MONITORING COTTON NUTRITION

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Legume-based cropping systems

The introduction of legumes into the cotton cropping system improves the N nutrition of the cotton following the legume crop. N fertilizer rates for cotton can be reduced by up to 50% when preceded by well-grown legume crops that can efficiently fix atmospheric N. The most effective N fixing legumes identified within this project include soybeans, lablab, faba beans, field peas and forage legumes, particularly vetches. While most growers aim for some financial return from their rotation crops, substantial benefits can be gained from green-manuring most legume crops, even those which have little value as seed crops (lablab and vetch).

Where legume crops have preceded cotton the maximum yield attained has been consistently 4-5% higher than the maximum yield attained where non-legume rotation crops were used. This is probably a result of improved soil structure (tilth) enabling better root development, which is reflected in improved crop nutrition and soil water relations. Yield improvement and saving in N fertilizer application are typified in Figure 1.

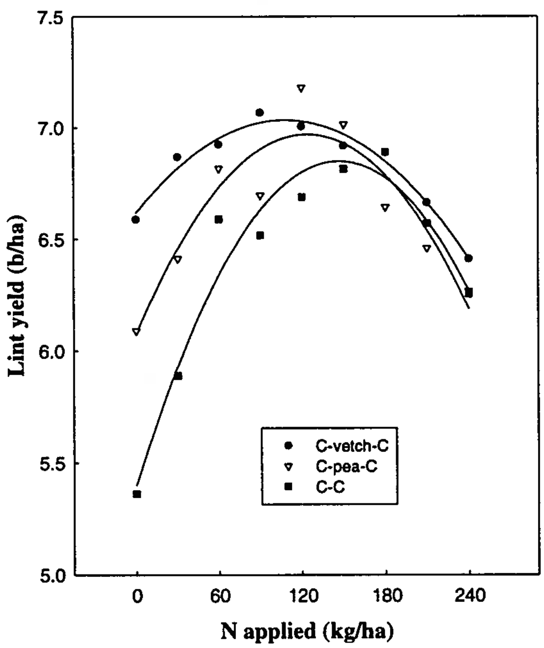

Figure 1.

Maximum lint yield was increased by 3% (0.2 b/ha) where vetch was grown, compared with fallow between annual cotton crops. Optimum N fertilizer application was reduced by 60 kg N/ha where vetch was grown. Interestingly, the maximum lint yield in the continuous cotton system was achieved with 150 kg N/ha – this could have been achieved in the vetch system with only 30 kg N/ha. Overuse of N fertilizer produced significant reductions in lint yield in all systems, indicating the importance of applying the correct N fertilizer rate, which can be identified with the aid of soil or plant tissue analyses.

Improving N fertilizer management

Soil testing:

Soil nitrate testing is a reliable means of identifying the N fertilizer requirement of a field. Soil can be collected up to three months prior to sowing cotton, but must be unfertilized soil. Sampling from 0 to 30 cm depth is fine, as this allows several cores to be bulked and subsampled (after careful mixing) to reduce the variation in soil nitrate levels commonly experienced in cotton fields. Variation is normally greater where soil nitrate levels are high. Deeper soil sampling may be warranted in lighter textured soils and dryland fields, particularly after a long fallow, but deeper nitrate will not be as accessible or available to the cotton crop as the N held in the upper soil profile. The NutriLOGIC program will help to indicate the optimum N fertilizer rate required to maximise lint yield in various situations, as displayed below in Figure 2. This relationship will change for different soil types and time of soil sampling – the NutriLOGIC program takes this into account.

