Managing Our Genetic Resources in Corn: The Bt Corn Story

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Monsanto
St. Louis, MO

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

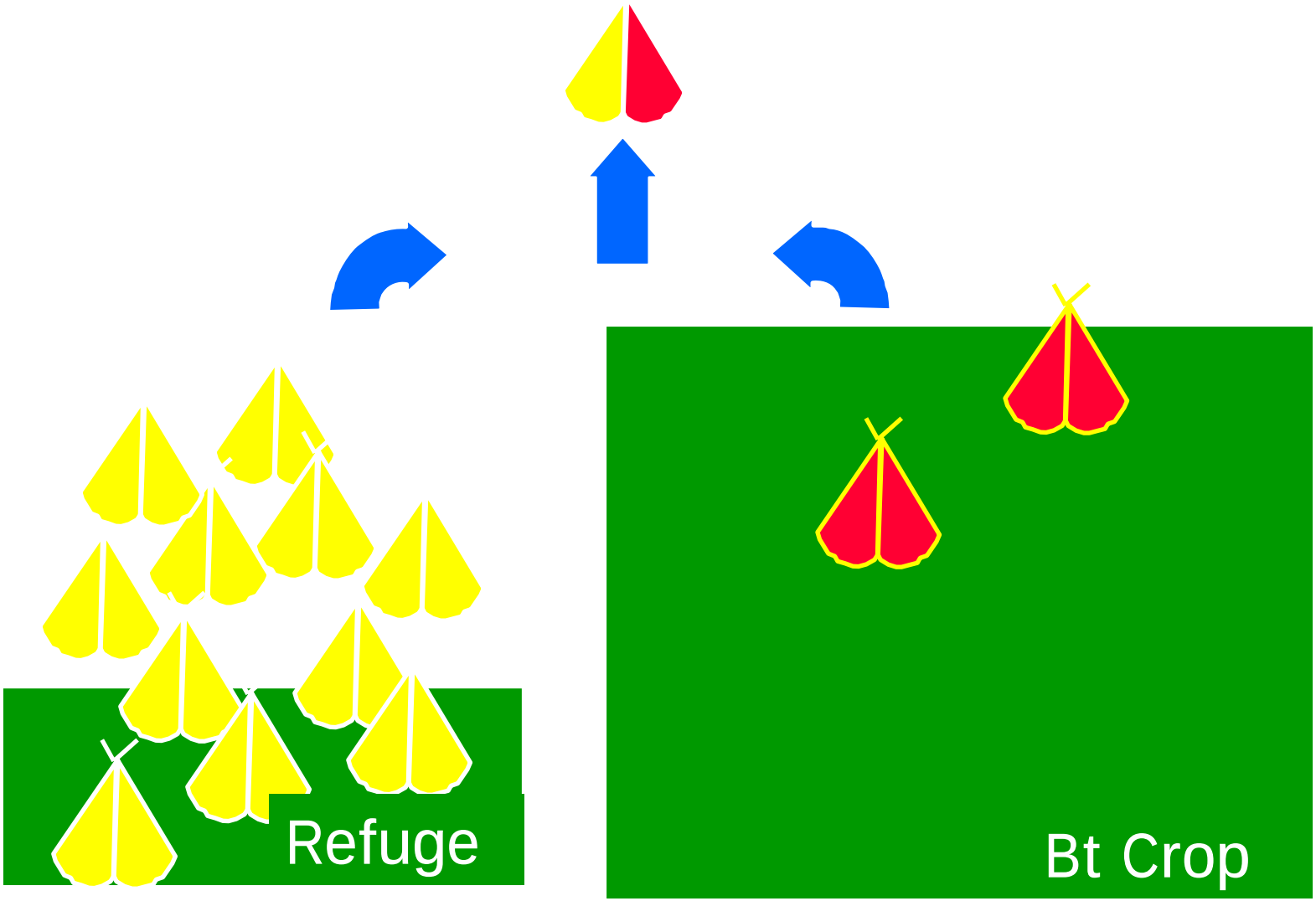
Collaborators

- 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)

