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Insecticides for the control of onion thrips—screening for resistance
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1 Executive summary

Some populations of onion thrips in South Auckland have been found to be resistant to synthetic pyrethroid insecticides. Baseline dose-mortality data for susceptible onion thrips have been determined for four of the five insecticides with label claims for onion thrips control on onion crops. Four populations of onion thrips from South Auckland and Canterbury were screened for resistance to these four insecticides.

The objectives of the study were to:

- determine the presence or absence of resistance in onion thrips to five insecticides in four onion crops, and
- determine the level of resistance in two populations to one insecticide each.

Onion thrips that were susceptible to synthetic pyrethroid insecticides and four samples of onion thrips from crops or harvested onions in Canterbury and at three Auckland sites were reared on leek segments in small ventilated jars.

Discs, 24 mm in diameter, cut from leek leaves were dipped in insecticide solutions or a water control. The concentration of each insecticide used killed all susceptible thrips. The dry leaf discs were placed in small ventilated plastic dishes. After thrips were added to dishes, they were closed and kept at 25°C for 24 h. Mortality was then assessed.

The experiments were carried out between January and June 2000 using the following insecticides:

Insecticide (product)	Diagnostic dose (mg ai/1 litre)	Recommended concentration (mg ai/1 litre)
Deltamethrin (Decis Forte)	19.8	19.8
Diazinon (Diazinon 50 W)	100	500
Dichlovos (Nuvan)	2500	1000
Endosulfan (Thiodan)	700	700
Parathion-methyl (Folidol M 50)	not available	480

Onion thrips were exposed to leek leaves that had been treated with the diagnostic dose of each insecticide.

- All four populations were resistant to **deltamethrin**.
- The three Auckland populations were also resistant to **diazinon and dichlorvos.**
- the Canterbury population was susceptible to the organophosphate insecticides **diazinon and dichlorvos**.

- Two of the Auckland populations and the Canterbury population were susceptible to **endosulfan**.
- As at 30 June the dose-mortality data and diagnostic dose for **parathion-methyl** had not been determined.

Onion thrips at Canterbury (site 2) were 700 times more resistant to deltamethrin than susceptible thrips. Onion thrips from Auckland (site 5) were 50 times more resistant to diazinon than the susceptible thrips.

The widespread resistance to diazinon and dichlorvos in Auckland and its absence in the Canterbury population tested suggests that there may be cross-resistance to these chemicals. The presence of resistance to diazinon may partly explain the poor results Auckland growers obtained with this chemical during the 1998/99 season.

The discovery of onion thrips in Canterbury that are resistant to synthetic pyrethroids (deltamethrin) emphasises the need for all onion growers to follow the recommendations of the onion thrips resistance management strategy, even if resistant thrips are not known to be present in their district.

Field and laboratory observations suggest that levels of resistance to synthetic pyrethroids decline rapidly so it should be possible to use one cluster of synthetic pyrethroid insecticide applications each year.

It is important that baseline data and diagnostic dose tests are developed for new insecticides that are registered for onion thrips control and for parathion-methyl if it continues to be used.

2 *Introduction*

In 1997, onion thrips from South Auckland onion crops were demonstrated to be resistant to synthetic pyrethroid insecticides. Onion thrips in other countries are also reported to be resistant to many other insecticides. There is no information in New Zealand about the extent of resistance to synthetic pyrethroids and the existence of resistance to other insecticides amongst insect pests of commercial crops.

Baseline dose-mortality data for susceptible onion thrips have been determined for four of the five insecticides with label claims for onion thrips control on onion crops. This enables onion thrips populations to be tested for resistance to these insecticides using a diagnostic dose that kills all susceptible thrips. If a high percentage of thrips survive the diagnostic dose, the population is resistant. The level of resistance is then determined by comparing the plotted dose-mortality lines of resistant and susceptible populations.

