TOXICITY OF ETHYLENE DIBROMIDE TO EGGS AND LARVAE OF THE CARIBBEAN FRUIT FLY, 
ANASTREPHA SUSPENSA¹

JOHN BRUECK III² AND A. K. BURDITT, JR.³
Subtropical Horticulture Research Station, 
13601 Old Cutler Road, Miami, Florida 33158

ABSTRACT

In laboratory studies ethylene dibromide (EDB) was found to be an effective fumigant against eggs and larvae of the Caribbean fruit fly, Anastrepha suspensa (Loew). Exposed eggs and larvae were killed by fumigations of less than 1 mg/1 for 2 hr. Higher dosages of EDB were needed to kill eggs artificially protected by grapefruit rind and larvae artificially protected by half grapefruit. Adult emergence from puparia of exposed and protected larvae surviving treatment was reduced or prevented. These laboratory studies indicate that EDB could be used to fumigate fruit infested by Caribbean fruit fly eggs and larvae.

In Florida the Caribbean fruit fly, Anastrepha suspensa (Loew), is mainly a pest of dooryard, tropical, and subtropical fruits (Weems 1966). Occasionally infestations have been found in less preferred fruits such as grapefruit, Citrus paradisi Macf., mango, Mangifera indica L., and avocado, Persea americana Mill., (Swanson and Baranowski 1972). Therefore fumigation of commercial citrus and other fruit is required when they are being shipped to areas where the Caribbean fruit fly could survive (Burditt and von Windeguth 1975).

Small scale laboratory fumigations, with 5-gal chambers, established the effectiveness of ethylene dibromide (EDB) against eggs and larvae of the Oriental fruit fly, Dacus dorsalis Hendel (Balock and Lindgren 1951). Additional research (Balock 1951) demonstrated the effectiveness of EDB as a fumigation treatment against eggs and larvae of the oriental fruit fly and other fruit flies infesting papayas, guavas, and tomatoes. As a result EDB was established as a commercial fumigant for quarantine use. EDB also was found effective as a treatment for fruits infested by eggs and larvae of the Mexican fruit fly, Anastrepha ludens (Lowe) (Shaw and Lopez 1954) and other Anastrepha spp. (Richardson 1952).

The objective of this study was to establish dosage-mortality values for EDB when used to fumigate Caribbean fruit fly eggs and larvae, exposed or artificially protected by grapefruit, in small-scale tests under laboratory conditions.

MATERIALS AND METHODS

Fumigations were conducted under ambient laboratory conditions (22-30°C) using 19.5 liter (5 gallon) glass bottles as test chambers (Fig. 1). The bottles were fitted with wood covers and a rubber washer for a tight

¹. Diptera: Tephritidae.
². Present address: 20 Bergen Blvd., Fairview, N.J. 07022.
³. This paper reports the results of research only. Mention of a pesticide or equipment in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended.
Fig. 1. 19.5 liter (5 gal) glass bottles as test chambers.

seal. Openings were provided in the cover for a gas inlet, gas outlet, and thermistor probe. Test specimens were supported in the bottles on a hardware cloth platform to allow optimum exposure to the gas. EDB concentrations were measured, to verify the applied dosage, with an infra-red spectrophotometer (Miran 1A Gas Analyzer, Wilks Scientific Corporation) and recorded on a strip chart recorder. EDB was injected into a 6.5 liter/ min pump, where it evaporated and was delivered into the test chambers and Miran unit. Brass unions and nylon tubing were used in connections from the pump to other parts of the apparatus. Each test was replicated 5 times.

Exposed eggs were incubated (25°C) for approximately 24 hr prior to testing. Fifty eggs were placed on a small square of black construction paper which was placed on blotting paper and fumigated in open Petri dishes. Dosages of EDB tested were 0.0, 0.07, 0.12, 0.16, and 0.22 mg/l.

After fumigation for 2 hr the eggs were left uncovered for approximately an hour to eliminate absorbed gas. The blotting paper was then moistened with 0.03% sodium benzoate solution, and the Petri dishes were covered. The eggs were examined 48 hr after exposure to determine mortality.

Eggs, artificially protected by grapefruit rind, were prepared and incubated in the same manner as for exposed egg tests. A 1-mm slice of grapefruit rind was placed over the square of black construction paper which contained the eggs, and was waxed onto the Petri dish. To prevent mold growth and dessication, 0.03% sodium benzoate solution was injected through the grapefruit rind. Dosages of EDB tested were 0.0, 0.25, 0.35, 0.45, and 0.55 mg/l. After fumigation for 2 hr, the grapefruit rind with the eggs under it was exposed to air for 24 hr. The grapefruit rind was then removed from the eggs, the Petri dish cover replaced, and the eggs were examined for hatch 48 hr after fumigation.

