

Beans and Mexican Bean Beetle

The discussion participants agreed that there were no other important insect pests in beans in our area besides the Mexican bean beetle and the potato leafhopper (which was dealt with in a previous session).

Biological Control of the Mexican Bean Beetle: From the Farm to the Garden

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The Mexican bean beetle (MBB) is an important pest of beans in the northeastern United States. The Maryland Department of Agriculture (MDA) conducts a successful biological control program, annually releasing up to three million of the parasitic wasp, *Pediobius foveolatus* Crawford (Hymenoptera: Eulophidae), to control MBB on commercial soybean acreage. MDA maintains stock colonies of this nonoverwintering parasitoid.

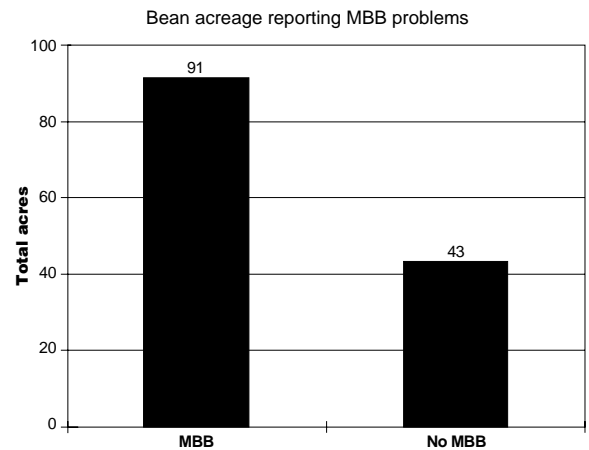
Responding to increasing interest from the organic farming community and the general public, MDA has cooperated with organic grower organizations, the Maryland Organic Certification Program, and commercial distributors of beneficial organisms to explore the use of *P. foveolatus* in fresh-market beans. Studies have shown that small numbers of *P. foveolatus* can effectively control MBB in garden and truck farm beans (Barrows and Hooker 1981, Forrester 1982). Unfortunately, release rates and strategies are not well-defined in these situations.

According to U.S. Department of Agriculture (USDA) figures, in 1994, approximately 2% of total U.S. produce acreage was organically grown (Dunn 1995). Total sales of organic food and fiber are growing at a rate of ca. 25% annually, spurred by incentives and an increasing market for organic produce. Implementation of USDA's Organic Foods Production Act is expected to increase consumer confidence in the "organic" label, encouraging even greater expansion in organic farm production. *P. foveolatus* offers an extremely effective alternative

to chemical control of MBB for an expanding market of organic growers, home gardeners, and other bean producers concerned with pesticide usage. MDA's goals include:

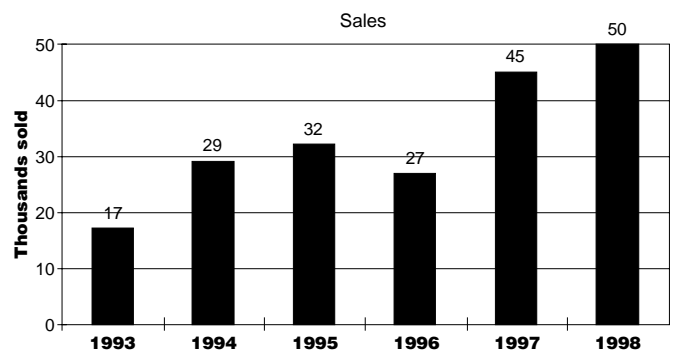
1. helping facilitate the transition of *P. foveolatus* use from the farm to the garden and encouraging commercial laboratories to produce and market this very effective parasitoid;
2. determining an effective release rate and strategy for *P. foveolatus* in small, successive bean plantings; and
3. evaluating economic benefit of *P. foveolatus* relative to cost of commercially available parasitoids.

