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EFFECT OF DATE OF DEFOLIATION ON YIELD OF AUTUMN BARLEY SOWN ON DIFFERENT DATES

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ABSTRACT

Illia and Triumph, two cultivars of barley were sown on irrigated light soil in Mid-Canterbury in April, May and June 1985. Portions of each crop were hard grazed at tillering or at the first node or third node stage of stem elongation. Herbage yields averaged 800 kg/ha at the first grazing but increased to 1200 kg/ha at the second and 1900 kg/ha at the third grazing. The nitrogen content of the herbage decreased from 2.3% N at the first to 1.6% N at the third grazing. Grain yields from ungrazed plots averaged 7000 kg/ha for the April sowing and 6000 kg/ha for the May and June sowing. Grazing reduced grain yields by 900 kg/ha at the first grazing, and 1800 kg/ha at the third grazing.

Herbage and grain yields were higher from the April sowing, but there was little difference between the May and June sowings. Triumph malting quality was high and generally unaffected by the grazing treatments.

Additional Key Words: Hordeum vulgare L., cultivars, yield components, digestibility, quality.

INTRODUCTION

During the recent resurgance of growing barley in Canterbury, there was a renewed interest in autumn sowing. Gallagher and White (1984) showed that barley yields can be increased if sown in autumn, confirming results from overseas (Gallagher, 1983). However, the earlier sowing of barley can lead to lodging of the crop because of excessive vegetative growth, and lost pasture production in winter because cultivation of the paddock is earlier.

These two problems could be overcome if the barley could be grazed. Apparent intake of barley grazed in mid August at Lincoln was over 1000 kg/ha (Scott, 1984), which suggests that winter barley could provide a very useful greenfeed as well as a grain yield. In addition, grazing of early sown crops may improve grain quality (J. Smart, pers comm).

MATERIALS AND METHODS

Time of sowing and time of grazing determine the yields of greenfeed and grain from barley. A trial was therefore established to examine the effect of sowing and grazing date on herbage and grain yield and quality.

The trial was undertaken in 1985 on a Lismore stony silt loam at the Winchmore Irrigation Research Station 13 km north of Ashburton. This was the third barley crop on the site. Results of soil tests taken prior to drilling were pH 5.8, Ca 9, K 8, P 18 and SO_4 12. A split plot design was used with main plots being two cultivars: Illia (a six row true winter cultivar needing vernalization) and Triumph (a two row spring cultivar and currently the only malting cultivar grown in New Zealand), and three sowing dates: 16 April, 21 May and 14 June. Subplots were grazing dates (Table 1) and these were determined by the stage of growth of Triumph. The first grazing was undertaken when the crop had 5-6 leaves (GS 15-16 (Zadoks *et al.*, 1974)), the second at the first node stage (GS 31) for Triumph (start of stem elongation (GS 30) for Illia), and the third at the third node stage (GS 33) for Triumph (two nodes (GS 32) for Illia).

Fifty kg of N, 33 kg of P and K and 23 kg of S, supplied as Cropmaster 15, were broadcast and harrowed in prior to each drilling. Seeding rates averaged 165 kg/ha for the Illia and 153 kg/ha for the Triumph giving around 195 plants/m^2 for each cultivar. Plot size was 14 m by 9 m and there were four replicates.

At each grazing, 20-25 sheep were penned on each plot until all the green material had been grazed off. This took from 24 hours for early grazings to 40 hours for late grazings. 100 kg/ha of nitrogen as urea was broadcast on to each grazed plot two to three weeks after its grazing finished. The ungrazed plots received the same topdressing when the first grazing of that sowing date took place.

The trial was flood irrigated on 3 September when soil moisture in the top 15 cm fell below 15% in the ungrazed plots. All sowings received five of six aphicide sprays and five fungicide sprays.

