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Farmer Responses to Resistance Issues in Corn Rootworm to Bt Corn: Qualitative Analysis of Focus Groups

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Abstract

Western corn rootworm is an important corn pest in the U.S. Some farmers noted unexpected corn rootworm injury of transgenic hybrids as early as 2008; however, the full extent of product performance is still not fully understood. We conducted telephone focus groups with farmers in 2013 to gain their perspective of current and future issues for corn rootworm. Respondents were surprised how quickly corn rootworm injury escalated in their fields and were disappointed with incorrect diagnoses from consultants and seed companies. Most participating farmers saw university Extension as an unbiased source of information.

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Introduction

Western corn rootworm is the most important corn pest in the U.S. (Gray, Sappington, Miller, Moeser, & Bohn, 2009). Approximately 30 million acres are infested by corn rootworm (CRW) every year, likely exceeding $1 billion in lost revenue (Metcalf 1986). Over the last 50 years, farmers have used multiple strategies to protect yield, including cultural, genetic, and chemical control (Cullen, Gray, Gassmann, & Hibbard, 2013). In 2003, a CRW larval toxin from *Bacillus thuringiensis* (Bt) was transgenically transferred into corn. Targeted insect species ingest the toxins and die shortly after consumption. There are four Bt-CRW toxins that target larvae in corn: Cry3Bb1, Cry 34/35Ab1, mCry3a, and eCry3.1Ab.

Since the commercialization of Bt-CRW hybrids, university entomologists have received sporadic reports from farmers of unexpected root injury. The Environmental Protection Agency (EPA) defines unexpected injury as having >1.0 node of injury (EPA 2010) on the 0-3 node injury scale, as described by Oleson, Park, Nowatzki, and Tollefson (2005). Eventually, western CRW resistance to

Cry3Bb1 was confirmed in IA and IL (Gassmann, Petzold-Maxwell, Keweshan, & Dunbar, 2011; Gray, Estes, Tinsley, & Bowman, 2014) and to mCry3A in Iowa (Gassmann et al., 2014). Surrounding states (e.g., NE, MN, and SD) have also reported unexpected injury to Bt-CRW hybrids.

Assessing CRW management tactics across a broad geographical range has been an on-going challenge for university entomologists for decades, but particularly with Bt traits. Information related to Bt performance is relayed from farmers to seed companies, and university personnel are not always included in this discussion. Companies are often leery of sharing this information with university scientists, hoping to avoid putting these unfavorable reports in the public limelight, thus giving their competitors a potential advantage when it comes to future product sales. As a result of this information lag to universities, we see a reduction in the capacity to serve the public sector with independent assessments and recommendations in a time frame needed by farmers.

Focus groups are useful for identifying needs that can be missed through other assessment techniques (Gamon, 1992). With the help of a professional facilitator, we convened telephone focus groups of farmers to:

1. Better understand farmers' perceptions and concerns regarding unexpected CRW injury in Bt corn;

2. Identify the kinds of information farmers need when Bt corn has failed to provide adequate root protection; and

3. Explore the role Extension could play in gathering and providing information when unexpected injury to Bt corn occurs and improving the communication across multiple levels (e.g., farmers, private sector, and Extension).

Focus Group Methodology

We sought volunteer farmers from IL, IA, MN, and NE who had experienced unexpected CRW injury in Bt corn in at least one field in at least one previous year. The farmers represented diversity of farm operation, size of operation, and age of farmer. Other selection criteria were:

- Considered the decision maker or were involved in corn production;

- Seemed reflective and willing to talk, but not domineering; and

- Represented diversity in geography, farm size, type of operation (e.g., livestock, cash grain, or both).

We used a multi-step recruiting process.

1. Authors identified farmers who fit the selection criteria, then invited them, by either phone or email, using predetermined talking points to assure recruiting consistency.

2. Names and contact information of farmers who were willing to participate were forwarded to the focus group facilitator.

3. The facilitator called these individuals, explained how she had gotten their name, reviewed the purpose of the study and IRB protocol, and asked which of the scheduled focus groups would work best for them. As an incentive, participants were offered $50, a chance to hear how other farmers are thinking about CRW issues, and a summary of what was learned from the groups.

4. As soon as a farmer agreed to participate, the facilitator mailed a confirmation letter, sent an email, or both, depending on what they preferred. The letter included the toll-free phone number to call and an access code.

