MONITORING OF RESISTANCE TO THREE INSECTICIDES
ON PEPPER WEEVIL (Anthonomus eugenii) IN POPULATIONS
FROM BAJA CALIFORNIA SUR, MEXICO

Rosalía Servín, Ricardo Aguilar, José L. Martínez, Enrique Troyo and Alfredo Ortega

SUMMARY

Toxicity levels of three insecticides, carbaryl, endosulfan and methomyl, were determined in populations of the pepper weevil Anthonomus eugenii. Insect populations were obtained from three locations in Baja California Sur, Mexico: Benito Juárez (27°53’N, 113°46’W), San José Viejo (23°07’N, 109°43’W), and San Juan de los Planes (23°58’N, 109°56’W). The highest LC50 values were found for carbaryl (178.4, 635.4 and 5462.1 μg/ml), endosulfan was intermediate (36.5, 34.1 and 47.1 μg/ml), respectively; and the lowest LC50 values corresponded to methomyl (1.3, 1.7 and 2.7 μg/ml), to Benito Juárez, San José Viejo and San Juan de los Planes, respectively. It is concluded can be inferred that pepper weevil populations in the farming zone of San Juan de los Planes are resistant to the three insecticides used, and are significantly more resistant to carbaryl, than are pepper weevil populations in San José Viejo and Benito Juárez. Levels of insecticide susceptibility correspond to the amounts of insecticides used against the pepper weevil in the three locations, and are a response to the selective pressure exerted by those chemicals.

RESUMEN

Se determinaron los niveles de toxicidad en poblaciones de picudo del chile Anthonomus eugenii a tres insecticidas, carbaryl, endosulfan y metomil. Las poblaciones de insectos fueron obtenidas de tres localidades en Baja California Sur, México: Benito Juárez (27°53’N 113°46’W), San José Viejo (23°07’N, 109°43’W) and San Juan de los Planes (23°58’N, 109°56’W). Las LC50 más elevadas corresponden al carbaryl (178.4, 635.4 y 5462.1 μg/ml); endosulfan tuvo valores intermedios (36.5; 34.1 y 47.1 μg/ml); mientras que los valores más bajos correspondieron a metomil (1.3; 1.7 y 2.7 μg/ml), para Benito Juárez, San José Viejo y San Juan de los Planes, respectivamente. Se puede concluir que las poblaciones de picudo del chile de San Juan de los Planes son resistentes a los tres insecticidas utilizados, teniendo mayor resistencia a carbaril, en comparación con las poblaciones provenientes de San José el Viejo y Benito Juárez. Los niveles de susceptibilidad corresponden con las cantidades de insecticidas usados en el control del picudo del chile en las tres localidades de estudio y son una respuesta a la presión selectiva ejercida por esos compuestos.

Introduction

The pepper weevil, Anthonomus eugenii Cano (Coleoptera: Curculionidae) is the primary insect pest of the different varieties of chili pepper grown in Mexico (Bujanos, 1993). This insect causes premature maturation, evidenced by the fall of floral buds and fruit, and by a darkening or yellowing of the fruit. The damage is caused by the larvae, which feed on the pulp and seeds of developing fruits. Flowers are susceptible to damage from oviposition and from feeding by adult weevils, thus causing a significant reduction in the fruit production per plant (Pacheco-Covarrubias, 1985; Bernot, 1992). In Mexico, economic loss caused by the pepper weevil may range from 50 to 100% of total pepper production (Laborde and Pozo, 1982; Bujanos, 1993; Riley and King, 1994; SAGAR, 1997). To solve this problem, several types of insecticide have been used as chemical control methods, especially carbaryl, endosulfan and methomyl. Avila (1987) notes that to obtain good crops, farmers have invested up to 45% of the total crop cost in insecticides recommended for the chemical control of the pepper weevil. In response to increasing pesticide application, the pepper weevil has developed efficient resistance mechanisms against these chemicals.

In the state of Baja California Sur, despite arid condi-

KEYWORDS / Anthonomus eugenii / Carbaryl / Endosulfan / Insecticides / Methomyl / Pepper Weevil /


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tions, the culture of chili pepper is very successful and is a significant source of employment. In the period 1993-1997, an annual average of 1600ha were planted, with a production of 28700 metric tons, and an approximate value of MX$ 70 million. However, losses due to pepper weevil has been estimated at MX$ 1600ha with an annual average of MX$ 70 million. The peppers are mainly used against the pepper weevil pest. Five different concentrations with five replicates each were prepared for every insecticide, using acetone as a solvent. Each replicate included a control with acetone only. Five adult insects were introduced in 20ml scintillation vials whose caps were modified to allow the organisms to breathe, and the tubes were inverted to ensure continuous contact between the insects and the insecticides. After 24hr mortality was evaluated, considering as affected or dead any individual that was immobile or that had abnormal mobility. Bioassays were conducted at room temperature, between 22.5 and 28.5°C, and relative humidity between 55% and 65%. The dose-mortality response lines for each chemical were obtained using the Probit program (Raymond, 1985).

