VARIABILITY IN THE MALTING QUALITY OF TRIUMPH BARLEY IN SOUTHLAND AND OTAGO

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ABSTRACT

Trials were conducted over two seasons to survey the effect of added nitrogen fertiliser on the grain and malting quality of Triumph barley.

In 1983-84, nitrogen applied to six sites in unreplicated trials increased grain nitrogen concentrations at rates above 100 kg N/ha but did not change malting quality as defined by malt extract. At two trial sites, malting quality was reduced but only at fertiliser rates of 100-150 kg N/ha. Grain nitrogen concentration, grain size, and malt extract values, averaged over all fertiliser treatments, varied markedly from site to site.

In the following season, nitrogen added to two trial sites resulted in a steady increase in grain nitrogen concentration and percentage screenings, a decrease of grain size, and, at rates of 150 kg N/ha and above, a decline in malting quality. In these trials, neither grain quality nor malting quality was affected by site or by splitting the application of 100 kg N/ha between sowing and early tillering.

Additional Key Words: *nitrogen fertiliser, split applications, grain nitrogen, screenings, micro-malting, malt extract*

INTRODUCTION

Recently there has been rapid growth in the area cropped in barley in the lower South Island and much of the increased production is malting grade barley destined for export. The quality attributes of malting barley differ from those of feed barley. However, there is little published data describing the effect of crop management practice and environmental parameters on the quality of malting barley grown under New Zealand conditions with the exception of some work investigating irrigation on light, stony Canterbury soils (Thompson *et al.*, 1974; Drewitt and Smart, 1981).

The lack of information about malting quality is partly due to the technical difficulties involved with evaluating malting potential in the laboratory and in particular, evaluation of the large numbers of grain samples generated by replicted field trials. The recent development of automated micro-malting equipment (Haslemore *et al.*, 1985) has overcome many of the problems associated with quality assessment.

The objective of this work was to survey the variation in malting quality of Triumph barley grown in nitrogen fertiliser trials on Southland and Otago sites over two seasons. All trial sites had been previously cropped extensively with cereals and showed significant grain yield increases with applied nitrogen (Risk *et al.*, 1984). This paper presents preliminary results relating grain and malting quality to fertiliser treatments and to differences between sites and seasons.

MATERIALS AND METHODS

Sites

Trials were conducted in 1983-84 on seven sites in Southland and Otago (Risk *et al.*, 1984). All sites had previously grown at least four successive cereal crops. Trials 2-7 only were evaluated and split nitrogen treatments were excluded.

In 1984-85, trials were grown on two Southland sites (Table 1) with trial 8 grown on the same paddock as for trial 7 the previous year. Rainfall ranged from 451-688 mm over all trials for the six months from October to March, compared with 30 year averages of 323-515 mm. January and March 1984 were particularly wet at all sites.

TABLE 1: Trial details for 1984/85.

	Trial 8	Trial 9
Location:	Thornbury	Heddon Bush
Soil type:	Waikiwi	Drummond
Previous crops:	5	6
Date sown 1984:	25 Oct	15 Oct
Split N application 1984:	22 Nov	14 Nov
Harvested 1985:	12 Mar	11 Mar

Experimental

Triumph barley was sown in all trials for both seasons. The trials used a split plot design with barley grown in the main plots and the fertiliser treatments at the sub plot level; there were four replicate plots of 17.1 x 1.17 m (20 m^2) for each treatment. Experimental details for the 1984-85 trials were similar to those described for trials 5, 6 and 7 in the 1983-84 season (Risk *et al.*, 1984) except that the nitrogen treatments were changed to 0, 50, 100, 150 and 200 kg N/ha, applied at sowing. The 100 kg N/ha treatment, split between sowing and early tillering (G.S. 14) in the proportion 25/75, 50/50 and 75/25 kg/ha, was the same as for 1983-84.

Grain and malt analyses

Screenings were measured by passing duplicate 200 g samples over an A6 screen (2.38 mm). Thousand grain weight (TGW) was measured from screened samples and corrected to a dry basis. Grain nitrogen concentration was measured by a micro-Kjeldahl procedure (Haslemore and Roughan, 1976) and the results quoted on a dry basis (% DM).

Screened samples (2 x 15 g) were micro-malted using the automated malting equipment and conditions described by Haslemore *et al.* (1985). Prior to mashing, micro-malts were ground in duplicate using a Buhler-Miag laboratory disc mill with gap settings of 0.2 and 1.0 mm. Malt samples (10 g) were mashed by a modified Institute of Brewing procedure and malt fine and coarse extract values were determined by a refractometric method (Gothard *et al.*, 1980). Fine-coarse extract difference was determined as the difference between malt fine extract (%) and malt coarse extract (%) for a particular malt sample.