3 Objective

- To assess four populations of onion thrips from South Auckland and Canterbury for resistance to five insecticides.
- To determine the level of resistance in two onion thrips populations to one pesticide each.

4 Methods

4.1 Onion thrips

Two colonies of susceptible onion thrips (*Thrips tabaci*) were used, one from a conservatory in Wellington and one from a susceptible population in Pukekohe to establish diagnostic doses. They were reared separately on segments of leek leaves in Agee jars (500 ml) at 25°C and in 16 h light : 8 h dark. Both populations were susceptible to synthetic pyrethroid insecticides.

Colonies of four onion thrips populations from three Auckland sites and one Canterbury site were established. The colony from Canterbury was collected from a vigorously growing crop (Site C-2) on 9 February 2000 pre top fall. Two colonies from Auckland were established from crops at the start of top fall, sites A-4 and A-5 on 27 January 2000, while the third Auckland population tested came from onion bulbs grown in Karaka.

4.2 Insecticide treatment

4.2.1 Insecticides

The onion thrips colonies were tested for resistance to the five insecticides listed in Table 1.

Table 1: The five insecticides with label claims for onion thrips control on onion crops, the diagnostic dose developed to test onion thrips populations and the recommended concentration (assuming 500 litres spray per hectare) for onion crop application for thrips control.

Insecticide (product)	Diagnostic dose (mg ai/1 litre)	Recommended concentration (mg ai/1 litre)
Deltamethrin (Decis Forte)	19.8	19.8
Diazinon (Diazinon 50 W)	100	500
Dichlovos (Nuvan)	2500	1000
Endosulfan (Thiodan)	700	700
Parathion-methyl (Folidol M 50)	not available	480

Note: all treatments, including the water control, contained Citowet (0.25 ml/litre water).

4.2.2 *Insecticide treatment*

Discs, 24 mm in diameter, were cut from the white part of leek leaves. Each disc was dipped for 5 seconds in an insecticide solution or water control and allowed to dry. A single diagnostic dose of each insecticide and a water control were used to test the populations for resistance. When determining the level of resistance in the resistant and susceptible colonies, five or six concentrations of each insecticide were used to determine the dose-mortality line for each colony-insecticide combination.

4.3 *Bioassay*

When dry, the leaf discs were placed, one each, in small plastic Petri dishes (50 mm in diameter). Ten live onion thrips were transferred to each dish which was closed with a ventilated lid. Ventilation was provided by a hole 12 mm in diameter covered by a fine mesh. The dishes were kept at 25°C in 16 h light : 8 h dark for 24 hours. The numbers of live and dead thrips in each dish were recorded and percentage mortality calculated. Thrips were considered to be dead if they failed to move when they were gently touched with a fine camel hair brush.

4.4 *Data analysis*

The percentage mortality due to the insecticide alone was calculated using Abbot's correction and the data graphed. The LC_{50} (concentration of insecticide which kills 50% of thrips) was calculated/estimated and the ratio of the LC_{50}s calculated to determine the levels of resistance.

5 *Results*

5.1 *Diagnostic dose tests*

The testing was done as baseline data and thrips populations became available.

5.1.1 *Decis Forte (deltamethrin)*

The Karaka strain was tested on 10 May 2000 and all of the other strains on 8 March 2000. All four populations were resistant to deltamethrin (Figs 1 - 2). Because there was higher than expected survival in the Wellington strain (Fig. 1), the tests were repeated and assessed after 24 and 48 hours. The 48 hour assessment showed high mortality in both susceptible populations and high survival at A-4 and C-2.

5.1.2 *Nuvan (dichlorvos)*

The Karaka strain was tested on 10 May 2000 and all other strains on 28 March 2000. The three Auckland strains were resistant to Dichlorvos, while the Canterbury strain tested was susceptible (Figs 3 - 4).

5.1.3 Diazinon

The Karaka strain was tested on 10 May 2000 and all other strains on 20 June 2000. The three Auckland strains were resistant to Dichlorvos, while the Canterbury strain was susceptible (Figs 5 - 6).

