Impact of an action learning activity on improved nitrogen management in southern Queensland.

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ABSTRACT

The Western Downs region of southern Queensland has traditionally produced high protein (>13%) wheat without application of nitrogenous fertilisers. A decline in soil nitrogen fertility to the extent that it is limiting yields and protein levels has occurred in most wheat growing areas of Queensland and northern NSW (2). However it is only just being recognised in this region and in fact the use of nitrogenous fertiliser is unusual in a wheat to wheat rotation in the western Downs. This paper describes an action learning activity with a group of farmers to improve nitrogen management of cereals produced for export and/or domestic purposes.

KEY WORDS

Nitrogen management, action learning, fertiliser, wheat.

INTRODUCTION

Nitrogen recommendations prior to 1990 in extension material have often been in the form of district fertiliser recipes. Cahill and Strong (1) through Operation Quality Wheat and MEY groups developed a new process of nitrogen management for wheat, barley and grain sorghum based on established critical grain protein concentration for yield optimisation. Combining past grain yields and proteins with strategic paddock soil testing farmers were able to both monitor and understand nitrogen management processes on a paddock to paddock basis. This process has been incorporated into most of the extension material in Queensland and northern NSW since then. These principles were also incorporated into the package developed by Lawrence et al. (3) in the series of nitrogen management workshops "Nitrogen in '95/96". The workshops attempted to incorporate the concepts of experiential, adult and action learning and provide a forum for understanding the processes affecting the nitrogen supplies to cereal crops.

The Condamine Farmers Group formed in December 1997 with the aim of improving productivity through sharing information and learning through group activities. Twelve farmers are involved, most running mixed grain and beef enterprises. Total area farmed by the group is about 20 000 ha with approximately 60% of the total area sown to wheat annually. The group identified crop nutrition, particularly nitrogen management and the challenge to produce high protein (>13%) Prime Hard (PH) quality wheat as their major issue of concern. At the time of formation of the group, most members were just coming to terms with soil nitrogen fertility decline and although they all had access to extension material mentioned above, were still trying to determine whether they should be applying nitrogen, and if so, how much to apply. Nitrogen fertiliser test strips had been tried on some of the farms with results generally perceived as inconsistent and/or uneconomic. Research from other districts for example at Warra (4) which is about 80 km to the east and has been farmed for 20 to 30 years longer than the Condamine district, were also used to try to develop strategies for use on the farm at home.

METHOD

An action learning activity involving a nitrogen management workshop combined with an on-farm nitrogen trial commenced in March 1998 with the Condamine farmers. The nitrogen workshop provided an understanding of the nitrogen processes in their farming system and the detailed trial provided "first hand" experience of the effects nitrogen fertiliser on yield and protein of wheat on a local soil with which they could all relate.

The site selected for the trial was a medium clay, typical of the main farming soil of the area and had been continuously farmed since 1965. Plant available water capacity was estimated to be 160 mm/metre of soil at field capacity with a useable soil depth of about 1.2 metres. The group was involved in planning and establishment of the trial and normal farm machinery was used for fertiliser application, planting and harvesting. At harvest, grain from each plot was weighed with a mobile weigh bin and a sample was taken for grain protein analysis. Plot size was 13 x 200 metres and treatments were replicated three times. Nitrogen was applied in the form of urea (46% N) at 0, 23, 46 and 92 kg N/ha with and without MAP

(12 % N, 22 % P) at 80 kg/ha (10 kg/ha N and 16 kg/ha P). Soil analysis prior to planting in 1998 measured 67 kg nitrate N/ha to 0.9 m and 17 mg/kg P (Colwell) and in 1999, adjacent to this site in the same paddock, 25 kg nitrate-N/ha to 0.9 m and 28 mg/kg P (Colwell). The trials were planted 25/5/98 and 15/6/99 and harvested 25/10/98 and 29/10/99. The yellow spot resistant wheat variety Leichhardt was used both years. Plant-available soil moisture was excellent at planting in both years. The 1998 season was exceptionally wet with severe waterlogging and widespread leaf disease resulting in premature plant death, high screenings and reduced yields.

