TOWARDS INTEGRATED PEST MANAGEMENT OF *THRIPS TABACI* IN ONIONS

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ABSTRACT

Populations of onion thrips, *Thrips tabaci*, and their natural enemies were monitored in small field plots of onions to which standard insecticide (methamidophos, endosulfan and chlorpyrifos), selective insecticide (imidacloprid and spinosad), organic (YR015) insecticide or no insecticide treatments were applied. The mean number of thrips per plant was kept below 12 in the standard and selective treatments. The numbers of thrips in the organic and no insecticide treatments were comparable, reaching over 60 thrips per plant. This resulted in increased plant damage and shorter leaves. High rainfall in 2001-02 coincided with a reduction in thrips numbers in untreated plots, which peaked at 70 thrips per plant, compared with nearly 500 thrips per plant in the drier 2000-01 season. Natural enemies observed in the unsprayed and organic treatments included *Ceranisia menes*, *Aeolothrips fasciatum*, *Buchananiella whitei*, syrphids and entomogenous fungi. None of these natural enemies increased sufficiently to provide effective thrips control. No natural enemies were found in the standard or selective insecticide treated plots.

Keywords: *Thrips tabaci*, onions, insecticides, biological control, rainfall.

INTRODUCTION

High populations of onion thrips (*Thrips tabaci* Lindeman (Thysanoptera: Thripidae)) can damage the leaves of onions (*Allium cepa* L.) in the field resulting in reduced crop yields (Edelson et al. 1989). If there are high populations of thrips on leaves when the crop is lifted, the thrips can invade the onion bulbs during curing, entering through the neck or splits in the skin. Once in the onion the thrips feed and breed on the fleshy scales. Damage to the bulb can continue during storage and in transit to export markets, lowering the quality and value of the onions.

In 1998 growers and advisors reported that synthetic pyrethroid insecticides were failing to control onion thrips in crops of onions (R. Wood, pers. comm.). Laboratory bioassays confirmed that onion thrips populations from South Auckland and Canterbury were resistant to the synthetic pyrethroid deltamethrin, and the South Auckland populations were also resistant to the organophosphates diazinon and dichlorvos (N.A. Martin & P.J. Workman, unpubl.data).

In response to the initial failure of insecticides, the onion industry developed an insecticide resistance management strategy which incorporates monitoring and action thresholds but still largely relies on the judicious use of insecticides. In 2001 *Ceranisia menes* Walker 1839 (Hymenoptera: Eulophidae), a parasitoid of thrips larvae, was found parasitising *T. tabaci* on onions after insecticide applications ceased. *Ceranisia menes*, a self introduced parasitoid of cosmopolitan distribution, was first recorded in New Zealand by Valentine (1967). This paper reports the incidence of *C. menes* and other naturally occurring natural enemies of onion thrips in small plots of onions that were either untreated or sprayed with standard, selective or organic insecticides. The effects of insecticides, rainfall and natural enemies on onion thrips populations are also discussed.

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METHODS

Four beds of onions (cv. Pukekohe Long Keeper), five rows wide, at the Pukekohe Research Centre, were divided into a 4x4 Latin square, with the plots (15 m long) allocated to four treatments. These were standard insecticide, selective insecticide, organic insecticide or no insecticide (Table 1). The onions were planted in May 2001, and thrips, aphid and natural enemy numbers were monitored each week (11 October 2001 – 2 January 2002) by counting the total numbers of insects on 10 plants from each plot. Insecticide applications began on 18 October and each insecticide was applied once a week for 4 weeks, except in the organic treatment where YR015 was applied each week throughout the trial, making a total of 10 applications. Citowet (25 ml/100 litres) was added to all insecticide treatments except for the oil based YR015. Insecticides were applied with a backpack sprayer and a hand held boom (626 mm) with three “Teejet®” flat spray tip (xr11004VP) nozzles at 300 mm spacing. All of the treatments received regular fungicide applications throughout the trial. The extent of feeding damage caused by the thrips was recorded by measuring the longest green leaf of 10 onion plants in each replicate starting in row 2 with the 5th onion and sampling every 10th onion along the row. Daily rainfall data were obtained from the Pukekohe Research Station. The data of mean thrips per plant and leaf length were subjected to analysis of variance. Samples of *Ceranisus menes* have been deposited in the New Zealand Arthropod collection, Landcare Research, Auckland.

