Efficacy of Bacillus thuringiensis preparations containing dead and live spores against two avocado pests: the giant looper, Boarmia seleanaria (Lep.: Geometridae) and the honeydew moth, Cryptoblasma gniidiella (Lep.: Phycitidae)

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Abstract. The activity of Torrey CT, a commercial preparation containing dead spores of Bacillus thuringiensis var. israelensis, was compared with that of two commercial preparations containing live spores, against the Giant Looper, Boarmia seleanaria (Lepidoptera: Geometridae) and the honeydew moth, Cryptoblasma gniidiella (Lepidoptera: Phycitidae). In laboratory experiments, Torrey CT was compared with Dipel B (B. thuringiensis var. aizawai) and a Torrey-B mix with Thiodicarb. In laboratory trials, 80% of B. seleanaria larvae aged 8 and 15 days were killed by a product concentration of 0.3% and 0.1% by a concentration of 1%, respectively, for Torrey CT and Dipel W77. 100% mortality of 15-day-old giant looper was reached only at the highest after 72 hours. In field trials, after 1 week some larvae remained in Torrey CT treated plots, but after 2 weeks no live larvae were found after Dipel CT and Thiodicarb HF treatments. Because of the great sensitivity of C. gniidiella to B. thuringiensis preparations, the 0.001-24-h-old larvae were killed by a product concentration of 24% or 4 days after treatment, depending on their age and the concentration of preparations used.

Keywords: Bacillus thuringiensis, biological pest control, avocado, Boarmia seleanaria, Cryptoblasma gniidiella

Introduction

Boarmia seleanaria is a serious pest of various crops in the world: avocado in Israel, coffee in Kenya and Panama, tea in Taiwan, India and Georgia, USSR, and citrus in Italy and South Africa. It has also been recorded on potatoes, alfalfa, apple and peaches (for pertinent references see Wysocki, 1967). Control of this pest is based on the use of preparations containing Bacillus thuringiensis (Isar, Wysocki and Ohashi, 1969). As only young larvae, up to 5 mm in length, are sensitive to the bacterium, a monitoring system based on trap hails with virgin females is used. On the basis of the fluctuation in numbers of moths trapped, about 2 weeks after the peak trapping and monitoring of the appearance of young larvae in the orchards, spraying of orchards with B. thuringiensis preparations from the air or ground is recommended (Wysocki and Ohashi, 1968). An additional significant pest in avocado orchards is the honeydew moth, Cryptoblasma gniidiella, and its control is also based on the use of commercial preparations of B. thuringiensis (Wysocki et al., 1975).

The sensitivity of this pest to these preparations is high and usually results in the death of the larvae after 24 hours. C. gniidiella is polyphagous, attacking the citrus, apricots, peaches, plums, grapes, pomegranates, oranges, loganberries, cherries, nettles, and other plants (Bodenheimer, 1930; Hovard and Ostfeld, 1988; Swed and Imseng, 1972; Shiratani and Sugi, 1975). The purpose of the investigations described here was to determine the activity of Torrey CT, which contains the B. thuringiensis A-entomocidus with killed spores, will have the same influence on B. seleanaria and C. gniidiella as the commercial preparation containing live spores, which are today used to control the pests in avocados orchards.

Materials and methods

The preparations tested were water-soluble powders containing Bacillus thuringiensis var. israelensis, commercially available in the following formulations: Torrey CT, with dead spores of the bacterium, con-
Field trials were carried out at Ein HaMeila, Western Galilee, on avocado trees cv. Hase, in which the efficacy of Thriocide HP was compared with that of TriAzin WP. In these trials larval mortality and the damage caused by the avocado tips were assessed. The effects of the sprays were checked after 1 or 2 weeks.

The efficacy of TriAzin CT against C. pustulatus was also assessed. The honeydew moth larvae were reared on the same artificial food as were R. solani, larvae, 5-day-old larvae were used, and experiments were conducted on a food medium, and 8-day-old larvae on fruit. In the experiments on fruit, two plastic rings (22 mm wide, 15 mm deep and 10 mm high) were glued to the avocado fruits (cv. Hase) and the upper part of the ring was covered with a piece of silk material. The larvae were inserted into the rings (five to a ring) 3 days before the experiments, for acclimatization. After acclimatization, the mortality rate was recorded.