Table 1 Sowing and Grazing Dates

	Grazing Date		
	1	2	3
Sowing Date			
16 April	5 August	2 September	16 September
21 May	13 September	23 September	9 October
14 June	19 September	2 October	17 October

Immediately prior to each grazing, quadrat cuts were taken for herbage yield, nitrogen percentage and digestibility. At maturity, quadrats were taken for yield components and then the plots were headed. Yield, screenings, 1000 grain weight and grain nitrogen were determined on the headed samples on a plot basis, and malting tests were done on the Triumph barley on a treatment basis.

RESULTS

The crop was grown in a season when autumn temperatures were 0.5°C above normal and winter temperatures 1.3°C above normal.

Grazings occurred practically on schedule. The Triumph matured earlier than the Illia and at the second grazing, the growing point averaged 4cm above the leaf bases compared with 0.5cm for the Illia. At the third grazing growing points were 5cm above leaf bases for Illia and 8cm for Triumph.

Grazing delayed maturity and also caused less even ripening. These were accentuated at later grazings.

Herbage Yield

Delayed grazing increased yields, particularly at the April sowing. There was no significant difference between yields at the grazing time between the May and June sowings.

There was no difference in grazed herbage yields between cultivars at the first grazing, but yields increased more rapidly with delayed grazing in Triumph compared to Illia (Figure 1).

Herbage Nitrogen

Grazings at later sowings had a lower concentration of herbage nitrogen. There was no difference between sowing dates at later grazings but some variations at the first grazing (Figure 1). Cultivar had no effect on herbage nitrogen.

Herbage Dry Matter Digestibility

Digestibilities of the herbage generally decreased with later sowings and increased with later grazings, with the significant exception of the last grazing of the second sowing (Table 2). There was no significant difference between cultivars.

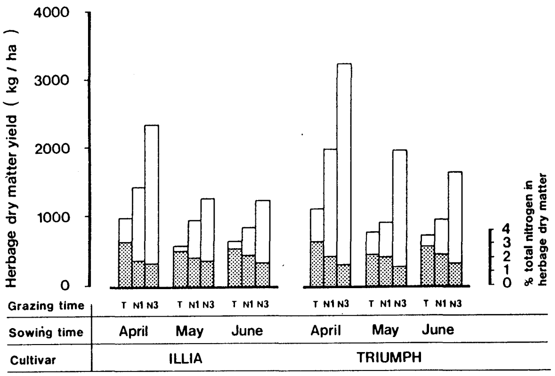

Figure 1 **Herbage dry matter yields and total nitrogen percentage (shaded) for each cultivar, grazing time and sowing time. T = grazed at tillering, NI = grazed at first node, N3 = grazed at third node. LSD (5%) for yield = 150 and 200 for grazing times within and between cultivars respectively, and 190 and 250 for grazing times within and between sowing times. LSD (5%) for % N = 0.28 for interactions between grazing times and sowing times.**

Table 2 **Herbage Dry matter Digestibility (%) : Sowing date and Grazing Time.**

Grazing Time	1	2	3
Sowing Date			
April	90.6	91.7	92.9
May	89.2	89.5	87.4
June	87.6	88.0	90.2

LSD (5%)	Horizontal comparisons:	1.4
	Vertical comparisons:	1.1

Reductions in grain yield due to grazing were mainly due to reduced head numbers in Triumph . Illia is a six row barley and has fewer ears but more grains per ear and yield reductions in this cutivar were due to lower number of grains per ear. Grain weight was considerably less affected by grazing, although sufficiently so to increase the percentage of screenings (in the last sowing) to unacceptable high levels.

Grain Yield and Screenings

Grazing at any stage reduced yield but the effect was greater as grazing was delayed, from 11% at grazing 1 to 30% at grazing 3. Grazing also increased screenings substantially (Figure 2), the screenings for the third grazing date were generally unacceptably high for malting barley or for export feed barley. Delayed sowing significantly increased screenings in Triumph but had no effect in Illia.

