

Demonstrating New Technologies for Improved Corn Rootworm Management

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Abstract:

On-farm demonstrations were initiated at the Cornell Musgrave Farm, Aurora and the Cornell Teaching and Research (T&R) Farm, Harford, to present, compare, and evaluate new and emerging corn rootworm (CRW) management strategies. In this second phase of a three year project, two ca. 0.7 acre field sites (Musgrave Farm field "X" and Animal Science Teaching and Research NYSEG field) were planted to a corn rootworm resistant (Bt transgenic) hybrid and a non – transgenic hybrid receiving one of the following treatments: no soil insecticide (control), conventional soil insecticides: Force 3.0 G, Lorsban 15G or Counter 20 CR, insecticide seed coatings: Gaucho (seed corn maggot rate), Prescribe (CRW rate), or TI-435. Treatments were compared for relative corn rootworm protection.

In addition to these treatments, ca. 0.7 acre plots of pumpkins and field corn were late planted at each site as trap crops to attract mature corn rootworm beetles (*Diabrotica* species). These sites attracted a concentrated infestation of gravid CRW females to provide a suitable number of eggs for a location to establish the CRW control comparison demonstration in 2002. Year 2 objectives have been completed and a summary of activities is presented.

Introduction and Justification:

Over the past decade, the western corn rootworm (CRW) has become established as the predominant insect pest of field corn in New York. The western CRW is more economically damaging than the ubiquitous northern CRW species. This potential for higher losses has increased grower awareness and concern of potential risks of CRW. Corn grown for silage is at particular risk from rootworm injury (Davis 1994).

Crop rotation is the most effective tactic to avoid CRW losses. This option, however, is not always possible given a farm's cropping or annual livestock feeding needs, constraints on land resources or other factors. CRW active soil insecticides, a second management option, can be relatively expensive, are toxic to handle and may not always provide adequate control.

Colonization by the western corn rootworm in NY over the past decade has been responsible for dramatic increases in overall soil insecticide use. A 1985 pesticide survey reported that 13.8% of NY's corn acreage received a soil insecticide (Specker et al 1986). By contrast, a 1994 NY PIAP survey found that 70.3% of corn for grain acres and 17.3% of corn for silage acres were routinely treated with an insecticide. Presumably a significant proportion of these insecticide applications were for CRW management (Partridge et al 1995).

Several advancements in CRW management are currently in development and are expected to be commercially available in the near future. In 1999, transgenic hybrids resistant to CRW were tested on a national level. Companies developing these hybrids originally projected commercial release in 2001 to 2002. Current estimates target commercial release in 2003 or 2004. Given the economic importance of CRW, it is anticipated that grower interest in these hybrids will be high. Bt hybrids for European corn borer (ECB) control first became commercially available in 1996. Some analyst's project that market penetration by these new CRW resistant releases will quickly

exceed the 20 - 25% national corn acreage market share currently occupied by transgenic ECB Bt-corn hybrids. Some predictions estimate as high as 75% market share.

In addition to transgenic hybrids, two companies are testing insecticide seed coating treatments for controlling CRW. Gustafson, Inc. (Dallas, TX), Inc. has a new insecticide seed treatment, imidacloprid, under development which at a low rate is effective against seed corn maggot (Gaucho) and at a higher rate is effective against low to moderate CRW populations (Prescribe). Bayer, Inc. (Kansas City, MO) is developing a new insecticide, clothianidin (TI-435), now in commercial and university trials. These treatments offer the potential benefits of efficacy, combined with a user-friendly CRW insecticide delivery method and an environmentally sensitive low a.i. rate per acre. Properly deployed, these novel tactics offer much promise to enhancing our CRW management options.

