

2019

Trait and Technology Use Manual



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TRAIT & TECHNOLOGY FOREWORD

PROVIDING SUSTAINABLE CROP SOLUTIONS FROM SEED TO HARVEST

At BASF, we help growers meet the ever-increasing demand for affordable and high-quality food, feed, fiber and energy crops, by helping you exceed your yield expectations and grow your business.

We have a passion for discovering new, integrated solutions and pioneering high-performing products to boost agricultural productivity and profitability. At the same time, we provide outstanding technologies to safeguard harvests. The process of introducing a new trait remains a lengthy one. According to a CropLife International study,¹ it takes approximately 13 years and approximately \$150 million from trait discovery to commercial launch of just a single trait, and even longer to get the necessary regulatory approvals for stacked trait varieties. Yet, our commitment to trait advancements and our investment in state-of-the-art research facilities throughout the United States has helped transform this process.

PLANT BIOTECHNOLOGY HELPS BOOST PRODUCTIVITY

The application of biotechnology in agriculture has resulted in benefits for both producers and consumers. For example, genetically engineered, insect-resistant cotton has allowed for a significant reduction in insecticide use. Similarly, herbicide-tolerant soybeans, cotton, canola and corn have enabled improved weed control and use of herbicides. Likewise, herbicide-tolerant crops permit the use of non- or reduced-tillage systems, which preserves topsoil by preventing erosion.²



COEXISTENCE

Coexistence of various production methods is a familiar concept to the agricultural community. Coexistence refers to the growing of crops (including GM crops), whose food, feed and environmental safety are demonstrated before they are allowed to enter the agricultural production system and supply chain. Farmers have practiced coexistence for generations, so as to meet demands for different types of products and to meet different quality standards for their customers. Farmers are accustomed to producing different crops alongside each other. Experience shows that coexistence of a wide range of production methods can occur, provided that best practices are carefully followed and cooperation between neighboring farm operations is encouraged. This applies equally to the cultivation of GM crops, conventional crops, hybrids and organic crops.

American farmers have the freedom and right to choose the system to produce crop types and/or utilize the production systems they wish to implement, to meet the needs of their own farm and their customers. It is important that every American farmer is encouraged to show respect for his or her neighbor's ability to make different choices from his or her own. Open conversation with neighbors will help promote coexistence and aid in the common success of all farmers. Successful coexistence of various production systems requires mutual respect and tolerance between farmers; no single system should be considered superior to another and needlessly exclude the other.

Farmers pride themselves on being good stewards of the land and being cooperative and neighborly in their communities. However, it is important to realize that the management decisions that a farmer makes have the potential to affect his or her neighbor's farming operation — whether the decisions are about weed and pest control, input use or the choice of crops and varieties that will be grown and their planting location.

Since a crop's marketing value could be impacted if an admixture occurs, resulting in the crop not meeting a marketing or quality standard, the costs and time associated with identifying and implementing workable management measures to minimize such admixture become an economic consideration. Those who will benefit economically from growing specialized crops or meeting specific market standards have the primary responsibility for implementing best production practices to satisfy a particular market. The ongoing success of coexistence strategies has depended upon cooperation, communication, flexibility and mutual respect for each cropping system and among growers using the various systems.



STEWARDSHIP

Product and trait stewardship is the responsible management of a product from its inception through to its ultimate use and discontinuation. BASF takes a responsible approach to resistance management and the launch of products derived through plant biotechnology. In advance of commercializing a plant biotechnology product, BASF is committed to fulfilling applicable regulatory requirements for cultivation and obtaining regulatory authorizations for commodity use in all key importing countries with functioning regulatory systems. Stewardship also applies to you, the grower. When you plant varieties and hybrids with biotechnology traits, you agree to implement stewardship requirements including, but not limited to:

- Reading, signing and complying with the BASF Grower Technology Agreement (BGTA) and reading all license term updates before purchasing or using any seed containing a BASF trait.
- Reading and following the directions for use on all product labels.
- Following applicable stewardship guidelines included as outlined in this Trait and Technology Use Manual. Reading and following the Insect Resistance Management (IRM) Guide prior to planting and complying with the applicable IRM requirements for specific biotechnology traits mandated by the Environmental Protection Agency (EPA), to help minimize the risk of resistance development. Observing planting restrictions mandated by the EPA.
- Following weed resistance management guidelines to help minimize the risk of herbicide resistance development. Complying with any additional stewardship requirements, such as grain or feed use agreements or geographical planting restrictions, which BASF deems appropriate or necessary to implement for proper stewardship or regulatory compliance. Selling crops or materials containing biotechnology traits only to entities that confirm authorization for use at export destinations. Not moving materials containing biotechnology traits across boundaries into nations where import is not permitted. Not selling, promoting and/or distributing within a state where the product is not yet registered.

We encourage growers to talk to their commodity merchants, brokers or product purchasers to confirm their buying position for commodity components of this product. Information regarding the regulatory status of these seeds can be obtained at www.biotradestatus.com.



BASF TRAIT AND TECHNOLOGY USE MANUAL

This manual provides technical information and recommended best management practices for: LibertyLink® and LibertyLink GT27 soybean seed, including Credenz®; LibertyLink corn seed; FiberMax® and Stoneville® cotton seed with combinations of LibertyLink, GlyTol®, TwinLink® or TwinLink Plus traits; and InVigor® canola seed. This guide also provides information on Integrated Pest Management (IPM) and the proper use of Liberty® herbicide, the only broad-spectrum herbicide that effectively controls grasses and broadleaf weeds, and has no known resistance in U.S. broadacre crops.

We sincerely appreciate your business and look forward to continuing to serve your seed, technology and crop production needs. It's our mission to help every field thrive so our communities thrive. In doing so, we will not only grow a healthier world, but also provide peace of mind for our communities.



BASF has partnered with AgCelerate®, an industry-wide licensing provider that simplifies your seed agreement requirements. Register with AgCelerate to easily review, sign and keep all agreements electronically for multiple trait providers all in one location. Save time and reduce the paperwork burden by going online with AgCelerate at agcelerate.com or call 1-866-784-4630.



INTEGRATED PEST MANAGEMENT (IPM)

As defined by the EPA, IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of common sense practices. IPM applies to all pests — diseases, weeds and insects — and should be an important component of every grower's operation.

Successful IPM programs rely on current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, while minimizing hazards to people, property and the environment.

For the grower, the opportunity is to take the tools (varieties, traits, crop protection and seed growth products) and blend them into a profitable enterprise.

MODE OF ACTION VS. SITE OF ACTION

The use of these terms has evolved somewhat differently in insect versus weed science. However, for the grower, the differences are not of practical significance. Both terms are used in resistance management to indicate that products with different modes or sites of action (SOAs) act independently within the target pest and, thus, are unlikely to be impacted by significant cross-resistance. For simplicity, we have adopted herein the use of site of action throughout this Trait and Technology Use Manual for both insecticides and herbicides. For insecticides, site-of-action groups are directly equivalent to the mode-of-action groups published by the Insecticide Resistance Action Committee (IRAC). Visit irac-online.org/modes-of-action to learn more.



INTEGRATED PEST MANAGEMENT IN PRACTICE

Good IPM programs are designed so all methods of pest suppression are considered. Overreliance on any one pest suppression tool, such as a biotechnology trait or a single SOA, can lead to problems such as insect, disease or weed resistance.

Effective IPM programs have several characteristics in common. They include some type of pest monitoring; reliable identification of pests — disease, weed or insect, good record keeping, intervention to reduce pest numbers, and program and performance evaluation. Managing pests should start at the end of every growing season, when growers evaluate crop performance and management tactics. Growers should assess fields continually for potential problems, such as surviving weeds or severe weed, insect or disease pressure. Rotation of crops and pesticide SOAs, in addition to other IPM practices, are powerful tools for managing pest problems and delaying the onset of resistance.

By the start of the growing season, growers should have most of their IPM program in place. Biotechnology traits perform best when the crop is growing well and environmental stress is low. Good hybrid or variety selection, recommended seeding rates, planting dates and planting depths can all promote plant health and, thus, optimize trait performance.

Growers are advised to follow agronomic best management practices. **The Integrated Weed Management (IWM)** recommendations and **Insect Resistance Management (IRM)** detailed in this manual provide an introduction to management practices that will optimize the investment in traits and crop protection products. Further information can be provided by appropriate local experts (Extension or consultants). In addition, more information can be found at agriculture.basf.com/us/en/Crop-Protection/Liberty.html and agriculture.basf.com/us/en/Crop-Protection/TwinLink.html

Scouting crops for key pests is essential. Growers must be aware of the growth stages of the crop and weeds, disease pressure and insect populations to make good decisions. Fields should be monitored on a consistent basis — at least once per week and more frequently when the pest threat is higher, such as when the bollworm egg deposition in cotton is at its peak.

TOP GROWER-REPORTED GLYPHOSATE-RESISTANT WEEDS BASED ON CROP ACRES

1. Marehail (42M acres)
2. Waterhemp (40M acres)
3. Palmer amaranth (39M acres)
4. Ragweed (13M acres)
5. Kochia (12.7M acres)
6. Ryegrass (3.6M acres)

Source: Weed Resistance Tracking USA 2016, Stratus Ag Research



INTEGRATED WEED MANAGEMENT (IWM)

Overreliance on a single weed-control method causes weeds to develop resistance faster. It also increases the risk that a particular herbicide-tolerant system may become ineffective, jeopardizing growers' freedom to cultivate specific crops in their fields. Growers often face additional costs to control resistant weeds through unplanned herbicide applications, intense manual labor and, in extreme cases, total crop loss. BASF suggests growers implement IWM practices for successful management of weed populations.

IWM involves the use of multiple management tools to reduce weed populations and protect crops from the problems caused by weeds. These include:

- Cultural methods – out-compete weeds by using cover crops or by rotating crops.
- Mechanical methods – destroy weeds and their seeds through exposure, burial or destruction.
- Chemical methods – control weeds by properly applying herbicides with multiple effective SOAs.

INDICATORS OF POTENTIAL WEED RESISTANCE

- ✓ A patch of weeds occurs in the same area year after year and is spreading.
- ✓ Surviving weeds appear next to dead weeds after the same herbicide application.
- ✓ Many weed species are managed, but one particular weed species is no longer controlled. For example, following a glyphosate application, actively growing marestail can still be seen in the absence of other weeds.
- ✓ A lack of control of specific weed species when the field has been sprayed repeatedly with the same herbicide SOA, particularly if there was no SOA diversity in the weed-management system.

