MALTING BARLEY YIELD AND QUALITY RESPONSES TO IRRIGATION

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ABSTRACT

The effects of irrigation on barley yield and malting quality were studied in a series of experiments over two seasons on three soil types, one light and two medium silt loams.

The barley variety Zephyr was used in all but one experiment. All experiments were spring sown and irrigation was by the border strip method.

On the light soil, irrigation increased yield and improved quality as indicated by lowering grain nitrogen % and increasing malt extract. Although irrigation in the early growth stage significantly improved these factors, a second irrigation after ear emergence made a further significant improvement. Increasing the number of irrigations above two gave only marginal improvements in yield and quality.

On the medium soils various irrigation treatments were applied but there were no significant effects to yield or quality.

INTRODUCTION

Barley grain quality produced on the Canterbury Plains has varied considerably from one year to another (Malcolm and Thompson 1959). Annual variation in quality was attributed to the incidence of rainfall, particularly during grain development. Nitrogen content is a useful index of grain quality and has been generally adopted as a quality index for both wheat and barley. While low nitrogen content in wheat or feed barley detracts from quality the reverse is the case for malting barley where high carbohydrate rather than high protein is indicative of quality.

Stone and Tucker (1969) and Drewitt and Rickard (1971) found a significant correlation between the amount of water applied to the wheat crop and the grain nitrogen content. Drewitt and Rickard (1091) recorded the influence of irrigation on the quality of wheat grown in Canterbury.

This study was initiated to determine the influence of irrigation on the yield and quality of malting barley in Canterbury.

EXPERIMENTAL

In the two seasons 1972-73 and 1973-74 five experiments were carried out in the Winchmore-Fairton district on Lismore stony silt loam and three at Templeton on Templeton silt loam and Waimakariri silt loam.

The barley variety Zephyr was used in all except one experiment in which the variety Research was used. All experiments were Spring sown with seeding rates of approximately 140 kg/ha. Superphosphate was applied to all experiments at sowing. A randomised block design was used and the number of replications varied from three to six.

Irrigation was by the border-strip method on borders 100-250m in length and treatments were applied according to soil moisture, stage of growth or farm practice.

Soil moisture was determined gravimetrically and is expressed as available soil moisture in the top 150mm of soil. Grain yields were calculated on a measured header run and have been corrected to 12% moisture content. Screenings percentage was determined using a 6A (2.37mm) screen.

Barley grain nitrogen was determined by the Kjeldahl method and expressed as percentage dry basis.

Malt quality was determined by micro malting (Meredith **et al.** 1962) 250g samples of barley and measuring the fine grind extract percentage using the European Method (Pollock 1962).

All results were subjected to analysis of variance.

RESULTS

Two sites (A & B) 4km apart were selected in the Winchmore area. The results of four of the experiments are presented in pairs; in each pair the two experiments received similar irrigation treatments in both seasons. The Winchmore A experiments were carried out on a farm property where irrigation was applied according to the farm practice of applying two irrigations per season, one early (at shooting) and one late (after ear-emergence). The Winchmore B experiments were carried out at the Winchmore Irrigation Research Station where irrigation was applied on a soil moisture or stage of growth basis.

In the absence of irrigation all available soil moisture, ASM, was depleted by the early shooting stage in both seasons.

Rainfall during the shooting or earing stage restored the level only temporarily and wilting point was again reached by the milk stage.

At Winchmore A, irrigation was applied at shooting (treatment 2) and after ear emergence (treatment 3). In all cases ASM remaining in the soil was less than 10% at the time of irrigation. There was no serious moisture deficit between the first and second irrigation on treatment 4. Details of grain yield and quality are given in Table 1.

TABLE 1: The effects of irrigation on barley grain yield, screenings, barley nitrogen and malt extract at Winchmore A site

Trt 1972-73*	Yield kg/ha	Screenings %	N%	%Extract
1 No irrigation	2700 dC	30.3 aA	1.75 a	77.7 bA
2 Irrigated early	3570 cB	33.7 aA	1.72 a	78.7 bA
3 Irrigated late	3830 bB	6.7 bB	1.70 a	79.7 abA
4 Irrigated early & late	4690 aA	8.3 bB	1.63 a	81.8 aA
C.V.%	3.2	12.5	5.0	1.2
1973-74				
1 No irrigation	1650 dC	1.5 a	1.53 bA	82.7 bAB
2 Irrigated early	2680 bB	2.1 a	1.34 cB	83.9 aA
3 Irrigated late	1990 cC	1.8 a	1.63 aA	82.1 bB
4 Irrigated early & late	3340 aA	1.4 a	1.33 cB	83.8 aA
C.V.%	3.8	20.8	3.3	0.6

* The variety Research was used in this experiment.

In 1972-73 irrigation after ear emergence gave a slightly higher yield than irrigation during shooting. The combination of two irrigations gave highly significant yield increases over one irrigation, early or late.

The screenings percentage was unaffected by irrigation at the shooting stage but was greatly reduced by irrigation after ear emergence. Grain samples with more than 15% screenings are unacceptable for malting purposes.

The malt extract was improved only by the two irrigation treatment, and then only at the 5% level.

The differences in barley nitrogen were not significant but here as with extracts there was a trend for improvement.

In 1973-74 irrigation at the shooting stage gave a highly significant yield increase over irrigation after ear emergence. As in the previous season two irrigations gave highly significant increases over one irrigation, early or late.

There was no difference in the screenings, all being at an acceptable level.

Irrigation at shooting reduced grain nitrogen, and increased malt extract.

At Winchmore B two treatments were not duplicated in both seasons; in 1972-73 there was no non-irrigated treatment and in 1973-74 the "one irrigation" treatment was not included.