5. The day before or the day of their scheduled call, the facilitator made a "reminder phone call" to each person.

The research team conducted five telephone focus groups between March 13 and March 26 2013; three in the evening and three in the afternoon to accommodate different schedules. Twenty farmers [IL (n=4), IA (n=5), MN (n=6), and NE (n=5)] participated. Every call had three to five participants and included farmers from at least two states. All groups were recorded, transcribed, and analyzed using the constant comparative method (Glaser & Strauss, 1967).

We followed standard telephone focus group protocol (Krueger & Casey, 2008) and chose to conduct telephone focus groups because potential participants were geographically dispersed. At least two people moderated each call, with the facilitator serving as the process expert and one or more of the authors serving as content experts. Each focus group was asked the same questions in the same order (Table 1), and then we allowed the farmers to ask questions. The length of the calls ranged from 60-90 minutes.

Table 1.

Route of Questioning and Duration of Each Focus Group

	Questions	**Minutes**
	Introduction	5
1.	How did you become aware of the problem in your field?	5
2.	How big a concern is unexpected CRW damage to you in your operation? Probe: Do you see this as a problem in that field or as a bigger problem?	5
3.	When you knew you had damage: a. What did you decide to do in that field for the next year? b. What were the primary factors that nudged you toward that decision? c. Who or what influenced that decision?	15

4.	Was there a point when you would have welcomed input from or interaction with extension? When was that?	5
5.	Let's say extension developed a system where farmers could alert extension to instances of possible CRW resistance in their Bt corn, so extension could get a better understanding of the extent of the problem. a. What would it take for farmers to voluntarily report unexpected CRW in Bt corn to extension as soon as they are aware of it? b. What would keep farmers from reporting unexpected CRW damage in Bt corn to extension?	15

Focus Group Summary

Farmers said they first became aware of unexpected CRW injury by seeing reduced or uneven plant stands and stunted plants. Large patches of downed corn were one indicator of a CRW problem, but a few participants indicated it is difficult to see the extent while walking through fields. In other cases, farmers were notified of high CRW populations by a crop consultant. Most farmers said unexpected CRW injury was a huge problem for them. Farmers used terms like "train wreck" and "big mess." Most of their concerns centered on input costs and declining yield in high-performing hybrids (Table 2).

Table 2.

Concerns Expressed by Farmers about Corn Rootworm (CRW) Resistance to Bt Corn

CRW causes increased costs and decreased yield .	
	Added input costs for switching to more expensive seed
	Added input costs for insecticides
	Added costs and time of harvesting downed corn
	Added cost of setting up planter for insecticide
For some, CRW damage threatens their current farming system.	
	Some farmers only grow corn.
	Some need corn for livestock.
	Some have planters that can't be adapted to put on insecticide.
The CRW problem seems to be moving quickly and be under-detected.	
	The severity of the problem within fields is quickly escalating, some people feel "blindsided."

	The geographic distribution of the problem is increasing rapidly
	The extent of the problem may be hidden; mild cases of CRW damage may be going undetected or farmers may be blaming low yields on other factors.
The solutions/treatments don't consistently work.	
	Seed technology they relied on is not working the way they expected.
	Insecticides don't always work as expected (e.g., granular not activated in drought).
	Some fear that rotating to beans is not a foolproof solution anymore.
	There seem to be "no good tools in the toolbox" to control the problem.

Farmers were generally surprised by how quickly CRW injury escalated. Several farmers said this is not only a huge issue for their operation, but that it is also an issue for the corn industry and the Corn Belt. Some participants indicated CRW injury was not diagnosed correctly by consultants or seed representatives. Several farmers said suppliers tended to blame problems on something other than their own product. Larval CRW injury to roots was mistaken as a problem with chemicals, seed genetics, nematodes, or stressful environmental conditions.

Factors That Influence Decisions

Based on farmers' comments, there were four stages in dealing with unexpected CRW injury: awareness of the problem, diagnosis, confirmation, and recommendations. As indicated above, most people discovered CRW injury themselves, but got diagnosis of their problem from a seed/chemical company or a crop consultant. In all cases, farmers (or their consultants) used state or regional university Extension entomologists to confirm the diagnosis and provide advice. Farmers gathered recommendations from some combination of hired crop consultant/agronomist, seed dealer/seed company, agricultural supplier/chemical representative, and regional or state Extension specialist in entomology. The overall tone from the focus groups was that individuals were going to be more aggressive with CRW management (Figure 1).

Figure 1.