GLYPHOSATE RESISTANCE IS SPREADING AT AN ALARMING RATE

**MORE SURVEYED
GROWERS SAY THEY
HAVE RESISTANT WEEDS**



Source: Glyphosate Resistance Tracking USA 2016, Stratus Ag Research

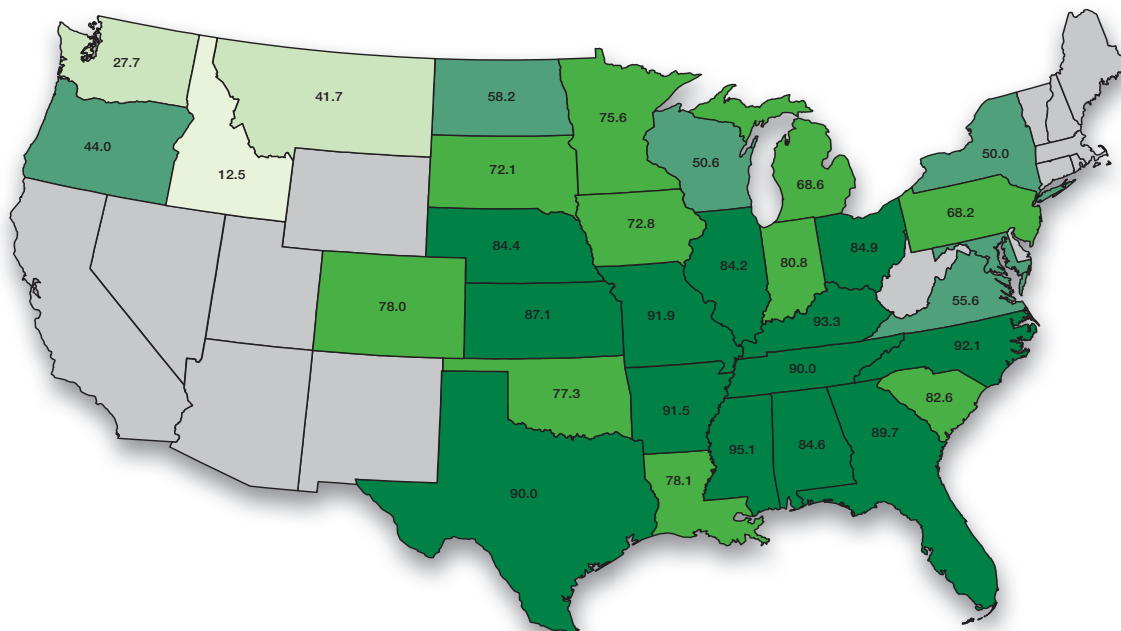


GROWERS REPORTING GLYPHOSATE-RESISTANT WEEDS

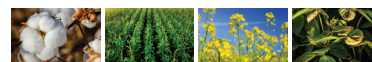
% OF RESPONDENTS



USA 2018-Weed Resistance



- Glyphosate resistance spread to 104M acres in 2016, with 67 percent of growers surveyed indicating they had one or more resistant weeds, up from 70M acres in 2013 and 84M acres in 2014.
- 40 percent of total U.S. crop acres are infested with glyphosate-resistant weeds.
- Just six weed species (marestail, Palmer amaranth, waterhemp, kochia, ragweed and ryegrass) make up the majority of all glyphosate-resistant acres in the United States.



LIBERTY® HERBICIDE

Liberty herbicide provides 98 percent control of a broad spectrum of broadleaf weeds and grasses,* making it an excellent tool for combating tough-to-control and resistant weeds, including key weeds like Palmer amaranth, waterhemp and marestail.

Superior Weed Control

- Broad spectrum control of broadleaf weeds and grasses. Excellent for management of key weeds like Palmer amaranth, waterhemp, kochia, ragweed, and marestail including those that have become resistant to other herbicides.
- The active ingredient in Liberty herbicide is the only herbicide that effectively controls grasses and broadleaves with no known resistance in U.S. broadacre crops.**
- Superior performance on weeds resistant to glyphosate, PPO and ALS inhibitors, and triazine herbicides.
- Application flexibility and fewer restrictions make Liberty herbicide more convenient to use.

Stewardship

Resistance is growing. With very few new sites of action having been developed since the mid-1980s and very few new sites of action in the pipeline, future solutions include mixing and stacking multiple sites of action to try to control weeds and prevent increased resistance. The unique site of action of Liberty herbicide (Group 10) is an excellent tool for stewarding existing chemistries (glyphosate, dicamba, PPOs, etc.).** To maintain its effectiveness, Liberty herbicide should be incorporated into a proper stewardship program.

*Results based on 5 years of trials where Liberty herbicide is applied according to S.T.O.P. Weeds with Liberty herbicide guidelines and as part of a complete weed control program where an effective residual product is used followed by Liberty herbicide.

**The active ingredient in Liberty herbicide is a Group 10 herbicide, which is the only broad-spectrum herbicide that effectively controls grasses and broadleaf weeds, and it has no known resistance in U.S. broadacre crops.



Growers who choose seeds with the LibertyLink® trait get an excellent built-in tolerance to Liberty® herbicide. This combination is the pre-eminent weed management system for tough-to-control weeds, and proper application is essential to ensure the highest level of effectiveness.

S **tart clean and stay clean**
Start with a clean field prior to planting.

Weeds, particularly glyphosate-resistant weeds, grow exceptionally fast. Palmer amaranth grows 1 to 2 inches a day*.

T **arget < 3" weeds**
Small weeds are easier to control.

Weeds, such as Palmer amaranth, can decrease yield by 10 to 55 percent, depending on the amount of weed pressure*.

O **ptimize coverage**
Follow the correct rate, water volume, AMS recommendation and droplet size.

Liberty herbicide is a contact herbicide, so proper coverage is key to ensure effective control.

P **air with residuals**
Use multiple effective sites of action for pre- and post-residuals.

The key to preventing resistance is to reduce the pressure on single herbicides.

*Palmer Amaranth: Biology, Ecology and Management, Texas A&M AgriLife Extension Services, Focus on Cotton webinar series, Plant Management Network, 2017.

S **TART CLEAN AND STAY CLEAN.**

Start with a clean, weed-free field by using an effective burndown application or conventional tillage.

Early action against weeds is key, so start early with the first application soon after emergence. Liberty herbicide should be applied between emergence and early bloom. As with all herbicides, growers should be sure to follow proper use rates according to the directions on the label. Liberty herbicide is most successful on smaller weeds. Scouting weeds and taking early action impact your success.



TARGET < 3" WEEDS

Successful control starts when weeds are small and easiest to manage. Weeds can grow exceptionally fast. Pigweeds, for example, can grow more than 2 inches per day and can drop hundreds of thousands of seeds. Halting weed growth early is crucial to weed control and protecting yields. Stop weeds by applying Liberty® herbicide before they are 3 inches as they become more difficult to control and rob yield.

MOST COMMON WEEDS AND SUSCEPTIBILITY				
	Roundup® (Glyphosate)	Dicamba	Liberty Herbicide (Glufosinate)	2,4-D
Foxtail (giant, green)	✓	No Grass Control	✓	No Grass Control
Lambsquarters	✓	✓	✓	✓
Velvetleaf	✓	✓	✓	✓
Cocklebur	✓	✓	✓	✓
Amaranth (Palmer, redroot and tumble)	Resistance Reported	✓	✓	✓
Common waterhemp	Resistance Reported	✓	✓	Resistance Reported
Common ragweed	Resistance Reported	✓	✓	✓
Giant ragweed	Resistance Reported	✓	✓	✓
Morningglory	✓	✓	✓	✓
Marestail	Resistance Reported	✓	✓	✓
Johnsongrass	Resistance Reported	No Grass Control	✓	No Grass Control
Kochia	Resistance Reported	Resistance Reported	✓	✓
Barnyardgrass	✓	No Grass Control	✓	No Grass Control



BROADLEAF WEEDS CONTROLLED WITH LIBERTY® HERBICIDE

(APPLY AT A RATE NEEDED FOR THE SPECIES TARGETING LESS THAN 3-INCH WEEDS)

32-43 fl oz/A		32-43 fl oz/A	
Amaranth, Palmer	C	Morningglory, sharppod	C
Anoda, spurred	C	Morningglory, smallflower	C
Beggarweed, Florida	C	Morningglory, tall	C
Black medic	C	Mustard, wild	C
Blueweed, Texas	C	Nightshade, black	C
Buckwheat, wild	C	Nightshade, eastern black	C
Buffalobur	C	Nightshade, hairy	C
Burcucumber	C	Pennycress	C
Carpetweed	C	Pigweed, prostrate	C
Catchweed bedstraw (cleavers)	C	Pigweed, redroot	C
Chickweed, common	C	Pigweed, smooth	C
Cocklebur, common	C	Pigweed, spiny	C
Copperleaf, hophornbeam	C	Pigweed, tumble	C
Cotton, volunteer ¹	C ¹	Puncturevine	C
Croton, tropic	C	Purslane, common	C
Croton, woolly	C	Pusley, Florida	C
Devil's claw	C	Ragweed, common	C
Eclipta	C	Ragweed, giant	C
Fleabane, annual	C	Senna coffee	C
Galinsoga, hairy	C	Sesbania, hemp	C
Galinsoga, small flower	C	Shepherd's-Purse	C
Groundcherry, cutleaf	C	Sicklepod (java bean)	C
Geranium, cutleaf	C	Sida, prickly	C
Hempnettle	C	Smartweed, Pennsylvania	C
Horsenettle, Carolina ²	C ²	Smell melon	C
Jimsonweed	C	Sowthistle, annual	C
Knotweed	C	Soybeans, volunteer ¹	C ¹
Kochia	C	Spurge, prostrate	C
Ladysthumb	C	Spurge, spotted	C
Lambsquarters, common	C	Starbur, bristly	C
Mallow, common	C	Sunflower, common	C
Mallow, Venice	C	Sunflower, prairie	C
Marestail ³	C ³	Sunflower, volunteer	C
Marsh-elder, annual	C	Thistle, Russian ²	C ²
Morningglory, entireleaf	C	Velvetleaf	C
Morningglory, ivyleaf	C	Waterhemp, common	C
Morningglory, pitted	C	Waterhemp, tall	C

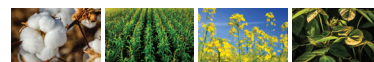
Full broadleaf weed list can be viewed on the Liberty herbicide label

C=Controlled S=Suppression

¹Volunteer LibertyLink® crops from the previous season will not be controlled.

²May require sequential applications for control.

³For optimum control, apply Liberty 280 SL herbicide on 6-inch marestail.



