

## DISEASE RESISTANCE IN WINTER WHEAT CULTIVARS AND EFFECTS OF FOLIAR FUNGICIDES ON YIELD

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### SUMMARY

Five field trials in three seasons investigated the effects of foliar fungicide applications on yields of winter wheat cultivars differing in their spectrum of disease resistance. Stripe rust was the most severe foliar disease in all trials, although powdery mildew, speckled leaf blotch, and leaf rust were also recorded. Yield losses of up to 63% were recorded for all cultivars from the comparison of fungicide-treated and untreated plots in at least some trials. Yield losses were mostly attributed to stripe rust infection, although powdery mildew was damaging to the cultivar 'Kotare', which frequently showed spike infection. Results suggest that disease management guidelines should be tailored to specific cultivars.

**Keywords:** stripe rust, leaf rust, powdery mildew, speckled leaf blotch

### INTRODUCTION

The importance of foliage diseases of wheat (*Triticum aestivum* L.) crops in New Zealand has increased dramatically since the appearance of stripe rust caused by *Puccinia striiformis* Westend. f. sp. *tritici* Erriks. in 1980 (Beresford 1982; Harvey and Beresford 1982). Since that time, considerable effort has gone into breeding stripe rust resistant cultivars (CromeY 1990). The wheat cultivars commonly grown in New Zealand differ widely in their resistance to stripe rust and in their spectrum of resistance to other common diseases. Apart from one report by Elmer and Gaunt (1984), who recorded yield responses of up to 65% resulting from the application of foliar fungicides, little information is available about the effects of chemical methods of disease control on the yields of crops of different wheat cultivars. Information on potential yield increases due to additional disease control using chemicals is important in preparing disease management guidelines for new cultivars.

This paper reports a series of trials which investigated the effects of disease control on the yield of winter wheat cultivars.

### METHODS

There were five field trials. In the 1985/86, 1986/87, and 1987/88 seasons, trials were carried out at the DSIR Crop Research farm at Lincoln. Two additional trials, one at the MAF farm at Winchmore, and one at St Andrews (South Canterbury), were sown in 1987/88. The trials were autumn-sown, and consisted of three replicates, in a randomised split-plot design, with spray treatments as the main plot and cultivars as sub-treatments. Sub-treatments were 4.5 m x 1.5 m. The cultivars represented a range in resistance (Table 1) to the wheat diseases commonly occurring in Canterbury and form part of a larger series of cultivar evaluation trials. The cultivars used in Trials 2-5 differ somewhat from those in Trial 1 (Table 2), with 'Ruapuna' replacing 'Advantage' and 'Abele' replacing 'Bounty'.

Fungicides (propiconazole, triadimefon, benomyl, prochloraz) at rates recommended on labels, were applied to treated plots at regular intervals in an attempt to keep disease levels as low as possible in these plots. Fungicides were applied using a compressed air back-pack sprayer with a hand-held boom fitted with Tee-jet nozzles (Spraying Systems Co. no. 25 cores, D2 discs) applying 500 litres/ha at 300 kPa. Disease occurrence in the trials relied on natural inoculum. Disease severity (percent leaf area affected) was assessed visually (using standard area diagrams) in the trials at regular intervals. Results for the assessment date when severity was greatest for each disease

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are recorded in Table 2. Plots were mechanically harvested when the grain was ripe. The harvested grain was weighed and the harvest weight adjusted to 14% moisture content.

**TABLE 1: Susceptibility of wheat cultivars to common diseases.**

|           | Stripe rust | Powdery mildew | Leaf rust | Speckled leaf blotch |
|-----------|-------------|----------------|-----------|----------------------|
| Abele     | R           | R              | R         | R                    |
| Advantage | MR          | R              | R         | S                    |
| Bounty    | R           | R              | S         | R                    |
| Kotare    | MR          | S              | S         | S                    |
| Rongotea  | S           | S              | S         | R                    |
| Ruapuna   | MR          | R              | MS        | S                    |
| Weka      | MS          | R              | R         | R                    |

Key: S = susceptible, MS = moderately susceptible, MR = moderately resistant, R = resistant