Statistical analyses

Replicated field samples from the 1983-84 trials were bulked before evaluation so grain and malting quality data were averaged over all sites for each nitrogen treatment and over all treatments for each site. These data were not analysed statistically. Data from the 1984-85 trials were analysed by a two-way analysis of variance.

RESULTS

1983-84 trials

Yield responses to applied nitrogen occurred at all sites with grain yields continuing to increase at the highest application rate (150 kg N/ha) for some of the trials (Risk *et al.*, 1984).

The overall trends describing the effects of nitrogen treatments on grain and malting quality analyses are given in Table 2. Increasing the quantity of nitrogen applied at sowing resulted in a small increase in grain nitrogen levels and a corresponding decrease in TGW, but only at 150 kg N/ha. The trends showed that there was a marginal increase in malt fine extract and a decrease in fine-coarse extract difference evident at fertiliser rates of 25-50 kg N/ha. For malting quality, there were some small interactions between sites and nitrogen treatments. For example, the malt fine extract values of grain grown on sites 3 and 7 peaked and then fell at or above 100 kg N/ha. It was not possible to determine whether these interactions were statistically significant.

In contrast to the lack of response to added nitrogen fertiliser averaged over all trial sites, there were some marked differences between the trials for grain nitrogen concentration and weight, and malting quality of the barley (Table 2). Mean malt fine extract and "difference" data were negatively and positively correlated respectively with mean grain nitrogen levels and the range between malt extract and "difference" values derived from the best (site 3) and worst (site 2) trials was considerable.

1984-85 trials

Grain yields for both trials responded to nitrogen with maximum increases of 48 and 53% higher than the control (2.44 and 2.30 t/ha increases for trials 8 and 9 respectively) at 150 kg N/ha (Figure 1). Yields were unaffected by splitting fertiliser applications between sowing and early tillering.

Grain nitrogen levels rose steadily with increasing rates of nitrogen and were significantly higher than the control at

TABLE 2: Effect of nitrogen and site on grain and malting quality of Triumph barley: 1983/84.

		Mean data for nitrogen treatments			
Nitrogen (kg/ha)	Yield (t/ha)	TGW (g)	Grain N (% DM)	Difference* (%)	Malt extract fine (%)
0	5.09	40.8	1.63	10.7	76.5
25	6.05	40.8	1.62	10.9	77.0
50	6.65	41.1	1.62	9.9	77.2
100	7.55	41.1	1.69	9.9	77.3
150	8.05	39.2	1.76	10.1	77.6
Overall Mean	6.68	40.6	1.66	10.3	77.1
Trial		Mean data for trial sites			
3	6.97	-	1.54	7.5	79.1
7	7.19	41.4	1.53	7.6	79.1
5	8.87	44.8	1.62	8.9	77.9
6	7.27	43.6	1.60	9.5	77.0
4	4.88	-	1.81	13.4	75.6
2	4.88	32.6	1.89	14.8	73.9

*Fine-coarse extract difference.

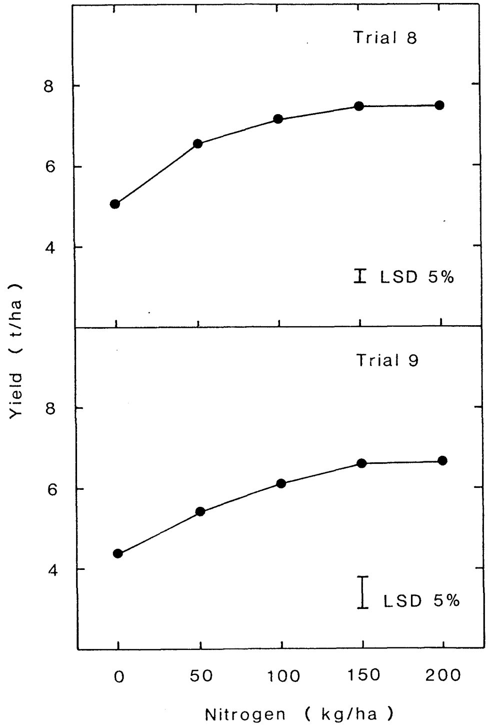

Figure 1: Grain yield responses to nitrogen applied at sowing: 1984-85 season.

100 kg N/ha and above (Table 3). The addition of nitrogen decreased grain size, with corresponding increases in the percentage screenings. Malt fine extract was unchanged by nitrogen applications up to 100 kg N/ha but decreased significantly at higher treatment rates. Fine-coarse extract difference was unaffected by nitrogen treatment. Split applications between sowing and early tillering had no effect on grain size or nitrogen concentration, screenings, or malting quality when compared with the addition of 100 kg N/ha at sowing (Table 3).

