

2023

CORN

UNITED STATES PRODUCT USE GUIDE



Stewardship Through Insect Resistance Management

Insect Resistance Management (IRM) for Bt Corn

Following an insect resistance management (IRM) program is an essential part of good stewardship. The aim of an IRM program is to reduce the probability of target insects developing increased tolerance to the insecticidal Bt proteins, thus maximizing the longevity and effectiveness of these valuable traits in an environmentally-conscious way. Sustainable preservation of this technology places individual responsibility on everyone in the seed distribution system, from the seed supplier to the grower planting the seed. Additionally, IRM is a legal obligation as requirements have been incorporated into the registrations granted by the EPA for all Bt corn products.

This Product Use Guide (PUG) contains important information on how to implement a proper IRM plan. If you have questions after reviewing this document, or if you wish to register a tip or complaint about a grower who may not be following the IRM refuge requirements, please contact your sales professional.

A decrease in susceptibility or field-evolved resistance of some insect populations to certain technology traits in corn has been observed in different geographies which may result in lower than expected efficacy. To help extend durability of this technology, Corteva Agriscience recommends you implement Integrated Pest Management (IPM) practices such as crop rotation, cultural and biological control tactics (including rotating sources of Bt-protected corn traits), pest scouting, and appropriate use of pest thresholds when employing management practices such as insecticide application. You must also plant the required refuge when using this technology. Please contact your sales representative or consult with your local University Extension for more information regarding insect resistance management guidelines, best management practices and to understand whether there has been a shift in susceptibility or insect resistance documented in your area.

IRM Requirements

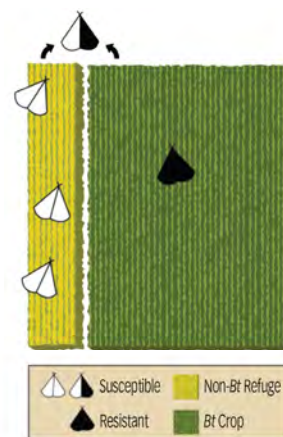
IRM programs address: (1) the amount of refuge, (2) the required proximity of hybrids with the Bt traits to the refuge, (3) the use of insecticides in the refuge, and (4) the design and management of the refuge.

What is a Refuge?

A refuge is a block or strip of corn that does not contain a Bt trait for controlling corn pests. The purpose of this refuge is to maintain a population of corn pests that is susceptible to Bt proteins. Potentially-resistant insects emerging from Bt fields can mate with susceptible insects from the refuge resulting in Bt-susceptible offspring.

Corteva Agriscience offers several refuge options including Enlist® Corn, Roundup Ready® Corn 2, and Liberty Link® Corn.

There are two types of refuge for Corteva Agriscience products with the Bt trait: integrated and structured. Some Bt products have an integrated refuge with refuge seed blended in the bag, while other Bt products require a structured refuge. Where available, an integrated refuge product allows a grower to conveniently deploy the refuge for a field with a single planting of one product, ensuring compliance on those acres. A structured refuge requires a grower to plant a portion of a field with another product that does not contain the insect-control traits of the Bt product. Grower-blended seed mixtures are not approved for use with any Bt hybrids to satisfy grower refuge requirements. Refuge requirements vary by product type and EPA-designated non-cotton and southern corn/cotton growing regions, as detailed on the following page.



IRM Compliance Assurance Program (CAP)

Corteva Agriscience requires all growers purchasing hybrids with a Bt trait sign a Corteva Agriscience Technology Use Agreement. By signing, the grower agrees to implement an IRM program—including planting a corn refuge and following EPA-mandated use requirements—as outlined in the PUG. Failure to follow these IRM requirements can result in the grower losing access to structured refuge products.

