*CONFIDENTIAL

WINTER WHEAT - YIELD MAXIMIZATION - BOUNTY

NAS 335 ML 81
2nd year

SUMMARY

Bounty responded to 240 kg/ha nitrogen and yield benefited from the protection of a fungicide programme. Yields were increased by splitting the nitrogen compared with a single application.

To obtain grain of sufficiently high protein content to reach a milling protein level (11% protein @ 86% d.m.) it was necessary to use very high levels of nitrogen (240 kg/ha) where the application was split or just over 200 kg/ha for the single application.

OBJECT

To investigate the main effects of a growth regulator, nitrogen level and timing, a fungicide programme and the interactions between these factors in maximizing the yield of winter wheat and the effect on its bread making characteristics.

TREATMENTS

Two randomised blocks with split plots.

Main plot treatments:

No fungicide versus a complete programme of disease control

Sub plot treatments:

| Nitrogen level | Nitrogen timing | Chlormequat |
|---|---|---|
| 120 | Single | Nil |
| 160 | Split x 2ø | 3.5 l/ha Cycocel (46% chlormequat) |
| 200 | Split x 3ø | |
| 240 | | |

plus extra treatments of 40 kg/ha and 80 kg/ha nitrogen, each as a single application, and 240 kg/ha nitrogen as splits of 80-120-40 at the 3 way split timings and 40-100-100 with the final application earlier than for the other treatments, i.e. at Zadoks G.S. 32 (when the 2nd node is detectable).

øSplit x 2 = 40 kg at early tillering and balance at the stem erect stage
Split x 3 = 40 kg at early tillering, 40 kg at flag leaf emergence and balance at stem erect stage

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METHOD

The trial area was ploughed on 20 September and a seedbed was prepared by a single pass of a Dutch harrow. The variety Bounty (as a 2nd winter wheat crop following potatoes) was drilled on 29 September into a good seedbed using a Carier drill. Weed control was achieved by an autumn spray of bromofenoxim/terbuthylazine (Mofix) at 1.7 l/ha of product on 31 October. An overall assessment of plant counts made on 12 November showed there to be about 271 plants/$m^2$.

This resulted in an initial spring tiller number of almost 2000/$m^2$. However as the result of attack by the larvae of *Opomyza florum*, despite application of dimethoate spray on 16 February, this was reduced by over one third.

Nitrogen was hand spread on the appropriate plots on 4 dates:-

| | |
|---|---|
| Early - 5 March | G.S. 23 (Early tillering) |
| Mid - 8 April | G.S. 30 (Pseudo stem erection) |
| Final application to 40-100-100 plots only - 11 May | G.S. 32 (2nd node detectable) |
| Late - 22 May | G.S. 39 (flag leaf emerged) |

Cycocel was applied to the appropriate plots at a rate of 3.5 l/ha on 11 April at G.S. 31 (first node just beginning to show).

On the appropriate main treatment a full programme of fungicide spraying was undertaken aiming at maximum disease control, as follows.

On 9 April G.S. 31 a 3 way mix of triademefon + carbendazim + captafol (Bayleton + Bavistin + Sanspor) was applied. This was followed at flag leaf emergence, on 26 May, with a spray of triademefon + captafol + benomyl (Bayleton CF + Benlate) and again after flowering at G.S. 71 on the 23 June with a spray of triademefon + captafol (Bayleton CF).

The crop was sprayed against aphids with Aphox (pirimicarb) on 4 July. All fungicide and chlormequat applications were made with a Drake and Fletcher knapsack sprayer applying 250 l/ha at 2 bars (30 psi). Spraying Systems 11002 T-jets were used.

An overall field assessment on 13 April showed there to be a 20% infection of eyespot in the Bounty crop. On the 27 July selected treatments i.e. those with nitrogen applied as a 3 way split were assessed for this eyespot infection.

Straw lengths were measured on 28 and 30 July and fertile tiller counts made on 30 July and 5 August.

