WHEAT AFTER RICE – HOW MANY IRRIGATIONS?

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QUICK TAKE

- Two spring irrigations achieved the highest grain yield (8 t/ha) and gross margin ($1309/ha) in this experiment but it will vary between years depending on winter and spring rainfall.
- A wheat crop grown after rice requires high levels of fertiliser—maximum grain yield and protein were achieved with 175 kg/ha DAP sown with the seed and 435 kg/ha urea topdressed in a split application at mid-tillering and early flowering.
- Wheat following rice can be a very profitable crop provided the field layout (drainage) is good, the rice stubble is removed early and the crop is established before the weather gets cold and possibly wet.

Wheat grown immediately following a rice crop can be one of the most profitable crops in the rice farming system. However, growers often face the dilemma of how many irrigations the crop will require to achieve good yields and profits, and/or if water required for an additional irrigation would be better used elsewhere.

In 2013, an experiment was established at Leeton Field Station to investigate the irrigation water requirements of a wheat crop grown immediately following rice and the impact of various levels of irrigation intensity on grain yield and quality, water use and profitability.

The hard-wheat variety, EGA Gregory, was direct drilled (100 kg/ha seed + 175 kg/ha DAP) into moist uncultivated, self-mulching, heavy clay soil after the rice stubble had been slashed and burned. The wheat followed the second consecutive rice crop grown in the field. A full list of cultural practices, their timing and other details are provided in Table 1.

Irrigation & nitrogen treatments

Four irrigation treatments were established:

- zero
- 1 irrigation
- 2 irrigations
- 4 irrigations.

There were four replications of each treatment and each treatment was in a separate bay so water use could be accurately measured. The timing of the irrigations was determined using a combination of evapotranspiration data, crop factors and rainfall, while keeping in mind the necessity for wheat to have adequate available soil moisture during flowering.

The irrigation treatments were split for nitrogen topdressing using urea at rates of:

- zero (0 kg/ha urea)
- 50 kg N/ha (109 kg/ha urea)
- 150 kg N/ha (325 kg/ha urea)
- 200 kg N/ha (435 kg/ha urea).

The urea was spread onto the dry soil in a split application with two timings, both before rain or irrigation (Table 1).

Grain yield

The highest grain yield was achieved by the 2 irrigations x 200 kg N/ha topdressed treatment, with 8.0 t/ha; this was similar to the 4 irrigations x 200 kg N/ha treatment with 7.9 t/ha. Both of these yields were significantly higher than the zero and 1 irrigation treatments (6.8 and 7.4 t/ha, respectively) with the same rate of topdressed nitrogen (Figure 1).

Grain quality

Average grain protein was 10.8% with no significant difference between the irrigation treatments. Increasing nitrogen application rate increased grain protein from 9.2%, with no topdressed nitrogen, to 12.6% when the crop was topdressed with 200 kg/ha of nitrogen (Table 2).

Table 1. Cultural practices timing and details

Practice	Details
Field preparation	Rice stubble burnt – no cultivation
Sowing	7 May – disc drill with 18 cm row spacing
Variety and rate	EGA Gregory wheat @ 100 kg/ha seed
Sowing fertiliser	DAP @ 175 kg/ha sown with seed
Establishment	189 plants/m^2 – no difference between bays
Herbicides	Ally @ 7 g/ha + wetter, no grass weed spray
Top-dressed nitrogen	6 Aug – prior to 10 mm rain, 0, 50 & 100 kg N/ha 4 to 10 Sep – prior irrigation or rain, 0, 50 & 100 kg N/ha
Irrigation dates	1 irrigation – 9 Sep 2 irrigations – 9 Sep, 11 Oct 4 irrigations – 5 Sep, 4 Oct, 18 Oct, 1 Nov

Screenings were similar between irrigation and nitrogen treatments, all very low at 1.3% or less. Grain weight averaged 83.9 kg/hL across the experiment with no difference between irrigation treatments, but increased topdressed nitrogen rate increased grain weight.

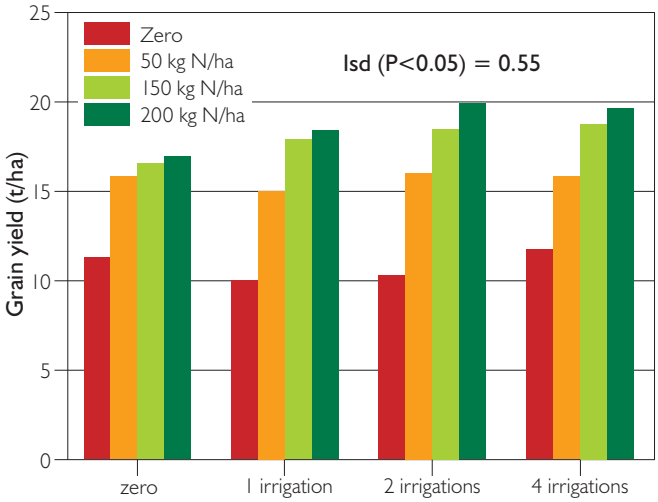

Figure 1. *Grain yield (t/ha) for irrigation and nitrogen topdressing treatments*

The small changes in grain weight and screenings between treatments meant that changes in irrigation treatment had no impact on grade of wheat and therefore grain price.

