**LABORATORY SCREENING OF NOVEL COMPOUNDS
AGAINST GREENHOUSE THRIPS
*HELIOTHRIPS HAEMORRHOIDALIS***

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ABSTRACT

The efficacy of seven chemicals against greenhouse thrips, *Heliothrips haemorrhoidalis*, a pest of citrus and other crops, was investigated in a series of laboratory trials. Chlorpyrifos, pyrethrum/piperonyl butoxide, abamectin/mineral oil, and imidacloprid gave 93-100% mortality to all thrips stages in a 1 day toxicity test. In the same test, mineral oil, sabadilla sugar bait, and low biuret urea gave 49, 13 and 7% mortality respectively. Imidacloprid gave 98.5% control of thrips in a systemic trial when stems with infested leaves were placed in treated solutions for 14 days. Both sabadilla sugar bait and urea failed to control thrips after 14-29 days on treated leaves and fruit. Chlorpyrifos, pyrethrum, imidacloprid and abamectin/mineral oil showed the most promise for control of greenhouse thrips.

Keywords: greenhouse thrips, *Heliothrips haemorrhoidalis*, citrus, insecticides, integrated pest management

INTRODUCTION

The feeding activities of thrips on citrus fruit result in unacceptable scarring of the epidermis with a consequent downgrading of fruit. A complex of several thrips species are present on citrus in New Zealand. Holt (1989) found that both the greenhouse thrips *Heliothrips haemorrhoidalis* (Bouché) and *Megalurothrips kellyanus* (Bagnall) were important damaging agents on grapefruit at an Auckland site. Control of thrips on citrus in New Zealand currently involves the application of organophosphorus insecticides. However, routine applications of organophosphorus insecticides may induce mite and scale problems on citrus.

A number of novel insecticides, which are being trialled or have registration for use to control thrips on citrus in overseas countries and may be compatible with integrated pest management or organic programmes on citrus, were considered for evaluation in New Zealand.

Abamectin is produced from a naturally occurring soil micro-organism and is chemically unrelated to any other commercially available acaricide or insecticide. Abamectin gave control of *Scirtothrips citri* (Moulton) on Californian citrus. It is recommended in combination with a narrow range oil (Dybas 1989). Sabadilla is a botanical extract of the seed of the lily *Schoenocaulon officinale*. It is mixed with sugar and then applied at low rates as a bait. It is currently registered for use against *S. citri* on Californian citrus (Luck *et al.* 1986). The pyrethrum and piperonyl butoxide mixture is a fast acting organic insecticide which is acceptable for Bio-Gro certification and organic production as it is produced from plant extracts. Foliar applied urea was considered to reduce citrus scarring by *Scirtothrips aurantii* Faure in South Africa (Grout and Richards 1988). Imidacloprid, a new chemical belonging to the nitroguanidine group, is a systemic insecticide with a broad spectrum of activity and low toxicity. Imidacloprid has given control of *S. aurantii* in South Africa (Buitendag and Naudé 1992; Broeksma *et al.* 1993). Mineral oil (D-C-Tron) is representative of

Proc. 48th N.Z. Plant Protection Conf. 1995: 143-148

the narrow range mineral oils commonly used on citrus for the control of scales, mites, aphids and thrips. Chlorpyrifos was chosen as an example of an organophosphorus insecticide and as an industry standard. The objective of these laboratory studies was to investigate short-term contact toxicity, residual toxicity and effects of longer term exposure, as well as systemic toxicity on different life stages of the greenhouse thrips.

METHODS

Contact toxicity trial

Individual leaves of the strawberry tree (*Arbutus unedo*) infested with high numbers of mixed-age populations of greenhouse thrips were enclosed in a small square (150 x 150 mm) of a fine mesh material (voile) to form a loose bag which was secured with a plastic tie. The leaf and voile bag were dipped in the test solution or a water control for 5 seconds with gentle agitation. After dipping, the bags were placed on paper towels to absorb excess moisture and then on top of a filter paper inside a plastic pottle (200 ml). Pottles were covered with a Petri dish to prevent escape of thrips. Leaves were held at 20°C and 75-80% RH for 1 day before assessing thrips mortality and growth stage under a microscope. Thrips were prodded with a pin to determine if they were dead or moribund. All thrips were assessed irrespective of whether they were on the leaf, bag or pottle.