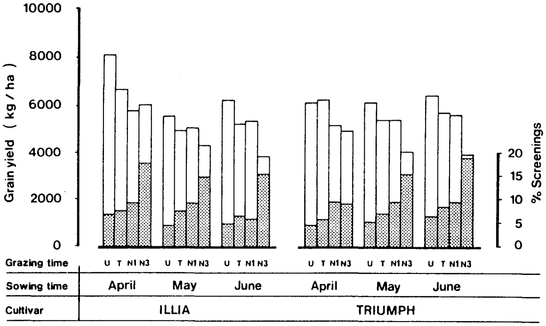

Figure 2 **Grain yield (t/ha) and screenings percentage (2.37 mm screen) (shaded) for each cultivar, grazing time and sowing time. U = ungrazed, T = grazed at tillering, NI = grazed at first node, N3 = grazed at third node. LSD (5%) for yield = 750 for grazing time sowing time interactions. LSD (5%) for screenings = 2.5 for grazing time sowing time interactions.**

There was a significant interaction between cultivar and sowing date in grain yield but this was mainly due to the large differences between cultivars at the April sowing (Figure 2). At this sowing, the Triumph matured first and was severely damaged by birds at the milk ripe stage.

Relationship Between Herbage and Grain Yield

Multiple regression analysis of treatment grain yield (omitting the bird damaged ungrazed first sowing of Triumph) against herbage yield, time of sowing and time of sowing squared gave:

$$GY = 7782 - 1.002HY - 87.9Z + 0.975Z^2$$
$$r^2 = 0.80^{**} \quad ....(1)$$

where GY = grain yield in kg/ha
HY = herbage yield in kg/ha
Z = sowing date (days after April 15)

Including other factors, including time of grazing, did not significantly improve on this regression. This regression shows that for every kg/ha increase in herbage yield, there was a kg/ha loss in grain yield. The regression also showed a declining effect of delayed sowing on yield over the range tested.

Figure 3 is the result of rearranging Equation (1) and plotting grain yield adjusted for sowing date against herbage yield. The equation of the line in Figure 3 is:

$$7800 (\pm 146) - 1.051 (\pm 0.111)\ HY\ (r^2 = 0.80^{**}) \ldots(2)$$

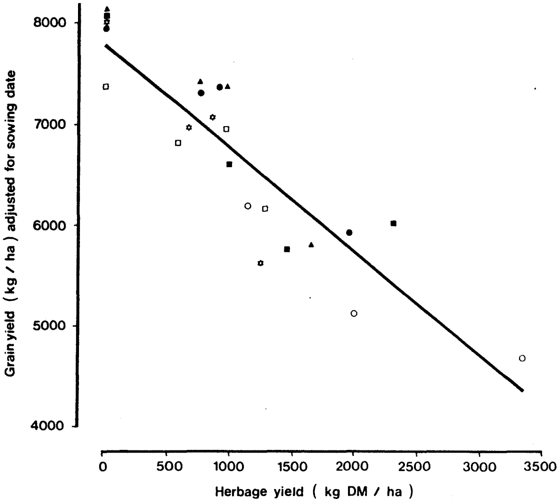

Figure 3 **Grain yields adjusted for sowing date (see Equation 1) plotted against herbage dry matter yields (kg/ha). ■ Illia sown April, □Illia sown May, ☆ Illia sown June, ○ Triumph sown April, ● Triumph sown May, ■ Triumph sown June. Regression line is from Equation 2.**

Straw Yield

Grazing reduced straw yields at all sowing dates (Table 3), particularly at the April sowing. Yields of grazed straw from this first sowing were similar to ungrazed straw yields from the later sowings. There was no significant difference in ungrazed or grazed stray yields between the May and June sowings.

Table 3 **Main effect of cultivar, sowing date and grazing date on straw yield, ear numbers, grain per ear and grain weight.**

	Straw Yield kg ha $^{-1}$	Head No. m^{-2}	Grain No. head^{-1}	Grain Wght mg
Cultivar				
Illia	3060	475	36.0	37.3
Triumph	3240	681	21.2	38.0
LSD (5%)	210	23	1.3	0.6
Sowing Date				
April	3760	634	29.9	37.4
May	2760	546	27.4	38.0
June	2940	554	28.5	37.4
LSD (5%)	260	28	1.7	0.7
Grazing Date				
Ungrazed	4130	628	31.1	39.5
1	2990	554	29.9	38.4
2	2700	561	27.7	37.6
3	2800	569	25.8	35.0
LSD (5%)	290	38	1.5	1.0
Significant interactions	SD*GD(1%)	C*GD(1%) SD*GD(5%) C*SD*GD(5%)	C*SD(1%) C*GD(1%) SD*GD(5%)	C*SD(1%) SD*GD(5%)

