Crop nitrogen management and conservation cropping

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Key messages

- Tillage or stubble management did not affect soil mineral nitrogen at sowing.
- Wheat crops grown in a burn-cultivate system recovered more nitrogen than those grown in a retained stubble-direct drill system, apparently because of greater nitrogen demand.

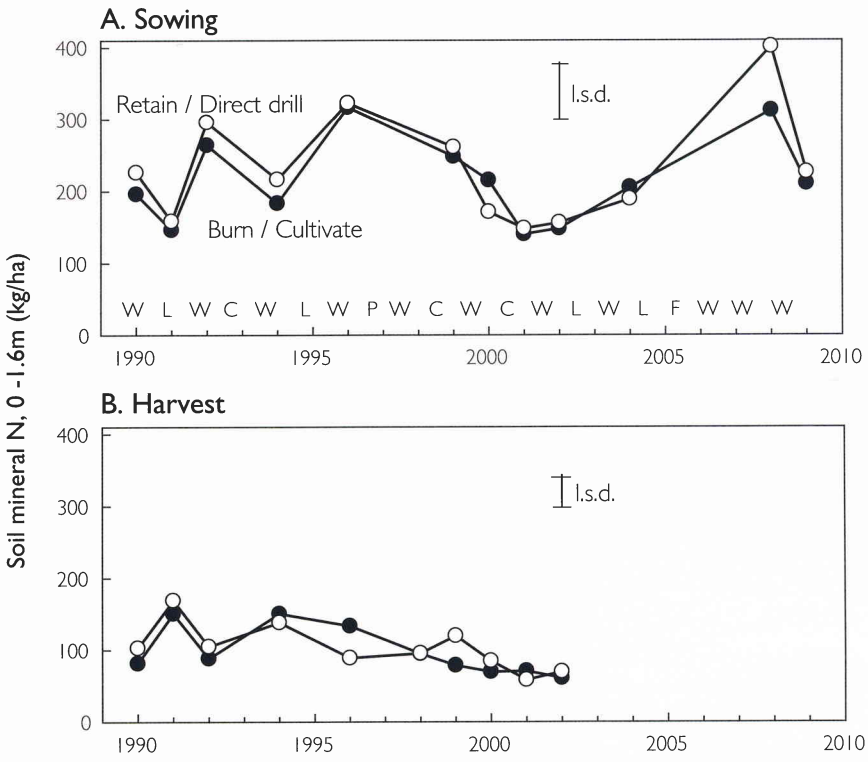
Background

Crops obtain nitrogen (N) from the soil when it is converted from organic to mineral forms by the process of mineralisation. The rate of mineralisation depends mainly on temperature, soil water and the amount and forms of organic nitrogen in the soil. All are affected by tillage and stubble management, so nitrogen measurements were a key part of the Harden long-term experiment. The components of mineral N are ammonium, which is confined to the topsoil, and nitrate, which can leach through and beyond the 1.6 m of rootzone.

Soil mineral N

Soil nitrate and ammonium levels in the root zone varied between 100 and 400 kg/ha over the period of the experiment (Fig. 1a). There was no significant difference between the levels in soil managed by stubble burning with cultivation (BC) and soil managed by stubble retention with direct drilling (RDD). The average levels are high by district standards and reflect the legacy of the previous perennial pasture. Crops received topdressed N fertiliser in 7 years of the 20 years, in amounts ranging from 20 to 110 kgN/ha depending on the status of soil water and mineral N. Our intention in managing fertiliser was that N level did not limit yield or the rate of straw decomposition.

There is no sign of decrease in mineral N over the 20 years. The fluctuations are due to the balance of inputs from mineralisation and the removals by crops and losses such as leaching. For example levels rose after the lupin crops (1991, 1995 and 2004) and after the dry years from 2002 to 2007 when crop uptake was low. There were also no effects of crop management on soil mineral N sampled at maturity (Fig. 1b). At that stage levels were much lower and were more uniform over time. Nevertheless mineral N may have limited growth at some stages of development in some seasons. One example was in 1990 when winter rain leached mineral N below the roots. Another was in 1996 when later sown crops were N deficient because of leaching.