Refuge Strategy

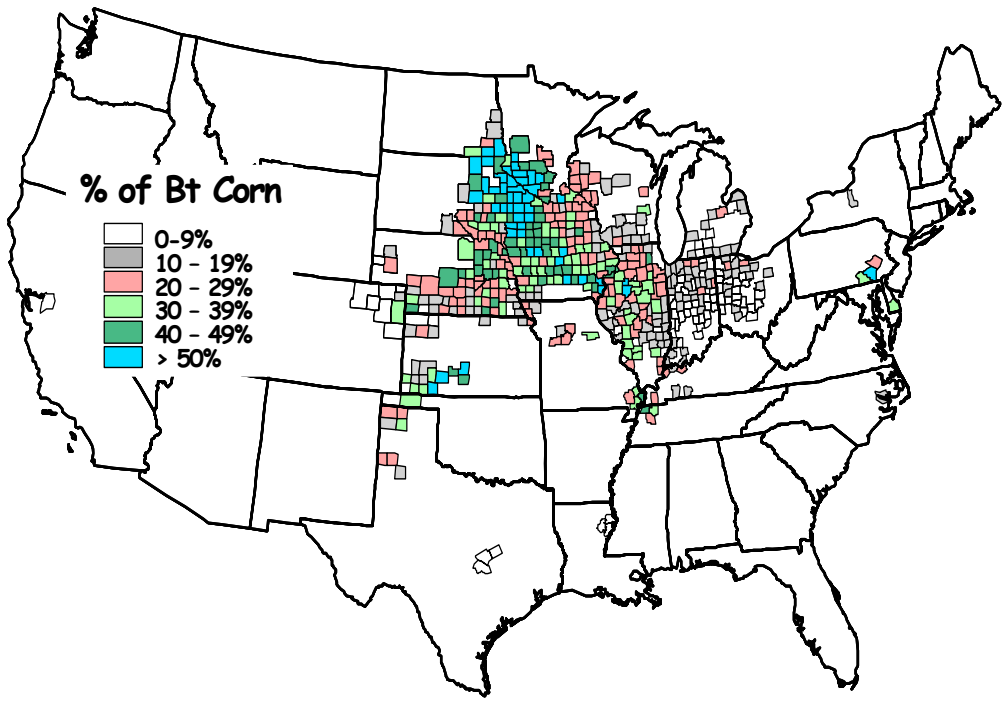


IRM Requirements for Borer-Resistant Bt field corn

- 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)

