CONTROL OF BARLEY YELLOW DWARF VIRUS (BYDV) DISEASE OF BARLEY IN MID-CANTERBURY

M.W. STUFKENS and J.A. FARRELL

Entomology Division, DSIR, Lincoln

SUMMARY

Control of BYDV in barley with insecticides and plant resistance was studied at Lincoln in 1986, when BYDV incidence was less than 5%. A pyrethroid spray at the seedling or early tillering stage reduced BYDV intensity by approximately 50%. A further spray at the pseudostem-erect stage reduced late BYDV in winter barley by 98%. Drilled terbufos granules at sowing had no significant effect on BYDV levels in winter or spring barley. In Fleet barley, BYDV infection was 75-66% less than the level in cultivars Triumph or Mata.

INTRODUCTION

Trials in Canterbury on the insecticidal control of barley yellow dwarf virus (BYDV) in autumn-sown wheat were completed prior to the appearance of the rose-grain aphid (RGA) *(Metopolophium dirhodum)* in New Zealand. Smith (1983) had shown that the application of an organophosphate spray at late tillering controlled the cereal aphid (CA) *(Rhopalosiphum padi)* vector, reduced BYDV incidence and increased grain yields. Mulholland and Jessep (1967) showed that disulfoton drilled at sowing was similarly effective. Recently, Kendal *et al* (1985) showed that the pyrethroid, cypermethrin, controlled BYDV and increased yields in Britain, when applied to wheat and barley at early tillering. Recent work at Lincoln (Farrell and Stufkens, unpublished) has shown that BYDV is transmitted by RGA, CA, the cornleaf aphid (CLA) *(Rhopalosiphum maidis)* and the blackberry — cereal aphid (BCA) *(Sitobion fragariae)*. This paper reports barley field trials on BYDV response to insecticides and barley cultivars at Lincoln in 1986.

METHODS

Barley growth stages are described using the Zadoks decimal system (Tottman and Makepiece 1979), where growth stages are represented as seedling = 1, tillering = 2, stem extension = 3, boot = 4, heading = 5.

Insecticide Trials

Triumph barley was sown on 8 May (winter trial) and 10 September (spring trial). A randomized block design was used, with four treatments and six replicates of 15m² plots, each 1.5 m x 10 m. Treatments were as follows.

1) Terbufos (Counter 20G) granules drilled at sowing, using rates of 3 kg ai/ha (winter) and 5 kg ai/ ha (spring).
2) Fenvalerate (Sumicidin 10EC) sprayed at GS12 (15 g ai/ha) on 5 June in the winter trial.
3) Fenvalerate (Sumicidin 10EC) sprayed at GS22 (15 g ai/ha) on 1 August in winter trial, and 16 October in spring trial.
4) Nil, no treatment.

Cultivar Trials

Three barley cultivars were sown on 1 May (winter) and 10 September (spring). A split-plot design was used, comprising three main treatments (cultivars) and two sub-treatments (insecticide) with six replicates of 30 m² plots, each 3 x 10 m. Cultivars were Triumph, Illia, Priver (winter) and Triumph, Mata, Fleet (spring). The first sub-treatment comprised permethrin (Ambush 50EC) sprayed at 50 g ai/ha at GS11 (23 May), GS23 (1 August) and GS30 (4 September) in the winter trial, and at GS22 (16 October) in the spring trial. The second sub-treatment received no insecticide.

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Winged aphid counts

Winged adults of four BYDV vector species (RGA, CA, CLA, BCA) were collected and identified from 5-10 m^2 of each treatment of winter trials on 20 May, 1, 4, 10 June (cultivar trial) and 3, 13 June (insecticide trial). Aphids were recorded from 5 m^2/treatment on 16 October in the spring cultivar trial.

BYDV counts

BYDV infection was recognized by chrome-yellow leaf colour on the distal lamina with, in Triumph, red margins and red flag-leaf lamina. Infected tillers were counted on whole plots on two occasions in each trial (Tables 1 and 4).