5.1.4 Thiodan (endosulfan)

Two Auckland strains and the Canterbury strain were tested on 20 June 2000. All strains were susceptible to endosulfan (Fig. 7).

5.1.5 Folidol (parathion-methyl)

A diagnostic dose has not been determined so no populations were tested for resistance.

5.2 Levels of resistance

5.2.1 Deltamethrin in onion thrips from Canterbury (site 2)

The LC_{50}, the concentration of deltamethrin required to kill 50% of onion thrips from Canterbury (site 2), was about 2500 mg per litre (Fig. 8), which is approximately 700 times the LC_{50} for the susceptible strain of about 3.5 mg per litre. The LC_{50} for the resistant strain is over 100 times higher than the recommended concentration for field sprays.

5.2.2 Diazinon in onion thrips from Auckland (site 5)

The LC_{50}, the concentration of diazinon required to kill 50% of onion thrips from Auckland (site 5), was about 2000 mg per litre (Fig. 9), which is approximately 50 times the LC_{50} for the susceptible strain of about 40 mg per litre. The LC_{50} for the resistant strain is over 4 times higher than the recommended concentration for field sprays.

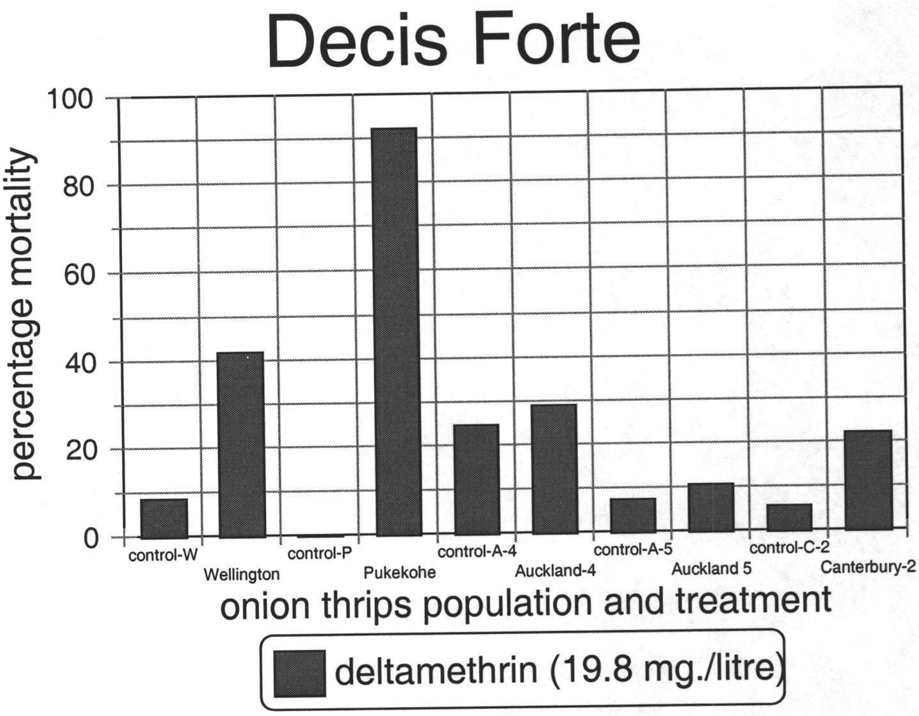

Figure 1: Mortality of onion thrips to the diagnostic dose of deltamethrin and water control after 24 hours. Comparison of five populations. Low mortality for the insecticide-treated thrips indicates that the thrips are resistant to the insecticide.

