## Abstract

In a long-term experiment repeated on two light mineral soils with different crop rotations yields were not significantly (P 0.05) affected by straw and cultivation treatment in 1992, 8 years after the first cereal straw was ploughed in.

At Morley, Norfolk, a winter barley crop was established after winter oats without problems on a site which had generally low mineral nitrogen levels during the winter. Crop growth was normal throughout the season. There was extensive crop lodging prior to harvest, especially at high rates of applied nitrogen, due to stormy weather conditions. Grain yields and grain quality were similar from plots where straw had been removed by burning or where straw had been ploughed in, with or without incorporation.

At Gleadthorpe, Nottinghamshire, a winter oilseed rape crop was established with some difficulty after winter barley due to exceptionally dry soil conditions. Establishment, early vigour and senescence were not affected by previous straw treatment, but there appeared to be more ground cover in the spring on plots where the straw had been incorporated by tined cultivator prior to being ploughed in, compared with ploughing straw in directly or burning the straw then ploughing. Seed yields were poor and little influenced by straw treatment.

## Objective

To determine, on light mineral soils, the long term effects of incorporating straw on the potential for nitrate leaching and the nitrogen requirements of subsequent crops together with effects on crop performance.

## Introduction

Results from the preceding experiment carried out on these sites indicated that in certain circumstances straw incorporation immobilised more soil nitrogen than where straw was ploughed in without prior cultivations or was removed by baling or burning. It is anticipated that continued annual additions of straw should result initially in greater immobilisation of nitrate during decomposition of the freshly incorporated straw and ultimately in enhanced mineral nitrogen production.

## Materials and method

**Site** Morley Research Centre

The experiment was situated on a sandy loam over chalky boulder clay (Ashley series). Further site details and meterological information are given in the Appendix.

## Management

Winter barley, cv Pipkin, was sown on 1 October 1991 and harvested on 22 July 1992.

## Treatments

The previous crop, winter oats, was harvested on 15 August 1991.

## Cultivations

1. Straw chopped on 6 September. Ploughed and drilled on 1 October 1991.

2. Straw chopped on 6 September. Cultivated by Flexicoil to 100 mm, 12 September 1991. Ploughed and drilled on 1 October 1992.

3. Straw burnt and ash incorporated by Flexicoil, 12 September 1991. Ploughed and drilled on 1 October 1991.

## Nitrogen rates

1. Nil
2. 50 kg/ha
3. 100 kg/ha
4. 150 kg/ha
5. 200 kg/ha
6. 250 kg/ha

Nitrogen was applied to sub-plots by hand as 34.5% ammonium nitrate fertilizer in a single application on 18 March 1992.

## Experiment design

The cultivation treatments were fully randomised in 4 blocks. The nitrogen treatments were superimposed on these areas as sub-plots. The area of each sub-plot was 64 $m^2$. The harvest area of each sub-plot was 34.4 $m^2$.

**Results** Morley Research Centre

Table 1 Soil mineral nitrogen content ($NH_4$-N and $NO_3$-N, kg/ha)
Total 0 - 0.9 m, 20 January 1992

| Cultivation treatment | Previous nitrogen rate (kg/ha) | | | | |
|---|---|---|---|---|---|
| | 0 | 100 | 150 | 200 | Mean |
| | | (SED vi ± 3.1, h ± 3.1) | | | (SED ± 1.5) |
| Plough | 35 | 32 | 32 | 41 | 35 |
| Tine/plough | 34 | 34 | 36 | 48 | 38 |
| Burn straw, plough | 33 | 38 | 42 | 47 | 40 |
| | | (SED ± 1.8) | | | |
| Mean | 34 | 35 | 37 | 46 | |

Main plot CV% (6 df) = 5.5
Sub-plot CV% (26 df) = 11.7

Total available soil nitrogen content, assessed in the winter, was significantly affected by straw and nitrogen treatments (P 0.05). There was more soil mineral nitrogen where straw had been burnt rather than ploughed in, and following the highest nitrogen rate applied to previous crops compared with 0, 50 and 150 kg/ha.