1997 Maryland Organic Acreage Survey



Organic bean acreage reporting problems with Mexican bean beetle

Pediobius foveolatus



Annual sales of *Pediobius foveolatus* by the Maryland Department of Agriculture

Experiments with Using a Parasitic Wasp for Biological Control of Mexican Bean Beetle on Snap Beans

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A parasitic wasp, *Pediobius foveolatus* (Crawford), has been used since the late 1970s for control of the Mexican bean beetle, *Epilachna varivestis* Mulsant, in soybeans. Because this wasp can not overwinter in the United States, it must be maintained in laboratory colonies during the winter and released again each year. This has been done for many years by the Maryland and New Jersey Departments of Agriculture and by at least one commercial supplier (see appendix B, "Sources of Commercially Available Biological Control Agents," page 66).

In my work with organic farmers and community gardeners, I found that although several of them had a significant problem every year with Mexican bean beetles (or with the closely related squash beetle, *Epilachna borealis*, which is also parasitized by this wasp), they were not aware of the possibility of using this wasp for control.

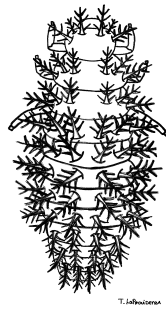
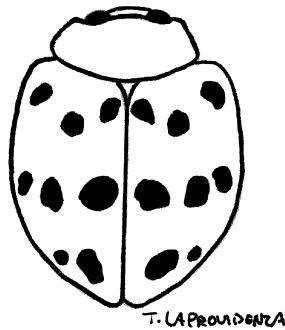
In addition, although control of Mexican bean beetles in community gardens with this wasp has been demonstrated (Barrows and Hooker 1981; Mahr 1995, 1996), the details of how to use it on small acreages, on snap beans rather than on soybeans, and on multiple plantings each growing season are not readily available.

This past summer, I made releases at three organic farms, our experiment station farm, and four community gardens; and I followed Mexican bean beetle populations at two organic farms where the wasp was not released. Results have been mixed so far, due in part to my inexperience with this system. In the coming year, I will be releasing the wasp again and conducting a more detailed study.

Discussion: Beans and Mexican Bean Beetle

Kim Stoner showed graphs of the numbers of Mexican bean beetles (adults, small larvae, and large larvae) and the numbers of mummies found over time at three organic farms where the *Pediobius* wasps were released and at two farms where they weren't. In this experiment, the releases were carried out by putting mummies on the plants in screen packets that allow the emerging wasps to escape. (In Maryland, the wasps are shipped as adults in plastic cups.) At each site, two releases were made, the first when adults and egg masses were found (around June 25), and the second one week later. A minimum of 20 mummies (approximately equivalent to 400 adult wasps) were released at each site on each date. At this point, the bean plantings at Easton and Shelton were a single long row. (There were successive plantings at all locations except the control site in Northford, where all the beans were destroyed.) At Cromwell, there was a much larger bean planting, probably an acre of snap, shell, and lima beans (and several acres of organic soybeans in the adjacent field). We released 340 mummies at Cromwell on the first date and 240 mummies a week later.

New mummies began to appear at all three release sites in mid to late July, but they were found in low densities (less than one mummy per meter of row, except on one sample date in Cromwell, where there were 1.3 per meter of row). At all three sites, higher densities of mummies were found starting August 10, from 2.2 to 3.8 per meter of row. These higher densities were found for one to four weeks at the three sites. By this time, the first generation of Mexican bean beetles had already developed to the stage of large larvae (third and fourth instars) and had done visible damage to the leaves. At two of the release sites (Easton and Cromwell), *Pediobius* apparently reached high numbers early enough to prevent the larvae from pupating in substantial numbers. Thus, few adults emerged, and the second generation larvae never reached the third instar. At the third release site in Shelton, there had been pupation before the first generation larvae were brought under control, so adults emerged and reached a density of 17.5 per meter of row. Their offspring, however, never reached the third instar.



Mexican bean beetle adult and larva

At one of the control sites where no releases were made, the plants were already completely defoliated by August 10, and there were no successive plantings. At the other, the first generation density of Mexican bean beetle larvae was much lower than in all other sites (probably because this was the first year growing beans in this location). Populations built up over the season, so that there were 15 large larvae per meter of row at the second generation peak, and these larvae went on to produce adults. A few mummies were found in mid-September, even though none were released at this site. They may represent wasps that traveled from other release sites over 20 miles away (movement over this distance was documented in Maryland before the wasps were commercially available), or someone nearby may have purchased and released the wasps.