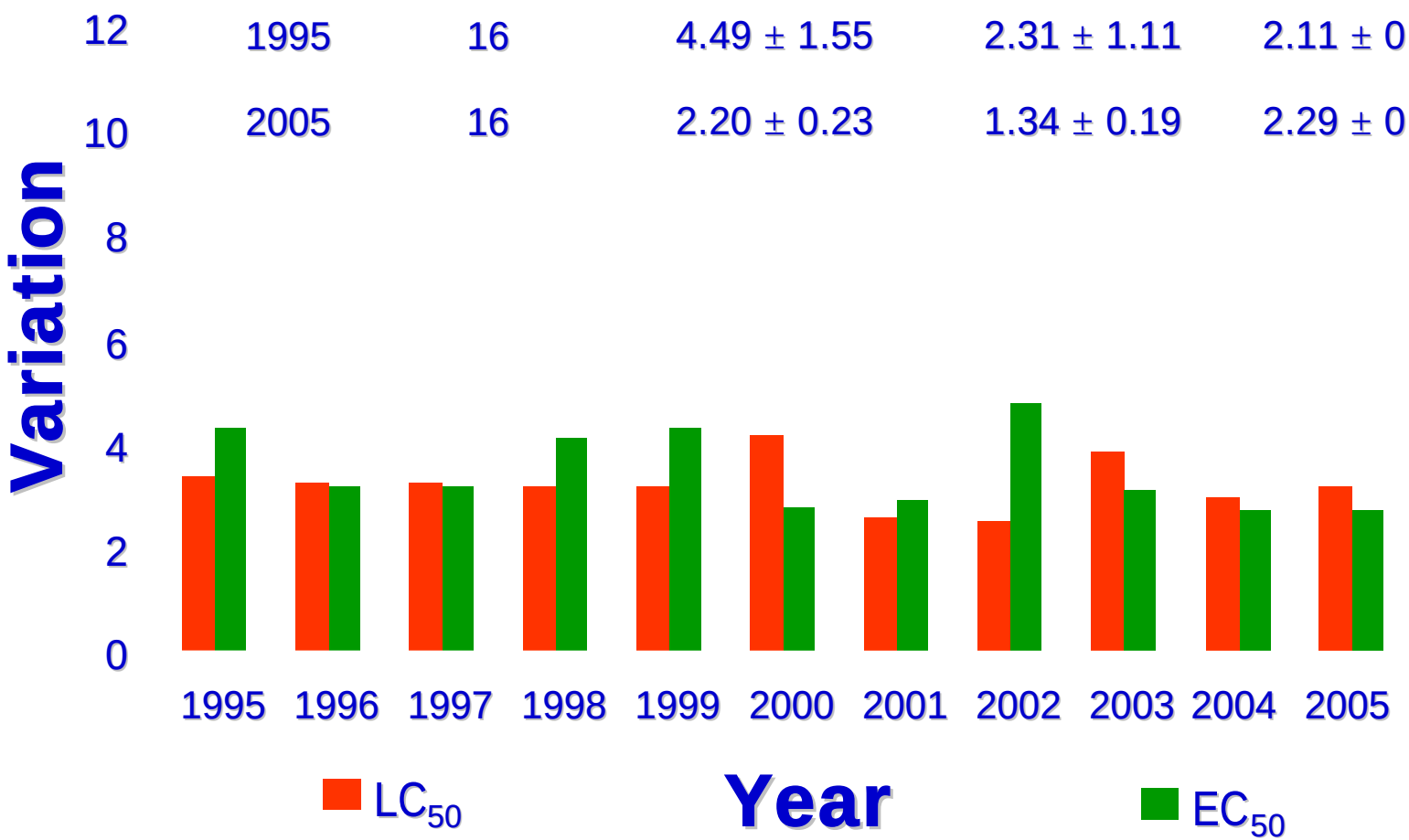
Resistance Monitoring

- 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

Year	Number of Populations	Average LC_{50} ± SE	Mean 95% Interval ± SE	Mean Slope ± SE
1995	16	4.49 ± 1.55	2.31 ± 1.11	2.11 ± 0.41
2005	16	2.20 ± 0.23	1.34 ± 0.19	2.29 ± 0.08



Grower License Agreements

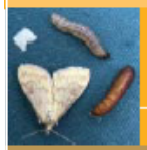
- Legal contract signed by the grower
- Seed companies must annually report the units of Bt seed sold and not sold under a signed grower agreement
- Dealers who sell Bt seed without a signed grower agreement in place risk losing access to sell the technology
- Evergreen document but applies to every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

YIELDGARD®



Corn Borer

Insect Resistance Management

2003 IRM GUIDE

A Grower Guide to Protecting Against Insect Resistance

YieldGard® Corn Borer Insect Protected Corn is genetically improved corn that provides full-plant, full-season protection against European corn borer, southwestern corn borer, and southern corn stalk borer. YieldGard Corn Borer Technology also suppresses corn earworm, fall armyworm, and stalk borer.

Every technology must be managed properly. That's why to preserve the benefits and insect protection of this technology, an Insect Resistance Management (IRM) plan must be part of the long-term and short-term planning by the seed industry and growers alike. Insect Resistance Management is a requirement when purchasing YieldGard Corn Borer Insect Protected Corn. An IRM plan is mandated by the US Environmental Protection Agency (EPA).

As a condition of registration by the EPA, seed companies will be conducting IRM compliance assessments during the 2003 growing season. Failure to follow IRM guidelines and properly plant a refuge may result in the loss of access to YieldGard Corn Borer technology. Please do your part to ensure that YieldGard Corn Borer technology is preserved by fully cooperating in refuge management.

For questions or additional information about compliance with IRM guidelines, contact Monsanto at 1-800-951-9511.

Insect Resistance Management Requirements

Combat Resistance with a Refuge

Although rare, resistance has developed in nature to some pest control tactics. The possibility of insect resistance is a real risk that must be planned for and minimized. The best way to preserve the benefits and insect protection of YieldGard Corn Borer corn is to develop an Insect Resistance Management plan. The key component of any IRM plan is a refuge.

A refuge is simply a block or strip of corn that does not contain a *B.t.* technology for control of European or southwestern corn borer. The primary purpose of a refuge is to maintain a population of corn borers that are not exposed to the *B.t.* protein found in YieldGard Corn Borer corn. The lack of exposure to the *B.t.* protein ensures that susceptible insects are available nearby to mate with any rare resistant corn borer moths that may emerge from *B.t.* corn. Susceptibility to *B.t.* technology is then passed on to their offspring, helping to preserve the long-term effectiveness of YieldGard Corn Borer corn.

