FINAL REPORT, 12/31/2006

Project title: Efficacy of biorational and natural insecticides for vegetable pest management

Principal investigator: Celeste Welty

Background: The insect pests that affect vegetable crops are the same whether grown on large farms for commercial production or on small diversified farms or home gardens, but the management tactics preferred by growers are often different for the different scale operations. Many market gardeners prefer to avoid using conventional pesticides because of concern about human safety and environmental contamination. During the past few years, many biorational or natural crop protection products have become available. Biorational products include microbial or growth regulator products that are specific to a narrow range of arthropod species. Natural products are derived from plants or other natural sources, and are typically not biorational but are broad-spectrum with short residual activity. While it is known that these products are safer to humans than conventional pesticides, it is often not known whether they are effective in controlling the target pests that they claim to control. Many of these are products are made by small companies that have no budget to support testing in university field trials. There is little to no unbiased data available on efficacy of these products. This deficit is a limiting factor in formulating up-to-date extension recommendations for growers. In a project initiated in 2005, I tested some of these products in lab bioassays and in small plot field trials. In 2006, this work was continued with additional pests and a wider range of products.

Objectives: To evaluate efficacy of biorational and natural products that are available for vegetable crop management, in comparison with standard conventional materials, in lab bioassays.

Methods:

Laboratory bioassays were conducted to evaluate toxicity of 21 insecticides to eight arthropod pests. Whole leaves or leaf pieces were treated on both sides and air-dried. Target insects and treated leaves were placed in plastic 8-ounce plastic deli dishes and held at constant temperature. Bioassays for beetles and bugs were residual tests, in which the leaf substrate was treated but the insects themselves were not directly treated. Bioassays for aphids were direct plus residual tests, in which the aphids plus the leaf substrate were treated. A typical bioassay dish contained one treated leaf and 3 to 10 insects; each dish was one replicate, and tests were replicated 3 to 5 times. Mortality was evaluated after 24 hours in all tests and also after 48 hours for most tests. Defoliation damage was rated for chewing pests.

Pests tested in 2006 were striped cucumber beetle, spotted cucumber beetle, squash bug nymphs, squash bug adults, harlequin bug nymphs, harlequin bug adults, potato aphid, and imported cabbageworm. Insecticides tested were spinosad, pyrethrins, pyrethrins + PBO, pyrethrins + oil, pyrethrins + soap, rotenone, cottonseed + rosemary oil, soap, neem seed oil, azadirachtin, capsaisin, garlic extract, B.T., and methoxyfenozide (an insect growth regulator). Conventional synthetic insecticides tested for comparison were carbaryl, cyfluthrin, endosulfan, esfenvalerate, lambda-cyhalothrin, malathion, and permethrin.

Results:

When striped cucumber beetles were tested in a bioassay to compare the various available forms of pyrethrins, damage was significantly reduced and mortality was significantly increased by two products with pyrethrins + PBO. Treatments that did not differ significantly from the water control were pyrethrins + soap, pyrethrins + oil, pyrethrins alone at a low rate, and pyrethrins alone at a high rate (Figure 1).

When striped cucumber beetles were tested on a wider range of products, the best control resulted from rotenone, esfenvalerate, and carbaryl. The worst control resulted from azadirachtin, pyrethrins + soap, neem seed oil, and pyrethrins alone at a high rate. Intermediate control resulted from spinosad, pyrethrins + PBO, endosulfan, pyrethrins + oil, permethrin, and malathion (Figure 1).

When spotted cucumber beetles were tested on a wide range of products, the best control resulted from esfenvalerate, carbaryl, and pyrethrins + PBO. The worst control resulted from malathion and pyrethrins + soap. Other products provided intermediate control (Figure 1).

Harlequin bug nymphs were most effectively controlled by rotenone and malathion, while the worst control was from carbaryl; intermediate control resulted from lambda-cyhalothrin, spinosad, permethrin, pyrethrins + PBO, endosulfan, and esfenvalerate (Figure 2). Harlequin bug adults were most effectively controlled by rotenone, esfenvalerate, and permethrin, while intermediate control resulted from malathion, lambda-cyhalothrin, pyrethrins + PBO, endosulfan, and carbaryl (Figure 2).

Squash bug nymphs were most effectively controlled by lambda-cyhalothrin, and fair control resulted from esfenvalerate, pyrethrins + PBO, spinosad, and malathion. Poor control resulted from endosulfan, rotenone, permethrin, carbaryl, and pyrethrins alone at a high rate (Figure 2). Squash bug adults were most effectively controlled by lambda-cyhalothrin, and fair control resulted from pyrethrins + PBO, malathion, and esfenvalerate. Poor control resulted from endosulfan, rotenone, carbaryl, spinosad, pyrethrins + soap, pyrethrins + oil, permethrin, and pyrethrins alone at a high rate (Figure 2).

Potato aphid was most effectively controlled by insecticidal soap and pyrethrins + PBO. Intermediate control resulted from esfenvalerate and lambda-cyhalothrin. Poor control resulted from oil (Mite-X), malathion, carbaryl, pyrethrins alone at a high rate, endosulfan, rotenone, azadirachtin, cyfluthrin, permethrin, pyrethrins + soap, pyrethrins + oil, and neem seed oil (Figure 2).

