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STRAW INCORPORATION

A LONG TERM STUDY OF NITROGEN EFFECTS ON A SANDY LOAM SOIL, 1991

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Summary

At this site there was differential lodging in winter oats receiving different nitrogen rates, with a tendency for lodging to be more severe where previous straw had been burnt or baled and removed compared with where straw had been ploughed in. This paralleled a trend in soil mineral nitrogen assessed in the winter. Grain yields were affected by the lodging and the maximum yields were reached at 100 kg/ha where straw was ploughed in or 75 kg/ha where straw had been burnt or removed.

Keywords: Straw, incorporation, nitrogen, soil mineral nitrogen.

Object

To investigate the long term implications of straw incorporation on the nitrogen requirements of crops, crop yields and on the potential for nitrate leaching.

Introduction

Preliminary investigations into the effects of straw incorporation compared with burning or removal on a sandy loam site showed little or no effects from the straw treatments.

At this site, it is expected that some nitrogen is being immobilised on those treatments where straw is accumulating. This may lead to an increased response to added nitrogen in the first few years of straw incorporation. The eventual breakdown of the straw should then release nitrogen into the soil to offset that being immobilised and the crop responses to nitrogen should then return to normal or even be reduced.

The original experiment has now been modified to allow continued monitoring of soil and crop nitrogen levels from a reduced number of straw treatments and an extended range of nitrogen rates.

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Materials and method

The current trial utilises a site at Morley (sandy loam over chalky boulder clay, Ashley series) where straw has been burnt, baled and removed or incorporated in various ways since 1984. In 1990 a crop of Tonic wheat was established in the late autumn after a one year break crop of sugar beet.

The straw from this crop was then disposed of according to treatment and the site was ploughed in early October. Winter oats were drilled on 23 October. The residual effects of the preceding repeated straw treatments were assessed on sub-plots receiving a range of nitrogen rates to determine any change in crop requirements for nitrogen.

The trial is a split-plot design with straw treatments on main plots randomised in 4 replicates as shown below.

Preceding straw treatments (main plots)

1 Straw burnt or baled and removed
2 Straw chopped, then incorporated into the top soil before being ploughed in
3 Straw chopped and ploughed in

Nitrogen rates (sub-plots) (kg/ha):

1 Nil
2 50
3 75
4 100
5 125
6 150

Results

Crop growth

Crop growth was normal and no vigour differences between straw treatments were apparent. Nitrogen sub-plots differed in intensity of colour in the spring and ultimately there were differences in crop lodging between treatments (Table 1).

Table 1. Crop lodging on 15 August (%)

Straw treatments	Nitrogen rates (kg/ha) Nil	50	75	100	125	150	Mean
1 Burnt or baled and removed	0.0	0.0	4.8	19.5	72.5	95.0	32.0
2 Incorporated and ploughed in	0.0	0.0	0.0	16.3	39.8	93.8	25.0
3 Ploughed in	0.0	0.0	0.0	0.0	23.8	82.5	17.7
LSD			h = 20.98; vi = 20.65				9.37
Mean	0.0	0.0	1.6	11.9	45.3	90.4	
LSD				12.12			

SE per main plot (6 df) = ±5.42 or 21.8% of GM
SE per sub-plot (45 df) = ±14.74 or 59.3% of GM

(LSD = least significant difference at 95% probability level)

There was more lodging on plots where straw had been burnt or removed than on plots where straw was ploughed in. Lodging increased with increasing nitrogen, starting at the 75 kg/ha rate on the plots where straw was burnt or removed. It was only apparent above 100 kg/ha where straw was ploughed in.

Yield

Table 2. Grain yield (t/ha at 85% dm)

Straw treatments	Nitrogen rates (kg/ha) Nil	50	75	100	125	150	Mean
1 Burnt or baled and removed	5.32	6.50	7.50	7.34	6.60	6.59	6.64
2 Incorporated and ploughed in	5.12	6.21	7.16	7.39	7.07	6.92	6.64
3 Ploughed in	4.87	6.44	7.25	7.56	7.32	6.63	6.68
LSD			h = 0.500; vi = 0.504				NS
Mean	5.10	6.39	7.30	7.43	7.00	6.71	
LSD				0.285			

SE per main plot (6 df) = ±0.354 or 5.3% of GM
SE per sub-plot (45 df) = ±0.348 or 5.2% of GM

(NS = no significant difference)

Overall there were no significant yield differences between straw treatments (Table 2) and there was a general trend for yields to increase with increasing nitrogen rate up to 100 kg/ha with a decline in yields at higher rates. However there appeared to be different optimum nitrogen rates for the primary straw treatments. Where straw was burnt or removed the maximum yield was reached at 75 kg/ha compared with 100 kg/ha for the treatments where the straw had been ploughed in.

Grain size

Table 3. Thousand grain weight (g at 85% dm)

Straw treatments	Nitrogen rates (kg/ha) Nil	50	75	100	125	150	Mean
1 Burnt or baled and removed	37.8	37.3	34.0	34.7	32.0	31.9	34.6
2 Incorporated and ploughed in	35.9	37.8	36.1	34.6	30.9	30.2	34.3
3 Ploughed in	37.5	37.1	36.4	35.6	33.2	35.1	35.8
LSD			h = 2.64; vi = 3.36				NS
Mean	37.1	37.4	35.5	35.0	32.0	32.4	
LSD				1.52			

SE per main plot (6 df) = ±2.36 or 6.8% of GM
SE per sub-plot (45 df) = ±1.85 or 5.3% of GM

Grain size (thousand grain weight) was not significantly affected by straw treatments (Table 3) but there was a significant size reduction in response to increasing nitrogen rate.