Table 2 Plant numbers per $m^2$, 2 January 1992

| Cultivation treatment | Previous nitrogen rate (kg/ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 50 | 100 | 150 | 200 | 250 | Mean |
| | | (SED vi ± 15.1, h ± 12.7) | | | | (SED ± 9.6) | |
| Plough | 279 | 266 | 268 | 289 | 294 | 287 | 280 |
| Tine/plough | 258 | 260 | 256 | 278 | 281 | 286 | 270 |
| Burn straw, plough | 276 | 266 | 303 | 282 | 258 | 286 | 278 |
| | | | (SED ± 7.4) | | | | |
| Mean | 271 | 264 | 276 | 283 | 278 | 286 | |

Main plot CV% (6 df) = 4.9
Sub-plot CV% (45 df) = 6.5

Plant establishment was satisfactory and there were no effects from previous straw or nitrogen treatments. Early crop colour differences were transient, initially main plots were darker where straw was burnt.

Table 3 Lodging score (0 - 10 scale, higher numbers denote more severe lodging), 23 June 1992

| Cultivation treatment | Nitrogen rate (kg/ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 50 | 100 | 150 | 200 | 250 | Mean |
| | | (SED vi ± 0.9, h ± 0.8) | | | | | (SED ± 0.5) |
| Plough | 0 | 0 | 5 | 10 | 9 | 10 | 6 |
| Tine/plough | 0 | 0 | 4 | 10 | 10 | 10 | 5 |
| Burn straw, plough | 0 | 2 | 6 | 10 | 10 | 9 | 6 |
| | | | (SED ± 0.5) | | | | |
| Mean | 0 | 1 | 5 | 10 | 10 | 10 | |

Main plot CV% (6 df) = 11.7
Sub-plot CV% (45 df) = 19.3

Despite use of growth regulators, stormy weather in June resulted in extensive crop lodging which was worse at the higher nitrogen rates. Straw treatment did not significantly affect lodging.

Table 4 Grain yield (t/ha at 85% DM)

| Cultivation treatment | Nitrogen rate (kg/ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 50 | 100 | 150 | 200 | 250 | Mean |
| | | (SED vi ± 0.285, h ± 0.225) | | | | | (SED ± 0.199) |
| Plough | 3.87 | 5.91 | 7.47 | 7.90 | 8.02 | 7.68 | 6.81 |
| Tine/plough | 3.75 | 5.86 | 7.29 | 7.95 | 7.90 | 7.93 | 6.78 |
| Burn straw, plough | 3.52 | 6.26 | 7.89 | 8.04 | 7.96 | 8.02 | 6.95 |
| | | | (SED ± 0.130) | | | | |
| Mean | 3.72 | 6.01 | 7.55 | 7.96 | 7.96 | 7.88 | |

Main plot CV% (6 df) = 4.1
Sub-plot CV% (45 df) = 4.6

Yields were not affected by straw treatment. Increasing nitrogen rate up to 150 kg/ha resulted in increasing yield, there was no benefit to yield from further nitrogen increases.

Table 5 Grain quality - % nitrogen (grain at 100% DM)

| Cultivation treatment | Nitrogen rate (kg/ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 50 | 100 | 150 | 200 | 250 | Mean |
| | | (SED vi ± 0.047, h ± 0.041) | | | | | (SED ± 0.029) |
| Plough | 1.37 | 1.31 | 1.50 | 1.76 | 1.91 | 2.24 | 1.68 |
| Tine/plough | 1.33 | 1.33 | 1.44 | 1.78 | 1.94 | 2.11 | 1.65 |
| Burn straw, plough | 1.24 | 1.35 | 1.55 | 1.74 | 1.97 | 2.06 | 1.65 |
| | | | (SED ± 0.024) | | | | |
| Mean | 1.31 | 1.33 | 1.50 | 1.76 | 1.94 | 2.14 | |

Main plot CV% (6 df) = 2.5
Sub-plot CV% (45 df) = 3.5

Grain %N content was not affected by straw treatment. Increasing nitrogen rate resulted in increasing grain nitrogen.

Table 6 Grain quality - Specific weight (kg/hl)

| Cultivation treatment | Nitrogen rate (kg/ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 50 | 100 | 150 | 200 | 250 | Mean |
| | (SED vi ± 0.26, h ± 0.25) | | | | (SED ± 0.12) | | |
| Plough | 65.5 | 67.4 | 68.5 | 68.8 | 68.9 | 68.9 | 68.0 |
| Tine/plough | 65.8 | 67.3 | 68.7 | 68.7 | 69.0 | 68.9 | 68.1 |
| Burn straw, plough | 65.8 | 67.6 | 68.2 | 68.2 | 68.6 | 68.5 | 67.8 |
| | | | (SED ± 0.15) | | | | |
| Mean | 65.7 | 67.4 | 68.5 | 68.6 | 68.8 | 68.7 | |

Main plot CV% (6 df) = 0.3
Sub-plot CV% (45 df) = 0.5

Grain specific weight was not affected by straw treatment. At the lower nitrogen rates specific weights increased as nitrogen rates increased.