TABLE 1: The products used in the organic, selective and standard insecticide treatments.

Treatment	Insecticide (product)	Concentration (formulation)	Rate of application (in 100 litres) ¹	Dates applied (number of applications)
Organic	YR015	Experimental product	250 ml	18 Oct-19 Dec (10 applications)
Selective	imidacloprid (Confidor)	50 g ai/kg (emulsifiable concentrate)	50 ml	18 Oct- 8 Nov (4 applications)
Selective	spinosad (Success)	120 g ai/litre (suspension concentrate)	80 ml	15 Nov-5 Dec (4 applications)
Standard	methamidophos (Tameron)	600 g ai/litre (soluble concentrate)	150 ml	18 Oct- 8 Nov (4 applications)
Standard	endosulfan (Thiodan)	350 g ai/litre (emulsifiable concentrate)	200 ml	15 Nov-5 Dec (4 applications)
Standard	chlorpyrifos (Lorsban)	500 g ai/litre (emulsifiable concentrate)	200 ml	12 Dec-19 Dec (2 applications)

¹ To each 22.5 m² plot, 3.75 litres of this solution was applied.

RESULTS AND DISCUSSION

Natural enemies

Ceranisus menes was first observed in the organic treatment on 18 October, but was not found regularly in the organic insecticide and non-insecticide treatments until 15 November (Table 2). Populations of this parasitoid remained low and peaked with an average of 0.28 parasitoids per plant in the non-insecticide treatment at the end of the trial. No natural enemies were found in standard insecticide treatments

apart from 0.3 *C. menes*/plant in the week after spraying finished. Other natural enemies observed in the non-insecticide and organic insecticide treatments were syrphid larvae (highest population 0.1 per onion) and occasionally the predator *Aeolothrips fasciatum* Linnaeus (Thysanoptera: Aeolothripidae). No natural enemies were found in the selective or standard insecticide treatments where insecticides were applied. *Buchananiella whitei*, Reuter (Hymenoptera: Anthrocoridae), an indigenous predator, occurred in low numbers when spraying had ceased. The entomogenous fungus, *Neozygites pavispora*, was also observed infesting adult thrips but treatment effects were not assessed. The number and variety of parasitoids and predators in the organic treatment, YR015, was similar to that in the non-insecticide treatment. Imidacloprid and spinosad, the insecticides chosen for the selective insecticide treatment appear to be harmful to all the predators and parasites that occurred in this trial.

In other countries *C. menes* has given variable control of *T. tabaci* in onions. In Rajasthan, India, 12-18% parasitism of *T. tabaci* in onion fields was reported (Saxena 1971). This parasitoid occurs regularly in *T. tabaci* on onion in Italy and Bulgaria but only in low numbers in onion fields in Central Europe (Loomans et al. 1995). Research in Japan showed that *C. menes* was present in onion crops when the average monthly temperatures were above 20°C, and while *C. menes* populations were not high enough to be an efficient mortality factor early in the season, by the end of the season onion thrips populations were kept in check with almost 100% parasitism (Sakimura 1937). *Ceranis menes* can also parasitize the larvae of many other thrips species including *Frankliniella occidentalis* Pergande (Thysanoptera: Thripidae) and *F. intonsa* Trybom (Thysanoptera: Thripidae).

TABLE 2: The mean number of natural enemies per onion plant in the untreated, organic and selective insecticide treatments¹. (*Cm* = *C. menes*, *Af* = *A. fasciatum*, *S* = syrphid larvae and *Bw* = *B. whitei*.)

