



TwinLink®

TwinLink® Plus

2019 Insect Resistance Management (IRM) Guide

IRM Program for TwinLink and TwinLink Plus Cotton

Pest resistance presents a constant threat to crop production. The ability of the tobacco budworm to develop resistance to common insecticides, such as organophosphates and pyrethroids, has directed many changes in cotton production over time. Yet with proper planning, producers can substantially slow the rate at which resistance develops. Doing so is the goal of IRM programs and comprises a critical component of the stewardship of TwinLink and TwinLink Plus technology.

BASF is committed to implementing effective IRM programs for TwinLink, TwinLink Plus and future traits that confer insect resistance to crops. In the United States, IRM programs specific to each insect-resistant crop are evaluated and approved by the U.S. Environmental Protection Agency (EPA) and mandated as a condition of registration. The IRM program for TwinLink and TwinLink Plus cotton is updated annually based on feedback from grower and industry groups, along with input from extension, research and regulatory experts.

IRM strategies for specific crops and regions vary due to region-specific differences in plant and animal biology, environmental and farming conditions, as well as public and producer concerns. The TwinLink and TwinLink Plus IRM plan has three major components: effective doses of multiple insecticidal protein, good Integrated Pest Management (IPM) practice and effective refuge. TwinLink cotton produces two insecticidal proteins from *Bacillus thuringiensis* (Bt), Cry1Ab and Cry2Ae, which have independent actions and result in the highly effective control of key lepidopteran pests in cotton.

TwinLink Plus produces the same two proteins, plus an additional vegetative insecticidal protein (Vip), Vip3Aa19. The addition of Vip3Aa19 is highly valuable in the management of lepidopteran pests and in delaying resistance. The other two IRM components — good IPM practices and effective refuge — rely on you, the grower. Prior to planting TwinLink and/or TwinLink Plus cotton seed, growers must read and sign the BASF Grower Technology Agreement. Doing so confirms that you read and will comply with requirements detailed in this IRM Guide and the Trait and Technology Use Manual.

Integrated Pest Management

There are many definitions of IPM; all have several components in common. All promote routine monitoring of pests, use of threshold-based control decisions, and a diversity of pest suppression methods, including cultural, mechanical and biological controls. These management tactics are deployed with consideration for both economic and environmental impacts, including those on beneficial organisms. Importantly, IRM and sound IPM go hand in hand.

The use of TwinLink and/or TwinLink Plus cotton will significantly reduce damage from caterpillar pests in cotton. Growers should understand that circumstances such as severe plant stress or high insect pressure may result in the need for supplemental control with foliar insecticides.



IPM Program for Insect Management in TwinLink® and TwinLink Plus

- Select varieties best adapted to the specific area, taking into consideration the impact of crop maturity in managing pests. For example, late-maturing varieties poorly adapted to the area may incur greater injury from target insect pests.
- Use agronomic practices that optimize growth and yield of varieties to reduce pest severity. For example, excessive nitrogen rates can lead to higher aphid populations. Also, excessive nitrogen can lead to more vegetative growth that makes the crop more attractive for moths to lay eggs.
- Have a consistent pest-monitoring program in place and use treatment thresholds developed for the area.
- When possible, choose insecticides with the least impact on natural enemies, such as pirate bugs, lacewings and big-eyed bugs. Natural enemies supplement the level of control provided by TwinLink and TwinLink Plus cotton.
- After harvest, manage stalk destruction on a timely basis to limit pest overwintering.

TwinLink and TwinLink Plus cotton are as susceptible as non-*Bt* cotton to non-lepidopteran pests, such as stink bugs, plant bugs, aphids and spider mites.

Cotton Refuge

The importance of refuges in delaying resistance buildup cannot be overstated. Refuges are a portion of the farming landscape that do not contain specific *Bt* genes and generate an abundance of susceptible target pests. These susceptible insects will mate with rare resistant insects that survive on the *Bt* crop, producing offspring that are killed by the *Bt* crop. This provides a mechanism to delay the rate at which resistance to *Bt* cotton increases in target pest populations, therein promoting the long-term effectiveness of the technology.

This guide describes two very different types of refuges for TwinLink and TwinLink Plus cotton: structured refuges and natural refuges. Structured refuges are mandated areas of non-*Bt* cotton that must be planted by growers. Natural refuges consist of crops other than those intentionally planted to serve as refuges, as well as non-crop vegetation, suitable to host target pests of TwinLink and TwinLink Plus cotton.