Table 7 Nitrogen uptakes (kg/ha)

| Cultivation treatment | Nitrogen rate (kg/ha) | | | | |
|---|---|---|---|---|---|
| | 0 | 100 | 150 | 200 | Mean |
| **Grain** | | (SED vi ± 7.7, h ± 7.7) | | | (SED ± 4.0) |
| Plough | 44 | 105 | 128 | 139 | 104 |
| Tine/plough | 48 | 110 | 124 | 124 | 102 |
| Burn straw, plough | 43 | 118 | 131 | 141 | 108 |
| | | (SED ± 4.4) | | | |
| Mean | 45 | 111 | 128 | 135 | |
| **Straw** | | (SED vi ± 10.0, h ± 9.7) | | (SED ± 5.5) | |
| Plough | 12 | 34 | 62 | 55 | 41 |
| Tine/plough | 15 | 44 | 48 | 45 | 38 |
| Burn straw, plough | 10 | 48 | 58 | 79 | 49 |
| | | (SED ± 5.6) | | | |
| Mean | 12 | 42 | 56 | 60 | |

| | Grain | Straw |
|---|---|---|
| Main plot CV% (6 df) = | 5.4 | 18.3 |
| Sub-plot CV% (27 df) = | 10.4 | 32.3 |

Nitrogen uptake, assessed on whole crop samples taken prior to harvest, was not influenced by straw treatment. Both grain and straw nitrogen uptakes were increased significantly by increasing nitrogen rate up to 150 kg/ha.

## APPENDIX I

### Details of site and crop husbandry

**Site:** **Morley Research Centre**

Field: Ravens Grove

Soil series: Ashley

Soil texture: Sandy loam over chalky boulder clay

Drainage: Good

Soil analysis: pH 7.1
P index 5
K index 2
Mg index 2

Previous cropping: 1991 W. Oats
1990 S. Wheat
1989 Sugar beet
1988 W. Wheat
1987 W. Wheat
1986 Sugar beet
1985 W. Barley

**Crop:**

Cultivar: Pipkin

Sowing date: 1 October 1991

Seedrate: 150 kg/ha

Fertilizer: N - as treatments
P & K residue from previous beet crop

Herbicide: Avadex (tri-allate) at 22 kg/ha and Encore (isoproturon + pendimethalin) at 4 l/ha on 28 October. Astix (CMPP) at 2 l/ha and Ally (metsulfuron-methyl) at 30 g/ha on 9 April.

Fungicide: Sportak (prochloraz) at 1 l/ha and Corbel (fenpropimorph) at 0.5 l/ha on 2 April. Bavistin (carbendazim) at 0.5 kg/ha on 23 April. Bavistin at 0.5 kg/ha and Tilt(propiconazole) at 0.5 l/ha, 18 May.

Growth Regulator: Chlormequat 700 (chlormequat) at 2 l/ha on 18 March. Terpal (2-chloroethylphosphonic acid + mepiquat chloride) at 1 l/ha on 11 May.

**APPENDIX II** **Rainfall and sunshine hours - Morley Research Centre**

| | Rainfall (mm) | | | Sunshine (hours) | | |
|---|---|---|---|---|---|---|
| | 1991 | 1992 | 24 y mean | 1991 | 1992 | 24 y Mean |
| Jan | - | 46.1 | 56.4 | - | 64.2 | 54.9 |
| Feb | - | 23.8 | 39.8 | - | 81.6 | 73.6 |
| Mar | - | 68.2 | 47.4 | - | 84.1 | 103.5 |
| Apr | - | 32.7 | 43.1 | - | 119.8 | 153.5 |
| May | - | 49.2 | 44.9 | - | 287.3 | 202.8 |
| Jun | - | 33.8 | 53.9 | - | 231.8 | 196.8 |
| Jul | - | 75.8 | 50.6 | - | 177.8 | 200.2 |
| Aug | 15.9 | - | 48.7 | 243.8 | - | 192.1 |
| Sep | 53.5 | - | 46.4 | 205.6 | - | 149.8 |
| Oct | 28.4 | - | 52.8 | 91.7 | - | 111.0 |
| Nov | 63.9 | - | 65.3 | 53.2 | - | 69.6 |
| Dec | 34.3 | - | 54.5 | 51.0 | - | 49.7 |