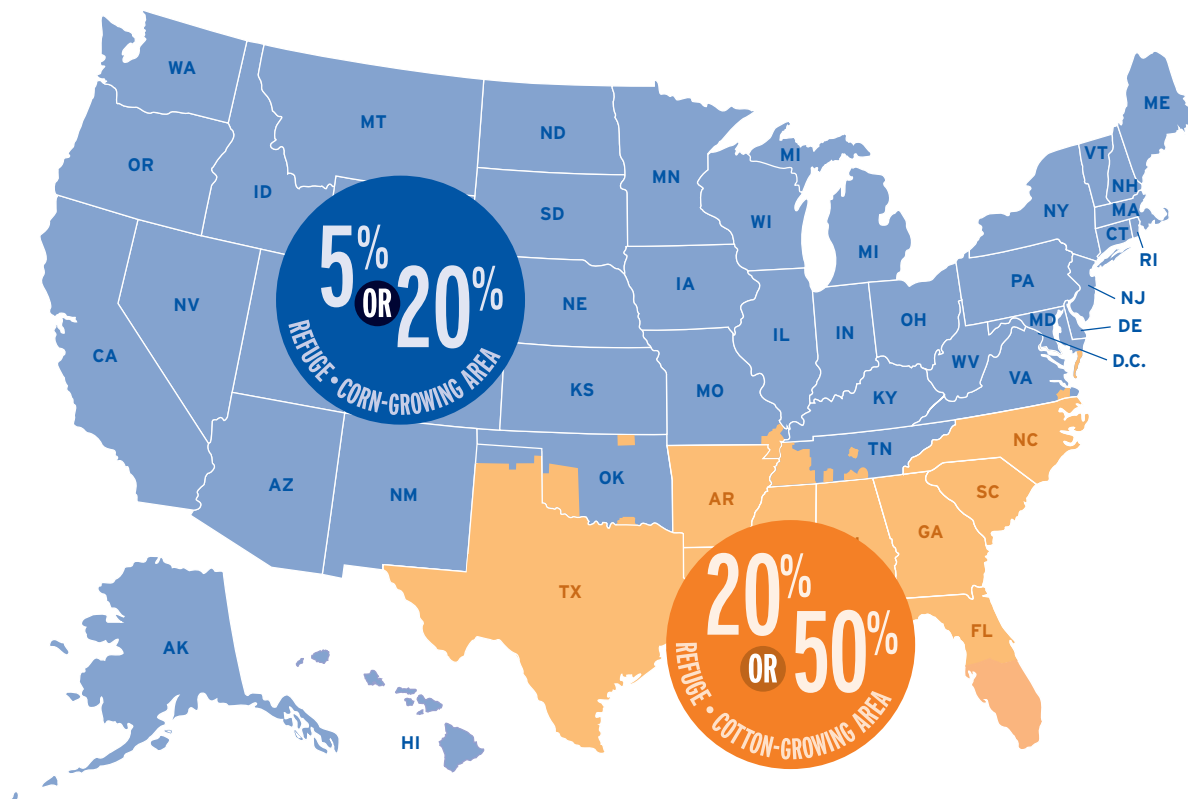
The EPA requires Bt corn seed providers to conduct on-farm visits as part of a comprehensive Compliance Assurance Program (CAP) to assess whether growers are following the IRM requirements. These on-farm assessments are conducted by an independent third party and directed toward areas at high risk of insect resistance based on pest pressure, Bt corn market penetration, or insufficient refuge seed purchase.

The CAP also outlines consistent standards developed by the EPA and Bt corn registrants for responding to growers who have not followed the IRM requirements to bring them into full compliance. These responses include:

- Notifying the grower by letter of IRM compliance deviations.
- Conducting a compliance assistance visit with the grower prior to planting to assist the grower in planning and implementing a proper IRM program.
- Conducting a compliance assessment visit with the grower the following growing season to assess IRM compliance.
- Providing the grower additional IRM educational materials.
- A grower found with a second incident of non compliance with refuge requirements within a five-year period will be denied access the next year to the registrant's structured refuge Bt corn products.



