Cucurbit Crops (Squash, Pumpkins, Cucumbers, Melons)

Integrated Pest Management for Cucumber Beetles

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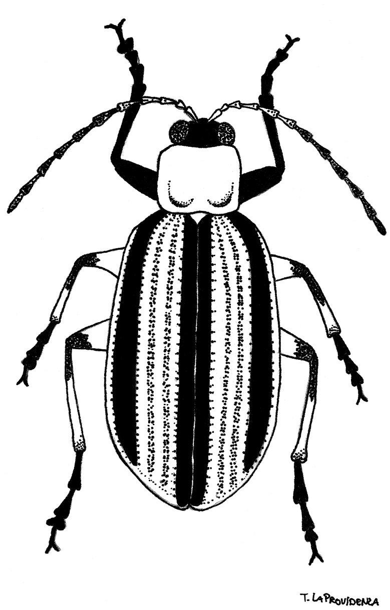
Cucumber beetles are the most important insect pests of vine crops (cucurbits) across most of the United States. Two species occur in the Northeast, the striped cucumber beetle, which is the most common, and the spotted cucumber beetle (also called the southern corn rootworm). The striped cucumber beetle feeds only on cucurbits, whereas the spotted cucumber beetle has a much wider range of host plants. Heavy infestations of adult cucumber beetles can destroy stems and cotyledons of young cucurbit plants. The cotyledons of some varieties contain high amounts of cucurbitacins, which are feeding stimulants for the beetles. On more mature plants, beetles will feed on leaves, vines, and fruits. The larvae feed on roots. How root damage affects the vigor and yield of the plants is not known, but it is known to increase the incidence of certain plant diseases. In addition, adult beetles transmit bacterial wilt. Cucumbers and melons are the most susceptible to bacterial wilt, squashes and pumpkins less so, and watermelon is apparently immune to the disease.



Striped cucumber beetle

In New York, striped cucumber beetles rapidly invade cucurbits in mid-June and remain fairly abundant through mid-July. Once striped cucumber beetles infest cucurbits, the female beetles lay clusters of orange eggs at the bases of plants. These eggs hatch and produce larvae that develop and appear as adults in mid-August. At the end of the season, these adults overwinter until the next year. Spotted cucumber beetle adults appear in cucurbits about mid-season. They are probably reproducing in field corn and then moving to cucurbits as the corn senesces. Likewise, the western corn rootworm also invades cucurbits about the same time. These are often mistaken for striped cucumber beetles and can appear in very high numbers. Over the past few years, we have been conducting research to form the basis for an insect pest management program for these pests. Reported here are the results of some continuing and completed projects.

Variety Choice

It has been well documented that reducing the levels of the cucurbitacins in cucurbits reduces the level of damage by cucumber beetles, especially when the plants are small. To determine which varieties/breeding lines are most preferred (damaged) by cucumber beetles, we have been screening varieties/breeding lines in cooperation with cucurbit breeders (Molly Kyle and Dick Robinson) at Cornell. This helps the breeders in their cucurbit breeding programs and helps growers by determining which varieties may be most susceptible to damage.

In addition, we have tested the use of highly preferred varieties as trap crops. Beetles aggregate on the highly preferred varieties and are kept off of the nearby crop that is being "protected." Results show that this tactic holds promise, especially when combined with cucumber beetle traps. The combined trap and trap crop tactic has reduced damage and beetle numbers on pumpkins by up to 50%.

Traps

We have also evaluated the use of baited traps to control cucumber beetles. Trials to date have shown that we can trap out about 60% of the beetles. The trap is covered with a yellow cloth that is saturated with oil that contains a very small amount of insecticide. The trap also uses a chemical attractant. Beetles land on the trap, contact the oil plus toxicant, and are controlled. In this trapping system, only a very small amount of toxicant is required, it is ultimately removed from the field, and none is applied directly to the crop. We have tested traps containing insect pathogens and insecticides that would be acceptable to organic growers but found them to be ineffective or slow-acting.

Damage Thresholds

Growers are legitimately concerned by the leaf feeding damage caused by cucumber beetles, but how much defoliation winter squash and pumpkins can tolerate without affecting yield has never been adequately evaluated. To determine this, we simulated damage to young plants. We also conducted similar trials where beetles caused various levels of damage. Results have shown that pumpkins are quite tolerant of damage. Pumpkin yield was not significantly reduced even when 80% of the leaf area was removed. In contrast, winter squash appears to be more sensitive to damage. Yield reduction seems to be greater when plants are subjected to moisture stress.