This demonstration presents and compares root damage and yield effects of these new CRW management options compared to conventional CRW soil insecticides and to no treatment. The results from this demonstration have been featured at annual farm field day event(s) and shared with a larger clientele audience through CCE outreach efforts such as the Cornell Field Crop Dealer meetings and other CCE venues. This project complements other studies designed to develop and test CRW insecticide-resistance management strategies (Cox and Shields, Shields and Calvin).

Objectives:

- 1) To introduce and compare effectiveness of new CRW management technologies.
- 2) To enhance development and outreach of new CRW management technology information and provide a timely forum for the discussion of benefits and concerns associated with their use.

This is the second year of a three year project.

Procedure:

Year 1 (2000).

CRW infestations were promoted in the selected study areas of the Cornell Musgrave Aurora) and Teaching and Research (Harford) farms. Trap crops were planted approximately one month after emergence of surrounding corn at each location. A mixture of cucurbits and field corn was planted, ca. 0.7 acres, in mid-June 2000 to attract late-season CRW infestation and encourage egg laying in the two study locations. Late maturing corn fields can attract large numbers of corn rootworm beetles since neighboring, more mature, corn may have stopped producing pollen, the beetles preferred food. Corn rootworm beetles are also naturally attracted to cucurbitacin produced in blossoms of members of the squash family. Standard agronomic practices, site preparation, fertility, seeding rates, herbicide use, etc. were utilized to establish trap crops. See the 2000 NYS LFC / IPM Reports for more information.

Year 2 (2001)

Research and demonstration plots of field corn were planted at Cornell's Musgrave farm (Aurora) and Teaching and Research farm (Harford) to evaluate new technologies managing corn rootworm. Plots were established at Harford on May 24 and at Aurora on May 25. Individual treatments were randomized and planted to one hundred foot rows. The experiment was replicated four times in a random complete block. Replications were separated by a twenty-five foot border. Treatments at each location were:

Conventional hybrid (Pioneer 37M81, 97 Day) treated with one of the following:

1. Force 3.0 G (tefluthrin, CRW soil insecticide, T-band, 4 oz. / 1000 linear feet, Syngenta Agribusiness, Inc. Basel, Switzerland)
2. Lorsban 15G, (chlorpyrifos, CRW soil insecticide, T-band, 8 oz. / 1000 linear feet, Dow AgroScience, Inc. Indianapolis, IN)
3. Counter 20 CR, (terbufos, CRW soil insecticide, T-band, 6 oz. / 1000 linear feet, BASF Corporation, RTP, NC)
4. Gaucho seed coating (imidacloprid, seed corn maggot rate (0.61 mg/kernel, seed corn maggot rate) Gustafson, Inc., Dallas, TX)
5. Prescribe seed coating (imidacloprid, corn rootworm rate (1.34mg/kernel, CRW rate), Gustafson, Inc., Dallas, TX)
6. TI-435 CRW insecticide seed treatment (clothianidin, 1.25mg/kernel, Bayer Corporation, Kansas City, MO)
7. Untreated (Check)

CRW-resistant hybrid

8. MON 863 (ca. 100 day hybrid, contains Cry III Bt, Monsanto Corp., St Louis, MO)

Harford plots were planted May 24, 2001 using a 2 row John Deere 7000 planter, planting rate 25K seeds / acre. Urea, 300#, was incorporated prior to planting (no fertilizer was applied at planting). Aurora plots were planted May 25, 2001 using a 2 row Kinze planter, planting rate 32K seeds / acre, Two hundred sixty pounds of 10-10-10 were applied at planting, and nitan a full rate was applied at the 4 leaf stage. Atrazine 1# / A and Dual 8E 2 pt./ A (metolachlor, Novartis, Inc. Greensboro, NC) were herbicides used at both locations. An application of Python herbicide at 1 oz / A (flumetsulam, Dow AgroScience, Inc. Indianapolis, IN) was applied at the Harford site to control triazine resistant common lambsquarters.