Grain yield

Grain yields were recorded from 18 m^2 strips in each plot of the winter cultivar trial. Samples of 0.5 kg/plot were dressed over screens of 2.4 mm slot width for determination of percent reject grain. Other trials were not harvested.

Statistical analysis

Data was analysed using the GENSTAT programme for ANOVA of split-plot and randomized block designs after transformation of data to log 10 (n + 1) for BYDV or $\sqrt{(n+1)}$ for aphid data.

RESULTS

Insecticide trials

Totals of winged aphids (RGA, CA)/10 m^2 collected on 3, 13 June in the winter trial were: untreated - 29; terbufos - 23; fenvalerate - 0. Early BYDV incidence in this trial was similar in all treatments but by October 31 incidence was significantly less ($P < 0.05$) in the fenvalerate treatment (Table 1). Virus incidence declined markedly between counts (Table 1). In the spring trial BYDV response to fenvalerate was significant ($P < 0.05$) at both counts. There was no significant BYDV response to terbufos in either trial (Table 1).

TABLE 1: Effects of insecticide on numbers of BYDV-infected tillers/10 m^2 in Triumph barley: winter and spring insecticide trials.

Treatment	Winter trial		Spring trial	
	9 Sept.	31 Oct.	19 Nov.	1 Dec.
	GS30	53	39	53
terbufos	217	14a	29ab	66ab
fenvalerate at GS12	214	5b	15bc	47bc
fenvalerate at GS22	283	3b	10c	40c
untreated	234ns	26a	48a	82a

Values are re-transformed from mean (log 10 (n + 1)) used for ANOVA: Treatment means bearing different letters are significantly different ($P < 0.05$) within dates; ns = no significant difference.

TABLE 2: Effects of permethrin treatment (23 May) on numbers of winged aphids/10 m^2 on Triumph barley in the winter cultivar trial.

Aphid species	Date: 20 May	Untreated		Treated	
		1-4 Jun.	10 Jun.	1-4 Jun.	10 Jun.
RGA	9	22	40	0	5
CA	41	20	19	0	3
CLA	235	33	0	0	0
BCA	3	1	2	0	0
Total	228	76	61	0	8

Cultivar trials

In the winter trial, winged aphids were recorded on Triumph barley on 20 May, before permethrin treatment on 23 May. Subsequently, treated plots were free of aphids for c. 12 days (Table 2). Table 3 shows that significantly ($P < 0.05$) more aphids

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TABLE 3: Effect of barley cultivar on numbers of winged aphids/10 m^2 (1-10 June) in the winter cultivar trial.

	Aphid species				
Cultivar	RGA	CA	CLA	BCA	Total
Triumph	28a	19a	8ns	2ns	57a
Illia	8b	9b	11	2	30b
Priver	4b	15ab	6	3	28b
Total	40	43	25	7	115

Treatment means bearing different letters are significantly different ($P< 0.05$) between cultivars; ns = no significant difference; from ANOVA of $\sqrt{(n+0.5)}$ values.

TABLE 4: Effects of barley cultivar (untreated plots) and permethrin on incidence of BYDV in winter and spring cultivar trials.

	No of BYDV-infected tillers/10 m^2				
	Winter trial			Spring trial	
Treatment Date:	11 Sept.	28 Oct.	Treatment	19 Nov.	4 Dec.
GS:	30	51		39	57
Main treatment					
Triumph	390a	161	Triumph	24b	81b
Illia	102b	166	Mata	32a	107a
Priver	106b	251ns	Fleet	1c	25c
Sub-treatment					
untreated	162a	189a	untreated	15a	74a
permethrin	68b	4b	permethrin	9b	51b

Values are re-transformed from mean log 10 $(n+1)$ used for ANOVA. Treatment means bearing different letters are significantly different ($P< 0.05$) within dates; ns = no significant difference.

accumulated on Triumph barley, which was preferred by RGA over Illia or Priver. Cereal aphids showed less response to cultivar, while CLA and BCA showed no significant response. Triumph barley emerged first, and had achieved a higher plant population by 17 June (290/m^2) than Illia or Priver (190, 145/m^2 respectively). No winged aphids were observed on spring barley after emergence or in searches on 16 October (GS22).