**Results**

In a series of experiments on larvae, the efficacy of TriAzin CT and of Dibip WP against 8-day-old caterpillars of R. solani was checked. The efficacy of TriAzin CT at 0.1% and 1% was in tests similar to and even somewhat better than that of Dibip WP (Table 1).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. of surviving larvae</th>
<th>Weight of surviving larvae (mg)</th>
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<tbody>
<tr>
<td>Control</td>
<td>49</td>
<td>28.4</td>
</tr>
<tr>
<td>TriAzin CT 0.1%</td>
<td>8</td>
<td>31.6</td>
</tr>
<tr>
<td>Dibip WP 0.1%</td>
<td>8</td>
<td>33.2</td>
</tr>
<tr>
<td>TriAzin CT 0.5%</td>
<td>6</td>
<td>35.1</td>
</tr>
<tr>
<td>Dibip WP 0.5%</td>
<td>8</td>
<td>37.8</td>
</tr>
<tr>
<td>TriAzin CT 1%</td>
<td>6</td>
<td>40.6</td>
</tr>
<tr>
<td>Dibip WP 1%</td>
<td>8</td>
<td>43.4</td>
</tr>
</tbody>
</table>

In an additional experiment, with 15-day-old larvae, the two preparations gave rise to similar mortality rates at the same concentration (Fig. 2) and the weight of the surviving larvae was lower in comparison with the control.

**Crop Protection Vol. 7 April 1988**
control (16 ppm) showed 25% with 1% Toruex CT and 2.5% with 1% Dipel WP (Table 2).

Because of the sensitivity of young and neonate larvae, additional experiments were carried out to study the effect of these preparations on B. thuringiensis which were grown on artificial food (Sherry and Has, 1968). The artificial diet was removed from the food medium and replaced by a vitamin mixture (Navon et al., 1981). The experiments were carried out on neonate (1-2, 5-10, and 12 days old) and used a very low concentration of the product—between 0.1% and 0.00125% (Table 3). The mortality rate of the 1- and 2-day-old larvae with either Toruex or Dipel was very high, reaching 100% after 2 days. Even 5-day-old caterpillars were very sensitive and died after 2 days. Larvae that were 10-12 days old died after 3 days, but with lower concentration of the two preparations tested the mortality rate did not reach 100%.

The efficacy of Toruex CT was compared with that of Thuricide HP against B. oleaeae larvae in cv. Haas avocado orchards (He for each treatment) at Es- haMifla. B-leaf with spraying the caterpillars on the thrips were counted. Spraying was carried out on 26 July, followed 1 and 2 weeks later by counts of larvae and denigrated trees. In each treatment 50 trees were used and a 0.05% Colfax. The number of B. oleaeae was reduced after 1 week, and after 2 weeks no larvae were found in the treated area; only one larva was found in the area treated with Thuricide HP (Table 4).

In laboratory experiments performed to determine the effect of Toruex CT on honeydew moth caterpillars, the results seemed to be no different from those with Dipel WP. Because of the great sensitivity of the pen to B. thuringiensis as well, good results were obtained very rapidly (Figure 3 and 4).

Discussion

Bacterial preparations containing Bacillus thuringiensis var. israelensis are used commercially in avocado orchards to control two important lepidopterous pests: the giant hopper, Bactrus oleaeae and the honeydew moth, Cryonobater pellucidus. The activity of the bacterium against the giant hopper is limited to caterpillars up to 1-2 mm in length (Sherry et al., 1979). Control of the pest was therefore carried out according to a timetable determined by sex ratio, utilizing virgin females (Wynicks and Silver, 1986). Two weeks after the peak of trapping, the avocados orchards are checked for infestation, and spraying with B. thuringiensis is recommended according to the results. Because of these limitations it was important to find additional, more virulent strains or varieties of the bacterium which would control larger caterpillars as well. In the past a number of B. thuringiensis strains have been examined (Cohn, Wynicks and Sherry, 1981; Wynicks and Jarvich, 1981), but their efficacy was unsatisfactory.

Toruex CT, which is characterized by massive spores, showed an effect against the two treated species similar to that of preparations with live spores, namely Dipel WP and Thuricide HP. The honeydew moth is very sensitive to preparations containing B. thuringiensis var. israelensis.

<table>
<thead>
<tr>
<th>Table 2: Total effect with Toruex CT (N) and Thuricide HP (N) against Bactrus oleaeae larvae.</th>
<th>Number of A. oleaeae larvae</th>
<th>Number of A. oleaeae larvae</th>
<th>Number of A. oleaeae larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>Day (1984)</td>
<td>Number of larvae counted</td>
<td>Total number of larvae counted</td>
</tr>
<tr>
<td>Black sprout</td>
<td>1 March</td>
<td>30</td>
<td>690</td>
</tr>
<tr>
<td>Toruex CT</td>
<td>1 July</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Thuricide HP</td>
<td>1 July</td>
<td>50</td>
<td>1000</td>
</tr>
<tr>
<td>Toruex CT</td>
<td>1 July</td>
<td>50</td>
<td>1000</td>
</tr>
<tr>
<td>Thuricide HP</td>
<td>1 July</td>
<td>50</td>
<td>1000</td>
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</table>
spores have not been approved, because they are considered to induce an infectious disease in silkworms.

Notes and acknowledgements


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References


Annals for control by Bacillus thuringiensis


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