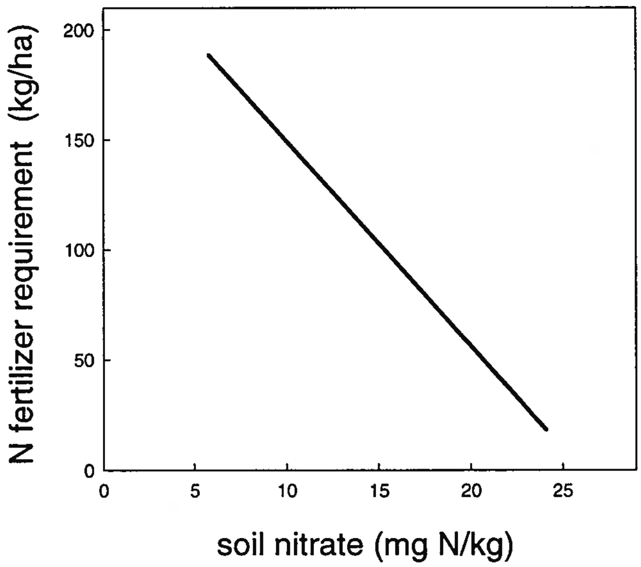

Figure 2. The relationship between N fertilizer requirement and soil nitrate-N concentration in an unfertilized clay loam soil, sampled in September, one month prior to sowing cotton.

Plant testing

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 a uniform area within a field, the petiole chosen is normally the one that connects the youngest mature leaf to the stem. This is usually the fifth unfolded leaf from the top of the plant. Because petiole nitrate levels are dynamic, it is important only to collect petioles from crops not subjected to recent environmental stresses (eg cold shock or waterlogging/drought). The most informative means of using petiole nitrate-N analyses is to collect petioles each week, and examine the rate of decline in nitrate concentration. The NutriLOGIC program can do this and indicate whether further N fertilizer is required to maximise lint yield in a particular field. The relationship displayed below in Figure 3 will change for different soil types, but moreso for time of petiole sampling – the NutriLOGIC program adjusts the N fertilizer recommendation by accounting for the day degrees since the crop was sown.

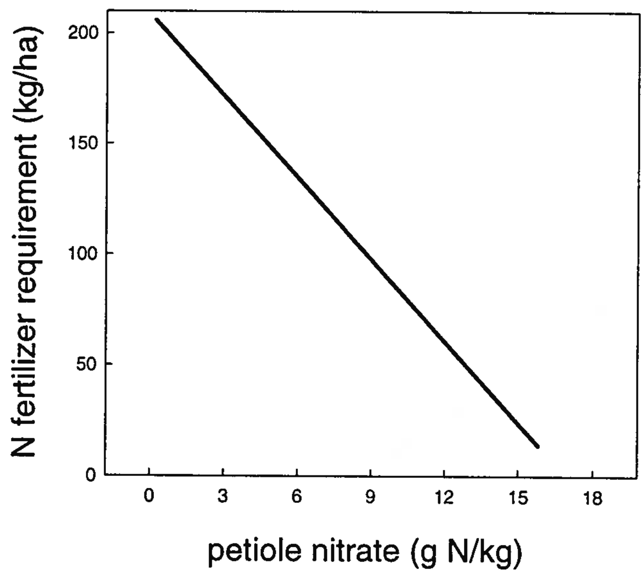

Figure 3. The N fertilizer requirement for cotton grown on clay loam soil as related to petiole nitrate-N concentration at 750 day degrees from sowing (first flower).

SPAD meter. Recent developments in colour meter technology have enabled production of relatively cheap optical devises to objectively measure the green colour of leaves. The meter is simply clamped over each leaf to be measured (say fifth unfurled leaf from the top of plant) and the mean of 30 readings recorded. Although calibration of these meters is continuing, an indication of the meter output and the relationship with the need for additional N fertilizer addition are shown in Figure 4. Further research is required to calibrate this meter for various regions, soil types and growing conditions. Initial examination indicated only slight differences in SPAD meter readings between cotton varieties, except for Pima cotton, which will require a separate calibration. Growth regulators, for example, thicken and darken leaves, thereby rendering this type of technology inaccurate. Little variation has been observed between cotton cultivars, except Pima varieties. The value of the meter is that a fertilizer management decision can be made in the field, based on the meter output, knowing the stage of crop growth (day degrees from sowing). It is advisable to collect successive readings over several weeks to assess crop N nutrition.

