A NEW INSECT GROWTH REGULATOR, CGA 59205, WITH PROMISING ACTIVITY AGAINST SCALE INSECTS

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SUMMARY

Laboratory and field trials were conducted to evaluate CGA 59205 to control scale insects. In the laboratory, CGA 59205 used at 0.03-0.20 g/litre stopped most first and second instars moulting but did not hinder development of third instar greedy scale (*Hemiberlesia rapax*). Immature third instar greedy scale treated with CGA 59205 produced significantly ($P < 0.001$) fewer crawlers, with highest rates almost completely stopping crawler production. Monthly field applications of CGA 59205 to citrus trees reduced leaf infestation by *Ceroplastes sinensis* and *Saissetia* sp.

Keywords: CGA 59205, citrus, greedy scale, *Hemiberlesia rapax*, *Ceroplastes sinensis*, *Saissetia* sp.

INTRODUCTION

In New Zealand, scale insects are key pests of a number of fruit crops with particular importance on citrus and kiwifruit. At present, these pests are mainly controlled by regular applications of organophosphate insecticides. However, in several major citrus growing regions overseas, organophosphates can no longer be used to manage some species of scale insects due to resistance. Carmean (1988) has suggested that insect growth regulators are the most promising group of insecticides to replace organophosphates for managing scale insects. They have the additional advantage of relatively low toxicity to natural enemies which may assist the development of Integrated Pest Management (IPM) systems.

A potentially suitable insect growth regulator discovered by Ciba Geigy, is CGA 59205, which is a dioxaline derivative that mimics juvenile hormone activity. CGA 59205 has activity against scale insects and the eggs of some species of Lepidoptera and low toxicity to pest natural enemies including predatory mites. It is neither systemic nor translaminar but has slight vapour activity.

This paper reports on laboratory and field trials conducted to evaluate CGA 59205 against various species of scale insects.

METHODS

Laboratory bioassays

Three bioassays were conducted to determine the effect of CGA 59205 on different instars (first, second or immature third) of greedy scale (*Hemiberlesia rapax*). Each bioassay had six treatments (Table 1), replicated six times with the basic unit being a potato infested with at least 30 greedy scale.

Potatoes were infested with greedy scale by exposing them for 3 days to a laboratory colony which was actively producing crawler stages (first instar). Treatments were applied by dipping potatoes into agitated solutions for 5 seconds, before air drying. Water plus Citowett (at 0.25 ml/litre) was used as the control. Potatoes were then individually placed in plastic pottles, fitted with gauze lids and held in a controlled environment room at 25°C, 55 - 75% RH and 16:8 photoperiod. For the bioassays treating second or third instar greedy scale, the scale-infested potatoes were held under the same controlled environment conditions both before and after treatment.

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Assessments were timed using thermal heat requirements (Greaves *et al.* 1994) to coincide with a stage when most insects would have reached later instars or maturity. Scale stage and mortality were recorded. During all assessments, third instar greedy scale were divided into the three substages described by Ferguson (1974); young immature, older immature and mature scale insects.

Greedy scale treated as immature third instars were examined twice. During the first assessment, an average of 7 (range 2-12) scale per potato that had settled individually and which were considered likely to mature and produce crawlers were selected and numbered. A barrier was then placed around each scale to prevent crawlers escaping and the scale were left until crawler production ceased before the numbers of crawlers per scale were counted.

Data on the proportions of scale in different instars were analysed using logit regression. Control data were often excluded from analyses because of their obvious difference from all other treatments, and to enable better comparison between the CGA 59205 treatments. The numbers of crawlers produced by treated third instar greedy scale were analysed using residual maximum likelihood because of differences between potatoes in the numbers of suitable scale insects available. Analyses were conducted separately for the numbers of crawlers found beneath or outside the scale cap after differences were noted among treatments in the location of crawlers during assessment.

Field trials

Two field trials were conducted on blocks of mature Miyagawa Satsuma mandarin trees located at Gisborne and on tangelo trees at Matangi near Hamilton. Trees at both orchards had not been treated with insecticides in the previous season.

The rates and timing of the applications used are listed in Table 2. Methidathion was included as a standard. Spreader/sticker (Citowett or Multifilm at 25 ml/100 litres) was used, with another insect growth regulator, fenoxycarb, included for comparison. All treatments were applied at a water rate of 2000 litres/ha using a CO₂ pressurised precision backpack sprayer, fitted with four D2-45 nozzles and operating at 500-600 kPa. A randomised complete block design was used with five replicates of single tree plots.

Scale infestation was determined at the end of the season by randomly sampling 20 mature leaves from throughout each tree. The proportion of leaves infested and the number of scale per 20 leaves was determined. Data were analysed with a generalised linear model with binomial errors for the proportion of leaves infested and Poisson errors for the number of scale insects per 20 leaves.

RESULTS

Laboratory bioassays

All CGA 59205 treatments prevented most first instar greedy scale moulting. Only 2% of first instars treated with the lowest rate (0.03 g/litre) had moulted to become second instars by 31 days after treatment. Later assessments, 48 and 69 days after treatment, showed these insects developed no further and died, with none reaching the third instar. By comparison, at 48 days after treatment, 80% of the scale insects in the untreated control had reached the third instar and 18% of these were in the older immature stage of development.

The effect of CGA 59205 on second instars was similar to that found with first instars. None of the scale treated as second instars with CGA 59205 at all rates had reached the third instar 57 days after treatment whereas by this time in the controls 47% and 37% were older immature or mature third instars respectively.

Examination of greedy scale 14 days after treatment as third instars showed that between 15-63% of the scale insects had matured from young immature into the next stage (older immature). There were no significant differences between treatments in the relative proportions of the scale insects which were found in the two developmental stages.