Areas Where Natural Refuge Has Been Approved for TwinLink and TwinLink Plus Cotton

Natural refuge has been approved for much of the central and eastern Cotton Belt. Growers should refer to the included map (Figure F) to determine if their specific fields are located in this area. If they are located in the natural refuge area, it is not necessary to plant a structured refuge. Specifically, growers in the states of Alabama, Arkansas, Florida, Georgia, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas (excluding Brewster, Crane, Crockett, Culberson, El Paso, Hudspeth, Jeff Davis, Loving, Pecos, Presidio, Reeves, Terrell, Val Verde, Ward and Winkler counties) and Virginia may use natural refuge.

Areas Where Growers Must Plant Structured Refuge for TwinLink and TwinLink Plus Cotton

If TwinLink or TwinLink Plus cotton is to be planted outside of the area approved for natural refuge (Figure F), a structured refuge of non-*Bt* cotton must be planted with it, using one of the options described herein. Specifically, cotton growers in the states of Arizona, California and New Mexico, as well as those in the West Texas counties of Brewster, Crane, Crockett, Culberson, El Paso, Hudspeth, Jeff Davis, Loving, Pecos, Presidio, Reeves, Terrell, Val Verde, Ward and Winkler, have a legal obligation to plant a refuge, as detailed herein. However, specific counties within these areas may have exemptions from this requirement by regulatory authorities, in accordance with state programs to eradicate pink bollworm. Growers are advised to inquire with local authorities, such as their respective state departments of agriculture, about whether such exemptions apply to the specific counties where they will plant TwinLink and/or TwinLink Plus cotton.

Areas Where TwinLink and TwinLink Plus Cotton Cannot Be Planted

Commercial planting of TwinLink and TwinLink Plus cotton is prohibited in Hawaii, Puerto Rico and the U.S. Virgin Islands. In addition, planting of TwinLink and TwinLink Plus cotton is prohibited south of Route 60 (near Tampa) in Florida. TwinLink and TwinLink Plus are not registered in states outside of the traditional U.S. Cotton Belt. Therefore, neither can be planted in Alaska, Colorado, Connecticut, Delaware, Idaho, Illinois, Indiana, Iowa, Maine, Massachusetts, Michigan, Minnesota, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota,



Utah, Vermont, Washington, West Virginia, Wisconsin, Wyoming and the District of Columbia.

Structured Refuge Requirements

For all of the structured refuge options detailed below, the variety and maturity range of non-*Bt* cotton used in refuge must be comparable to that of the corresponding TwinLink® and/or TwinLink Plus cotton. In addition, the refuge must be managed the same way as the corresponding TwinLink and/or TwinLink Plus cotton. This includes planting time, fertilization rate, weed control, irrigation and termination.

Embedded Refuge

Embedded refuge consists of blocks or rows of non-*Bt* cotton planted within the TwinLink and/or TwinLink Plus cotton. Three approved embedded refuge options are available to growers. For Options 1 and 2, the grower

must plant at least 5 acres of non-*Bt* cotton for every 95 acres of TwinLink and/or TwinLink Plus cotton. For Option 3, at least 10 percent of the cotton planted must be non-*Bt*.

Insecticide treatments of embedded refuge.

The refuge (non-*Bt*) cotton may be treated with insecticides (excluding foliar *Bt kurstaki* products) labeled for control of tobacco budworm, bollworm or pink bollworm (including sterile insects and pheromones), as long as all the TwinLink and/or TwinLink Plus cotton in which it is embedded is also treated at the same time. That is, the *Bt* cotton and the embedded refuge must be treated as one; no distinction can be made between the TwinLink, TwinLink Plus and refuge cotton when treating for target pests.

Embedded Refuge*

Embedded Refuge Option 1 (5 percent single embedded block)

- **Typical use.** For smaller fields, typically less than 1/2 mile in length and width. The refuge (non-*Bt*) cotton is embedded as a single contiguous block within the TwinLink or TwinLink Plus cotton field.
- **Refuge size.** The single embedded block of refuge must average 150 feet in width.
- **Refuge location.** The single embedded block of refuge must be located within the TwinLink or TwinLink Plus field for which it serves as refuge. See Figure A.
- **Example calculation.** Multiply the total field size by 0.05 to determine refuge size. To plant an 80-acre field, multiply 80 by 0.05 for a total of 4 acres of refuge.
- **Result.** Plant 4 acres of refuge embedded in the 76 acres of TwinLink and TwinLink Plus cotton.

