Delayed flooding of rice - effect on yields & water

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in a nutshell

- Delayed flooding provides an opportunity to improve the water productivity of rice
- The exceptionally high growth rates of rice between panicle initiation and flowering necessitate an abundance of water which can only be satisfied under flooded conditions
- If a particularly hot spell of weather (say longer than four days) is forecast leave the crop flooded

Rice production in the Murray and Murrumbidgee valleys uses a substantial proportion of the available supply of irrigation water and water accounts for about 40% of the variable costs of rice production. Any management practice that has the potential to reduce water use and/or increase water productivity (t/ML; kg/ha/mm) should be evaluated. Delayed flooding is one possibility.

Delayed flooding involves intermittent irrigation of the crop until about ten days before panicle initiation (PI). The timing (scheduled at 50–60 mm of cumulative ET0) and number of irrigations will be determined by the growing season temperatures.

This technique was evaluated at Yanco in the early 1980s and involved the variety Calrose (combine sown). Grain yield was not reduced provided the crop was flooded approximately ten days before PI. The Yanco experiments indicated water savings of 20–25%, however, there was substantial deep drainage below the root zone which made computation of actual water use difficult and perhaps the result is misleading. The Yanco experiments included a treatment where the crop was irrigated weekly throughout the whole season. This produced poor vegetative growth and low grain yields (2.5–5.1 t/ha).

The Murray Valley Field Station at Deniliquin provided a site where it was anticipated that drainage below the root zone would be much lower than at Yanco. Also current varieties (semi-dwarf) have a much higher yield potential than Calrose. Thus further experiments were conducted at Deniliquin from 2001–02 to 2003–04 to assess the feasibility of delayed flooding as a water management practice for rice.

Experiments at Deniliquin

Only results from Amaroo are reported here. In all the intermittent treatments the permanent flood (re-flood for aerial sowing) was applied approximately ten days before PI.

Combine sown

In both 2001–02 and 2002–03 the combine sown treatment received eight irrigations as well as the first flush which initiated germination. This was compared to conventional combine sowing with permanent flood at the 3-leaf stage.

Aerial sown

The aerial sown treatments were flooded and once the crop was established the treatments were drained and subsequently received three or four irrigations; the time taken for establishment (3–4 leaves) ranged from 34–43 days.

These treatments were compared with conventional water management (ponded all season) for aerial sown crops.

Grain yields

Combine sown

In 2001–02 grain yield from the intermittent treatment was similar to the permanent flood at the 3-leaf stage. In 2002–03 grain yield was reduced by 10%. The maximum temperatures experienced during November and December 2002 (when the crop was being intermittently irrigated) were well above average and presumably reduced the early growth of the crop sufficiently to carry through to a reduction in grain yield.

Aerial sown

In all three seasons there was no reduction in grain yield when the crop was subjected to intermittent irrigations.

Water use

Water use in 2002–03 was relatively high. The potential water use for the crop in that season was 17 ML, 30% above the long-term average.

The reduction in water use where the crop was intermittently irrigated ranged from 8–18%. Whilst recognising that these

measurements are based on small plots it is reasonable to expect some reduction in water use for commercial crops.

Water productivity

Whenever there is a reduction in water used whilst maintaining the same grain yield water productivity must increase. The water productivity achieved in the experiments at Deniliquin is shown in Table 1. Where intermittent irrigation was applied, there was an increase in water productivity ranging from 0.06 to 0.23 t/ML. This increase was primarily due to a decrease in water use. In one instance there was a decrease of 0.02 t/ML – water use was decreased but grain yield was also lower.

Disadvantages

An efficient layout is essential for intermittent irrigation, especially if the crop is combine sown. Ideally bays would be accurately levelled (no 'low spots') and have individual inlet and outlet structures. Even with a good layout there is an additional work load until the permanent flood is applied.

Weeds, especially barnyard grass, may be difficult to control prior to the application of the permanent flood, although more effective herbicides are becoming available. There was no second germination of weeds in the aerial sown plots.

There is likely to be some reduction in the efficiency of nitrogen fertiliser applied at establishment. A panicle initiation nitrogen test is recommended to provide a guide to the topdressing rate required to avoid any reduction in grain yield due to insufficient nitrogen supply to the crop.

Conclusion

Intermittent irrigation until ten days before panicle initiation should reduce the water use of the rice crop. For combine sown crops this will be between 15 and 20%. For aerial sown crops a reduction of 10% could be expected. However, water and crop management need to be good as any reduction in grain yield will reduce the potential gain in water productivity.

The rice crop has an exceptionally high growth rate from panicle initiation to flowering. A rice crop growing under favourable conditions will produce 250–300 kg/ha of dry matter per day (rates as high as 360 have been measured at Deniliquin). This is at least double that of a well managed crop of maize or lucerne. To achieve this growth rate an abundant supply of water is required which can only be provided by a flooded field.

Acknowledgements

The Rice CRC provided funding for this work.

Further information

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Figure 1: Intermittent irrigation until 10 days before particle initiation can reduce water use without reducing grain yield, with good water and crop management

Table 1: Grain yield, water use and water productivity. Water use includes rainfall and an adjustment for the change in soil moisture from before to after the rice crop.

Combine sown	**Irrigation treatment**	**Grain yield** (t/ha)	**Water use** (ML)	**Water productivity** (t/ML)
2001–02	Flood at 3-leaf stage	8.7	15.7	0.55
	Intermittent irrigations	8.8	13.0	0.68
2002–03	Flood at 3-leaf stage	11.5	16.6	0.69
	Intermittent irrigations	10.3	15.3	0.67
Aerial sown	**Irrigation treatment**	**Grain yield** (t/ha)	**Water use** (ML)	**Water productivity** (t/ML)
2001–02	Permanent flood	9.5	17.0	0.56
	Intermittent irrigations	9.2	14.0	0.66
2002–03	Permanent flood	11.2	18.3	0.61
	Intermittent irrigations	11.2	16.7	0.67
2003–04	Permanent flood	11.3	15.0	0.75
	Intermittent irrigations	12.8	13.1	0.98