Grain nitrogen

Table 4. Grain nitrogen (% of dry matter)

Straw treatments	Nitrogen rates (kg/ha) Nil	50	75	100	125	150	Mean
1 Burnt or baled and removed	1.51	1.63	1.80	1.77	1.85	1.81	1.73
2 Incorporated and ploughed in	1.58	1.65	1.63	1.78	1.72	1.82	1.70
3 Ploughed in	1.52	1.59	1.64	1.73	1.72	1.81	1.67
LSD			h = 0.165; vi = 0.245				NS
Mean	1.54	1.62	1.69	1.76	1.76	1.81	
LSD				0.094			

SE per main plot (6 df) = ±0.173 or 10.2% of GM
SE per sub-plot (45 df) = ±0.116 or 6.8% of GM

Grain nitrogen content was influenced by nitrogen rate. Table 4 shows the increase with increasing nitrogen, but the absence of any influence of straw treatment.

Nitrogen offtakes

Table 5. Nitrogen in crop (kg/ha) at selected N rates

Straw treatments	Nitrogen rates (kg/ha) Nil	75	100	125	Mean
N in grain					
1 Burnt or baled and removed	64.3	108.2	103.0	104.9	95.1
2 Incorporated and ploughed in	61.0	95.3	106.6	104.0	91.7
3 Ploughed in	70.0	89.8	100.8	107.3	91.4
LSD	h = 15.30; vi = 5.36				NS
Mean	65.1	97.7	103.4	105.4	
LSD	8.83				
N in straw					
1 Burnt or baled and removed	10.3	27.9	32.9	39.7	27.7
2 Incorporated and ploughed in	10.0	18.8	33.8	33.9	24.1
3 Ploughed in	11.3	20.7	27.9	33.7	23.4
LSD	h = 8.60; vi = 5.70				3.40
Mean	10.5	22.5	31.5	35.7	
LSD	4.96				

N in grain: SE per main plot (6 df) = ±3.69 or 4.0% of GM
N in grain: SE per sub-plot (27 df) = ±10.54 or 11.3% of GM

N in straw: SE per main plot (6 df) = ±3.93 or 15.7% of GM
N in straw: SE per sub-plot (27 df) = ±5.92 or 23.6% of GM

The nitrogen in the grain and straw is shown in Table 5. Nitrogen uptake increased in line with nitrogen rate and there was a tendency for higher grain and straw nitrogen where straw was burnt or removed.

Soil nitrogen residues

Table 6 shows residual nitrogen levels present in soil samples taken in December 1990. Overall there was significantly more nitrogen where straw had been burnt or baled than where it was returned to the soil. There is a clear indication that the higher residual level where straw had been removed influenced the overall lodging level.

Table 6. Available soil N (kg/ha) 0-90 cm, December 1990

Straw treatments	Nitrogen rates (kg/ha) Nil	75	100	125	Mean
1 Burnt or baled and removed	55	75	66	91	72
2 Incorporated and ploughed in	46	36	52	46	45
3 Ploughed in	32	37	29	31	32
LSD		h = 18.7; vi = 45.0			26.9
Mean	44	49	49	56	
LSD			NS		

SE per main plot (6 df) = ±31.0 or 62.4% of GM
SE per sub-plot (45 df) = ±12.9 or 25.9% of GM

Discussion

The results represent the accumulative effects of repeated straw treatments on the same plots commencing in the autumn of 1984. There is a consistency in the lodging and yield data which is paralleled by measurements of mineral soil nitrogen in the winter. All results indicate that straw burial is still immobilising soil nitrogen.

An appendix which contains site and crop diary is available on request.

APPENDIX - NAS 206 ML 91 (MAFF PROJECT: T105/002)

A LONG TERM STUDY OF NITROGEN EFFECTS ON A SANDY LOAM SOIL, 1991

Site details:	Morley (Raven's Grove Field)
Soil type:	Sandy loam over chalky boulder clay
Previous cropping:	1990 spring wheat
	1989 sugar beet
	1988 winter wheat
	1987 winter wheat
	1986 sugar beet
	1985 winter barley

Diary

28 August 1990	Straw chopped and spread.
11 September	Straw burnt on appropriate main plots; straw incorporated by rotavating on appropriate main plots.
20 October	Site ploughed and rolled.
23 October	Winter oats, var. Image, drilled into good seedbed.
31 October	Farm applied 2.25 kg/ha Glytex (isoxaben + methabenzthiazuran, 3.4 + 70 g ai/kg) for overall weed control.
19 November	Oats emerged evenly.
3 April 1991	Nitrogen treatments spread by hand. GS 30.
29 April	Farm applied 2.2 l/ha Chlormequat 700 (chlormequat-chloride, 700 g ai/l), for lodging control. GS 32.
10 May	Farm applied 1.0 l/ha Starane (fluroxypyr, 200 g ai/l) for additional weed control overall and 0.75 Corbel (fenpropimorph, 750 g ai/l) for mildew control.
14 May	No straw treatment differences visible.
27 June	Heavy showers have resulted in considerable crop lodging on high N plots.
12 August	Destructive samples taken for grain/straw N offtakes.
15 August	Trial combined.