2002 Northeast IPM Project
Final Report

Grant Number: 2002-34103-11899

Title: **Multi-state evaluation of Trichogramma ostriniae in vegetable production.**

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States Involved: Virginia, Pennsylvania, Massachusetts, Maine, New York

Years Funded: 2002-2005
Funding Amount: $125,000

Non-technical Summary
This project represents multi-state testing of a biological control agent, Trichogramma ostriniae, to help manage European corn borer - a pest of corn, peppers, potatoes, and several other crops in the Northeast. There were three main components: 1) commercial-scale testing of the egg parasitoid, Trichogramma ostriniae, for biological control the European corn borer in New York processing sweet corn, 2) initial testing of inoculative releases of T. ostriniae to control the European corn borer in fresh market sweet corn in Northeastern states, and 3) initial testing of T. ostriniae to control the European corn borer in sweet peppers and potatoes.

C. Introduction
European corn borer (ECB), Ostrinia nubilalis, is a damaging pest of vegetables in the northeastern U.S. and elsewhere. In 2004, fresh market sweet corn occupied 215,300 acres and was valued at $411 million in the states affected by ECB. Additionally, processing sweet corn accounted for about approx. 314,000 acres and a monetary value of about $135 million. Sweet corn is the top ranked crop out of 35 crops grown on diversified farms in New York, New Jersey, Maryland, and Pennsylvania, with 60% of farms reporting commercial sweet corn production. Surveys show that the average diversified fresh-market grower in Pennsylvania derives 22% of the farm income from sweet corn. In Maryland, sweet corn is also ranked first in vegetable acreage, accounting for 38% of the total acres harvested for fresh market vegetables.
In the Northeast, the European corn borer (ECB) is the primary insect pest of economic importance in sweet corn. With uni-voltine and bi-voltine generations, ECB poses a risk to sweet corn over the entire season. Even when the sweet corn is treated with insecticides ECB can still cause economic losses. In controlled studies with insecticide treated sweet corn, ECB damaged ears were reported as high as 8%. In untreated fields, from 3 to 46% of ears may be unmarketable due to ECB. Less than 5% damaged ears is generally considered to be acceptable

in fresh market corn. The tolerance for damaged ears in processing sweet corn is somewhat higher, but still relatively conservative.
Biological control of ECB can provide an alternative to reliance on insecticides. Trichogramma ostriniae is a small wasp that parasitizes ECB eggs and our research since 1992 provides strong evidence that inoculative releases of T. ostriniae can successfully reduce ECB population levels and concomitant damage to sweet corn. Overall field parasitism can reach as high as 97%, ECB survival has been reduced as much as 30%, and ear damage has been reduced by 50%. By using T. ostriniae and integrating ECB egg mortality into scouting protocols, we can substantially reduce the number of insecticide applications.
Peppers are an extremely high value crop for vegetable producers, and are grown on more than 1,500 different farms in Delaware, Maryland, Pennsylvania, and Virginia and with about 500 acres grown in Massachusetts. Insect pest management is critical to producing a profitable crop of peppers and insecticide usage is intense. For instance, as many as nine to eleven insecticide applications are made per crop per season in the Mid-Atlantic Region. Most of the insecticides applied by growers are FQPA-targeted broad-spectrum toxins such as organophosphates and pyrethroids that are sprayed preventively with little to no knowledge of the pest population level. European corn borer, Ostrinia nubilalis, is the primary target of most of the insecticide sprays.
In this project, we tested and demonstrated augmentative biological control of ECB with T. ostriniae by evaluating its performance in Maine, Massachusetts, Pennsylvania, New York, and Virginia. Testing efficacy over a wide range of environmental conditions is a prerequisite to commercialization of the tactic in the Northeast and elsewhere. Commercialization, adoption and implementation of the method has now begun, and we anticipate that much of the sweet corn and pepper acreage in the Northeast might benefit economically from biological control of ECB with T. ostriniae.

D. Objectives
1) Evaluate the effectiveness of inoculative releases of T. ostriniae for suppression of European corn borer in sweet corn in several states and under a variety of pest pressures and agronomic environments.
We achieved this objective and showed that biological control of ECB eggs is feasible. Stalk and ear damage were also reduced, but that damage reduction can be inconsistent.

2) Integrate inoculative releases of T. ostriniae into pest management decision-making in sweet corn.
We achieved this objective and demonstrated that T. ostriniae has an effect on the decision to spray.

3) Cost benefit analysis of the release program for sweet corn.
We partially achieved this objective. After the first year of testing, it was questionable whether T. ostriniae would be cost effective in processing corn, so we modified our objective and conducted a lifetable study for European corn borer with and without T. ostriniae. The results showed that T. ostriniae was as effective as a single, well timed spray for reducing borer damage to ears.

