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Long-term straw management effects on yields of sequential wheat (*Triticum aestivum* L.) crops in clay and silty clay loam soils in England

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Abstract

The incorporation of chopped wheat (*Triticum aestivum* L.) straw into soil by tine cultivation (non-soil inversion) or ploughing was compared with burning straw followed by tine cultivation at six sites in England over a period of 11 years. Three sites had clay soils and three silty clay loam soils. Effects of straw management on weed incidence, take-all (*Gaeumannomyces graminis* var. *tritici*) infection and grain yield of following wheat crops and occasional break crops were studied. Soil mineral nitrogen and organic matter contents were measured at the end of the study. Incorporating straw by tines rather than burning reduced mean yield at all but one site. The yield reduction from tine incorporation ranged from 5 to 8% on clay soils and 3–18% on silty clay loam soils. Ploughing straw into soil only had an occasional adverse effect on yield of following crops. Much of the yield penalty associated with tine incorporation of straw was attributed to weed competition by *Bromus* spp. Difficulties in preparing a good seedbed, resulting in variable plant emergence, was the other main cause of lower yields with tine incorporation and in situations where plough incorporation reduced yields compared to burning straw. Method of straw disposal had no consistent effect on take-all infection. The effects of straw incorporation on soil mineral nitrogen and organic matter contents were small and inconsistent. There was no consistent effect of straw management practice on yield response to additional autumn application of nitrogen fertiliser.

These results demonstrate that on those soils where ploughing is preferred, it is a suitable option for disposing of straw. Where non-ploughing methods have traditionally been used after straw burning they can still be employed with success, but occasional ploughing or planting of suitable break crops may be required to control grass weeds.

Keywords: Straw incorporation; Weeds; Take-all; Nitrogen; Organic matter; Tillage

1. Introduction

During the 1970s and 1980s, declining demand for cereal straw in the UK and increased production of cereals resulted in a surplus of straw, the majority being burnt in the field. By 1984, 6 million tonnes of straw was being burnt, representing 60% of the wheat growing area (Anon., 1992). This highly visible activity occasionally caused significant damage to hedges, trees and property, and caused public outcry each year. A report by The Royal Commission on Environmental Pollution (1984) recommended a ban on straw burning

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and this was introduced from autumn 1992. By 1992 the amount of straw burnt had reduced to about 2 million tonnes. Previous work had demonstrated the potential for buried straw to affect the growth and yield of following wheat crops (Oliphant, 1982). With changes in farming practices and a much wider range of soil cultivation equipment available, a new study was designed jointly by ADAS (formerly known as the Agricultural Development and Advisory Service) and the former Agriculture and Food Research Council (AFRC). This started in autumn 1983 and tested, on large plots, a range of options appropriate to different soil types and sites. This paper reports some of the results obtained during a 11-year period at six sites. The experiment investigated method of incorporating or burning straw on crop establishment, grain yield, weed and disease incidence, and soil mineral nitrogen and organic matter contents.

2. Materials and methods

2.1. Sites

Six sites across England, ADAS Boxworth in Cambridgeshire, ADAS Bridgets in Hampshire, ADAS Drayton in Warwickshire, ADAS High Mowthorpe in North Yorkshire, ADAS Terrington in Norfolk and a farm at Rochford in Essex were selected to represent the main cereal growing areas of England. Descriptions of the soil type and particle size distribution for each site are given in Table 1. The sites divide into two broad soil types—clays and silty clay loams. While the textural descriptions of the soils are similar, the soils at Bridgets and High Mowthorpe are shallow (30–50 cm deep) and overlay chalk, while the soil at Terrington is a deep marine silt clay loam.

2.2. Cropping

The intention was to grow winter wheat continuously throughout the period of the experiment. This had to be modified by including break crops in order to control grass weeds, which could not be adequately controlled by chemical means in wheat. Therefore at several sites oilseed rape (*Brassica napus* L.), peas (*Pisum sativum* L.), linseed (*Linum usitatissimum* L.) or sugar beet (*Beta saccharifera*) breaks were introduced into the cropping sequence. Table 2 gives details of the crops grown in each harvest year. The crop cultivars grown varied among sites and years, but were typical of commercial practice. The whole trial area at Rochford had to be ploughed after the 1988 harvest and treatments were re-established. These later data are not reported here.

2.3. Treatments and design

The number of cultivation treatments tested varied from 4 to 12 among sites. Three core treatments were included at each site in each year studied: (1) tine/disc cultivation to 15 cm on chopped straw, (2) ploughing to 20 cm on chopped straw and (3) straw burning followed by tine/disc cultivation to 10 cm. Only the results of these treatments are reported here. In these treatments, off-set discs and spring-tine cultivators were used. Ploughing was by reversible mouldboard plough, followed by secondary cultivations as necessary.

Table 1
Description of soils at experiment sites[a]

Site	Soil texture	UK soil series	Soil particles (%)		
			Sand	Silt	Clay
1. Boxworth	Clay	Hanslope	24	31	45
2. Drayton	Clay	Evesham	20	28	52
3. Rochford	Clay loam	Wallasea	4	40	56
4. Bridgets	Calcareous silty clay loam	Andover	12	56	32
5. High Mowthorpe	Stony calcareous silty clay loam	Wold	14	63	23
6. Terrington	Silty clay loam	Agney	11	60	29

[a] Size groupings were clay <2 μm, silt 2–63 μm and sand 63–2000 μm. FAO soil descriptions by site—(1) and (2) fine textured Calcaric Gleysol, (3) fine textured Eutric Fluvisol, (4) and (5) medium textured Calcaric Regosol, and (6) medium textured Calcaric Fluvisol.