CARRYOVER OF SOIL NITRATE-N FOLLOWING FERTILISER APPLICATION TO WHEAT IN NORTHERN NEW SOUTH WALES

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Summary. The carryover effect of N applied as fertiliser in one year, on three successive wheat crops, and measured in terms of grain nitrogen yield and soil nitrate N levels, was studied in northern NSW over the period 1992-95.

High levels of soil nitrate-N resulting from fertiliser application in 1992 declined in successive years, over three wheat crops. Differences in the decline curves due to different N applications remained separate over the experimental period, clearly demonstrating that nitrate-N was being carried over from one season to the next. Efficiencies for the cumulative recovery of applied N in wheat grain declined successively from 45% in the case of the application of 40 kg N/ha to 26.5% for the application of 200 kg N/ha. Fertiliser N applied in excess of the requirements for wheat in 1992 was therefore available to the crop in 1993. Drought prevented differentiation among treatments in 1994.

INTRODUCTION

Numerous fertiliser-rate experiments on cereals lasting one season have been reported, resulting in equally numerous productivity responses across sites, due to variation in soil fertility and/or seasonal factors. Results of this experimental approach have arguably underpinned attitudes among farmers that application of fertiliser N is risky. Fertiliser N has therefore been treated as a variable cost, and the expense wholly accounted to the year of application. Failure of a crop to respond to fertiliser N applied in a season is considered to represent a loss. Sufficient evidence exists to show that the effect of fertiliser N may carryover into the next (1, 2), or later season, and so fertiliser N, like soil fertility itself, should be treated as an asset. Such carryover should be viewed as a depreciation over time, with the rate of depreciation determined by a combination of factors including crop demand for N, immobilisation-mineralisation, and loss processes.

We present results of a field study to determine how much of the mineral N applied to wheat in one year and not removed in grain was carried forward over three subsequent crops. The aim was to further our understanding of N dynamics, and enable farmers to better manage their cereal-production systems.

MATERIALS AND METHODS

The experiment was commenced in 1992 at North Star (28^{o} 58' S, 150^{o} 21' E) on a degraded brigalow clay-loam. Main plots were sown to wheat, chickpea and barley, and split for applications of 0, 40, 80, 120, 160 and 200 kg N as urea, which was applied on 14 April 1992. Wheat was sown over all plots without additional N inputs for the following three years. A basal application of triple superphosphate (50 kg/ha) was applied at sowing. The experiment was sown after a fallow, in which residues from a wheat crop in the previous season were retained, but incorporated by the farmer using three cultivations. Each subsequent fallow period was no-tilled.

The experiment was designed as a Latin Square of main plots, each split for N rate, in four replications. Plot size was 40 m x 3.5 m. The cultivars Sunco (wheat), Grimmett (barley) and Amethyst (chickpea) were used (sown 7 May 1992). Wheat in subsequent seasons was planted on 26 May 1993 (cv. Janz), 11 June 1994 (cv. Sunco), and 22 May 1995 (cv. Sunco).

Measurements were made of soil nitrate-N to 120 cm depth at sowing and post-anthesis in each year. Plant measurements in each year included crop yield and components, and post-anthesis biomass and N concentration. For the purposes of this paper, data from wheat treatments only are presented.

RESULTS AND DISCUSSION

Trends in soil nitrate-N

Levels of soil nitrate-N at sowing in 1992 did not reflect the amounts added as fertiliser, probably due to immobilisation since nitrification of the fertiliser applied earlier should have been almost complete (Fig. 1).

Soil nitrate-N at sowing declined successively in 1993 and 1994, but changed little between 1994 and 1995, presumably due to the severe drought in 1994 which greatly reduced crop demand for N.

Throughout the three years of the study, the nitrate-N curves for each of the six fertiliser N rates remained clearly separable. Levels of nitrate-N had fallen to low values by sowing in 1995, but 45 kg N/ha more nitrate-N was present in the N200 treatment than in the unfertilised control.

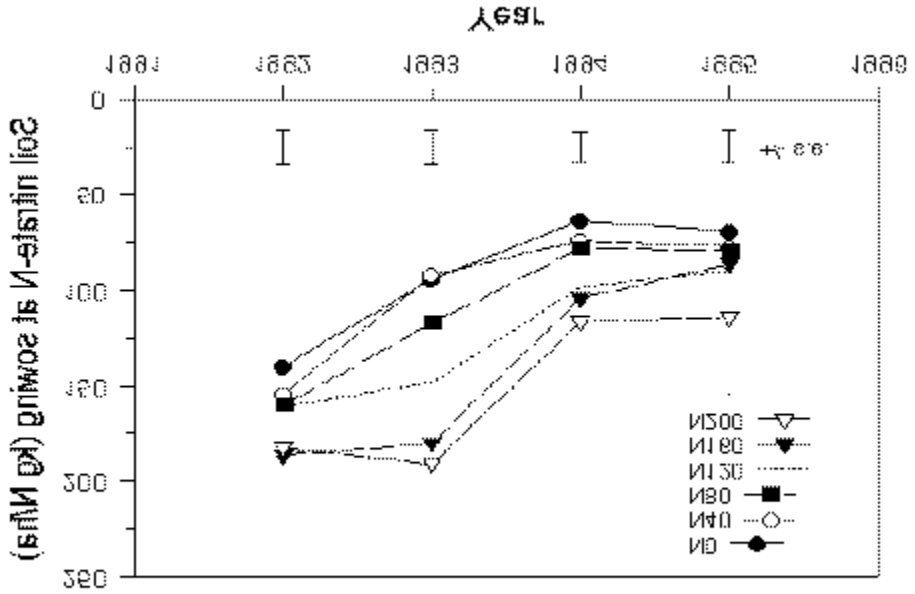

Figure 1. Trends in soil nitrate-N at planting in each year of the experiment.