Corn rootworm assessment:

Beetle emergence:

Adult beetle emergence data was collected from a portion of the non insecticide treated plot area at each site to document relative larval survival of CRW. Emergence traps were installed at both locations in mid June. Cages were centered over a randomly selected plant. Cages spanned mid row to mid row (Chaddha et al 1993, Hein et al 1985). Three cages per treatment were deployed at Harford. A single cage per treatment was used at the Aurora site. Beetle emergence data was collected weekly from 24-25 July through August 30 and September 23 for Aurora and Harford respectively. Number of beetles emerged per cage per week were recorded.

Rootworm damage assessment:

On August 2, five plants were randomly selected from the center of each treatment row, and roots excavated, washed, and rated for rootworm injury (Hills and Peters, 1971). One hundred sixty root systems were evaluated per location.

Harford field plots were harvested October 17 for silage yields using a one-row chopper, and weighed with a platform scale. Final yields were adjusted to 65% moisture.

Pumpkin / Field Corn Trap Crop plantings (for 2002 study sites)

In addition to the treatment plots described above trap crops of corn and pumpkins, approximately 0.7 acre, were planted at each study location to provide a site attractive for corn

rootworm egg laying. This area will be used as the planting site for the 2002 demonstration. Trap crop planting was delayed approximately 30 days after adjacent corn fields to provide a late food source for corn rootworm beetles. Rows of field corn only were alternated with rows of a field corn and pumpkin mixture. Approximately 16,000 corn seeds per acre (mix of 3 locally adapted Pioneer brand, 100 day hybrids) and ca. 1.5 lbs. of pumpkin seeds per acre (Harris Seed Co., variety “Spookie”, 110 day) were planted at a depth of 1.5 inch and a row spacing of 30 inches. Fertilizer and herbicide applications were as described as above for the corn demonstration trial. Procedures followed were as described in the 2000 NYS LFC IPM Report.

Field corn and trap crops were grown using standard agronomic practices appropriate for central NY. A good stand of corn and pumpkins was established at Aurora and a better stand established at Harford which attracted large numbers of corn rootworm beetles. Observations in the trap crops mid August 2001, during the time of corn and pumpkin flowering, estimated 10 – 15 corn rootworm beetles per pumpkin blossom and 1 - 3 beetles per corn plant. Pumpkins had an extended period of flowering that continued from early August through mid September.

Demonstration Outreach. The new corn rootworm management technology demonstration was featured at the Aurora farm field day August 15, 2001. Information generated by this study has also been shared with additional clientele through CCE extension outreach at Stutzman’s Research Farm Field Day, Arkport, NY August 23, CCE Field Crop Dealer Meetings: October 30 Clifton Park, October 31 New Hartford, November 1 Batavia, November 2, Auburn, and the CCE Production Ag InService November 28. In addition the results of this study will be shared in extension presentations this winter in NY and VT.

This demonstration project is on-going and pending funding will be continued in 2002.

Results and Discussion

Peak corn rootworm beetle emergence occurred in mid to late August coinciding with corn pollination. Adult rootworm populations were higher at Harford than the Aurora location. (Table 2).

Table 2. Corn rootworm beetle emergence trap data.

Aurora CRW Beetle Population*

	7/24	7/31	8/7	8/9	8/14	8/16	8/21	8/23	8/28	8/30	Total
Total CRW	5	8	18	3	14	15	3	4	5	5	80
CRW / Trap	0.31	0.50	1.13	0.19	0.88	0.94	0.19	0.25	0.31	0.31	5.00

*16 traps per sampling date, 4 traps per each of 4 replications

Harford CRW Beetle Population

	7/25	7/30	8/2	8/6	8/8	8/13	8/15	8/17	8/20	8/22	8/25	8/27	8/29	9/1	9/4	9/6	9/11	9/13	9/18	9/23	Total
Total RW	2	12	11	15	53	127	120	116	107	101	79	47	30	33	18	32	21	9	12	3	948
/ Trap	.02	.14	.13	.18	.63	1.51	1.43	1.38	1.27	1.20	.94	.56	.36	.39	.21	.38	.25	.11	.14	.04	11.3

