CONTROL OF THE SAW-TOOTHED GRAIN BEETLE IN RAISINS: A PRELIMINARY REPORT

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ABSTRACT

This paper records the preliminary steps taken to control raisin packing-plant infestations of the saw-toothed grain beetle, *Oryzaephilus surinamensis* Linne. The two complementary measures discussed relate to the destruction of beetles concentrated in trash by routine procedure and the protection of storage sheds by metal barriers.

INTRODUCTION

The average raisin plant combines storage features with those of the manufactory. The processing routine largely frees the fruit from the saw-toothed grain beetle but, where the insects are abundant, packed goods are subject to reinfestation and are therefore commonly fumigated just before shipment. This procedure, valuable as it may be in respect to marketed goods, has no effect in limiting infestations at the plant. This paper deals only with plant infestations.

The problem divides itself naturally into two phases; namely, reducing existing infestations and minimizing the hazard of infestation during storage. The former contemplates the destruction of beetles which have already exercised a detrimental influence upon stored fruit, while the latter has to do with preventing infestation of stored raisins.

I. REDUCING EXISTING INFESTATIONS

As the initial processing procedure, raisins pass through the stemming machine where the great bulk of extraneous matter is eliminated. The lighter waste material known as "stemmer trash" and consisting of sand, chaff, and the small cap-stems is removed on the entrance side of the

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1. This paper was prepared in December 1924.
2. *Oryzaephilus surinamensis* Linne.
machine, being collected in "picking boxes" immediately in front of the "cylinder." On the average, 3 tons or 120 picking boxes of raw-stock raisins produce about 1 picking box (1.5 cu. ft.) of stemmer trash.

It is in this stemmer trash that the great majority of Oryzaephilus adults collect. Probably less than 5 per cent of the beetles entering the stemmer remain connected with the raisins subsequent to passage through it. Incidentally, goodly numbers of Oryzaephilus larvae collect here also. Early estimates based upon actual counts of small samples made during August indicated the average beetle-content per picking box of trash produced from first-run stored fruit at 15,000. Later estimates showed this figure to be very conservative. During December the beetle-content of a picking box of trash produced from very heavily infested fruit was found, by measure of the collected insects, to be 154,000. Owing to the difficulty of extracting them from the trash this figure is slightly below the actual number.

In the past the insect-laden stemmer trash has been used for roadway improvement at the plant or by growers for land fertilization. In either case the trash has accumulated near the building, allowing the insects to disperse and enter packing and shipping rooms as well as fresh storage stacks. In short, past practices relating to this waste material have tended to perpetuate the plant infestations.

From the above discussion it is clear that, in reducing plant infestations, the most effective single action consists of destroying the beetles while they are so heavily concentrated in the stemmer trash.

**Treatment of Stemmer Trash**

Several methods designed to eliminate the insect from plant premises have proved undesirable or impracticable. These include: burning, placing on city dumping grounds, sacking as produced for burning or burying away from the plant, fumigation at the plant in boxes beneath canvas with HCN; and immediate and continuous fumigation in a trap-door hopper with calcium cyanide dust. The impracticability of the last two methods was established experimentally.

The requirements of the situation have been met by a cupboard-like fumigatorium designed by the senior author. This chamber is of board and paper construction, fitted interiorly with wooden runners along either side, permitting the placing of picking boxes in shelf-like arrangement. Thus a house measuring (i.d.) 2 feet wide by 8 feet long by 7 1/3 feet high will receive 36 boxes in 6 tiers of 6 boxes each. The tiers are separated by 4 inches, while clearances of 1 foot and 8 inches, respective-
ly, are provided at the bottom and the top of the chamber. Two shallow wooden trays receive the fumigant and are then placed on the floor of the fumigatorium. Such a house will, then, accommodate the production of trash from a plant processing approximately 100 tons of fruit per day.

Because of the density of the material to be penetrated and the difficulty of retaining a heavy concentration of gas in such a structure, calcium cyanide in flake form seemed most promising by virtue of supplying a smaller amount of gas over a longer period, as well as permitting application by hand.

**Experimental Testing of Effectiveness of Fumigatorium**

For testing, the insects were placed with a small quantity of trash in small cheese cloth bags. Positions selected in the chamber included the end and center boxes on the bottom, lower-middle, and top rows. Location of test-bags in each box was as follows: 1—on top of box, barely covered with trash; 2—in center of box; 3—on bottom of box, midway between sides; 4—on bottom of box, in corner. In one experiment parallel tests were made, using capsules instead of cloth bags. Small capsules, thoroughly perforated with tiny holes, contained the insects, and these were placed together with trash in densely punctured veterinary capsules. Results of these experiments are summarized in Table 1.

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<th>Table 1.—Summarized Results of Steamer Trash Treatment for the Destruction of Adults of the Saw-toothed Grain Beetle</th>
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<tr>
<td>No. of Expt.</td>
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<tr>
<td>OZ.</td>
</tr>
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<td>------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>4</td>
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<tr>
<td>5</td>
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The first experiment showed a decreased effectiveness from bottom to top in the chamber. The fumigant evolving from the bottom and the tendency of HCN to rise, at once suggested the need of increased charges. The fourth and fifth experiments, both representing increased charges, show proportionate increases in kill throughout the chamber, the top still being the area of least effectiveness.

The majority of test-bags, being placed deeply within the trash, constituted conditions decidedly prejudiced in favor of conservative results since the greater portion of the beetles in bulk trash crawl out of it into the free space.
This fumigator permits immediate placing of the trash as produced, thus not only preventing dissemination of the beetles pending fumigation but facilitating their destruction by allowing time for them to emerge from the trash and concentrate on edges of boxes and in various corners. Again, one fumigation suffices, and this at night in the absence of operatives. After treatment the trash is already boxed and may be used about the yard in any desired manner. The whole operation fits so evenly into the routine procedure that not more than 15 minutes additional are required per day for such treatment.