GRASS WEEDS CONTROLLED WITH LIBERTY® HERBICIDE

(APPLY AT A RATE NEEDED FOR THE SPECIES TARGETING LESS THAN 3-INCH WEEDS)

32-43 fl oz/A		32-43 fl oz/A	
Barley, volunteer ³	C ³	Millet, proso volunteer	C
Barnyardgrass	C	Millet, wild-proso	C
Bluegrass, annual	C	Oat, wild ²	C
Corn, volunteer ¹	C ¹	Panicum, fall	C
Crabgrass, large ²	C ²	Panicum, Texas	C
Crabgrass, smooth ²	C ²	Rice, red	C
Cupgrass, woolly	C	Rice, volunteer ¹	C ¹
Foxtail, bristly	C	Sandbur, field ²	C ²
Foxtail, giant	C	Shattercane	C
Foxtail, green	C	Signalgrass, broadleaf	C
Foxtail, robust purple	C	Sorghum, volunteer	C
Foxtail, yellow ²	C ²	Sprangletop	C
Goosegrass ³	C ³	Stinkgrass	C
Johnsongrass, seedling	C	Wheat, volunteer ²	C ²
Junglerice	C	Witchgrass	C

C=Controlled S=Suppression

¹Volunteer LibertyLink® crops from the previous season will not be controlled. A timely cultivation 7-10 days after an application and/or retreatment 10-21 days after the first application is recommended for controlling dense clumps of volunteer corn or rice.

²For best control of yellow foxtail, field sandbur, crabgrass and wild oats, treat prior to tiller initiation.

³A sequential application may not be necessary for control.

BIENNIAL AND PERENNIAL WEEDS CONTROLLED WITH LIBERTY HERBICIDE

32-43 fl oz/A		32-43 fl oz/A		32-43 fl oz/A	
Alfalfa	C	Dandelion	C	Orchardgrass	C
Bermudagrass	C	Dock, smooth	S	Poinsettia, wild	S
Bindweed, field	C	Dogbane, hemp	S	Pokeweed	C
Bindweed, hedge	C	Goldenrod, gray	C	Quackgrass	C
Bluegrass, Kentucky	C	Johnsongrass, rhizome	C	Sowthistle, perennial	C
Blueweed, Texas	C	Milkweed, common	S	Thistle, bull	S
Bromegrass, smooth	C	Milkweed, honeyvine	S	Thistle, Canada	C
Burdock	C	Muhly, wirestem	S	Timothy	S
Bursage, woolyleaf	C	Nightshade, silverleaf	C	Wormwood	C
Chickweed, mouse-ear	C	Nutsedge, purple	S		
Clover, red	C	Nutsedge, yellow	S		

C=Controlled S=Suppression

^aFor a control of the biennial and perennial weeds listed, tank-mix partners or sequential applications of Liberty 280 SL herbicide are recommended by crop (see crop sections of Liberty herbicide label).



OPTIMIZE COVERAGE

Liberty® herbicide is a contact herbicide, requiring thorough spray coverage. The manner in which Liberty herbicide is applied is key to its effectiveness and your ability to control weeds. Good coverage is obtained by selecting and using nozzles and pressures that produce medium to coarse droplets in 15-20 gallons/A water volume. If dense canopy, large weeds or unfavorable growing conditions are present, increase water volume to a minimum of 20 GPA. Warm temperatures, higher humidity and bright sunlight are ideal application conditions.

NOTE: Weed control with very coarse, extremely coarse or ultra coarse nozzles will not provide adequate coverage and will cause unsatisfactory weed control.

ADDITIVES: Ammonium sulfate (AMS) should be used at a rate of 1.5 to 3 lb/A. Rates are dependent on conditions. Research has consistently shown AMS with Liberty herbicide improves weed control. AMS is beneficial for difficult-to-control weeds, such as velvetleaf and lambsquarters, under difficult environmental conditions (low relative humidity) or hard water. Talk to your local retailer or BASF representative for specific local AMS recommendations.

NOZZLE SELECTION

Nozzle selection is a process that maximizes product performance by managing the interaction between application volume (GPA), nozzle flow rate (GPM), nozzle type, operating pressure, travel speed (MPH), nozzle spacing (W) and droplet size category. Understanding nozzle characteristics will further enhance the delivery of herbicide and enable the grower to maximize product effectiveness.

Nozzle Type Recommendations

To optimize coverage, Liberty herbicide should be applied with nozzles that deliver a medium-to-coarse-sized spray droplet to enhance coverage and reduce the possibility of drift. Medium- to coarse-sized droplets cover a larger surface area of the plant, which is beneficial for contact herbicides, such as Liberty herbicide. Refer to nozzle manufacturers' catalogs, apps or tech sheets for nozzles that are capable of delivering spray droplets with desired size categories when properly selected and operated.

The following are examples of four manufacturers where additional guidance can be located:

- **Spraying Systems:** www.teejet.com
- **Greenleaf Technologies:** www.turbodrop.com
- **Pentair:** www.hypropumps.com
- **Delavan AgSpray:** www.delavanagspray.com

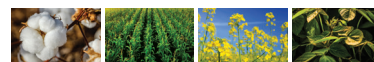
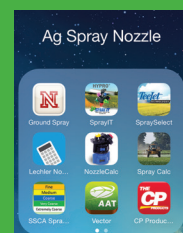
OPTIMUM DROPLET SIZE FOR COVERAGE			
	Glufosinate (Liberty Herbicide)	Glyphosate (Roundup® Herbicide)	Dicamba (Engenia® Herbicide)
Medium	✓	NR	Not Labeled
Coarse	✓	✓	Not Labeled
Very Coarse	NR	✓	✓
Ultra Coarse	NR	NR	✓

NR = Not Recommended

Manufacturers and Extension services have apps available for smartphone or tablet use to conduct calculations and identify the appropriate nozzle for your herbicide application.

Nozzle app examples include:

- Ground Spray
- SprayIT
- SpraySelect
- Lechler Nozzle Calculator
- NozzleCalc
- Spray Calibration
- SSCA Spray Quality
- Vector Sprays
- CP Products Calculator



PAIR WITH RESIDUALS

A key to superior weed control and resistance prevention is to reduce the pressure on single herbicide site of action use. Make sure to use multiple effective sites of action. For best results, a preemergence residual herbicide should be applied prior to or at-planting, and a residual tank-mix partner is used with Liberty® herbicide. Additional recommendations include:

- Use an overlapping residual weed control program.
- Take aggressive action with early-season weed management, to avoid yield loss and weed escapes. Residual herbicides applied at burndown, preemergence and/or tank-mixed in the first post application help ensure optimal weed management.
- Apply broad-spectrum preemergence and residual herbicides that are effective on the targeted weeds.
- Consider expected weed species and populations, as well as environmental variables in the area, when selecting a residual herbicide.

Liberty herbicide may be applied in tank-mix combinations with labeled rates of other products, provided these other products are labeled for the timing and method of application for the crop to be treated. Tank-mix partners must be used in accordance with the label limitations and precautions.

MIXING INSTRUCTIONS

1. Start with properly calibrated and clean equipment.
2. Fill spray tank half full with water.
3. Start agitation.
4. Add AMS to spray tank.

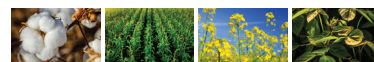
Research has consistently shown AMS with Liberty herbicide improves weed control. AMS is especially needed for difficult-to-control weeds, such as Palmer amaranth and waterhemp, under difficult environmental conditions (low relative humidity) or hard water.

5. Add a tank-mix partner.
6. Complete filling spray tank with water.
7. Add Liberty herbicide and continue agitation.
8. If foaming occurs, use a silicone-based antifoam agent.



LIBERTY® HERBICIDE QUICK FACTS

Labeled Crops for In-Season Use	Complete crop tolerance in LibertyLink® soybeans, cotton, canola and corn	Surfactants/Oils	The use of additional surfactants or crop oils (i.e., EC) may increase the risk of crop injury
Active Ingredient	Glufosinate-ammonium	Application Timing	Apply when weeds are less than 3 inches tall
Site of Action	Glutamine synthetase inhibitor, Weed Science Society of America (WSSA) Group 10	Application Window	Soybeans: Emergence to early bloom Corn: Emergence up to the V6 growth stage Canola: Emergence up to early bolt growth stage Cotton: Emergence up to early bloom
Activity	Nonselective, broadleaf and grasses		
Nozzle	Medium-to-coarse droplet size		
Formulation	2.34 lb/gal SL (280 g/l)		
Package Size	2.5-gal jugs, 270-gal shuttles and bulk	Spray Volume	15-20 GPA; if dense weed canopy exists increase to 20 GPA
Use Rate In-Season*	LL Soybeans: 32-43* fl oz/A + residual LL Corn: 22-32 fl oz/A + residual LL Sweet Corn: 22 fl oz/A LL Canola: 22-29 fl oz/A + graminicide LL Cotton: 32-43* fl oz/A + residual	Rainfast	Four hours
		Pre-Harvest Interval	Soybeans¹: 70 days Corn forage: 60 days Corn grain and fodder: 70 days Canola¹: 65 days Cotton: 70 days
		Restricted Entry Interval	12 hours
Max. Season Use Rate	LL Soybeans: 87 fl oz/A LL Corn: 87 fl oz/A LL Sweet Corn: 44 fl oz/A LL Canola: 87 fl oz/A LL Cotton: 87 fl oz/A (72 fl oz/A if more than 29 fl oz/A was used on any application)	Signal Word	Warning
		Tank-mixes	<ul style="list-style-type: none"> • Tank-mix with a labeled residual herbicide to extend control. • Glyphosate may be tank-mixed in LibertyLink crops that are also tolerant to glyphosate.
Adjuvant	Ammonium Sulfate (AMS) at 1.5 to 3 lb/A.** Talk to your local retailer or BASF representative for specific local AMS recommendations.	<small>*According to weed size chart. **Research has consistently shown AMS with Liberty herbicide improves weed control. AMS is especially needed for difficult-to-control weeds under difficult environmental conditions (low relative humidity) or hard water. ¹Do not graze treated canola or soybeans, or cut for hay.</small>	





LIBERTYLINK® GT27

THE LIBERTYLINK GT27 TRAIT IN SOYBEANS

The LibertyLink GT27 system will couple high-yielding, elite genetics with three sites of herbicide action for broad-spectrum weed control.

UNPRECEDENTED YIELD

- Outstanding performance from new, elite genetics

WEED CONTROL FLEXIBILITY

- LibertyLink GT27 soybeans are the first and only soybean technology featuring tolerance to both Liberty® herbicide and glyphosate herbicides.
- Enables use of a new HPPD MOA herbicide for soybeans, pending EPA approval.*

LIBERTY PLUS GLYPHOSATE

- Tank-mixing glyphosate with Liberty herbicide can improve performance on difficult weeds.
- Combines the superior control of Liberty herbicide with the utility of glyphosate to provide broad spectrum control of resistant and susceptible grasses and broadleaf weeds.
- Best practices for preventing and managing herbicide resistance include use of multiple MOAs to control weeds.