The trial was harvested on 17 and 18 August, combining a 2.1 m width from the centre of each plot, which was 15.2 m long.

## RESULTS

### Lodging

No lodging at all was recorded in the trial.

### Diseases - Eyespot

On 27 July assessments were made on those plots receiving a 3 way split of nitrogen only. Analysis shows the fungicide programme markedly reduced infection of eyespot (Cercosporella herpotrichoides) and appeared to have a slight effect in increasing sharp eyespot (Corticum solani). The incidence of eyespot was reduced from 22.2% to 2.4% and sharp eyespot was increased from 5.0% to 7.6%.

### Mildew

Only very low levels of mildew were observed and no assessment was made.

### Septoria

Although it was not recorded separately, Septoria tritici was very severe in the trial. It continued to develop in June and by the flowering stage infection had already reached the flag leaf. The disease was almost completely controlled by the fungicide but was particularly severe on untreated high nitrogen plots.

### Crop Development - Green Leaf Assessment

A green leaf area assessment of the flag leaf was made on 23 July (block II) and 24 July (block I). On average (but excluding the extra treatments) the fungicide programme increased the area of green on the flag leaf remaining from 32.5% to 91.2%. Nitrogen level significantly affected the mean percentage green leaf area, with a plateau being reached at 200 kg/ha and above.

Table 1 % Green Area on Flag Leaf 23 and 24 July

| Nitrogen level kg/ha | Fungicide Nil | Fungicide Full | Mean |
|---|---|---|---|
| 40 | (37.5) | (78.0) | |
| 80 | (42.0) | (87.3) | |
| | (±5.44) | | (±1.46) |
| 120 | 32.5 | 87.0 | 59.7 |
| 160 | 27.7 | 91.0 | 59.4 |
| 200 | 36.2 | 91.7 | 64.0 |
| 240 | 33.7 | 95.0 | 64.3 |
| 80-120-40 | (30.5) | (96.3) | |
| 40-100-100 | (36.3) | (91.8) | |
| | (±5.14) | | |
| MEAN (120 to 240) | 32.5 | 91.2 | |

S.E. per main plot (1 d.f.) = ±7.27 or 11.8% of G.M.
S.E. per sub plot (46 d.f.) = ±7.13 or 11.5% of G.M.

It can be seen that the fungicide programme had a greater beneficial effect at higher nitrogen levels, showing that as last year at these higher levels (probably at 160 kg/ha and above), a good fungicide programme becomes increasingly important.

Fertile Tiller Counts

The husbandry techniques seem to have had no significant effect on fertile tiller numbers, though there was a non-significant trend for nitrogen levels of 160 kg/ha and above to produce a higher number of fertile tillers.

Straw Length

Both timing of nitrogen and application of chlormequat had a very significant effect on straw length, as would be expected.

Table 2 Straw Length (mm)

| Nitrogen Timing<br>Chlormequat | x 1<br>− | x 1<br>+ | x 2<br>− | x 2<br>+ | x 3<br>− | x 3<br>+ | MEAN |
|---|---|---|---|---|---|---|---|
| Nitrogen Level | | | | | | | |
| 40 | (781) | (687) | | | | | |
| 80 | (759) | (711) | | | | | |
| | | | (±19.9) | | | | (±8.1) |
| 120 | 740 | 717 | 809 | 731 | 800 | 752 | 758 |
| 160 | 756 | 698 | 805 | 766 | 820 | 782 | 771 |
| 200 | 803 | 696 | 808 | 717 | 791 | 742 | 760 |
| 240 | 757 | 689 | 772 | 731 | 821 | 749 | 753 |
| 80-120-40 | | | | | (796) | (758) | |
| 40-100-100 | | | | | (804) | (709) | |
| MEAN (120 to 240) | 764 | 700 | 798 | 736 | 808 | 756 | |

S.E. per main plot (1 d.f.) = ±2.5 or 0.3% of G.M.
S.E. per sub plot (34 d.f.) = ±39.9 or 5.2% of G.M.