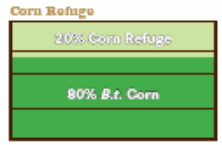
The refuge should be planted with a similar hybrid, as close as possible to, and at the same time as, the majority of *B.t.*-protected corn. It is important to practice resistance management to help reduce the risk of corn borer resistance before it develops. Growers can then continue to benefit from the consistent corn borer control and top yield potential found in YieldGard Corn Borer hybrids.

YIELDGARD® Corn Borer

Refuge Requirements for the Corn Belt

In this area, refuges must be established as follows:

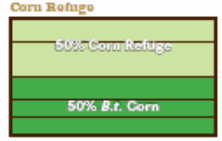
- On each farm, plant up to 80 percent of corn acres with *B.t.* corn. Plant at least 20 percent of the corn acres to a corn refuge that does not contain a *B.t.* technology for control of European or southwestern corn borer. The refuge corn can be treated with insecticides only when the level of pest pressure meets or exceeds economic thresholds. Sprayable *B.t.* insecticides must not be applied to the refuge corn.
- Plant the refuge within, adjacent to, or near YieldGard Corn Borer corn fields.
- The refuge must be placed within 1/2 mile of the YieldGard Corn Borer field (1/4 mile or closer preferred).



Refuge Requirements for Cotton-Growing Areas

In the cotton-growing areas shown on the bottom of this page, there are special refuge requirements for YieldGard Corn Borer corn, as follows:

- On each farm, plant up to 50 percent of corn acres with YieldGard Corn Borer corn. Plant a minimum of 50 percent of corn acres to a corn refuge that does not contain a *B.t.* technology for control of European or southwestern corn borer. The refuge corn can be treated with insecticides only when the level of pest pressure meets or exceeds economic thresholds. Sprayable *B.t.* insecticides must not be applied to the refuge corn.
- Plant the corn refuge within, adjacent to, or near the YieldGard Corn Borer corn fields.
- The refuge must be placed within 1/2 mile of the YieldGard Corn Borer field (1/4 mile or closer preferred).



Cotton Growing Areas

Alabama
All Counties

Arkansas
All Counties

Florida
All Counties

Georgia
All Counties

Louisiana
All Counties

Mississippi
All Counties

Missouri
Counties of:
Dunklin
New Madrid
Pemiscot
Scott
Stoddard

North Carolina
All Counties

Oklahoma
Counties of:
Beckham
Caddo
Comanche
Custer
Greer
Harmon
Jackson
Kay
Kiowa
Tillman
Washita

South Carolina
All Counties

Tennessee
Counties of:
Carroll
Chester
Crockett
Dyer
Fayette
Franklin
Gibson
Hardeman
Hardin
Haywood
Lake
Lauderdale
Lincoln
Madison
Obion
Rutherford
Shelby
Tipton

Texas
All Counties except:
Carson
Dallam
Hansford
Hartley
Hutchinson
Lipscomb
Moore
Ochiltree
Roberts
Sherman

Virginia
Counties of:
Dinwiddie
Franklin City
Greensville
Isle of Wight
Northampton
Southampton
Suffolk City
Surrey
Sussex

Maine
The sale, distribution, and planting of *B.t.* corn, including YieldGard Corn Borer hybrids, is prohibited in the State of Maine.

IRM Education - Producer Use Guide

Refuge Planting Details

Any corn hybrid that does not contain a *B.t.* technology for control of European or southwestern corn borer and is planted on a grower's farm within 1/2 mile of *B.t.* corn can serve as a refuge.

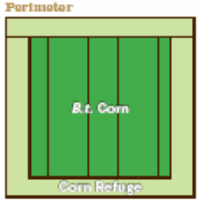
- Plant a refuge on every farm where YieldGard Corn Borer corn hybrids are planted.
- Plant the refuge within 1/2 mile of (1/4 mile preferred), and at the same time as YieldGard Corn Borer corn.
- Manage the refuge the same as YieldGard Corn Borer corn is managed. Reducing inputs or putting the refuge on marginal land reduces the effectiveness of the refuge.
- Plant the refuge only with corn that does not contain a *B.t.* technology for control of European or southwestern corn borer.
- Mixing non-*B.t.* seed with YieldGard Corn Borer seed for use in the refuge is not permitted.