* LibertyLink GT27 is not tolerant to all HPPD herbicides. HPPD herbicides currently on the market are prohibited for use with LibertyLink GT27 soybeans and may result in significant crop injury.

LIBERTYLINK GT27 HERBICIDE RECOMMENDATION PROGRAM FOR SOYBEANS			
Program	Preemergence Residual	Post Application	Second Post Application (if needed)
Guidelines	<ul style="list-style-type: none"> • Pre-plant • Pre-plant incorporated • At planting 	<ul style="list-style-type: none"> • Weeds < 3" • Use a residual tank-mix 	<ul style="list-style-type: none"> • Min. 5 days after first application
Recommended Program	Zidua® Pro herbicide @ 4.5 - 6 oz/A**	32-43 oz Liberty herbicide/A + Zidua herbicide + Outlook® herbicide + glyphosate	32-43 oz Liberty herbicide/A + Outlook herbicide + glyphosate

*Talk to your local retailer for specific local herbicide recommendations.

**Talk to your local retailer or BASF representative for specific local herbicide recommendations.





LIBERTYLINK® SOYBEANS AND LIBERTYLINK GT27

THE LIBERTYLINK TRAIT IN SOYBEANS

The LibertyLink system combines the high-performing LibertyLink trait with the power of Liberty® herbicide for PROVEN excellent yield performance. The system provides superior weed control with greater flexibility and convenience, plus no known resistance.

EXCELLENT YIELD PERFORMANCE

- High-performing genetics, protected by superior weed control to ensure weeds are better controlled to reduce their drain on yield.
- 2+ bu/A advantage over Asgrow® Roundup Ready 2 Xtend® in over 2,100 observations*.

SUPERIOR WEED CONTROL

- **98 percent** control of a broad spectrum of grasses and broadleaf weeds,** including key weeds like Palmer amaranth, waterhemp, marestail and kochia, when part of a complete recommended program.
- The ONLY working nonselective herbicide effective on tough-to-control and resistant grasses and broadleaf weeds:***
- The active ingredient in Liberty herbicide is the only herbicide that effectively controls grasses and broadleaves with no known resistance in U.S. broadacre crops.
- Superior control of PPO-resistant weeds, ALS, glyphosate and triazine.
- Application flexibility and fewer restrictions make Liberty herbicide more convenient to use.

*Yield shown summarizes average of LibertyLink and Asgrow RRRxtend varieties entered across the Midwest, Delta, Northeast and Southwest. Endorsement or recommendation by the universities is not implied.

**Results based on five years of trials where Liberty herbicide is applied according to S.T.O.P. Weeds with Liberty herbicide guidelines and as part of a complete weed control program where an effective residual product is used followed by Liberty herbicide.

***The active ingredient in Liberty herbicide is a Group 10 herbicide, which is the only broad-spectrum herbicide that effectively controls grasses and broadleaf weeds, and it has no known resistance in U.S. broadacre crops.

****Weed Science Society of America site of action classification.

WHERE TO FIND LIBERTYLINK SOYBEANS

The LibertyLink trait is broadly licensed to combine high-yielding genetics with the powerful, nonselective, postemergence weed control of Liberty herbicide. Soybean seeds are now available through more than 78 seed companies, including the Credenz® brand, and growers can manage their weed pressure with LibertyLink varieties that fit their growing conditions.

HERBICIDE RECOMMENDATION PROGRAM FOR LIBERTYLINK SOYBEANS			
Program	Preemergence Residual	First Post Application	Second Post Application (if needed)
Guidelines	<ul style="list-style-type: none"> • Pre-plant • Pre-plant incorporated • At planting 	<ul style="list-style-type: none"> • Weeds < 3" • Use a residual tank-mix 	<ul style="list-style-type: none"> • Min. 5 days after first application
Recommended Program	Zidua® Pro herbicide @ 4.5 - 6 oz/A**	32-43 oz Liberty herbicide/A + Zidua herbicide or Outlook® herbicide	32-43 oz Liberty herbicide/A + Outlook herbicide

*Sequential applications should be at least five days apart.

**Talk to your local retailer or BASF representative for specific local herbicide recommendations.

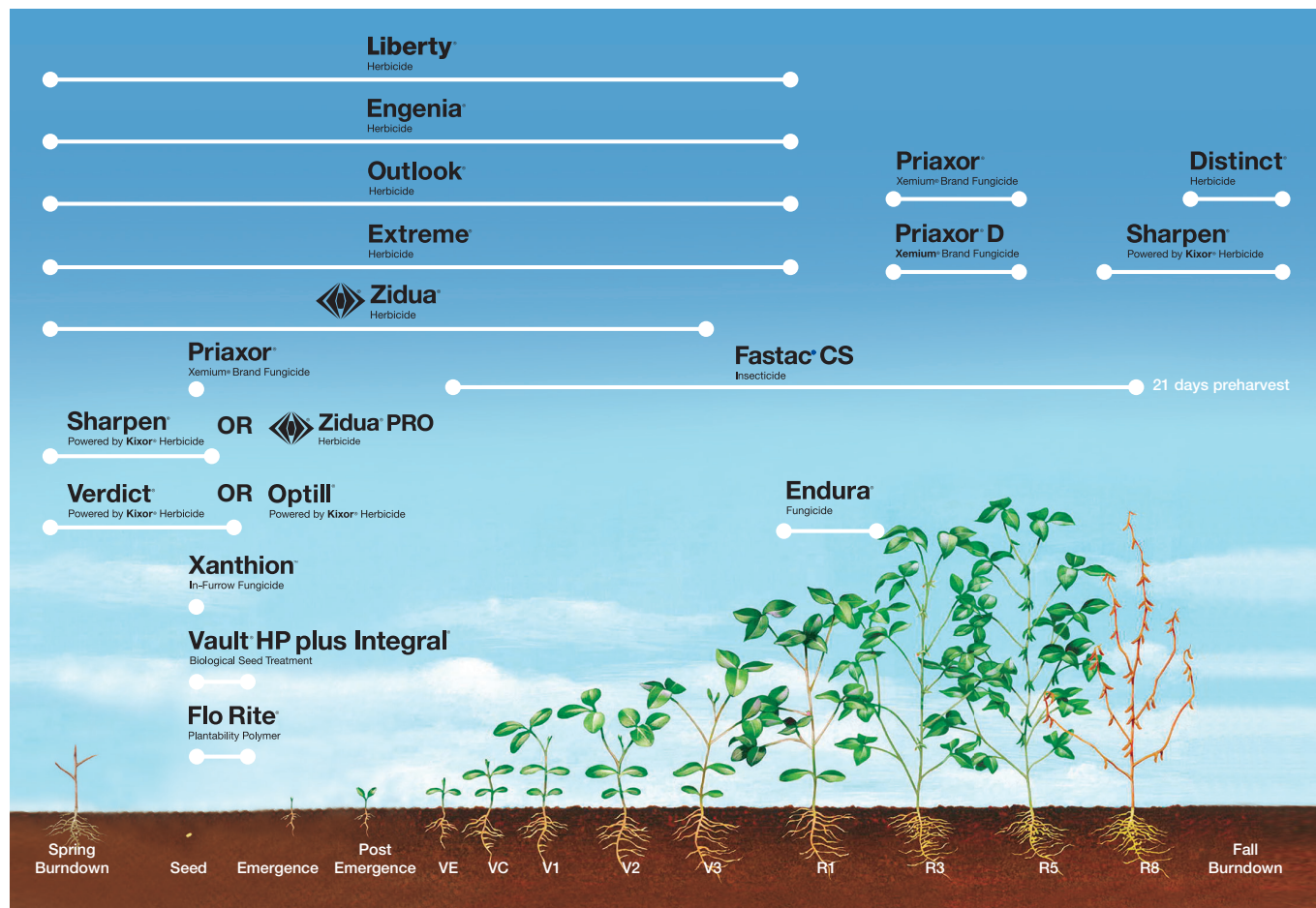


WHERE TO FIND LIBERTYLINK® SOYBEANS (CONT.)

A zero-tolerance weed management approach can greatly improve control from season to season. If tough-to-control weeds are present late in the season, it is recommended that they be removed before they can go to seed.

Liberty® herbicide may be applied in tank-mix combinations with labeled rates of other products, provided these products are labeled for the timing and method of application for the crop to be treated. The tank-mix partner must be used in accordance with the label limitations and precautions. No label dosage rates may be exceeded. Liberty 280 SL herbicide cannot be mixed with any product containing a label prohibition against such mixing.

Tank-mix partners for Liberty herbicide in soybeans may include:



S.T.O.P. Weeds with Liberty® Herbicide Program Application Guidelines for Maximum Control:

S **tart clean and stay clean**
Control emerged weeds prior to planting and control escapes throughout the season.

T **arget < 3" weeds**
Small weeds are easier to control.

O **ptimize coverage**
Follow the correct rate, water volume, AMS recommendation and droplet size.

P **air with residuals**
Use multiple effective sites of action for pre- and post-residuals.

APPLICATION GUIDELINES

- Recommended Program — residual used preemergence, PPI or at planting:
 - Apply Liberty herbicide at 32 fl oz/A over the top of LibertyLink® soybeans from emergence to 14 days after crop emergence or when weeds are no more than 3 inches tall.
 - Apply Liberty herbicide at 32 fl oz/A on an as-needed basis following the first application at 32 fl oz/A. If needed, apply Liberty herbicide at a minimum of five days after the first application at 32 fl oz/A.
- If environmental conditions prevent timely application and/or residuals are not activated:
 - Up to 43 fl oz/A may be made.
 - If needed, a second application up to 43 oz/A may be applied a minimum of 5 days after the first application.
- Including a residual product such as Zidua® herbicide or Outlook® herbicide is recommended to extend control.
- Maximum per year: Up to 87 fl oz/A of Liberty herbicide can be applied on soybeans per growing season.
- Do not apply Liberty herbicide if soybeans show injury from prior herbicide applications or environmental stress.

- Make all Liberty herbicide applications before soybeans begin to bloom. Consult state Extension service for additional information on prebloom period for soybeans in the state.