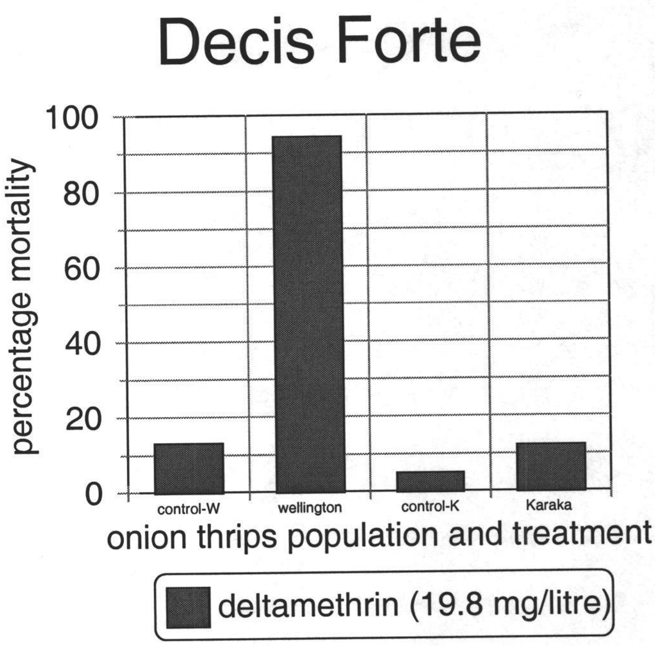

Figure 2: Mortality of onion thrips to the diagnostic dose of deltamethrin and water control after 24 hours. Comparison of two populations. Low mortality for the insecticide-treated thrips indicates that the thrips are resistant to the insecticide.

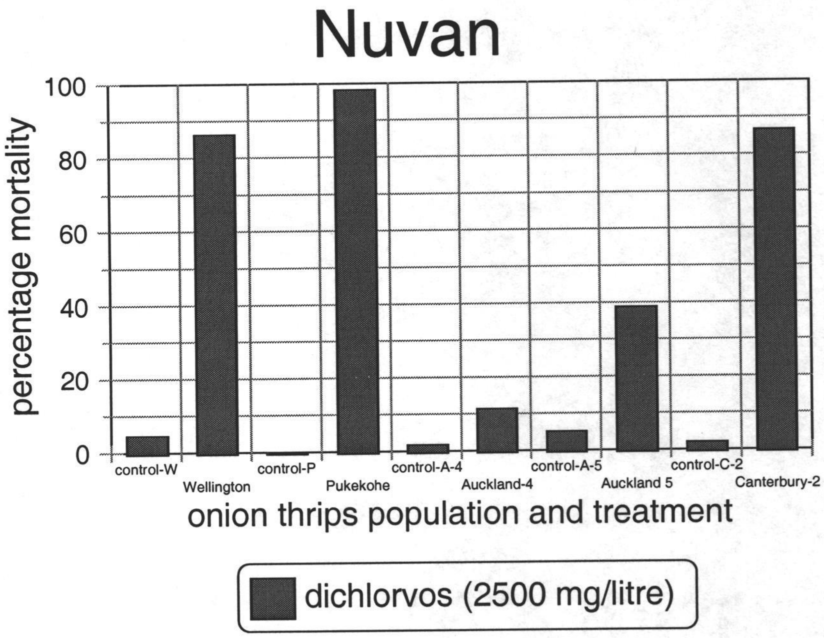

Figure 3: Mortality of onion thrips to the diagnostic dose of dichlorvos and water control after 24 hours. Comparison of five populations. Low mortality for the insecticide-treated thrips indicates that the thrips are resistant to the insecticde.

