Validation and Calibration of NutriLOGIC

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Introduction

Since 1992, experiments to validate the Decision Support System CottonLOGIC have been conducted. These experiments have focused on insect management and have been located on commercial cotton farms in the upper and lower Namoi Valleys. During the 1998/99 and 1999/00 seasons experiments were conducted on commercial cotton farms within a wider range of regions (Table 1). The reason for conducting experiments on commercial farms is to test the capabilities of CottonLOGIC in a range of environments that represent a commercial system.

In 1998, the NutriLOGIC module was incorporated into CottonLOGIC. This system informs the user of the need for nitrogen (N) fertiliser for a given field or cotton crop based on soil or petiole nitrate analysis.

The science behind NutriLOGIC was derived from calibrations that were developed by Dr. Greg Constable and Dr. Ian Rochester of CSIRO Cotton Research Unit, Narrabri. The program predicts the economic optimum N fertiliser rate based on a calculation of N fertiliser cost and the economic return for cotton lint. Soil or petiole nitrate levels, regional yield responses and sampling time are the main inputs of the program.

The objective of these experiments was to examine the output of NutriLOGIC and to provide further data to adjust the current calibrations and improve the reliability of the recommendations given by NutriLOGIC. This will be achieved by comparing the NutriLOGIC N fertiliser recommendations with the optimum N fertiliser rate derived through N responses in the field.

This paper presents the results of two years of validation and discusses the field performance of NutriLOGIC and the current limitations of its use.

Experimental Design

Table 1. Experiment sites

Season	Region	Farm Name	Soil Type
1998/99	Gwydir	"Caroale"	Grey Clay
1998/99	Theodore	"Nandina"	Heavy Grey/Brown Clay
1998/99 & 1999/00	Lower Namoi	"Leitch Block"	Grey Clay
1998/99 & 1999/00	Upper Namoi	"Milchengowrie"	Grey Clay
1999/00	D. Downs	"Bonwin"	Heavy Grey/Black Clay

Treatments
Treatments were imposed to generate fertiliser response curves to determine the economic optimum rate of N fertiliser which could be compared with the N fertiliser requirement recommended by NutriLOGIC.

The treatments included;

Treatment 1 = NutriLOGIC Recommendation
Treatment 2 = NutriLOGIC Recommendation – 40 kg N / ha
Treatment 3 = NutriLOGIC Recommendation + 40 kg N / ha
Treatment 4 = Nil

As illustrated in Figure 1, the treatments were replicated and randomised, with nil N strips at either end. Each plot was either 6 or 8m wide and went the length of the field.

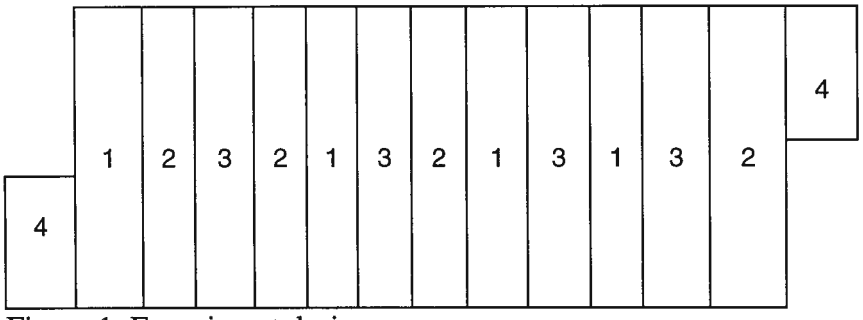

Figure 1. Experiment design.

Measurements

Soil Nitrate Analysis
Fields were selected to cover a range of soil types and rotation systems. Soil samples were taken from these fields in July/August to a depth of 30cm, and analysed for nitrate N. The results were then entered into NutriLOGIC.

The NutriLOGIC program generated an estimate of the required rate of fertiliser in N kg/ha. This became treatment 1, treatment 2 became the required rate minus 40 kgN/ha and treatment 3 became the required rate plus 40 kgN/ha. Not all collaborators agreed to have 2 nil plots.

Petiole Nitrate Analysis
Petiole Nitrate analysis was carried out three times in each plot between 600 and 750-Day Degrees. To obtain a representative sample, 50 petioles were randomly selected from the 5th leaf from the top of the plant. The samples were kept cool before being dried at 60 °C for 24hrs. They were then ground and immediately tested in the laboratory for nitrate N. These results were entered into NutriLOGIC to further assess the N fertility of each treatment and the need for additional N fertiliser.

Yield
The lint yield of each plot was determined by weighing the pickers using trailer scales. R results were then further examined to determine the optimum rate of N fertiliser.

Results

1998/99 season

From the soil nitrate analysis, the NutriLOGIC program was used to indicate the rate of N fertiliser required. Table 2 shows the experimental sites and the treatments that were imposed.

Table 2. Rates of N fertiliser applied in the 1998/99 NutriLOGIC experiments.