Other Research

We are also investigating the potential of cultivation for control of beetles late in the season. If overwintering populations can be reduced in the fall, it would mean fewer beetles present early in the next year when plants are small. We are also continuing to investigate how cucurbitacin content affects the survival and development of striped cucumber beetle larvae under field conditions. Given that there is nearly a complete lack of information about the immatures when they feed on roots of cucurbits, this research may point to new management options. Lastly, we are investigating the importance of biological control. This year, two parasitoids were recorded parasitizing relatively high levels of adult beetles. These natural enemies need to be investigated further to determine their impact and to determine if they can be enhanced.

Squash Vine Borer Control with Cotton Row Cover

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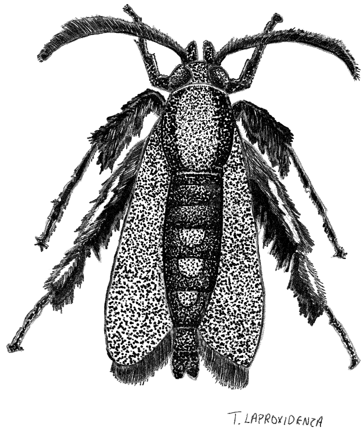
In the 1998 growing season, we researched the use of cotton row covers on summer squash *(Cucurbita pepo)* with monitoring of squash vine borer *(Melittia cucurbitae* [Harris]). Our study was aimed at determining the best planting dates of summer squash, as well as evaluating the effectiveness of the row cover in excluding squash vine borer (SVB). The study was conducted at our farm in Lebanon, Connecticut, where there has been consistently heavy damage to the squash crop by SVB. This is likely due to a large amount of commercial pumpkin growing in the area.

The 1998 growing season was very good for us. We are slowly expanding our vegetable and fruit production to about 3 acres, and things are looking good for further expansion next year. Demand for organically grown fresh local food is very high here, and production in the area is not nearly keeping up. The farm is organically managed, production is high, and the soil is good and getting better. Every year we improve farm techniques. This research has no doubt improved our squash production permanently.

Robert Durgy from the University of Connecticut Cooperative Extension System was my technical advisor on the project. He and the extension system provided me with much technical information, consultation, and materials like the monitor traps. Robert put in constant attention to this project, and it was a pleasure to work with him. He is also disseminating this study's results through the extension system.

The project consisted of six planting dates (May 6, May 25, June 3, June 15, July 1, and July 15). Each planting included a covered and an uncovered section. The cotton row cover was held above the plants on wire hoops and fastened to the ground



Squash vine borer adult

with wire staples until the squash flowered, at which time it was removed. The row cover excluded SVB and other insects until this time. The row cover was 7 feet, 3 inches wide, and the hoops were made of #9 galvanized wire. The squash were planted on 3-foot-wide beds and 12-inch in-row spacing. The beds were 70 feet long. Yields were recorded in pounds to evaluate the most productive planting.

On May 6, we started the first group inside a greenhouse in soil blocks. The spring was cold and wet, so we waited until May 25 to set them out in the first row. We also direct-seeded the second group on the same day. The covered portions were covered immediately. By June 1, the second row had germinated, and we were busy picking striped cucumber beetle (SCB) off the first group's uncovered portion. On June 3, we planted the third group and realized that we were going to have to control SCB by daily hand-picking if the uncovered plots were to survive at all! On June 8, we set two Heliothis monitor traps with pheromone for SVB. Daily handpicking of the SCB and squash bugs off the uncovered plots continued while covered rows remained undamaged, and faster growth was observed. On June 15, we planted the forth row of squash, and there were many SCB requiring several hours of hand picking daily for the uncovered plots. We hand-hoed the rows and hand-picked SCB and squash bugs through the end of June. On June 26, the row cover was removed from the first row because of flowering. The first SVB was caught in the monitor trap. July 1, we planted the fifth row. July 3, the cover was removed from the second row because of flowering. July 7, the first harvest of the first row was done. July 8, the third row cover was removed. July 15, the final planting was done. Two more SVB were caught in the monitor traps.

There was a lack of bees for pollinating, so many fruit fell off. Hoeing and hand-picking of insects continued. By this time, the SCB became more interested in the flowers than the new uncovered seedlings, and hand-picking stopped. Vine borers were trapped through August 21.