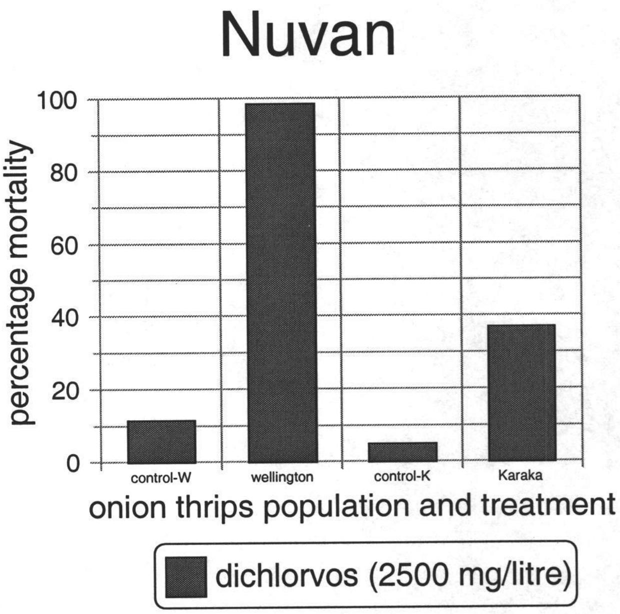

Figure 4: Mortality of onion thrips to the diagnostic dose of dichlorvos and water control after 24 hours. Comparison of two populations. Low mortality for the insecticide-treated thrips indicates that the thrips are resistant to the insecticide.

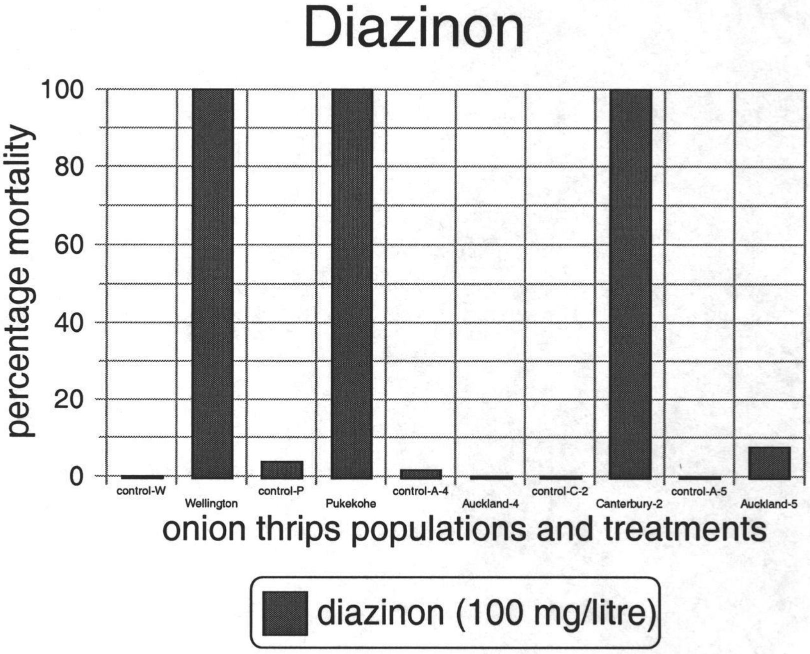

Figure 5: Mortality of onion thrips to the diagnostic dose of diazinon and water control after 24 hours. Comparison of two populations. Low mortality for the insecticide-treated thrips indicates that the thrips are resistant to the insecticide.

