EFFICIENT NITROGEN USE FOR RICE GROWING

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PHOTO: **Urea applied to the dry soil surface before applying permanent water to a drill sown crop is an efficient method for applying nitrogen to rice. Credit: Tina Dunn**

QUICK TAKE

- **The correct timing and placement of nitrogen fertiliser enables efficient nitrogen use, high grain yield, high water productivity and profitability.**
- **Spreading urea onto dry soil before the application of permanent water is a highly efficient method of applying nitrogen to drill sown rice.**
- **Applying urea into flood water when the rice plants are small results in large losses of nitrogen and is the least efficient use of nitrogen in rice.**

Nitrogen is an important nutrient for obtaining high rice grain yields and a major input cost of the rice production system. The current price of nitrogen fertiliser has made it even more important that nitrogen is used efficiently when growing a rice growing. The more efficient the use of nitrogen the more cost effective and profitable rice growing becomes.

THE most efficient time to apply nitrogen to a rice crop is before applying permanent water, regardless of the sowing or irrigation method (Table 1). The nitrogen attaches to the clay particles and mostly remains in the soil with minimal losses until used by the plant. Positioning the nitrogen in the soil is achieved by either drilling urea into the soil before permanent water for aerial or dry broadcast sowing, or spreading urea onto dry soil before, but close to, permanent water being applied to crops managed by conventional drill or delayed permanent water.

Nitrogen use efficiency of pre-permanent water applied nitrogen is lower for aerial sown crops than for conventional drill and delayed permanent water crops because of the losses that occur before the plant is large enough to start using the nitrogen. Spreading urea onto the dry soil surface before filling up for delayed permanent water crops is the most efficient (Figure 1) as the plants have a large root system and are actively growing, so quickly take up the nitrogen that is washed into the soil and use it to produce plant biomass (Table 1).

Table 1. Nitrogen use efficiency ranges for different nitrogen application timings. These efficiencies are based on the best practice being used for each application method.

Timing	Sowing method	Nitrogen use efficiency	Comments
Pre-permanent water	Aerial and dry broadcast	40–60%	Lower efficiency if urea spread on soil surface than if drilled > 5 cm deep pre-PW
	Conventional drill	50–70%	Best applied to dry soil close to PW application with no rain before PW
	Delayed permanent water	65–75%	DPW may need 25% less nitrogen pre-PW than aerial or dry broadcast
Mid-tillering	–	10–25%	If no urea is applied pre-PW, wait for plants to grow then apply in multiple splits over a month
Panicle initiation	–	30–35%	A full canopy reduces volatilisation losses and a large root system takes up nitrogen quickly

PW = permanent water; DPW = delayed permanent water

PI nitrogen application

Applying nitrogen at PI is less efficient than applying nitrogen at permanent water (Table 1), but this timing has the advantage of being able to measure crop growth using the PI tissue test service and then making an evidence-based decision on how much fertiliser to apply. The more nitrogen deficient the crop, the closer to PI the nitrogen should be applied to maximise potential yield increase.

Normalised difference red edge (NDRE) imagery of the field at PI is valuable to show rice growth differences and provide a guide for zone sampling for the PI tissue test. Normalized difference vegetation index (NDVI) imagery is of little use for rice at PI as the crop biomass is very high, which saturates the NDVI reading, therefore it does not show the true extent of plant growth variability throughout the field.

Late tillering nitrogen to address field variability

Variability in soil nitrogen availability is common in a rice field, particularly after landforming has moved topsoil. When a blanket rate of nitrogen is applied, it is common at PI to see variability in crop growth throughout the field.

It is not recommended to apply nitrogen during tillering, as this timing is relatively inefficient (Table 2). However if the crop, or areas of it, have not reached a PI N uptake of 80 kg N/ha, grain yield potential could be reduced. Where there is large variability in the field, it can be beneficial to obtain NDVI imagery during tillering to identify the poor growth areas that might require an application of nitrogen 2 or 3 weeks before PI.

Least efficient nitrogen application practices

There are several practices when applying nitrogen fertiliser that should be avoided as they result in large losses of nitrogen. These losses are both a direct cost of the lost fertiliser and a potential yield reduction when the crop receives insufficient nitrogen to maximise yield. Practices that should be avoided include:

1. **Spreading urea into a flooded field when plants are very small (up to 70% loss)** – the nitrogen does not move into the soil and the plants cannot take it up before it is lost to the atmosphere through volatilisation.
2. **Drilling urea with seed or into the soil before flush irrigations (up to 50% loss)** – the wetting and drying of the soil from flush irrigations lead to large nitrogen losses by nitrification/denitrification.
3. **Spreading urea onto wet soil before permanent water is applied (up to 30% loss)** – the nitrogen is not washed into the soil when permanent water is applied, and nitrogen is lost from the flood water through volatilisation.
4. **Spreading urea rather than drilling pre-permanent water urea for aerial sown (up to 20% loss)** – if urea is spread on the soil surface rather than drilled > 5 cm deep, nitrogen can be lost before the plants can use it.

The range of the nitrogen losses from these practices is very variable due to many factors such as temperature, soil pH, the time between nitrogen application and permanent water, the time between irrigations, placement and rate.

Applying nitrogen into the flood water when rice plants are small results in large losses of nitrogen and should be avoided. Photo: Brian Dunn

Correct management for best result

Nitrogen is the most important nutrient in terms of quantity required to achieve high rice grain yields. The correct rate, timing and placement of nitrogen fertiliser enables efficient fertiliser use, high grain yield, water productivity and profitability.

Acknowledgements

We acknowledge the input from rice growers and agronomists as well as AgriFutures and NSW DPI for funding the research used in developing this article.

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