Ten thrips-infested leaves were dipped in each test solution and initially five leaves were assessed for each treatment. Additional leaves were assessed where the total numbers of thrips were less than 140. All ten leaves were examined for the untreated and urea full rate treatment irrespective of thrips numbers. An analysis of variance of percentage mortality for each thrips stage, weighted according to the numbers of thrips assessed for each repeat, was used to estimate means and standard errors.

Leaf systemic and long term efficacy trial

Stems (20-25 cm) of the strawberry tree with leaves infested with mixed-age populations of greenhouse thrips were placed in a small container of water inside a liver pail. Imidacloprid treatments were incorporated with the water so that it could be transferred systemically to the leaves. Urea and sabadilla sugar treatments were sprayed onto the leaves using a hand sprayer to give low volume coverage. Stems of untreated leaves were placed in water. There were three replicates of each treatment. Leaves were held at 20°C and checked at regular intervals. The number of thrips alive or dead on the leaves, thrips stage and number of thrips which had dropped off into the liver pail were assessed after 14 days. An analysis of variance of arcsine transformed percentages was used to determine statistical significance between treatments.

Fruit residual activity trial

Mature tangelos were picked from an unsprayed orchard block the day before applying treatments. Tangelos were dipped for 5 seconds in 150 ml of a 1% urea solution in a 250 ml beaker. Untreated fruit were dipped in water. Fruit were allowed to dry after which a barrier of grease (Tangelfoot) was applied in a circle (30 mm diameter) to form a test arena on the blossom-end of the fruit. Individual fruit were placed in a plastic container with the test arena upwards. Using a blunt piece of wire, approximately 20 droplets of the sabadilla sugar bait treatment were applied evenly across the test arena. Fifteen small immature greenhouse thrips of approximately the same development stage were inoculated onto the test arena of each fruit. Fruit were held at 21±1°C. There were five replicates for each treatment. Detailed assessments of thrips were carried out after 2, 9 and 26 days. An analysis of variance of arcsine transformed percentages was used to distinguish significance between treatments.

Feeding on sucrose trial

Drops of red and blue food colouring (Hansells) were mixed with a 3% and a 30% sucrose solution. Droplets of red or blue sucrose solutions were placed on leaves or in Petri dishes containing greenhouse thrips. At intervals up to 10 days immature thrips were examined under a microscope for evidence of red and blue colouration in their gut contents and excretion droplets.

RESULTS

Contact toxicity trial

An average of 67 small nymphs (SEM 2), 38 large nymphs (wingbud stages) (SEM 7) and 103 adults (SEM 7) were assessed per treatment. There was little difference in treatment mortalities between small, large nymphs and adults (Table 1). Thrips mortalities for the urea and sabadilla treatments were not significantly different from the untreated. All other treatments gave significantly ($P < 0.001$) greater mortalities, combined over all stages, than did the untreated.

TABLE 1: Toxicity of chemicals to greenhouse thrips 1 day after dipping thrips infested leaves.

Treatment	Rate (g ai/100 litres or %)	Small nymphs	% Mortality ($\pm$ SE) Large nymphs	Adults	Total
chlorpyrifos	25	100	100	100	100
(Lorsban 50 WP)	12.5	97 (3)	100	100	99 (1)
pyrethrum/piperonyl butoxide	7/28	100	100	100	100
(Yates Pyrethrum)	3.5/14	100	100	100	100
abamectin/mineral oil	0.76/0.5%	98 (2)	86 (5)	94 (5)	93 (4)
(Abamectin/D-C-Tron)	0.38/0.25%	100	100	100	100
imidacloprid	150	100	100	98 (2)	98 (2)
(Confidor 350 SC)	75	36 (10)	18 (7)	47 (7)	42 (7)
mineral oil	2%	58 (7)	10 (6)	51 (8)	49 (7)
(D-C-Tron)	1%	27 (8)	9 (3)	44 (9)	31 (6)
sabadilla alkaloids/sugar	30/3%	14 (5)	7 (4)	15 (7)	13 (5)
(Red Devil Sabadilla/sucrose)	15/1.5%	5 (4)	0	26 (8)	18 (6)
urea	1%	5 (2)	3 (1)	12 (5)	7 (2)
(BASF low biuret Urea)	0.5%	6 (4)	0	6 (5)	4 (3)
untreated	-	3 (1)	0	10 (5)	5 (2)

