Split nitrogen continues to show an advantage

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in a rice hull

- Split nitrogen application continues to show an advantage over a total pre-flood nitrogen application
- A minimum application of 90 kg N/ha pre-flood is required in fields of low nitrogen status to sustain growth for a good grain yield
- In bays undergoing mid-season drainage, nitrogen topdressing just prior to re-irrigation should be considered
- Nitrogen uptake at panicle initiation in mid-season drained bays is different to that in conventionally managed bays, thus new calibrations are necessary to assess the nitrogen status at panicle initiation in drained bays

Research into the effect on grain yield of a range of nitrogen management practices for rice crops, such as varying rate and timing of nitrogen fertiliser application and mid-season drainage, continued in the 2005–06 season to verify the findings of the two previous seasons.

Results of investigations conducted during the 2003–04 and 2004–05 seasons showed split nitrogen application to have beneficial effects on yield compared with a total pre-flood nitrogen application. Split nitrogen application, ie two thirds of the total rate at pre-flood and one third at panicle initiation, showed about 0.5–1.5 t/ha yield advantage in continuously flooded bays, particularly at high nitrogen application rates. In bays where mid-season drainage was practised, split nitrogen application of two thirds at pre-flood and one third just prior to re-irrigation gave the best result for the treatments investigated.

The results may be attributed to the incidence of cold damage resulting from unusually low temperatures during the young microspore stage in these two seasons. It is commonly observed that high nitrogen status crops (such as those that have a total nitrogen application pre-flood) suffer to a greater extent from cold damage than lower nitrogen status crops. High nitrogen status increases the risk of cold damage by reducing the number of engorged pollen grains per anther, causing increased spikelet sterility. High nitrogen status can also delay panicle development, thereby increasing the risk of encountering low temperatures during the young microspore and flowering stages. The extra biomass produced due to heavy rates of nitrogen fertiliser at pre-flood could also increase the risk of exposing the rice plant to extreme temperatures during reproductive development.

It could be argued that split nitrogen application would only be of benefit in seasons experiencing low temperatures during the reproductive period. However given the unreliable nature of predictions for seasonal weather conditions, a split nitrogen application strategy is a useful way to reduce the risk of cold damage if low temperatures occur during the reproductive period.

During the 2005–06 rice season, trials were carried out at Leeton, Jerilderie and Wakool to quantify the nitrogen requirements of the new long grain variety, YRL 125 and its older counterpart Langi, and to further assess the response of Australian rice cultivars to split nitrogen application. Four nitrogen rates (0, 90, 180 and 270 kg N/ha) and two nitrogen application strategies (total nitrogen at pre-flood, and two thirds of nitrogen at pre-flood and the remaining third at panicle initiation) were investigated.

In addition, trials were conducted at Griffith and Wakool to further investigate the effect of timing of nitrogen application on the performance of rice in bays where mid-season drainage was practised. The response of Amaroo to four nitrogen rates (0, 90, 180 and 270 kg N/ha) and four timings of nitrogen application were investigated. The treatments were:

1. total nitrogen pre-flood
2. two thirds nitrogen at pre-flood and one third just before re-irrigating after mid-season drainage
3. an equal three-way split of nitrogen at pre-flood, just before re-irrigating and at booting
4. two thirds nitrogen at pre-flood and one third at panicle initiation.

Temperatures during the season

Air and water temperature data were collected at 30 minute intervals during the 2005–06 rice season at Jerilderie and Wakool, with the two sites showing similar air and water temperature patterns (Figure 1). The season was quite warm when compared with the two previous rice seasons, however some nights experienced temperatures below 15°C during the reproductive period. Nevertheless, the deep water levels maintained after panicle initiation were able to keep water temperatures around the base of the rice plants above the critical minimum (17°C), showing the importance of deep water to protect rice plants during the reproductive period.

Air and water temperature data were also taken at 30 minute intervals at Griffith and Wakool where mid-season drainage was practised (Figure 2). As expected, air temperatures followed similar patterns to those in conventionally managed rice bays. Deep water also gave the necessary protection during the reproductive period. However, air temperatures near the soil surface in the bay at Griffith exceeded 50°C during mid-season drainage (14–24 December). The pink sections of Figure 2 show the air temperature 2 cm above the ground in the bay during the drainage period, which is actually the soil surface temperature. Similar temperatures were observed during the drainage period (12–21 December) in bays at Wakool, although the soil temperature did not exceed 50°C.

