THE EFFECT OF SOWING TIME AND CULTIVAR ON BARLEY YIELD AND QUALITY

T.L. Knight[1], R.J. Martin[2], E.G. Drewitt[1]
[1]MAFTech, Winchmore Irrigation Research Station, Private Bag, Ashburton
[2]MAFTech, P.O. Box 24, Lincoln

ABSTRACT

A study was carried out in Mid Canterbury over two years 1985/86 and 86/87 to evaluate the performance of barley sowings from May to November on light soils under irrigation.

Cultivars Triumph, Magnum and Illia were established at monthly intervals. In the first year two irrigation levels were imposed.

Yields from the three cultivars were similar until the September sowing. The yield from Illia, a true winter barley, then dropped sharply as temperatures were too high for complete vernalization. Yields of Triumph and Magnum increased with the October sowing and then dropped when sowing was delayed until November.

Quality was good until September sowing but screenings % increased after that. Malting quality of Triumph was highest from autumn/winter and September sowings. The only effect of increasing the irrigation level was a lowering of quality with smaller grain and increased screenings.

The project demonstrated that barley can be established in autumn and winter with good quality and yield. With adequate inputs of disease and pest control and irrigation there was no yield advantage from these early sowings but they will assist the barley grower by spreading the overall workload.

Additional Key Words: Hordeum vulgare L., *irrigation, components, malting quality.*

INTRODUCTION

Barley is an important crop in Canterbury. It is used for malting and animal feed, and is traded both on the local and international markets. For some time there has been interest in autumn and winter sown barley as there are practical advantages to the grower. Sowing at this time spreads the workload at sowing and at harvest and allows early establishment of following feed crops or pastures.

Gallagher (1983) calculated from European data that, because of the longer growing period, autumn and winter sown barley should have a yield advantage over spring sown. This advantage should be greatest where moisture is a limiting factor over the spring and summer, as much of the growth from autumn sowing will occur before this limitation.

Gallagher and White (1984) and Wright *et al.* (1984) confirmed this at Lincoln on light soils and demonstrated that the earlier the sowing the higher the yield. Carter and Fitzgerald (1987) and Lampang (1987) also achieved higher yields from a true winter barley sown in autumn than from traditional spring cultivars sown in either autumn or spring. Lampang (1987) also achieved higher yields from Triumph when autumn sown, but Wright *et al.* (1984) showed that good disease control was necessary to get high yields from this susceptible cultivar.

Lampang (1987) found that Illia sown in September produced under half of the yield of a July sowing and suggested that the mean monthly temperature of 9.8 °C was too high for vernalization. This confirmed the results of Trione and Metzger (1970) which demonstrated that winter barley required temperatures between 5 and 10 °C to commence reproductive development.

When growing spring barley, Drewitt and Muscroft-Taylor (1978) obtained similar yields from sowings in late August, September and October. Carter and Stoker (1985) sowed barley at monthly intervals from September to December with highest yields from an October sowing.

Carter and Fitzgerald (1987) found no difference in malt extract between autumn and spring sown Triumph barley but Carter and Stoker (1983) noted a decline in malt quality in c.v. Zephyr from September to December sowings and an increase in grain nitrogen content.

The project reported in this paper examined the following hypotheses.

1. Autumn and winter sown barley will outyield spring sown barley.
2. Autumn and winter sowings will produce high quality grain.
3. Early spring sowings will outyield October and November sown barley.

MATERIALS AND METHODS

The experiment was conducted over two years 1985/86 and 86/87 at the Winchmore Irrigation Research Station in Mid Canterbury. The soil type is Lismore stony silt loam (NZ Soil Bureau 1968) under border strip irrigation. In both years the experiment was established after a wheat crop which had followed four years in irrigated pasture.

It was a split plot design with two replicates in the first year and four in the second. Main plot treatment factors in the first year were irrigation levels and sowing date, and in the second only sowing date.

Irrigation was applied in the first year at two levels, when 90% and 60% of the available soil moisture was depleted. This corresponded to 12% and 18% actual soil moisture measured gravimetrically. In the second year irrigation was at 75% depletion (15% actual soil moisture). Sufficient water was applied by the flood method at each irrigation to restore the soil to field capacity. Table 1 details irrigation.

TABLE 1: Number of irrigations and fungicide applications.