RESULTS and DISCUSSION

Nitrogen workshop 1998

The nitrogen workshop was conducted along the lines reported by Lawrence et al. (3). Ten paddocks were sampled and the soil analysed for nitrate-nitrogen and available phosphorus. At the pre-planting workshop, group members were navigated through soil nitrogen processes. The group tabled their individual soil analyses and calculated nitrogen budgets for each paddock (Table 1-a). At the post-harvest workshop, actual yields and proteins were added to the pre-harvest table, nitrogen requirements to produce this outcome were calculated and the differences from the budget were recorded (Table 1-b). It was at this follow-up workshop where the farmers appreciated the deficiencies of the budget approach in an unpredictable environment such as that of southern Queensland. For a given nitrogen supply, a number of possible yield and protein outcomes are possible depending on the season and these outcomes can also be affected by other factors such as waterlogging, disease, frost etc. in any particular year.

Table 1. Nitrogen budget details as tabulated at the pre-planting and post harvest workshops

(a)	First workshop				(b)	Second workshop				
Name	Target		N req'd (kg/ha)	Available N to 0.9 m (kg/ha)	N fert added	Harvest		N used (grain N x 2)	N avail at planting	+/-
	Yield	Protein				Yield	Protein			
Russell 1	2.5	13	114	71	0	2.0	10.8	76	71	+5
Russell	2.5	13	114	71	46	2.3	11.1	89	117	-28

2										
Rod 1	2.5	12.5	109	84	38	4.3	11.6	175	112	+63
Rod 2	2.5	12.5	109	84	38	2.8	13.2	130	112	+18
Gordon	2.5	13	114	75	0	1.8	12.7	80	75	+5
Godfrey	2.4	13	110	58	0	1.5	15.0	78	58	+20
Rian	3.6	13	164	91	46	1.6	12.4	70	137	-67
Scott	2.5	13	114	143	0	1.8	12.9	81	143	-62
Paul	3.0	13	137	202	0	1.6	14.5	81	202	-121
Frank	1.8	13	82	83	0	1.8	12.6	80	83	-3

+ve in the column at the right means that more N was apparently used than was present at planting.

Trials

Results in 1998 showed a significant yield and protein response ($P<0.05$) to both nitrogen and phosphorus although yields were much lower than expected through the effect of waterlogging and leaf disease

(Table 2). Protein increased with higher nitrogen supply although at 102 kg/ha N/ha it was only 11.7% indicating nitrogen supply was still limiting yield. Apparent efficiency of recovery of nitrogen in the grain for the control was 44.5% when a figure above 50% may have been expected at a protein level of 10.5% (W.M. Strong, pers. comm). Apparent efficiency where 200 kg/ha urea was applied was only 33.0%. The recovery efficiency of the applied nitrogen for this treatment was only 24.1%. These levels of recovery are low probably because of severe waterlogging.

Table 2. The effects of N and P application on grain yield and protein in 1998 and 1999

	1998		1999	
Treatment	Yield (t/ha)	Protein %	Yield (t/ha)	Protein %
Control	1.72	10.5	2.70	8.7
N10 + P16	2.03	10.5	2.98	9.0

N23	1.95	10.7	3.19	9.8
N33 + P16	2.34	10.6	3.29	10.1
N46	2.27	11.1	3.49	10.8
N56 + P16	2.63	10.9	3.54	10.9
N92	2.62	11.7	3.65	12.0
N102 + P16	2.78	11.5	3.75	12.4
l.s.d. (5%)	0.169		0.153	

In 1999 under more normal growing conditions, the results were much more conventional displaying a classical nitrogen response curve (Figure 2). The highest fertiliser rate was not sufficient to attain PH quality (13% protein). There was no response to phosphorus fertiliser.

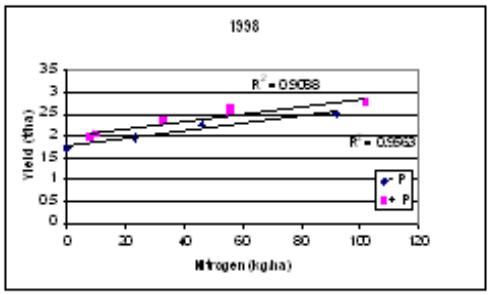


Figure 1. The effect of N fertiliser on yield with and without P, 1998.