LIBERTY HERBICIDE QUICK FACTS	
Application Timing	< 3" weeds
Application Window	Emergence up to early bloom (R1)
Site of Action	Group 10 (Weed Science Society of America site of action classification.)
Activity	Nonselective, broadleaf and grasses
Adjuvant	Ammonium Sulfate (AMS) at 1.5 to 3 lbs/A*. Talk to your local retailer for specific local AMS recommendations.
Spray Water Volume	15-20 GPA; if dense weed canopy exists increase to 20 GPA
Nozzle	Select nozzle type, size, and pressure to produce medium-coarse droplets
Ground Speed	< 10 mph to attain good coverage
Wind Speed	< 10 mph
Rainfast	Four hours
Glyphosate on LibertyLink GT27	<ul style="list-style-type: none"> • Adding glyphosate to applications of Liberty herbicide in LL GT27 soybeans can improve control of difficult grasses and some broadleaves.

For more information, review the Liberty herbicide section on page 14

*Research has consistently shown AMS with Liberty herbicide improves weed control. AMS is especially needed for difficult-to-control weeds, such as velvetleaf and lambsquarters, under difficult environmental conditions (low relative humidity) or hard water.



YIELD LOSS DUE TO COMPETITION

Weeds that emerge with the crop or shortly thereafter have the greatest potential to negatively affect yields. The yield loss associated with this flush of weeds is strongly influenced by the length of time weeds remain in the field and compete with crops for light, water and nutrients.

Residual herbicides can improve weed control, reduce problematic weeds and extend the time period between planting and the first postemergence treatment of Liberty® herbicide. This allows for flexibility when weather conditions prevent timely postemergence applications. Additionally, using a residual herbicide in your weed-control program introduces another herbicide SOA in the field, improving your weed-management program.

A study conducted by the University of Nebraska determined that the critical period for weed removal in soybeans is based upon the soybean row spacing. For soybeans planted in 30-, 15- and 7.5-inch rows, the critical removal time is V3, V2 and first trifoliate, respectively. Furthermore, the study shows there is a 2 percent yield loss for each soybean leaf-stage delay in applying a nonselective herbicide to the crop, during the critical time for weed removal.

YIELD LOSS EXAMPLES

- According to research by the University of Illinois, particularly troublesome weeds, such as waterhemp, can cause up to a 40 percent yield loss in soybeans.³

	\$/Bushel		
	\$9	\$10	\$11
Lost \$/A from waterhemp*	\$180	\$200	\$220
Lost \$/1,000 A from waterhemp*	\$180,000	\$200,000	\$220,000

*Based on above study while assuming 50 bu/A initial yield.

- The study continued, when another known resistant weed, Palmer amaranth, is present, this figure can climb to as high as 79 percent.³

	\$/Bushel		
	\$9	\$10	\$11
Lost \$/A from Palmer amaranth*	\$356	\$395	\$434
Lost \$/1,000 A from Palmer amaranth*	\$356,000	\$395,000	\$434,000

*Based on above study while assuming 50 bu/A initial yield.





LIBERTYLINK CORN

THE LIBERTYLINK® TRAIT IN CORN

- The LibertyLink system pairs a high-yielding hybrid with Liberty® herbicide's outstanding control of everyday weeds and also the tough-to-control weeds that glyphosate is unable to manage.
- LibertyLink corn allows growers to spray Liberty herbicide in-crop for nonselective postemergence control of even the toughest weeds, including Palmer amaranth, giant ragweed, waterhemp and marehail.
- Spraying Liberty herbicide early will control weeds before they jeopardize yield potential. Liberty herbicide works fast, dominating weeds within days versus weeks, under favorable growing conditions.
- LibertyLink corn hybrids are available in elite Herculex®, SmartStax® and Agrisure® hybrids with corn borer protection. They are also available as refuge-in-a-bag products with corn borer protection and popular refuge-in-a-bag offerings from Monsanto, Pioneer and other top seed companies.
- For best results, experts recommend a preemergence residual herbicide like Verdict® herbicide, Zidua® herbicide or Outlook® herbicide always be applied prior to or at-planting and a residual tank-mix partner is used with Liberty herbicide.
- Liberty herbicide can be tank-mixed with postemergence residual products, such as Armezon® herbicide and Status® herbicide and other herbicides labeled for use in corn.

All LibertyLink corn hybrids have built-in tolerance to Liberty herbicide, combining excellent crop safety with agronomic performance and yield. LibertyLink corn is approved for export to all major export countries around the world. This trait is widely available now in high-yielding hybrids from elite germplasm providers. LibertyLink corn is ideal for U.S. growers, whether on rotated acreage or in aggressive corn-on-corn production systems.



WHERE TO FIND LIBERTYLINK® CORN



The LibertyLink trait is licensed to combine high-yielding genetics with the powerful, nonselective, postemergence weed control of Liberty® herbicide. With corn seed available from virtually all corn seed companies, growers can manage their weed pressures with LibertyLink varieties that fit their growing conditions.

Herculex hybrids that come stacked with the LibertyLink trait are available in the following versions:

- Herculex 1 (HX1) provides protection against European corn borer, Southwestern corn borer, black cutworm, fall armyworm, Western bean cutworm, lesser cornstalk borer, Southern cornstalk borer and sugarcane borer.
- Herculex XTRA (HXX) is a stacked-trait product that combines the above-ground insect protection of HX1 with the below-ground protection of HXRW.

Optimum® AcreMax® products offer single-bag integrated refuge in a variety of options to fit a wide range of situations. All Optimum AcreMax family of products, including Optimum AcreMax 1 (AM/AM1), Optimum AcreMax RW (AMRW), Optimum AcreMax Xtra (AMX), Optimum AcreMax TRIsect® Insect Protection System (AMT), Optimum AcreMax XTreme (AMXT), Optimum Intrasect® Insect Protection, Optimum Leptra® and Optimum TRIsect have the LibertyLink trait in 100 percent of the seeds in the bag and can be sprayed over the top with Liberty herbicide.

New Qrome™ products from Dow DuPont are all LibertyLink enabled.

Agrisure hybrids with corn borer protection come stacked with the LibertyLink trait in the following products:

- Above-ground insect protection – Agrisure 3010, Agrisure Viptera® 3110
- Above/below ground insect protection – Agrisure 3000GT, Agrisure Viptera 3111

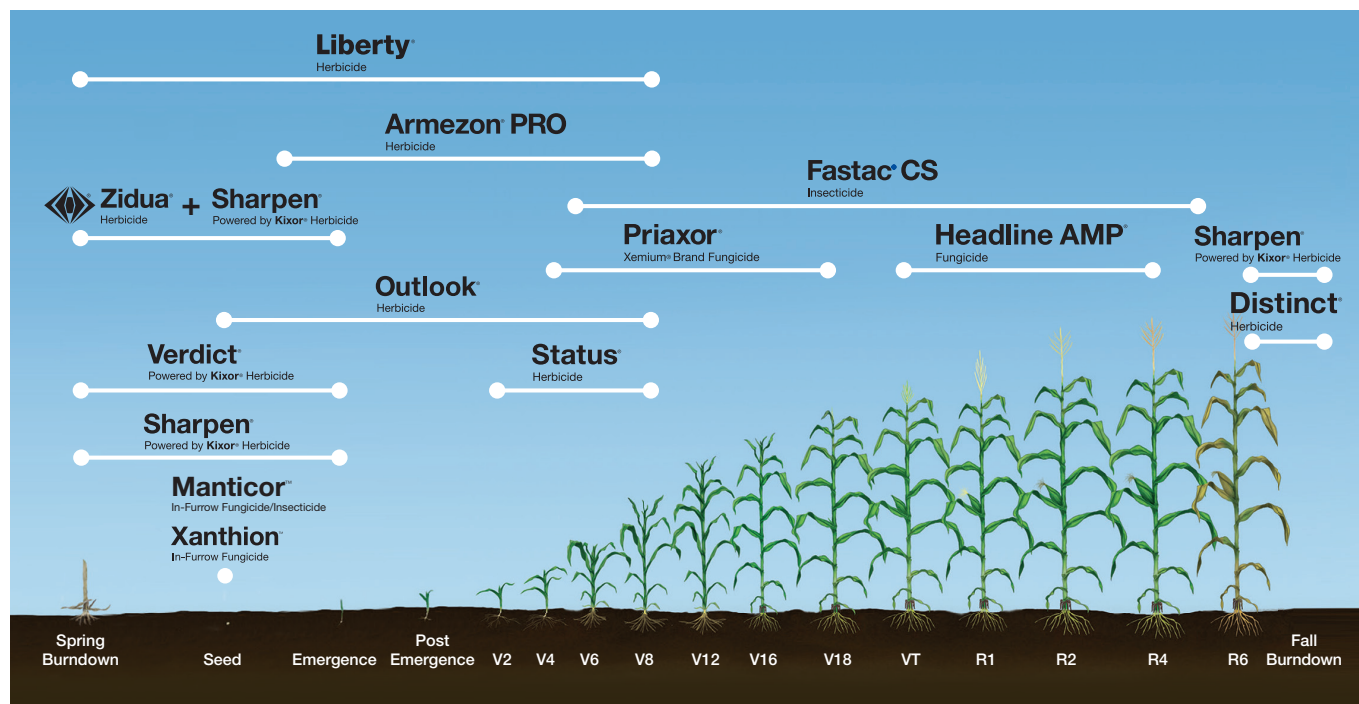
- Insect protected hybrids with E-Z Refuge – IMPORTANT: consult bag tag or seed seller for E-Z Refuge product information regarding tolerance to Liberty herbicide. Only those labeled EZ1 are LibertyLink and may be sprayed with Liberty herbicide.

Artesian trait stacks may be available and will be indicated with a letter “A” at the end of the trait stack name. All other traits, including Liberty herbicide tolerance, are the same with the addition of the Artesian trait.

SmartStax hybrids also come stacked with the LibertyLink trait in the following products:

- Genuity® SmartStax corn offers broad-spectrum above- and below-ground insect protection, plus LibertyLink and Roundup Ready herbicide tolerance.
- Genuity SmartStax RIB Complete® corn blend is a single-bag refuge solution with broad-spectrum above- and below-ground insect protection, plus LibertyLink and Roundup Ready herbicide tolerance.
- Refuge Advanced® powered by SmartStax also offers a single-bag refuge solution with the same above- and below-ground protection of SmartStax, including LibertyLink and Roundup Ready herbicide tolerance traits.





LIBERTY® HERBICIDE UTILITY IN *Bt* CORN REFUGE

- To preserve the efficacy of *Bt* corn technology, government regulations require growers to implement an Insect Resistance Management (IRM) plan. For corn products without seed blends such as a RIB, a proper IRM plan includes a separate non-*Bt* corn refuge planted in required proximity to *Bt* corn acres to delay insect resistance to the technology.
- Selecting a LibertyLink® refuge hybrid for any of the previously mentioned LibertyLink *Bt* hybrids will allow you to use Liberty herbicide across the entire area, enabling you to obtain the full value and convenience of the LibertyLink trait. If a suitable LibertyLink hybrid is not available, configuring the refuge area in a separate field or in a contiguous block within the same field as the *Bt* hybrid will allow Liberty herbicide to be used for weed control in the *Bt* hybrid area. It is imperative that the location where each hybrid is planted be clearly documented and marked, either on a GPS map or with flags or markers in the field, to help ensure that Liberty herbicide is sprayed only on fields planted with LibertyLink hybrids.