	Irrigations			Fungicide Applications	
Sowing	1985/86		1986/87	1985/86	1986/87
Date	12%	18%	15%		
May	1	2	2	4	4
June	1	2	2	3	4
July	1	2	2	2	3
August	1	2	3	2	4
September	1	4	3	3	3
October	1	2	4	2	4
November	1	2	3	1	3

In both years sowing took place in the first week of the months of May to November, except for July 1986 when rain delayed sowing until the 17th.

Sub plot treatments were three barley cultivars; Triumph, two row, malting; Magnum, two row, feed, and Illia, six row, feed. Illia is a true winter cultivar with a vernalization requirement while Triumph and Magnum can be sown either in autumn and spring.

Barley seeding rate was from 130 to 150 kg/ha.

In 1985 27 kg N, 24 kg P and 60 kg S/ha was applied at drilling as a 2:1 superphosphate/ammonium sulphate mix. In 1986 45 kg N, 30 kg P, 30 kg K and 21 kg S/ha was applied at drilling as Cropmaster 15. Urea, 100 kg N/ha in 1985 and 56 kg N/ha in 1987, was topdressed when each sowing reached the mid tillering stage.

Fungicides and insecticides were applied as required to keep disease and pests to a minimum. Table 1 details the number of fungicide applications but as all cultivars were sprayed at the same time the results do not give any indication of individual cultivar requirements.

Bird damage, at the milk stage, occurred in the May sown Triumph and Illia. This was particularly severe in 1986/87. The damage was measured at harvest and grain yields adjusted to compensate. Screenings were determined as the percentage by weight of grain passing through a 2.37 mm (A6) screen. Malt quality was determined by micromalting 250 g samples (Meredith *et al.*, 1962) and measuring the fine-grind extract percentage using the European method (Pollock, 1962). Grain nitrogen levels were measured using a Near Infra Red Reflectance Meter.

Malt extract and grain nitrogen were measured on a bulked treatment basis while all other data were measured and statistically analysed on a per plot basis.

RESULTS

Climatic data are detailed in Figs 1 and 2. Rainfall (Fig. 1) in the first year was generally close to the 10 year mean from May to October and then higher in November, December and February. In the second year it was substantially higher in March, July, August and February and very low in December and January.

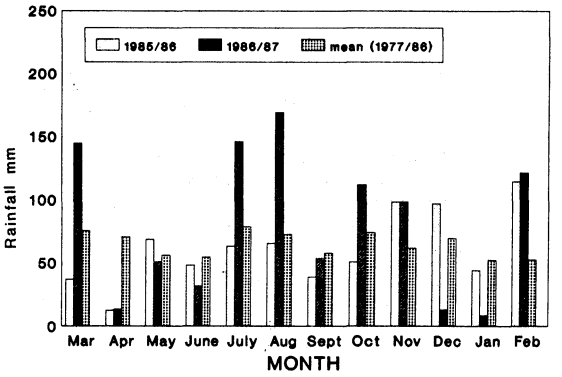

Figure 1: Total monthly rainfall at Winchmore Irrigation Research Station m.m.

Irrigating in the first year at 12% soil moisture required only one irrigation at all sowing dates (Table 1) and the 18% level required only one more at all sowing dates except September which required 3 extra. 1986/87 was drier than the previous year with higher irrigation requirements for the spring sowings.

1985/86 was warmer than 1986/87 (Fig. 2) from June to September and cooler from October to December. Relative to the 10 year mean, August 1986 was substantially colder and in both years January was warmer. October and November temperatures in both years were higher than the maximum for complete vernalization in true winter cultivars (Trione and Metzger, 1970).

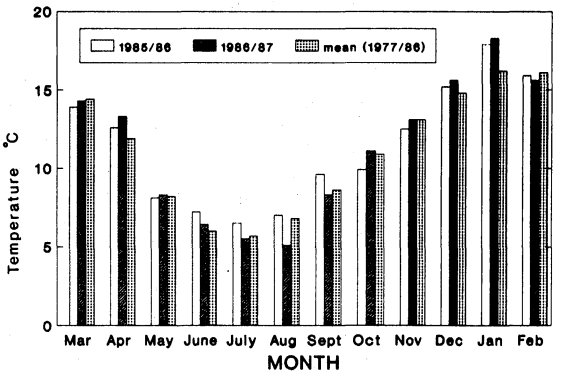

Figure 2: Mean monthly screen air temperature at Winchmore Irrigation Research Station. °C.