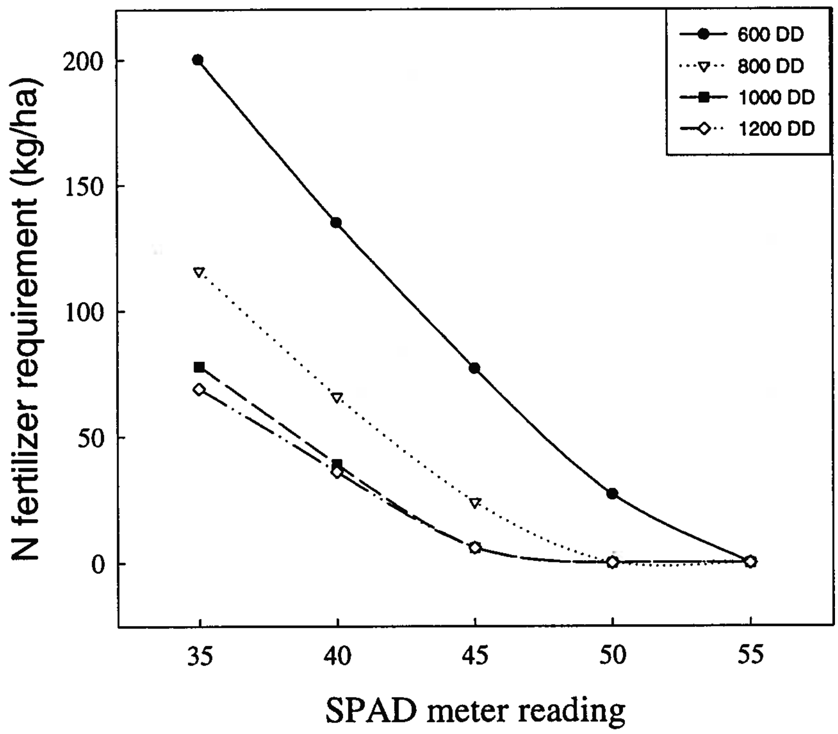

Figure 4. SPAD meter readings decline with leaf age and growth of the crop. This can be used to estimate the degree of N deficiency in cotton and indicate rates of N fertilizer required to remediate the condition.

Identifying nutritional disorders through soil and leaf analyses.

Although comprehensive soil analysis will indicate a measure of the availability of nutrients in the soil (Table 1), plant analyses will more directly indicate which nutrients are limiting or in excess. Leaf analysis (Table 2) is possibly the most appropriate means of identifying nutritional disorders. Leaf analysis, combined with soil analysis, will give a much clearer indication of nutrient imbalances and enable remedial action to be taken as soon as possible to avoid loss of production. Because the relative concentration os each nutrient will change during the growing season, interpretation of the analytical results will be affected by the stage of crop development at the time of leaf sampling.

Table 1: Interpretation of soil analysis

Nutrient	Extractant	Critical value
Nitrogen (N)	nitrate in aqueous extract	Depends on soil sampling time, but generally >25ppm
Phosphorus (P)	bicarbonate lactate	6 ppm 5 ppm
Potassium (K)	ammonium acetate	0.2 -0.4 meq/100g 100-150 ppm
Sulfur (S)	acetate buffer	5-10 ppm
Zinc (Zn)	DTPA EDTA	0.5 ppm 4 ppm

Table 2: Ideal nutrient concentrations in leaves at flowering.

Nutrient	ideal range
Nitrogen (N)	3.5 – 4.5 %
Phosphorus (P)	0.25 - 0.5 %
Potassium (K)	1.5 - 3.0 %
Sulfur (S)	0.2 - 0.4 %
Zinc (Zn)	20 – 60 ppm
Boron (B)	20 – 60 ppm

A much more detailed coverage will be published in the **NUTRIpak** manual.