The high air temperatures in the bay during drainage were mainly due to very high ambient air temperatures (39–43°C) during the period, and the complete dryness of the soil surface in the bay. This is an alarming situation for those who practise mid-season drainage. Had the hot weather continued for another couple of days, the plants would have suffered severe stress and recovery would have been a difficult task. Therefore, it is advisable to carry out mid-season drainage during the first half of December to avoid the periods of highest risk of hot weather, towards the end of December.

Yield responses to nitrogen for Langi & YRL 125

Unlike trials in the two previous rice seasons, trials in 2005–06 showed a trend for yield to increase with increasing nitrogen rates up to 180 kg/ha (Figure 3). This may be due to favourable weather conditions during the season, ie high maximum daily temperatures and minimum temperatures above the critical level during the reproductive period. In the 2005–06 trials, the treatment with total nitrogen application pre-flood (no split) showed the lowest yield for all treatments at nitrogen rates beyond 90 kg N/ha, and a significant yield decline beyond the 180 kg N/ha rate for Langi and YRL 125 at Jerilderie and for Langi at Wakool. The two cultivars showed similar nitrogen responses at all three sites (Jerilderie, Wakool and Leeton).

At all sites, a split nitrogen application of two thirds at pre-flood and one third at panicle initiation resulted in higher grain yield compared with total pre-flood nitrogen applications, at rates beyond 90 kg N/ha. These findings support results from the two previous rice seasons, when low temperatures were experienced during the reproductive period.

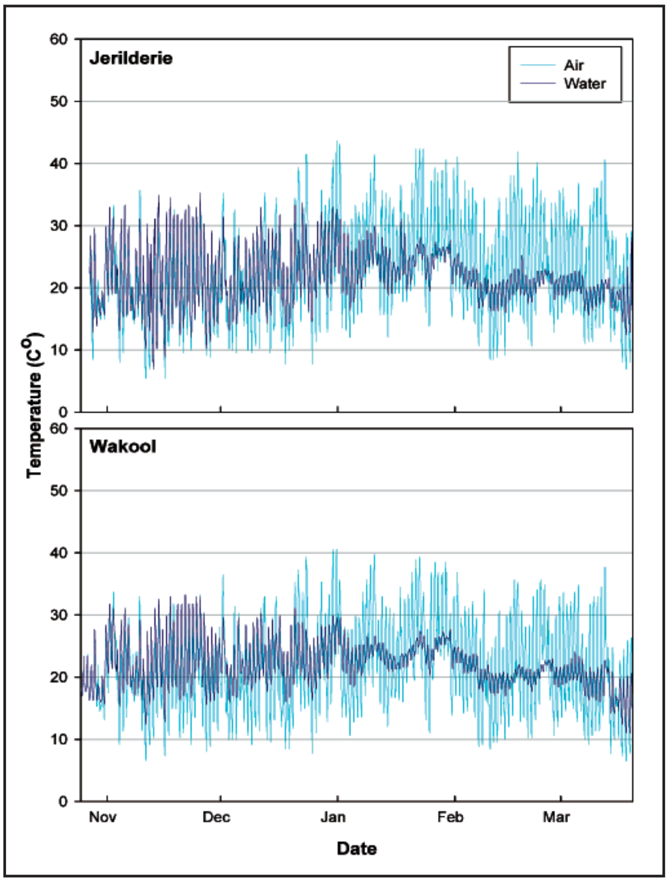

Figure 1: Air and water temperatures recorded during the 2005–06 rice growing season in rice bays with conventional water management at Jerilderie and Wakool.