SOWING DATE AND CULTIVAR EFFECTS

Barley yield

Yields from Triumph and Magnum were similar in both years (Figs 3 and 4). Yields from June to October sowings were similar in 1985/86 and in November the yield from Triumph was significantly lower. In 1986/87 yields from Magnum increased from the June to October sowing while Triumph had similar yields from June to September with a significant increase in October. Both cultivars declined significantly at the November sowing.

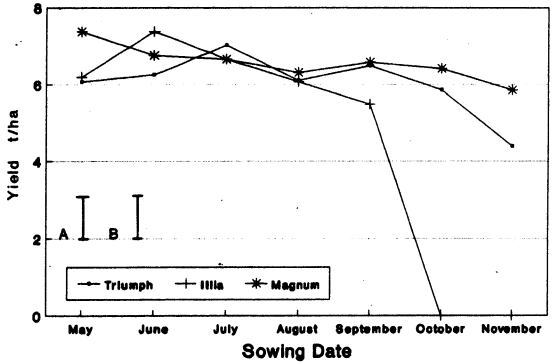

Figure 3: Grain yield (t/ha) 1985/86, for each cultivar and sowing time.
A = LSD (5%) for cultivars at the same sowing time.
B = LSD (5%) for other comparisons.

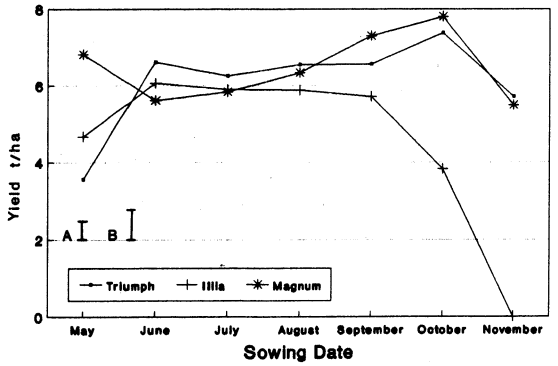

Figure 4: Grain yield (t/ha) 1986/87, for each cultivar and sowing time.
A = LSD (5%) for cultivars at the same sowing time.
B = LSD (5%) for other comparisons.

Illia only outproduced the other two cultivars at the June sowing in 1985/86 and this was only significant compared with Triumph. In general Illia produced similar yields to Triumph and Magnum until the August sowing. It was slightly lower yielding in September and dropped to nil when October sown 1985 and November sown in 1986. Illia sown in October 1986 stayed in the vegetative stage much longer than the other cultivars which resulted in a harvest one month later than same sowing of Triumph and Magnum.

Although we attempted to compensate for bird damage the yields from Triumph and Illia at the first sowing are still low especially in 1986/87. As there is no other obvious reason for this it appears that our method of assessment did not estimate the full extent of the damage.

Grain weight

Triumph and Magnum had similar grain weights and in both years there was a large drop at the October sowing with a recovery in November (Fig. 5). Illia had a higher grain weight than Triumph and Magnum at most sowings in both years. Only in September 1985 was it substantially lower. Grain weights were considerably higher in 1986-87 at all sowing dates.

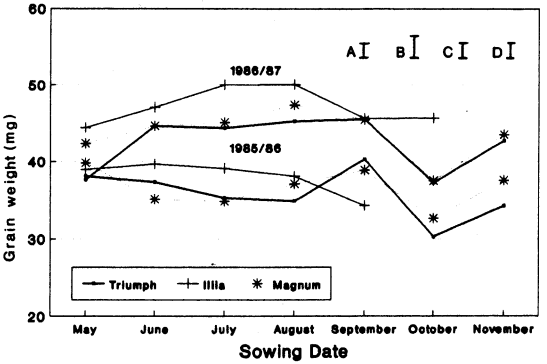

Figure 5: Grain weight (mg) for each cultivar and sowing time.
A = LSD (5%) 1985/86 for cultivars at the same sowing time.
B = LSD (5%) 1985/86, for other comparisons.
C = LSD (5%) 1986/87, for cultivars at the same sowing time.
D = LSD (5%) 1986/87, for other comparisons.

Screenings

Screenings % (Fig. 6) followed a close inverse pattern to grain size with a large significant increase in October sowings of Triumph and Magnum in both years.

The standard for locally consumed malting barley (J. Smart pers. comm.) is no price discount up to 5% screenings with increasing discounts up to 10% above which it is unacceptable. All Triumph sowings except October were acceptable in 1986/87 but in the first year only May, June and September were under 10%.

