Development of Bio-intensive Integrated Pest Management for Sweet Corn

Ruth Hazzard and David N. Ferro
Department of Entomology

Mary Jane Else
Dept. of Plant and Soil Sciences

Bob Christensen
Department of Resource Economics

Sweet corn is a key vegetable crop in Massachusetts, accounting for approximately 40% of the land in vegetables (7,800 acres) and 30% of the crop value (1987 Census of Agriculture). Conventional sweet corn production uses significant amounts of insecticide and herbicide. Through pest monitoring, accurate timing of applications, and improved spray coverage, the Sweet Corn IPM program has reduced insecticide use by 40-60% on cooperating farms, but these farms still make an average of 3.2 insecticide applications per crop (Hazzard, 1990). To make further reductions, we need to develop new management tactics that are not dependent on broad-spectrum insecticides. For weed control, many IPM growers have reduced their herbicide application rates by delaying the timing of application. However, we believe that herbicide use can be reduced even further by use of banded application or by using cultivation only, without herbicide. In all cases, the cost and efficacy of these alternatives must be evaluated to determine if they are practical for use by commercial farmers.

The next stage of development of the Sweet Corn IPM program is to explore the use of bio-rational insecticides, biological controls, and cultural methods for weed and insect control, as well as biological sources of crop nutrients. The Nutrient Management project within Vegetable IPM is examining use of legume/grass winter cover crops as a nitrogen management tool that can absorb free nitrogen in the fall and supply nitrogen to summer crops after being plowed under in the spring. Our ultimate goal is to develop a fully "bio-intensive" system in which chemical controls are not needed for the management of either weeds or insects, and in which a major portion of crop nutrients are derived from biological sources. We foresee gradual movement toward this goal as our knowledge of alternative methods develops and these methods are shown to be practical and effective on a farm scale. Research begins by addressing insect and weed control and nutrient management independently, followed in future years by studies which integrate the most successful tactics. A sustainable sweet corn farming system will incorporate a variety of practical, alternative methods that meet the mutual goals of environmental protection and successful crop production.

European corn borer (*Ostrinia nubilalis*) is a key pest of sweet corn throughout Massachusetts. In June and through much of July it is often the only major insect pest, one which requires 1-4 sprays even under IPM management. Because of broad-spectrum insecticides used against European corn borer (ECB), natural enemies of both corn borer and corn leaf aphids are depleted in corn fields. Outbreaks of aphids which require further insecticide applications are common. If bio-rational insecticides such as those based on the bacteria *Bacillus thuringiensis* (BT) were to be used for corn borer control, most corn growers would not need to use a synthetic insecticide until late July or August when migratory flights of corn earworm threaten late-season plantings of corn. BT materials have been used successfully in both potato and cabbage IPM programs in Massachusetts and offer both environmental and economic benefits. (See attached fact sheet on *Using B.t. for Insect Control*). In recent years several biotechnology companies have developed new strains or new formulations of BT which have high levels of activity against the European corn borer. Several of these are registered for use in sweet corn,

but few growers currently know about or use these products. We need to test their efficacy and understand appropriate timing and thresholds before recommending these as part of an IPM system.

European corn borer (ECB) is an introduced pest which is poorly suppressed by the existing natural enemies, both native and introduced, in Massachusetts. The opportunity exists for classical biological control through introduction of new parasites of ECB. *Trichogramma ostrinae* was imported in 1990 by Dr. Ferro from temperate regions of China, where it parasitizes the eggs of its native host, the Asian corn borer. This species overwinters successfully in temperate climates and causes high levels of parasitism without annual innundative releases. Evidence to date under both laboratory and field conditions show *T. ostrinae* to readily parasitize the European corn borer. *T. ostrinae* was released at several sites in Massachusetts and New York in the summer of 1991, and was recovered from all sites at the end of the growing season. Because other researchers are examining other species of *Trichogramma* for controlling the European corn borer, we are focusing our efforts on *T. ostrinae*.

The need for alternative weed control methods in sweet corn in Massachusetts is particularly urgent because the 1992 Groundwater Protection Regulation (333CMR 12.00) requires sweet corn growers in Zone II areas to eliminate use of the most viable herbicides, metolachlor and atrazine. Alternative chemical controls which are available are less effective, especially for broadleaf weed control, and are more difficult to use. The treatments which will be tested in this study are those which we regard as the most viable responses to these regulations, and therefore those which are most likely to be adopted. These include dramatically reducing the rates of the materials considered to be potential groundwater contaminants by banding them or delaying their application, or using cultivation alone. All corn growers are aware of pressure to reduce or eliminate herbicide use, and will benefit from this study.