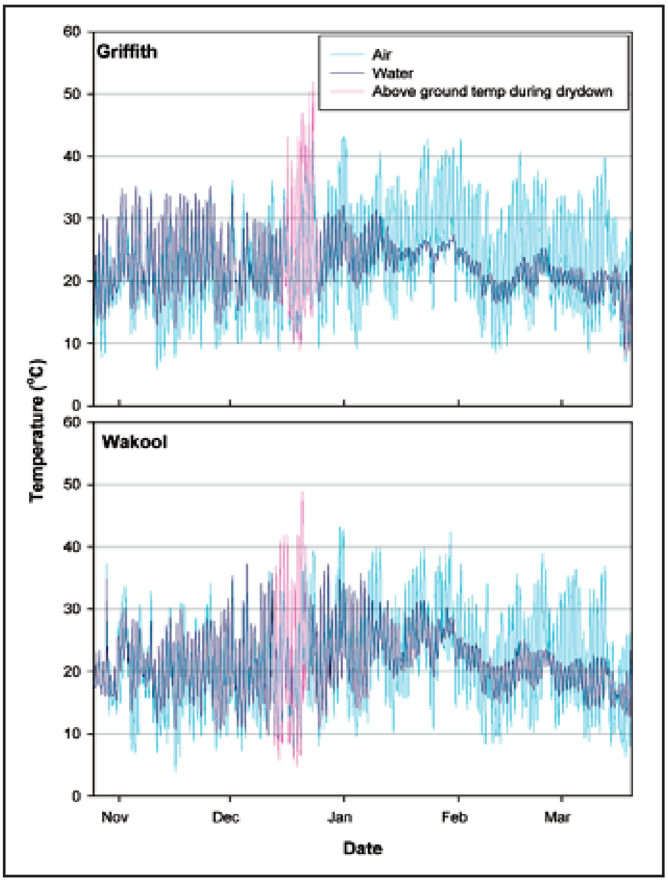

Figure 2: Air and water temperatures recorded during the 2005–06 rice growing season in rice bays with mid-season drainage at Griffith and Wakool.

These findings suggest that during the reproductive period rice roots are unable to take up pre-flood applied nitrogen placed below the soil surface, particularly after the formation of the superficial root mat, even though most of the pre-flood applied nitrogen below the soil surface is in a form available to rice plants. Moreover, pre-flood applied urea may have pushed down with the initial flooding to the deeper soil layers below the root zone. Further research into why this is happening is required. Nevertheless, with recommended fertiliser applications and mineralisation of nitrogen from the soil, adequate quantities of nitrogen should still be available during the vegetative growth stage of the crop to produce sufficient biomass to achieve a good yield. Based on these findings, and in agreement with previous nitrogen management strategies, it is recommended to apply a minimum of 90 kg N/ha pre-flood, if rice is to be grown on continuously cultivated bays, and then apply a maintenance requirement of nitrogen at panicle initiation. This practice will enable yield optimisation, as well as reduce the extent of cold damage.

Yield responses to nitrogen treatments in mid-season drainage

The yield response of Amaroo to different rates and timings of nitrogen application at experimental sites at Griffith and