Twenty-five mature, 3rd instar larvae were put into 12-oz waxed cardboard ice cream containers, covered with saran screen, and fumigated with EDB for 2 hr at dosages of 0.0, 0.05, 0.20, 0.35, or 0.50 mg/l. Exposed larvae which did not pupate after 48 hr were considered dead. Larvae which pupated were left in the containers and subsequent emergence of adults was observed.
For tests in which larvae were artificially protected by half grapefruit, 25 mature, 3rd larval instars were put into a 5-ml glass beaker and covered with saran screen. Grapefruit were cut in half, a piece of the pulp was removed, and the beaker of larvae was inserted in the fruit. The periphery of the cut surface of the grapefruit was attached to a watch glass with masking tape. These larvae were fumigated with EDB for 2 hrs at dosages of 0.0, 1.0, 4.0, 7.0, or 10.0 mg/l. The half-grapefruit was left covering the larvae for 24 hr, at which time the larvae were removed and put in 12-oz, waxed, cardboard ice cream containers, covered with saran screen. The larvae were left in these ice cream containers for an additional 24 hr to permit pupation to ascertain the effect of EDB on adult emergence.

Data from these tests were analyzed by a probit program developed by Daum and Killcreas (1966) and modified at our laboratory by Rosa Lopez-Dellamary for a Wang 2200B.

RESULTS AND DISCUSSION

Results of EDB fumigation of eggs and larvae of the Caribbean fruit fly, exposed and artificially protected by grapefruit rind, are given in Table 1. These results show that eggs are more susceptible to EDB than are larvae. A threefold increase in dosage of EDB was needed to attain the LD₉₀ of eggs protected by grapefruit rind as compared to exposed eggs. A tenfold increase in EDB dosage was needed to attain the LD₉₀ of larvae protected by half-grapefruit as compared to exposed larvae. Sorption and the mechanical protection of eggs by grapefruit rind and larvae by half-grapefruit were apparently part of the cause of increased dosages of EDB required.

The effect of the grapefruit on mortality of the eggs and larvae during fumigation can further be observed in the slopes of the dosage-mortality regression lines. The dosage-mortality regression line slope is steeper for exposed eggs and larvae than for the slope of those protected by grapefruit. The range of upper and lower confidence units indicate a more homogeneous response in exposed eggs and larvae to EDB as compared to the more variable, heterogeneous response of those protected by grapefruit. Owing to sorption and mechanical blockage of EDB molecules by grapefruit, there is a less direct exposure to EDB, causing a more varied response.

When exposed larvae were fumigated, adult flies emerged from 42.9% of the control puparia, compared to 39.6%, 7.4%, 0.0%, and 0.0% for those fumigated at 0.05, 0.20, 0.35 and 0.50 mg/l, respectively. When larvae were tested under half-grapefruit, adults emerged from 30.7% of the control puparia compared to 20.8%, 1.8%, 0.0%, and 0.0% of surviving puparia fumigated at 1.0, 4.0, 7.0, and 10.0 mg/l, respectively. Low emergence of flies from control puparia apparently was due to desiccation during the holding period.

ACKNOWLEDGEMENT

The authors thank D. L. von Windeguth and J. B. Owens for their assistance in supplying insects and equipment used in this study. This research was funded under USDA, ARS, Cooperative Agreement 12-14-7001-119.


<table>
<thead>
<tr>
<th>Stage fumigated</th>
<th>Dosage (mg/l)*</th>
<th>Limits**</th>
<th>Limits**</th>
<th>Limits**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LD-50</td>
<td>Upper</td>
<td>Lower</td>
<td>LD-95</td>
</tr>
<tr>
<td>Exposed eggs</td>
<td>0.11</td>
<td>0.12</td>
<td>0.10</td>
<td>0.21</td>
</tr>
<tr>
<td>Eggs under grapefruit</td>
<td>0.31</td>
<td>0.37</td>
<td>0.22</td>
<td>0.69</td>
</tr>
<tr>
<td>Exposed larvae</td>
<td>0.29</td>
<td>0.32</td>
<td>0.26</td>
<td>0.71</td>
</tr>
<tr>
<td>Larvae under grapefruit</td>
<td>2.92</td>
<td>3.74</td>
<td>2.09</td>
<td>15.92</td>
</tr>
</tbody>
</table>

*Dosage required to prevent 50% and 95% hatch of eggs or pupation of larvae.

**95% confidence limits for lethal dosages.
文学参考


阴影采样：一种快速、无痛的方法收集秋粘虫卵团（注）。在佛罗里达州释放卵寄生虫Telennus remus (Nixon)之后，花费了大量时间试图回收它，于是从现场收集到的Spodoptera frugiperda (J. E. Smith)卵团。S. frugiperda更喜欢幼叶和一般在叶的下侧产卵。卵是通过将植物从土壤中取出并检查它们，或者通过观察在植物的下侧卵团或叶子。当采卵团时，发现它们在上面会显示出深色的斑点，从叶子的上表面向下。当植物在采样器的阴影中时，这种方法被使用。用阴影方法采样时，采样器简单地行走，将其阴影投射到一边，以便在叶子下看到叶子。然后对叶子进行检查。这种方法比上面提到的三种方法更有效。

三种采样方法被用于比较效率，通过采样8片玉米地。收集到的卵群的数量和所需时间被记录下来。每片地的长度为50英尺，其中植物相距约6英寸。这片田地上的植物是第5阶段（J. J. Hamilton, 1966, Iowa St. U. Special Rep. no. 48）时采样。首先，对所有叶子的下侧进行采样，然后检查了所有植物的叶片，最后将叶子从地里拔出并检查。