Title
Insecticidal Activity of a New Synthetic Compound, S-5602 \(\alpha\)-cyano-3-phenoxybenzyl-2-(4-chlorophenyl)-isovalerate on Tobacco Cut Worms (Spodoptera litura Fabricius)

Author(s)
HIRANO, Masachika

Citation
防虫科学 (1977), 42(3): 100-104

Issue Date
1977-08-31

URL
http://hdl.handle.net/2433/158977

Type
Departmental Bulletin Paper

Textversion
publisher

Kyoto University
Insecticidal Activity of a New Synthetic Compound, S-5602 \((\alpha\text{-cyano-3-phenoxybenzyl-2-}(4\text{-chlorophenyl})\text{-isovalerate})\) on Tobacco Cut Worms \((\text{Spodoptera litura Fabricius})\).

Masachika Hirano

14. 新合成殺虫剤 S-5602 \((\alpha\text{-cyano-3-phenoxybenzyl-2-}(4\text{-chlorophenyl})\text{-isovalerate})\)

のハスモンヨトウ (\textit{Spodoptera litura Fabricius}) に対する殺虫特性 平野雅親 (住友化学工業株式会社農薬事業部研究部, 兵庫県宝塚市高司4丁目2番1号) 52. 1. 24受理解

Since the chemical structures of the insecticidal principles of natural pyrethrins were elucidated by La Forge et al.\(^1\), a number of studies on analogues of chrysanthemic acid esters have been conducted, and many synthetic pyrethroidal compounds were discovered such as allethrin\(^2\), tetramethrin\(^3\), resmethrin\(^4\), furathrin\(^5\), proparthrin\(^6\), phenthothin\(^7\) and permethrin\(^8\). But these compounds except permethrin and phenthothin were not tried as agricultural insecticides\(^9\).

Ohno et al. reported that \(\alpha\)-substituted phenylacetic acid esters possessed insecticidal activities\(^10\). And among various derivatives of these compounds, S-5602 \((\alpha\text{-cyano-3-phenoxybenzyl-2-}(4\text{-chlorophenyl})\text{-isovalerate})\) possessed the highest efficacy against many species of insect pests\(^11\).

This paper describes the efficacy and the mode of action of S-5602 on tobacco cut worms \((\text{Spodoptera litura Fabricius})\).

Materials and Methods

I) Test insects

The larvae of tobacco cut worms \((\text{Spodoptera litura Fabricius})\) were reared on artificial diet\(^12\) in our laboratory (16L 8D 27°C RH 60%).

II) Insecticides

S-5602: Technical grade (98.1%) was synthesized in this institute and 20% EC was formulated from the technical grade.

Methomyl: Technical grade (98.4%) was synthesized in this institute and 45% WP was purchased from Nippon Noyaku Co., Ltd.

Salithion: 25% EC was purchased from Kumiai Kagaku Co., Ltd.

III) Testing methods

(1) Foliar spray method

Each insecticide (EC and WP) was diluted with water and sprayed to potted Chinese cabbage plants. After air-drying the treated leaves were cut out and put in a plastic cup (\(\phi 11\)cm) and 10 larvae (4th instar) of tobacco cut worms were released. Mortality counts were made after 48 hours. This experiment was performed in triplicate. The LC\(_{50}\) value was calculated by Finney's graphic approximate method based on the
mortality at 48 hours.

(2) Topical application method

Half a µl of acetone solution of each technical grade insecticide was applied to the ventral thorax of test insects with a microsyringe. Thirty larvae were used at each dosage. Mortality counts were made after 48 hours. The LD₅₀ value was calculated by Finney's graphic approximate method based on the mortality at 48 hours.

(3) Film contact method

One ml of acetone solution of each technical grade insecticide was applied to a glass dish (φ 9cm). After acetone had evaporated off, 10 larvae (4th instar) were released into the treated dish. Agonized larvae were counted at 30, 60, 90, 120 and 180 minutes after releasing. And also alive and dead larvae were counted after 24 hours. This experiment was performed in triplicate.