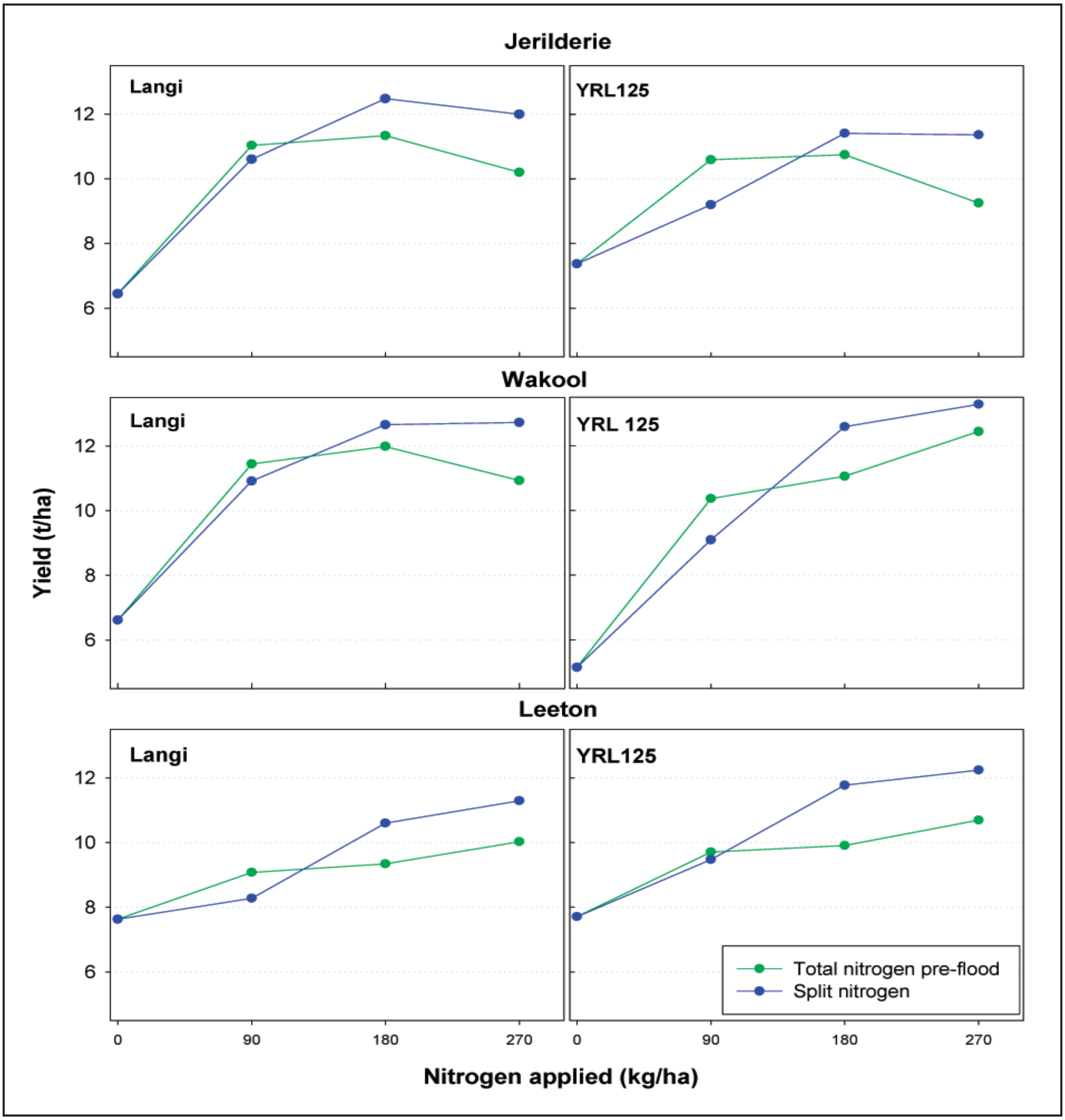

Figure 3: Yield response of two cultivars (Langi and YRL 125) to applied nitrogen at Jerilderie, Wakool and Leeton in the 2005–06 rice growing season.

Wakool, where mid-season drainage was practised, are shown in Figure 4. Overall, yield increased with an increase in the application rate of nitrogen, as expected in a hot year. The treatment with total nitrogen application pre-flood (no split) showed the lowest yield for all treatments, at nitrogen rates beyond 90 kg N/ha.

The treatment of split nitrogen application with two thirds nitrogen at pre-flood and one third just before re-irrigation after drainage showed the highest yields at nitrogen rates beyond 90 kg N/ha. The next highest yield was the split application with two thirds at pre-flood and one third at panicle initiation. These two application methods gave about a 1–2 t/ha yield advantage over the other two treatments (Figure 4).

The results are similar to findings from the 2004–05 season and suggest that recommendations could be made for topdressing just prior to re-irrigating. This gives an option for farmers to apply the fertiliser using tractors and ground spreaders, as the bays are fairly dry after a mid-season drainage, rather than having to use aerial contractors. In addition, an application of nitrogen just before re-irrigation could minimise nitrogen losses through denitrification, compared with losses experienced with topdressing into a flooded bay at panicle initiation. In addition, some of the fertiliser applied just prior to re-irrigation could enter into cracks in the soil created during the dry down, thus further reducing the potential for denitrification. Further research is necessary to quantify the reduction of nitrogen losses through this practice.

