Nitrogen fertilisation of wheat under different fallow management practices in near south west Queensland

G.A. Thomas, G. Gibson, R.G.H. Nielsen, W.D. Martin, B.J. Radford, G.B. Wildermuth and J.P. Thompson

Queensland Department of Primary Industries,
Queensland Wheat Research Institute, PO Box 2282, Toowoomba QLD 4350
Hermitage Research Station, M.S. 508, Warwick QLD 4370
Biloela Research Station, PO Box 201, Biloela QLD 4715

Summary. An experiment in the near south-western area of Queensland studied the effect of a range of fallow management practices on annual wheat production. In a drier growing season, zero tillage with stubble retained gave similar or higher grain yields compared to more frequent or aggressive tillage treatments, as a result of greater soil water storage. In a wetter growing season, zero tillage with stubble retained gave lower yields than other treatments, even with the addition of nitrogen fertiliser. A greater incidence of a number of plant diseases occurred in zero tillage with stubble retained, although their effect on yield was not quantified.

Introduction

In the near south-western grain growing area of Queensland, annual rainfall is relatively low (560 mm) and unreliable and annual evaporation is relatively high (1760 mm). Crop growth and yield are largely dependent on soil water stored during a six to eight month fallow period between crops.

An experiment was conducted under annual wheat production between 1983 and 1987 in the Billa Billa district (approximately 40 km north of Goondiwindi) to determine the effect of a range of fallow management practices on soil water storage, soil nitrate accumulation and crop growth (1). Combining zero tillage with stubble retention generally stored more soil water but less soil nitrate than other treatments. Zero tillage with stubble retained outyielded the more frequent or aggressive tillage treatments in drier growing seasons due to improved moisture supply but was outyielded in wetter seasons, when its growth and yield were considered to be limited by lower soil nitrate levels.

In order to determine whether lower yields, under zero tillage with stubble retained in wetter growing seasons, were associated with lower nitrogen fertility, nitrogen fertiliser treatments have been imposed on the original treatments since 1988. This paper reports on results from selected treatments in the 1988 and 1989 wheat crops.

Methods

Treatments included tillage frequency (zero, reduced and frequent), primary tillage with either a disc or blade plough and stubble (crop residue) retention or removal (1). Reduced and frequent tillage treatments received an average of two and five tillage operations during the fallow period, respectively. Secondary tillage was carried out with a scarifier or tine cultivator in all treatments. Since 1988, the main treatment plots (30x6 m) have each been split into three subplots (10x6 m) to which 0, 20 or 60 kg N/ha have been applied each year at planting as urea, drilled into the soil in a band 12.5 cm from the seed rows which were at 25 cm spacings. All treatments received an annual basal application of 20 kg P/ha as triple super (19.4% P, 2% S, 18.5% Ca), banded with the seed at planting. Wheat (cv. Hartog) was planted on 19 May 1988, following a wheat crop in 1987, and on 25 May 1989.

Soil water content was determined to a depth of 1.2 m at planting and maturity in the 0 and 60 kg N/ha treatments, using a neutron probe. Soil nitrate-N levels were determined to a depth of 1.2 m prior to planting in all treatments. Grain yield adjusted to 12% moisture content was also determined for all treatments. Crop water use was calculated as the difference between soil water content to a depth of 1.2

m at planting and at maturity, plus rainfall received between these times. Runoff was not measured but, from observation, appeared to be negligible during crop growth in both years.

Results and discussion

Soil water content at planting was relatively high in both 1988 and 1989, following above-average autumn rainfall in both years. Zero tillage with stubble retained had significantly (P<0.05) higher soil water content at planting than frequent disc tillage treatments in the 1989 crop (Table 1), as observed in previous years (1), due to greater water storage at a depth of 3090 cm.

Table 1. Available soil water and soil nitrate-N prior to planting of 1988 and 1989 wheat crops in zero (Z), reduced blade (RB) and frequent disc (FD) tillage, each with stubble removed (S-) or retained (S).

			Soil nitrate-N (kg/ha), 0-1.2 m			
	Available soil water (mm), 0-1.2 m		1988	1989 N rate (kg/ha)		Mean
Fallow treatment	1988	1989		0	60	
ZS-	151	129	286	91	238	165
ZS	154	142	142	71	121	96
RBS-	150	132	222	132	115	124
RBS	157	136	212	82	161	122
FDS-	148	122	324	212	245	229
FDS	148	121	283	181	196	189
Mean	151	130	245	128	179	154
l.s.d. (P=0.05):						
Fallow treatment means (F)	ns	18	128			78
N rate means (N)	na	ns	na			23
F x N interaction	na	ns	na			ns

As in previous years (1), soil nitrate-N levels at planting in 1988 and 1989 were generally lower in zero and/or reduced tillage treatments and with stubble retention (Table 1). Mean soil nitrate-N levels before planting of the 1989 crop were significantly (P<0.05) higher where 60 kg N/ ha had been applied at planting in 1988 (Table 1), indicating that the N fertiliser applied to the 1988 crop was largely unused.

