DEPARTMENT OF
PRIMARY INDUSTRIES

Crop management and nutrient runoff

The role of crop management in the high rainfall zones (HRZ)

Nutrients are an essential part of productive crop production and it is crucial they are used in a way that minimises their impact on the environment.

The key factors in the export of nutrients from cropped paddocks are likely to be:

- soil structure and infiltration rate;
- the cropping practice in place (e.g. stubble burning vs. stubble retention and direct drilling vs. conventional cultivation);
- the timing of fertiliser application in relation to rainfall (soil wetness); and
- the paddock and farm layout and the ability to retain, detain or clean-up runoff water before it leaves the property.

Tillage, stubble management and nutrient loss

As part of the project 'Management of high rainfall cropping to improve water quality and productivity', research at Rutherglen in the HRZ of north east Victoria using a rainfall simulator has shown that

Cultivation trials used for rainfall simulation experiments at long-term trial site at DPI Rutherglen

crop management techniques can influence nutrient exports in surface runoff. The three tillage systems investigated during the study were: (a) direct drilling with stubble retained; (b) direct drilling with stubble burnt; and (c) conventional cultivation with stubble burnt.

Results from the study undertaken by the Soil Chemistry team at DPI indicate that cultivation and stubble burning increases surface runoff compared to direct drilling and stubble burning. Direct drilling and the retention of stubble decreases the volume of water leaving the paddock compared to direct drilling and stubble burning.

While greater concentrations of nitrogen and phosphorus were measured in runoff from the direct drill treatments, the decrease in the volume of water leaving the paddock, if any left at all, means that less nutrients would end up off-site than from conventionally cultivated systems with stubble burning.

This study showed that total phosphorus and total nitrogen concentrations in surface runoff from all three tillage treatments studied during the rainfall simulation exceeded those recommended by Australian authorities for lowland rivers in southeast Australia, with the exception of total nitrogen from the direct drill with stubble retained treatment.

Fertiliser timing and placement

The length of time between fertiliser application and rainfall that causes runoff has a large influence on the amount of nutrient lost; irrespective of the depth the fertiliser is placed. Research by DPI showed that three days after fertiliser placed at either 1 cm, 3 cm or 5 cm depths, the dissolved form of phosphorus lost in runoff decreased by 29% for DAP and 22% for MAP compared to runoff occurring 8 hours after fertiliser placement.

This supports previous studies from the dairy industry which indicate that while P from slow-release fertilisers can be mobilised, greater P mobilisation is likely to occur if rainfall occurs soon after (within 7 days) application of water-soluble fertilisers.

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While the quantity of phosphorus lost is relatively small, it is enough to contribute to potential water quality problems.

The potential loss of nitrogen is more complicated than phosphorus because it will leach through the soil profile as well as in surface runoff. In the same fertiliser placement study, the movement of nitrogen was the reverse to phosphorus, with the plant absorbed form of nitrogen, or nitrate, in the runoff increasing by 17% when placed at 5 cm depth, compared to when placed at 1 cm depth, regardless of the fertiliser type used. It is unclear why there was increased nitrate in the runoff because this form of nitrogen is expected to leach downward through the profile rather than move to the surface.

Fertiliser type

Studies suggests that more phosphorus is lost in a runoff event from the shallow-placed (1 cm depth) MAP than DAP, while DAP loses more phosphorus than MAP when placed at depth of 3 cm or 5 cm. These results take into account the differences in the percentage of phosphorus in the two fertilisers.

When comparing the nitrogen losses from MAP and DAP with urea if runoff occurs, there is greater loss of nitrogen, as nitrate, from MAP (more than 60% N added is lost) and DAP (approx 60% of nitrogen added is lost) than urea (less than 30% N added is lost). This loss occurred at all soil depths. Further studies are continuing to investigate if the nitrogen loss from broadcast urea is more or less than buried urea.

Runoff

Runoff collected from the automated monitoring sites installed at Hamilton and Cressy as part of the 'Management of high rainfall cropping to improve water quality and productivity' project indicate that the concentrations and forms of phosphorus and nitrogen can be quite variable, but that total nitrogen and total phosphorus concentrations are usually higher than recommended stream concentrations.

At Hamilton the runoff was a result of a combination of surface and subsurface pathways, while at Cressy the majority of water and nutrients lost was via surface runoff.

Runoff at Hamilton was triggered by a 15 mm rainfall event in early July 2007 that resulted in continuous runoff for almost 2 months with another 40+ mm of rain in early August. More runoff occurred after a 70 mm rainfall event in November but this time runoff lasted just 24 hours. Average concentrations of total P were 0.06 mg P/L in July, 0.02 mg P/L in August and 0.14 mg P/L in November. Average concentrations of total N were 23.3 mg N/L in July, 12.3 mg N/L in August and 1.54 mg N/L in November.

After broadcast application of 50 kg of urea on the 1st August and 51 mm of rainfall in July, runoff was collected from the 2nd of August through to 19th August with concentrations of total N ranging from 8.3 – 18.5 mg N/L. The maximum base-flow nutrient concentration of total N recommended in the Glenelg-Hopkins region to prevent the deterioration of aquatic ecosystem health is 1.0 mg N/L. These results would indicate that a sizeable proportion of the applied urea was lost as runoff and urea should not have been applied at this time.

At Cressy, surface runoff was first collected in early July 2007 after an 8 mm rainfall resulting in runoff for a period of approximately 5 hours. In November, after 4 days of rain totalling more than 50 mm, runoff was first collected on the 4th day and continued for approximately 24 hours. Average concentrations of total P were 2.14 mg P/L in July and 0.11 mg P/L in November. Average concentrations of total N were 0.21 mg N/L in July and 1.52 mg N/L in November.

Soil Crusting

Surface crusting can affect flow patterns in cultivated soils. It restricts water infiltration and therefore favours surface rather than subsurface nutrient exports.

If fertiliser is applied on the surface of a soil that is prone to crusting, and is NOT incorporated into the soil, then it will be retained on the soil surface and will then be mobilised by and transported in surface runoff.

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