For more detailed information on refuge options and acceptable configurations for specific *Bt* products, consult with your seed seller or *Bt* trait provider.



S.T.O.P. Weeds with Liberty® Herbicide Program
Application Guidelines for Maximum Control:

S

tart clean and stay clean
Control emerged weeds prior to planting and control escapes throughout the season.

T

arget < 3" weeds
Small weeds are easier to control.

O

ptimize coverage
Follow the correct rate, water volume and droplet size.

P

air with residuals
Use multiple effective sites of action for pre- and post-residuals.

LIBERTY HERBICIDE RECOMMENDATION PROGRAM FOR CORN			
Program	Preemergence Residual	Post Application	Second Post Application (if needed)
Guidelines	<ul style="list-style-type: none">• Pre-plant• Pre-plant incorporated	<ul style="list-style-type: none">• Weeds < 3"• Use a residual tank-mix	Minimum 7 days between applications
Recommended Program	Verdict® herbicide 10-15 fl oz/A or Zidua® herbicide SC 3.5-4.0 fl oz/A + Atrazine*	Liberty herbicide 22-32 fl oz/A + Outlook®* herbicide	

*Talk to your local retailer or BASF representative for specific local herbicide recommendations.

APPLICATION GUIDELINES

- Recommended Program:
 - a. Apply a preemergence herbicide with residual control, such as Verdict herbicide or Zidua herbicide, according to label.
 - b. Apply Liberty herbicide at 22-32 fl oz/A plus a residual postemergence herbicide such as Outlook herbicide. Apply Liberty herbicide over the top of corn when weeds are no more than 3 inches tall.
- Maximum per year: Up to 87 fl oz/A of Liberty herbicide can be applied on corn per growing season.
- Liberty herbicide can be applied in-crop to LibertyLink® corn from emergence up to V6 growth stage (six fully developed leaf collars).
- Application may be made with drop nozzles up to 36" tall corn.

*Weed Science Society of America site of action classification in parentheses.



LIBERTY® HERBICIDE QUICK FACTS

Application Timing	< 3" weeds
Application Window	Up to V6 growth stage
Site of Action	Group 10 (Weed Science Society of America site of action classification)
Activity	Nonselective, broadleaf and grasses
Adjuvant	Ammonium Sulfate (AMS) at 1.5 to 3 lbs/A*
Spray Water Volume	15-20 GPA; if dense weed canopy exists increase to 20 GPA
Nozzle	Medium-to-coarse size spray droplet
Ground Speed	<10 mph to attain good coverage
Wind Speed	<10 mph
Rainfast	Four hours

For more information, review the Liberty herbicide section on page 14

*Research has consistently shown AMS with Liberty herbicide improves weed control. AMS is especially needed for difficult-to-control weeds, under difficult environmental conditions (low relative humidity) or hard water.

Talk to your local retailer or BASF representative for specific local AMS recommendations.

YIELD LOSS DUE TO COMPETITION

Research indicates that delaying a postemergence herbicide application until weeds are 6 inches tall results in a significant yield loss. Many factors come into play, such as weed species and the density of the plants present. Ultimately, a lack of weed control early in the season costs growers at harvest.

YIELD LOSS EXAMPLES

As most growers are all too aware, Palmer amaranth exhibits aggressive growth and competitiveness with crops for water, sunlight and nutrients. Within two months, Palmer amaranth plants that emerged were more than 6 feet tall at Purdue University's Palmer amaranth research site. When allowed to compete throughout the growing season, Palmer amaranth created yield losses of up to 91 percent in corn.⁴

	\$ / Bushel		
	\$3	\$4	\$5
Lost \$/A from Palmer amaranth**	\$369	\$492	\$615
Lost \$/1,000 A from Palmer amaranth**	\$369,000	\$492,000	\$615,000

**Based on above study with average yields of 135 bu/A.





INVIGOR® CANOLA

THE LIBERTYLINK® TRAIT IN CANOLA

- InVigor canola hybrids carry the LibertyLink trait, which provides built-in tolerance to Liberty® herbicide.
- InVigor canola hybrids with the LibertyLink trait:
 - Are performers, known for strong early season growth and outstanding yield.
 - Consistently deliver superior crop establishment, uniform maturity and greater harvestability over many other hybrids.
 - Are developed from high-yielding, strong-performing, elite germplasm, which results in stable and consistent performance in the field.
- The LibertyLink system provides excellent weed control and preserves the yield of high-performing hybrids.
- Crops with the LibertyLink trait allow growers to spray Liberty herbicide in-crop for nonselective postemergence control of the toughest weeds, including giant ragweed, waterhemp, kochia, wild buckwheat and marehail.
- With a unique site of action, Liberty herbicide allows growers to control weeds within days, not weeks, under favorable conditions.
- InVigor canola hybrids with the LibertyLink trait have outyielded competitive lines since InVigor canola introduction.

S.T.O.P. Weeds with Liberty Herbicide Program Application Guidelines for Maximum Control:

- S** **tart clean and stay clean**
Control emerged weeds prior to planting and control escapes throughout the season.
- T** **arget < 3" weeds**
Small weeds are easier to control.
- O** **ptimize coverage**
Follow the correct rate, water volume and droplet size.
- P** **air with residuals**
Use multiple effective sites of action for pre- and post-residuals.



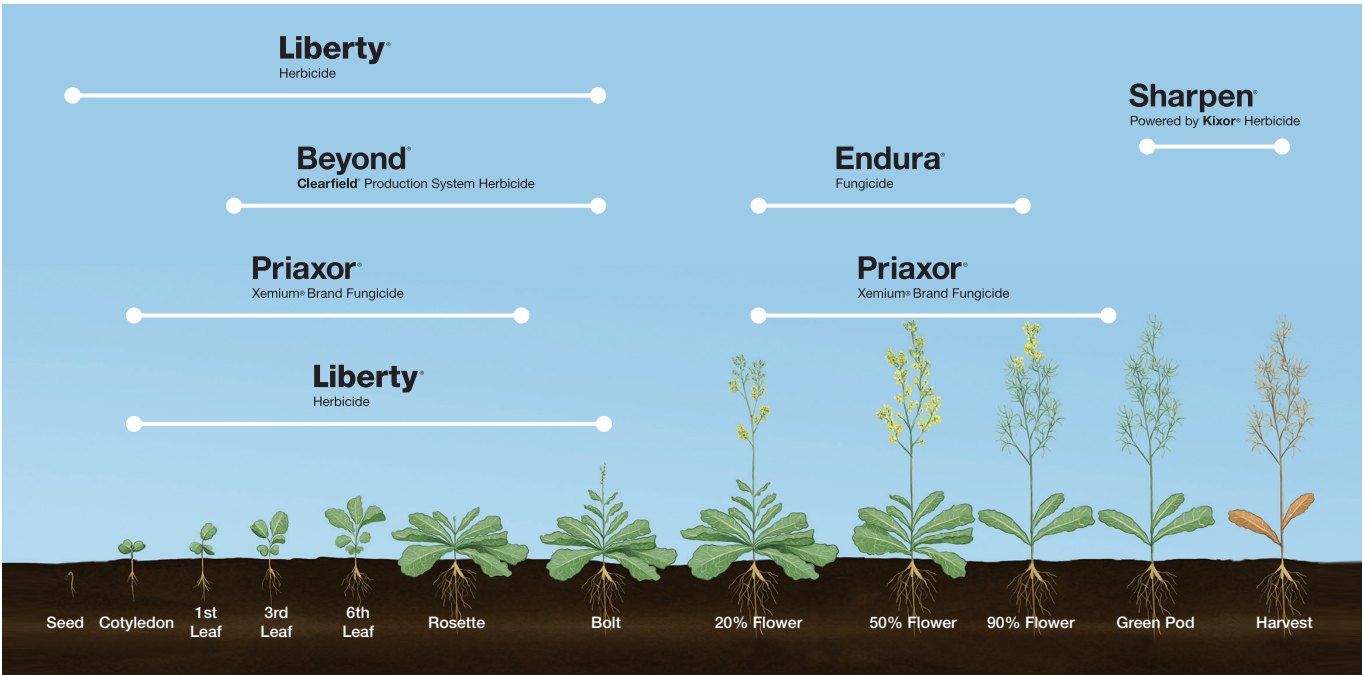
WHERE TO FIND INVIGOR® CANOLA

The LibertyLink® trait is available in top-yielding InVigor varieties. These varieties deliver robust early season growth and continue to dominate yield rankings in trials. The unique seeds offer the top protection of LibertyLink, allowing for weed control with Liberty® herbicide. Contact your local seed dealer/distributor or BASF representative about where to find the best varieties for your needs.

LIBERTY HERBICIDE RECOMMENDATION PROGRAM FOR CANOLA			
Program	Preemergence Residual	First Post Application	Second Post Application (if needed)
Guidelines	<ul style="list-style-type: none"> • Pre-plant • Pre-plant incorporated • At planting 	<ul style="list-style-type: none"> • Weeds < 3" • Use a tank-mix for additional grass control 	<ul style="list-style-type: none"> • Min. 7 days after first application
Recommended Program	Use preemergence residuals	Liberty herbicide 29 fl. oz./A + Poast® herbicide*	Liberty herbicide 29 fl oz/A + Poast herbicide*

*Talk to your local retailer for specific local herbicide recommendations.

For additional grass control, a Group 1* herbicide can be tank-mixed at labeled rates, provided these other products are labeled for the timing and method of application for the crop to be treated.



APPLICATION CONSIDERATIONS

- Post-Canola Emergence:
 - a. Apply Liberty® herbicide at 22-29 fl oz/A, plus graminicide such as Poast® herbicide, over the top of InVigor® LibertyLink® canola from emergence to 10 days after crop emergence or when weeds are no more than 3 inches tall.
 - b. Apply Liberty herbicide at 22-29 fl oz/A on an as-needed basis following the first application at 22-29 fl oz/A. If sequential applications are planned, apply the second application minimum 7 days after the first application.
- Maximum seasonal use: Up to 87 fl oz/A of Liberty herbicide can be applied on canola per growing season. (This includes pre-plant burndown and in-season postemergence use.)
- Do not use in the states of AL, DE, GA, KY, MD, NJ, NC, SC, TN, VA and WV.
- Do not graze treated crop or cut for hay.