Rows one and two were yielding heavily at this time. Rain was heavy throughout the summer, so the plants required hardly any irrigation, and the straw mulch normally used for weed control was never applied for fear of keeping the soil too wet. July 24, the first signs of SVB damage was observed in the stalks of the first row, both covered and uncovered. The covered plants were consistently larger in each planting. July 31, the row cover was removed from row five. Daily harvesting of squash continued. By August 4, wilting was observed in

Table 1. Yield of squash by planting date with and without row cover

Planting	1-C	1-UC	2-C	2-UC	3-C	3-UC	4-C	4-UC	5-C	5-UC	6-C	6-UC
Planting date:	5/6	5/6	5/25	5/25	6/3	6/3	6/15	6/15	7/1	7/1	7/15	7/15
Yield start:	7/7	7/7	7/10	7/13	7/15	7/22	8/6	8/4	8/10	8/10	8/26	8/26
Yield end:	9/1	9/1	9/1	8/26	8/26	8/26	8/26	8/26	8/26	8/22	9/8	9/8
Total yield (lbs/100 row feet):	384	320	228	255	94	58	25	50	85	40	20	25

C = Covered, UC = Uncovered
Total yield from 600 feet of row: covered – 836 lbs; uncovered – 748 lbs

the squash, and many SVB were found in the first four rows. By mid-August, yields were reduced in all the rows, and many plants had died from disease. The vines were heavily infested with SVB. The final row had the cover removed on August 12. By August 26, most of the plants had died, except for the first and second rows, which continued to yield lightly, and the last row, which just started to yield. They quickly became infested, and all squash stopped yielding by September 8.

Higher yield with less labor was achieved through the use of cotton row cover. Though the yield is not that much greater in the covered rows, the labor required to hand-pick SCB and squash bugs in the uncovered plots was very high. Basically, the first through fourth rows would have been destroyed by SCB. The July plantings had reduced SCB pressure, but it was at this time when the SVB pressure was the greatest. Yields were reduced in these rows due to this pressure, regardless of whether the covers were used or not. It also seemed obvious that early plantings in combination with the use of row cover yielded the best due the fact that the plants were very large by the time SVB burrowed into them. The larger plants could withstand this damage better compared to the younger plants. The first planting had the longest duration of continuous yielding.

The row cover was very effective at excluding the SCB, squash bugs, and SVB. When the covers were removed, the plants were infested immediately. The SVB did the most damage to these plants compared to SCB and squash bugs. The plants with covers grew faster and were healthier, but yields were still reduced in later plantings. The material itself was a pleasure to work with for several reasons, and here are some examples:

1. Excellent light, air, and water penetration.
2. No trouble with wind blowing or ripping it. We found it adhered to the ground and hoops without any need for fastening, which is better for the reuse of this material.
3. Slightly earlier yield.
4. Exclusion of target pests as well as larger pests such as deer and groundhogs.
5. Improved microclimate under the cover.
6. Compostable, so disposal of the material is easier.

The material does need to be handled carefully and kept from decomposing where it comes in contact with the ground if it is to be used more than once.

At about $30 for 100 feet of row, it seems economically wise to use this product on early squash plantings. The labor involved with hand-picking insects is much higher than this in an early squash crop. The material can be used more than once, perhaps many times if treated carefully, and it doesn't require much labor to set up.

Next year, we plan to put most of our squash in by June 1 using covers and maybe try an August 1 planting. We are discussing with a local pumpkin grower how he may better control SVB, thus helping us. But for now, we will plant lots, early. We have found the cover useful on many other crops also. We will try it with winter squash next year. The late planting date puts the SVB and the young winter squash in direct competition.

I am highly recommending cotton row cover to other growers, with specific information on how to use it and its effectiveness with early summer squash plantings. In addition to talking with other growers, I have submitted articles for both the NOFA/CT newsletter and *The Grower,* a Cooperative Extension publication.

Harvesting Greens as a Strategy to Control Squash Bugs (Anasa tristis)

Eero Ruuttila
Nesenkeag Coop Farm
Litchfield, New Hampshire

Each season I employ eight to ten field workers, most of whom are Cambodian immigrants who have farmed most of their life, both in Cambodia and the United States. Over the years, they have helped me procure seeds and cuttings for traditional Southeast Asian crops and taught me how the crops are grown and harvested. My farmworkers enjoy eating their traditional foods, and by sharing their lunches, I have learned how their cuisine cleverly incorporates botanical intervention. Their use of vegetative plant parts is a model of biological efficiency. It appears as if every leaf, stem, root, or flower is fair game as an ingredient for one of their exotic and flavorful dishes. Young shoots, flowers, and terminal buds are especially popular in their dishes. I have eaten traditional dishes made from pea and hairy vetch tendrils, pepper blossoms, bitter melon vine, cilantro roots, immature watermelon, tomato leaves, and tips from squash and pumpkin vines.