Results and Discussion

The insecticide concentration lethal to 50% of the insects (LC50), the confidence range at 95% (CR 95%), the lethal concentration at 95% (LC95), the slope of each regression line, and the standard error (SE) for each population were determined using the Probit analysis. The study was conducted from December 1997 to March 1998, in the main chili pepper cultivating areas in Baja California Sur. The locations were Benito Juárez (27°53'N, 113°46'W) in the municipality of Mulegé; San José Viejo (23°07'N, 109°43'W) in the municipality of Los Cabos; and San Juan de los Planes (23°58'N, 109°56'W), in the municipality of La Paz. These areas are geographically isolated from each other by natural mountain barriers and by xerophytic vegetation on non-agricultural land, conforming agricultural valleys or oases. Within each location, parcels of land on which chili peppers ("Ancho San Luis" variety) are cultivated were selected. In each parcel, 10-12kg of dropped fruit were collected and deposited in plastic containers of 60cm diameter and 25cm depth. The containers were covered with a screen and kept in the laboratory until the adult insects hatched.
Based on the results, it is evident that of the three pepper weevil populations evaluated in Baja California Sur, that from the agricultural zone of San Juan de Los Planes has the greatest pesticide resistance problem, due to the selective pressure exerted by the compounds used to combat them. The populations of San José Viejo showed an intermediate susceptibility of the three populations to endosulfan and methomyl is quite similar. Therefore, it is suggested that if these pesticides are used, precaution should be taken to avoid repetition of the carbaryl problem. Other strategies should be implemented in order to reduce selection pressure on the pepper weevil and other insect pests in this region. These may include planting dates, destruction of plant residues, establishment of host-free periods, alternative chemical or biological insecticides, and biological control.

There is little information published on pepper weevil resistance to the insecticides used in this study. Genung and Osaki (1972) refer methomyl, carbaryl and endosulfan resistance when conducting field assessments with these products. In test fields and commercial parcels Rolston (1977) found pepper weevils resistant to endosulfan and methomyl, reporting mortalities of 15% and 65%, respectively. In the agricultural-valley of La Paz, Baja California Sur, Servín and Aguilar (2000) found insects resistant to carbaryl with an LC₅₀ of 3565.7 µg/ml, and to endosulfan, with an LC₅₀ of 131.8 µg/ml, consistent with the results presented in this study. According to the insecticide application record in the studied zone, the situation in San Juan de los Planes is critical. It is important to consider that these pesticides are highly toxic to organisms other than the pepper weevil. The use of methomyl and carbaryl is restricted, as they are highly poisonous to human beings and other animals by inhalation or contact. In addition, some pesticides are unstable; 50% of the applied endosulfan residue is lost or degraded within three to seven days. The control alternatives for the pepper weevil are not encouraging; therefore, it is important to regularly assess the reincidence of this pest and to manage pesticide use in order to avoid increased resistance.

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REFERENCES


TABLE I

TOXICITY OF INSECTICIDES AGAINST Anthonomus eugenii IN THREE LOCATIONS OF BAJA CALIFORNIA SUR, MEXICO

<table>
<thead>
<tr>
<th>Location</th>
<th>Pesticide</th>
<th>LC₅₀ (µg/ml)</th>
<th>95% CR</th>
<th>LC₉₀ (µg/ml)</th>
<th>Slope</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benito Juárez</td>
<td>Carbaryl</td>
<td>178.4</td>
<td>104.8 - 284.6</td>
<td>3585.8</td>
<td>1.26</td>
<td>0.206</td>
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<td></td>
<td>Endosulfan</td>
<td>36.5</td>
<td>23.3 - 54.4</td>
<td>345.5</td>
<td>1.68</td>
<td>0.298</td>
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<td></td>
<td>Methomyl</td>
<td>1.3</td>
<td>0.6 - 1.8</td>
<td>11.7</td>
<td>1.77</td>
<td>0.507</td>
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<tr>
<td>San José Viejo</td>
<td>Carbaryl</td>
<td>635.4</td>
<td>327.9 - 1420.1</td>
<td>31541.6</td>
<td>0.97</td>
<td>0.188</td>
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<td>Endosulfan</td>
<td>34.1</td>
<td>2.2 - 67.9</td>
<td>1277.4</td>
<td>1.04</td>
<td>0.387</td>
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<td>Methomyl</td>
<td>1.7</td>
<td>0.9 - 2.4</td>
<td>10.9</td>
<td>2.02</td>
<td>0.51</td>
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<td>San Juan de los Planes</td>
<td>Carbaryl</td>
<td>5462.1</td>
<td>3135.7 - 15144</td>
<td>132089</td>
<td>1.18</td>
<td>0.282</td>
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<td></td>
<td>Endosulfan</td>
<td>47.1</td>
<td>17.9 - 108.3</td>
<td>5059.6</td>
<td>0.81</td>
<td>0.24</td>
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<tr>
<td></td>
<td>Methomyl</td>
<td>2.7</td>
<td>2.2 - 3.3</td>
<td>8.1</td>
<td>3.46</td>
<td>0.503</td>
</tr>
</tbody>
</table>

Figure 1. LC₅₀ values obtained with carbaryl, endosulfan and methomyl in three locations of Baja California Sur, Mexico.

: Benito Juárez, : San José Viejo, : San Juan de los Planes.
* Maximum level for carbaryl concentration in San Juan de Los Planes was 15.144 µg/ml.

(1990) 95% CR: 65.5% - 100%
Campbell Experimental Norte de Guanajuato / Campo Experimental Baja. SARH, INIFAP. PIAPEG. México, 6pp.


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