Site	Treatment 1 (NutriLOGIC)	Treatment 2	Treatment 3
Upper Namoi	120	80	160
Namoi	150	110	190
Gwydir	130	90	170
MacIntyre	150	110	190
Theodore*	170	130	210

*The NutriLOGIC recommendation at Theodore was 200kg/ha.

Due to a very wet start to the season, applications were delayed until after planting in 4 out of 5 experiments.

Petiole nitrate analysis indicated that extra N applications were not necessary at any site on any of the treatments.

On each site in 1998/99, N response curves were drawn. From this information, we calculated the optimum economic N fertiliser rate. Table 3 compares the optimum N rate with the NutriLOGIC recommendation.

Table 3. 1998/1999 Comparison between NutriLOGIC and the optimum rates and yields.

Site	NutriLOGIC N Rate	NutriLOGIC Yield (Bales/ha)	Optimum Rate	Optimum Yield (Bales/ha)
Upper Namoi	120 kg N / ha	5.1	110 kg N / ha	5.2
Namoi	150 kg N / ha	4.9	100 kg N / ha	5.0
Gwydir	130 kg N / ha	9.0	190 kg N / ha	9.3
MacIntyre	150 kg N / ha	8.1	160 kg N / ha	8.2
Theodore	200 kg N / ha	8.2	190 kg N / ha	8.4

The NutriLOGIC recommendation was comparable to the calculated optimum rate in 3 out of the 5 experiments. Results from the Namoi site showed an unusual trend with the lower rate treatment producing the highest yield. Hence the reason why the calculated optimum rate was a low 100kg N/ha. Results from the Gwydir experiment showed the higher N rate treatments having the highest yields. The calculated optimum rate in this experiment was 190kg N/ha, where the NutriLOGIC recommended treatment was 130kg N/ha.

The lint yield results demonstrated that more nitrogen applied doesn't necessarily result in an increase in yield, and that NutriLOGIC can perform reasonably well under wet conditions and post-plant N applications.

1999/2000 season
Unlike the previous season, all of the experiments in the 1999/2000 season had pre-plant applied N fertiliser.

Three sites from the 1998/99 season were used again, with an additional site in the Darling Downs near Bongeen.

From the soil nitrate analysis, NutriLOGIC predicted optimum N rates as shown in table 4.

Table 4. N fertiliser rates applied in the 1999/00 NutriLOGIC experiments.

Site	**Treatment 1 (NutriLOGIC)**	**Treatment 2**	**Treatment 3**
Upper Namoi	80	40	120
Namoi	90	50	130
MacIntyre	115	70	150
Darling Downs	80	40	120

Results from the Petiole nitrate analysis again indicated that extra Nitrogen applications were not necessary on any treatments at any site.

The following data on Table 5 shows yield results from all treatments with the optimum rate in comparison with the NutriLOGIC recommendation.

Table 5. 1999/2000 Comparison between NutriLOGIC and the optimum rates and yields.

Site	**NutriLOGIC N Rate**	**NutriLOGIC Yield (Bales/ha)**	**Optimum N Rate**	**Optimum Yield (Bales/ha)**
Upper Namoi	80 kg N / ha	6.7	182 kg N / ha	7.7
Namoi	90 kg N / ha	3.6	224 kg N / ha	4.7
MacIntyre	115 kg N / ha	7.8	260 kg N / ha	9.4
Darling Downs	80 kg N / ha	6.6	100 kg N / ha	6.7

Table 5 shows that at the majority of sites, the optimum N fertiliser rate was substantially higher than those predicted by NutriLOGIC.

Even though the two seasons had many differences in weather and pest pressures, this data has demonstrated the need to further calibrate the relationships in NutriLOGIC.

Conclusion

In 1998/1999, 3 out of 5 experiments gave evidence to suggest that by using NutriLOGIC to help decide on a Nitrogen fertiliser rate, you can achieve optimum economic yield. However the results from 1999/2000 indicated that NutriLOGIC did not closely indicate the optimum N rate.

The cool, slow start to the 1999/00 season, may have limited organic nutrient uptake and fertiliser use efficiency. Due to the poor use of N fertiliser in this season, higher N rates were required.

The petiole nitrate analysis consistently indicated that the crop nitrogen status was adequate. This was true for experiments conducted by other researchers, and reflects the cool, slow start to the 1999/00 season.

NutriLOGIC currently does not compensate for seasonal variation. The program has been designed to predict the optimum N fertiliser rate for an average season for the particular region. Soil nitrate analysis (pre-plant) and petiole nitrate analysis (pre-flower) may not always indicate the N fertiliser requirement accurately. The predications from NutriLOGIC are only as reliable as the nitrate N data that is entered. Further work is underway to calibrate NutriLOGIC and ensure the test results used are reliable so that the program can take variable conditions into account.

Through constant revision and large scale testing, NutriLOGIC is developing into a valuable decision support tool that many growers will use to improve their fertiliser management.

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