The young tips of pumpkins and squash vines are harvested along with the male blossoms and incorporated into wonderful soup with bamboo shoots and pork. The spiny tough outer skin of the squash vine is slit and peeled, revealing a mucilaginous hollow straw-like plant part which is both slippery and slightly crunchy at the same time, a little like fresh lotus root.

What does this have to do with managing insect pests? The young tendrils and leaves of pumpkins and squashes are favored sites for squash bugs to lay their eggs. As the eggs hatch the squash bug nymphs inject toxic fluids into their host leaves, causing them to wilt, blacken, and die. Harvesting the egg-laying sites *before* the eggs hatch significantly reduces squash bug damage.

On my farm, pumpkin and squash vine tips are marketed for about six weeks beginning the second week in July through the end of August. The July harvests virtually eliminate all squash bug nymph damage, because we cut about one-third of the young vines of most squash and pumpkin plants when the adult squash bug is laying its eggs. The harvests stimulate the plants to set more flowers, and it is the female blossoms, which sit closer to the center of the plant, that bear fruit. About a third of my income from squash and pumpkin plantings comes from the sale of the tendrils and male blossoms. Income begins within 40 days of seed germination, and harvest contributes to pest management. This is a new way to look at a crop that normally requires 100 or more days for fruit maturity and that, in New England, gluts the market from September until Thanksgiving.

Discussion: Cucurbits

In response to questions, Eero Ruuttila said that he has striped cucumber beetles, but they are not a problem, even though he direct seeds most of his cucurbits. He also said that he no longer needs to use any kind of spray on his farm, including Bt. He used to spray Bt to control Colorado potato beetle, tomato hornworm, and imported cabbageworm but has not needed to for the last two years. (He has been farming for 12 years at the same place.) Steve Gilman commented from the audience that he has observed several other long-term organic farms like Eero's that reach a point where the farmers don't need to use anything — not even Bt — for pest management.

Mike Hoffmann answered several questions about the possibilities of trapping out striped cucumber beetles. He has worked with a grower who tried this. He would recommend combining the chemical attractant, preferred varieties, and traps. He moved away from sticky traps, because the sticky material loses its effectiveness as insects and debris accumulate, so he redesigned the traps using insecticide-impregnated oil on a yellow cloth. Kim Stoner commented that she has found Multigard® traps (which are made by Ecogen) to have a higher catch than the more common brands of yellow sticky traps (Pherocon® and Olson®). This may be due to color (the Multigard® traps are fluorescent yellow-green) or to differences in the sticky trapping material applied.

The availability of the chemical attractant is a practical problem. It is simply a mixture of three chemicals, all of which can be bought from chemical supply houses. The mixture, however, is not available. It seems like an opportunity for the Northeast Organic Farming Association (NOFA) or some commercial entity to buy the chemicals, package the lures in a convenient form, and sell them to farmers.

There were questions about the possibility of using insect-parasitic nematodes against striped cucumber beetle larvae and squash vine borer larvae. Mike Hoffmann had experimented with nematodes against striped cucumber beetles, but without effective control. He suggests that a different species of nematodes in the genus *Heterorhabditis* (marketed as Hb) would have been more likely to find the beetle larvae in the soil. Kim Stoner mentioned that *Steinernema carpocapsae* nematodes are being tested against clear-winged moths (other species related to squash vine borers) that bore into trees (Gill et al. 1994). The nematodes are sprayed on the trunks of the trees. They search the bark surface, find the holes made by the borers, and move inside to attack the borers in place (inside tree trunks and branches). She suggested that might be a useful technique to test on squash vines. Bryan O'Hara mentioned that he had tried injecting nematodes into the squash stems, but was not certain how effective they were, given his high population pressure.

Bryan O'Hara also discussed his efforts to work with his neighbor to reduce the local population of squash vine borers. His neighbor grows pumpkins every year, on a larger acreage than Bryan, and he does not plow his field until just before planting the following year — when the squash vine borers are all ready to emerge. Jude Boucher said that, in his experience, deep plowing is more effective in killing squash vine borers than rototilling or harrowing. If Bryan could get his neighbor to plow earlier in the year (then he would probably follow with light cultivation just before planting), the local population of squash vine borers might be substantially reduced.