Ear number

Triumph and Magnum had similar ear numbers/m^2 and produced over twice as many as Illia (Fig. 7). October sowing produced more ears than other spring sowings in both years. Ear numbers were higher in 1985/86 and this may be associated with higher nitrogen rates applied at mid tillering in that year.

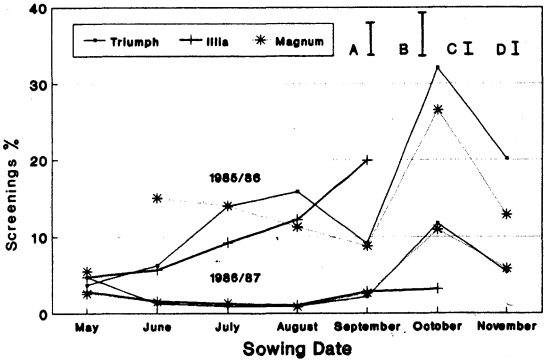

Figure 6: Screenings % for each cultivar and sowing time.
A = LSD (5%) 1985/86 for cultivars at the same sowing time.
B = LSD (5%) 1985/86, for other comparisons.
C = LSD (5%) 1986/87, for cultivars at the same sowing time.
D = LSD (5%) 1986/87, for other comparisons.

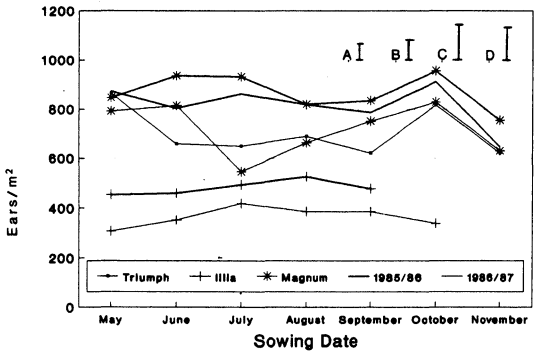

Figure 7: Ear number/m² for each cultivar and sowing time.
A = LSD (5%) 1985/86 for cultivars at the same sowing time.
B = LSD (5%) 1985/86, for other comparisons.
C = LSD (5%) 1986/87, for cultivars at the same sowing time.
D = LSD (5%) 1986/87, for other comparisons.

Grain Number/ear

In 1985/86 there was little difference between Triumph and Magnum or sowing dates (Fig. 8), but in 1986/87 Triumph had a greater number of grains/ear than Magnum with again only small differences between sowing dates.

Illia, a six row cultivar, produced higher grains/ear in both years at all sowing dates, although not significantly higher than Triumph at the November sowing in 1986/87.

Grain Nitrogen — Triumph

In general grain nitrogen increased (Fig. 9) as sowing date was delayed although July 1985 and September 1986 went against this trend. The May sowing of 1986/87 with severe bird damage was also much higher than other sowings of that year.

The Canterbury Malting Co. accepts barley up to 2% grain nitrogen but prefers that a large part of their barley are in the 1.6-1.7% range (J. Smart, pers. comm.).

All sowings except November 1985 are below this 2% level. In the second year all sowings had a lower grain nitrogen level.

Micromalt Test — Triumph (Fine extract %)

There was a general downward trend with delayed sowing with the following exceptions, September 1985 and 1986 and November 1985. May 1986 was also low with the bird damage problem. 1986/87 levels were higher than 1985/86, the converse of grain nitrogen %.

All fine malt levels were acceptable for local malting which requires a minimum of 79.5% (J. Smart, pers. comm.).

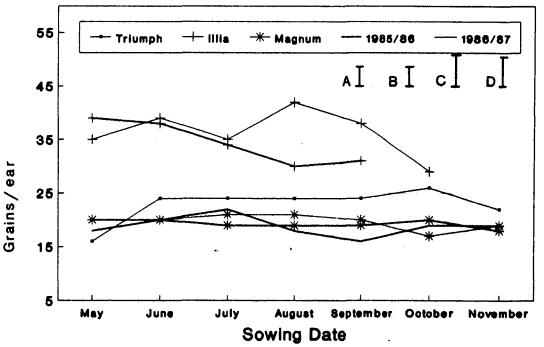

Figure 8: Grain number/ear for each cultivar and sowing time.
A = LSD (5%) 1985/86 for cultivars at the same sowing time.
B = LSD (5%) 1985/86, for other comparisons.
C = LSD (5%) 1986/87, for cultivars at the same sowing time.
D = LSD (5%) 1986/87, for other comparisons.