In 1972-73 all treatments received irrigation at the shooting stage (ASM 10%), treatment 2 received additional irrigation at the milk stage (wilting point) and treatment 3 received additional irrigation at ear emergence (45% ASM) and at the milk stage (20% ASM). In 1973-74 treatment 2 was irrigated each time wilting point was reached (shooting and dough) and treatment 3 each time ASM fell to 25% (shooting, boot and milk). Grain yield and quality are given in Table 2.

TABLE 2: The effects of irrigation on barley grain yield, screenings, barley nitrogen and malt extract at Winchmore B site

Trt 1972-73	Yield kg/ha	Screenings %	N%	%Extract
1 One irrigation	3710 bB	44.7 aA	1.64 a	78.7 bA
2 Two irrigations	4880 aA	9.3 bB	1.53 a	81.9 aA
3 Three irrigations	5140 aA	9.8 bB	1.45 a	81.8 aA
C.V.%.	10.5	39.0	8.4	2.2
1 No irrigations	2280 bB	8.0 abA	2.37 aA	78.5 bB
2 Two irrigations	4050 aA	11.5 aA	1.60 bB	81.7 aA
3 Three irrigations	4510 aA	7.1 bA	1.53 bB	82.7 aA
C.V.%.	6.8	25.2	6.8	0.7

In 1972-73 treatments receiving two or three irrigations gave a significant yield and quality improvement over one irrigation as reflected by the increase in yield, decrease in screenings and increase in malt extract. There was no yield or quality difference between the two and three irrigation treatments.

In 1973-74 barley yields and quality were greatly improved by irrigation but there was no significant difference between the two irrigated treatments. Screenings were at an acceptable level in all treatments.

At Fairton in 1972-73 irrigation was applied to treatments 2 and 3 after ear emergence (wilting point); treatment 3 received additional irrigation at the milk stage (25% ASM), Table 3.

TABLE 3: The effects of irrigation on barley grain yield, screenings, barley nitrogen and malt extract at Fairton 1972-73.

Trt	Yield kg/ha	Screenings %	N%	%Extract
1 No irrigation	2720 bB	52.0 aA	2.59 aA	73.8 bB
2 One irrigation	3990 aAB	10.0 bB	2.02 bA	78.7 aAB
3 Three irrigations	4240 aA	7.0 bB	1.90 bA	79.0 aA
C.V.%.	10.7	41.0	8.6	1.7

Grain yields and malt extracts were increased by both irrigation treatments, the response to one irrigation was at the 5% significance level and the response to two irrigations was at the 1% significance level. The difference between the two irrigation treatments was non-significant.

There was a highly significant reduction in the screenings percentage and a significant (5%) reduction in nitrogen with both irrigation treatments, but again the differences between treatments were not significant.

On Templeton and Waimakariri silt loams various irrigation treatments were applied to three experiments but there were no significant responses to irrigation either in yield or quality. The means of grain yield and quality measurements in the two seasons on Templeton silt loam are given in Table 4.

TABLE 4: Treatment means of barley grain yield, screenings, barley nitrogen and malt extract at Templeton.

Season	Yield kg/ha	Screenings %	N%	%Extract
1972-73	4350	6.9	1.65	81.1
1973-74	2890	6.2	1.52	82.2

In 1973-74 harvesting was delayed. Some grain shattering occured and the possible effects of this on grain yield will be discussed later.

DISCUSSION

On the lighter soil, Lismore stony silt loam, and in both seasons, there was a significant response to irrigation both in yield and quality. Although irrigation also improved grain size, where there were high screenings in the non irrigated plot an irrigation after earing was needed to bring size up to an acceptable level.

On these soils the ASM was depleted before the end of the shooting stage. Irrigation at this time gave yield increases from 870 to 1030 kg/ha or 32% to 66%. Although this was not always accompanied by a reduction in screenings, it was accompanied by an improvement in malting quality. Irrigation applied after earing had commenced gave variable yield and quality responses, but reduced screenings to an acceptable level. High yields and good malting quality, including satisfactory grading were obtained by irrigating at the shooting stage followed by a further application after ear emergence. Increasing the number of irrigations above two gave only marginal improvements in yield and quality.

The farm practice of irrigating twice during the season appears to be well founded. On a soil moisture basis, this amounted to irrigating each time the ASM approached zero (wilting point) in the experiments reported here. In the four experiments at Winchmore this treatment gave yield responses of 74, 80 (estimated), 103 and 78 per cent, and highly satisfactory improvement in quality.

On the Waimakariri and Templeton silt loam there was no significant response to irrigation either in yield or quality, but trends were present and apparent visual grain yield responses were noted during growth. Both these soils have similar characteristics, are stone free, and have slightly higher water holding capacity than the Lismore soil. Although the ASM reached wilting point, it would appear the plants were not put under sufficient stress to effect the barley yield and quality, consequently irrigation made no significant improvement. Although this was true of the two seasons in question, it need not hold for other seasons. In 1973-74 harvesting was delayed and there was considerable grain shattering before sampling. It is possible that the extent of shattering could have been greater on the more heavily irrigated treatments, but no assessment of losses was made.

As mentioned previously grain nitrogen is a useful index of barley quality as there is a highly significant negative correlation between it and malt extract. Both figures are shown in the results, but more significance is placed on malt extract. The higher the potential recoverable extract the more desirable the barley is for malting. Other indices of malting quality were determined, namely coarse grind extract, total malt nitrogen, soluble malt nitrogen and diastatic power; but these were either not significantly affected by irrigation or showed the same trends as the fine grind extract. Because they would contribute nothing more to the results they have been omitted.

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