Refuge Configuration Options

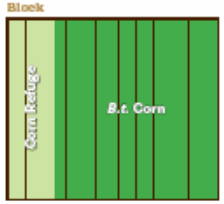
The refuge on each farm may be arranged in a number of configurations. These options offer the flexibility to easily incorporate an effective corn refuge into farm operations. Options include:

- Plant a separate corn refuge within 1/2 mile of each *B.t.* corn field (1/4 mile preferred).
- Plant a corn refuge as strips or blocks within a *B.t.* field.
- Split the planter to alternate four or more rows (six or more preferred) of corn refuge with *B.t.* corn.
- Plant field perimeters or end rows to a corn refuge.

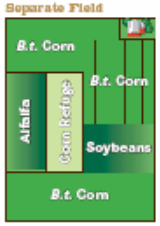
Perimeter



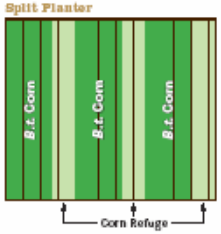
Block



Separate Field



Split Planter



2003 IRM GUIDE

YIELDGARD® Corn Borer

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.

- Plant corn hybrids with YieldGard Corn Borer to ensure that an "effective dose" of *B.t.* is available for corn borer control throughout the plant, throughout the season. This will control nearly all susceptible insects.
- Plant a corn refuge block close to the YieldGard Corn Borer corn. The block will serve as a refuge to support the survival of susceptible corn borers. These corn borers will play a crucial role in preserving the effectiveness of the YieldGard Corn Borer technology.
- Practice Integrated Pest Management (IPM) to preserve the natural enemies of corn borers and other insect pests. Natural predators such as lacewings, wasps, ladybugs, spiders and minute pirate bugs can help reduce corn borer populations. YieldGard Corn Borer insect protection aids IPM because it affects only target insects and allows beneficial insects to thrive.
- Growers should monitor their fields of YieldGard Corn Borer insect protected corn and contact their seed dealer or Monsanto representative if performance problems are observed.

Corn Borer Protection™

Before opening a bag of seed, be sure to read and understand the stewardship requirements, including applicable refuge requirements of insect resistance management, for the biotechnology traits expressed in the seed as set forth in the Monsanto Technology Agreement that you sign. By opening and using a bag of seed, you are reaffirming your obligation to comply with these stewardship requirements.

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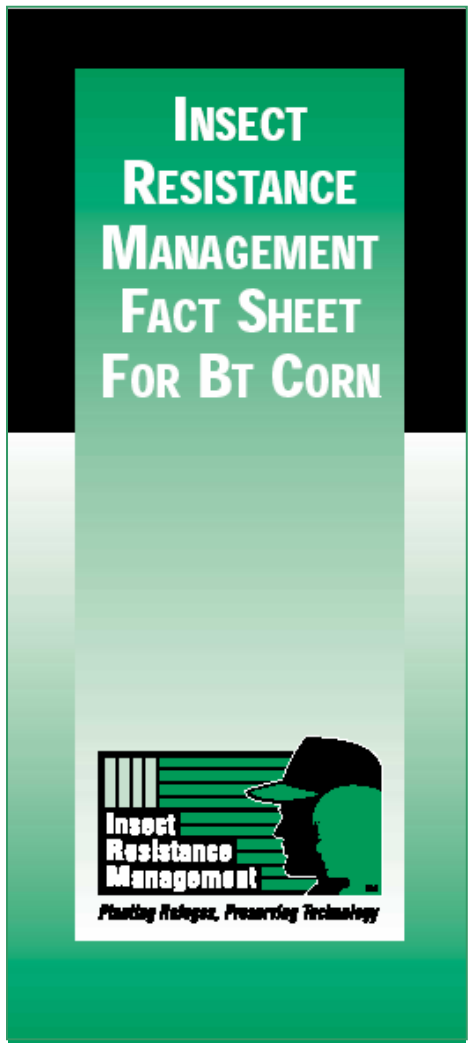
IRM Education - ABSTC Brochure



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).

Corn/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.