Imported cabbageworm was not available in adequate numbers for replicated tests due to high levels of parasitism, but a small unreplicated test provided preliminary data. The most effective products were esfenvalerate and pyrethrins + PBO. Carbaryl was least effective. Intermediate control resulted from spinosad, permethrin, malathion, methoxyfenozide, and B.t. (Figure 1).

Conclusions: The bioassays demonstrated a wide range in toxicity of insecticide residues to common pests. Market gardeners and home gardeners who are interested in using biorational or natural insecticide products should find the data helpful in selecting products that are best suited to their operation.

Figure 1. Results of laboratory bioassays on chewing pests, 2006.

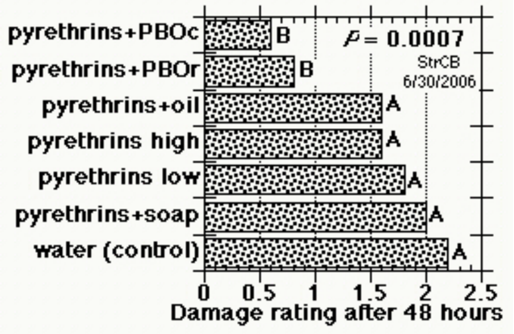
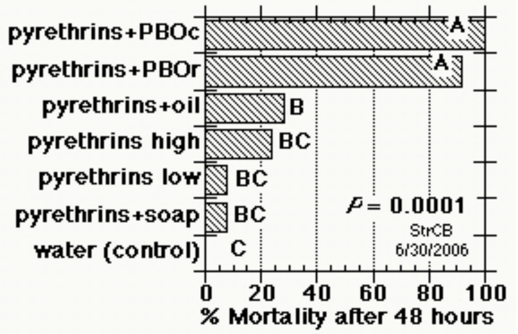
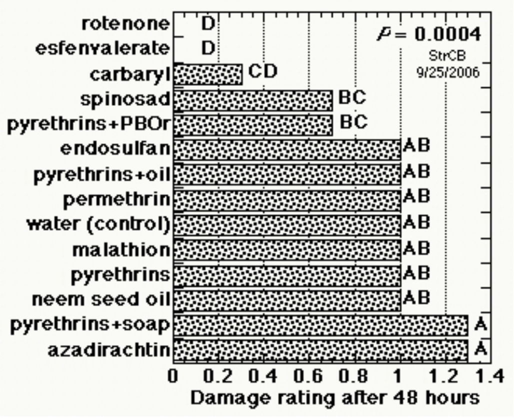
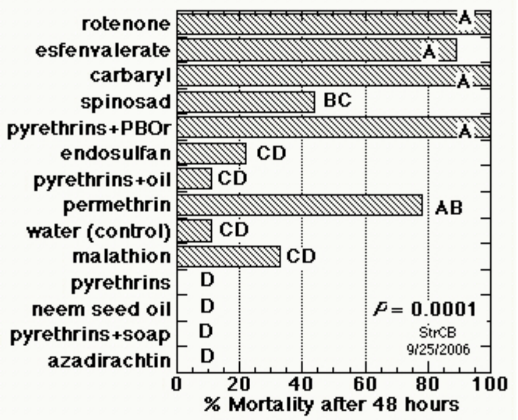
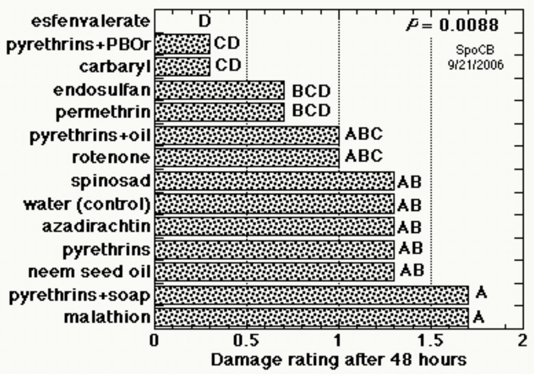
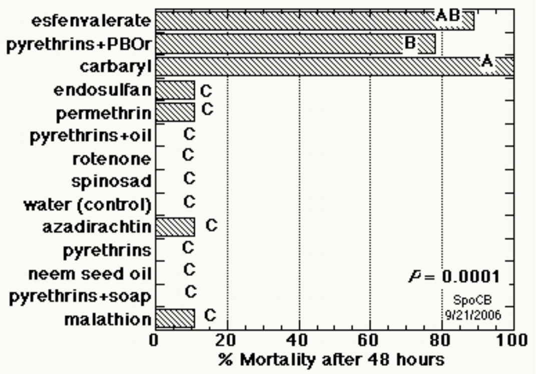
