

Healthy soil and free nitrogen

The dynamics of soil nitrogen and its availability vary markedly under different farming systems in the Mallee. This is one of the findings of David Roget and Bill Davoren, CSIRO Sustainable Ecosystems and Vadakattu Gupta, CSIRO Entomology who have studied the dynamics of nutrient availability and soil organisms in Mallee soils at the project's core sites at Waikerie (S.A.), and Kerribee station (NSW), for the past eight years. Their findings cumulate in some radical changes in recommendations for nitrogen management in the Mallee that have positive implications for profitability and the environment.

Traditionally rotations in the Mallee consisted of wheat followed by a medic pasture or wheat followed by a long fallow. However, intensive crop rotations have resulted in significant improvements in soil microbial activity ensuring that nitrogen is retained in the system in its microbial form, rather than being lost to the environment through leaching of mineral nitrogen.

Where medic populations are actively fixing nitrogen or following a long fallow during a dry summer and autumn considerable amounts of nitrogen can be available to the following crop. However, in many medic pastures across the Mallee medic growth was found to be poor or the symbiotic activity of the nitrogen fixing rhizobia bacteria was restricted by root disease, herbicide residues or dry conditions and consequently levels of nitrogen fixation were low.

Even when nitrogen fixation was adequate much nitrogen was leached from the soil following summer and autumn rainfall events. Losses of up to 50kg N/ha were recorded after pasture or during the fallow phase. In long fallow it was only in dry years where a nitrogen benefit was recorded and this, rather than extra soil water, was more likely to be responsible for any crop improvement following a long fallow.

Management of nitrogen under intensive cereal cropping systems is more critical due to the annual removal of nitrogen but the intensive system was found to be less dependent on fertiliser nitrogen than previously considered. The reason for this lay in improved microbial populations and activity.

The sandy nature of Mallee soils together with low levels of organic matter dictate that the 'background' level of soil microbial activity is low. Intensive cropping results in annual additions of organic matter in the form of stubble and roots; these are a vital food source for soil organisms. More food equals increased microbial activity and the practical benefits of increased microbial activity have been multiple.

Two major benefits relate to nutrient retention and availability. An average of 20kg/ha/year of nitrogen derived from microbial activity has been recorded under the intensive cropping rotations. This nitrogen is from free living rather than symbiotic bacteria and is sufficient to supply 30-50 per cent of the total, long term nitrogen requirement of an intensive cereal based farming system.

Secondly, the combination of high stubble loads and high microbial activity results in nitrogen tie-up. This means negligible levels of available nitrogen in the soil over summer and early autumn and consequently minimal leaching by rainfall events.

High populations of soil microbes provide a store of nutrients that become available at different rates during the growing season. This can be especially beneficial in seasons with favourable spring rains. The rain triggers both crop growth and nitrogen mineralisation. In soils with stores of microbial nitrogen this mineralisation can meet the plants requirements without the need for and added risk of top-dressing extra fertiliser. However, David Roget cautions that this microbial store is unlikely to be able to supply sufficient nutrients when there is a run of favourable seasons.

The increased input of carbon in the form of stubble and roots from intensive cropping was found to change the activity and composition of the microbial community. The proportion of beneficial to pathogenic organisms improved resulting in suppression of diseases such as take-all and rhizoctonia. In some soil types suppression increased to the point where diseases were completely controlled. The lower level of available nitrogen in summer helps optimise the populations of disease suppressive micro organisms.

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