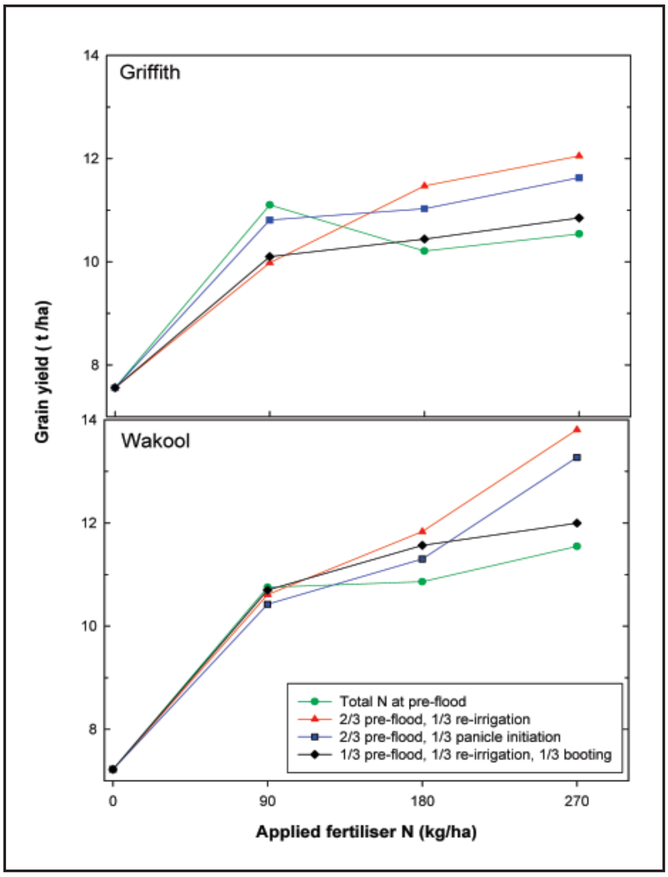

Figure 4: Yield response of an Amaroo crop to different rates and timings of nitrogen application in bays where mid-season drainage was practised, at Griffith and Wakool during the 2005–06 rice growing season.

Nitrogen uptake with mid-season drainage

Nitrogen uptake at panicle initiation was lower in bays with mid-season drainage compared to that in conventional bays, but similar yields were achieved (Figure 5). For example, at a 10 t/ha yield, nitrogen uptake at panicle initiation with mid-season drainage was around 80 kg/ha, compared with around 150 kg/ha in conventional bays. The difference in uptake may be attributed to a slow recovery process of the plants after the stress imposed during drainage. The slow recovery process of plant could result in low biomass production by panicle initiation with mid-season drainage. As a consequence, for crops submitted for NIR testing at panicle initiation, a reduced nitrogen uptake result will be reported as nitrogen uptake is calculated based on biomass. However, the results show that mid-season drained crops produce similar yield to that of conventional bays, suggesting biomass levels and nitrogen uptake data at panicle initiation in mid-season drained bays are misleading (in the context of current knowledge) and does not reveal the actual nitrogen status at panicle initiation. Current knowledge would suggest that fertiliser be applied where nitrogen uptake is low, however for mid-season drained bays this may not be necessary.

It is necessary to carry out further investigations to determine the appropriate stage to perform plant sampling for nitrogen assessment and develop a new set of calibrations to determine required nitrogen application at panicle initiation for bays where mid-season drainage is practised.

Future work

Further investigations will be carried out in the 2006–07 season to compare the effect of timing and rate of nitrogen application in conventionally irrigated crops and in mid-season drained crops, with the emphasis on comparing nitrogen use efficiencies under the two systems and to ascertain the appropriate stage of plant sampling to assess nitrogen status of mid-season drained crops.

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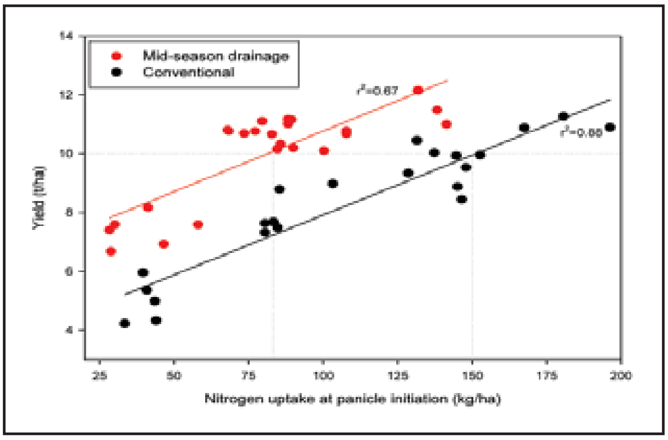

Figure 5: The relationship between nitrogen uptake at panicle initiation and yield in crops grown with mid-season drainage (red) and conventional water management (black).