*84 traps per sampling date, 3 traps per each of 7 treatments per each of 4 replications

Root Ratings. Rootworm injury ratings were similar for both locations. Root ratings of insecticide treated hybrid and the Bt hybrid were well below the 3.5 root rating economic threshold. All insecticide treatments provided protection against corn rootworm. The Bt hybrid had the lowest root rating but was not significantly different from other insecticide treatments. Non-treated plots were above 3.8 indicating economic damage (Table 3).

Table 3. Corn Rootworm Injury Ratings – Aurora and Harford, NY, August 2001

Treatment	Application	Rate	CRW Root Rating ¹	
			Aurora	Harford
Counter 20CR	T-Band	6 oz/1000 ²	2.0	2.6
Force 3G	T-Band	4 oz/1000	2.1	2.45
Lorsban 15G	T-Band	8 oz/1000	2.35	3.1
Gaicho	<i>On Seed</i>	0.61 mg/K	2.6	2.8
Prescribe	<i>On Seed</i>	1.34 mg/K	2.2	2.3
TI 435	<i>On Seed</i>	1.25 mg/K	2.35	2.9
Untreated Check			3.86	3.82
Mon 863 CRW Resistant	<i>“In” Seed</i>		1.8	1.8

¹ Rating scale Hills and Peters, 1971. Economic injury level = CRW Root Rating of 3.5 or higher.

²oz per 1000 linear feet, mg / kernel.

Silage yield. Preliminary analysis of silage yield data showed untreated check plots had the lowest yield while there appeared to be no significant yield differences between insecticide treated plots. Yield of the Bt hybrid was intermediate among “insecticide” treatments. Final silage yield information was not available at time of this report but will be available as part of the year 3 report.

The results of this study indicate new insecticide seed coating and CRW resistant Bt hybrid technologies hold promise for corn rootworm protection. The insecticide seed coatings Prescribe (CRW rate), TI-435 and the Bt hybrid Mon 868 showed efficacy comparable to the conventional soil insecticides Force 3.0 G, Lorsban 15G or Counter 20 CR. Prescribe and TI-435 are known to be effective against low to moderate populations of CRW (Shields, personal communication). The Bt CRW resistant hybrid Mon 863 also had very low root damage rating scores indicating it’s potential for managing CRW. The seed coat Gaicho (seed corn maggot rate) also showed a lowered CRW root rating but this is viewed as an experimental anomaly and not truly reflective of it’s potential against CRW.

Over the past decade, the western corn rootworm (CRW) has become established as the predominant insect pest of field corn in New York. The economically damaging capacity of western CRW has increased grower awareness and concern over potential risks of CRW. Corn grown for silage is at particular risk from rootworm injury (Davis 1994).

Current options for managing CRW include crop rotation or use of a soil insecticide at planting. Crop rotation is the most effective tactic to avoid CRW losses. This option, however, is not always possible given a farm’s annual cropping or livestock feeding needs, constraints on land resources or other factors. CRW active soil insecticides, the second management option, are relatively expensive, toxic to handle and may not always provide adequate control.

These insecticide seed coat treatments and Bt hybrids resistant to CRW offer the potential benefits of efficacy, combined with a user-friendly CRW insecticide delivery method and an environmentally sensitive low a.i. rate per acre. Properly deployed, these novel tactics offer much promise to enhancing our CRW management options. This demonstration is developing local data and affords NY growers the opportunity to view these new CRW management options at work in the field. The demonstration has also enhanced discussion regarding the benefits, concerns and constraints of these technologies and field corn IPM in general. The timing of the demonstration is providing extension personnel, growers, associated agriculture industry personnel with field data in advance of the expected commercial release of new CRW-hybrids and seed treatments (2003 – 2004).

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