Managing Our Genetic Resources in Corn: The Bt Corn Story

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5th National IPM Symposium
Agricultural Biotechnology Stewardship Technical Committee

- Address scientific issues central to responsible stewardship of Bt corn products
- Promote broad stakeholder involvement and establish standards for product stewardship
- IRM Monitoring, IRM Stewardship, Nontarget Organism Safety Assessment, Animal Feed Performance, and DNA Detection in MME

**Participants**
- Bayer Crop Science
- Dow AgroSciences
- Dupont/Pioneer
- Monsanto
- Syngenta

**Collaborators**
- National Corn Growers Assoc.
- American Seed Trade Assoc.
- Biotechnology Industry Assoc.
- Universities
- USDA-ARS
Involvement in IRM for Bt Corn

- Comprehensive IRM Program for Bt Corn
- Insect resistance monitoring in key target pests
  - European corn borer
  - Southwestern corn borer
  - Corn earworm
- IRM Compliance Surveys
- Implementation of Compliance Assurance Program (CAP)
IRM Requirements for Borer-Resistant Bt field corn

- Up to 80% Bt: 20% non-Bt (50:50 in cotton areas)
- Bt corn must be within ½ mile of a refuge, ¼ mile preferred
- “Strip” refuge must be at least four rows wide, six preferred
- Treat refuge only when economically necessary
- Treat refuge only with non-Bt insecticides
- Applies to all Cry1 corn products (MON 810, Bt11, TC1507)
Resistance Monitoring

■ ABSTC coordinates collections of European corn borer, southwestern corn borer and corn earworm
  ➢ Collections are targeted based on market adoption and insecticide use e.g., 4-6 populations of ECB from each of three regions

■ Bioassays carried out by academic or contract labs for Cry1Ab and Cry1F
  ➢ ECB: Siegfried (UNL); SWCB: Song (UM); CEW: Lang (Custom Bioproducts)
## ECB Resistance Monitoring

### Data Summary

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Populations</th>
<th>Average LC&lt;sub&gt;50&lt;/sub&gt; ± SE</th>
<th>Mean 95% Interval ± SE</th>
<th>Mean Slope ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>16</td>
<td>4.49 ± 1.55</td>
<td>2.31 ± 1.11</td>
<td>2.11 ± 0.41</td>
</tr>
<tr>
<td>2005</td>
<td>16</td>
<td>2.20 ± 0.23</td>
<td>1.34 ± 0.19</td>
<td>2.29 ± 0.08</td>
</tr>
</tbody>
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### Graphical Representation

- **X-axis**: Year
- **Y-axis**: Variation
- **LC<sub>50</sub>** (red)
- **EC<sub>50</sub>** (green)

The graph illustrates the variation in ECB resistance monitoring from 1995 to 2005, showing the number of populations and the average LC<sub>50</sub> values with their respective standard errors (SE) and 95% confidence intervals (CI). The mean slope ± SE is also depicted for each year.
Grower License Agreements

- Legal contract signed by the grower
- Seed companies must annually report the units of Bt seed sold and not sold under a signed grower agreement
- Dealers who sell Bt seed without a signed grower agreement in place risk losing access to sell the technology
- Evergreen document but applies to every Bt corn purchase
Key to Success: IRM Education Program

- Comprehensive, consistent IRM education program aimed at:
  - Growers
  - Seed representatives and dealers
  - Seed company employees
  - Trade associations
  - Extension service
  - Other stakeholders

- Multi-faceted approach using a variety of mediums designed to provide growers with numerous sources of consistent information
  - Printed material from companies
  - Grower meetings
  - Broadcast media
  - Internet
**IRM Education - Producer Use Guide**

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**Corn Borer**

**Insect Resistance Management Requirements**

Corn is resistant to a Bt technology for control of European corn borer. The primary purpose of a refuge is to maintain a population of corn borers that are not exposed to the Bt protein found in YieldGard Corn Borer corn. The refuge is simply a block of land that does not contain a Bt technology for control of European corn borer. The size of the refuge must be large enough to ensure that susceptible insects are available to mate with any non-Bt resistant corn borer. If no refuge is established, the loss of resistance management is reduced. Please call your local pest management advisor for more information.

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**Refuge Requirements for the Corn Belt**

- On each farm, plant up to 100 percent of corn acres with Bt corn. Plant at least 20 percent of the corn acres to a corn refuge that does not contain a Bt technology for control of European corn borer.

**Refuge Requirements for Cotton-Growing Areas**

- On each farm, plant up to 100 percent of corn acres with Bt corn. Plant a minimum of 20 percent of corn acres to a corn refuge that does not contain a Bt technology for control of European corn borer. The refuge can be treated with insecticides only when the pest pressure meets or exceeds economic thresholds. Syngenta Bt insecticides may not be applied to the refuge.

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For questions or additional information, contact your local pest management advisor.
Insect Resistance Management

Refuge Planting Details
Any corn hybrid that does not contain a Bt technology for control of European or southwestern corn borer and is planted on a grower’s farm within 1/2 mile of Bt corn can serve as a refuge.

- Plant a refuge in an area where YieldGard Corn Borer corn is not grown.
- Plant the refuge within 1/2 mile of Bt corn.
- Plant the refuge only with corn that does not contain a Bt technology for control of European or southwestern corn borer.
- Manage the refuge the same as YieldGard Corn Borer corn. Managed refuge inputs or putting the refuge near main roads reduces the effectiveness of the refuge.

Refuge Configuration Options
This refuge can be arranged in a number of formations. These options offer the flexibility to easily incorporate an effective corn refuge into farm operations. Options include:

- Plant a separate corn refuge within 1/2 mile of each Bt cornfield (1/4 mile preferred).
- Plant a corn refuge as strips or as blocks within a Bt field.
- Split the planter to alternate days or rows when possible (1/4 mile preferred) of corn refuge within Bt corn.
- Plant field perimeters or end rows as a corn refuge.