Embedded Refuge Option 2 (5 percent multiple embedded blocks)

- **Typical use.** For larger fields, typically greater than 1/2 mile in length and/or width.
- **Refuge size.** Each of the multiple embedded blocks of refuge must average 150 feet in width.
- **Refuge location.** Refuge blocks must be located no more than 1/2 mile apart within the TwinLink and/or TwinLink Plus field in which they are embedded. See Figure B.
- **Example calculation.** Multiply the total field size by 0.05 to determine refuge size. To plant a 320-acre field, multiply 320 by 0.05 for a total of 16 acres of refuge.
- **Result.** Plant 16 acres of refuge embedded in the 304 acres of TwinLink and/or TwinLink Plus cotton.

Embedded Refuge Option 3 (embedded individual rows)

- **For pink bollworm only.** This option is not recommended for regions with a history of significant bollworm or tobacco budworm damage.
- **Typical use.** For regions of the Southwest with no history of cotton bollworm or tobacco budworm infestations.
- **Refuge size.** Plant at least one row of non-*Bt* cotton within every six to 10 rows of TwinLink and/or TwinLink Plus cotton. See Figure C.
- **Result.** On a 12-row planter, place non-*Bt* seed in two planting boxes interspersed within 10 planting boxes containing TwinLink and/or TwinLink Plus cotton seed.

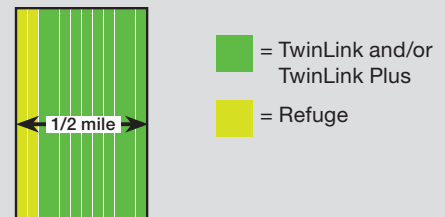


Figure A. Embedded Refuge Option 1 for Small Fields. 5 percent block refuge.

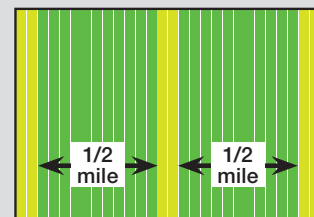


Figure B. Embedded Refuge Option 2 for Large Fields. 5 percent multiple block refuge.

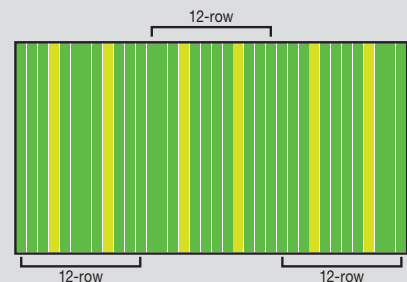


Figure C. Embedded Refuge Option 3. 10 percent (or greater) embedded individual refuge rows.



External Refuge

External refuge consists of blocks of non-*Bt* cotton planted adjacent to or in close proximity to the TwinLink® and/or TwinLink Plus field for which they serve as refuge. Growers may plant external refuges of either 5 percent or 20 percent, as illustrated below.

Five percent refuges must be within 1/2 mile (preferably 1/4 mile or less), and 20 percent refuges must be within 1 mile (preferably 1/2 mile or less) of the corresponding TwinLink and/or TwinLink Plus field. When TwinLink or TwinLink Plus cotton is grown for seed production, the placement of refuges must follow these requirements as closely as permitted by state regulations of seed production.

Insecticide treatments of 5 percent unsprayed external refuge. Treatment options for this refuge are very specific and are tied to the growth stage of the cotton to be treated. At the presquaring cotton stage, the refuge may be treated with any insecticide labeled for control of foliage-feeding caterpillars. Once cotton

has begun squaring, this refuge may not be treated with any insecticide labeled for the control of tobacco budworm, cotton bollworm or pink bollworm (including sterile insects or pheromones), except as follows:

1. Throughout the season, the refuge may be treated with acephate or methyl parathion at rates that will not control tobacco budworm or the cotton bollworm (i.e., equal to or less than 0.5 lb AI/A).
2. Throughout the season, the refuge may be sprayed with labeled insecticides for control of insect pests other than caterpillars, as long as these insecticides do not control tobacco budworm, cotton bollworm or pink bollworm.

Insecticide treatments of 20 percent sprayed external refuge. Growers choosing this option may treat the refuge with labeled insecticides (excluding foliar *Bt kurstaki* products) that control tobacco budworm, bollworm or pink bollworm, including sterile insects or pheromones, consistent with label requirements.