The 1988 wheat crop gave relatively high yields due to the favourable seasonal conditions experienced (197 mm rainfall during crop growth) (Table 2). As in previous years under such conditions (1), zero tillage with stubble retained gave significantly lower (P<0.05) yields than most other treatments even with the addition of 60 kg N/ha, although there was a significant (P<0.05) mean yield response to N application. Although crop water use was similar for most treatments, efficiency of water use for grain production was significantly (P<0.05) lower for zero tillage with stubble retained (Table 3). These results indicate that yields from zero tillage with stubble retained were limited by factors other than nitrogen fertility in this season. The number of root-lesion nematodes, *Pratylenchus neglectus,* in the soil prior to planting was higher in zero tillage than cultivated treatments, although the numbers were not considered to be high enough to be a major problem. Also, the incidence of crown rot, *Fusarium graminearum,* and yellow spot, *Pyrenophora tritici-repentis,* was greater in zero tillage with stubble retained than in frequent disc tillage treatments, although the effect of these differences on grain yield was not quantified.

Table 2. Grain yields for 1988 and 1989 wheat crops in zero (Z), reduced blade (RB) and frequent disc (FD) tillage, each with stubble removed (S-) or retained (S).

	Grain yield (t/ha)							
	1988				1989			
	N rate (kg/ha)			Mean	N rate (kg/ha)			Mean
Fallow treatment	0	20	60		0	20	60	
ZS-	4.30	4.34	4.46	4.36	2.02	2.20	2.40	2.21
ZS	3.08	3.30	3.52	3.30	2.68	2.40	2.12	2.40
RBS-	4.19	4.14	4.28	4.21	2.51	2.26	2.53	2.43
RBS	3.68	4.12	4.26	4.02	2.41	2.33	2.29	2.34
FDS-	3.50	4.31	4.11	3.97	2.25	2.16	1.81	2.07
FDS	4.24	4.47	4.00	4.24	2.22	2.18	2.00	2.14
Mean	3.83	4.11	4.11	4.02	2.35	2.26	2.19	2.27
l.s.d. (P=0.05):								
Fallow treatment means (F)				0.53			0.37	
N rate means (N)				0.14			0.10	
F x N interaction				ns			ns	

The 1989 wheat crop gave lower yields due to a drier growing season (97 mm rainfall during crop growth) (Table 2). As in previous years under similar conditions (1), zero tillage with stubble retained gave higher yields than frequent disc tillage, as did reduced blade tillage. Yields tended to decline with N application. Grain yields followed similar trends to available soil water at planting (Table 1) and crop water use (Table 3), so that efficiency of water use (Table 3) was similar for most treatments.

Reduced tillage practices, coupled with stubble retention, generally result in improved fallow soil water storage in this environment, but the potential for higher yields is not always realised in wheat monoculture under zero tillage, especially when good rainfall occurs during the growing season. Certain plant diseases appear to be associated with lower yields under zero tillage with stubble retained in these situations. Further research is needed to define more clearly the importance of these factors in production of wheat under zero tillage and to study management strategies to eliminate or minimise their effects, such as late-fallow burning of crop residues and rotation of wheat with non-susceptible crops or pastures.

Table 3. Crop water use and efficiency of water use for grain production for 1988 and 1989 wheat crops in zero (Z), reduced blade (RB) and frequent disc (FD) tillage, each with stubble removed (S-) or retained (S).

Fallow treatment	Water use (mm) 1988 N rate (kg/ha) 0	60	Mean	1989	Efficiency of water use (kg/ha/mm) 1988 N rate (kg/ha) 0	60	Mean	1989
ZS-	276	293	285	187	15.5	11.0	12.5	11.8
ZS	275	293	284	214	11.7	13.1	9.6	11.4
RBS-	277	291	284	196	15.0	12.8	12.9	12.9
RBS	285	281	283	206	14.1	11.5	11.4	11.5
FDS-	286	278	282	188	13.5	11.5	9.9	10.7
FDS	274	283	279	180	14.8	12.8	10.8	11.8
Mean	279	287	283	195	14.1	12.1	11.2	11.7
l.s.d. (P=0.05)								
Fallow treatment means (F)			ns	19	2.1			1.7
N rate means (N)			5	ns	ns			0.6
F x N interaction			ns	ns	ns			ns

Acknowledgments

This project was conducted on the property of S. and D. Ford, Moruya', Billa Billa and was funded by the Wheat Research Committee for Queensland.

Reference

1. Radford, B.J., Gibson, G., Nielsen, R.G.H., Butler, D.G., Smith, G.D. and Orange, D.N. 1991. Soil Tillage Res. (in press).