4) Assess the potential for releases of T. ostriniae for control of European corn borer in peppers

and potatoes.
We achieved this objective. Pepper fruit damage was reduced with T. ostriniae, as was stem tunneling in potatoes. The results were sufficiently compelling to help secure additional funding to further test the potential for T. ostriniae in peppers.

5) Extend information on releases of T. ostriniae to vegetable producers in the northeast.
We have made good progress in disseminating the results of this research. Information has been disseminated to grower groups, extension personnel, private consultants, researchers, and educators. Currently, we have an agreement with IPM Laboratories in Locke NY for the rearing, sales and distribution to T. ostriniae to practitioners of biological control.

E. Approach
Processing sweet corn- Trials were conducted in 2002 and 2003 north of Penn Yan, NY. In each year of the study the parasitoids were released into 10-11 commercial processing sweet corn fields at a nominal rate of 30,000 females per acre using parasitized E. kuehniella eggs. Parasitoids were introduced to individual fields after regional European corn borer activity had begun and when the corn was approximately 40cm height. Each of those fields receiving the parasitoid was paired with a nearby control field of the same corn cultivar and a similar planting date but at least 300 yds distant to minimize contamination. At weekly intervals following the inoculative release, corn plants were examined for European corn borer egg masses. All egg masses that were found were collected and brought back to the laboratory to observe for any latent signs of parasitism. At harvest, 100 plants per field were assessed for frequency of damaged stalks and ears. Differences in number of insecticide application and number of times a treatment decision was reached based on sequential sampling were also analyzed.

Fresh market sweet corn- Releases were conducted in 2002 and 2003 in NY and MA. Each release field was paired with a nearby non-release field planted at the same time. A single release of 30,000 wasps per acre was made and release and non-release fields were scouted weekly starting at early tassel emergence. Growers received recommendations to spray fields if the fields exceeded a numerical damage threshold. At harvest, a 100-200 ear sample was collected from release and non-release fields and examine for ECB damage and larvae. Spray records were collected from growers for all fields. ECB levels in the field, damage at harvest, and insecticide applications were compared between release and non-release fields.

Evaluations in Pepper- We established T. ostriniae release and non-release plots of bell pepper at six locations in 2002 and three locations in 2003 in VA and PA. Release and non-release plots were separated by at least 200m and no insecticides were applied to pepper plots. We made four or five separate releases of ~30,000 to 50,000 T. ostriniae per release plot. Beginning on the day of first release until last harvest, we inspected 50 to 100 plants weekly in each plot for European corn borer egg masses. Peppers were hand-harvested and evaluated for damage. At each harvest, we inspected a sample of 100 fruit per plot for insect injury.

Evaluations in potato- In 2002 and 2003, we established T. ostriniae release and non-release plots of potato in Virginia and Maine. Parasitoids were released at approximately 30,000/acre. In mid-June in Virginia and in late Aug in Maine of both years, before potato plants dried down, we examined 200 randomly selected potato stems per plot for signs of ECB infestation to analyze

potential treatment differences in number of stems with tunnels and number of ECB larvae per 200 stems.

F. Progress

We conclude that T. ostriniae is effective at parasitizing a substantial portion of ECB eggs and that it can reduce corn ear and stalk damage. By including egg mortality into the sampling and decision process, T. ostriniae reduced the number of sprays recommended in fresh market sweet corn and processing sweet corn.

In processing sweet corn that is routinely sprayed, but relatively few times each season, we could not demonstrate a dollar cost benefit from using T. ostriniae. However, in fresh market corn, a single inoculative release that currently costs about $14/ acre was as least as effective as a single well timed spray, suggesting the potential for savings by using T. ostriniae.

Initial releases of T. ostriniae into peppers and potatoes caused significant reduction in damaged fruit and stem tunnels. Results were sufficiently compelling that funded research continues in Virginia, Pennsylvania, Maryland, Massachusetts and Delaware.

Information has been, and continues to be, disseminated in all participating states to growers, consultants, and extension personnel via talks, seminars, web sites, information sheets, in-service extension presentations and via retail sales.

G. Results

Processing sweet corn- In 2002, 62% of ECB egg masses were parasitized and in 2003 36% were parasitized. In 2003 the weather was cool and wet and ECB activity ramped up later in the season. As a consequence, T. ostriniae releases occurred during a lull in oviposition and did not begin to increase until 34 days after releases were initiated.

In both years of the study, the incidence of stalk damage by O. nubilalis was lower in fields receiving T. ostriniae and five of ten release fields benefited from T. ostriniae reducing stalk damage. Those fields were limited to the later planted fields. In 2003, five of nine fields benefited from releases but two of nine release fields had a higher incidence of stalk damage. The incidence of ear damage by ECB was not reduced by T. ostriniae in either year of the study, but ear damage was below economically damaging levels regardless of treatment. However, sampling based on protocols developed for fresh market sweet corn indicated that control fields were over threshold on 28 occasions compared to 19 for fields treated with T. ostriniae. The difference was not statistically significant.