The cost of the fumigatorium averages about $35.00. Cost of calcium cyanide flake as used in the fifth experiment amounts to 30 cents per day. Fourteen units of the size mentioned were installed at various raisin plants during November and December, while ten others will be constructed shortly.

II. Protection of Raisins from Infestation during Storage

The handling of trash just reviewed is estimated to destroy from 75 to 85 per cent of the beetles present in stored raisins. The remainder escape during transfer from the storage sheds to and about the stemming machine. Oryzaephilus-infested raisins are no doubt occasionally received from growers, but the greater infestation occurs on the plant premises.

Obviously, then, in heavily infested plants stored fruit needs protection from yard infestation. Again, since a certain hazard of infestation is practically omnipresent, it is none the less desirable to provide such protection as a routine practice. In other words, protection against infestation is preferable to partial destruction of the beetles after they have fed upon and bred in the fruit, because of the resulting shrinkage in weight and the loss of lustre and general fresh appearance.

In this connection the senior author designed a metal arc-barrier and the junior writer suggested a modification which will be termed the angle-barrier. At this writing only the principles embodied and inconclusive results may be reported.

The Arc-barrier

The arc-barrier is made from thin galvanized sheet iron 18 inches in width by rounding the upper 6 inches to form a perfect half-cylinder of a 4-inch diameter. All corners are spliced to preserve the same rounded curve throughout, and all joints are carefully soldered. This device is designed for use around the base of the open storage shed. The shed would first be surrounded by 1 by 12 inch boards set on edge, sunk 4
inches into the ground, and secured to the supports of the shed. The barrier would then be applied exteriorly to this board facing with the over-hanging half-cylinder directed away from the shed and the straight 12-inch metal surface sunk 4 inches into the earth.

The design of this barrier is based upon observations on the habits of Oryzaephilus adults. All of the writers' observations indicate that their locomotion is restricted to crawling, despite their possession of fully-developed wings. Another common tendency is that of crawling upward. Again, they seek areas of lesser intensity of light. Pending the outcome of other experiments their non-flight has been accepted as tentative and experiments with the barriers carried out.

In order to enter stacks so protected, the crawling beetles would pass over three distinct surfaces. The ascent of the vertical surface would be followed successively by the concave and the convex facings of the half-cylinder.

In the first experiment, of 24 hours duration, 6000 beetles were used. Upon liberation at the foot of the vertical surface the majority crawled upward. Later, some which had previously gone downward were observed travelling upward over the supporting apparatus, finally mingling with those on the barrier. The beetles slipped back repeatedly on the vertical surface, only those which crawled with extreme slowness attaining the concave surface. Here a further reduction occurred as they became more directly subjected to the pull of gravity. Among those remaining attached, a marked tendency to come to rest at the zenith of the concave was noted. The progress of those few which advanced toward the over-hanging edge indicated that this portion of travel was even more difficult than the previous way.

During the first four hours of the experiment a total of 7 beetles was noted to have passed the over-hanging edge of the concave. Two of these fell from the convex surface when about two inches above the edge. Another one reached the top of the convex and was returning toward the edge when it also fell. Two others, after wandering about the top of the convex, returned to the concave facing and finally came to rest at its zenith. Two others observed upon the convex surface had disappeared at the next observational period.

**The Angle-barrier**

This barrier is made from galvanized sheet iron 18 inches in width by bending the upper 6 inches to form a 20-degree angle with the vertical 12-inches. The corners are spliced to preserve the same angle throughout.
EXPERIMENTAL RESULTS

Table 2 shows the number of beetles observed to reach the downward-projecting edge and also the number of beetles found in the raisins placed inside the barriers. The detailed happenings above cited relate to the 7 beetles which reached the edge in experiment number 1 with the arc-barrier.

<table>
<thead>
<tr>
<th>Type of Expt.</th>
<th>Duration of Expt. (hrs.)</th>
<th>No. beetles used</th>
<th>No. beetles observed to barrier at end of experiment</th>
<th>No. beetles in raisins inside barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc</td>
<td>1</td>
<td>6000</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Arc</td>
<td>2</td>
<td>5000</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Angle</td>
<td>1</td>
<td>5000</td>
<td>5</td>
<td>2</td>
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The above experiments show that the metal barriers exercised a very considerable retarding effect upon Oryzaephilus adults. Furthermore, the protective values of the barriers seem to lie more in causing the beetles to come to rest in the shadow at the zenith of the concave or angle than in constituting a handicap which cannot be overcome by at least a percentage of them.

Despite the promising results of these laboratory tests the writers quite recognize that the alternate coating of the metal surfaces with moisture and dust or a seasonal variation in the habits of the insect might greatly reduce the effectiveness of the devices. Long-time experiments under actual plant conditions are expected to be installed shortly.

THE LIFE HISTORY OF DIABROTICA VITTATA FABR. IN IOWA (CHRYSomELIDAE, COLEOPTERA)

By HARVEY L. SWEETMAN, University of Minnesota

ABSTRACT

Two generations of the striped cucumber beetle, *Diabrotica vittata* Fabr. were found in Iowa. The first required 37 days and the second 51 for development. Females of the first averaged 225 eggs and the second 337. The over-wintering stage in this state has not been discovered and any extensive recommendations for biological methods of control must await this knowledge.

The striped cucumber beetle, *Diabrotica vittata* Fabr., has been known as the most destructive of all cucurbit insects in parts of the United States and Canada since Gaylord first recorded its ravages in 1843. In

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1This work was done at the Iowa Agricultural Experiment Station.