Table 2 shows that a chlormequat application reduced straw length by about 7.5% and that a single application of nitrogen resulted in straw shorter by between 4.6% and 6.4% compared with the two and three way splits respectively. Splitting the nitrogen involved putting 40 kg/ha or 80 kg/ha on early, it appears that straw length was promoted by nitrogen applied before G.S. 30.

Grain Size and Yield

Grain size as measured by Thousand Grain Weight was significantly reduced by the application of a chlormequat growth regulator, both in the main trial and the extra plots.

Grain size was generally much smaller this year than in the previous one, but again the fungicide programme resulted in the production of grain some 7.3 g (per thousand) heavier than the untreated.

Table 3 Thousand Grain Weight (g) @ 85% d.m.

| Chlormequat | Fungicide Nil | Fungicide + | Mean |
|---|---|---|---|
| | ($\pm$0.66) | | ($\pm$0.42) |
| Nil | 38.12 | 46.52 | 42.32 |
| + | 37.21 | 43.37 | 40.29 |
| | ($\pm$0.51) | | |
| Mean | 37.66 | 44.94 | |

S.E. per main plot (1 d.f.) = $\pm$0.725 or 1.8% of G.M.
S.E. per sub plot (46 d.f.) = $\pm$2.912 or 7.0% of G.M.

Grains per Ear

It was found that only the nitrogen level had had a significant effect on the number of grains per ear. Increasing the level of nitrogen increased the number of grains per ear.

Table 4 Effect of Nitrogen on Number of Grains Per Ear

| Nitrogen Level kg/ha | 40 | 80 | 120 | 160 | 200 | 240 | 80-120-40 | 40-100-100 |
|---|---|---|---|---|---|---|---|---|
| | | | | ($\pm$0.49) | | | | |
| Grains per ear | 24.5 | 27.7 | 29.0 | 29.7 | 29.5 | 31.1 | 31.6 | 30.7 |

S.E. per main plot (1 d.f.) = $\pm$2.27 or 7.6% of G.M.
S.E. per sub plot (46 d.f.) = $\pm$2.41 or 8.1% of G.M.

Grain Yield at 85% D.M.

The grain yield was greatly affected by the incidence of Take-all in the crop, which was distributed in large patches across the field in an apparent random manner and in no way related to treatment. So the yields tended to be variable.

However an assessment of Take-all was made at ground level on 23 July and with the aid of an aerial photograph taken on 3 July an estimate of the percentage of Take-all present on each plot was made. Using this data, the computer then performed an analysis of covariance, so removing much of the variation due to the Take-all from the grain yield. In this way it was possible to estimate the effects of most of the husbandry techniques in the absence of Take-all. Unfortunately it was not possible to obtain a variance ratio for the effect of the fungicide programme, because this was a main plot treatment and so a very low covariance efficiency was produced, which would give a misleading value for this comparison.

From this it is seen that the other three husbandry techniques (nitrogen level and timing and growth regulator application) all had a significant effect on grain yield, when the effect of the Take-all was removed.

Increasing the level of nitrogen applied - all the way up to 240 kg/ha - and splitting the application both increased the yield significantly, with a 3 way split giving a greater increase than a 2 way split. However application of chlormequat gave a significant reduction in yield. As would be expected, the fungicide programme resulted in a considerable increase in yield where applied.

Table 5 Grain Yield @ 85% D.M.