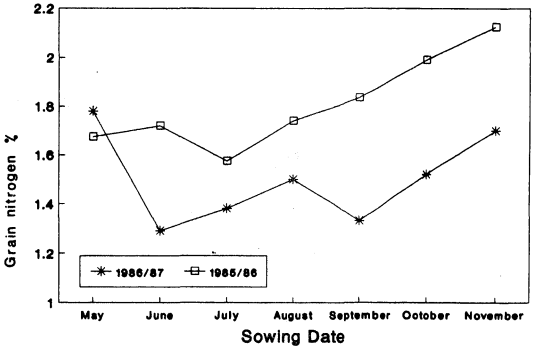

Figure 9: Grain nitrogen % for Triumph at each sowing time (N.I.R. test) 1985/86 and 86/87.

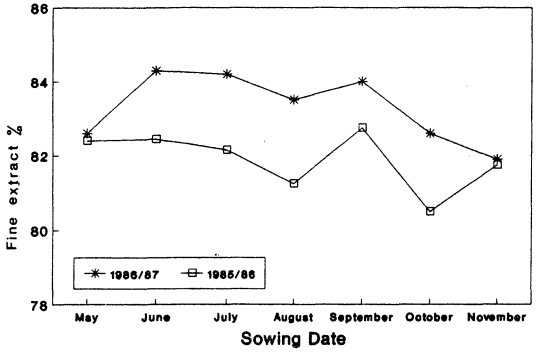

Figure 10:Micromalt-fine extract % for Triumph at each sowing time, 1985/86 and 86/87.

Irrigation Effects

Irrigating at 18% vs 12% in 1985/86 (Table 2) produced no difference in grain yield, ear number, grains/ear or malt quality of Triumph. There was no main effect on grain weight but in Triumph the increased irrigation significantly (5%) reduced grain weight. Screenings overall were increased significantly by increased irrigation. August and Triumph were the month and cultivar most affected. Increased irrigation reduced Triumph grain nitrogen.

TABLE 2: Irrigation main effects (1985/86).

	Irrigation Level (actual soil moisture) 12%	18%	
Grain yield (t/ha)	5.77	5.67	n.s.
Grain weight (mg)	33.9	32.5	n.s.
Screenings %	10.2	13.5	5% sig.
Ear number/m²	666	686	n.s.
Grains/ear	21.2	20.8	n.s.
Grain nitrogen % (Triumph)	1.86	1.76	
Fine malt extract % (Triumph)	81.9	81.9	

DISCUSSION

Yields of Triumph and Magnum sown from June to October were similar. These results differed from those of Gallagher and White (1984), who recorded higher yields from the earlier sowings but their trial was without irrigation. Carter and Fitzgerald (1987) on light irrigated soils, achieved similar results to this study. Thus the yield increase of two t/ha from autumn sowing predicted by Gallagher (1983) did not eventuate in these trials. The longer duration of growth of the autumn sown barley did not result in an increase in any of the yield components. However, it did result in better malting quality in Triumph contrary to experience in the Northern Hemisphere (Smart, 1983).

These results were achieved with good levels of disease control which add substantially to costs. There is a need for a cultivar combining high malting quality and disease resistance to allow the growing of malting barley in autumn through to spring to fit into overall farm management at reasonable costs.

Illia, the true winter cultivar, produced good yields until September sowing but temperatures in October and November were too high for complete vernalization (Trione and Metzger, 1970) which slowed or stopped stem elongation and produced very low or nil yields. Although Illia had no yield advantage over Triumph or Magnum its greater resistance to scald and net blotch may make the growing of winter sown Illia for feed grain more profitable.

The sowing in early October, which Carter and Stoker (1983) and Drewitt and Muscroft-Taylor (1978) found to produce the best yield also yielded well in this study but all quality measurements were poorer when compared with September sowing. Therefore for malting, spring sowings should be made as early as possible.

Ear numbers were higher at the October sowing than other spring sowings but grains/ear were unaffected resulting in increased grain numbers and this may be the reason for the high screenings. Plant numbers were not recorded in 1985/86 but in 1986/87 September and October were similar. Therefore, increased tiller production and/or survival must have produced the high ear number. The higher ear numbers in the October sowings may have resulted from increased nitrogen available at tillering in this sowing.

