Soil water and nitrogen dynamics of stubble-retained cropping systems for dryland wheat

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Stubble retention in dryland cropping systems contributes to soil and water conservation and also to greater crop productivity. Productivity is increased primarily by more efficient utilisation of water, the major limiting factor in dry environments. However, other constraints such as nitrogen supply and soil type interact strongly with water availability. This paper summarises the soil water and nitrogen changes over a period of four seasons of stubble retention and reduced tillage in the Wimmera and Malice districts of Victoria.

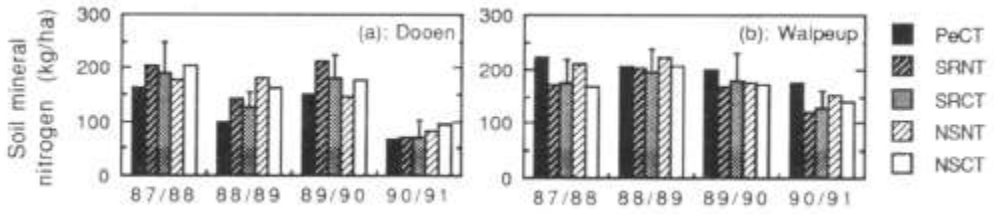
Methods

The field experiments were commenced in 1987 at the Wimmera Research Station, Dooen, Vic. (annual rainfall; 420 mm, grey self-mulching clay (chromic vertisol) Ug 5.2) and the Mallee Research Station. Walpeup, Vic. (annual rainfall; 340 mm, solonised brown soil Gc 1.2). The specific effects of stubble retention and mechanical *versus* chemical weed control were evaluated in a 2 x 2 factorial randomised block design of four fallows with (SR) and without (NS) stubble (6 t/ha), with tyned tillage (CT) and without (NT) (zero tillage). Stubble was removed with a lawn mower and hand rake. A continuously cropped rotation (pea-wheat) was used as a control (PeCT).

Results and discussion

At Dooen, on the vertisol, the common fallow (no stubble and cultivated; NSCT) increased soil water storage, by sowing, on average by 76 mm (range 24-122 mm) above the continuously cropped pea/wheat rotation. Stubble retention added a further 52 mm (range 36-65 mm). Zero tillage was slightly beneficial, but was largely eclipsed by the presence of stubble. At Walpeup, on a solonised brown soil. the common fallow system provided an average of 37 mm (range 23-56 mm) more water at sowing than the pea/wheat rotation. Stubble retention together with zero tillage increased water storage by 27 mm in only one year.

Figure 1. Soil mineral nitrogen accumulation in four years at two sites. Error bars arc l.s.d.'s (P=0.05) for individual treatment comparisons



At Dooen, soil mineral nitrogen (SMN) accumulation was nearly always less than at Walpeup despite twice the total soil organic N at Dooen (Dooen 0.11%, Walpeup 0.05%). At Dooen the common fallows accumulated, by sowing. 46 kg N/ha more SMN than the pea/wheat rotation (Fig. la). Stubble retention depressed SMN by 26 kg N/ha in 2 of the 4 years. In one year SMN was increased by 20 kg N/ha. There was significant annual variation in SMN ranging from 66 to 215 kg N/ha. At Walpeup the pea crop increased SMN in 2 out of the 4 years by an average of 46 kg N/ha above the common fallow (Fig. 1). Zero tillage without stubble retention increased SMN by 44 kg N/ha in only one year.

Reduced tillage, primarily stubble retention, offers consistent and large increases in soil water storage on heavy textured clay soils with the possibility of significant reductions in SMN. On the lighter sandy loam soils the gains in soil water storage are less frequent and are unlikely to be justified in terms of additional

water use or improved N nutrition of subsequent wheat crops. Computer simulation models are being tested to extrapolate the observed responses to a wider rats' of weather patterns and to intermediate soil types.