N.B. Adjusted to remove variation due to Take-all

(Figures in brackets have not been adjusted)

| Nitrogen Timing / Chlormequat | | x 1 − | x 1 + | x 2 − | x 2 + | x 3 − | x 3 + | Mean (120 to 240) |
|---|---|---|---|---|---|---|---|---|
| Nitrogen Level | Fungicide | | | | | | | |
| 40 | − | (4.73) | (3.79) | | | | | |
| | + | (5.65) | (5.32) | | | | | |
| 80 | − | (5.30) | (5.06) | | | | | |
| | + | (6.64) | (6.46) | | | | | |
| | | | | (±0.164) | | | | (±0.067) |
| 120 | − | 5.28 | 5.34 | 5.41 | 5.08 | 5.52 | 5.37 | 6.17 |
| | + | 6.88 | 7.02 | 7.28 | 6.79 | 7.12 | 6.92 | |
| 160 | − | 5.52 | 5.24 | 5.33 | 5.55 | 5.84 | 5.67 | 6.39 |
| | + | 7.34 | 6.82 | 7.58 | 6.70 | 7.66 | 7.36 | |
| 200 | − | 5.48 | 5.38 | 5.42 | 5.52 | 5.88 | 5.26 | 6.42 |
| | + | 7.06 | 7.04 | 7.20 | 7.34 | 7.92 | 7.52 | |
| 240 | − | 5.41 | 5.32 | 5.75 | 5.43 | 5.59 | 5.76 | 6.60 |
| | + | 7.55 | 7.37 | 7.94 | 7.47 | 7.93 | 7.65 | |
| 80-120-40 | − | | | | | (6.15) | (5.94) | |
| | + | | | | | (8.39) | (7.92) | |
| 40-100-100 | − | | | | | (6.35) | (5.40) | |
| | + | | | | | (8.31) | (7.07) | |
| | | | | (±0.057) | | | | |
| Mean (120 to 240) | | 6.25 | | 6.36 | | 6.56 | | |

Mean of Nil chlormequat 6.50 (±0.047)
3.5 l/ha chlormequat 6.29
Nil fungicide 5.47
Full fungicide 7.31

S.E. per sub plot (45 d.f.) = ±0.324 or 5.1% of G.M.

Some of the values of the yield of the plots receiving chlormequat at 40 kg/ha N and 40-100-100 kg/ha N were lower than expected. This was due to the presence of Take-all and the yields for these plots were not adjusted to take this into consideration.

GRAIN NITROGEN

The analysis of grain nitrogen showed that it was significantly affected by nitrogen level, timing and chlormequat application.

Increasing the level of nitrogen applied increased the grain nitrogen.

Table 6 % Nitrogen in Grain @ 100% D.M.

| Nitrogen Timing<br>Chlormequat | | x 1<br>− | x 1<br>+ | x 2<br>− | x 2<br>+ | x 3<br>− | x 3<br>+ | Mean<br>(120 to 240) |
|---|---|---|---|---|---|---|---|---|
| Nitrogen Level | Fungicide | | | | | | | |
| 40 | − | (1.84) | (1.72) | | | | | |
| | + | (1.70) | (1.74) | | | | | |
| 80 | − | (1.74) | (1.97) | | | | | |
| | + | (1.82) | (1.95) | | | | | |
| | | | | (±0.100) | | | | (±0.028) |
| 120 | − | 2.06 | 2.06 | 2.04 | 1.96 | 1.92 | 2.35 | 2.02 |
| | + | 1.94 | 1.99 | 1.89 | 1.96 | 1.83 | 2.19 | |
| 160 | − | 2.17 | 2.19 | 2.08 | 2.05 | 2.09 | 2.16 | 2.10 |
| | + | 2.06 | 2.30 | 1.94 | 1.98 | 1.96 | 2.15 | |
| 200 | − | 2.20 | 2.24 | 2.16 | 2.13 | 2.26 | 2.27 | 2.21 |
| | + | 2.14 | 2.31 | 2.25 | 2.13 | 2.20 | 2.19 | |
| 240 | − | 2.41 | 2.57 | 2.21 | 2.44 | 2.38 | 2.27 | 2.32 |
| | + | 2.27 | 2.31 | 2.21 | 2.35 | 2.16 | 2.25 | |
| 80-120-40 | − | | | | | (2.41) | (2.31) | |
| | + | | | | | (2.14) | (2.29) | |
| 40-100-100 | − | | | | | (2.38) | (2.37) | |
| | + | | | | | (2.41) | (2.06) | |
| | | | | (±0.024) | | | | |
| Mean<br>(120 to 240) | | 2.20 | | 2.11 | | 2.17 | | |

