No-tillage wheat production in Northern NSW

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Summary. Experiments at five sites in northern NSW from 1983 to 1990 demonstrated that in a continuous wheat system. stubble retention rather than tillage reduced wheat yields compared to stubble burning after harvest. At sites and in seasons where this yield penalty was significant. it was associated with reduced soil nitrate availability at planting.

Introduction

The continued viability of cropping requires that soil is not degraded by erosion and excessive cultivation. Soil erosion is a concern in the northern wheat farmlands of NSW because of high intensity summer storms. unprotected fallow and highly erodible soils. Conservation tillage practices such as no-till and stubble-mulch reduce soil loss by erosion (7), but adoption of these practices has been slow (2).

No-till, or zero-till farming represents a major change in fallow/residue management that involves uncertainty about long term crop productivity, and requires additional expertise over conventional cultivation practices in costing inputs, weed control and machinery.

Research has been done in both NSW and Queensland to understand, develop and promote the adoption of no-till farming. Results from a long term field experiment to compare four methods of fallowing for annual winter cereal production on an eastern Darling Downs vertisol in the period 1969 to 1979 showed that fallow water storage efficiency was greatest in untilled treatments, particularly under drier conditions, nitrogen mineralisation was depressed in some years by residue retention but grain yields averaged over 12 crops were similar for the four fallowing systems (I). In the drier environment of south west Queensland, residue retention throughout the fallow generally resulted in more soil water at planting, and higher grain yields in dry growing seasons (5). Increased frequency of tillage and residue removal also increased the amount of soil nitrate-N.

Methods

Long term trials were commenced in 1981 at five sites representative of the major soil types (4) in northern NSW in the 550-700 mm rainfall zone to evaluate fallow management practices after harvest on subsequent wheat production. These trials were done under commercial conditions using large plots and grower equipment for tillage operations in accordance with the standard practice for that farm. Sites were established at Breeza (black earth, Ug 5.15, annual rainfall 550 mm), Warialda (black earth, Ug 5.15, 700 mm), Winton (brown solodic, Db 1.43, 650 mm), Gurley (grey clay, Ug 5.16, 550 mm), and Croppa Creek (grey brigalow clay, Ug 5.17, 600 mm).

The experiments at Warialda. Winton. Gurley and Croppa Creek comprised three main treatments, no-till (NT), cultivated with the stubble burned (SB), and cultivated with the stubble retained (SM). split for six to eight sub-treatments devoted to variations in agronomy or crop sequence. Two of these sub-treatments were continuous wheat given only basal fertiliser application. There were six replicates containing subplots each 40 m by 10 m. At Breeza the three main plots were rotations of continuous wheat, wheatsorghum-wheat, or opportunity cropping with wheat, sorghum and grain legume. in four replicates with NT. SB or SM as sub-treatments. Each sub-plot was 35 m long by 20 m wide.

Only data for the continuous wheat sub-treatments from these sites for the period 1983-90 are presented in this paper.

Results and discussion

Influence of tillage practice on wheat yield

Wheat yields for continuous wheat cropping under no-till, stubble burned and stubble mulched fallow regimes are shown in Table I. Burning stubble and cultivating often resulted in higher yields than did stubble mulching or no-till treatments. There were large effects in some seasons. For example. grain yields with no-till were more than I t/ha less than those from burned plots at Gurley in 1986, Breeza in 1987 and Winton and Warialda in 1988, and more than 2 t/ha less at Croppa Creek in 1988.

Overall, the productivity of no-till and mulched systems was similar with stubble mulching having yield advantage compared to no-till in excess of I t/ha only at Croppa Creek in 1988. so the cultivation effect was small. Removal of residue by burning. followed by cultivation during the fallow tended to produce highest yields. so that in these experiments, retention of stubble rather than cultivation was the important factor in reducing yields.

Fallow management and soil nitrate-N

The supply of available N may be decreased by no-till, as was found in a long term trial at Hermitage in southern Queensland (6): a combination of zero tillage and stubble retention resulted in less nitrate-N in the soil profile prior to planting after fallow. We observed that considerable variation occurred between sites and seasons in the amount of nitrate-N prior to planting. This could be a major factor in accounting for reductions in yield under no-till in some seasons. One such season was 1988, when soil profiles were full of water at planting due to a wet autumn following a very dry fallow. In this case, difference in soil water across treatments was not a factor, but variation in nitrate-N was large. It was the major factor accounting for yield variation at the three most northern sites Croppa Creek, Gurley and Warialda (Fig. 1). where soil nitrate-N was lowest under no-till and highest in burned treatments.

The pros and cons of no-till

It is understandable that, given the lower grain yields from no-till continuous wheat, growers have been slow to change from their traditional farming practices. The disincentives of lower productivity, a greater level of management skill. and possibly higher costs appear to outweigh those of conserving soil. Limitations upon no-till technology at present include lower nitrate-N. possibly lower water use efficiency (5) and higher disease levels (3). However, it is likely that when more is learned about managing nitrogen in these systems. and the possibilities for improved productivity in crop rotation fully explored, these limitations might be overcome. We have observed, however, since the commencement of this and similar programs in Queensland, that although not having widely adopted no-till. many growers have reduced from 5 - 6 to 2 - 3 the number of cultivations made during the fallow.