Malting Quality (Triumph only)

Grain nitrogen percentage was low for all ungrazed plots (Figure 4). Grazing decreased grain N% at the April sowings but increased it at later sowings, the increase being greater at later grazings. Even so, grain nitrogen levels overall were good, being below 1.7% nitrogen.

Fine extract behaved in the opposite way (Figure 4). At the first sowing only the final grazing had fine extract greatly below the ungrazed treatment, whereas by the third sowing, all grazed treatments had fine extracts considerably below the ungrazed treatment.

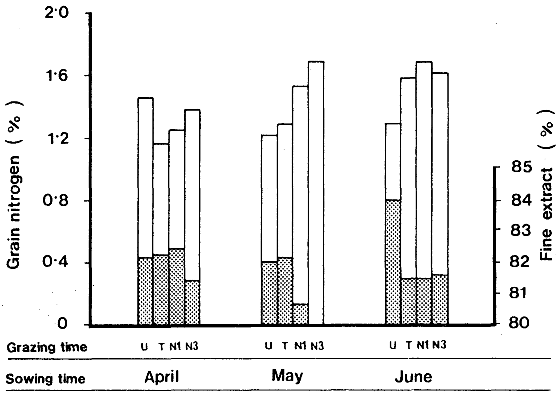

Figure 4 **Triumph grain nitrogen percentage and fine extract percentage for each grazing and each sowing. U = ungrazed, T = grazed at tillering, NI = grazed at first node, N3 = grazed at third node. LSD (5%) for grain N% = 0.12 within sowing dates and 0.15 between cultivars. Fine extract determinations carried out on bulked replicates. * = missing sample.**

Yield Components

Yield Components were calculated from hand cut samples from two quadrats 0.375 cm square in each plot. Yield component main effects are shown in Table 3.

Ear Numbers

Triumph averaged 44% more ears per m^2 than Illia. There was a significant decline in ears per m^2 in Triumph from the April to May sowing, particularly for the ungrazed treatment. In Illia there was no significant difference between sowing dates. Grazing generally had no effect on numbers of ears in Illia whereas grazing depressed ear numbers in Triumph by 17% irrespective of the time of grazing.

Grain Numbers

Grain numbers per ear in Illia decreased after April but increased slightly in Triumph when sowing was delayed, so that, (at the April sowing), Illia had double the number of grains of Triumph and 56% more at the other two sowings. Illia grain numbers were reduced by grazing, the effect being greater (up to 25%) at later grazings, whereas Triumph grain numbers were generally unaffected by grazing. There was no consistent effect of sowing date on each grazing treatment.

Grain Weight

Grain weight was relatively less affected by the imposed treatments than ear numbers and grain numbers per ear. Illia had significantly lighter grains at the April sowing than Triumph but there was no difference between cultivars at the other sowing dates. The early grazing only significantly affected grain weight at the May sowing, and the second grazing only at the April and May sowings. All late grazings significantly reduced grain weight by around 11%.

DISCUSSION

Grazing at any stage reduced grain yield, and the reduction appeared to be proportional to the amount of herbage removed by the grazing, which in this trial was equal to the amount present at each grazing.

Herbage yields of Illia were lower irrespective of sowing and grazing date. This was not due to its more prostrate growth habit, as cutting and grazing were practically to ground level, and all herbage was removed.