For all irrigation treatments when the wheat was topdressed with zero or 50 kg N/ha, the lower grain protein resulted in only achieving the ASW1 wheat grade. ASW1 had a $39/t lower price than H2 grade which was achieved when topdressing with 150 or 200 kg N/ha. Additional topdressed nitrogen would have been required to reach the H1 grade (protein >13%) but given the increased premium was only $6/t it may not have been

Craig Hodges and Chris Dawe collecting soil samples and Tina Dunn measuring wheat establishment, during the 2013 investigation of irrigation water requirements of a wheat crop grown immediately following rice.

Flume and waterdepth logger measuring the amount of water supplied to the wheat crop during an irrigation event

The wheat crop at maturity in a 2 irrigations treatment

economically viable. Grain prices used in this article are based on GrainCorp prices delivered Yanco, 4 December 2013.

Water use & water productivity

The zero irrigation treatment received 2 ML/ha as rainfall during the crop growing period, with the 1, 2 and 4 irrigation treatments using 2.9, 3.8 and 5.1 ML/ha respectively consisting of rainfall and irrigation water (Table 2).

A large rainfall event occurred in mid-September when 52 mm was received just as the wheat was beginning to flower; this had a big impact on the results of this experiment. Without this rainfall, coming at such a critical time, it would be expected that grain yield and quality of the zero and 1 irrigation treatments would have been significantly reduced.

Gross margin analysis

The 2 irrigations treatment returned the highest gross margin at $1309/ha, followed by the 4 irrigations and 1 irrigation treatments with $1269/ha and $1184/ha respectively (Table 3).

The gross margin per megalitre was highest for the zero irrigation treatment, which only used soil moisture and rainfall to grow the crop, at $530/ML, followed by the 1, 2 and 4 irrigation treatments at $408/ML, $344/ML and $249/ML respectively.

The gross margin analysis only considers the variable cost of the irrigation water and does not take into account the fixed water costs or the value of the allocation as a tradable item. If these items were included the gross margin per megalitre would be considerably different between the different irrigation treatments (Table 3).

Conclusions

The full soil moisture profile that occurs after rice provides a significant resource for the following wheat crop, which can be successfully grown on a reduced number of irrigations. But good layouts are critical to achieving high wheat grain yields following rice, as any period of extended waterlogging will greatly reduce yield. It is important that the field is not bogged up during rice harvest and that stubble burning or removal and wheat sowing are conducted in a timely manner to get the wheat established before the weather gets cold, and possibly very wet.

Two spring irrigations timed to ensure moisture is available during the critical flowering period provided the best economic returns in a season with average to below average winter/spring rainfall. In wet seasons, fewer irrigations may be required but in drier seasons three irrigations may be necessary.

After a rice crop there is very little nitrogen remaining in the soil and to achieve a high yielding wheat crop, with good grain protein levels, considerable nitrogen fertiliser needs to be applied at both sowing and mid-season.

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Further information

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Table 2. Wheat growth, grain yield, water use and grain quality results and wheat grade achieved

Treatment Irrigation No.	Topdressed nitrogen (kg N/ha)	Grain yield (t/ha)	Water use (rain+irrig.) (ML/ha)	Water productivity (t/ML)	Grain protein %	Test weight (kg/hL)	Screenings < 2 mm%	Wheat grade
Zero	Zero	4.5	2.0	2.3	9.6	84	0.3	ASWI
	50	6.3		3.2	9.5	84	0.5	ASWI
	150	6.6		3.4	11.8	85	0.5	H2
	200	6.8		3.5	12.6	85	0.8	H2
1 irrigation	Zero	4.0	2.9	1.4	9.1	83	0.5	ASWI
	50	6.0		2.1	9.5	83	0.8	ASWI
	150	7.2		2.6	11.7	86	1.3	H2
	200	7.4		2.6	12.4	86	0.4	H2
2 irrigations	Zero	4.1	3.8	1.1	8.9	82	1.0	ASWI
	50	6.4		1.7	9.8	84	1.0	ASWI
	150	7.4		1.9	11.9	85	1.0	H2
	200	8.0		2.1	12.8	85	0.5	H2
4 irrigations	Zero	4.7	5.1	0.9	9.1	82	0.8	ASWI
	50	6.3		1.2	9.6	82	1.1	ASWI
	150	7.5		1.5	11.6	84	1.1	H2
	200	7.9		1.5	12.4	84	0.9	H2
lsd (P<0.05)		0.55	0.2	0.15	0.72	n.s.	n.s.	na

Table 3. Gross margin analysis of the four irrigation treatments using the 200 kg N/ha topdressed nitrogen rate which achieved the highest grain yield for each treatment

Treatment	Zero irrigation	1 irrigation	2 irrigations	4 irrigations
Price $/t	$264/t	$264/t	$264/t	$264/t
Grade	H2	H2	H2	H2
Yield (t/ha)	6.8	7.4	8.0	7.9
Total income ($/ha) (A)	**1795**	**1954**	**2112**	**2086**
Variable costs				
Sowing + seed + treatment ($/ha)	81	81	81	81
Fertiliser, DAP + Urea ($/ha)	383	383	383	383
Herbicide, Ally + spraying ($/ha)	12	12	12	12
Contract harvest & bin ($/ha)	105	114	122	121
Cartage ($/ha)	95	104	112	111
Levies & insurance ($/ha)	59	64	70	69
Irrigation* @ $13.27/ML ($/ha)	0	12	24	41
Total variable costs ($/ha) (B)	**736**	**770**	**803**	**817**
Gross margin/ha ($/ha) (A-B)	**1060**	**1184**	**1309**	**1269**
Gross margin/ML ($/ML)**	**530**	**408**	**344**	**249**

* Variable costs only, fixed costs of irrigation not included;
** rain + irrigation