FIGURE 1: Numbers and stage of live thrips remaining on leaves 14 days after treatment (SED total thrips = 182).

Leaf systemic and long term efficacy trial

An average of 110 leaves (SE 5) were assessed per treatment and 1485 live and dead thrips (SE 64) were recovered from the untreated, urea and sabadilla treatments. In contrast, there were only 645 thrips recovered from the imidacloprid treatment.

The numbers of live thrips present on the leaves and recovered from the liver pail are presented in Fig. 1. Untreated leaves had a total of 1159 live thrips/100 leaves with 45% small nymphs, 26% large nymphs and 29% adults. The urea and sabadilla sugar treatments had similar total numbers of live thrips to the untreated but the proportion of each stage varied. In marked contrast the imidacloprid treatment had only 14 live thrips remaining which gave 99% control relative to the untreated.

The imidacloprid treatment gave a significant ($P < 0.001$) increase in the mortality of all thrips stages on the leaves and also gave a significant ($P < 0.05$) increase in the 'drop-off' of small nymphs and all stages compared to the untreated (Table 2). The numbers of large nymphs remaining in the imidacloprid treatment were too low to accurately determine effects on this stage. The urea and sabadilla sugar treatments were not significantly different from the untreated leaves in terms of mortality and drop off.

TABLE 2: The mortality and drop off of greenhouse thrips 14 days after treatment of leaves

Treatment	Rate (g ai/100 litres or %)	Small nymphs	Large nymphs	Adults	All stages
Mortality on leaves (%)					
imidacloprid	150	96	33	74	73
sabadilla/sugar	30/3%	2	1	8	3
urea	1%	4	0	4	2
untreated		0	0	3	1
SED (approx)		6.2	18.3	4.4	3.9
Drop off (%)					
imidacloprid	150	90	39	89	88
sabadilla/sugar	30/3%	9	1	56	30
urea	1%	39	0	70	37
untreated		10	2	37	21
SED (approx)		19.0	11.2	14.6	12.1

Fruit residual activity trial

There were no obvious differences in the development stages of thrips between treatments. On average, over all treatments after 9 days, 43% were large nymphs with wingbuds and the remainder small nymphs. After 26 days all remaining live thrips were adults. During the course of the trial 3% of the initial starting population became trapped in the Tangelfoot barrier after 9 days and 18% after 26 days. A further 12 and 20% of the initial starting population was not recovered after 9 and 26 days respectively. Many of the thrips that were lost from the test arena may have flown away as adults or dead bodies were not found.

There was no significant difference between the survival of thrips on treated and untreated fruit (Table 3). The sabadilla sucrose bait spots were observed to have dried up after 9 days.

Feeding on sucrose trial

Thrips that were feeding on untreated leaves commonly had a dark black-green colouration of the gut contents and carried a similar coloured droplet balanced on the anal area. The red dye was therefore more readily detectable than the blue dye. Sufficient nymphs with red coloured gut contents were observed to confirm that they

did feed on the sucrose solutions. However the technique was not considered robust enough to justify quantifying the level of feeding by the thrips population. The 3% sucrose droplets dried out over a period of 1-2 days and required reapplication whereas the 30% sucrose droplets remained for at least 10 days.

TABLE 3: The residual effect of an urea dip and a sabadilla sucrose bait applied to tangelo fruit on the survival of immature thrips.