(4) Feeding method

Chinese cabbage leaves were cut out at the size 0.7cm in diameter with a cork borer. Half a µl of acetone solution of each technical grade insecticide was applied to the leaf disc with a microsyringe. After acetone had evaporated off, the treated leaf was sandwiched with an untreated leaf by Campbell and Filmer's method. Each disc was put into a plastic cup (φ 7cm) and a 5th instar larva was released. Thirty larvae were used at each dosage. Mortality counts were made after 24 hours. The LD₅₀ value was calculated in the same manner as in experiment 2.

(5) Vapor effect test method

Each insecticide (EC and WP) was diluted with 100ml water and poured into a one l glass beaker at the rate of 1.7mg a.i./beaker (200g a.i./10 a). A 50 mesh wire net was placed in the beaker 3cm above the bottom to avoid direct contact with the insecticide. After release of ten larvae (4th instar), the top of the beaker was covered with cheese cloth. Mortality counts were made after 24 hours. This experiment was performed in triplicate.

(6) Systemic activity test method

Each insecticide (EC and WP) was diluted with water and applied to the surface of the soil in a pot (φ 9cm), where three Chinese cabbage plants were grown to 3-leaf stage. The leaves were cut out 3 and 72 hours after the application, and put in a plastic cup (φ 11cm), then 10 larvae (4th instar) were released. Mortality counts were made 48 hours after the release of larvae. This experiment was performed in triplicate.

**Results and Discussion**

The insecticidal efficacy of S-5602 against tobacco cut worms (*Spodoptera litura* Fabricius) was about two times higher than that of salithion and one and a half times higher than that of methomyl by foliar spray method as shown in Table 1. At a concentration above 10 ppm, S-5602 killed most larvae. At 2.5 or 5.0 ppm, the insecticidal activity was partial, but the damage caused to the leaves was only slight. On the other hand, sublethal concentrations of methomyl and salithion did not prevent leaf damage. Therefore, S-5602 seems to control tobacco cut worms to a greater extent than it might appear on the bases of its LC₅₀ value.

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Concentration and mortality (%) at 48 hrs LC₅₀</th>
<th>2.5</th>
<th>5.0</th>
<th>10</th>
<th>20</th>
<th>40</th>
<th>ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-5602</td>
<td></td>
<td>6.7</td>
<td>53.3</td>
<td>96.7</td>
<td>100</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>Methomyl</td>
<td></td>
<td>28.7</td>
<td>76.7</td>
<td>83.3</td>
<td>83.3</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Salithion</td>
<td></td>
<td>3.3</td>
<td>43.3</td>
<td>90.0</td>
<td>100</td>
<td>11.0</td>
<td></td>
</tr>
</tbody>
</table>
Meanwhile, effects of dermal and oral applications on efficacy of S-5602 against tobacco cut worms were investigated in comparison with methomyl. As the average body weight of test insects at each application was different, the efficacy was compared by the dose per body weight. As the result, the LD₅₀ value (µg/g) of methomyl in topical application was the same as that in feeding method as shown in Tables 2 and 4. On the other hand, the relative efficacy of S-5602 in topical application was two times of methomyl, but the relative efficacy of this compound in feeding method was one fourth of methomyl. In other words, the oral and the dermal toxicity of methomyl against tobacco cut worms seemed almost equal in these experiments regarding as the respective LD₅₀ values (µg/g). And as for S-5602, the dermal toxicity was eight times higher than the oral toxicity, if each toxicity of S-5602 was calculated based on methomyl. When these insecticides were compared by film contact method, the efficacy of S-5602 was higher than that of methomyl as shown in Table 3, namely, the KT₅₀ value and the mortality at 0.05mg/m² of S-5602 were almost equal to the respective values of methomyl at 0.2mg/m². The result of film contact method showed the similar tendency as in the case of topical application. The efficacy of S-5602 as contact poison was far higher than that as stomach poison in these experiments. It has been reported that the contact poison of pyrethrins are higher than the stomach poison against insects¹⁰.

Furthermore, investigation was carried out to ascertain if S-5602 possesses vapor effect and systemic activity in comparison with salithion and methomyl. Salithion possessed high vapor effect against tobacco cut worms, but as for S-5602, this type of effect was not observed as shown in Table 5. Methomyl possessed systemic insecticidal activity against tobacco cut worms, but this type of activity was not observed with S-5602 as shown in Table 6. Vapor effect and systemic activity have not been recognized with pyrethroidal insecticides like pyrethrins, phenothin and permethin¹⁰.