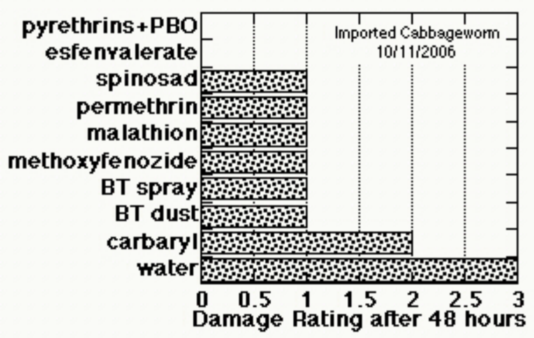
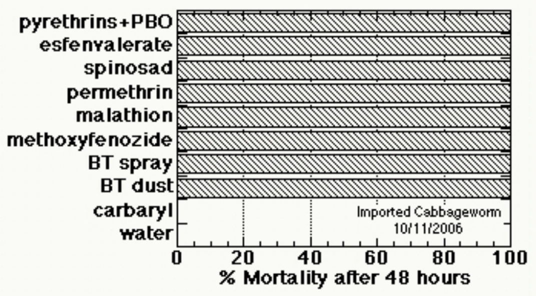
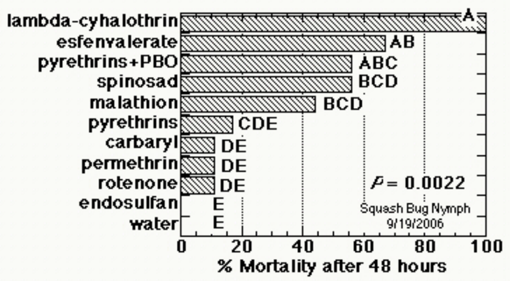
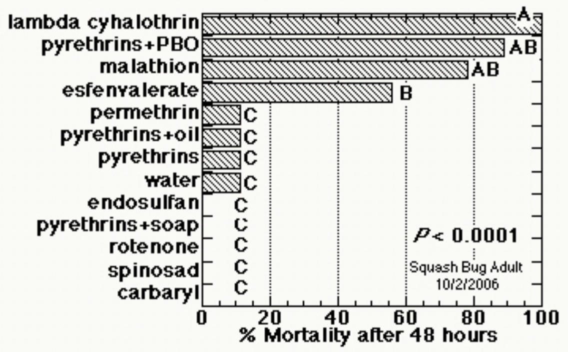
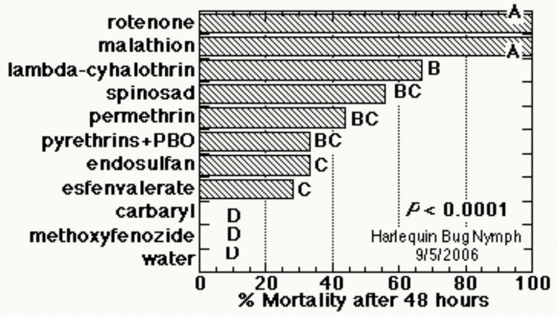
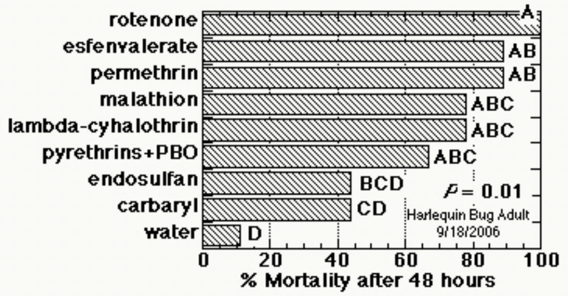
<table>
<tr><th>Pest</th><th>Damage</th><th>Mortality</th></tr>
<tr><td>Striped cucumber beetle, test 1</td><td>
</td><td>
</td></tr>
<tr><td>Striped cucumber beetle, test 2</td><td>
</td><td>
</td></tr>
<tr><td>Spotted cucumber beetle</td><td>
</td><td>
</td></tr>
<tr><td>Imported cabbage worm</td><td>
</td><td>
</td></tr>
</table>

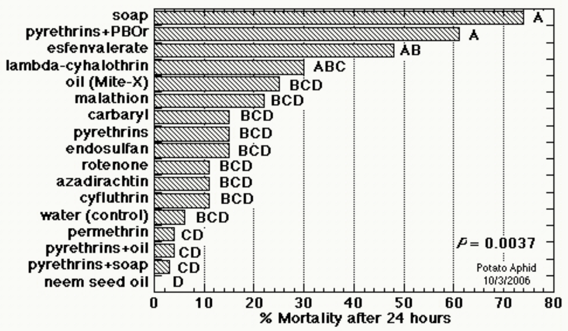
Figure 2. Results of laboratory bioassays on sucking pests, 2006.

<table>
<tr><th>Pest</th><th>Mortality</th></tr>
<tr><td>Squash bug, nymphs</td><td>


</td></tr>
<tr><td>Squash bug, adults</td><td>


</td></tr>
<tr><td>Harlequin bug, nymphs</td><td>


</td></tr>
<tr><td>Harlequin bug, adults</td><td>


</td></tr>
<tr><td>Potato aphid</td><td>


</td></tr>
</table>