	No Insecticides				Organic Insecticides				Selective Insecticides			
	<i>Cm</i>	<i>Af</i>	<i>S</i>	<i>Bw</i>	<i>Cm</i>	<i>Af</i>	<i>S</i>	<i>Bw</i>	<i>Cm</i>	<i>Af</i>	<i>S</i>	<i>Bw</i>
11 Oct												
18 Oct					0.03		0.03					
24 Oct												
1 Nov												
8 Nov					0.08		0.08					
15 Nov	0.08		0.08		0.05		0.05					
21 Nov	0.10	0.03	0.10		0.13		0.13					
28 Nov	0.05		0.08		0.03	0.03	0.03					
5 Dec			0.05		0.03		0.03		Last spray			
12 Dec	0.10		0.10		0.10		0.1					
19 Dec	0.10				0.13	Last spray			0.03			
2 Jan	0.28			0.03	0.15			0.13	0.20			0.03

¹Standard insecticide treatment data are not shown as there was only 0.3 *Cm*/plant in the week beginning 2 January, the week after spraying had ceased.

Control of thrips with insecticides

Both the standard and selective insecticide treatments gave good control of thrips, and the mean numbers of thrips remained below 12/plant. From 12 October to 12 December thrips numbers in the standard and selective insecticide treatments were less than the non-insecticide treatment ($P < 0.05$) (Fig. 1). The organic treatment, Y015, did not reduce thrips populations as numbers of thrips were comparable with thrips numbers in the untreated

plots. The numbers of thrips per plant in the organic and untreated plots reached over 60 thrips (Fig.1). This resulted in increased leaf damage, with the mean length of green leaf at the beginning of top-fall (20 December 2001) being significantly shorter in the organic insecticide (282 mm) and non-insecticide (317 mm) treatments than in the standard insecticide (460 mm) and selective insecticide (455 mm) treatments ($P < 0.01$).

Aphids were the only other pest noted on plants in the trial plots. All of the insecticide treatments appeared to give good control of aphids. At the end of the trial the mean number of aphids per plant in the control treatment was 15.5, while it was 0.3, 0.03 and 0.05 for the organic insecticide, selective insecticide and standard insecticide treatments respectively.

FIGURE 1: The mean number of thrips (adults and larvae) on onions with no insecticide, organic insecticide, selective insecticide and standard insecticide treatments. Arrows indicate time of treatment, and the chemical applied for selective, standard and organic insecticides respectively is noted above the arrows.

Effect of rainfall on thrips in onions in the non-insecticide treatment

Between 29 October and 8 November there was rain on 9 of the 11 days, with a total of 94.7 mm rainfall being recorded. During this period the numbers of thrips larvae in the untreated plots declined. A second reduction in larval numbers occurred after 62.5 mm of rainfall on 23 November. High rainfall events during December may also have accounted for the continuing decline of thrips larvae, but onion plants also stopped growing over this period and reduced larval numbers may be partly attributable to the declining food value of the onion leaves. Adult thrips populations were much lower than larval numbers, with large rainfall events, as on the 23 November, being associated with a decline in adult numbers.

The high rainfall experienced during this trial may have contributed to the low infestation levels of thrips on onion plants in the untreated plots. Thrips populations on onions in the unsprayed treatment, peaked with an average of 71.9 thrips per plant. This was much lower than observed on onions at the same site in the drier 2000-01 season, when thrips populations peaked at nearly 500 thrips per plant. Total rainfall for November and December 2000 was 142.2 mm, while for the same period in 2001 total rainfall was 293.9 mm. While this trial was not designed to determine the effect of climate on thrips populations, other researchers have also observed that heavy rainfall can reduce thrips infestations on onions. Ferrari (1980) observed that *T. tabaci* infestations on onions were heavier in drought conditions and that heavy rainfall caused up to 70% mortality of the thrips. Domiciano et al. (1993) noted that onion thrips populations increased more rapidly in the absence of rain. High rainfall may also have been responsible for

FIGURE 2: Weekly onion thrips infestation on onions with no insecticide compared with daily rainfall.

the low numbers of natural enemies found during this trial. Saxena (1971) reported that *C. menes* was absent during the wet season in Rajasthan, India.

CONCLUSIONS

The organic insecticide, YR015, allowed natural enemies to persist but it failed to reduce thrips populations. Imidacloprid and spinosad decreased thrips populations, but weekly applications prevented the development of natural enemies. Natural enemies cannot be included in integrated pest management programmes for onions unless methods are found to maintain and increase their incidence in onion crops in the presence of effective selective insecticides.

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