BYDV infections first appeared in late July (winter) and mid November (spring trial). Table 4 shows that permethrin significantly ($P<0.01$) reduced BYDV counts in both trials. In the winter trial, Triumph had significantly ($P< 0.001$) more BYDV than other cultivars at GS30, but there was no response to cultivar at GS51. The decline in Triumph BYDV incidence between these stages may be attributable to masking of infected plants by the growth of healthy tillers. In the spring trial, Fleet showed significantly ($P<0.001$) less BYDV than other cultivars at both counts. Tiller densities, estimated from quadrat counts at the flowering stage, were c. 700/m^2 in Illia and Fleet,

TABLE 5: Effects of cultivar and permethrin treatment on grain yield (tonnes/ha) of winter-sown barley.

	Main Treatment			Sub-treatment
Sub-treatment	Triumph	Illia	Priver	mean
untreated	9.1b	10.7	7.5b	9.1b
permethrin	9.8a	11.0ns	9.0a	9.9a
Main treatment mean	9.5b	10.9a	8.2c	-

Means bearing different letters are significantly different ($P<0.05$). Values for main-treatment/sub-treatment combinations are compared between sub-treatments only.

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and c. 1000/m^2 in other cultivars. Maximum rates of visible infection were thus c. 1-4% in winter, and <1% in spring barley.

Grain yield of winter barley was significantly increased (P<0.01) by three applications of permethrin (Table 5). Yields of cultivars varied significantly (P<0.01): Illia > Triumph > Priver (Table 5). The proportion of reject grain passing a 2.4 mm screen was 3% in all treatments.

DISCUSSION

Although pyrethroid treatment, at GS12 and 23, reduced early BYDV counts (GS30-39) in all trials except winter insecticide there was late BYDV infection recorded at GS51-57. This may have been the result of secondary spread from early primary infections, which had been masked by healthy crop growth, particularly in Triumph barley. Control of late BYDV infections in the winter cultivar trial by permethrin was associated with a marked reduction in number of wingless RGA between May and late October (Farrell and Stufkens unpublished). In this treatment permethrin reduced early BYDV by c. 50% and late BYDV by c. 98% following applications at GS11 and 23, and GS30 respectively. However, the earliest spray was too late to prevent aphid settlement on emerging barley. A single insecticide spray at GS30 may give the most cost-effective protection against BYDV, particularly when applied as a tank mix with the herbicide normally sprayed at the late tillering — pseudostem stages in cereal growth. This recommendation is consistent with the findings of Smith (1963), and allows forecasting of the BYDV risk from early BYDV intensity.

Insecticide treatment of winter barley gave a significant yield increase of c. 9% under low virus challenge in 1986. In 1985, insecticide (pirimicarb) treatment at GS31 under high virus challenge did not control BYDV or increase yields (Stufkens and Farrell 1986, unpublished); this result may have been due to cross-infection between small plots in the field trial.

In the winter cultivar trial early counts of winged RGA and BYDV were significantly lower in Illia and Priver than in Triumph where tiller density was greater than in other cultivars. In the spring cultivar trial, Fleet showed markedly less BYDV infection than Mata or Triumph. These results are consistent with earlier findings (Stufkens and Farrell 1986) and indicate that cv. Fleet is moderately resistent to BYDV.

Canterbury winter cereals are usually sown in late May-June, whereas our trials were sown on 1-8 May in order to ensure BYDV infection. Late sowing, recommended by Lowe (1967), is probably a major factor in the low incidence of BYDV observed in the province (Stufkens and Farrell 1986). Loss of yield due to BYDV rarely justifies insecticide treatment, and is difficult to forecast. In addition to late sowing, the development of virus-resistant cereals such as Fleet and other cultivars adapted to New Zealand conditions (Burnett and Klatt 1986) offers a low-cost alternative to insecticide treatment for the control of BYDV.

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