Volume 97-4
SARE Project ANE95-26
April 1997

GROWER

NEW ENGLAND VEGETABLE AND SMALL FRUIT NEWSLETTER

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On-Farm Trials of *Bacillus thuringiensis* (*B.t.*) Products for European Corn Borer Control, 1994-1996—Final Report, Part I

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The UMass Vegetable Integrated Crop and Pest Management Program conducted on-farm trials of *B.t.* products in early-season sweet corn for three years, from 1994-96. The purpose of these trials was to determine whether products containing *Bacillus thuringiensis* (*B.t.*) can control European corn borer (ECB) as effectively as conventional broad-spectrum insecticides.

European corn borer is the only caterpillar pest of sweet corn during the early season, before corn earworm and fall armyworm migrate into the region. Early plantings of sweet corn typically receive one to

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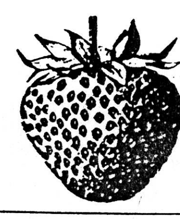

Bacillus thuringiensis

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four insecticide applications for control of ECB. Previously, sweet corn farmers have had no alternative to broad-spectrum insecticides for ECB control. If growers can replace these with products containing Bacillus thuringiensis, they will reduce the health risk to themselves as applicators, reduce environmental risk to air and water, and conserve natural enemies of several corn pests. In addition, if growers can use the same timing, equipment and number of applications as they normally use, then this change can occur at no extra cost to growers.

Methods

Farmers were involved in planning, implementing and evaluating this project. A total of seventeen farmers participated in the three-year project, including ten to thirteen farms per year. Farms were located in six counties in central and western Massachusetts (Figure 1). Each farmer divided one early planting of one cultivar into two blocks, one receiving applications of a *B.t.* product and the other a broad-spectrum insecticide for control of ECB. Several additional farms compared *B.t.* treatments to unsprayed corn (control). Scouting was conducted by UMass field assistants or private IPM consultants, and all the crop management was done by the farmers. *B.t.* products tested included Dipel ES™ (Abbott Laboratories), MVP™ or MVP II™ (Mycogen Corp.) and Condor OF™ or Condor XL™ (Ecogen, Inc.). A spreader-sticker was used with all the *Bt* products. Conventional products included methomyl, permethrin, esfenvalerate and thiodicarb. In certain instances, an early corn earworm (CEW) flight necessitated a single spray of a broad-spectrum insecticide to the entire planting

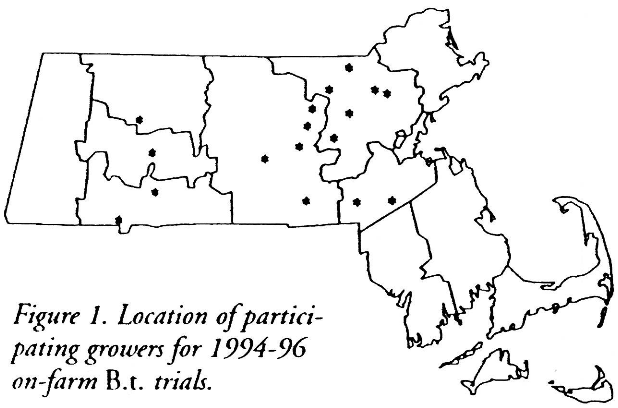


Figure 1. Location of participating growers for 1994-96 on-farm B.t. *trials.*

during the silking period. This occurred on four farms in 1994 and six farms in 1996. CEW damage, if it was present, was not included in the harvest data.

Growers timed their sprays according to the standard UMass IPM system. They started applications at the pretassel or green tassel stage, when fields were >15% infested with ECB larvae. Both conventional and *B.t.* plots received the same number of treatments, five to seven days apart, for a total of one to four applications. Farmers used their standard spray equipment, which included both airblast and boom sprayers. *B.t.* products were applied with a sticker (with three exceptions in 1994 and 1995). Rates were moderately high; Dipel ES, MVP II and Condor XL were applied at 2, 3 and 1.5 pts. per acre, respectively. At harvest, farmers sampled at least 200 unculled ears from each treatment and examined them for ECB feeding damage. Ears with any damage to the kernels or tip were considered unmarketable. Superficial feeding damage on the husk was noted but not considered unmarketable.