Fresh market sweet corn- In New York 13 out of 29 fields had lower ECB damage levels in the release field compared with the non-release field. In both NY and MA, infestation levels at harvest were similar for release and non-release fields both years, and typically below the target level of 5% infestation, which would be expected since fields were sprayed if the threshold was exceeded. The real benefit of T. ostriniae can be seen when comparing the number of insecticide sprays- combining data from NY and MA, 40 insecticide applications occurred in control fields compared to 24 in fields receiving releases.

Peppers- In 2002, heavy pest pressure from ECB occurred in peppers at all four Virginia locations and moderate pressure occurred at the Pennsylvania locations. In 2003, low to moderate ECB pressure occurred at all three locations. Very little (1.9 ± 1.6%) parasitism occurred in ECB egg masses collected from non-release (control) plots, whereas, 48.7 ± 6.8% of

the egg masses collected from release plots were parasitized by T. ostriniae. At harvest, the percentage of fruit damaged averaged 27.3 ± 6.3% in control plots, and was significantly lower in release plots, averaging 8.7 ± 1.6%.

Potatoes- In both years, very few natural ECB egg masses were encountered in the potato plots and sentinels had very little (<1%) parasitism. Thus, parasitism data were not analyzed. The number of potato stems damaged by ECB was significantly less in T. ostriniae release plots. Similarly, the number of ECB larvae per 200 stems was significantly less in T. ostriniae release plots.

H. Impacts

The results of our research show that biological control with T. ostriniae could have substantial impact in the northeastern and mid-Atlantic states. There are several thousand acres of corn, peppers and potatoes that could benefit from reducing the number of insecticide sprays needed for European corn borer. The results are also transferable to other regions of the US where ECB is a pest.

Information regarding the use of T. ostriniae has been widely disseminated by cooperating researchers, ag consultants and extension personnel in NY, MA, PA and VA. This summer (2005), in the first season of T. ostriniae sales, the equivalent of 225 acres worth of T. ostriniae have been sold for use in sweet corn, peppers and grapes (grape berry moth), so we feel that the initial phases of adoption and implementation are under way.

The greatest economic benefits appear to come from reducing the number of insecticide sprays needed to maintain acceptable fruit quality, but in unsprayed crops yield improvement equates to profit. Because T. ostriniae currently costs approximately $14/acre and because it is so highly mobile the labor cost of a release is negligible (one release location per acre), biological control is now feasible and cost effective, and probably less expensive than conventional insecticidal control practices for European corn borer in sweet corn. For example, assuming a potential of 30% damaged ears in untreated sweet corn; a 50% reduction in damaged ears when using T. ostriniae; and an average of 900 dozen / acre priced at $3.00/ dozen, growers could receive a benefit of $405/acre, far outweighing the cost of the parasitoid.

We determined that augmentative releases of the parasitic wasp, Trichogramma ostriniae, can be a viable option for biological control of European corn borer in peppers and potatoes pepper, reducing damage by as much as 60-70%. Not only does this approach provide a useful and much-needed management tool for organic growers, it also provides an excellent IPM strategy for commercial conventional growers.

In peppers, 5 inundative releases of the parasitoid can minimize the need or reduce the number of applications of organophosphate or pyrethroid foliar insecticides, which are typically applied approximately 7 to 10 times per crop. In potatoes, two releases of T. ostriniae can eliminate the need for late-season foliar insecticide sprays of organophosphates, carbamates, or pyrethroids. We are confident that future adoption of the use of T. ostriniae for European corn borer management will reduce the amount of FQPA-targeted chemicals on vegetable crops such as sweet corn, peppers and potatoes.

This research has contributed to the implementation of IPM participating states. In Massachusetts this study was made public by: one to two newsletter articles per year with a circulation of 400 growers, advisors, and consultants in MA and New England; a presentation to 100 growers at the Northeast Vegetable Growers and Berry Growers Association; 10 growers

and educators were trained; in 2005, six growers used T. ostriniae. In Virginia, the work contributed to four refereed and five un-refereed publications, and eight presentations. Ultimately, this work represents the first practical biocontrol system for ECB in corn and peppers and encourages the use of pheromone traps for timing and better understanding of pest phenology. Also, this research and education effort expanded interest and increased collaboration with larger conventional sweet corn growers, and small-scale organic growers who do not use pesticides at all. In New York, the research led to three extension in-service presentations and two refereed journal articles. It has also led to the commercial sales of T. ostriniae.
Further research and demonstration is anticipated to: expand implementation; evaluate efficacy in ornamental corn; evaluate higher release rates to eliminate sprays in early corn; evaluate T. ostriniae integration into peppers IPM; test T. ostriniae against corn earworm; and to compare T. ostriniae with T. brassicae, the other Trichogramma species recommended for corn.

I. Appendices