Response of grain N yield in each year to fertiliser N.

The responses to applied N in 1992 and 1993 were similar (Fig. 2). Low grain N yield in 1994 resulted from severe drought. Crop results for 1995 were not available at the time of preparing this paper, but we predict that a further residual response will be measured.

Efficiency of recovery of applied N in grain

The amounts of applied N recovered in grain N summed over 1992 and 1993 (Table 1) were high, and consistent with high efficiencies reported by others (3).

The highest efficiency of use of applied N in wheat grain was observed for the N40 treatment in which the equivalent of 45% of the applied N was recovered. Efficiency of cumulative N uptake declined with each

increment of applied N, so that only 26.5% of the N applied in the N200 treatment was recovered over the three year period observed.

When the amounts of nitrate-N at sowing in 1995, in excess of that for the control are taken into account, and assumed to be recovered in grain with 50% efficiency, the overall efficiencies rise to 55%, 45%, 42.9%, 39.7% and 37.8% respectively for the N40, N80, N120, N160 and N200 treatments. It is expected that these figures will be confirmed when 1995 crop results are available.

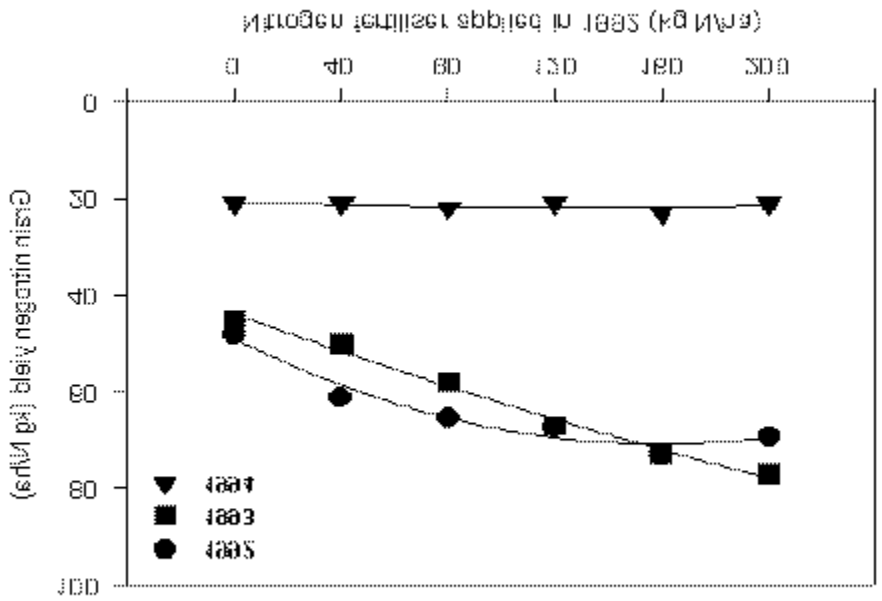

Figure 2. Response of wheat grain N yield over a three-year period to N applied in 1992.

We conclude that fertiliser N applied in excess of demand for N by the crop in the year of application was carried over to be available for the next wheat crop, under the conditions encountered in northern NSW over the period 1992-1995.

Table 1. Summary of recovery of applied N in wheat grain over three years.

Applied N treatment	Year	GNY (kg N/ha)	Cumulative GNY	Efficiency of recovery (% of control)
N0	1992	48	48	Control
	1993	45	93	
	1994	21	114	

N40	1992	61	61	32.5
	1993	50	111	45.0
	1994	21	132	45.0
N80	1992	65	65	35.4
	1993	58	123	37.5
	1994	22	145	38.8
N120	1992	67	67	15.8
	1993	67	134	34.2
	1994	21	155	34.2
N160	1992	73	73	15.6
	1993	73	146	33.1
	1994	23	169	34.4
N200	1992	69	69	10.5
	1993	77	146	26.5
	1994	21	167	26.5

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REFERENCES

1. Strong, W. M, Harbison, J., Nielsen, R.G.H., Hall, B.D. and Best, E.K. 1986. Aust. J. Exp. Agric. 26, 353-359.

2. Vanotti, M.B. and Bundy, L.G. 1994. Agron. J. 86, 881-886.

3. Craswell, E.T. and Godwin, D.C. 1984. Adv. Plant Nutr. Vol. 1. (Eds P. B. Tinker and A. Lauchli) (Praeger: New York). pp. 1-55.