United States Refuge Size Requirements



Southern Corn/Cotton Growing Regions

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

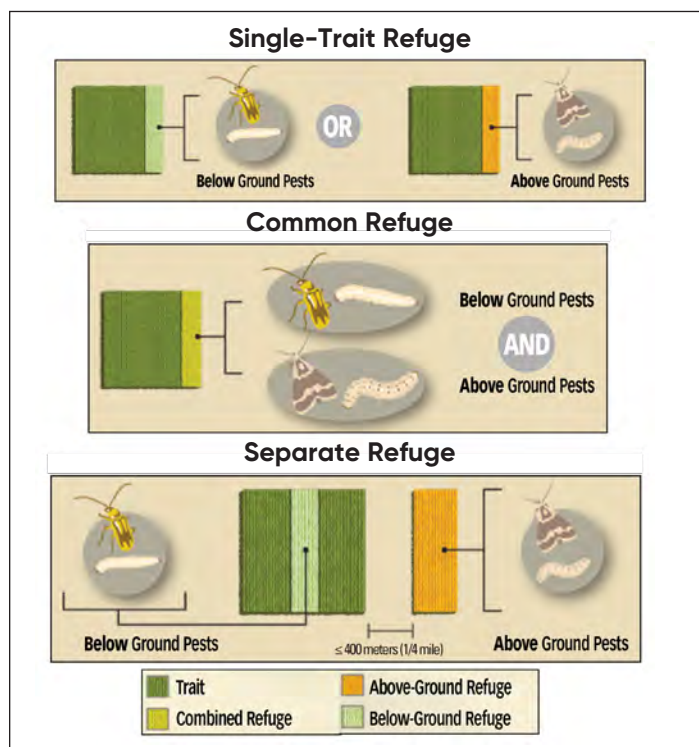
VIRGINIA
Counties of:
Dinwiddie
Franklin City
Greensville
Isle of Wight
Northampton
Southampton
Suffolk City
Surry
Sussex

Structured Refuge Requirements

In **non-cotton** growing areas, the structured refuge requirements are 5% or 20% of corn acres planted for corn borer-protected products and 20% for corn rootworm-protected products. In **cotton** growing areas, the structured refuge requirements are 20% or 50% of corn acres planted for corn borer-protected products and 20% for corn rootworm-protected products.

Structured Refuge Planting Options for Above-Ground, Below-Ground, and Above+Below-Ground Products

A **single-trait refuge** is one that can be used for corn rootworms or corn borers, but not both. A **common refuge** is a single field that serves as a refuge for both corn borers and corn rootworms simultaneously. A **separate refuge** is a refuge designed exclusively for corn borers or exclusively for corn rootworms—i.e., a stacked Bt product can require two separate refuges.



Select Similar Hybrid for Structured Refuge

One key to establishing an effective refuge is selecting an appropriate hybrid—one that is agronomically similar to the Bt hybrid. This helps ensure that the refuge hybrid has the same likelihood of attracting adult insects as the Bt field. The refuge hybrid should match the Bt hybrid in maturity, early vigor and plant height.

Refuge Management

Management practices in the refuge acres and Bt corn acres must be as similar as possible to promote parallel hybrid development.

- To be effective, the refuge must be the correct size and distance from the Bt field, and be planted with a similar hybrid under similar management practices.
- Plant the refuge at the same time as the Bt hybrid.
- Fertility programs, including starter and sidedress, should be similar.
- Use the same tillage system in the Bt field and the refuge. Different tillage operations may result in dissimilar residue levels on the soil surface. Soil temperature differences could then lead to dramatic early development differences between the Bt field and the refuge.
- Reducing inputs on the refuge or planting it on marginal land also decreases the effectiveness of the refuge.
- If the refuge is planted on rotated ground, the trait corn must also be planted on rotated ground. If the refuge is planted on continuous corn ground, the trait corn may be planted on either continuous corn ground or rotated ground. It is also recommended that growers planting continuous corn plant the refuge in the same location each year.
- Practice Integrated Pest Management (IPM) to preserve the natural enemies of corn borer, corn rootworm and other insect pests. Natural predators such as ground beetles and ants can help reduce corn rootworm larvae populations. Bt corn insect protection aids IPM because it affects only target insects and allows beneficial insects to thrive.
- Popcorn can be used as a refuge option, but sweet corn and/or silage corn cannot.

Field Monitoring

Monitoring Bt fields for insect resistance development is an integral part of an IRM plan. If resistant populations are detected early, alternative control measures can be quickly implemented to reduce the population and halt the spread of resistance. Because of its importance in maintaining the effectiveness of Bt technology, the EPA mandates active monitoring as a condition of registration of Bt products. Corteva Agriscience requires customers to monitor Bt fields for unexpected levels of insect damage and report any high level of suspected insect damage to a sales representative for further investigation. Acres planted with Bt hybrids should be correctly marked at planting to prevent confusion when monitoring.