Options Suggested by Farmers for Improving Yield protection from Corn Rootworm

switch to a hybrid with Bt pyramided (2 or more traits targeting the same pest) genetics
alternate to a hybrid with a different single CRW trait
select a hybrid with a large root system
incorporate a hybrid without CRW traits
rotate to a non-host crop (e.g., soybean or alfalfa), or implement a corn-corn-

soybean rotation
use the same CRW trait and add a soil insecticide, or increase the rate of soil insecticide
target CRW adults with a foliar spray
scout for CRW larvae and adults
reduce volunteer corn
improve record keeping

Knowing resistance to Bt-CRW traits was a regional issue, focus groups discussed how they determined important elements of future management. Farmers had to determine if the unexpected injury was isolated to a field or was prevalent throughout the farm. Respondents tended to think of managing the entire farm if the damage was extensive within and between fields, and if similar observations were detected in neighboring farms. For those fields in continuous corn production, participants also expressed interest in controlling larvae and adults to minimize yield loss the following year.

When the groups were asked why they did not see crop rotation as an effective option for long-term CRW management, participants indicated:

- Need corn to feed livestock;
- High market value of corn;
- Field conditions are not conducive for soybean (e.g., soil pH, soil type, flood prone);
- Manure created from animals will be wasted;
- Landlord only wants corn, or land leasing rates are too high for soybean; and
- Belief that crop rotation is no longer a viable strategy for CRW management.

Does Extension Play a Role?

All of the people in the focus groups had direct or indirect support from university Extension, but we asked if Extension entomologists could be more involved with making recommendations for CRW. Many indicated the decline in available local Extension personnel and felt independent crop consultants were equivalent support. One person candidly said, "I am sorry to say that in Illinois they gutted Extension. I can't even tell you who the guy is to deal with crops in my area."

Farmers suggested that Extension could emphasize the awareness of the problem. These farmers assumed that using Bt-CRW traits meant they would not have larval survivorship and therefore did not anticipate resistance developing in the field. These participants said farmers need to know Bt resistance is happening throughout the Corn Belt, understand unexpected root injury and how to make field assessments, and what are the options to protect yield.

Other people stated that Extension's role should be to get their "arms around the issue" by conducting research, being an unbiased source of information, and assessing the geographic extent of unexpected CRW injury. Some farmers didn't feel they can trust the information they get from seed companies. They felt they have little power and little recourse. Some farmers would like a third party to help hold seed companies accountable.

Farmer Reporting of Unexpected CRW Injury

Getting farmers to report unexpected CRW injury will be a challenge. Farmers are unlikely to report CRW injury if the perceived barriers to reporting outweigh the perceived incentives. Some people in the focus groups indicated they would be willing to voluntarily report CRW injury if they received something they perceived as valuable in return. Most farmers indicated that if they made an injury report, they would expect a personal confirmation and management advice. In addition, they also were interested in knowing more about the extent of the problem on a landscape level.

Potential barriers to reporting CRW injury generally focused on trust. The farmers also talked about becoming increasingly sensitive about data privacy and ramifications for sharing information. Before they would volunteer reporting on CRW injury, they would like to know who has access to the data and how it would be used. Also, some farmers might have anxiety about potential regulatory obstacles with the EPA or interactions with environmental activists. One individual said, "I think there are a lot of guys that think that by reporting something that they will end up getting audited."

Participants were concerned that reporting will be time-consuming and complicated. Others discussed not having enough time or not knowing who to call was a concern. The participants in these focus groups sounded like they had sophisticated farming operations, but at least 25% of the farmers didn't have an email address, did not use email, or said their Internet connection was questionable.

Most farmers didn't automatically see the importance, or larger benefit, of reporting damage. A few thought farmers may be embarrassed, ashamed, or fear they have done something wrong. Interestingly, some farmers blamed themselves for unexpected Bt-CRW injury because of their seed selection choices or lack of refuge implementation.

Several farmers said one barrier is that the seed companies don't want the information to get out and were asked to keep quiet about the problem. Some people also expressed unease about seed companies not wanting to get negative press about the Bt-CRW traits not working effectively anymore, appearing to craft a code of silence around the issue.

Conclusions

Extension needs to be much more explicit about how reporting CRW injury benefits the corn industry or society, which in turn would benefit farmers. A reporting system that relies on sending photos by phone or using a computer may leave out a fair number of farmers. Farmers suggested designing a reporting system based on input from agricultural professionals like crop consultants and input suppliers because of their expertise and connections with extension. Advantages of this design are that Extension could have more confidence in the accuracy of the data, it builds on existing

relationships between Extension and crop consultants, and it is less likely to overload Extension entomologists. The disadvantage is that agricultural professionals associated with seed companies may not be willing to participate.

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