LIBERTY HERBICIDE QUICK FACTS	
Application Timing	< 3" weeds
Application Window	Up to early bolt stage
Site of Action	Group 10 (Weed Science Society of America site of action classification.)
Activity	Nonselective, broadleaf and grasses
Adjuvant	Ammonium Sulfate (AMS) at 1.5 to 3 lbs/A*
Spray Water Volume	15-20 GPA; if dense weed canopy exists increase to 20 GPA
Nozzle	Medium-to-coarse size droplet
Ground Speed	<10 mph to attain good coverage
Wind Speed	<10 mph
Rainfast	Four hours

For more information, review the Liberty herbicide section on page 14

*Research has consistently shown AMS with Liberty herbicide improves weed control. AMS is especially needed for difficult-to-control weeds, under difficult environmental conditions (low relative humidity) or hard water. Talk to your local retailer for specific local AMS recommendations.



YIELD LOSS DUE TO COMPETITION

According to the Canola Council of Canada⁵, yield loss from weed competition due to late herbicide applications vary depending on application rate, and overall health of field and growing conditions. However, yield losses can reach up to 30 percent.

Weed	Plants/Square Meter	Yield Reduction
Oat, wild	2	5%
Barley, volunteer	2	5%
Spring wheat, volunteer	4	5%
Foxtail, green	100	5%

Source: Canola Council of Canada

YIELD LOSS EXAMPLE

	\$/Bushel		
	\$6	\$8	\$10
Lost \$/A*	\$54	\$72	\$90
Lost \$1,000/A*	\$54,000	\$72,000	\$90,000

*Based on above Canola Council of Canada study of 30% yield loss at 30 bu/A yield.



COTTON TRAITS

THE LIBERTYLINK® TRAIT IN COTTON

- The LibertyLink system pairs high-yielding varieties with Liberty® herbicide's outstanding control of tough-to-control weeds that glyphosate is unable to manage.
- LibertyLink cotton allows growers to spray Liberty herbicide in-crop for nonselective postemergence control of even the toughest weeds, including Palmer amaranth, giant ragweed, waterhemp and marehail.
- Spray Liberty herbicide early to control weeds quickly, before they jeopardize yield potential. The rapid action of Liberty herbicide controls weeds within days versus weeks, under favorable growing conditions.

S.T.O.P. Weeds with Liberty Herbicide Program Application Guidelines for Maximum Control:

- S** **tart clean and stay clean**
Control emerged weeds prior planting and control escapes throughout the season.
- T** **arget < 3" weeds**
Small weeds are easier to control.
- O** **ptimize coverage**
Follow the correct rate, water volume and droplet size.
- P** **air with residuals**
Use multiple effective sites of action for pre- and post-residuals.

THE GLYTOL® TRAIT IN COTTON

- GlyTol trait technology delivers season-long, in-plant tolerance to glyphosate herbicide. The GlyTol trait provides protection from any brand of glyphosate labeled for cotton. GlyTol gives growers a competitive edge with a wide window for postemergence applications and additional trait combinations.
- GlyTol is available in high-yielding, high-performing FiberMax® and Stoneville® varieties across U.S. cotton geographies, offering growers:
 - Proven crop tolerance to various glyphosate formulations, with no impact on yield, quality or plant height.
 - Over-the-top, season-long use of any glyphosate brand labeled for cotton, which gives growers freedom in their herbicide choice.
 - Production efficiency and flexibility to allow growers to make the right decisions for their farm.



THE GLYTOL® LIBERTYLINK® TRAIT STACK IN COTTON

GlyTol LibertyLink (GL) stacked technology in cotton has full tolerance to both Liberty® herbicide and glyphosate and is only available in elite, high-performing FiberMax® and Stoneville® cotton seed varieties. Growers can make over-the-top applications of both Liberty herbicide and glyphosate. This gives growers two herbicide sites of action to control weeds effectively and reduce the potential for resistance as part of a comprehensive, full-season, overlapping residual herbicide plan.

TWINLINK® TRAIT STACK IN COTTON

- TwinLink cotton technology combines season-long *Bt* protection against worm pests with powerful weed-management technology.
- TwinLink contains two BASF proprietary *Bt* genes that provide effective management of major lepidopteran pests, such as tobacco budworm, pink bollworm, cotton bollworm, fall armyworm and beet armyworm. TwinLink also confers full tolerance to Liberty herbicide, to control a wide range of broadleaf and grass weeds.
- TwinLink is available as a GlyTol LibertyLink TwinLink (GLT) trait package, which provides multiple *Bt* genes plus full tolerance to Liberty herbicide and glyphosate. This trait package is a powerful tool for high-level caterpillar control and offers two choices for over-the-top, broad-spectrum herbicide applications. GLT gives growers the flexibility to choose the herbicide applications that best fit their growing conditions and farm management practices.
- With GLT, growers have the ability to rotate herbicide SOAs to control weeds effectively and reduce the potential of weed resistance.
- TwinLink produces two insecticidal *Bt* proteins, Cry1Ab and Cry2Ae, with independent actions for highly effective control of key leaf- and fruit-feeding lepidopteran pests of cotton. These novel *Bt* genes protect against a wide range of worm pests, to help cotton growers maximize yield potential and fiber quality.
- TwinLink is available in both FiberMax and Stoneville brands, as well as other cotton brands in the United States.



TWINLINK PLUS TRAIT IN COTTON

- TwinLink Plus cotton technology has received all regulatory approvals and is available in FiberMax and Stoneville cotton seed varieties.
- TwinLink Plus cotton technology combines two proprietary *Bt* genes (Cry1Ab and Cry2Ae) and the Vip3Aa19 *Bt* gene for effective protection against worm pests
- Improved control over *Helicoverpa* and *Spodoptera* lepidopteran pests, including fall armyworm, compared to two-gene *Bt* technologies.
- The enhanced activity of TwinLink Plus against bollworm and armyworm decreases the likelihood of needing supplemental applications to control worm pests.
- TwinLink Plus is available in the GlyTol LibertyLink TwinLink Plus (GLTP) trait package, which allows for over-the-top application of Liberty herbicide and glyphosate.



WHERE TO FIND COTTON VARIETIES WITH GLYTOL®, LIBERTYLINK®, TWINLINK® AND TWINLINK PLUS TRAITS

- LibertyLink trait technology is currently available in high-yielding, high-quality FiberMax® and Stoneville® cotton seed varieties, as well as other seed products.
- GlyTol trait technology is currently available in high-yielding, high-quality FiberMax varieties.
- GlyTol LibertyLink stacked technology is available in elite, high-performing FiberMax cotton seed varieties.
- GlyTol LibertyLink Bollgard II® stacked technology is available in high-yielding FiberMax and Stoneville varieties.
- GlyTol LibertyLink TwinLink stacked technology is available in elite FiberMax and Stoneville cotton seed varieties.
- GlyTol LibertyLink TwinLink Plus is available in elite FiberMax and Stoneville varieties.
- For more information about FiberMax and Stoneville cotton seed varieties, go to <https://agriculture.basf.com/us/en/Crop-Protection/FiberMax.html> or <https://agriculture.basf.com/us/en/Crop-Protection/Stonevill.html>.
- Find the right variety of cottonseed to fit your field using the Variety Selector Tool™ at agproducts.basf.us.
- Contact your local seed dealer/distributor or BASF representative about where to find the latest varieties available.

Program	Guidelines	Recommended for Southwest 	Recommended for Mid-South 
Preemergence Residual		Pre-plant: Prowl® H2O herbicide At Planting: Caparol or Direx 4L	Preplant or At Planting: Prowl H2O herbicide + Cotoran 4L
First Post Application	<ul style="list-style-type: none"> • Weeds < 3" • Use a residual tank-mix 	<u>Liberty® herbicide 32-43 fl oz/A + Outlook herbicide 10 fl oz/A</u> Options: Outlook® herbicide (15), Zidua® herbicide (15), Dual (15), Warrant (15), Staple® (2)	<u>Liberty herbicide 32-43 fl oz/A + Outlook herbicide 10 fl oz/A</u> Options: Outlook herbicide (15), Zidua herbicide (15), Dual (15)
Second Post Application	<ul style="list-style-type: none"> • Minimum 10 days after first application • Use a residual tank-mix 	<u>Liberty herbicide 29 fl oz/A + Outlook herbicide 10 fl oz/A</u> Options: Outlook herbicide (15), Zidua herbicide (15), Dual (15), Warrant (15), Staple (2)	<u>Liberty herbicide 29 fl oz/A + Outlook herbicide 10 fl oz/A</u> Options: Outlook herbicide (15), Zidua herbicide (15), Dual (15)
Third Post Application (if needed)		Valor® (14), Diuron® (7), MSMA (1)	Valor (14), Reflex (14), Cotoran (7), Diuron (7), Caparol (5), MSMA (1)

Always read and follow label directions.

Glyphosate may be included with Liberty herbicide applications on varieties tolerant to both Liberty herbicide and glyphosate to increase activity on grasses and some broadleaf weeds.

Weed Science Society of America site of action classification in parentheses.



Talk to your local retailer or BASF representative for specific local herbicide recommendations.



Liberty® herbicide may be applied in tank-mix combinations with labeled rates of other products, provided these other products are labeled for the timing and method of application for the crop to be treated. The tank-mix partner must be used in accordance with the label limitations and precautions. No label dosage rates may be exceeded. Liberty 280 SL herbicide cannot be mixed with any product containing a label prohibition against such mixing. A list of potential weed control options and tank-mix partners for Liberty herbicide are listed below:

Burndown	Pre-plant Incorporated Pre-plant	Planting Preemergence	Post Application 1 and 2	Layby
Glyphosate (9) (AI: gly) Direx® (7) Gramoxone® (22) Valor® (14) Dicamba (4) Clarity® (4) (AI: Dicamba) 2,4-D (4) (AI: 2,4-D) Aim® (14) Sharpen® herbicide (14) LeadOff® (2) Direx® (7) (AI: Diuron)	Treflan® (3) (AI: Trifluralin) Prowl® herbicide (3) Reflex® (14) Warrant® (15) Gramoxone (22) Valor (14)	Caparol® (5) Direx (5) Cotoran® (7) Dual® (15) Warrant (15) Glyphosate (9) Gramoxone (22) (AI: paraquat) Prowl herbicide (3) Staple® (2) Reflex (14) Staple LX (2) Dual II Magnum (15,9) Liberty herbicide (10) Glyphosate (9) (AI: gly)	Assure (1) Select Max (1) (AI: Clethodim) Fusilade (1) Fusion® (1) Poast Plus® (1) Staple (2) Staple LX (2) Dual (15) Dual II Magnum (15,9) Warrant (15) Outlook® herbicide (15) Envoke® (2) Liberty herbicide (10) Glyphosate (9) (AI: gly) Zidua® herbicide (15)	Valor (14) Direx (7) (AI: Diuron) Lorox® (7) (AI: linuron) Linex (7) (AI: linuron) MSMA (17) (AI: MSMA) Caparol® (5) Reflex (14) Liberty herbicide (10) Glyphosate (9) (AI: gly)

Weed Science Society of America site of action classification in parentheses.