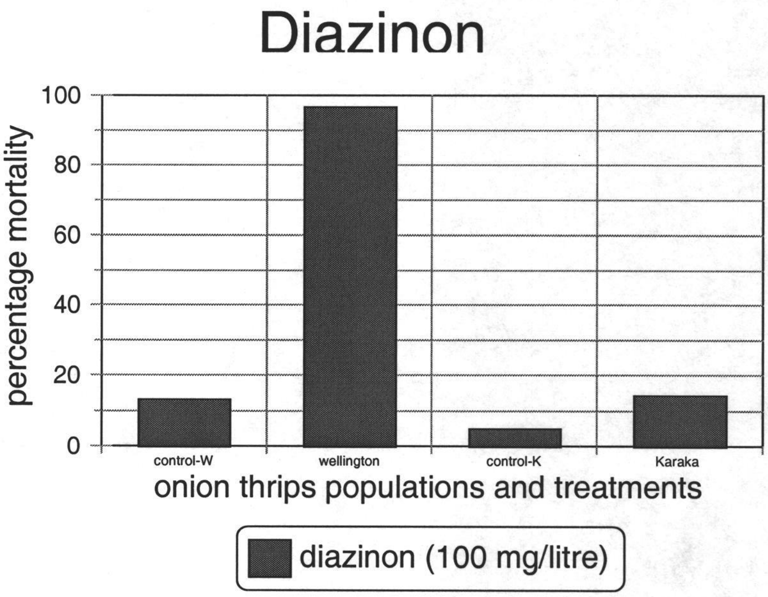

Figure 6: Mortality of onion thrips to the diagnostic dose of diazinon and water control after 24 hours. Comparison of two populations. Low mortality for the insecticide-treated thrips indicates that the thrips are resistant to the insecticide.

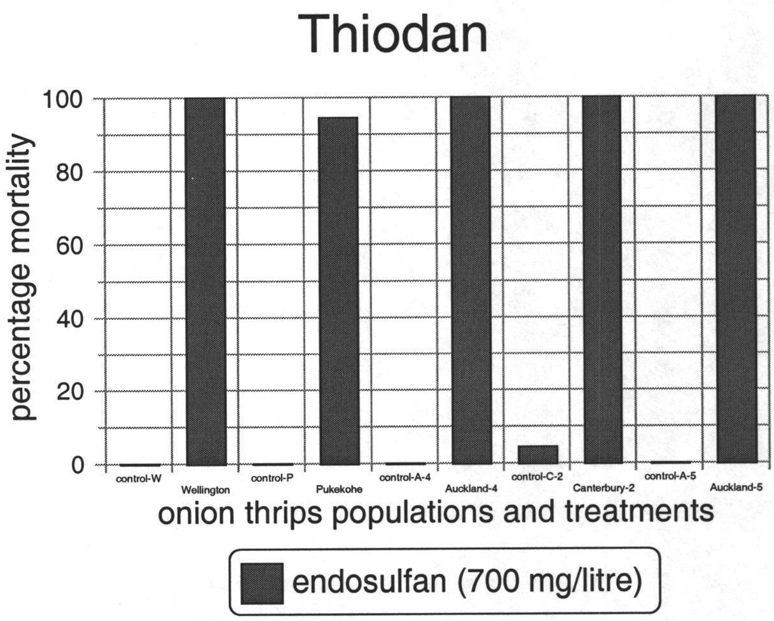

Figure 7: Mortality of onion thrips to the diagnostic dose of diazinon and water control after 24 hours. Comparison of five populations. Low mortality for the insecticide-treated thrips indicates that the thrips are resistant to the insecticide.

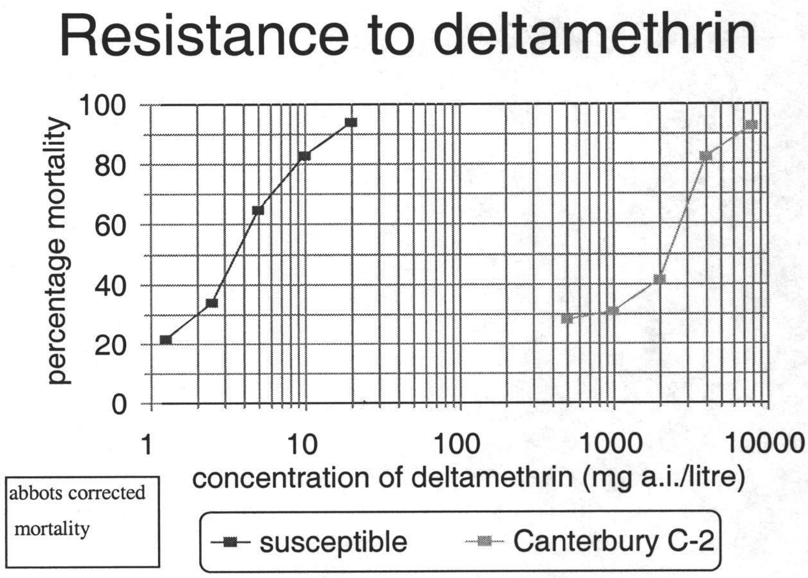

Figure 8: Dose mortality lines for two onion thrips population exposed to leek leaf discs dipped in solutions of deltamethrin. The population C-2 is about 700 times more resistant than the susceptible thrips.

