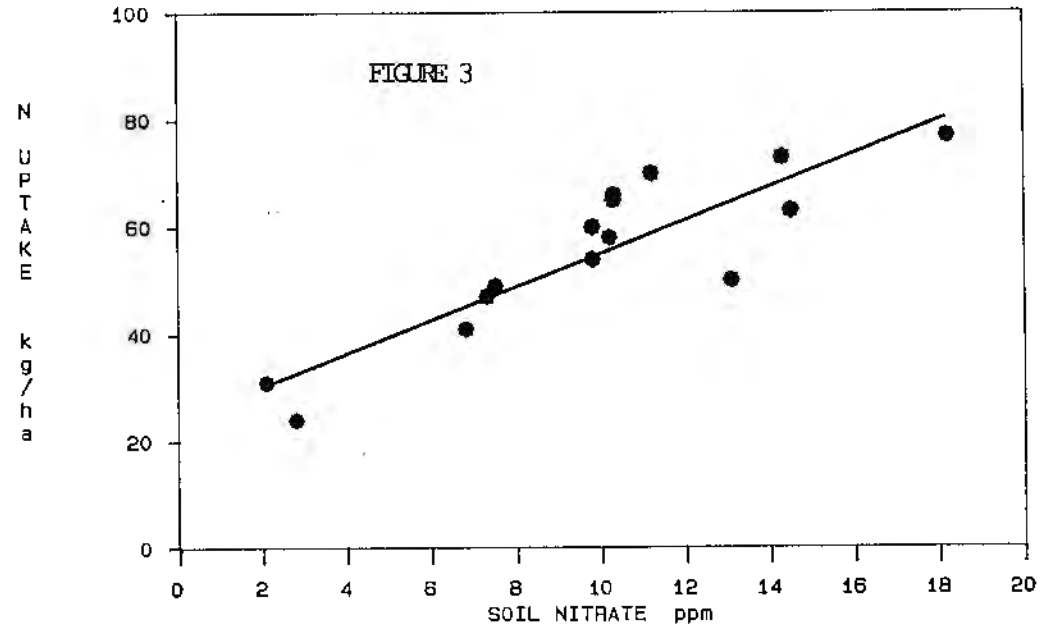
FIGURE 3
N UPTAKE kg/ha
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18
20
SOIL NITRATE ppm