In the 1996 trials, we also assessed the impact of the two insecticide treatments on beneficial insect populations. On six different farms, fifty plants per treatment were examined on two sample dates after at least one insecticide application. All beneficial insects were counted, identified and classified as either dead or alive. Beneficial insects included coccinellids (including *Coleomegilla maculata,* the 12-spotted ladybeetle and *Harmonia axyridis,* the multicolored Asian ladybeetle), insidious flower bugs (*Orius insidiousus*), various other species of predatory bugs (Hemiptera) and lacewings (Neuroptera). These predators attack European corn borer eggs and larvae as well as corn leaf aphids.

For statistical analysis, each trial, whether on the same farm or different farms, was considered one replicate. Sprayer type (boom vs. airblast) and *B.t.* products were also tracked and compared for efficacy during the three-year project. These data were analyzed with the SAS™ statistics program, using ANOVA and Duncan's Multiple Range Test. Student's t-test (p = .05) was used to compare the percent of ECB damage and the beneficial insect counts from the *Bt* and conventional treatments.

Results

1994: *B.t.* vs. conventional. Thirteen trials on ten farms were successfully completed and generated

Table 1. Comparison of Average Percent Damage from ECB in *Bt* and Conventional Blocks[1]

Year	# of Trials	*Bt*	Conventional
1994	13	4.6	2.8
1995	11	4.3	3.2
1996	12	6.6	5.9
1994-96, pooled	36	5.1	3.9

[1]Means of the two treatments in each row are not significantly different. (t-test, p+0.05)

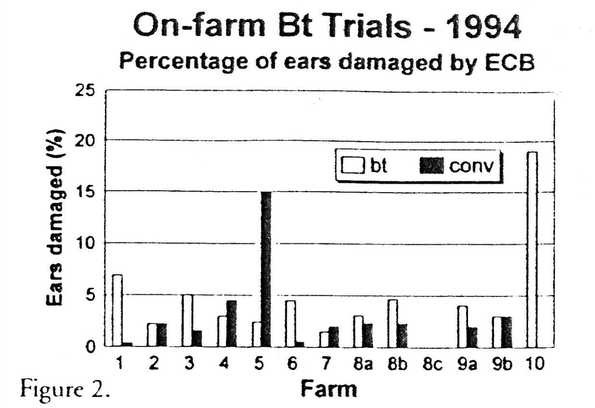


Figure 2.

harvest data (Figure 2). ECB infestation in the trial fields at the pretassel stage ranged from 12% to 98%, averaging 44%; all but one of the trials were above the 15% treatment threshold at this stage. At harvest, the average ECB damage was slightly higher in the *B.t.* (4.6%) than in the conventional treatments (2.8%), but the difference was not statistically significant (Table 1). *B.t.* plots ranged from 2% to 19% damage and conventional plots ranged from 0% to 15% damage.

If the trials are separated into those farms where CEW flight occurred and farmers applied a broad-spectrum pesticide once during silking, and those farms where no CEW was present and silk remained unsprayed, there was no difference in ECB damage (4.7% vs. 4.3% respectively).

***B.t.* vs. unsprayed.** In three trials, *B.t.* was compared with unsprayed blocks (Figure 3). Because of an early CEW flight, tip damage from CEW was significant on all three farms. In their harvest sample, growers separated ECB damage from CEW damage. The average damage from ECB in *B.t.* blocks was 3.4% compared to 19.9% in unsprayed blocks.

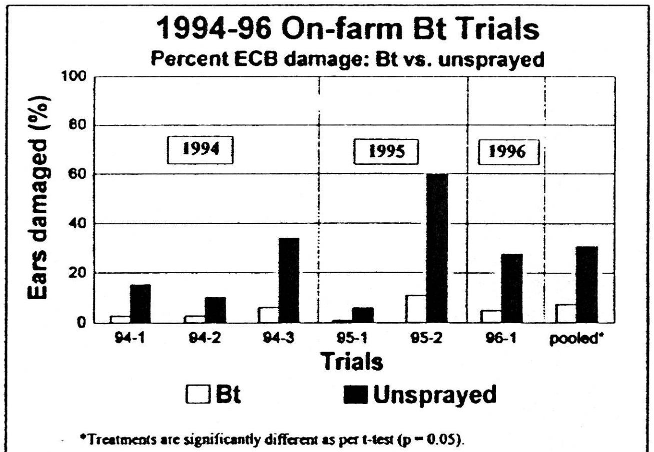


Figure 3.