There were no significant differences between the sites for mean grain or malting quality data (Table 3) and barley harvested from both trials gave similar responses to the various treatments. Furthermore, these treatments did not affect measured micro-malting parameters such as steep moisture uptake and malting loss or other malting quality attributes such as wort filtration performance.

DISCUSSION

The most important character of the numerous grain and malt parameters that define good malting quality in a barley cultivar is malt extract which should be as high as possible (Pollock, 1962). In New Zealand, the brewing industry specifies malt with at least 80% extract (Smart, 1983) and a change of as little as one-two percentage units can be important to the maltster and brewer. The fine-coarse extract difference indicates how well the barley has modified during malting and is negatively correlated with malting quality (Pollock, 1962). The malting conditions used in this study have been specifically chosen to give enhanced "difference" figures to aid assessment of comparative changes in quality.

TABLE 3: Effect of nitrogen and site on grain and malting quality of Triumph barley: 1984/85.

	Mean data for nitrogen treatments				
Nitrogen (kg/ha)	Screenings (%)	TGW (g)	Grain N (% DM)	Difference* (%)	Malt extract fine (%)
0	3.6	44.5	1.46	6.0	80.1
50	5.1	42.7	1.50	6.1	80.5
100	6.4	40.5	1.56	5.6	80.2
150	9.1	38.5	1.74	6.5	79.0
200	10.5	39.3	1.78	6.9	79.3
100	6.4	40.5	1.56	5.6	80.2
25/75	7.3	41.5	1.59	5.4	79.8
50/50	7.1	40.8	1.55	5.4	80.4
75/25	6.7	42.4	1.54	5.8	79.8
L.S.D. (P=0.05)	2.5	3.1	0.08	1.0	0.8
Overall Mean	6.96	41.26	1.59	6.0	79.9
Trial	Mean data for trial sites				
8	6.5	42.2	1.61	6.3	79.7
9	7.4	40.3	1.57	5.6	80.1
(P=0.05)	ns	ns	ns	ns	ns

*Fine-coarse extract difference.

Malting quality is dependent on grain quality, and potential malt extract is positively correlated with grain size and negatively correlated with grain nitrogen concentration within a particular cultivar (Smart, 1983). In intensive cropping rotations though, high rates of fertiliser nitrogen are needed to maintain consistent yields, particularly where more than three cereal crops are grown in succession (Greenwood *et al.*, 1984). For these trials a preliminary analysis of the yield data indicated that growers could achieve economic returns by applying in excess of 100 kg/ha. In the case of malting barley, however, it is important to apply that quantity of nitrogen which maximises profit without reducing the quality of the grain for malting.

We found that the effect of added nitrogen on malting quality was inconsistent between seasons and, at times, between trials in the same season. In 1983-84, malt extract was generally unaffected by the addition of up to 150 kg N/ha. This may have been due to the extensive cropping history of all trial sites as crop yields continued to increase with higher nitrogen treatments (Risk *et al.*, 1984) with little change in grain nitrogen concentrations. Malt extract decreased at upper levels of applied nitrogen only at the two sites (3 and 7) which gave the best malting quality and higher yields. Sites 2 and 4 produced low yields and such poor quality malt that other factors may have limited grain development (Table 2). In contrast, malt extract values in 1984-85 decreased significantly at and above 150 kg N/ha. In this case, grain nitrogen levels increased almost linearly with added nitrogen but at the expense of a decrease in grain size and higher screenings. The percentage screenings reached commercial penalty levels between 50-100 kg N/ha. For all trials in both seasons, malt fine extract was only moderately correlated with grain nitrogen levels with a correlation coefficient of -0.57^{***} ($n = 105$).

Drewitt (1983) has reviewed previous work in New Zealand relating malting quality to agronomic practice. Added nitrogen has been shown to give increased grain nitrogen levels and higher screenings (Drewitt and Smart, 1981; Wauchop and Field-Dodgson, 1978) with a corresponding decline in malt extract (Drewitt and Smart, 1981). Our results from the 1984-85 season support these findings, although these trials differ in terms of soil type, regional location and paddock history from those described previously.

CONCLUSIONS

There was much greater variation in grain and malting quality between trial sites than between nitrogen treatments from zero to 200 kg N/ha. In 1983-84, there were marked differences between some sites in terms of malting quality and much of the barley grown this season was far inferior compared with that grown on fewer sites in 1984-85. Malting quality was unaffected by fertiliser treatments in 1983-84, but was reduced when 150 kg N/ha or greater was applied during the 1984-85 season. These preliminary data suggest that farmers growing malting grade barley on extensively cropped areas in this region could expect profitable returns from grain yields, without reducing quality, by using in excess of 100 kg N/ha.

If the recent expansion in the cropping of malting barley is to be sustained then it is essential that greater effort be directed towards understanding the complex relationships between crop management, the crop environment and crop quality.

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