Nitrogen fixation, growth and yield of summer crops under two tillage systems

D.F. Herridge & J.F. Holland

N.S.W. Department of Agriculture, Agricultural Research Centre, R.M.B. 944, Tamworth, 2340

Reduced rates of mineralization of organic nitrogen under no-tillage combined with enhanced immobilisation of mineral nitrogen and denitrification may result in levels of soil available nitrogen insufficient for crop growth (1). Nitrogen fixing grain legumes can play an important role in maintaining the optimum nitrogen economy of subsequent crops in no-tillage cropping systems especially if supplemented by precise applications of fertilizer-N. Accordingly, experiments are in progress to examine the effects of fallow and tillage treatments on growth and yield of six summer crop species, four of which are legumes, and levels of soil available nitrogen and nitrogen fixation by the legumes.

Methods

Details from two sites (A & B) are reported. Soil type at both sites was an alkaline, self mulching black clay. Design was randomized complete block with the main plots of no-tillage fallow (NTF), cultivated fallow (CF) and double crop split for species (see Table 1). Weed control in the NTF was obtained using 2,4-D and glyphosphate. The cultivated fallows were worked with tined tillage implements. Sowing dates were 4 January 1983 (A site) and 18 December 1983 (B site). Methods used to measure soil available nitrogen and to assess nodulation and nitrogen fixation were previously described (2).

Results and Discussion

At both sites there was a general response in plant growth to no-tillage (Table 1). The response was greatest in absolute and relative terms for soybean, pigeonpea (1983 & 1984), sorghum (1983) and sunflower (1984). The relationships between plant growth and grain yield were not entirely consistent. In the dry 1983 season (194 mm rainfall during the 4 month plant growth season) responses in plant growth to no-tillage tended to be greater than responses in grain yield. The reverse trend was evident in the 1984 season (527 mm rainfall).

Table 1. Responses in total crop dry matter and grain yield to no-tillage for the six species at the two sites.

	Crop dm increase with NTF compared with CF		Grain yield increase with NTF compared with CF	
	A site	B site	A site	B site
	t ha^{-1} (%)		t ha^{-1} (%)	
soybean	1.64 (60)	3.27 (37)	0.40 (46)	0.45 (16)
cowpea	0.42 (17)	0.07 (1)	0.05 (7)	0.47 (35)
mungbean	0.46 (26)	-0.16 (-2)	0.02 (2)	0.19 (10)
pigeonpea	1.33 (38)	2.50 (41)	0.10 (10)	0.46 (19)
sunflower	0.33 (11)	1.46 (21)	0.17 (12)	0.43 (29)
sorghum	1.78 (42)	0.25 (2)	0.75 (41)	0.06 (1)

At sowing, the A site contained 801 more nitrate than the B site (mean of both tillage treatments, 0 to 120cm depth). There was an average 24% more nitrate in the cultivated soils than in the no-tillage soils. As a result, nodulation by all legumes was effectively suppressed at the A site. At site B, nodulation and nitrogen fixation by Forrest soybean was significantly greater under no- tillage relative to the cultivated treatment. At this site, tillage had no effect on nodulation by cowpea, mungbean and pigeonpea.

1. Ebelhar, S.A., Frye, W.W. and Blevins, R.L. 1984. Agron. J. 76, 51-5.

2. Herridge, D.F., Roughley, R.J. and Brockwell, J. 1984. Aust. J. Agric. Res. 149-61.