1995: *B.t.* vs. conventional. Eleven trials, on eight farms, successfully completed the trial (Figure 4). ECB infestation in the trial fields at the pretassel stage ranged from 6% to 72%, with an average of 32%; all but one of the trials were above the 15% treatment threshold. There was no statistical difference between the ECB damage in *B.t.* vs. conventional plots (4.3 vs. 3.2%, respectively). The level of ear damage ranged from 0% to 13% in *B.t.* plots, and 0$ to 11% in conventional plots.

***B.t.* vs. unsprayed.** Two additional farms compared *B.t.* to unsprayed treatments. Unsprayed corn averaged 33% infested ears at harvest, compared to 6% infested ears in the *B.t.* blocks. One farm had 99% clean corn with *B.t.*, and the other had 89% clean corn (Figure 4).

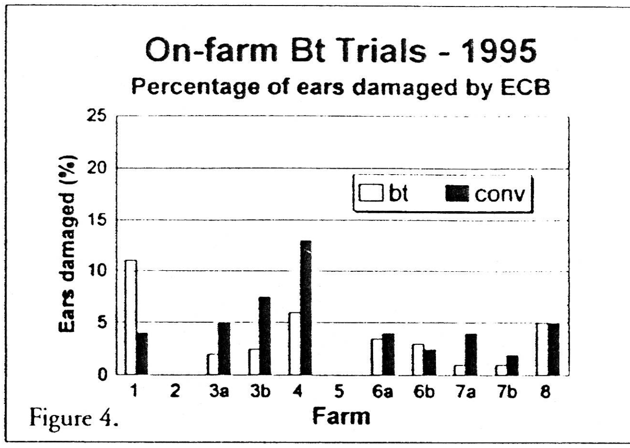


Figure 4.

1996: *B.t.* vs. conventional. Twelve trials on ten farms were completed (Figure 5); ECB pressure was high, and all trials exceeded the action threshold of 15%. ECB infestation at the pretassel stage ranged from 28% to 78%, averaging 51%. The level of ear damage ranged from 1% to 24% in *B.t.* plots and 0% to 24% in conventional plots. On average, there was no difference in damage between *B.t.* (6.6%) and conventional treatments (5.9%). Farms that needed to use a single silk spray to control an early CEW flight and those that did not showed no difference in ECB damage at harvest.

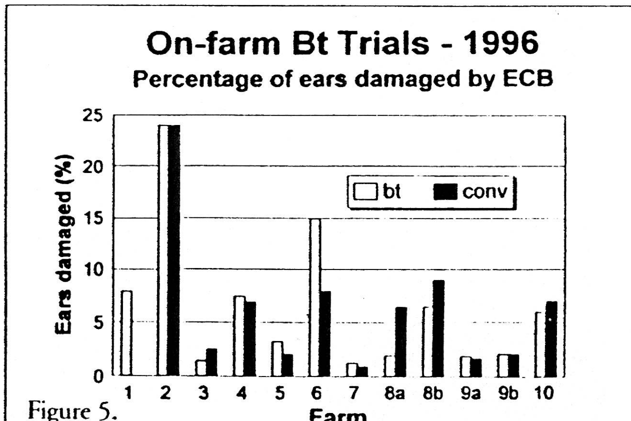


Figure 5.

***B.t.* vs. unsprayed.** One farm compared *B.t.* to unsprayed corn. The result was 4.8 % damage in the *B.t.* block, and 27.8 % in the unsprayed block.