External Refuge*

5 Percent Unsprayed External Refuge¹

- This refuge cannot be sprayed for bollworms, budworms or pink bollworm during the period from squaring through harvest.
- *Typical use.* For areas where embedded refuge is impractical due to field size or location.
- *Refuge size.* External refuge blocks must have an average length and width of no less than 150 feet.
- *Refuge location.* Refuge blocks must be located within 1/2 linear mile of the TwinLink and/or TwinLink Plus field for which they serve as refuge. See Figure D.
- *Example calculation.* Multiply the number of acres of TwinLink and/or TwinLink Plus cotton planted by 0.053 to determine refuge size. If 70 acres of TwinLink and/or TwinLink Plus are planted, multiply 70 by 0.053 for a total of 3.7 acres of refuge.
- *Result.* Plant 3.7 acres of refuge within 1/2 linear mile of 70 acres of TwinLink and/or TwinLink Plus cotton.

20 Percent Sprayed External Refuge²

- This refuge has no restrictions on labeled insecticide use except that foliar *Bt kurstaki* products are prohibited.
- *Typical use.* For areas where embedded refuge is impractical due to field size or location.
- *Refuge size.* External refuge blocks must have an average length and width of no less than 150 feet.
- *Refuge location.* Refuge blocks must be located within 1 linear mile of the TwinLink and/or TwinLink Plus field for which they serve as refuge. See Figure E.
- *Example calculation.* Multiply the number of acres of TwinLink and/or TwinLink Plus cotton planted by 0.25 to determine refuge size. If 70 acres of TwinLink and/or TwinLink Plus are planted, then multiply 70 by 0.25 for a total of 17.5 acres of refuge.
- *Result.* Plant 17.5 acres of refuge within 1 linear mile of 70 acres of TwinLink and/or TwinLink Plus cotton.

¹ Growers must plant at least 5 acres of refuge for every 95 acres of TwinLink and/or TwinLink Plus cotton.

² Growers must plant at least 20 acres of refuge for every 80 acres of TwinLink and/or TwinLink Plus cotton.