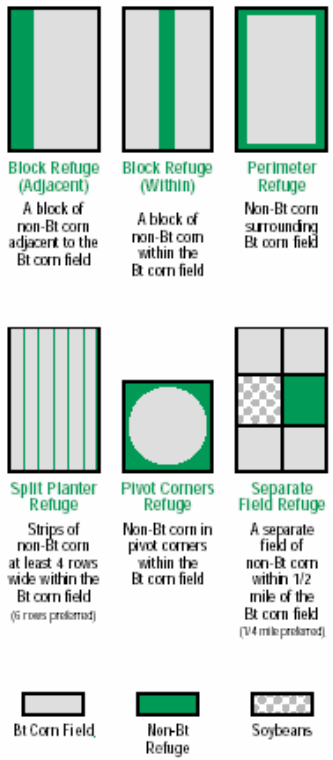
Refuge Distance Requirement

A non-Bt refuge must be planted within 1/2 mile of each Bt corn field, but preferably within 1/4 mile.

IRM Education - ABSTC Brochure

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 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.

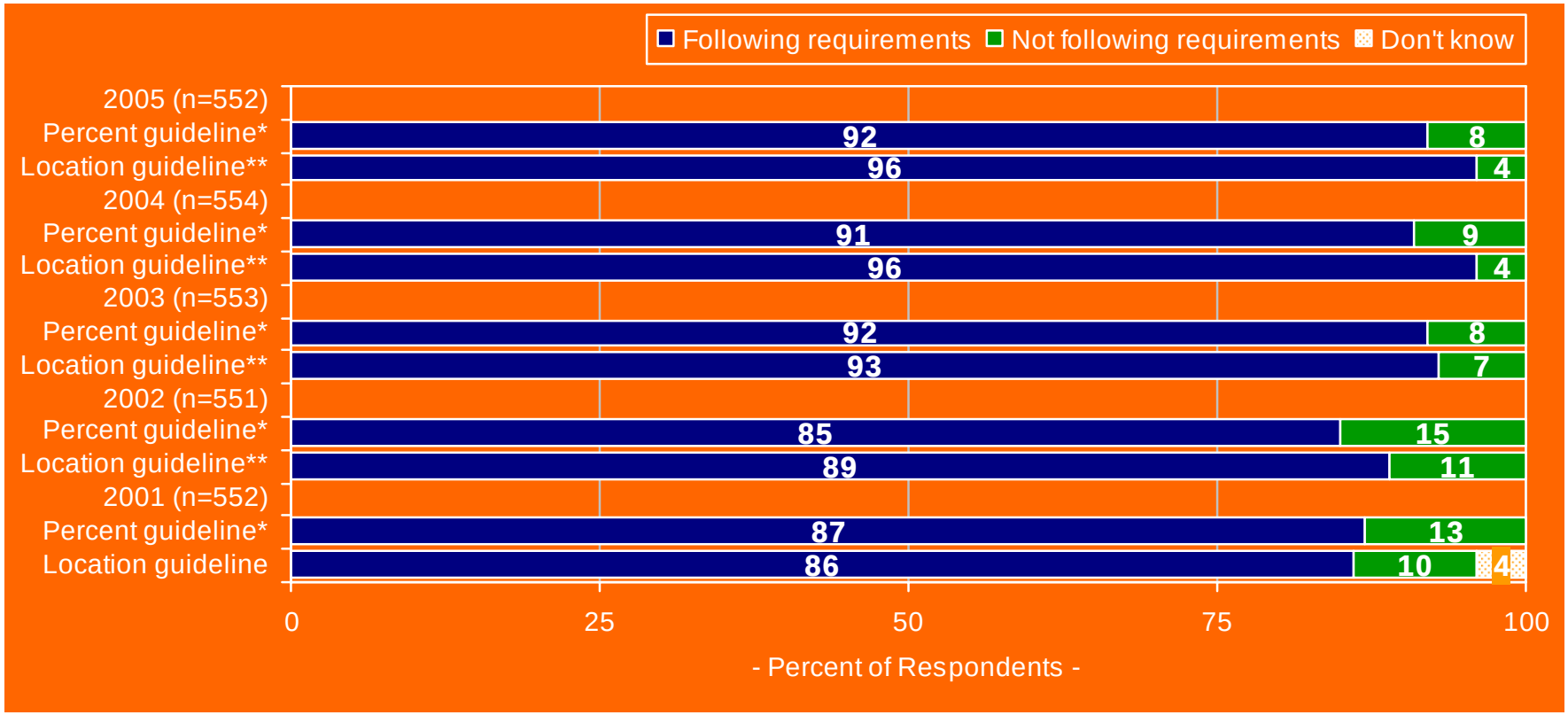
National Corn Growers Association
www.ncga.com

