BARLEY RESPONSES TO NITROGEN FERTILISER IN OTAGO AND SOUTHLAND

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ABSTRACT

In seven field trials, nitrogen fertiliser was applied to barley, either at sowing in spring or as a split dressing at sowing and early tillering. Trials were established after four to nine previous consecutive cereal crops.

Grain yield responses occurred at all sites ranging from 0.92 to 5.18 t/ha. Responses continued up to fertiliser application rates of 150 kg N/ha at the more productive sites (yields 8.4 to 10.6 t/ha), with lower rates being indicated where production was lower. Nitrogen application increased fertile tiller numbers at the four sites where yield component data were collected. However, grains/ear and individual grain weight measurements indicated only occasional changes in these components.

Splitting nitrogen application (100 kg N/ha) between sowing and early tillering increased grain yield in two trials.

INTRODUCTION

The area of barley sown in Otago and Southland increased from 12,500 hectares to 32,700 hectares between 1980/81 and 1983/84. Much of this area is on land which had been previously cropped for several years with wheat. The increase in barley is largely at the expense of wheat and farmers are increasingly adopting long rotations in cereals. These barley crops will therefore require nitrogen fertiliser which is now being widely used. However, there has been no experimental work in the region to determine the optimum application rate on barley or to compare single with split applications. Accurate nitrogen fertiliser recommendations are important since excessive rates can reduce yield (by causing lodging) as well as rates which are less than optimum. This series of trials was established to measure the response to nitrogen fertiliser of barley sown after a number of successive crops and to compare single with split applications, with a view to providing reliable advice on nitrogen fertiliser use to barley growers.

MATERIALS AND METHODS

Sites

Seven trials were established in the cropping districts of North and South Otago and Southland in the spring of 1983 (Table 1). Sites were chosen which had been in a cropping rotation for at least three seasons and were free of 'Take-all' (*Gaeumannomyces graminis* (Sacc.) v. Arx et Olivier var *tritici*). As an added precaution against 'Take-all', the three Southland trials (sites 5 to 7) were sown after an oil-seed rape crop. One site was on a recent soil and three each on yellow-grey and yellow-brown earth soils (N.Z. Soil Bureau, 1968). All sites were flat. Rainfall ranged from 530 to 1100 mm and was evenly spread throughout the year. Trial 1, which received 530 mm rainfall, was irrigated.

Experimental

All sites were sown with the barley cultivar Triumph using fungicide Baytan F-17 (triadimenol plus tuberidaszole) treated seed at 300 seeds/m^2 in trial 1 and 400 seeds/m^2 in the remaining trials. An eight or nine coulter drill was used. Nitrogen was applied as urea. The treatments were 0, 25, 50, 100 and 150 kg N/ha applied at sowing or a total of 100 divided between sowing and early tillering (growth stage (G.S.) 14 (Zadoks *et al.*, 1974)) at 25/75, 50/50 and 75/25 kg/ha. A basal dressing of superphosphate at 30 kg P/ha was applied at all sites and potassium chloride at 30 kg K/ha was applied at sites 5, 6 and 7. These were incorporated into the soil prior to sowing at sites 5, 6 and 7 and surface applied at sites 1, 2, 3 and 4. Treatments were replicated four times, except in trial 1 where one replicate was discarded because of 'Take-all' infection.

In trials 1 to 4, the nitrogen applied at sowing was broadcast on the soil surface immediately after seeding; while in trials 5 to 7 it was broadcast before sowing and mixed into the top 10 to 12 cm of soil with a power implement. The nitrogen application at G.S. 14 was broadcast over the soil surface.

To prevent the development of fungal diseases, trials 5 to 7 were sprayed at G.S. 30 with benomyl and propiconazole and at G.S. 60 with propiconazole. All trials were sprayed for weed control with various proprietary herbicides.

In trials 1, 5, 6 and 7 plant establishment and fertile tiller numbers were measured on the middle seven rows of each plot, and straw yield, grain weight and grains/head were determined from fourteen 0.25 m lengths cut from each plot just prior to harvest. All trials were harvested with a small plot header. In trials 1 to 4, whole plots were harvested while in trials 5 to 7 outside rows were discarded and the middle seven rows harvested. Grain weights were adjusted to 14% moisture.