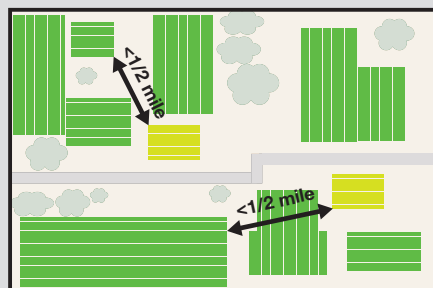


Figure D. 5 percent unsprayed external refuge

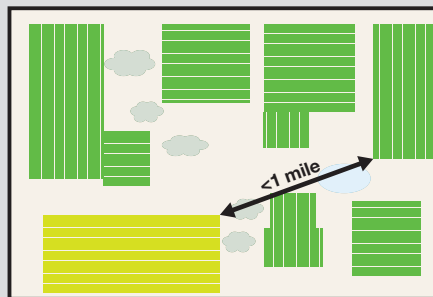


Figure E. 20 percent sprayed external refuge

■ = TwinLink and/or TwinLink Plus
■ = Refuge



PLANTING RESTRICTIONS AND REFUGE REQUIREMENTS FOR TWINLINK® AND TWINLINK PLUS COTTON

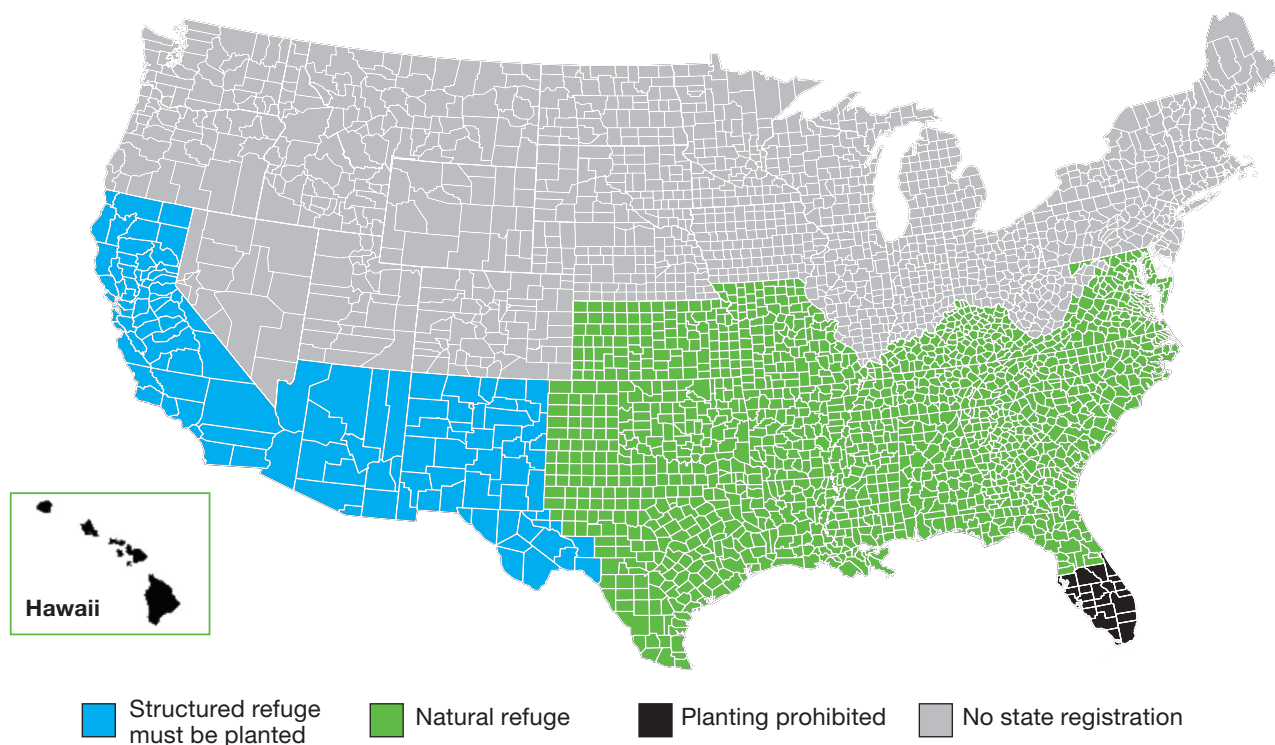


Figure F. Refuge requirements and planting restrictions for TwinLink and TwinLink Plus cotton. Producers should consult local authorities prior to planting to confirm requirements for specific fields or locations.

Important stipulations for planting of refuges

- Refuge blocks, whether embedded or external, must be managed by the same grower as the TwinLink and/or TwinLink Plus field for which they serve as refuge. The variety of non-*Bt* cotton used in the refuge block must be comparable to that of the corresponding TwinLink and/or TwinLink Plus cotton, especially in maturity range. In addition, the refuge must be managed the same way as the corresponding TwinLink and/or TwinLink Plus cotton. This includes planting time, fertilization rate, weed control, irrigation and termination.
- Intentional mixing of non-*Bt* seed with TwinLink and/or TwinLink Plus technology is not permitted.
- To avoid unintentional mixing of non-*Bt* seed with TwinLink and/or TwinLink Plus seed, thoroughly clean seed boxes and hoppers when switching between *Bt* and non-*Bt* seed.
- Monitor TwinLink, TwinLink Plus and refuge cotton routinely, and contact your local seed dealer if problems are observed.



EPA-Mandated Compliance Assurance Program

An EPA condition of registration of *Bt* crops requires registrants to assess grower compliance with planting of refuges. This is done on a yearly basis through telephone surveys and on-farm assessments. Failure to follow the refuge requirements detailed herein may result in the loss of future access to TwinLink® and TwinLink Plus cotton products. If you have any questions about complying with refuge requirements, please contact the distributor from which you obtained TwinLink and/or TwinLink Plus seed.

Commitment to Stewardship Initiatives

We set a high standard of customer care and stewardship and take a responsible approach to product launches, including those involving products of plant biotechnology. In addition, we have adopted stewardship programs for product launches that are consistent with the Excellence Through Stewardship® Guide for Product Launch Stewardship of Biotechnology-Derived Plant Products and the Guide for Resistance Management for Biotechnology-Derived Plant Products.

In advance of commercializing a plant biotechnology product, we are committed to meeting applicable

regulatory requirements in all countries where the product will be cultivated and in key importing countries with functioning regulatory systems. These countries are identified by assessing the global markets and trade of the product using information available through the commodity value chain.

Additionally, we routinely consult with and inform key stakeholders throughout the value chain regarding our research and development pipeline and product launch plans. We also actively support the development of initiatives designed to facilitate global trade and minimize trade disruptions that may result from asynchronous approvals of plant biotechnology products or incidental small amounts of biotech material in a commercial product (low level presence or LLP).

*Figures are indicative only. Growers should always contact their local seed representative to confirm refuge planting requirements if they are unsure.

This program was developed to be aligned with the ETS Guide for Resistance Management of Biotechnology-Derived Plant Products.



IMPORTANT: This bulletin is not intended to provide adequate information for use of these products. Read the label before using these products. Observe all label directions and precautions while using these products.

Always read and follow label instructions.

TwinLink is a registered trademark of BASF. Excellence Through Stewardship is a registered trademark of Excellence Through Stewardship. © 2019 BASF Corporation. All rights reserved. APN SC-19-0005
19BASF0319LLINK0288

TwinLink®
TwinLink®
Plus