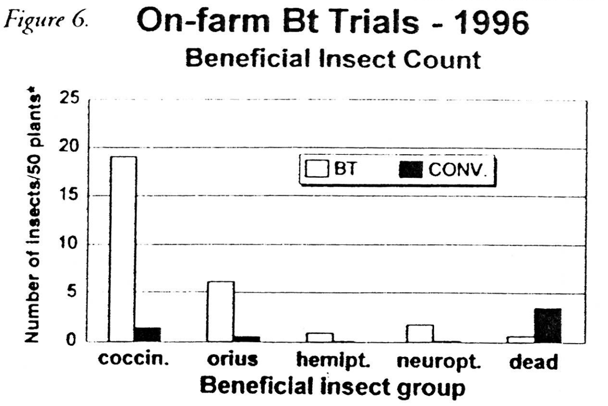
Continued

Bacillus theringiensis

Continued from page 3

Beneficial insects. All four groups of predators (ladybeetles, insidious flower bugs, other Hemiptera and lacewings) were more numerous in the *B.t.* blocks (Figure 6). In addition, there was a higher number of dead beneficial insects in all conventional blocks (Figure 6).

Figure 6.



*Numbers represent means from each sampling date.
Note: There was a significant difference between treatments for each insect group listed (t-test, p=0.05).

Summary, 1994-1996

A total of forty-two trials were completed over the three years. Thirty-six of these compared *B.t.* to conventional insecticides; six compared *B.t.* to an unsprayed plot.

Throughout the three-year trial period, European corn borer pressure was high. The level of infestation at the pretassel stage when treatments were initiated exceeded the action threshold in 34 of the 36 trials. Infestation ranged from 6% to 98% with an overall average of 43%, far in excess of the level that will result in ear damage if left uncontrolled. In many cases, infestations remained high during tasseling, and two to three applications were required to achieve control. This occurred in both *B.t.* and conventional blocks.

In trials with unsprayed corn, damage from corn borer in untreated plots was high, averaging 25.5%. *B.t.* significantly reduced the damage from ECB, with an average damage level of 4.6 % (Figure 3).

The *B.t.*-based products were as effective as conventional products in controlling pest damage to the ears. The average damage for all 36 trials was 5.1% in *B.t.* blocks and 3.9% in conventional blocks, a difference that is not statistically significant (see Table 1). Over the three-year period, control with both *B.t.* and conventional products ranged from 76* to 100%.

The three *B.t.* products were comparable in effectiveness. Based on three years of data, the average ECB damage was 6.1% for Dipel ES, 4.9% for Condor and 4.4% for MVP, not a significant difference.

Airblast and boom sprayers resulted in equally good control (up to 100% clean ears) when applying *B.t.* Ear damage averaged 5.6% for airblast sprayers (n=20) and 5.0% (n=13) for boom sprayers.

The use of a spreader-sticker may have improved the effectiveness of the *B.t.s.* Two instances where growers did not include a sticker resulted in poorer levels of control than conventional products. 1996 trials at UMass Research Farm did not show a significant benefit from a sticker but suggested that some products may be improved by adding a sticker.

Editor's Note: Part II of this final report on the use of *B.t.* products will be in the next issue of the *Grower.* Grower evauations, discussion and recommendations will be covered.

Summary of Mycostop Trial on Greenhouse Tomatoes

Vern Grubinger
University of Vermont Extension

Greenhouse tomatoes in Vermont are generally grown in ground beds filled with compost-amended soil. It is common to find signs of disease on roots in such plantings, especially on the popular cultivar, Buffalo, and, in particular, after a greenhouse has been in tomatoes for several years. Typically, older roots will have numerous dark, slightly sunken lesions, and secondary roots may be completely brown, sometimes dry and shriveled. On several occasions, the UVM Plant Diagnostic Lab has identified *Rhizoctonia* on roots with these symptoms.

Mycostop is a biological fungicide labeled for use on many crops, including greenhouse tomatoes, to suppress several soil-borne diseases, including *Rhizoctonia.* A trial using Mycostop as a soil drench treatment was conducted in 1995 in a commercial greenhouse that had the root disease symptoms described above in previous years.

Tomato seeds of the cultivar Buffalo were sown on January 6 in plug trays containing equal parts of peat and vermiculite. Transplanting took place on February 1 into 5" pots containing a mix of 4:2:1:1 peat:compost:vermiculite:perlite plus an organic nutrient mix of limestone, greensand, dried blood and bone meal. On February 24, stocky plants with

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Custom Processing Small Fruits

R. Alden Miller
University of Massachusetts Marketing Specialist

There are too many jobs on a farm to get them all done properly and, in some cases, economically. Most businesses farm out certain procedures where they can be done more efficiently.