TABLE 1: Trial details

	Trial 1	2	3	4	5	6	7
Location:	Papakaio	Milton	Warepa	Momona	Drummond	Oreti	Thornbury
Soil type:	Hilderthorpe	Tokomairiro	Warepa	Koau	Drummond	Drummond	Waikiwi
Previous crops:	4	4	5	4	9	4	4
Date sown 1984:	20 Sept	21 Oct	31 Oct	8 Nov	6 Oct	14 Oct	27 Oct
Split N application 1984	1 Nov	2 Dec	6 Dec	13 Dec	14 Nov	23 Nov	30 Nov
Harvested 1985:	20 Feb	26 Mar	3 Apr	6 Apr	14 Mar	20 Mar	28 Mar

RESULTS

All trials established well and made rapid growth with plant numbers between 300 to 350/m². In trial 4, a moderate level of couch (*Agropyron repens* L.) developed across the site and actively competed with the crop. There was no serious pest or disease infestation.

Rates of Nitrogen

Analysis of the grain yield data showed a significant response at all sites to the rates of nitrogen applied at sowing (Figure 1). Maximum responses ranged from 21 to 156% of control (0.92 to 5.18 t/ha) with the maximum yield occurring at different N application rates in the respective trials. There was evidence of a curvilinear response in some instances, with this being more dependent on the precision associated with the trial site rather than the shape of the response curve itself. For example, trial 6 gave a significant curvilinear response, but not trial 2. At the sites where higher yields were recorded (trials 1, 5 and 6), a continuing increase in yield above the highest application rate was apparent.

Fertile tiller numbers recorded in trials 1, 5, 6 and 7 were consistently increased by increasing rates of nitrogen

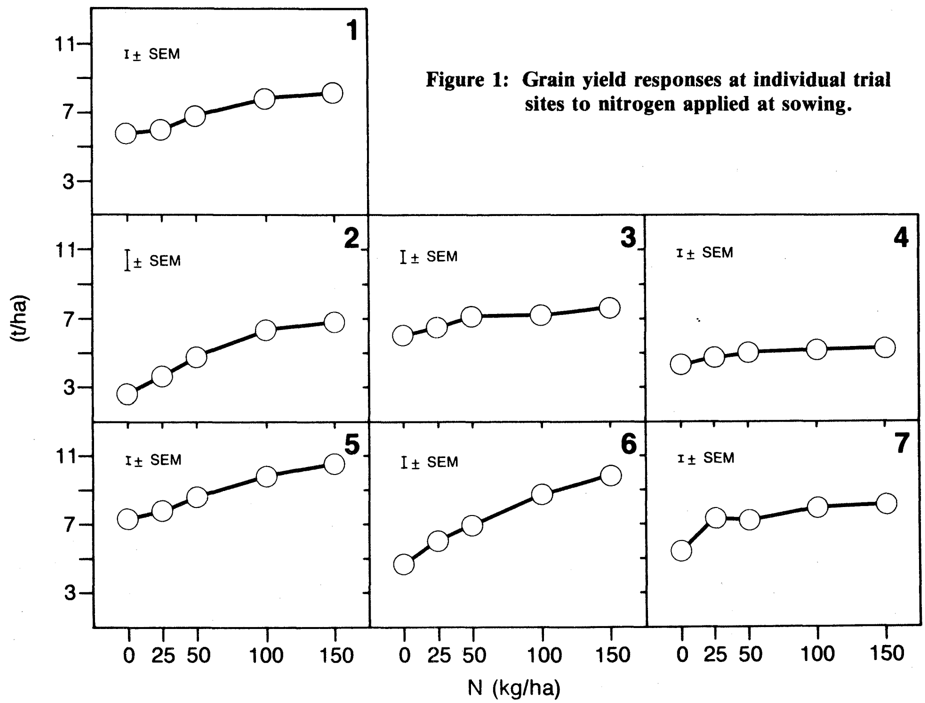

Figure 1: Grain yield responses at individual trial sites to nitrogen applied at sowing.

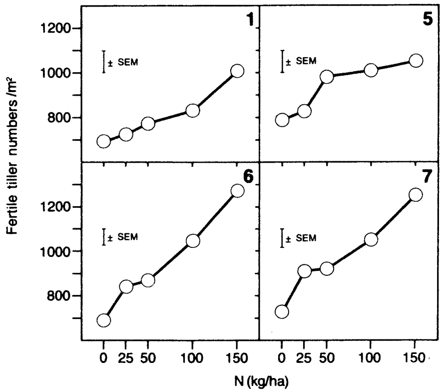

Figure 2: Fertile tiller numbers/m² from sites 1, 5, 6 and 7.

(Figure 2). On the other hand, other yield components altered significantly only in the following cases:

1. An increase in grains/head with higher nitrogen rates in trial 6 (17.13 v 20.28; S.E.D. = 0.71); and
2. a decrease in 1000 grain weight with higher nitrogen rates in trial 7 (43.22 g v 39.04 g; S.E.D. = 0.86 at 0 and 150 kg/ha respectively).