Mean of Nil chlormequat 2.12
3.5 l/ha chlormequat 2.20
Nil fungicide 2.20
Full fungicide 2.13

S.E. per main plot (1 d.f.) = ±0.051 or 2.4% of G.M.
S.E. per sub plot (46 d.f.) = ±0.136 or 6.3% of G.M.

As last year, it was noted that a 3 way split i.e. including a late application of nitrogen resulted in a higher level of grain nitrogen than a 2 way split, but neither was quite as high as that resulting from a single application.

Application of chlormequat increased the grain nitrogen (it decreased yield) and the fungicide programme (which resulted in an increased grain yield) had the effect (though non-significant) of lowering the grain nitrogen.

To obtain grain of high enough protein level to procure a milling premium (given for grain over 11% protein @ 86% d.m.) it is necessary to have a grain nitrogen level of 2.24% nitrogen @ 100% d.m.. This was achieved at 240 kg/ha nitrogen in a split application or at 200 kg/ha nitrogen in a single dressing, when chlormequat was applied.

CONCLUSIONS

It was noticed that although the Oporyza attack drastically reduced the initial tiller count, by the time the plants had reached a mature state the number of fertile tillers produced had been made up to an acceptable level. However at lower nitrogen levels the ears may have been smaller, as reflected in the grains per ear measurement. This suggests that it is the effect of the plant compensating for the removal of one third of its tillers that has resulted in non-significant differences in the number of fertile tillers with respect to the nitrogen level and growth regulator treatments, but that size of ears (i.e. number of grains per ear) and size of grain (thousand grain weight) may be much reduced as a result.

A patchy infestation of Take-all, severe in places, in this years trial, added a great deal of variation to the trial which was not treatment-related. When this was removed by analysis of covariance, it was suggested that yield was increased by the husbandry techniques of an intensive fungicide programme coupled with high levels of nitrogen split into 2 or 3 applications, with the extra treatment of 80-120-40 giving a higher yield, showing the importance of early nitrogen for a good yield. Yield for the 40-100-100 treatment was lower than expected as two of these plots were infected with Take-all, but yields were not adjusted to compensate.

To obtain a grain of sufficiently high protein content to obtain a milling premium, which for 1981 was given at 11% protein at 86% D.M., if was found necessary to increase nitrogen input to very high levels i.e. 240 kg/ha. Though at this level there was little difference between the split applications of the dressing, the highest protein level was achieved by a single dressing at G.S. 30.

It seems that to obtain a high yield with a sufficient grain nitrogen content it is necessary to apply high levels of nitrogen preferably split into 3 dressings. It is likely that the final dressing could be earlier than has been traditional for a 3-way split - at G.S. 32 rather than 37-38.

As last year this agrees with earlier work suggesting that early nitrogen boosts growth and yield whereas later applications boost grain protein.

A fungicide programme was required to protect the crop from disease, to maintain good grain size and to produce a good yield. However it did marginally reduce the grain protein (though not by a significant amount). It seems that the nitrogen in the grain was diluted in a greater yield.

An application of a growth regulator (chlormequat) had the effect of reducing the yield a little by reducing grain size, but it did appear to increase the percentage grain nitrogen a little. This is the opposite effect to the one it had in the previous year, when it increased the yield but decreased grain nitrogen.

In this trial the responses to fungicide and nitrogen were economic. The crop responded to increasing nitrogen to 240 kg/ha. The response to the fungicide varied from an increase of 1.23 t/ha @ 40 kg/ha to an increase of 2.11 t/ha @ 240 kg/ha.

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