**Trial 1.** (1985/86, Lincoln)

Disease was assessed on five dates, between October 21 and December 11, with the final assessment data in Table 2. Stripe rust was the only disease identified in this trial and the epidemic developed rapidly from early October. By December, 84% of the flag leaf area was affected in unsprayed plots of the susceptible cultivar 'Rongotea'. It proved difficult to control the disease in sprayed plots late in the season, especially on flag leaves. Stripe rust was considerably more severe on 'Rongotea' than on any of the other cultivars. 'Bounty' was resistant to stripe rust at all growth stages. All other cultivars were susceptible at seedling growth stages, but progressively developed a degree of adult plant resistance. Resistance developed later in 'Weka', than in 'Kotare' and 'Advantage', with substantial rust infection recorded on the two leaves prior to the flag leaf. Severity of disease on flag leaves was similar on the three cultivars. The magnitude of the differences in yield between sprayed and unsprayed plots (Table 3) reflected the differences in stripe rust severity, over all growth stages, between cultivars. Thus the greatest yield difference was recorded for 'Rongotea', with smaller differences for 'Weka' and 'Kotare', and no yield differences for 'Advantage' or 'Bounty'.

**Trial 2.** (1986/87, Lincoln)

Disease was assessed six times between September 25 and December 16 (Table 2). Speckled leaf blotch (caused by *Mycosphaerella graminicola* (Fuckel) Schroeter) was observed early in the season, being particularly severe in 'Kotare', but did not develop on later leaves. Stripe rust was again the predominant disease, but did not become established until late October. Stripe rust was most severe in 'Rongotea', although 'Weka' was also infected to a greater extent than in Trial 1. Powdery mildew (caused by *Erysiphe graminis* de Candolle) appeared in October, particularly on 'Kotare', where it was observed on spikes, and 'Rongotea'. Leaf rust (caused by *Puccinia recondita* Roberge ex Desmazieres) was recorded late in the season, but did little damage. Yield differences through fungicide application (Table 3) varied markedly between cultivars. Highest yield differences were in 'Rongotea' and 'Kotare', with a smaller difference in 'Weka', and no differences for 'Ruapuna' or 'Abele'.

**Trial 3.** (1987/88, Lincoln)

Stripe rust was again the predominant disease, being severe at all growth stages in 'Rongotea', and moderately severe in 'Weka'. Stripe rust was present in early growth stages in 'Kotare', but was not severe on the flag leaf. Yields followed the pattern of previous trials, although a 16% yield loss was recorded for 'Abele', where little foliar disease was recorded (Table 3).

**Trials 4 & 5.** (1987/88, Winchmore and St Andrews)

Formal disease assessments were not carried out in these trials, although severe stripe rust and powdery mildew were observed in Trial 4. Yield differences were recorded from all cultivars (Table 3).

**TABLE 2: Maximum severity (% leaf area affected) of several foliage diseases recorded on different wheat cultivars as affected by spray application of fungicides.**

| Disease                   | Fungicide | Date | Cultivar |      |        |           |        |
|---------------------------|-----------|------|----------|------|--------|-----------|--------|
|                           |           |      | Rongotea | Weka | Kotare | Advantage | Bounty |
| Trial 1. 1985/86, Lincoln |           |      |          |      |        |           |        |
| Stripe rust               | -         | 11   | 84       | 8    | 11     | 11        | 0      |
| rust                      | +         | Dec  | 18       | 5    | 6      | 3         | 0      |
|                           |           |      |          |      |        | Ruapuna   | Abele  |
| Trial 2. 1986/87, Lincoln |           |      |          |      |        |           |        |
| Stripe rust               | -         | 16   | 82       | 30   | 1      | 5         | 0      |
| Leaf rust                 | +         | Dec  | 1        | 3    | 0      | 0         | 0      |
|                           | -         | 16   | 0        | 0    | 1      | 1         | 0      |
|                           | +         | Dec  | 0        | 0    | 0      | 0         | 0      |
| Powdery mildew            | -         | 4    | 5        | 0    | 5      | 0         | 0      |
| Speckled leaf blotch      | +         | Dec  | 0        | 0    | 1      | 0         | 0      |
|                           | -         | 25   | 2        | 1    | 7      | 4         | 1      |
|                           | +         | Sep  | 2        | 0    | 5      | 2         | 1      |
| Trial 3. 1987/88 Lincoln  |           |      |          |      |        |           |        |
| Stripe rust               | -         | 3-   | 53       | 27   | 1      | 1         | 0      |
| Leaf rust                 | +         | Nov  | 1        | 10   | 0      | 0         | 0      |
|                           | -         | 30   | 0        | 0    | 1      | 0         | 0      |
|                           | +         | Nov  | 0        | 0    | 0      | 0         | 0      |
| Powdery mildew            | -         | 15   | 0        | 0    | 1      | 0         | 1      |
|                           | +         | Sep  | 0        | 0    | 0      | 0         | 0      |