Small New England farms lend themselves to special operations, whereby, value can be added to the products. If a farm is limited in production volume, additional value of that production is needed to increase farm income. Also, our rather short production season means that any sales period that can be extended beyond the time when farm fresh products are normally available would be advantageous.

Two years ago, two Massachusetts small fruit farms explored the possibility of having some small fruits custom processed. On one of the farms, returns per pound of raspberries after production, picking and wholesale sales was zero; sold by U-Pick was 15 cents per pound; by farm retail stand $1.00 per pound; and by custom-processed, eight-ounce jars $3.10 per pound of product. The other farm netted 90 cents per

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Custom Processing

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pound when U-Picked; $1.60 when sold through its stand; and $3.29 per pound of fresh product when processed and then sold in various places.

The approximate cost of the farm products and custom processing ran about 95 cents per eight-ounce jar and retailed for $3.00 to $3.35, depending upon the retail clientele. Further advantages of selling fresh fruit as a processed item are reduced waste during the production season, developing a market for a lower quality yield and extending the farm's income period.

Probably the most difficult part of the project is to find a custom processor. There are a few companies that will pack in small glass jars on a custom basis. Out of several possibilities in Massachusetts, we located one ideal operation.

Basically, the way the program works is that the producer must provide a 130-pound (determined by our particular processor) batch of frozen small fruit. A 130-pound batch will yield about 480 eight-ounce jars. With hulled strawberries, the batch is one part by weight of sugar and four parts of berries. This helps holding color and aids in thawing for processing. Raspberries and blueberries are farm frozen without the sugar. Once the volume you want to process is frozen and stable, the batch is then scheduled for processing and delivered. Our custom processor will hold the farmer's frozen product for a few days until processing is on line and thawing the product is under his control for processing.

After processing, the farm then picks up the cases of jars for farm labeling, unless labeling has been arranged with the processor. The processor knows all the laws, rules and health control aspects of the job. That is part of the technology and service provided by the custom processor.

A custom processor probably will work with a producer to develop special blends or quality products. However, expect to pay a food technologist for this additional service. If the customer is content with a generic batch run, there should be very little startup cost.

Growers participating in the project indicated that freezing 130-pound batches was not a problem. For very small operators, we are investigating the possibility of blending the contributions of several farms into a larger batch. Each contributing farm would get a proportion of the processed goods. One farm with some freezer space will serve as a cluster or staging area, take all the product to the processor and return it to the cluster for participating farm pickup. A generic state or other label could be used, or individual farms could label their own. If a farm should receive more product back than can be sold, the cluster operator could also serve as a distributor to other retailers.

More information on custom processing can be obtained from the author or from Bonita Oelke, Massachusetts Department of Agriculture, 617-727-3018.

On-Farm Trials of *Bacillus thuringiensis* (*B.t.*) Products for European Corn Borer Control

Final Report, Part II

Ruth Hazzard
Jeffrey Lerner
Suzanne Lyons
University of Massachusetts IPM

Grower Evaluations

Growers were asked about their assessment of the *B.t.* products. Fourteen (82%) were satisfied with the control they achieved with *B.t.* and plan to use *B.t.* products in all or part of their early corn in the future. Three (18%) were not completely satisfied and felt that they needed to test *B.t.s* further, on a trial basis, before using them widely on their farm. Two growers observed more feeding damage on the husk than was acceptable to them; the rest had no problem with husk damage in *B.t.* plots.

When asked about their reasons for using *B.t.*, growers most often listed applicator safety. They like handling a safer material. Relations with neighbors was also given as a plus. With the *B.t.s*, they don't have to be as concerned about drift of highly toxic materials. Fields do not have to be posted with bright restricted pesticide signs as they do with conventional products. Farmers also like the fact that *B.t.s* are easy on beneficial insects and that workers can reenter the fields within hours after an application. As long as they can count on good control, they said that they, if necessary, would be willing to pay a little more for a product that is safer to handle.

