Effect of panicle initiation nitrogen timing on rice grain yield

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Key findings

- At all crop nitrogen levels applying nitrogen at panicle initiation (PI) increased grain yield above where no PI nitrogen was applied.
- When crop nitrogen levels are deficient applying nitrogen close to PI increased grain yield above later applications.
- The timing of PI topdressing nitrogen application had no effect on grain yield when crop nitrogen levels were adequate.

Keywords panicle initiation, nitrogen, rice, yield

Introduction

Rice growers have no reliable method to determine how much soil nitrogen (N) will be available to a rice crop before sowing. They rely on their knowledge of cropping history, soil organic N levels, Primefacts (Rice variety guide, https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/summer-crops/rice-development-guides/rice-variety-guide-202122) and agronomists to guide their decision on how much N to apply before permanent water (PW).

Panicle initiation is the second-most efficient time to apply N to a rice crop. As PI is a defined growth stage, crop N level can be measured, and N topdressing recommendations based on experimental results provided to growers and agronomists. The recommended PI topdressing window is from PI to 10–12 days after PI. By applying N at this time, the crop still has the ability to use the N to increase grain yield.

In 2022, many rainfall events occurred around PI that made the aerial application of N very difficult. With wet/unusable airstrips and a back log of jobs, the question was asked 'how late is too late to apply N after PI?'.

Site details

An experiment was established at Rice Research Australia Pty Ltd (RRAPL), Coree, 20 km west of Jerilderie on a self-mulching medium clay soil.

Treatments

Rice variety

The variety grown was V071$^{\phi}$, which is a semi-dwarf, bold, medium-grain rice variety with high yield potential. It has superior grain yield and cold tolerance to Reiziq$^{\phi}$, the most common rice variety currently grown in southern NSW.

Sowing rates

The experiment was sown with a disc drill seeder at 20 cm row spacing with a 140 kg/ha sowing rate. The first flush was on 29 October 2021 and it received 3 flush irrigations before PW was applied on 7 December 2021. Weed control was managed as per commercial recommendations.

Nitrogen treatments

The experiment had 2 replications with N treatments applied as urea at multiple timings:

1. Main plots received N at rates of 0, 60 and 120 kg N/ha applied onto the dry soil before PW.
2. At PI, each main plot was split with N applied at timings of 1, 8 and 15 days after PI. Nitrogen rates of 0, 60 and 120 kg N/ha were applied each time to produce sub-plots 3 m by 2 m in size.

Results

Permanent water nitrogen (PW N)

The addition of N applied before PW increased grain yield from 9.01 t/ha to 11.40 t/ha and 12.89 t/ha for the 60 and 120 kg N/ha rates respectively (Table 1). The N applied at PW also increased total dry matter (TDM) and the number of tillers at harvest, but the latter was not statistically significant.

Plant height increased significantly from 78 cm to 84 cm and 87 cm for the 0, 60 and 120 PW N treatments respectively, while harvest index was significantly lower for the 120 PW N treatment than the other 2 treatments (Table 1).

Table 1 Effect of nitrogen rates applied to pre-permanent water on plant growth and grain yield averaged across all PI N treatments.

PW N (kg/ha)	Plant height (cm)	TDM (g/m^2)	Harvest tillers (No/m^2)	Grain yield (t/ha@14%)	Harvest index
0	78	1420	325	9.01	0.56
60	84	1802	426	11.40	0.56
120	87	2104	490	12.89	0.54
l.s.d. ($P<0.05$)	3.4	90	n.s.	3.09	0.009

l.s.d. = least significant difference, n.s. = not significant.

Panicle initiation nitrogen (PI N)

Applying N at PI significantly increased grain yield above the zero control regardless of N rate or when applied. When averaged across PW N treatments, there was no significant difference in grain yield between the PI N applications for either the 60 kg N/ha or 120 kg N/ha PI application rates (Table 2).

Total dry matter and plant height were increased by additional N at PI, although not always significantly and the number of tillers at harvest was not changed by N applied at PI (Table 2).

Table 2 Effect of PI nitrogen rates and application timing on plant growth and grain yield averaged across PW N treatments.

