Note

Miticidal Activity of a New Organotin Compound against Tetranychidae Species

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INTRODUCTION

Phytophagous spider mites cause heavy damage to the citrus, apple, tea, strawberry and many other horticultural crops. One effective means of control is with chemicals. However, resistance to a variety of miticides has become a serious problem worldwide, and new potent miticides are needed.

We assayed the miticidal activity of various types of organotin compounds against spider mites. The properties of bis(2-methyl-2-phenylpropyl)-2-trimethylsilylmethyl stannyl chloride, which is the most potent among the compounds, are reported here.

MATERIALS AND METHODS

1. Chemicals

Bis (2-methyl-2-phenylpropyl)-trimethylsilylmethyl stannyl chloride (code name: SSI-121) was synthesized with a purity of 99%. For bioassay, technical SSI-121 and its 25% W.P. formulation were used. References were cyhexatin (25% W.P.), fenbutatin oxide (25% W.P.) and hexythiazox (10% W.P.), produced by Kumiai Chemical Industry Co., Ltd., Yamamoto Noyaku Co., Ltd., and Nihon Soda Co., Ltd. respectively.

2. Mites

Two-spotted spider mites, *Tetranychus urticae*, and carmine spider mites, *T. cinnabarinus*, had been successively reared for about 20 years without any exposure to miticides were used. Kanzawa spider mites, *T. kanzawai*, resistant to cyhexatin (CR strain) were collected at tea fields

in the Haibara district of Shizuoka Pref. in 1985 and had been kept according to the breeding procedure of Ditttrich.¹⁾ Another strain of *T. kanzawai* susceptible to cyhexatin (CS strain) was collected at tea fields near our laboratory in 1985, where no miticides had been used, and had been reared since without any exposure to miticides. All strains of these mites were reared on kidney bean seedlings at $25 \pm 1^\circ\text{C}$ and 30-50% R.H. under continuous fluorescent light condition. Three strains (A, B, C) of citrus red mites, *Panonychus citri*, were from Dr. Furuhashi's collection at the Shizuoka Prefectural Citrus Research Station. Strain A was susceptible to both hexythiazox and fenbutatin oxide, strain B susceptible to hexythiazox but resistant to fenbutatin oxide, and strain C resistant to both hexythiazox and fenbutatin oxide. These mites were reared separately on potted lemon trees at $25 \pm 1^\circ\text{C}$.

3. Bioassay

3.1 Activity of SSI-121 formulation against female adults

Ten female adults of *T. urticae* were transferred onto kidney bean leaf discs (2 cm diam.) and sprayed with 5 ml of test suspensions. The treated mites were kept at $25 \pm 1^\circ\text{C}$ and 30-50% R.H. under continuous fluorescent light. Female adults of *P. citri* were also treated in the same manner except that they were transferred onto lemon leaf discs (3 cm diam.). Mortality was assessed 48 hr after treatment with correction with Abbott's formula.²⁾ LC_{50} values of active ingredients were calculated according to Bliss's method.³⁾ Test suspensions of the formulations were all sprayed with a rotary-type spray apparatus.

3.2 Activity of SSI-121 formulation against eggs and immatures

Ten female adults of each *T. urticae*, *T. cinnabarinus* and *T. kanzawai* were transferred onto kidney bean leaf discs (2 cm diam.) and allowed to lay 15-20 eggs for 24 hr. The adults were then removed and the eggs were sprayed with the test suspensions. The eggs of *P. citri* were also treated in the same manner except that lemon leaf discs (3 cm diam.) were used. The treated eggs were kept under the same conditions as described above. Mortality was observed until the eggs and immatures developed into adults.

3.3 Activity of SSI-121 formulation against immatures

Fifteen female adults of *T. kanzawai* (CS strain) were transferred onto kidney bean leaf discs (2 cm diam.) and allowed to lay eggs for about 12 hr. The adults were then removed and the eggs were kept under the same conditions as described above for several days until the resultant larvae, protonymphs and deutonymphs emerged. These larvae and nymphs were sprayed with the test suspensions. All unhatched eggs and overstage mites were removed just before the treatment. Mortality was assessed 48 hr after the treatment.

3.4 Activity of SSI-121 as an oral toxicant

SSI-121 dissolved in acetone was diluted with 2.5% sucrose solution. The final acetone concentration of each sample was 1% (v/v). Each test included a matched control to which the same amount of acetone was added. Ten female adults of *T. kanzawai* (CS strain) were introduced into a plastic cup (10 ml), the top of which was then covered with a Parafilm sachet containing a test suspension. Mortality was assessed 24 hr after the treatment.

3.5 Activity of SSI-121 as a contact toxicant

Chloroform solution (100 μ l) of SSI-121 was put into a 6.2 ml glass tube with a micropipette to form a film of SSI-121. After evaporation of the solvent, ten female adults of *T. kanzawai* (CS strain) were confined in the tubes. Mortality was assessed 24 hr after the treatment.

RESULTS AND DISCUSSION

SSI-121 had significantly higher miticidal activity against female adults of *T. urticae* than cyhexatin. There was no significant difference in the miticidal activity against *T. kanzawai* (CS strain) and *T. cinnabarinus* between SSI-121 and cyhexatin (Table 1). In egg treatment, SSI-121 was also significantly more active against

eggs and immatures of *T. urticae* and *T. kanzawai* (CS strain) than cyhexatin (Table 2). Among the compounds tested, hexythiazox showed the highest miticidal activity in egg treatment.