Structured Refuge Configuration

Because Bt corn growers use different management practices, considerable flexibility is allowed in laying out the refuge. Several of these refuge patterns are described below.

Surveys indicate that most farmers plant the refuge within the Bt field. This closer proximity increases refuge effectiveness and maximizes Bt acreage in the field.

Refuge Within the Bt Field:

- Block
- Perimeter or Border
- 4-row Strips Required

Separate-Field Refuge Distance Requirements:

- Appropriate refuges must be planted on every farm with a field that contains Bt corn—i.e., you cannot use a neighbor's field to satisfy the refuge requirements.
- For corn borer-Bt products, refuge must be planted within 1/2 mile of each Bt corn field.
- For corn rootworm-Bt products, refuge must be planted adjacent to Bt hybrids; it can be separated by a ditch or a road but not by another field.

Single-Trait (Corn Borer or Corn Rootworm) and Common Refuge Configurations

Within



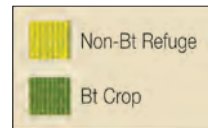
Block



Perimeter



Strips



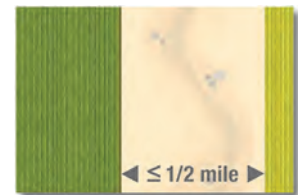
Adjacent



Adjacent



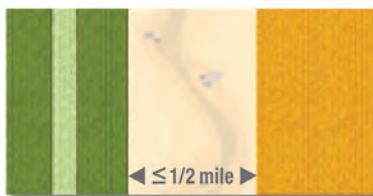
Within adjacent field



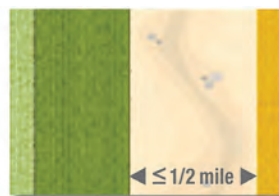
For single-trait corn borer only

Adjacent options separated by a road, path, ditch, etc., but not another field.

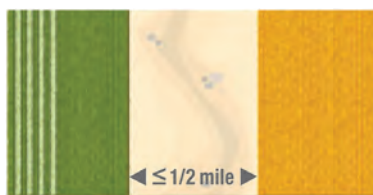
Separate Refuge Configurations



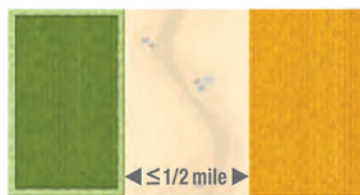
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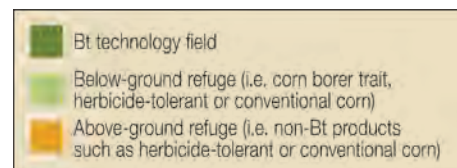
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Strips



Perimeter



Corn rootworm refuge must be within or adjacent to the Bt field – separated by a road, path, ditch, etc., but not another field. Corn borer refuge must be within or adjacent to the Bt field or within 1/2 mile of the Bt field.

Corn Technologies (cont.)