PI N (kg/ha)	Number of days after PI	Plant height (cm)	TDM (g/m^2)	Harvest tillers (No/m^2)	Grain yield (t/ha@14%)	Harvest index
0	0	80	1652	415	10.17	0.55
60	1	82	1779	415	11.09	0.55
	8	83	1762	407	11.00	0.55
	15	83	1718	393	10.90	0.56
120	1	82	1879	444	11.75	0.56
	8	86	1855	417	11.46	0.55
	15	82	1782	404	11.32	0.56
l.s.d. ($P<0.05$)		2.4	90.1	n.s.	0.57	0.009

l.s.d. = least significant difference, n.s. = no significant difference.

The grain yield interaction between PW N and PI N was not statistically different, but distinct trends can be seen particularly when no N was applied before PW (Figure 1). In the treatment with no PW applied N, grain yield was highest when the PI N application was closest to PI and declined the later the N was applied (Figure 1). This same trend was not apparent when 60 kg N/ha or 120 kg N/ha was applied at PW.

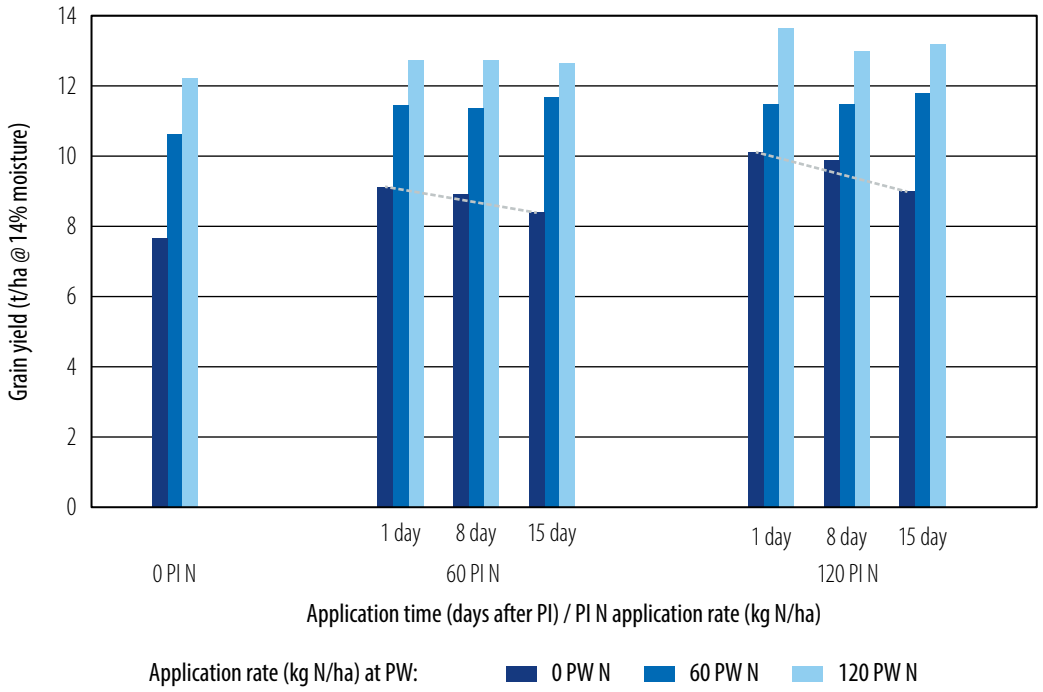

Figure 1 Effect of PI nitrogen application timing on grain yield of rice with 0, 60 and 120 kg N/ha applied at PW.

Nitrogen applied before PW produces a much higher grain yield than N applied at PI. However, with no reliable method to determine how much soil N will be available to a rice crop before sowing, N topdressing at PI is often required to reach optimum yield.

Previous research has shown that it is too late to topdress crops once the majority of panicles are more than 50 mm long. Further, the yield response and economic return on N application declines with plant age (Ward 2021), and by heading (approximately 30 days after PI), it is completely ineffective.

Summary

From these preliminary results we can conclude that a rice crop with a low N status requires N topdressing as close to PI as possible. The crop requires more time to use the added N to grow and increase dry matter and yield potential.

This experiment was designed mid way through the 2022 rice season when the question was asked 'how late is too late to apply N after PI?'. Because of this, only 2 replications of the main plots were possible making it difficult to draw significant conclusions from the results. Therefore, further investigation of the effect PI N application timing has is required to fully identify the differences in treatments.

References

Ward R (ed) (2021) *Rice growing guide 2021*, 2nd edn, NSW Department of Primary Industries.

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