Crawlers were found both under the mother scale caps and outside the caps, trapped by the barrier placed around each scale insect. In the untreated control, most

crawlers were found outside the mother scale cap, but in the CGA 59205 treatments the proportion outside the mother scale cap decreased with increasing rates.

CGA 59205-treated greedy scale reduced crawler production. So few crawlers were found on the potatoes treated with the three highest rates of CGA 59205, that these data were excluded from the analyses, although they are shown in Table 1. No significant differences in numbers of crawlers beneath the scale caps were found between the untreated and CGA 59205 at 0.03 or 0.05 g/litre treatments. However, the numbers of crawlers outside the caps, differed significantly ($P < 0.001$) between these three treatments.

TABLE 1: Number¹ of first instars found underneath or outside the cap of mature greedy scale treated with CGA 59205 as immature third instars.

Rate (g ai/litre)	Total no. of mother scale	No. of first instars		% outside cap
		under cap	outside cap	
0.20	49	0.1 (0.41)	0.2 (0.09)	15
0.15	31	0 (0.53)	0 (0)	0
0.10	41	0 (0.28)	0 (0)	0
0.05	45	0.3 (0.79)	3.6 (0.31)	17
0.03	41	1.4 (1.04)	11.2 (1.34)	51
0	47	3.1 (1.03)	39.2 (3.15)	88
SED ²		(0.24)	(0.33)	

¹ Raw means with log_e of number of crawlers in brackets.

² This SED value applies only for comparison of control and CGA 59205 at 0.05 and 0.03 ml/litre.

TABLE 2: Percentage (±se) of citrus leaves infested by soft scale insects for 20 leaves sampled at Hawkes Bay and Matangi on 1 July and 22 June 1993 respectively.

Treatment ¹	Rate (g ai/ 100 litres)	Chinese wax scale		<i>Saissetia</i> sp.	
		Hawkes Bay	Matangi	Hawkes Bay	Matangi
unsprayed	-	9.0 (2.7)	7.0 (2.5)	22.0 (4.0)	10.0 (2.9)
methidathion (Supracide)	50	0	0	1.0 (1.0)	
fenoxycarb (Insegar 25WP)	10	3.0 (1.7)	1.0 (1.0)	1.0 (1.0)	4.0 (1.9)
CGA 59205 (250SC)	10	4.0 (1.9)	4.0 (1.9)	2.0 (1.4)	2.0 (1.4)
	20	0	1.0 (1.0)	1.0 (1.0)	0

¹ Applications for Hawkes Bay and Matangi respectively were; 9 December 1992, 5 January, 3 February, 2 March, 5 and 30 April 1993; 7 January, 4 and 24 February, 23 March, 20 April 1993.

Field trials

All insecticide treatments significantly reduced leaf infestation by the two scale species present at both sites (Chinese wax scale, *Ceroplastes sinensis*) and *Saissetia* sp. (probably black scale, *S. oleae*) (Table 2). At Hawkes Bay, there was a significantly lower proportion of leaves infested with Chinese wax scale on trees treated with

methidathion and the highest rate of CGA 59205 than on unsprayed trees ($P < 0.01$). At Matangi, only the methidathion-treated trees had significantly fewer Chinese wax scale infested leaves, compared to the unsprayed trees ($P < 0.001$).

For *Saissetia* sp., the proportion of unsprayed leaves infested with this scale species was significantly higher than all insecticide treatments at Hawkes Bay, and all, except fenoxycarb-treated trees, at Matangi. The same trends were found between treatments in the number of scale insects per 20 leaves, except that significantly fewer *Saissetia* were also found on fenoxycarb-treated than unsprayed tree leaves at Matangi. Fewer Chinese wax scale (up to 3/leaf) than *Saissetia* (up to 8/leaf) were found on individual leaves. The two scale species also had different settling sites, with most *Saissetia* found beside the midrib on the lower leaf surface, whereas Chinese wax scale settled on the upper leaf surface.

DISCUSSION

The laboratory bioassays demonstrated that CGA 59205 affected greedy scale by disrupting moulting between instars, and by interfering with crawler production. This insecticide appears to have superior activity, at least at the rates tested, to that shown for fenoxycarb in other trials (Tomkins 1992). The ability of CGA 59205 to stop crawler production is important as this will enable the prevention of fruit infestation. Even when crawlers were produced they appear to have either died or were unable to escape from under the mother scale cap.

The field trials provided some preliminary data to show that CGA 59205 also has activity against soft scale insects. In these trials no attempt was made to time applications of CGA 59205, and it is probable that with better timing, this insecticide can be used to manage scale insects to the level required for export crops. It will require laboratory bioassays against the scale insect species infesting citrus trees to enable the development of a timing strategy.

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REFERENCES

- Carmean, L., 1988. Managing pesticide resistant red and yellow scale. *Citrograph* 73(7): 142.
- Ferguson, A.M., 1974. Biology of greedy scale, *Hemiberlesia rapax* (Comstock) on kiwifruit, *Actinidia chinensis*. *Proc. Kiwifruit Seminar, MAF Tauranga*: 20-26.
- Greaves, A.J., Davys, J.W., Dow, B.W., Tomkins, A.R., Thomson, C. and Wilson, D.J., 1994. Seasonal temperatures and then phenology of greedy scale populations (Homoptera: Diaspididae) on kiwifruit vines in New Zealand. *N.Z. J. Crop & Hort. Sc.* 22: 7-16.
- Tomkins, A.R., 1992. Evaluation of an insect growth regulator, fenoxycarb, for greedy scale control on kiwifruit. *Acta Hort.* 297: 517-522.