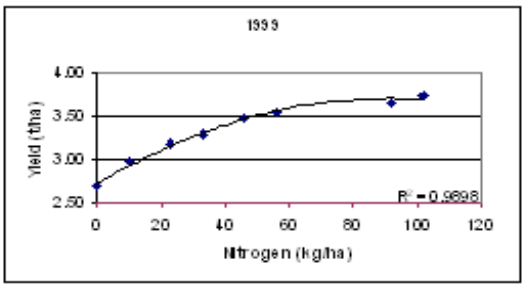
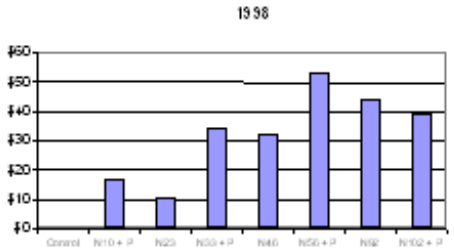


Figure 2. The effect of N fertiliser on yield,1999.

Economics

All treatments in both 1998 and 1999 gave a positive return (Figures 3 and 4). In 1999 applying 200 kg/ha urea at a cost of $60 /ha gave an extra return of $210/ha or a return of $3.50 for every dollar invested in fertiliser nitrogen in spite of not achieving desired PH quality. From the farmers' point of view, the positive return from nitrogen fertiliser under difficult weather (waterlogging) and economic (low grain price) conditions, when grain protein did not reach the PH (13 %) requirement, was probably one of the major factors influencing their decisions to apply fertiliser nitrogen in subsequent crops.



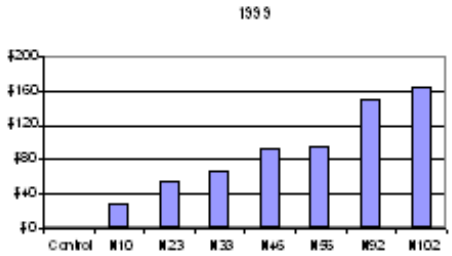


Figure 3. Extra return less fertiliser costs

Figure 4. Extra return less fertiliser N. costs.

Changes in nitrogen management practices

Nitrogen management practices and current usage (prior to 1998) were recorded at the nitrogen workshop.

- There were only two regular users of nitrogenous fertiliser. One of these farmers had moved to the district in 1996 and had used urea in both 1996 and 1997. Both farmers applied approximately 100 kg/ha urea annually.
- Four had tried test strips or test paddocks without obvious positive results.
- Six had not used nitrogenous fertiliser.

The changes in the use of nitrogen fertiliser in 2000 have been dramatic. All participants except one have used urea on their wheat at rates ranging from 80 kg/ha to 150 kg/ha (37 to 69 kg/ha N). To make these decisions they have used the principles detailed in the nitrogen workshop i.e. crop expectations based on soil moisture at planting and yields and proteins levels from the previous seasons, and soil test information. The results from the trials (the economics in particular) and the group discussion of these results gave several participants the confidence to become first-time nitrogen fertiliser users.

CONCLUSIONS

This action learning activity combining the nitrogen management workshop with farmer initiated field trials has successfully provided the learning opportunity for this group of farmers to gain an understanding of the nitrogen processes impacting their crop management decisions thereby increasing skills and confidence to manage nitrogen effectively. They were able to experience "first hand" the benefits of nitrogen fertiliser on the wheat yield and protein on a soil type they could all relate to during two quite different winter seasons. The pre-planting workshop introduced growers to quantities of nitrogen required by wheat crops, and the post-harvest workshop was the main learning activity where growers reconciled actual outcomes with targeted outcomes. The farmer-initiated trials have reinforced principles learned at the workshops and emphasised the need to target nitrogen supply rather than a particular yield and protein. All except one grower applied urea to wheat this year and these nitrogen management decisions are largely the result of information assimilated during this action learning activity. In consequence, there has been a major change in total nitrogen fertiliser usage by the group from less than 50 tonnes of urea in 1997 to more than 1000 tonnes in 2000.

Acknowledgments

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