The LC_{50} and its 95% confidence limit (in parenthesis) values of SSI-121 to larvae, protonymphs and deutonymphs of *T. kanzawai* (CS strain) were 2.5 (2.3–2.8), 3.7 (3.2–4.3) and 5.5 (4.8–6.2) ppm, respectively. Thus, the miticidal activity of SSI-121 to *T. kanzawai* (CS strain) decreased as development proceeded. SSI-121 also showed ovicidal activity against *T. kanzawai*, although it was weak (110 ppm in LC_{50}).

The LC_{50} values of SSI-121 and cyhexatin against female adults of *T. kanzawai* were 9.8 and 10.2 ppm to the CS strain and 71.2 and 2883.1 ppm to the CR strain with the resistance factor being 7.3 for SSI-121 and 282.7 for cyhexatin, respectively. The CR strain of *T. kanzawai* may have had some cross resistance to SSI-121.

As shown in Table 3, strain A of *P. citri* was susceptible to both fenbutatin oxide and hexythiazox, and strains B and C were highly resistant to fenbutatin oxide and hexythiazox, respectively. The miticidal activity of SSI-121 was higher against eggs and immatures of strain A *P.*

Table 1 LC_{50} values of SSI-121 to female adults of Tetranychidae species by spray application.

Mite species	LC_{50} (ppm in a.i.)	
	SSI-121	Cyhexatin
<i>T. urticae</i>	2.9 (2.6–3.2)	10.5 (9.5–11.8)
<i>T. cinnabarinus</i>	2.3 (1.2–3.4)	3.9 (2.9–4.9)
<i>T. kanzawai</i> ^{a)}	9.8 (9.4–10.2)	10.2 (8.6–12.2)

The 95% confidence limit is shown in parentheses.

^{a)} A strain susceptible to cyhexatin.

Table 2 LC_{50} values of SSI-121 to eggs and resultant immatures of Tetranychidae species by egg treatment.^{a)}

Compound	LC_{50} (ppm in a.i.)		
	<i>T. urticae</i>	<i>T. cinnabarinus</i>	<i>T. kanzawai</i> ^{a)}
SSI-121	2.3 (1.9–2.4)	2.4 (2.1–2.7)	1.5 (1.3–1.7)
Cyhexatin	4.2 (3.7–4.8)	2.8 (2.5–3.3)	4.2 (3.8–4.7)
Hexythiazox	0.040 (0.030–0.044)	0.33 (0.29–0.38)	0.20 (0.18–0.23)

After spraying eggs with test suspensions, mortality was assessed until immatures developed into the adults.

95% confidence limit is shown in parentheses.

^{a)} A strain susceptible to cyhexatin.

Table 3 LC₅₀ values of SSI-121 to eggs and resultant immatures of three strains of *P. citri*.

Compound	LC ₅₀ (ppm in a.i.)		
	Strain A	Strain B	Strain C
SSI-121	5.3 (4.8–5.8)	29.2 (25.1–34.5)	42.9 (38.9–47.7)
Fenbutatin oxide	24.7 (21.1–29.3)	5000–10,000	1457 (883–2015)
Hexythiazox	1.3 (1.2–1.5)	1.4 (1.1–2.3)	>400

Strain A: susceptible to both hexythiazox and fenbutatin oxide, Strain B: susceptible to hexythiazox and resistant to fenbutatin oxide, Strain C: resistant to both hexythiazox and fenbutatin oxide.

95% confidence limit is shown in parentheses.

citri than against those of strains B and C. Thus, both strains B and C showed some cross resistant to SSI-121.

The LC₅₀ (and its 95% confidence limit) values of SSI-121 were 153.0 ppm (124.3–189.9) when it was applied as an oral toxicant to female adults of *T. kanzawai* (CS strain), and its LC₅₀ value was 18.0 ng/cm² as a contact toxicant to female adults of *T. kanzawai* (CS strain). As described earlier, the LC₅₀ value of SSI-121 was 9.8 ppm when it was sprayed onto female adults on kidney bean leaf discs. A suspension (5 ml) of 9.8 ppm SSI-121 sprayed on the leaf disc with a rotary-type spray apparatus covered the disc with 39.2 ng/cm² of SSI-121. These observations suggested that SSI-121 acted as a contact toxicant rather than an oral one.

From the results of a series of experiments, SSI-121 was concluded to be effective for control of four species of Tetranychidae mites. SSI-121 was effective against *T. kanzawai* resistant to cyhexatin and against *P. citri* resistant to fenbutatin oxide and hexythiazox.

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要 約

新規有機錫化合物の殺ダニ活性

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新規殺ダニ剤, ビス (2-メチル-2-フェニルプロピル)-トリメチルシリルメチルスタニルクロライド (SSI-121), はナミハダニ, ニセナミハダニ, カンザワハダニおよびミカンハダニに対して接触毒として有効に作用した。サイヘキサチン抵抗性のカンザワハダニ, ならびにヘキシチアゾクスおよびフェンブタチンオキサイドの両者に抵抗性のミカンハダニは, 本化合物に対して交差抵抗性を示したが, その程度は低かった。