FEEDING RESPONSE OF THE CHINESE ROSE BEETLE, Adoretus sinicus Burmeister, TO AZADIRACHTIN TREATED HOST PLANTS

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ABSTRACT

Snap bean and strawberry plants sprayed with a 0.18% aqueous solution azadirachtin displayed significantly reduced Chinese rose beetle leaf feeding in split-leaf, cage and field trials. In the field trials, azadirachtin treated snap bean plants had significantly less feeding damage compared to water treated plants up to 4 weeks following seedling emergence.

KEYWORDS: Chinese rose beetle, Adoretus sinicus Burmeister, Azatin EC, antifeedant, Neem

INTRODUCTION

There are over 2,000 plant species that possess compounds that have insecticidal properties (Ahmed & Grainge 1985). Included among the more well known of these compounds are: 1) pyrethrins which are extracted from the flowers of a chrysanthemum plant grown in Africa and South America; 2) sabadilla which comes from the seeds of a member of the lily family; and 3) nicotine which is extracted from the tobacco plant (Ware 1980). One of the newest and most promising compound comes from the neem, Azadirachta indica A. Juss., plant.

There are a number of complex compounds called tetratropolenes which have been identified in the seeds and plant parts in neem which control (in varying degrees) over 250 species of insects, many of which are agricultural pests. These compounds do not directly kill insects but control through (depending on the insect) repellency, antifeedant, and growth regulating actions. The most active of these tetratropolenes is azadirachtin (Ahmed 1995).

Azadirachtin is the active ingredient in the commercially produced insecticide, Azatin EC manufactured by Agridyne. This insecticide is environmentally friendly, compatible with IPM programs, has a low mammalian toxicity and is cleared for many ornamental and food crops.

The Chinese rose beetle, Adoretus sinicus Burmeister (Coleoptera: Scarabaeidae) is a polyphagous pest of agriculturally important crops. Plant damage is caused by the nocturnal

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1 Mention of trade names does not imply endorsement by the University of Hawaii at Hilo, College of Agriculture of the products named, nor criticism of similar ones not mentioned.
feeding of the adults which results in a characteristic skeletonization of the leaves (Habeck 1963). Present control for this insect is restricted to synthetic insecticides which do not have the same above mentioned advantages of Azatin EC. Thus the purpose of this study was to determine the effectiveness of Azatin EC as an antifeedant for A. sinicus control.

MATERIALS AND METHODS

Plant Material. For the paired feeding and cage trials, snap bean, Phaseolus vulgaris L. cv. Manoa Wonder, seeds and strawberry, Fragaria chiloensis (L.) Duch. cv. Pine Crush, runners were planted 1 cm deep in plastic (10 cm diameter) pots containing a standard nursery potting mix (Pro-Mix BX; Riviere Du Loup, Quebec, Canada). Snap bean and strawberry plants were utilized since there were reported by Arita et al. (1993) as preferred hosts of A. sinicus. One week after sowing, plants were fertilized with a controlled-release fertilizer (17-6-12) [N-P_2O_5-K_2O] plus minor elements (Sierra Chemical, Milpitas, CA) at a rate of 2.0 g per pot. The plants were watered daily and grown on wooden benches under a fiberglass-covered greenhouse until experimental use. For field trials, snap bean seeds were planted 1 cm deep in plastic starter trays (3 x 4 x 4 cm cells with 36 cells per tray) using the potting mix described above. The seedlings were grown under similar conditions as described for paired feeding and cage trials. Seedlings were grown for 2 weeks before transplanting into the field. The field plot was located at the University of Hawaii at Hilo, College of Agriculture Farm Laboratory in Panaewa, Hawaii. The field plot (7.5 x 11 m) was covered with a black polypropylene weed mat for weed control. Ten cm holes made 60 cm apart in the mat for the bean transplants. The planting consisted of 6 rows with a spacing of 86 cm between rows. One week after transplanting, the plants were fertilized with a controlled-release fertilizer (same as used above) at a rate of 2.0 g per plant.

Paired Feeding Trials. The most recently matured leaf from 10- to 14- day-old snap bean plants was removed and sectioned along the midrib. One leaf section was dipped into a 0.18% solution of azadirachtin. The corresponding leaf section was dipped into water and served as the control. Both sections were allowed to air dry until no surface moisture was visible. After drying, the leaf sections were reassembled to simulate a whole leaf and placed into a 9 cm petri dish fitted with a Whatman no. 2 filter paper moistened with 1 ml distilled water. A single field collected A. sinicus adult was placed into the petri dish and the dish held for 48 h in a growth chamber at 24°C with a 12 h light : 12 h dark photoperiod. The sections were then removed from the dish and the area consumed by the beetle quantified with a leaf area meter (LI-3000A; LICOR, Lincoln, NE). Thirty replicates were made. The results of the paired feeding trials were analyzed with a paired t test P<0.05 (StatView II; Abacus Concepts 1987). The same protocol and replicate number were used for paired feeding trials with strawberry.

Cage Trials. Ten-day-old potted bean plants were treated with 0.18% solution azadirachtin or water (control) as a foliar spray until run-off using a non-freon powered hand sprayer. Surface spray was allowed to air dry before experimental use. After drying, one azadirachtin treated and one control bean pot were placed into a wooden framed cage (38 x 38 x 61 cm) containing four field
collected *A. sinicus* adults. After 3 days, the leaves from each plant were removed and the area consumed by the beetles were quantified with a leaf area meter. Thirty replicates were conducted. Using the same protocol, feeding damage between azadirachtin treated and control strawberry plants was assessed. Treatments for strawberries were consisted of 48 replicates. Data were analyzed with a paired *t* test at a significance level of *P*<0.05.

