Saving water, lifting efficiency

Brian Dunn[1], Don Gaydon[2] & Colin Dunn[1]

[1] Industry & Investment NSW, Yanco Agricultural Institute; [2] CSIRO Sustainable Ecosystems, St Lucia, Qld

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- After two seasons of research we are confident that delaying the application of permanent water to drill sown rice is a viable alternative to conventional water management for drill sown rice on red-brown earth soils.
- Over the two seasons, water savings of between 16 and 21% were achieved resulting in a 10–17% increase in water productivity.
- Delaying permanent water until two weeks prior to panicle initiation (PI) slows crop development so it may be necessary to sow 7–10 days earlier than recommended for conventionally managed drill sown crops.
- The practice of delaying permanent water is not a reduced input, low management technique; considerable weed control and water management is required for it to be successful.

A replicated experiment was established at Yanco Agricultural Institute in October 2008 with rice being irrigated at a range of moisture stress levels until two weeks prior to panicle initiation when permanent water was applied. The aim of the experiment was to quantify water use for each level of moisture stress and measure plant growth and grain yield resulting from the delayed application of permanent water – delayed permanent water.

A second year of the delayed permanent water experiment was conducted in the 2009–10 season. A description of the whole experiment and results from the first year's experiment can be found in the IREC *Farmers' Newsletter*, No 181, Spring 2009, pages 4–7.

Irrigation treatments

The experiment in the 2009–10 season again consisted of three replications of four irrigation treatments:

1. **Aerial** – permanent water applied 21 October.
2. **Conventional/drill** – a traditional conventional drill sown treatment = 2 flush irrigations then permanent water at the 3-leaf stage, 16 November.
3. **DPW (delayed permanent water)** 80 mm ET – drill sown with flush irrigations every 80 mm cumulative ET = 5 flushes, permanent water 23 December.
4. **DPW 160 mm ET** – drill sown with flush irrigations every 160 mm cumulative ET = 3 flushes, permanent water 23 December.

The delayed permanent water experiment nearing harvest, 23 March 2010. Maturity differences between treatments are obvious.

The medium grain variety Quest was sown (150 kg/ha) into a cultivated seedbed on 18 October 2009 and the first flush irrigation applied on the 21 October. In the aerial sown treatment dry seed (150 kg/ha) was spread on the soil surface on the 19 October and permanent water applied on the 21 October.

This season, crop factors of 0.6 for 1–15 November and 0.8 for 16–30 November were applied to the daily evapotranspiration (ET) values. At this time the rice plants were small and not using much water. This resulted in both the 80 and 160 mm treatments receiving one less flush irrigation than last season.

Crop growth

Dry matter accumulation was quicker for the Aerial and Conventional/drill treatments than the delayed permanent water treatments, which were delayed in both growth and development by the delaying of permanent water and the associated moisture stress (Figure 1).

At physiological maturity the total dry matter accumulated was similar for the Aerial, DPW 80 mm and DPW 160 mm treatments, while the Conventional/drill was significantly higher.

Grain yield

The grain yield of the Conventional/drill treatment was similar to the yields achieved by both of the DPW 80 mm and DPW 160 mm treatments (Figure 2). The grain yield of the Aerial treatment is lower than we expected as aerial sown yields are normally equivalent to those of drill sown crops. Factors including lower establishment numbers and higher floret sterility due to microspore occurring when there were some cooler nights have contributed to this difference.

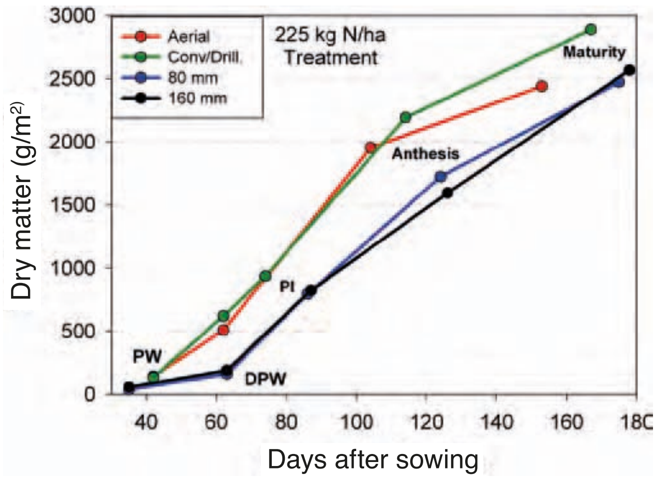

Figure 1. Rice dry matter accumulation for the irrigation treatments at 225 kg/ha of applied nitrogen.

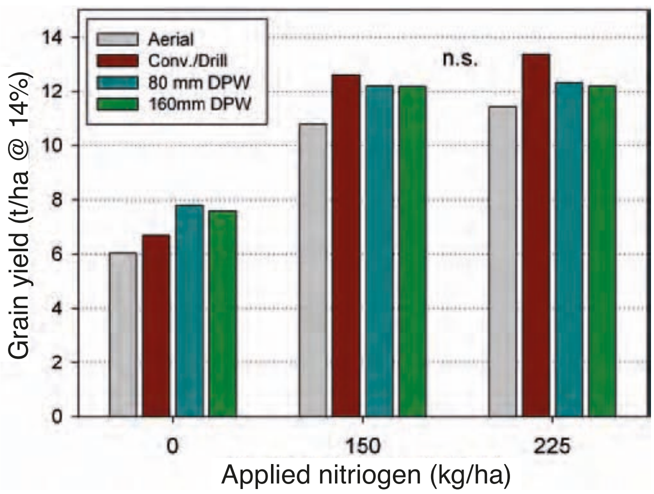

Figure 2. Rice grain yield at 14% moisture for the irrigation treatments, at three levels of applied nitrogen.