Treatment	Rate (g ai/100 litres or %)	Live thrips remaining on tangelos (%)		
		2 days	9 days	26 days
urea	1%	97	97	60
sabadilla/sugar	30/3%	93	76	40
untreated		93	89	39
SED (approx)		9.6	7.1	17.1

DISCUSSION

The sabadilla sugar treatment was found to be ineffective at controlling thrips when tested either as a bait both on leaves and fruit or in the direct contact toxicity trial. Although there was evidence that thrips would feed on dyed sucrose it was impossible to determine how frequently or what proportion of the population fed on the sucrose. The small droplets of 3% sugar solution dried out and this may reduce feeding opportunities when used as a bait. Our results suggest that either the feeding behaviour of greenhouse thrips differs from *S. citri* or that sabadilla is relatively innocuous.

There was no evidence that foliar urea applications affected greenhouse thrips either in contact or residual trials. This was in contrast to preliminary studies by Californian research workers who found that the high levels of ammonia given off by foliar-applied urea applications gave significant mortality of *S. citri* first instar nymphs.

The pyrethrum mixture gave a high level of contact activity. However, the effects on non-target insects will need to be carefully considered as the closely related pyrethroid sprays are generally not recommended on citrus because of the risk of mite or scale outbreaks.

The abamectin and mineral oil mixture has recently been registered for use against thrips on Californian citrus (Morse 1994). Only a single application per season is allowed to reduce the risk of development of citrus thrips resistance. The monitoring of thrips and predacious mites is essential to correctly time the treatment. The damage threshold for thrips and the occurrence of natural predators in New Zealand is unknown. In order to successfully use strategically timed single applications of abamectin an increase in basic information on thrips on citrus will be required.

The use of systemic insecticides such as imidacloprid applied either as a trunk treatment (injection or painted) or soil treatment may be compatible with integrated pest management. Applying insecticides via the sap stream of the tree means that only phytophagous insects are affected whilst protecting predators and parasites. The imidacloprid treatment may require several days for the chemical to move to the outer foliage and fruiting regions of the tree. The residual effect of imidacloprid against pests is likely to last several weeks. The effect on fruit residues at harvest will need to be evaluated.

Chlorpyrifos, pyrethrum, imidacloprid and abamectin/mineral oil showed the most promise for control of greenhouse thrips with the last two materials having the most potential to be compatible with integrated pest management on citrus. Of the latter two materials, imidacloprid may be more robust for use by growers and may give control over a longer period of time. Abamectin may require more precise timing to obtain optimum control of thrips. Neither of these materials currently has registration on citrus in New Zealand.

ACKNOWLEDGEMENTS

Our thanks to Mrs J.M. Kelly for technical assistance, Mrs B.W. Dow for assistance with statistical analyses, and to the citrus sector research committee for financial assistance.

REFERENCES

- Broeksma, A., Robbertse, E. and Saba, F., 1993. Field trials with Confidor (imidacloprid) for the control of various insect species on citrus in the Republic of South Africa. *Pflanzenschutz-Nachrichten Bayer* 46: 5-32.
- Buitendag, C.H. and Naudé, W., 1992. Insecticide stem treatments for the control of citrus pests. *Citrus Journal* 2: 36-39.
- Dybas, R.A., 1989. Abamectin use in crop protection. Pp. 287-310. *In: Ivermectin and Abamectin*, W.C. Campbell (Ed.); Springer-Verlag, New York.
- Grout, T.G. and Richards, G.I., 1988. Annual report on research for the period August 1987 to July 1988. Entomology Section, Citrus Exchange, Port Elizabeth, South Africa.
- Holt, V.A., 1989. Pest status and inter-relationships between three species of thrips, (Thysanoptera: Terebrantia) *Heliothrips haemorrhoidalis*, *Megalurothrips kellyanus*, and *Thrips obscuratus*, present on citrus in the Auckland area. M.Sc. Thesis, University of Auckland.
- Luck, R.F., Morse, J.G. and Moreno, D.S., 1986. Current status of integrated pest management in California citrus-groves. Pp. 533-542 *In: Integrated Pest Control in Citrus-groves*. R. Cavalloro and E. Di Martino (Eds.). A.A. Balkema, Rotterdam.
- Morse, J.G., 1994. Controlling citrus thrips with abamectin. *Citrograph*, April: 12-13.