IRM-2001

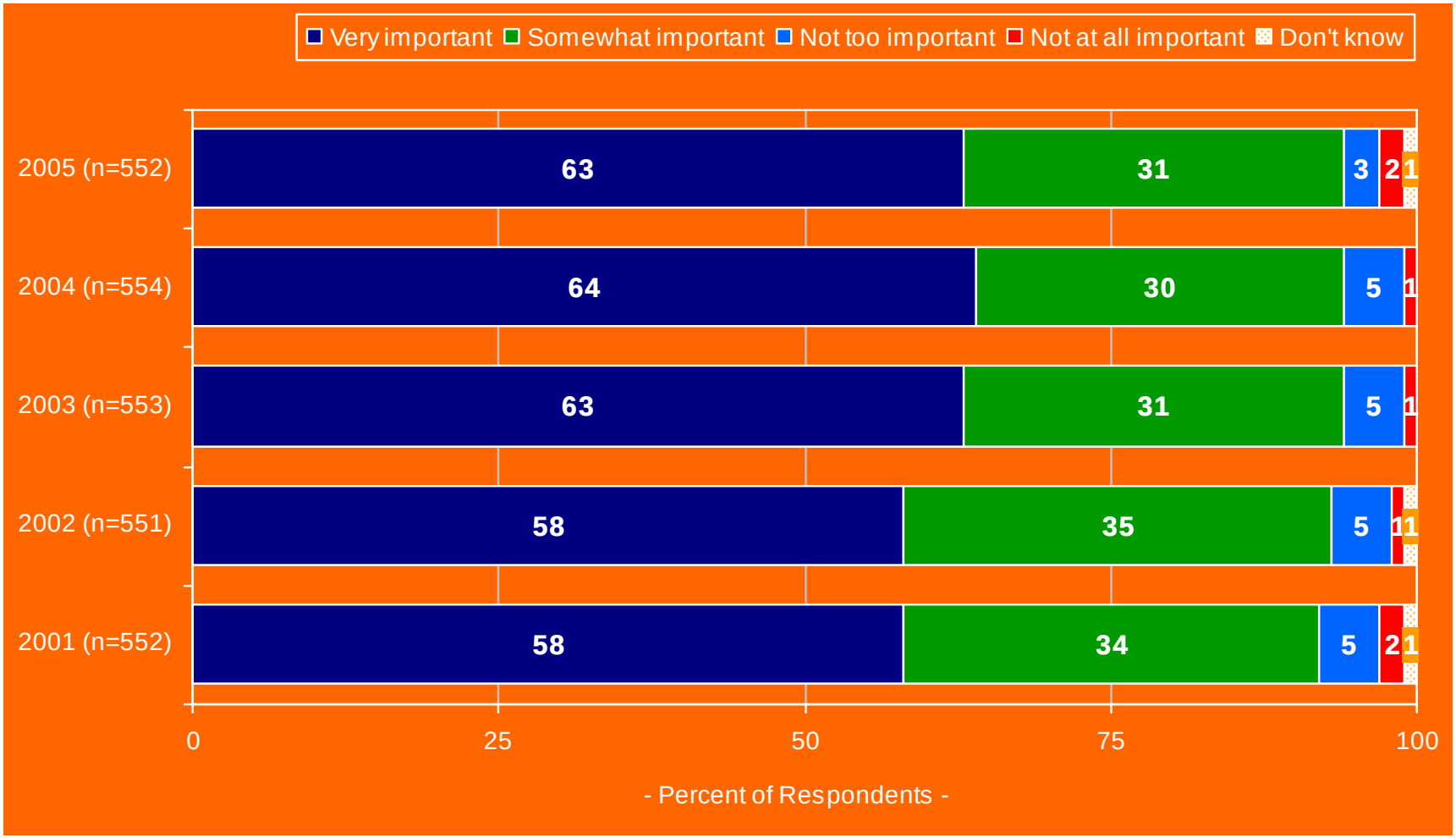
IRM Compliance

- 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



IRM Awareness 2001-2005



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