Use of Parasitic Wasp (*Trichogramma ostriniae*) for Bio-Control of European Corn Borer (*Ostrinia nubilalis*) in Sweet Corn
FNE02-407

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The goal of this project was to determine if the parasitic wasp *T. ostriniae* is an effective bio-control for European Corn Borer (ECB), a major sweet corn pest.

New Morning Farm produces 40 crops of mixed vegetables, berries and herbs on 25 acres. Jim and Moie Crawford have farmed full time for 30 years and the farm has been certified organic since 1987. The farm supplies farmers markets in Washington DC and is part of a growers cooperative. Of the farm's 40 crops, sweet corn is one of the most profitable, bringing in around $15,000 annually. During the 2002 season 8 successive generations of sweet corn were planted. Each generation was approximately 1/3 of an acre. Every year the sweet corn crop is damaged by ECB and corn ear worm (CEW). Numerous unsuccessful attempts have been made to control these pests, including the release of other species of Trichogramma.

Jim Crawford, Holly Zipp, Shelby Fleischer and Ron Hoover were involved in the project. Holly Zipp, an intern at the farm, was responsible for implementation of the project under the guidance of Penn State entomologist Shelby Fleischer and On-Farm Research Coordinator Ron Hoover. Her responsibilities included setting up and servicing the pheromone traps, collecting trap count data for a PSU database, scouting for both healthy and parasitized ECB egg masses, scouting for signs of ECB infestation and damage, and ordering and releasing the Trichogramma. Dr. Fleischer provided information on ECB and Trichogramma life cycles and trapping methods, and predicted the timing for ECB infestations, or 'flights'. Ron Hoover visited mid season to check on the progress of the project and delivered corn samples to PSU for analysis in mid September.

On June 15, pheromone traps were set up in the sweet corn plantings to monitor the presence of E-race and Z-race ECB. The traps' pheromone strips were replaced every other week, and the traps were moved as successive generations of sweet corn matured. Trap count data was recorded and entered into the online database on a weekly basis until the end of September. As the season progressed and the sweet corn plantings matured, individual plants were periodically monitored for both normal ECB egg masses and parasitized ECB egg masses. The first infestation of ECB occurred in mid to late June. The first shipment of Trichogramma was set out on June 28, and it is likely that it did not coincide with the peak of the infestation. In an effort to avoid another mistimed release, the second shipment of Trichogramma arrived on July 18, in time for the second wave of

ECB which was predicted for mid to late July. Trichogramma were ordered on a weekly basis for the next five weeks with the hope that this would maintain a constant population in the field. Each shipment consisted of 30,000 Trichogramma, a treatment sufficient for one acre. During each harvest a number of ears of sample ears were inspected for ECB damage and for live ECB larvae. In mid September, Ron Hoover took approximately 80 sample ears from the seventh generation harvest to PSU labs for a damage analysis.

The first trap count for ECB was made on June 19; four days after the traps were set up. The combined total for both ECB races on that day was 43. The total count was 59 on June 24; 15 on July 1; 20 on July 8; and zero for the following two weeks. Trichogramma were not set out until the June 28, after trap counts for ECB began to drop.

The second shipment of Trichogramma arrived on July 18, while trap counts for ECB were still zero. On July 29, the count jumped to 23, and continued in double digits through August, with a peak of 62 on August 19. Shipments of Trichogramma arrived weekly until the 4th Thursday in August with the exception of one week, for a total of six shipments. No more shipments were available after August 22, because the lab where they were raised stopped producing at this time. However, there continued to be significant ECB pressure throughout September, with a trap count as high as 45 on September 23. All eight generations of corn were harvested by this date.

Corn plants were inspected for egg masses on six occasions during the season. 81 plants were inspected on June 26. A total of eight normal egg masses and three parasitized egg masses were identified. Interestingly, these parasitized egg masses were found before the first shipment of Tricho was set out, suggesting that they were parasitized by a native Tricho parasite. On the remaining five occasions, July 18, July 25, July 30, August 2, and August 6, 100 plants were inspected each time. Only two normal egg masses were found on August 6, and no parasitized egg masses were ever identified.

A number of mature ears were inspected at every harvest for ECB larvae or signs of ECB damage. As expected, the first generation of corn sustained significant damage, which corresponds with the high trap counts recorded in late June. Not surprisingly, the second, third and fourth generations were mostly clean, as the weeks in which they were most susceptible to damage did not coincide with the elevated pest pressure that is associated with high trap counts. Weeks 5,6,7, and 8 all sustained damage from both Corn Earworm (CEW) and ECB. Unfortunately, because of time constraints, methodical identification of larvae in harvested sample ears was not available until the seventh generation of corn. However, among the random ears inspected in the field, each generation seemed to have a much higher percentage of CEW larvae than ECB larvae. This pattern was confirmed in an analysis of the sample ears from the seventh generation conducted at PSU. Of 77 ears harvested from two sites in the seventh generation, only seven ears had live ECB larvae, whereas 70 ears had live CEW larvae.

Although relatively few egg mass searches were conducted, it was surprising how few egg masses were found in the field, parasitized or not. This may be explained by the egg-

laying habits of the ECB moth. According to some research, egg masses are easier to find during the first ECB flight than the second. This is because ECB moths prefer to lay their eggs on corn plants early in the season and on other host plants later in the season. Only corn plants were inspected when searching for egg masses. This may explain why so few egg masses were found in general-regardless of high trap counts- and why most of them were found in June.