Figure I. The relationship between wheat grain yield and soil nitrate-N at planting for no-till (N). stubble burned (B) and stubble mulched (M) treatments at Croppa Creek. Gurley and Warialda in 1988.

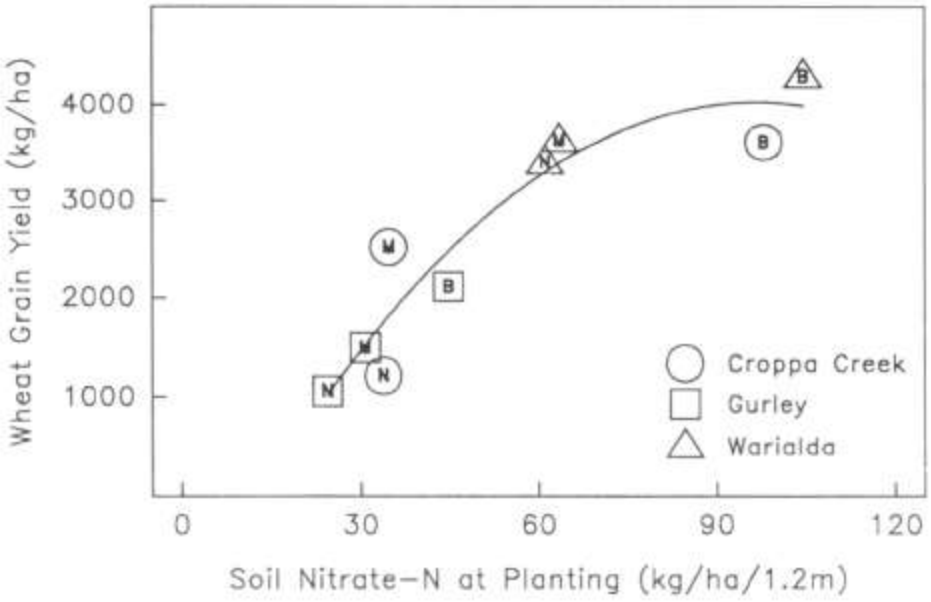

Table 1. Grain yield for continuous wheat cropping under no-till, stubble burned and stubble mulched fallow practices at five sites in northern NSW. 1983-90.

Site	Year	Crop yield (t/ha)			
		No-till	Stubble burned	Stubble mulched	s.e. of difference
Breeza	1983	3.32	3.14	3.22	0.10
	1984	2.64	3.12	2.87	0.12
	1985	1.32	2.14	1.65	0.21
	1986	3.42	3.43	3.21	0.11
	1987	2.36	3.46	2.49	0.11
	1988	2.13	2.39	1.35	-
	1989	2.24	2.95	2.40	-
Croppa Creek	1983	4.42	4.34	4.35	0.19
	1984	2.23	2.66	2.54	0.31
	1985	3.12	3.62	3.18	0.33
	1986	2.59	2.83	2.51	0.13
	1987	2.34	2.19	2.06	0.17
	1988	1.33	3.66	2.54	0.19
	1989	1.93	2.33	2.19	0.13
	1990	2.06	2.66	2.48	0.27
Gurley	1983	3.42	3.36	3.49	0.12
	1984	1.01	1.27	1.23	0.09
	1985	2.55	2.55	2.49	0.13
	1986	2.38	3.44	3.10	0.13
	1987	1.89	2.66	1.99	0.14
	1988	1.08	2.08	1.45	0.11
	1989	2.05	2.05	2.09	0.10
	1990	2.41	2.48	2.78	0.13
Warialda	1983	4.05	3.79	3.58	0.23
	1984	3.69	3.68	3.50	0.15.
	1985	2.81	2.67	2.64	0.13
	1986	3.47	3.22	3.11	0.18
	1987	2.31	2.40	2.75	0.16
	1988	3.14	4.22	3.73	0.18
	1989	3.56	3.28	3.24	0.21
	1990	3.56	3.86	3.07	0.30
Winton	1983	2.94	3.51	3.26	0.23
	1984	1.41	1.32	1.18	0.22
	1985	2.47	2.39	2.28	0.18
	1986	1.59	2.13	1.75	0.18
	1987	1.85	2.57	2.14	0.17
	1988	1.34	2.44	1.48	0.17
	1989	1.89	2.03	1.29	0.19
	1990	3.19	3.43	3.23	0.24
Mean		2.50	2.87	2.56	

Despite the limitations with no-till. many farmers acknowledge that their current cropping practices have lead to a decline in productivity and profitability and arc not viable in the long term.

The work reported in this paper highlights that eliminating tillage alone, even if effective alternative methods of controlling weeds are available, will not achieve a more sustainable farming system. Although it is a very important initial step in reducing soil erosion potential. other initiatives are required to overcome problems such as nitrogen fertility and diseases.

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