	Corn products containing the Herculex® I (HX1) trait provide protection or suppression against susceptible European corn borer, southwestern corn borer, black cutworm, fall armyworm, lesser corn stalk borer, southern corn stalk borer, sugarcane borer, and corn earworm.
	Corn products containing PowerCore® technology are a pyramid of Bt traits that combines three proteins to deliver broad spectrum protection against above-ground pests. This season-long insect control is specialized for areas with minimal rootworm pressure to protect your high yield potential corn crop.
	Corn products containing PowerCore® technology are a pyramid of Bt traits that combines three proteins to deliver broad spectrum protection against above-ground pests. This season-long insect control is specialized for areas with minimal rootworm pressure to protect your high yield potential corn crop. PowerCore® Enlist® hybrids are tolerant to 2,4 D choline, glyphosate, glufosinate and FOP herbicides. Enlist One® herbicide, a straight-goods 2,4 D choline, and Enlist Duo® herbicide, a combination of 2,4 D choline and glyphosate, are designed to be applied to crops with the Enlist trait. Enlist herbicides with Colex-D® technology provide exceptional weed control and on-target application. Additional product-specific stewardship requirements for Enlist crops can be found in the Enlist® Product Use Guide, and at www.Enlist.com. Always read and follow label directions. Consult Enlist herbicide labels for weed species controlled.
	Corn products containing Optimum® Intrasect® Insect Protection provide protection or suppression against susceptible European corn borer, southwestern corn borer, black cutworm, fall armyworm, lesser corn stalk borer, southern corn stalk borer, sugarcane borer, stalk borer, and corn earworm.
	Corn products containing Optimum® Leptra® Insect Protection provide protection or suppression against susceptible corn earworm, European corn borer, southwestern corn borer, black cutworm, fall armyworm, western bean cutworm, lesser corn stalk borer, southern corn stalk borer, stalk borer, and sugarcane borer.
	Corn products containing Herculex® XTRA insect protection (HXX) have two insect protection traits: the Herculex I (HX1) trait and the Herculex RW (HXRW) trait. Hybrids that contain HXX traits provide protection or suppression against susceptible European corn borer, southwestern corn borer, black cutworm, fall armyworm, lesser corn stalk borer, southern corn stalk borer, sugarcane borer, and corn earworm; and also provide protection from larval injury caused by susceptible western corn rootworm, northern corn rootworm, and Mexican corn rootworm.
	Corn products containing SmartStax® technology use multiple modes of action to protect corn from the broadest spectrum of above-and-below-ground corn insects. It offers reduced refuge requirements of only 5 percent in the Corn Belt. By allowing growers to plant 95 percent of their acres to high yield potential, insect-traited hybrids, SmartStax helps farmers maximize whole-farm yield potential.
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Corn Technology Refuge Requirements

STRUCTURED REFUGE PRODUCTS	Insect Protection	Herbicide Traits	Corn Region		Cotton Region	
			Add'l Refuge	Refuge Design	Add'l Refuge	Refuge Design
		LL/RR2		Within, adjacent, or up to a half mile		Within, adjacent, or up to a half mile
		LL/RR2		Within, adjacent, or up to a half mile		Within, adjacent, or up to a half mile
		LL/RR2/ENL		Within, adjacent, or up to a half mile		Within, adjacent, or up to a half mile
		LL/RR2		Within, adjacent, or up to a half mile		Within, adjacent, or up to a half mile
		LL/RR2		Within, adjacent, or up to a half mile		Within, adjacent, or up to a half mile
		LL/RR2		Common – Within or adjacent Separate – CB: Within, adjacent or up to a half mile CRW: Within or adjacent		Common – Within or adjacent Separate – CB: Within, adjacent or up to a half mile
						Separate – CRW: Within or adjacent
		LL/RR2		Common – Within or adjacent Separate – CB: Within, adjacent or up to a half mile CRW: Within or adjacent		Common – Within or adjacent Separate – CB: Within, adjacent or up to a half mile CRW: Within or adjacent
		LL/RR2/ENL		Common – Within or adjacent Separate – CB: Within, adjacent or up to a half mile CRW: Within or adjacent		Common – Within or adjacent Separate – CB: Within, adjacent or up to a half mile CRW: Within or adjacent

CB: Corn borer
CRW: Corn rootworm
LL: LibertyLink®
RR2: Roundup Ready® Corn 2
ENL: Enlist®



Above Ground Insect Protection



Below Ground Insect Protection



Above and Below Ground Insect Protection

Calculating Structured Refuge



Refer to this diagram for the examples below.

- A** Total Corn Acres[†]
- B** Refuge Acres
- C** Bt Acres
- %** Percent of Required Refuge— **5%** **20%** or **50%**
Based on total corn acres

[†]Includes all corn acres that are infield or adjacent to each other and will be allocated to the Bt product and its associated refuge.

THE CORRECT WAY TO CALCULATE Example shown is for a 20% refuge product.

START with the **TOTAL** number of corn acres you want to plant in an area.

Multiply by the **PERCENT** of refuge required for the Bt trait.

This is your minimum **REFUGE ACRES**.

Example **A** 200 X **%** 20% = **B** 40 ✓

Your Field _____ X _____ = _____

Next, subtract your refuge acres from your total corn acres.

This is your maximum **Bt ACRES**.

Example **A** 200 - **B** 40 = **C** 160

Your Field _____ - _____ = _____