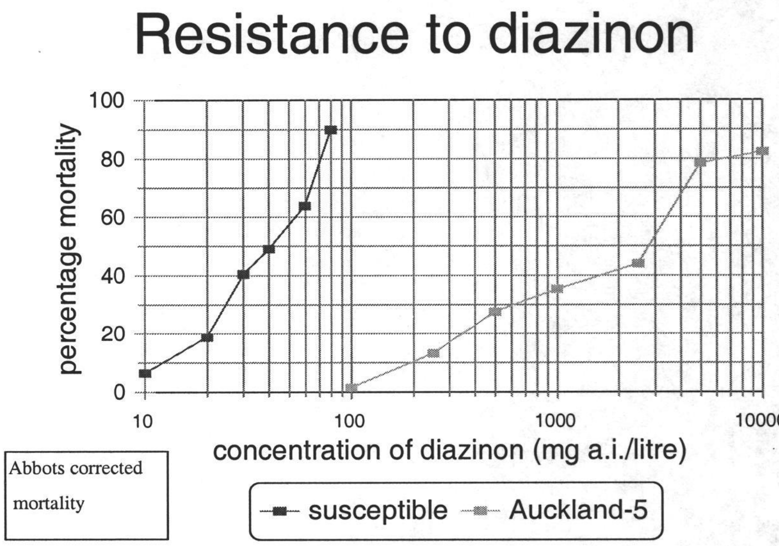

Figure 9: Dose mortality lines for two onion thrips population exposed to leek leaf discs dipped in solutions of deltamethrin. The population A-5 is about 50 times more resistant than the susceptible thrips.

6 Discussion

This survey of four populations of onion thrips has found no resistance to endosulfan, but thrips with resistance to synthetic pyrethroids were present in all four properties, three in the North Island and one in the South island. The presence of resistance to synthetic pyrethroids in the South Island means that thrips resistant to these insecticides or any other insecticide could be present on any crop. It is a warning to all growers to follow the onion thrips resistance prevention and management strategy, regardless of whether resistant thrips have been found on their property or even in the district.

Resistance has also been found to both the two organo-phosphate insecticides tested, dichlorvos and diazinon. Resistance to both chemicals was present in the three North Island populations, but not the Canterbury population.

Diazinon was not used on any of the Auckland sites in 1999/00, but was used the previous season when it appeared to give poor control. The discovery of resistance to the insecticide is probably the reason for poor field control during the previous growing season.

Dichlorvos was used this season on sites that we monitored, including one where resistance was found. However, because of the time of application and the critical conditions for effective use of the insecticide, it is not possible to know if resistance led to failures in field control.

The high resistance of onion thrips to Decis and other synthetic pyrethroids is clearly associated with the failure of thrips control in the field. However, there is good evidence that synthetic pyrethroids initially reduced thrips populations where they were only used late season. We find a similar phenomenon in our laboratory colonies, in which resistance declined over time. This suggests that resistance levels can decline quickly in the field, making the use of one cluster of sprays effective.

This study shows the value of monitoring for resistance to insecticides. When new insecticides are registered for onion thrips control, baseline data and diagnostic dose tests should be developed for them and for parathion-methyl if this insecticide continues to be used.

7 Acknowledgements

Thanks to Peter Workman and Rebecca Bush for help with rearing the thrips and conducting the insecticide experiments, and to Richard Wood for finding thrips populations for testing.