We did not attempt to measure yield, but one farmer (in Cromwell) told us that she had been unable to harvest any beans from her late plantings after Labor Day for several years because of damage by the Mexican bean beetle. In this year, she was able to harvest until mid-October. Some of the plants that had been damaged by bean beetles and drought in mid-summer recovered in the fall, and she harvested from those plants, too. We hope to set up a demonstration project with her next year, where we will do the *Pediobius* releases and monitor beetle populations and she will document her yield and sales.

The bottom line is: The wasps controlled the Mexican bean beetles in the second generation. This benefited the late plantings of beans. However, depending on the initial population and rate of development of the beetles, they may damage early

bean plantings, and the first generation may even reach adulthood before the parasites bring them under control. In the coming year, we will try adjusting the timing and numbers of *Pediobius* released to see if we can get control earlier in the season. We will also see if numbers are lower next year in release sites due to a reduced population of overwintering adults.

Audience: When the wasp comes out of the mummy, how long does it take to begin parasitizing?

Carol Holko: They have to mate first, so there is a lag of two to three days.

Audience: Are they also looking for nectar sources? What if the beans aren't flowering when they emerge?

Carol Holko: They are quite mobile. We assume that it is not difficult for them to find nectar sources in the area and then move back to find hosts to parasitize.

Kim Stoner: In New Jersey, there was a study of how flower structure affected the ability of various small parasitic wasps to feed (Patt et al. 1997). They found that plants in the Apiaceae (carrot family, used to be called the Umbelliferae) had flowers that were easier for *Pediobius* to feed on. I think that this might be important in a large monoculture of beans. On the organic farms where I worked, there were always a lot of nectar sources — wildflowers, weeds, cultivated flowers grown for sale, herbs, etc.

Carol Holko: We release adult parasites that have a source of honey and water right in the cup. That is another advantage of releasing adults rather than setting out mummies. I am nervous about releasing mummies. You may not get good emergence or predators may find and eat them in the field.

Kim Stoner: I did take some samples of the mummies I was sent and checked the emergence rate in the laboratory. In retrospect, I should have flagged the plants I set the mummies on and gone back to retrieve them and see if they had exit holes or were damaged in the field.

Carol Holko: We package 50 mummies in a cup to get 1,000 parasites. We do quality control to make

sure that we get 20 wasps per mummy. When we ship them out, we can see the emerged adults moving around on the inside of the lid of the cup. We sell them at cost.

Kim Stoner: We haven't talked about cost yet. The New Jersey Department of Agriculture sold them to me at \$0.50 per mummy. I am not sure what their policy is about selling to the general public. The commercial supplier (Rocky Mountain Insectary) sold them for \$9 for six mummies.

Carol Holko: We have been selling for about \$22–23 per cup with 1,000 wasps, which is our cost, to growers in Maryland. That is a little less than New Jersey and considerably less than the commercial market. One of the things I would like to see is the development of an artificial diet for Mexican bean beetle larvae to make the rearing of *Pediobius* less labor intensive and less expensive.

Audience: You need to price your product at fair market value. Private industry needs to be shown that there is already an established market so that we can have a supply readily available to order.

Carol Holko: That may be right. Even though our costs may not be the same, you shouldn't give people a false sense of security, which may be what we have done over the years.

Kim Stoner: Rocky Mountain Insectary tells you to release six mummies per 500 square feet of beans. [Editor's note: We tried various calculations on the spot, but I am not sure we realized that 6 mummies/500 square feet would be 523 mummies per acre. At \$0.50 per mummy, that would be \$261 per acre, and at the price charged by Rocky Mountain Insectary, it would be three times as much.]

Carol Holko: I have seen the figure of six mummies per 500 square feet before, but I've never been sure where it came from. There hasn't been enough research to figure out rates, timing, and effectiveness on small farms and in gardens. There has been just one study in community gardens in Washington, DC (Barrows and Hooker 1981). They had some control and 100% parasitism by the end of the season. People call me all the time and ask about the rates at which to release the parasite, and there isn't enough known.

Kim Stoner: Setting up realistic experiments is difficult, because these insects are normally highly mobile. So, to try out different rates and timing, you need a separate farm for each treatment. Then you have to have replications and controls.