> Figure 1. Mineral N (nitrate plus ammonium) at sowing at sowing and harvest.

Crop N

The amount of N in wheat crops varied between years (Fig. 2). The low values were in the droughts in 1994 and 2002 and also in 1990, probably because of nitrate leaching and rhizoctonia during the wet winter. B-C wheat crops contained more N than R-DD crops in 1998 but not in the other years. Since the soil contained the same amount of mineral N at sowing, it is likely that the differences were due to the N demand by the crops.

When plant nitrogen is expressed as a percentage of the supply there was a significantly greater recovery from B-C than R-DD (Fig. 3). In this case N supply is calculated as the amount present at sowing (Fig. 1) plus nitrogen fertiliser and in-crop mineralisation, estimated using the Lime and Nutrient Balance (www.grdc.com.au/lnb).

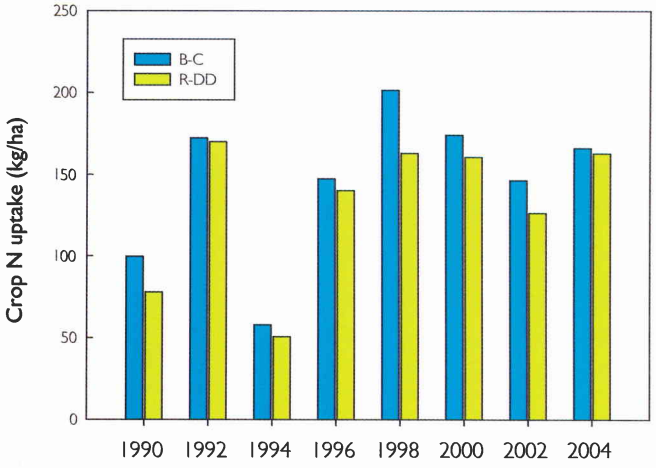
Practical implications

The level of soil mineral N was consistently high after many years of continuous cropping system, raising questions about the need for supplementary fertiliser. Nitrogen uptake by crops was a small fraction of the soil N supply and was greater with B-CC than R-DD. This result indicates that the demand for nitrogen is at least as important as the supply in deciding on fertiliser application.

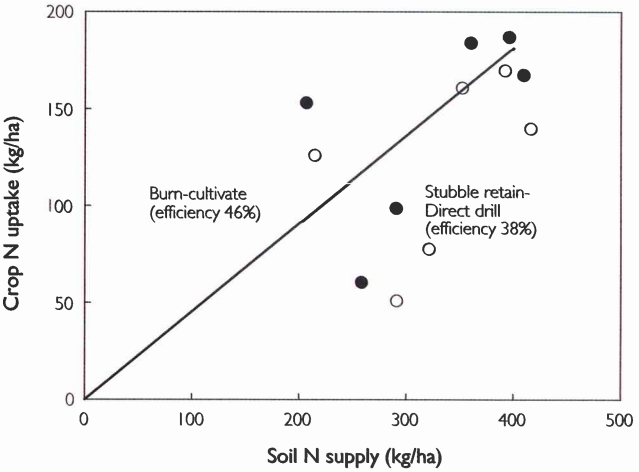
Further reading

Angus, J.F., Bolger, T.P., Kirkegaard, J.A. and Peoples, M.B. (2006) Nitrogen mineralisation in relation to previous crops and pastures. *Australian Journal of Soil Research* 44: 355-365.

Angus, J.F., van Herwaarden, A.F., Fischer, R.A., Howe, G.N. and Heenan, D.P. (1998) The source of mineral nitrogen for cereals in southeastern Australia. *Australian Journal of Agricultural Research* 49: 511-522.



> Figure. 2. Nitrogen contained in the above-ground parts of wheat crops at maturity. B-C: burnt stubble and cultivated; R-DD: retained stubble and direct drilled.



> Figure. 3. Crop N uptake in relation to the supply of mineral N. Wheat crops managed by burn-cultivation (●) recovered 46% of the supply, which was significantly greater than the 38% recovered by stubble retain-direct drill crops (o). B-C: burnt stubble and cultivated; R-DD: retained stubble and direct drilled.