Illia was slower in its phenological development than Triumph (R.J. Martin, pers comm) which meant that stem elongation and consequent large increases in vegetative mass were less advanced in this cultivar at each grazing date. However, this appeared to have little effect on grain yield between the two cultivars (Figure 3). However, more contrasting cultivars may behave more differently. Data presented by Anderson (1983) indicated that in Syria grain yield of an unimproved high tillering two row barley was more affected by grazing at an equivalent herbage yield than a six row barley with rapid early growth and high yielding ability

Reduction in grain yield is not only related to time of grazing but also to intensity of grazing (Holliday, 1956). In some trials, lax cutting or grazing, have actually increased grain yields (e.g. Day, 1967). This trial was grazed very intensively, and less severe grazing may have resulted in higher grain yields from the grazed plots. However, farmer practice in grazing barley crops for forage is more likely to be a high stocking rate for a short duration to allow even grazing of the whole paddock, using strip grazing if necessary, and to prevent grazing of regrowth, trampling damage, etc.

A relatively high seeding rate and relatively high rates of nitrogen were used in this trial, and these are likely to show increased grain and herbage yields over more conventional rates (Anderson, 1985). However, to maximise herbage yields from grazed plots, Anderson (1985) needed to double conventional seed rates, although optimum rates for grain were often lower than those conventionally used. Anderson (1985) also found that nitrogen requirements for maximum grain yields in grazed plots were approximately double those required in ungrazed plots. In this trial, initial nitrogen levels were very low with severe yellowing in the crop before top dressing with nitrogen.

In this experiment, malting quality of the Triumph barley was generally reduced by grazing, and the later the grazing the greater the reduction. Thus additional nitrogen may increase yields after grazing but could depress quality. In the first sowing, all grazing treatments showed the same trend for grain nitrogen to increase with delayed grazing but were lower than the ungrazed. This could have been due to the bird damage in the treatment as more nitrogen may have been accumulated in the remaining grains.

Nutritive value of the herbage was very high. Lawes and Jones (1971) showed similar levels of nitrogen and digestibility in grazed barley before booting. However, Droushiotis (1984) found that digestibility and protein content of barley herbage were considerably reduced when barley was grazed during grain filling.

These are data from only one season which was considerably milder than normal. In seasons with average autumn and winter conditions, herbage yields would undoubtable have been lower, as the rate of appearance and expansion of barley leaves increases rapidly with temperatures above 0°C (Biscoe & Gallagher, 1978), and also the effect on grain yield may have been more severe at early grazings. However trials elsewhere in Canterbury (Gallagher and White, 1984; Scott, 1984) have given higher herbage yields at equivalent growth stages (W.R. Scott, pers comm).

Is the grazing of barley economic? The regression line in Figure 3 indicates that, in this experiment, every kilogram of herbage dry matter removed reduced grain yield by one kilogram. Thus, in this situation, the value of the herbage would have to be equal to the value of the grain. Grain values recently have varied between $90/t for feed barley to $190/t for malting barley. Prices for grazing have varied from 15 c to 60 c/ewe/week which (allowing 1.0 kg DM/ewe/day) equates to $21 to $86/t for herbage dry matter.

The reduction in straw weight with grazing, which agreed with visual observations of straw height, will have significantly reduced the likelihood of lodging. However, the use of chemical growth regulators to shorten straw would be a more financially attractive means of reducing lodging without affecting yield. These chemicals may also increase yield by altering photosynthate distribution within the plant (Penny *et al.*, 1986).

Therefore, in the case of malting barley, grazing is not economic, unless feed in late winter is short and so grazing values are high, and the farmer is certain of getting very low grain yields. For feed barley the same conditions hold, but low grain prices may make the grazing relatively more valuable.

CONCLUSIONS

1. Delaying grazing increased forage yield of barley but decreased grain yield.
2. Early sowing increased grain yield. It also increased forage yield at a given date but this increase meant a greater reduction in grain yield. As a result, for most of the treatments, grain yields were very similar.
3. Hence, if farmers are to optimise both grain and grazing yields, plantings should be made as early as possible in the autumn. However to avoid severe reductions in grain yields, grazing should be completed before stem elongation.
4. Unless grain prices are very low, grazing of barley is unlikely to be economic.
5. Grazing reduced malting quality, particularly at late grazings.
6. There was no evidence that Illia, a true winter barley, was more tolerant of grazing than Triumph, which is a spring cultivar.

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