Audience: Isn't this just one more example of how the free market doesn't work for some things? It should be an easy decision for the private sector to raise these parasites and sell them. But in the end, the producers have better things to do.

Carol Holko: It would be an easy decision, if Mexican bean beetles weren't so easy to kill with insecticides.

Audience: Well, the organic industry is growing. Thankfully, it's so huge in Texas, California, and Florida that organic groups are going to drive market forces for the benefit of us all. They have the numbers to justify private industry getting into this. And it looks as though rotenone and pyrethrins will perhaps no longer be an option for organic farmers. That will change the equation.

Even for conventional farmers, if it's not much more expensive to use this parasite than to spray, they might use this technique if the data is there for them to see.

Kim Stoner: They might not be willing to risk losing their early-season beans. We timed the release as well as we could and we still got damage in the first generation.

Audience: You had physical damage to the leaves, but did you lose yield? The leaves can tolerate a lot of defoliation.

Kim Stoner: We did not measure yield last year. We will try to do more of that this year, but again, it is a complicated measurement — to measure the effect accurately, you have to have a sprayed control. And where I've been working, the growers have multiple plantings of different varieties. It is true, though, that in soybeans, they say the plants can tolerate up to 60% defoliation.

Carol Holko: There are critical times (when defoliation has a greater effect on yield). Bean beetle populations exploded in 1992 to levels not seen in many years. We did an analysis of that year. Coop-

erating farmers in our program that year realized an average net savings of \$3.26 per acre due to parasitism, with a maximum savings of \$18.29 per acre. That's in soybeans.

[Editor's note: The technique used for release in soybeans was never well described here, because we were focusing on vegetables — snap beans, shell beans, and lima beans. Because snap beans are preferred to soybeans by the bean beetles, and in order to establish the wasp early, the soybean growers plant a small ($\frac{1}{8}$ acre) nurse plot of early snap beans, scout for the bean beetles there, and release *Pediobius* into the nurse plot at prescribed rates. Thus, the soybean growers were not releasing the wasps at rates of six mummies/500 square feet over their entire soybean fields. To get specific recommendations about using *Pediobius* in soybeans, contact the extension service in Maryland or New Jersey.]

Audience: People grow soybeans on large acreages, some have 1,500 acres.

Carol Holko: So again, with large numbers of beetles, you get economic benefit. In snap beans and other fresh market beans, you get high numbers every year, right, it's not sporadic for you?

Kim Stoner: Talking to growers around the state, there are some that say, "I've grown beans for years and I've never seen these insects," and other people get them in large numbers every year.

Carol Holko: In fresh market beans, you have an all-or-nothing situation. In soybeans, it's more sporadic. People will say "I saw them back in the '80s."

Audience: An old recommendation was: Don't try to have the first beans on the market in your area. If you don't plant until later, you miss that first flight, and you won't build up a population.

Kim Stoner: One thing I think is odd is that I had heard of *Pediobius* years ago in soybeans but nothing about it since. Why hadn't anybody up here ever heard of this? It's not in the New England or the New York bean recommendations. When I proposed trying this out in snap beans, everyone I talked to seemed to have forgotten that it works in soybeans.

Audience: Lack of communication is a major problem all around. How many other things are there that were researched 20–30 years ago, and we've never been told about them?

Carol Holko: The liaison for the information is the extension service. In Maryland, they do include our *Pediobius* in the commercial soybean recommendations. I don't think they put them in the vegetable recommendations, because they are looking for a prescription. I am not comfortable telling fresh market bean growers they should release X number of parasites. I don't refuse to sell them to anyone — I just can't tell them how many to release. We are cautious disseminating information because of accountability. People depend on us.

Audience: Do you foresee any problems with complete eradication of Mexican bean beetle from an area? Is it a species that may be of some benefit somewhere in the ecosystem, or would killing it upset a balance somehow?

Kim Stoner: Mexican bean beetle is native to the Southwest. Entomologists don't have many qualms about getting rid of pest species that aren't native to this part of the country. The history is that the beetles were accidentally brought to the East early in this century. In addition, because *Pediobius* cannot overwinter here, it is unlikely to wipe out Mexican bean beetles (or squash beetles, which it also parasitizes) completely. If there were a problem, we could just stop releasing *Pediobius* for a while.