Discussion

These results show that *B.t.* products can be integrated into a standard IPM system for European corn borer control as a direct replacement for conventional broad-spectrum insecticides. This is a situation where a safer, equally-effective product can be used without additional cost to the grower. Cost, in this context, is more than just the cost of the product itself. *B.t.* products do cost the same or only slightly more than conventional products ($9 to $15/acre/application). Other significant costs are the farmer's management time for scouting and spraying, the cost of equipment and the cost of any crop losses from insect damage. These, too, are equivalent with conventional and *B.t.* products. The benefits of *B.t.*s—more worker safety and easier relations with neighbors—should not be underestimated. These are also part of the cost of farming today.

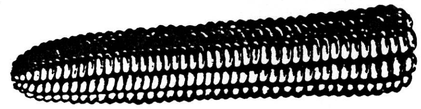
The beneficial insects that are conserved under a *B.t.* regime can potentially have an impact on the whole farm. Early corn is one of the most attractive habitats on the farm for predators seeking food in June and early July. Aphids, insect eggs, pollen and caterpillars are all found there. The lady beetles, insidious flower bugs and other predators that feed in early corn will reproduce and, along with their offspring, will move into other habitats as the season progresses. The corn leaf aphids found in late corn and the green peach aphids found in potatoes may be suppressed by the offspring of the beneficials that fed in early sweet corn!

Recommendations

The following practices are suggested for farmers who want to use *B.t.*s for European corn borer (ECB) control in sweet corn:

- As with any new product or practice, test *B.t.* products on just one section of early corn first, before committing a large amount of acreage.
- Monitor ECB flight with pheromone traps, and begin scouting early corn fields at the pretassel stage after first-generation flight has begun. Use the 15% threshold.
- When applying *B.t.* products, use an adequate rate. We have used rates that are at least two-thirds of the maximum label rate. Lower rates may give poorer control.
- Spreader-stickers may be helpful, especially with some products. Our results are inconclusive on this issue. They can be used without adding significantly to the cost (less than $1 per acre/application) and may be of significant benefit; a conservative approach is to include a sticker with the *B.t.*
- As always, make sure you have good spray coverage of the tassel and ear zones of the plant throughout the entire block of corn.
- Make applications five to seven days apart. A study at UMass showed that weekly treatments with *B.t.* were as effective as twice-weekly treatments. Use spray intervals that have worked effectively for you in the past.
- Corn should be rescouted after one or two applications to determine the need for more treatments. If ECB flight is high during tasseling and silking, new larvae may be hatching and controls may be needed to protect ears.
- If CEW arrives during the silking period, switch to a broad-spectrum material. Although larvae are susceptible to *B.t.* toxins, many larvae enter the ear without feeding and, so, will not ingest a toxic dose. *B.t.*s will suppress CEW but not to an acceptable market level.
- In late-season corn, during the second ECB flight, *B.t.*s can be used whenever corn is infested with ECB but CEW is not present. For example, *B.t.* can be used to control ECB at the tassel stage, followed by broad-spectrum materials against CEW during silking.

Note: We would like to express our appreciation to the following farmers and consultants who participated in this study: John Arena, Jr., Gordon Bemis, Jeff Bober, Jeff Cole, Paula Cruz, Ken Foppema, Dave Harper, John Miczek, Steve Mong, Ron Patenaude, Ray Rex, Laura Tangerini, Jim Ward, John Weinach, Tim Wheeler, Paul Willard, Sandy Williams, Mike Yates, and Jim Mussoni; and to Abbott Laboratories, Mycogen Corp. and Ecogen, Inc. for supplying product and financial support. We would also like to thank Jeff Lerner, Suzanne Lyons, Dan Wasiuk, Mark Mazzola and Joe Marcocia for technical support. This work was supported in part by funding from USDA, Northeast Region SARE/ACE program, grant # 95ANE95.26 #1.



Dacthal to be Discontinued

Richard A. Ashley
Extension Specialist, Vegetables

I recently received word that the herbicide Dacthal will no longer be manufactured. The producer will continue tolerances for a period of time, likely several years, to enable stores of the product already on hand to be used.