In 1985/86 the increased irrigation level did not increase grain yield, grain weight or malt extract but increased screenings. The only positive result of increasing irrigation was the decrease in grain nitrogen. Previous studies on light soils (Drewitt and Smart, 1981) showed increased yields with increases in irrigation, no increase in screenings and enhanced quality, i.e. lower grain nitrogen and higher malt extract. However, increased irrigation promoted leaf growth which in this year caused an increase in lodging resulting in smaller grains and increased screenings.

Bird damage was severe in May sown Triumph and Illia which affected all results. Although this problem is much greater with small plots it should be taken into account when sowing early autumn barley on a larger scale. There was a strong cultivar effect with little damage to Magnum although it was growing alongside the other cultivars.

CONCLUSIONS

In this study, where diseases and pests were controlled, and irrigation and fertiliser applied at optimum levels the following conclusions can be drawn.

1. Cultivars Triumph, Magnum and Illia produced similar yields when sown from June to September.
2. Malting quality of cultivar triumph was better in autumn and winter sowings.
3. September was best for spring sowing of Triumph and Magnum. October gave higher yields but lower quality

while August and November had lower yields and quality.

4. Illia should not be sown after August.
5. Increased irrigation reduced grain nitrogen levels but gave no yield increase and increased screenings.

ACKNOWLEDGEMENTS

We wish to thank Mr Neil Alexander for assistance with running the trial, Mr John Smart of the Canterbury New Zealand Malting Company for micromalt and grain nitrogen analyses and Mr Dave Saville for assistance with biometrics.

REFERENCES

Carter, K.E., Fitzgerald, P.D. 1987. A comparison of autumn and spring sown barley on Lismore soils with and without irrigation. *Proceedings Agronomy Society of N.Z. 16:* In Press.

Carter, K.E., Stoker, R. 1983. Irrigation and sowing date effects on yield and malting quality of barley. *In:* Barley: Production and Marketing. Wright, G.M., Wynn-Williams, R.G. (Editors). Agronomy Society of N.Z. Special Publication No. 2, Agronomy Society of N.Z. 123-126.

Carter, K.E., Stoker, R. 1985. Effects of irrigation and sowing date on yield and quality of barley and wheat. *N.Z. Journal of Experimental Agriculture 13:* 77-83.

Drewitt, E.G., Muscroft-Taylor, K.E. 1978. The effect of sowing date on spring wheat and barley. *N.Z. Journal of Agriculture 136:* 31-32.

Drewitt, E.G., Smart, J.G. 1981. The effect of irrigation and nitrogen fertiliser on the yield and malting quality of barley. *Proceedings Agronomy Society of N.Z. 11:* 23-28.

Gallagher, J.N. 1983. Winter barley — possibilities, problems and prospects. *In:* Barley: Production and Marketing. Wright, G.M., Wynn-Williams, R.B. (Editors). Agronomy Society of N.Z. Special Publication No 2. Agronomy Society of N.Z. 89-99.

Gallagher, J.N., White, E.M. 1984. Why sow barley early. Ashley Dene field day 25 October 1984 handbook, Lincoln College. 18-21.

Lampang, A.N. 1987. Effects of sowing date, cultivar and disease on grain yield components of barley (*Hordeum vulgare* L.). M.Ag. Sci. Thesis, University of Canterbury, N.Z. 88p.

Meredith, W.O.S., Anderson, J.A., Hudson, L.E. 1962. Evaluation of malting barley. *In:* "Barley and Malt". Editor. A.H. Cook, Academic Press, New York and London. 234-235.

N.Z. Soil Bureau. 1968. General survey of the soils of South Island, New Zealand. N.Z. Soil Bureau Bulletin 27. Department of Scientific and Industrial Research. 404p.

Pollock, J.R.A. 1962. The Analytical Examination of barley and malt. *In:* "Barley and Malt". Editor. A.H. Cook, Academic Press, New York and London. 413-415.

Smart, J.G. 1983. Malting Quality — What is it? *In:* Barley: Production and Marketing. Wright, G.M., Wynn-Williams, R.B. (Editors). Agronomy Society of N.Z. Special publication No. 2, Agronomy Society of N.Z. 109-112.

Trione, E.J., Metzger, R.J. 1970. Wheat and barley vernalization in a precise temperature gradient. *Crop Science 10:* 390-392.

Wright, A.C., Henry, S., Elmer, P.A.G., Gaunt, R.E. 1984. An investigation of sowing date, cultivar and disease interactions in autumn sown barley. *Proceedings N.Z. Weed and Pest Control Conference 37:* 284-289.