Water use & water productivity

Total water use (irrigation + rainfall) for the Conventional/drill treatment was 15.0 ML/ha. The Aerial treatment used 2.1 ML/ha more. The DPW 80 mm and DPW 160 mm treatments used 2.2 and 3.2 ML/ha less water respectively than the Conventional/drill treatment (Table 1).

The water productivity calculated for the 225 N rates was highest for the DPW 160 mm treatment with 1.04 t/ML, followed by the 80 mm (0.97 t/ML), Conventional/drill (0.89 t/ML) and lowest was the Aerial (0.67 t/ML) (Table 1). The DPW 160 mm treatment produced a 17% increase in water productivity over the Conventional/drill treatment.

Plant maturity

The Aerial treatment reached panicle initiation 10 days earlier than the Conventional/drill which was 15 days earlier than the 80 and 160 mm DPW treatments. This pattern continued through to physiological maturity with the Aerial treatment reaching physiological maturity 10 days before the Conventional/drill treatment. The DWP treatments reached physiological maturity 15 and 19 days after the Conventional/drill treatment. These results are averaged over the nitrogen rates.

Table 1. Rice grain yield, water use and water productivity for the 225 N treatments

Treatment	Grain yield (t/ha)	Water use (ML/ha)	Water productivity (t/ML)
Aerial sown	11.4	17.1	0.67
Conventional/drill	13.4	15.0	0.89
DPW 80 mm	12.3	12.8	0.97
DPW 160 mm	12.2	11.8	1.04

Col Dunn counting panicles with exposed anthers to determine treatment flowering dates. The stages of maturity were recorded for each treatment throughout the growing season.

Gross margin analysis

A rice price of $300/t was used when calculating the gross margin analysis for the Conventional/drill and DPW 160 mm treatments. On a per hectare basis the Conventional/drill treatment returned $2564/ha which was 15% higher than the DPW 160 mm treatment with $2191/ha (Table 2). When comparing the treatments on a per ML basis the DPW 160 mm treatment returned $186/ML which was 9% higher than the Conventional/drill treatment with $171/ML.

Findings for 2009–10

The use of crop factors to extend the period between irrigations when the plants are small reduced the number of irrigations and total water use, with no detrimental impacts on rice growth or yield.

Applying more of the nitrogen prior to permanent water in the delayed permanent water treatments increased nitrogen use efficiency and plant growth compared to the three time nitrogen split used last season. Further research is needed into nitrogen application timing of delayed permanent water to determine the most effective nitrogen splits to achieve high yield with efficient nitrogen use.

When the crop is sown at the recommended date for the variety, the delay in crop development due to delaying the application of permanent water raises problems; these include the crop not reaching microspore at the most opportune time and delayed harvest. Therefore in future we may recommended that any crop being grown using delayed permanent water be sown 7–10 days earlier than recommended for that variety.

Conclusions

After two seasons research we are confident that delaying the application of permanent water to drill sown rice is a viable alternative to conventional practice on red-brown earth soils. Over the two seasons, water savings of 16–21% were achieved, resulting in 10–17% increase in water productivity.

It needs to be emphasised that this is not a low input, low management technique, with considerable care needed for weed control, water management and time of sowing.

The delaying of permanent water is not recommended for fields with soil salinity issues. The moisture stress from the delayed permanent water, combined with the stress from the salinity, can cause serious plant injury.

Where to now?

Future experiments are planned for a heavy self-mulching clay site, to determine potential water savings for that soil type and help fine tune the practice. Nitrogen experiments will be conducted on both soils types in future seasons.

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Further information

Brian Dunn, Research Agronomist
T: 02 6951 2621
E: brian.dunn@industry.nsw.gov.au

Table 2. Gross margin analysis of the Conventional/drill and DPW 160 mm 225 N treatments from the Yanco experiment

	Conventional Drill treatment		DPW 160mm ET	
		$/ha		$/ha
Income	$300/t		$300/t	
Yield	13.4 t/ha		12.2 t/ha	
Total income (A)		4020		3660
Variable costs				
Cultivation	2 x scarify, roterra, grade	54		54
Seed	Quest @ 150 kg/ha	73		73
Fertiliser	PW: 326, PI: 163 kg/ha urea	280	Till: 163, DPW: 326 kg/ha urea	257
Herbicides & insecticides	Roundup®, Magister®, Stomp®	58	Roundup, Magister, Stomp	58
	molinate, Londax®	158	Stam @ 10 L/ha, molinate	298
Irrigation	15.0 ML/ha @ $15.90/ML	238	11.8 ML/ha @ $15.90/ML	188
Harvest	Harvesting @ $25/t	335		305
	Cartage @ $11.50/t	154		140
Crop insurance	1.65%	66		60
Research levy	$3/t	40		36
Total variable costs (B)		1456		1469
Gross margin/ha (A-B)		2564		2191
Gross margin/ML		171		186