LEADA

Lower Eyre Agricultural Development Association

Stubble Guidelines

Managing Nitrogen for Productivity and Profit in Stubble Retained Systems on Lower Eyre Peninsula

Local Management Guideline for the GRDC Stubble Initiative Project (LEA0002)

The best management practice for nitrogen (N) depends on the specific combination of soil, season, crop and grower preference for yield verses profit maximisation.

As cropping systems continue to intensify on the Lower Eyre Peninsula (LEP), the pressure to manage N fertiliser for the most efficient outcome grows in parallel. LEADA trials have demonstrated that fertiliser use efficiency or the amount of extra N exported in a crop is generally less than 50% of the fertiliser N applied.

Approximately 80% of a LEP farm variable budget is spent on chemicals including fertiliser. The profit-risk incentive for optimised management of N is high. Grower surveys indicate that the management of N on LEP farms is changing with a view to increase fertiliser efficiency and profitability. There are significant gaps in our knowledge of how to easily make decisions that optimise the returns from N inputs.

Nitrogen losses and gains in Lower EP cropping soils

There are a number of processes that control the supply of N to crops. Net gains come from fertiliser input and mineralisation of N in soil. Losses in plant available N are immobilisation (temporary), volatilisation, leaching and denitrification

The processes that drive the net gains and losses of N in cropping systems are inherently variable and difficult to measure. However, a basic grasp on the processes at play does mould how we set up strategies for the management of N (eg. smaller amounts of N more often in leaching prone soils).

Nitrogen in soil is predominantly present in the organic form (generally **>80%**). The remainder of N is in the inorganic (mineral-nitrate and ammonium) form and this is the form of N most readily available to plants. Mineral N is the form of N that is most commonly measured when soil testing for N. Nitrate is the dominant form of mineral N taken up by agricultural crops.

Mineralisation is the conversion of organic N to plant available inorganic forms. This process is facilitated by the presence of moisture, warm temperatures and a carbon source for the microorganisms. Mineralisation is negligible at soil temperatures below 5°C, reduced at 5-15°C and optimal at 15-28°C. In SA research has shown net N mineralisation ranged from 0.5-4.3 kg N/ha/day, equal to approximately 15-120 kg through the growing season.

Immobilisation is the conversion of inorganic to organic N by microbes or plants. This process generally 'ties up' soil N early in the cropping season as the microbes work to decompose the mature crop residues over the summer fallow.

When urea is added to soil, there is a risk of loss of N through volatilisation which is the conversion of urea to ammonia gas. The risk of loss is increased if the urea is applied when there is no rain event to wash the N into the soil. Data from Australia suggest ammonia volatilisation of around 5-10% is common.

Texture contrast soils of Lower Eyre Peninsula prove challenging in terms of managing N fertiliser inputs efficiently Fertiliser N losses on waterlogging soils are usually attributed to denitrification and leaching. Soils with a high sand content are especially vulnerable to the leaching of N as the soil has a very low capacity to retain N in the surface layers due to low levels of clay or organic matter. In a WA study leaching losses were in the order of **3-4%** (14-72 kg N/ha) of nitrate N in the profile.

The amount of nitrate-N lost through denitrification will increase with the duration of waterlogging and becomes significant after 2-3 days of continued waterlogging. The time since urea fertiliser applied is an important determinant of the magnitude of nitrate-N lost in a waterlogging event. If it is only 2-3 days since urea was applied it is less likely to have been converted to nitrate-N and is more resistant to these loss pathways.

Role of Nitrogen in developing crop yield

Nitrogen is important early in the growth cycle of wheat for the determination of tiller formation and spikelet and floret number and later in the growth cycle it is important for the filling of grain and the accumulation of grain protein. There can be a mismatch in the soil supply of and crop demand for nitrogen. This is especially the case in mid-winter when crops are tillering but conditions are cold and on LEP soils are potentially waterlogged. This is a particularly important time to ensure that the N supply to crops is managed with fertiliser applications.

Simulation work on a texture-contrast LEP soil shows the crop demand for N over the growing season. It shows that the crop have a lag in demand until later in the season while N fertilisers tend to have a small lag and then a relatively linear release pattern. Recovery of N applied as Urea is typically 30-50% in the year of application, at the lower end of this value in waterlogged soils.

Continuous cropping will reduce the amount of N supplied to crop plants through mineralisation of N due to the rundown in organic N reserves. The inclusion of legumes in the system can increase the amount of organic N in the system and the rate of mineralisation of organic N in subsequent cereal crops.

The supply of N from a prior legume does not synchronise well with crop demand. An example is the effect of early Autumn rains on legume residues which may cause them to mineralise N in warm soils prior to the timing of crop demand.

Nitrogen Use Efficiency

Several Lower EP paddocks were monitored for wheat crop N use efficiency in the 2015 and 2016 growing seasons. N use efficiency was determined according to the following:

$$\text{Nitrogen Use Efficiency} = \frac{\text{Nitrogen Yield}}{\text{Fertiliser N Supply + Presowing Mineral N + Soil N Supply In-season}}$$

Where:

$$\text{Nitrogen Yield} = \text{Grain Yield (kg/ha)} \times \frac{\text{Protein}}{0.567}$$

$$\text{Fertiliser N Supply} = \text{Fertiliser added} \times \text{estimated efficiency} (\approx 0.5)$$

Pre-sowing Mineral N at 0-60 cm depth

$$\text{Soil N Supply In-season} = \text{Estimate of the amount of N a soil will supply to a crop in a growing season}$$

N use efficiency varied according to soil type and residue type with no consistent effect of a legume residue on N use efficiency when compared with canola residue. There was a wide variation in efficiency from just 12% on a leaky sand over gravel up to 68% on a fertile deep clay. The lowest efficiency was the result of a high carryover of N from the pre-sowing mineral N (reflected in the pre-sow soil test value), relatively high fertiliser input compared with yield potential, a soil prone to leakiness and constraints to soil cycling of N.

Nitrogen efficiency can be managed on farm through;

- Understanding the soil's yield potential through soil testing and adjust fertiliser N inputs accordingly,
- Understanding how prone to leakiness the soil is and adjust how much and when N fertiliser is applied if possible,
- Measuring pre-sowing mineral N and adjust early fertiliser inputs if levels are high relative to yield potential,
- If there are productive non-cereal options, considering their inclusion for longer term sustainability of N cycling.

Contributors

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