The chemical structure of S-5602 is different.

Table 2. Efficacy of S-5602 and methomyl against tobacco cut worms by topical application.

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Regression equation</th>
<th>LD₅₀ µg/larva* µg/g</th>
<th>Relative efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-5602</td>
<td>Y=4.890+2.119 (X-2.274)</td>
<td>0.021 0.70</td>
<td>205</td>
</tr>
<tr>
<td>Methomyl</td>
<td>Y=4.885+1.664 (X-1.572)</td>
<td>0.043 1.43</td>
<td>100</td>
</tr>
</tbody>
</table>

* Average body weight : 30mg

Table 3. Efficacy of S-5602 and methomyl against the 4th instar larvae of tobacco cut worms by film contact method.

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Dosage mg/m²</th>
<th>Percentage of agonized larvae</th>
<th>KT₅₀</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30' 60' 90' 120' 180'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-5602</td>
<td>0.013 0 0 0 0 0 0 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.05 0 10.0 10.0 52.3 63.3 110 80.0</td>
<td>53.3 73.3 80.0 83.3 56 100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.2 0 53.3 73.3 80.0 83.3 56 100</td>
<td>0 0 0 0 0 0 0 0</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>Methomyl</td>
<td>0.013 0 0 0 0 0 0 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.05 0 0 0 0 0 0 0</td>
<td>3.4 13.8 44.8 62.1 72.4 110 65.5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 4. Efficacy of S-5602 and methomyl against tobacco cut worms by feeding method.

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Regression equation</th>
<th>$LD_{50}$</th>
<th>Relative efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$Y=4.610+2.242(X-1.750)$</td>
<td>0.84</td>
<td>6.5</td>
</tr>
<tr>
<td>S-5602</td>
<td></td>
<td>0.21</td>
<td>1.6</td>
</tr>
<tr>
<td>Methomyl</td>
<td>$Y=4.589+3.548(X-3.198)$</td>
<td>0.84</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.21</td>
<td>1.6</td>
</tr>
</tbody>
</table>

* Average body weight: 130mg

from those of other pyrethroidal insecticides in that S-5602 does not have cyclopropane ring in the acid moiety as shown in Fig. 1. However, the molecular shape of S-5602 seems to be similar to those of pyrethroidal compounds based on molecular model analysis (Ohno et al.10,11). Furthermore, this investigation, mode of action of this compound against tobacco cut worms was shown to be similar to that of pyrethroidal compounds. With these results, it is concluded that S-5602 belongs to the group of insecticides called pyrethroids.

**Summary**

S-5602 ($\alpha$-cyano-3-phenoxybenzyl-2-(4-chlorophenyl)-isovalerate) exhibited high efficacy against tobacco cut worms (Spodoptera litura Fabricius) by foliar spray method in comparison with methomyl and salithion. The dermal toxicity of this compound against the pest was about eight times higher than the oral toxicity. This compound exhibited neither vapor effect nor systemic activity against tobacco cut worms. It seems that the mode of action of this compound against tobacco cut worms is similar to that of pyrethroidal compounds.

**Acknowledgements**: The author is grateful to Sumitomo Chemical Co., Ltd. for its permission to publish this work.

**References**


Water-based aerosol formulation has been studied since 1950s, mainly for the purpose of lowering cost of the conventional oil based aerosol. Water-based aerosols can be classified into two types, two-phase and three-phase aerosols. Two-phase type consists of two layers, namely, gaseous phase composed of vaporized propellant, and liquid phase composed of active ingredients, solvent, water, emulsifier, and liquefied propellant. Three-phase type consists of vaporized gas phase, water phase and another phase composed of active ingredients, solvent and liquefied gas. In the latter case, the containers have to be shaken before spraying for unification of the layers. Three-phase type has been widely used as a household insecticidal formulation owing to their better stability of active ingredients and generally less corrosion risk of container.

Compatibility of many active ingredients with water-based formulations has been studied. Glessner[1] has described that chlordane, heptachlor, and organo-phosphates such as DDVP and mala-