Components of long-term nitrogen balance in central Qld grain cropping systems.

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Abstract

Components of the crop and soil nitrogen balance were monitored at farming systems trials situated on the two dominant cropping soils in central Qld. Annual apparent mineralisation ranged from 20-27 kgN/ha/yr at the 'Open Downs' soil (low OC%) site to 47-78 kg/ha/yr at the 'Brigalow scrub' soil (high OC%) site. A low and variable proportion (14-52%) of applied N fertiliser was recovered as either N in grain or crop residues or change in soil nitrate N. Unused N accumulated above 1m in depth in the soil profile in the high N treatments on the Brigalow Scrub soil.

Key Words

nitrogen, mineralisation, fertiliser

Introduction1

A mass balance approach has been widely used in northern Australian grain cropping regions to estimate cereal crop N demand and fertiliser requirements. This approach has met with varied success in central Qld cropping systems on some soil types and there are many instances where no yield or protein response is observed to N fertiliser application rates derived using this approach. Anecdotal evidence suggests that the anticipated response is less likely to occur on soils with high organic carbon and total nitrogen levels and that differences in response to applied N is likely to be related to differing levels of fallow and in-crop mineralization. This paper investigates component of the N balance derived from long term monitoring of grain cropping sequences in central Qld grain cropping systems.

Methods

Nitrogen application rate treatments were included in long term farming systems trials conducted on the two dominant soil types in central Qld. Site 1 ('*Kilmore'*, 40 km SE of Emerald) is situated on a 'Brigalow Scrub' soil (endocalcareous, self-mulching, black or brown vertosol) with an organic carbon content of the 0-10 cm layer of 1.6 – 1.9% and was monitored from Jan 2000 to Apr 2005. Site 2 ('*Moonggoo'*, 40 km N of Emerald) is situated on an 'Open Downs' soil (epicalcareous, self-mulching, black vertosol) with an organic carbon content of the 0-10 cm layer of 0.8-0.9% and was monitored from Feb 1998 to May 2001.

Nitrogen rate treatments included nil, budget (B, N rate based on soil nitrate N measured prior to planting and anticipated crop demand) and high (H, usually 60 kgN/Ha) and were applied as Urea prior to planting in the same plots each year. At each site, N treatments were applied within conservative (c) and aggressive (a) cropping sequences. Grain yield, grain protein concentration and soil nitrate at planting and harvest were recorded for each crop produced during the monitored period. Grain and crop residue N removal was estimated using standard N concentrations (Dalal & Probert, 1997). Apparent N mineralisation was estimated as the difference between N inputs and N removal in the nil N treatments. N fertiliser recovery efficiency was estimated as the proportion of applied N that was recovered as either extra grain N removal or change in profile soil nitrate over the period of monitoring.

Results

N Mineralisation

Annual apparent N mineralisation rates of between 20 and 78 kgN/ha/year were observed (Table 1).

Table 1. Components of the N balance and estimates of N mineralisation in nil N aggressive (a) and conservative (c) treatments (kgN/ha)

N balance component	Site 1c	Site 1a	Site 2c	Site 2a
Final soil nitrate N	236	81	5	6
+ Total N removed in grain	195	181	144	68
+ N in stubble at end	13	6	5	9
- Starting soil nitrate N	36	19	74	19
= Apparent Mineralisation	408	249	80	64
Apparent mineralisation per year	78	47	27	20

Fertiliser N Recovery

The efficiency of recovery of applied N varied between 13 and 52% (Table 2).

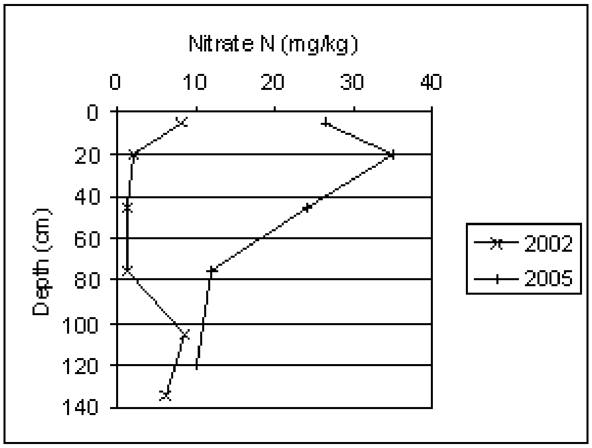
Table 2. Efficiency of recovery of applied N

	Site 1c		Site 1a		Site 2c		Site 2a	
N treatment	B	H	B	H	B	H	B	H
N applied (kgN/ha)	104	220	121	260	140	240	250	240
Additional N removed in grain (kgN/ha) (1)	4	-5	-3	-43	41	52	48	70
Additional soil nitrate N and crop residue N at end of period (kgN/ha) (1)	10	111	53	177	4	33	6	36
Total Applied N recovered (kgN/ha) (1)	14	106	50	134	45	85	54	105
Applied N recovery efficiency (%)	13	48	41	52	32	35	36	44

(1) compared with nil N treatment

Soil N accumulation

Unutilised N accumulated above 1m depth in the soil profile over the monitoring period, as illustrated for Site 1a in Figs 1 & 2.



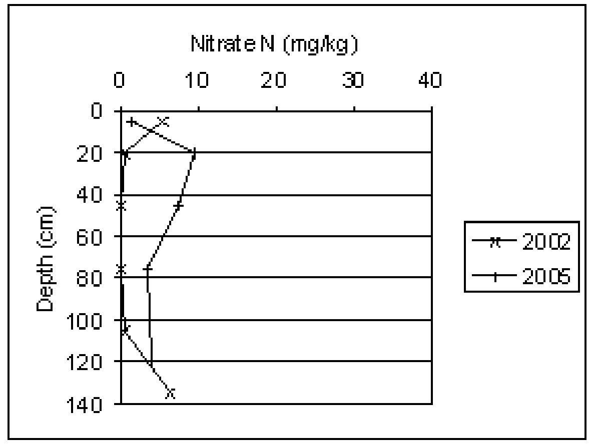


Fig 1. Profile nitrate at harvest for 2002 and 2005 in the High N treatment at site 1a.

Fig 2. Profile nitrate at harvest for 2002 and 2005 in the nil N treatment at site 1a.

Conclusions

Annual mineralisation rates vary widely between soil types and the quantity of N mineralised is high in relation to typical crop requirements. The N mineralisation capacity of individual soils is a significant component of the N balance and needs to be accounted for when determining N fertiliser application rates. The relatively low recovery efficiency of applied N is of concern and highlights a need to further quantify the fate of applied N rates and application strategies. Unutilised N accumulates in the soil profile and may be accessible to future crops but equally may be lost to denitrification or deep drainage events.

References

Dalal, RC and Probert, ME (1997). Soil Nutrient Depletion. In Sustainable crop production in the sub-tropics. Eds AL Clarke & PB Wylie. DPI, Qld