Multi-phased Approach to Insect Resistance Management
Adding a refuge to a corn production program is just one part of resistance management.

For the most effective results, researchers recommend a multi-phased approach.

- Rove corn hybrids with YieldGard Corn Borer to ensure that an effective dose of Bt is available for corn borer control throughout the season. This will control many of susceptible insects.
- Plant a refuge block close to the YieldGard Corn Borer field. The block will serve as a refuge to support the survival of susceptible corn borers. These corn borers will receive a higher level of protection when planting refuge areas.
- Practice integrated pest management (IPM) to prevent the buildup of corn borers and other insect pests. Natural predators such as ladybugs, wasps, and predatory groundhogs can help reduce corn borer populations. YieldGard Corn Borer insect protection via IRM because it effectively targets pests and allows beneficial insects to thrive.
- Grower should establish buffer strips of YieldGard Corn Borer insect-resistant corn and ensure their seed dealer or Minnesota representative performs tests when problems are observed.
**Bt Corn**

Bt corn has proven to be an important technology to help corn growers control damaging insect pests and produce higher yields and better quality grain.

**Insect Resistance Management (IRM)**

To preserve the many benefits of Bt corn technology, the implementation of an IRM plan is essential. Experts agree, and government regulations require, that an effective Bt corn IRM plan includes the planting of a non-Bt refuge (a block of non-Bt corn) planted close to your Bt corn acres.

All Bt corn products designed to control European corn borer, southwestern corn borer, and corn earworm require implementation of an IRM program according to the refuge size, distance guidelines and insecticide usage described in this fact sheet.

Growers who fail to follow these IRM requirements risk losing access to Bt corn technology.

**Refuge Size Requirements**

**Corn-growing Areas (At Least 20% Refuge)**

On each farm, plant at least 20 acres of non-Bt corn for every 80 acres of Bt corn (minimum of 20% non-Bt refuge, maximum of 80% Bt corn).

**Com/Cotton-growing Areas (At Least 50% Refuge)**

On each farm, plant at least 50 acres of non-Bt corn for every 50 acres of Bt corn (minimum of 50% non-Bt refuge, maximum of 50% Bt corn). See your seed company product use guide for the list of counties that fall under this requirement.

**Refuge Distance Requirement**

A non-Bt refuge must be planted within 1.2 mile of each Bt corn field, but preferably within 0.4 mile.
Refuge Planting Options

As illustrated below, the appropriate size non-Bt corn refuge may be planted a number of ways.

Insecticide Usage in Non-Bt Refuges

Your non-Bt corn refuge may be treated with conventional insecticides ONLY if target pest pressure reaches economic thresholds. Bt-based foliar insecticides are NOT to be used within the refuge.

Refuge Management

In order to maximize the effectiveness of the refuge, you should manage your non-Bt corn and Bt corn in a similar manner. This can be accomplished by planting your non-Bt corn as close to and at the same time as your Bt corn. In addition, select non-Bt hybrids and Bt hybrids that have similar growth and development characteristics.

Seed companies, universities and the National Corn Growers Association (NCGA) all agree that there should be a unified commitment to responsible stewardship of Bt technology so it can be preserved as an important tool in corn management.

The NCGA encourages producers to implement IRM plans when planting Bt corn. This EPA requirement is the right thing to do in order to preserve this important technology.

For more information on IRM, visit www.ncga.com.
IRM Compliance

- Tool to assess growers understanding and adherence to IRM requirements

Annual Grower Survey

- Determine the level of adherence to the IRM requirements
- Measure changes in awareness of IRM requirements vs. the 2000 baseline
- Obtain grower feedback for improvement of education and compliance programs
IRM Compliance 2001-2005

- Percent of Respondents -
IRM Awareness 2001-2005

- Percent of Respondents -
Compliance Assurance Program

- EPA required registrants to design, publicize and implement an IRM Compliance Assurance Program
- Registrants required to make on-farm assessments
- Required actions for growers who have IRM compliance deviations
  1. Send a warning letter to the grower.
  2. Conduct a “Compliance Assistance” visit with the grower prior to planting.
  3. Conduct a “Compliance Assessment” visit with the grower the next growing season to assess IRM compliance.
  4. Provide the grower with additional IRM educational materials.

- Growers found significantly out of compliance in two consecutive years lose access to Bt corn
Annual Affirmation System

- Reminders to assure that Bt growers are aware of their contractual IRM obligations
- All registrants print language on seed bag or tag
- Each registrant implements at least one other option
  - Execution of invoice or delivery receipt statement
  - Electronic signature
  - Annual Grower License Agreement with signature
  - Execution of technology ID card or license number
Affirmation Bag Tag

Do not open this bag of seed until you have read and understand the stewardship requirements, including applicable refuge requirements for insect resistance management, for the biotechnology traits expressed in this seed as set forth in the Monsanto Technology Agreement that you signed. By opening and using this bag of seed, you are reaffirming your obligation to comply with those stewardship requirements.
The Bottom Line

- Bt corn registrants are committed to IRM stewardship
  - Robust IRM Requirements
  - Technology Agreements and Annual Affirmation
  - Multifaceted IRM Education Program for Growers and Dealers
  - Promotion of IRM Requirements Via Ag Media
  - Grower Survey to Track Compliance and Awareness
  - On-farm Visits to Address Cases of Non-compliance
  - Insect Resistance Monitoring Program
  - Annual Reporting to EPA

- The majority of Bt corn growers respect the need for stewardship and follow the IRM requirements

- We are working with NCGA and universities to continue promote responsible use of Bt technologies

- The Bt corn IRM stewardship program is working