There are a number of factors that affected the success of this project and therefore influenced the project's results. First and most importantly, this project is particularly complicated because of the many complexities associated with its three main components: corn plants, Trichogramma and ECB. Each of these three organisms has a specific time line associated with the stages of its life cycle. This is complicated by the fact that not only must each life cycle and its associated timeline be considered independently, but each must also be understood in conjunction with the others because they are inherently interrelated. At the outset of the project, most of these details were not necessarily obvious. This explains why the first few stages of the project- namely setting up the traps and ordering the first shipment of Trichogramma- were not carried out in a timely manner. However, as the season progressed, many of these details were ironed out. One of the results of this was that the subsequent shipments of Trichogramma arrived when they were needed.

Second, for an intern with numerous responsibilities on the farm, there was not enough time to devote to the project. As a result, the project did not receive the attention it deserved in light of how complicated it was. However, based on the mistakes that were made and all that was learned in this first effort, it seems that Trichogramma holds promise as a biological control tool. A second attempt at this project would almost certainly be conducted more efficiently and would likely provide more conclusive results.

With close attention to timing and detail and with better organization, this project could be carried out with relatively little labor and material cost. As long as a strict schedule is followed, labor is limited to trap upkeep, Trichogramma release, a few well-timed egg mass searches, and weekly larvae identification during the harvest season. As for material costs, the traps, lures and Trichogramma shipments are relatively inexpensive, and are well worth the investment if they are used successfully.

In a second attempt at this project, there are a number of things that should be done differently. Traps should be set up in mid May and monitored vigilantly for the first signs of ECB moth flight. Trichogramma should be ordered as soon as any moths are identified in the field. To be safe, they should be ordered at least once a week, or even every two or three days if possible. This is the inundative approach suggested by some research. At least one thorough egg mass search should be conducted early in the season during the first flight, since egg masses should be easier to find on corn plants. Theoretically these measures should better protect the first generation of corn from ECB. Thereafter, weekly monitoring of traps should continue, although it seems that the next few generations of corn should be safe from ECB damage as was found this season. In preparation for the second flight in late July, Trichogramma should be ordered for

another inundative treatment, particularly if trap counts continue in double digits. As mentioned earlier, repeated egg mass searches at this stage will be less useful, but it may be worth it to conduct one or two. During the second flight, weeds should be kept down along the fields' borders because this is where the ECB eggs are more likely to be deposited. As harvests proceed, larvae identification in sample ears should be carried out and recorded to help establish if treatments have been successful. Finally, it would be useful to maintain both treatment and control areas with sufficient spacing between them. This would aid in gauging the success of egg mass parasitization and in comparing samples infested with live larvae.

To date, outreach from this project consists of the trap count data which was entered into the online PSU database every week for 14 weeks.

In conclusion, I (Jim) had more difficulty finding time to supervise this project than I had expected. I did personally harvest (with crew help) every patch of corn we planted. The worm damage in weeks 2 through 5 was minimal or none, which is better than other years, but damage did increase in later weeks. Overall, our harvest of marketable ears (2720 dozen) was better than any year in our history except 1999 (2962 dozen) and better than last year, 2001 (2528 dozen). But, unfortunately, we did not collect enough data to say for certain that the bio-control was the responsible factor in the success of the crop. Time pressures and work distractions kept us from staying focused on data collection.

Our biggest shortcomings were:

- Not identifying and counting live ECB in harvested ears on a regular basis, every harvest.
- Not having an isolated control (untreated) plot to compare with treated ones.
- Not having data from other years for comparison.

Next year I do intend to use Trichogramma ostriniae again, with releases timed to trap counts. I hope to do a better job of monitoring populations of live ECB in harvested ears. One economy I intend to use is to discontinue searching for parasitized egg masses, since so few were ever found. Also I hope we will be able to plant at least one control patch isolated from others, to be harvested in the period of high ECB pressure.

Jim Crawford
Holly Zipp
February 25, 2003

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David L. Holm
Program Manager, SARE
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November 19, 2002

Dear Mr. Holm:

(separate cover)

I am belatedly enclosing my paperwork for my SARE grant approved by your office on April 1, 2002. I apologize for my tardiness and will certainly understand if it has disqualified me. The documents were put on my desk and then buried under other paperwork when the spring farm work overwhelmed me. Things got away from me partly because I was briefly hospitalized at our busiest time (June). That was when I received your reminder.

Fortunately, while this was happening, we did nevertheless proceed to carry out the trichogramma project pretty much as planned, thanks to the work of my energetic employee Holly Zipp. Holly had been our apprentice in two previous seasons and this year came to take over all of our various pest control efforts, among other horticultural duties. She is very competent—a college grad with experience on another farm as well as her seasons with us—and she committed herself to carrying out the trichogramma program, working closely with extension entomologists at Pennsylvania State University. In May Shelby Fleisher of PSU came down to the farm to get Holly started. They set up a trapping/monitoring site so that Holly could follow the timing of the European corn borer flights as they varied through the summer.

During the season we planted and harvested eight successive certified organic patches of sweet corn, about 1/3 of an acre each, for a total of 2.4 acres, as we usually try to do, although this year's crop was more consistent and better yielding than many other years have been.

Holly ordered the trichogramma eggs on schedule and placed them in the patches. During the harvest (July 27 to Sept. 28) she collected data on the damage from the European corn borer. Results were a bit ambiguous, but overall we felt there was significantly less damage from this pest than we usually see. Holly is drafting a final detailed report, and we'll have it ready by January, consistent with the program I described in my application.

I hope I have clarified where we stand with this project. Whether or not SARE is able to continue working with us, we feel we learned a lot and it was worth doing. Please let me know if you need more information. Thank you for your patience.

Sincerely,

Jim Crawford

Jim Crawford