Non-chemical weed management methods available to growers of vegetable crops include cultivation, mulches, cover crops, crop rotation, fallowing, manual control, and biological control. While all of these methods hold some promise as means of reducing weed pressure, only cultivation will provide the level of weed control needed for good sweet corn yields on a farm scale. Because of the low value of the crop per acre relative to other horticultural crops and the availability of effective and relatively inexpensive chemical controls, cultivation has not been widely adopted as the primary weed control method. It is commonly used for between-row weed control and incorporation of side-dressed nutrients, but only as a supplement to herbicides. Achieving in-row weed control with tractor-mounted equipment is the key challenge with this approach and must be done successfully to make cultivation economically viable, because hand weeding is prohibitively expensive in this crop. Cultivating equipment now exists which can provide in-row weed control, but is generally owned and used only by organic growers. Little information is available on the effectiveness and costs of using cultivation or reduced-rate methods for weed control.

Few studies have been done on the costs and returns of alternative practices in vegetable crops. Sweet corn production in Massachusetts operates with marginal profitability, and growers will adopt new practices only if the economics favor those methods. Therefore economic assessment of any alternative management methods is essential.

1992 Projects

I. Evaluation of Trichogramma ostrinae, an egg parasite of European corn borer.

T. ostrinae was released on 4 farms in 1991. It was recovered from each of these sites at the end of the season. Growers left the late plantings standing to encourage overwinter survivorship of this wasp. In the spring of 1992, sentinel European corn borer egg masses were placed in these fields and returned to the lab after 3-4 days' exposure to assess whether T. ostriniae survived the winter. The parasite was recovered from two locations.

At the South Deerfield research farm, *T. ostriniae* was released weekly into early and late sweet corn plantings. European corn borer egg masses were placed in the field and returned to the lab to be evaluated for parasitism. Studies are also being conducted on the searching efficiency of the wasp at various densities of ECB egg masses in the field. Corn will be left standing over the winter as a refuge for *T. ostriniae* and its survival evaluated in spring of 1993. The South Deerfield farm provides a secure release site for establishing this new parasite of ECB. The parasite will also be released on several additional farms in 1992.

II. Field testing of new formulations of *Bacillus thuringiensis* (BT) products for control of European corn borer.

Replicated field trials are being conducted at South Deerfield on the efficacy of B.t. products for controlling both the first and second generations of European corn borer. We are also looking at two non-chemical methods for controlling a key late-season corn pest, the corn earworm. B.t products have also been evaluated at two cooperating farms. Both farmers reported excellent control of first- generation borer (<2% infestation of harvested ears) with two applications of B.t. In one case, the untreated control block had infestation levels of 35% in harvested ears.

III. Comparing efficacy and cost of alternative weed control methods.

At eleven cooperating farms, we are evaluating two methods which reduce the rate of herbicide application as well as the use of cultivation without any chemical weed control. One reduced-rate method is delaying the application of herbicide until just after corn germinates, when it is at the "spike" stage. Lower rates applied at this stage can be equally effective as high rates used at the time of planting, because the herbicide is applied just at the time when it is needed, which is when the weeds are germinating. The second reduced-rate method is application of herbicide only in a band over the row, with between-row weed control achieved by cultivation. The non-chemical weed control method is use of 3-5 mechanical cultivations from before germination until the corn canopy closes over the row, to control weeds as they germinate both in and between the rows. At each farm, one corn planting has been divided into a treatment plot where one of the alternative methods is being used, and a control plot for comparison. This study is being conducted on both organic and conventional farms.

IV. Cost and returns analysis of alternative management methods for weeds and insects.

Production costs for each of the alternative methods are being compared with the costs of conventional practices and current IPM practices. Data being collected includes machinery costs, labor, cost of materials, and yield.

Funding

This research is being supported by a Conte Grant of $18,000 from the University of Massachusetts and by the annual state and federal allocations for the Vegetable and Weed Integrated Pest Management Programs of the University of Massachusetts. In addition, the USDA/APHIS/PPQ Biological Control Laboratory in Mission Texas will provide rearing and shipping of Trichogramma ostrinae for release in Project I.