Split Nitrogen Application

Splitting applications of 100 kg N/ha between sowing and G.S. 14 (early tillering), gave a significant grain yield increase in two of the seven trials (Table 2). This increase occurred when the larger portion of the nitrogen was applied late, that is 25/75 kg/ha (sowing:tillering) and was not recorded in the 50/50 or 75/25 kg/ha treatments.

TABLE 2: A comparison of split nitrogen application yield components for individual sites.

Trial	1	2	3	4	5	6	7
Grain yields (t/ha)							
25 + 75	7.93	6.45	8.55	5.13	10.52	8.54	8.08
50 + 50	7.54	6.44	7.61	5.15	10.21	8.66	7.77
75 + 25	7.79	6.04	7.15	5.05	10.09	8.35	8.00
100 + 0	7.75	6.45	7.19	5.13	9.84	8.75	7.94
S.E.D.	0.28	0.82	0.54	0.26	0.26	0.45	0.30
C.V.%	4.6	19.9	10.3	7.4	3.8	7.7	5.7
Fertile tiller numbers (/m²)							
25 + 75	898	-	-	-	1198	1268	1127
50 + 50	916	-	-	-	1083	1219	1062
75 + 25	900	-	-	-	1098	1114	1079
100 + 0	835	-	-	-	1012	1049	1055
S.E.D.	75	-	-	-	75	52	61
C.V.%	10.4	-	-	-	10	6.6	8.1

Yield components measured in trials 1, 5, 6 and 7 gave significant responses only in trials 5 and 6, where splitting nitrogen application increased tiller numbers (Table 2), mainly in the 25/75 kg/ha treatment. In trial 6, there was a trend for grains/head and 1000 grain weight to increase as the proportion of nitrogen applied at early tillering increased. This trend was not evident in the other trials although some significant differences were recorded in trial 5.

DISCUSSION

This series of trials has shown that in continuous cereal cropping very large barley grain responses (up to 5 t/ha) may be obtained from fertiliser nitrogen application. Fitted response curves indicate that worthwhile nitrogen responses (greater than 6 kg grain/kg N) continued up to application rates of at least 150 kg N/ha at the three most productive sites (maximum yields 8.4 to 10.6 t/ha). At lower yielding sites, optimum nitrogen application rates were also lower but, even at the least productive site (maximum yield 5.3 t/ha), an application of about 50 kg N/ha was justified.

Present MAF recommendations for nitrogen fertiliser on barley are that 3rd or subsequent consecutive crops should receive 75 kg N/ha plus 25 kg/ha for each expected tonne of grain in excess of 4.5 t/ha (Greenwood *et al.*, 1984). These tentative recommendations were taken from trial data on wheat because of the lack of relevent local trials on barley. The current trials gave general support to the recommendations although there is an indication that a small reduction of about 25 kg N/ha in the recommended rate may be in order.

As reported in other South Island wheat trials (Feyter and Cossens, 1977; Scott *et al.*, 1977) fertile tiller number was the main yield component increased by nitrogen application. Tiller survival was high and was a reflection of the adequate seasonal rainfall which largely eliminated water stress. This contrasts with the seasonally dry Canterbury/North Otago region where moisture stress often restricts nitrogen responses, mainly by restricting tillering and tiller survival (Greenwood and McLeod, 1980). The optimum number of tillers for maximum yield is therefore higher under irrigation and in wetter regions, such as South Otago and Southland; hence the response to nitrogen fertiliser is more reliable and predictable.

Splitting nitrogen application has the potential advantage of reducing possible leaching losses in a wet climate. Such an effect is unlikely to have occurred in this series of trials as there were no heavy falls of rain in the periods between the two nitrogen applications. However, yield responses did occur at two sites and where yield components were measured (site 5) this could be attributed to an increase in the number of fertile tillers, with little or no effect on grains/head or individual grain weight. On the other hand, in trial 6 an increase in fertile tillers was accompanied by decreases in grains/head and individual grain weights, consequently there was no yield increase from split nitrogen application. These results do not provide strong support for splitting nitrogen applications.

Nevertheless it may be a useful insurance against leaching loss should the early part of the growing season prove to be unusually wet.

No lodging occurred in these trials, even at the high rates of nitrogen applied. The test cultivar, Triumph, is of medium height, is strong strawed and is suitable for heavy nitrogen fertiliser application. Other cultivars which are taller growing, or weaker strawed, may be over-stimulated and lodge if high rates of nitrogen are used.

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