**TABLE 3: Grain yields (kg/ha) from plots of different winter wheat cultivars in five field trials, as affected by spray application of fungicides.**

| Fungicide                    | Cultivar |       |        |           |        |
|------------------------------|----------|-------|--------|-----------|--------|
|                              | Rongotea | Weka  | Kotare | Advantage | Bounty |
| Trial 1. 1985/86, Lincoln.   |          |       |        |           |        |
| unsprayed                    | 2110     | 3880  | 3900   | 3420      | 4550   |
| sprayed                      | 3310*    | 4380* | 4220   | 3440      | 4510   |
| % loss                       | 36       | 11    | 8      | 0         | 0      |
| Trial 2. 1986/87, Lincoln.   |          |       |        |           |        |
| unsprayed                    | 4750     | 5900  | 4050   | 7200      | 9900   |
| sprayed                      | 8500*    | 7500* | 7100*  | 7600      | 9900   |
| % loss                       | 44       | 21    | 43     | 5         | 0      |
| Trial 3. 1987/88, Lincoln.   |          |       |        |           |        |
| unsprayed                    | 5629     | 5649  | 6215   | 6795      | 8573   |
| sprayed                      | 9922*    | 8320* | 7165*  | 6897      | 10259* |
| % loss                       | 43       | 32    | 13     | 2         | 16     |
| Trial 4. 1987/88, Winchmore  |          |       |        |           |        |
| unsprayed                    | 3826     | 5020  | 3380   | 5173      | 5112   |
| sprayed                      | 7488*    | 7335* | 6831*  | 6565*     | 6899*  |
| % loss                       | 50       | 32    | 51     | 21        | 26     |
| Trial 5. 1987/88, St Andrews |          |       |        |           |        |
| unsprayed                    | 2917     | 6019  | 5741   | 5880      | 9122   |
| sprayed                      | 7964*    | 8196* | 8288*  | 8195*     | 9538   |
| % loss                       | 63       | 27    | 31     | 28        | 4      |
| mean % loss                  | 47       | 25    | 29     | 11        | 9      |

\* significant yield difference (P&lt;0.05)

### DISCUSSION

Stripe rust was the most important disease in each of the trials. Speckled leaf blotch was observed at an early growth stage in some trials, but did not develop later in the season. Powdery mildew was present in some cultivars, being most severe in 'Kotare'. The leaf rust epidemic probably developed too late to have a major impact on yield.

'Rongotea' was the cultivar most susceptible to stripe rust. This was reflected in the disease severity data and the high yield differences obtained through fungicide treatment in all trials. The cultivar is also susceptible to leaf rust and powdery mildew but there was little green tissue unaffected by stripe rust available in the untreated plots for these diseases to develop.

'Weka' was susceptible to stripe rust at the seedling stage and moderately susceptible as adult plants, but resistant to the other diseases present. The yield losses in this cultivar therefore largely represent the effect of stripe rust infection.

'Kotare' was also susceptible to stripe rust as seedlings, but developed a moderate amount of adult plant resistance. This cultivar is also highly susceptible to speckled leaf blotch, powdery mildew, and leaf rust, so yield loss will depend largely on the disease spectrum in a particular crop or trial. This can be seen by the highly variable effects of disease control on yield of this cultivar in different trials. It is likely that the yield of 'Kotare' can be markedly affected by powdery mildew, especially when it is present on spikes.

'Ruapuna' has moderate to good resistance to all foliar diseases seen in the trials, including adult plant resistance to stripe rust. This is reflected by the relatively small effect of disease control in this cultivar. 'Bounty' and 'Abele' were both highly resistant to stripe rust, and so did not respond to disease control in most trials.

It is important to assess disease in the field at different growth stages, since different diseases may predominate at different periods. For instance Bowen *et al* (1991) found that, in the North Carolina, the effect of powdery mildew and leaf rust on yields of winter wheat was additive, although the two diseases were predominant at different periods.

Most cultivars responded to fungicide application, but the degree of response depended largely on the susceptibility of each to stripe rust. Cultivars such as 'Rongotea', which are highly susceptible to stripe rust, require regular applications of fungicide in order to achieve an adequate yield. Cultivars with adult plant resistance to stripe rust may require one to two well-timed applications of an appropriate fungicide in order to minimise yield loss due to disease. Cultivars which are highly resistant to stripe rust will usually require no fungicide applications, depending on their susceptibility to, and the occurrence of, other diseases. These results suggest that it is important for disease management guidelines to be tailored to specific cultivars.

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