**Field Trials.** Ten days after seeding, 50% of seedlings (90 plants) were randomly selected and sprayed (as described in cage trials) with 0.18% solution of azadirachtin. The remaining plants were sprayed with water (control). The spray treatment was repeated 2 more times at 14 day intervals. The individual bean plants were visually rated (0, 0%; 1, 25%; 2, 50%; 3, 75%; 4, 100%) (Arita et al. 1988) for *A. sinicus* damage every week for 6 weeks from first application. Weekly statistical analysis of the data was conducted with a paired *t* test at a significance level of *P*<0.05.

**RESULTS AND DISCUSSION**

The results of the paired feeding and cage trials are presented in Table 1. In the paired feeding trials, there was significantly more feeding on the control bean leaves (9.52%) compared with the azadirachtin treated bean leaves (0.11%). Interestingly of the 30 replicates conducted, there was feeding damage on only 1 azadirachtin treated leaf section and within that replicate, the amount of damage on the control leaf section was double. A statistically significant difference was also observed using strawberry as the host plant in the paired feeding trials. There was a mean of 4.07% leaf area consumed on the control strawberry leaf section and 0.01% leaf area consumed on the azadirachtin treated leaf section.

The same feeding pattern was also evident in the cage trials. On the control bean leaves, there was a mean of 6.35% leaf area consumed per cage compared with 0.61% leaf area consumed on the azadirachtin treated leaves. Using strawberry as the host plant, 8.59% leaf area was consumed on the control leaves per cage as compared with 0.35% on the azadirachtin treated leaves.

The results of the paired feeding and cage trials show strong evidence to support the antifeedant action of azadirachtin on reducing feeding damage caused by *A. sinicus* adults on preferred host plants. Under controlled laboratory conditions, adults consistently chose to feed on control bean and strawberry leaves rather than the leaves treated with azadirachtin.

Since the results of both host plants (strawberry and bean) were similar under laboratory conditions and because of the difficulty in assessing damage on the low growing strawberry plants, the effects of azadirachtin in the field were assessed only on bean plants. The results of the field trials are presented in Figure 1. In week 1, there was no feeding damage observed on the azadirachtin treated plants and a rating mean of 0.033 on the control plants. Week 2 and 3, the amount of feeding damage was 0.66 on the azadirachtin treated plants and 0.2 and 0.23 on the control plants, respectively. There was a rating of 0.2 on the azadirachtin treated plants and 0.6 on the control plants in week 4 and in week 5 there was 0.6 on the azadirachtin treated and 0.9 on the control plants. During week 6, there was a rating damage of 1.0 on the azadirachtin treated and 1.2 on the control plants.
Significantly more feeding damage was observed on the control bean plants when compared with the azadirachtin treated bean plants in the field for the first four weeks. In week 5 and 6, though there was more feeding damage on the control bean plant leaves when compared with the azadirachtin treated bean plant leaves, the difference was not significant.

The results of the field trials also confirm the definite antifeedant action of azadirachtin for reducing feeding damage caused by *A. sinicus* adults. The field results show that the greatest action of azadirachtin is observed during the first few weeks of application. For many types of crops, initial propagation is done under greenhouse conditions with subsequent transplanting to the field. For new transplants, the period just subsequent to field planting is critical to establishment. Reducing feeding damage during this period would therefore be of great benefit in insuring survivability. Since azadirachtin has its greatest antifeedant effects during the initial weeks of planting, this product would provide protection to new transplants during a very critical period until such time that the transplants can tolerate feeding damage by *A. sinicus*. In summary, the results of the paired feeding, cage and field trials suggest that azadirachtin should be considered for field use to reduce feeding damage caused by *A. sinicus* adults.

ACKNOWLEDGMENT

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LITERATURE CITED


Table 1. *A. sinicus* feeding damage on snap bean and strawberry plant leaves treated and nontreated with azadirachtin under paired and cage trials.

<table>
<thead>
<tr>
<th>Crop Treatment</th>
<th>n</th>
<th>% leaf area consumed, x ± SEM</th>
<th>Paired t value&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Paired Trials&lt;sup&gt;a&lt;/sup&gt;</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azatin EC</td>
<td>30</td>
<td>0.11 ± 0.11</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>9.52 ± 2.13</td>
<td>4.40 *</td>
</tr>
<tr>
<td>Strawberry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azatin EC</td>
<td>30</td>
<td>0.01 ± 0.03</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>4.07 ± 1.11</td>
<td>3.52&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Cage Trials</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azatin EC</td>
<td>30</td>
<td>0.61 ± 0.25</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>6.35 ± 1.43</td>
<td>4.18&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Strawberry</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Azatin EC</td>
<td>48</td>
<td>0.35 ± 0.16</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>48</td>
<td>8.59 ± 1.49</td>
<td>4.93&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Split-leaf treatment pairs.

<sup>b</sup> Paired t value followed by * significant at P<0.05
Figure 1. Weekly *A. sinicus* feeding damage on snap bean plants treated and nontreated with azadirachtin. Visual ratings scale 0, 0%; 1, 25%; 2, 50%; 3, 75%; 4, 100%. Mean separation within dates by paired *t* test at *P*<0.05.