Program	Guidelines	Recommended for Southeast 	Recommended for Mid-Atlantic 
Preemergence Residual		Preplant or At Planting: Prowl H2O herbicide + Cotoran 4L or fomesafen	Preplant or At Planting: Prowl H2O herbicide + Cotoran 4L or fomesafen
First Post Application	<ul style="list-style-type: none"> Weeds < 3" Use a residual tank-mix 	<u>Liberty herbicide 32-43 fl oz/A</u> <u>+ Outlook herbicide 12.8 fl oz</u> Options: Outlook herbicide (15), Zidua herbicide (15), Dual (15), Warrant (15), Envoke® (2), Staple (2),	<u>Liberty herbicide 32-43 fl oz/A</u> <u>+ Outlook herbicide 10 fl oz</u>
Second Post Application	<ul style="list-style-type: none"> Minimum 10 days after first application Use a residual tank-mix 	<u>Liberty herbicide 29 fl oz/A</u> Options: Outlook herbicide (15), Zidua herbicide (15), Dual (15), Warrant (15), Envoke (2), Staple (2),	<u>Liberty herbicide 29 fl oz/A</u> <u>+ Outlook herbicide 10 fl oz</u> Options: Valor (14), Diuron (7), Caparol (5), or MSMA (1)
Third Post Application (if needed)		Valor (14), Diuron (7), Caparol (5), MSMA (1)	Valor (14), Diuron (7), Caparol (5), MSMA (1)

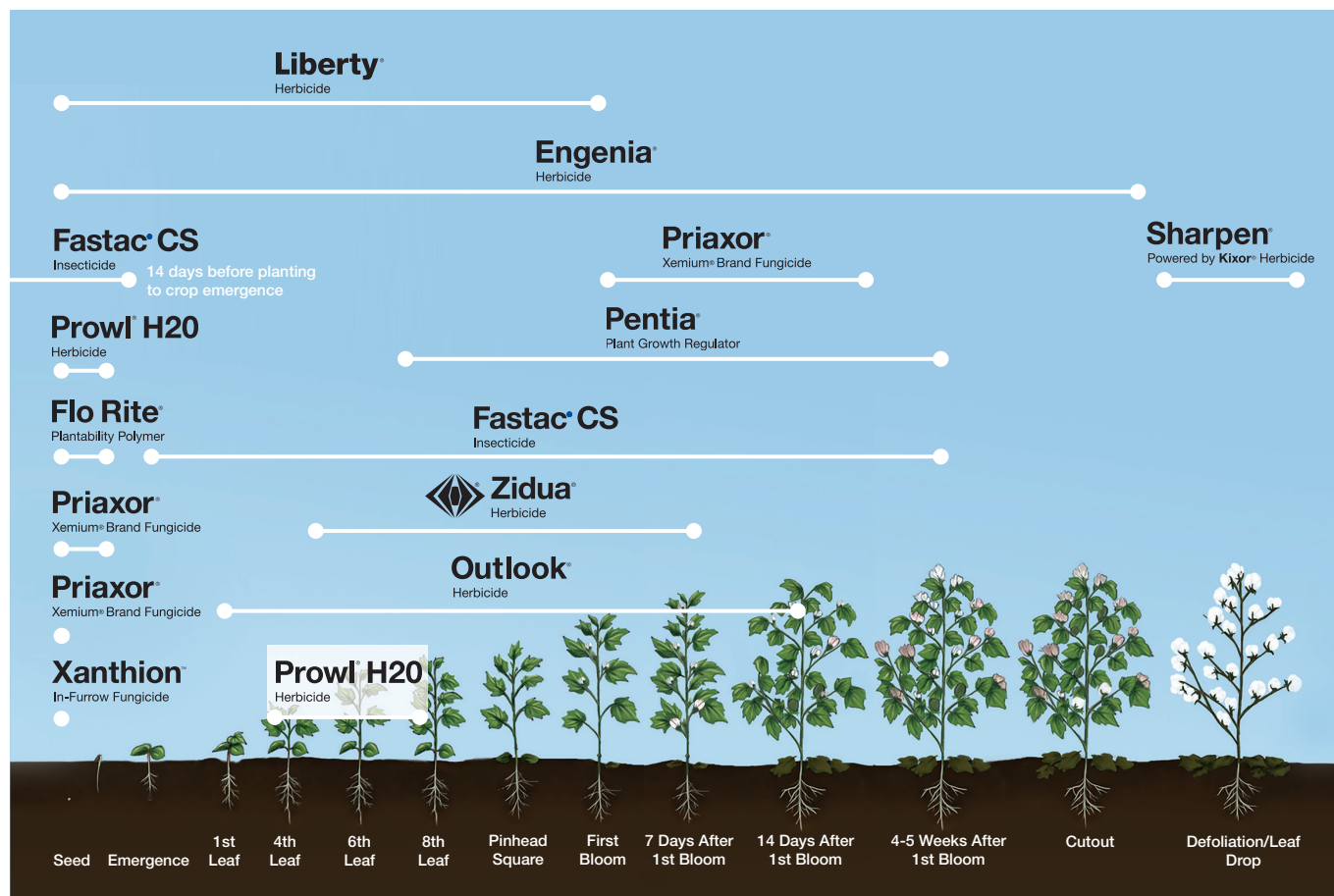
Always read and follow label directions.

Glyphosate may be included with Liberty herbicide applications on varieties tolerant to both Liberty herbicide and glyphosate to increase activity on grasses and some broadleaf weeds.

Weed Science Society of America site of action classification in parentheses.

Talk to your local retailer for specific local herbicide recommendations





GENERAL APPLICATION GUIDELINES

• Scenario 1:

- Apply Liberty herbicide at 32-43 fl oz/A, plus residual such as Outlook herbicide, over the top of LibertyLink[®] cotton from crop emergence to 14 days after crop emergence or when weeds are no more than 3 inches tall.
- If needed apply a second application of Liberty herbicide at 29 fl oz/A plus a residual herbicide such as Outlook herbicide. The second application should be at least 10 days after the first.
- Maximum per year is 72 fl oz/A (if more than 29 fl oz/A was used in a single application).

• Scenario 2:

- Apply Liberty herbicide at 29 fl oz/A, plus residual such as Outlook herbicide, over the top of LibertyLink cotton from crop emergence to 14 days after crop emergence or when weeds are no more than 3 inches tall.

- For a second postemergence application, apply Liberty herbicide at 29 fl oz/A, plus residual such as Outlook herbicide at least 10 days after the first application.
- A third application of Liberty herbicide at 29 fl oz/A may be applied if needed in cotton if neither of the previous applications exceeded 29 fl oz/A.
- Maximum per year is 87 fl oz/A (as recommended with no single application at a rate higher than 29 fl oz/A).



LIBERTY® HERBICIDE QUICK FACTS

Application Timing	< 3" weeds
Application Window	Up to early bloom
Site of Action	Group 10*
Activity	Nonselective, broadleaf and grasses
Adjuvant	Ammonium Sulfate (AMS) at 1.5 to 3 lbs/A**
Spray Water Volume	15-20 GPA; if dense weed canopy exists, increase to 20 GPA
Nozzle	Medium to coarse-size spray droplet
Ground Speed	<10 mph to attain good coverage
Wind Speed	<10 mph
Rainfast	Four hours
Tank-mixes with Glyphosate	<ul style="list-style-type: none"> • Adding glyphosate to Liberty herbicide applications on varieties tolerant to both Liberty herbicide and glyphosate may improve control of grasses and some broadleaf weeds. • Applications with glyphosate should be made according to Liberty herbicide application recommended guidelines listed above.

For more information, review the Liberty herbicide section on page 14

*Weed Science Society of America site of action classification.

**Research has consistently shown AMS with Liberty herbicide improves weed control. AMS is especially needed for difficult-to-control weeds, under difficult environmental conditions (low relative humidity) or hard water.

Talk to your local retailer or BASF representative for specific AMS recommendation.

YIELD LOSS DUE TO COMPETITION

Weeds that emerge with the crop, or shortly thereafter, have the greatest potential to adversely impact yields. The yield loss associated with this flush of weeds is strongly influenced by the length of time weeds remain in the field and compete with crops for light, water and nutrients.

Weed scientists state that effective weed control during the first nine weeks after emergence is critical to produce optimum cotton yields.

Residual herbicides improve weed control, reduce problematic weeds and extend the time period between planting and the first postemergence treatment of Liberty herbicide. Furthermore, the use of residual herbicides increases application flexibility in case of unfavorable weather conditions. The use of a residual herbicide in your weed-control program will introduce another herbicide SOA in the field and enhance your weed-management program.

According to the University of Tennessee,⁶ cotton growers lost more than \$138 million due to glyphosate-resistant Palmer amaranth. In fact, in 2006 growers were estimated to spend about \$60 per acre on herbicides, but in 2014 that cost rose to an estimated \$100 per acre or higher.



YIELD LOSS EXAMPLES

Cotton yield was reduced by 67 percent when Palmer amaranth was established at the same time as the crop, while delaying weed establishment until six weeks after crop planting reduced yield loss to less than 30 percent.⁷

	\$/Pound			
	\$0.52**	\$0.60	\$0.70	\$0.80
Lost \$/A from Palmer amaranth*	\$348	\$402	\$469	\$536
Lost \$/1,000 A from Palmer amaranth*	\$348,000	\$402,000	\$469,000	\$536,000

*Based on above study with start yield at 1,000 lb/A.

**Represents Commodity Credit Corporation Loan Rate.

COMPLIANCE ASSURANCE PROGRAM

The U.S. EPA requires BASF to take corrective action in response to a finding of noncompliance by growers to the refuge requirements of GLT and GLTP cotton. BASF or an approved agent of BASF is required to monitor compliance with refuge requirements. The BASF Grower Technology Agreement (BGTA) stipulates that, upon request by BASF or an approved agent, a grower must provide the location of all fields planted with BASF biotechnologies and the locations of all associated required refuge areas, so that they may be verified to be in compliance with GlyTol® LibertyLink® TwinLink® and GlyTol LibertyLink TwinLink Plus registration requirements. BASF will provide the grower advance notice of any inspections, and such inspections will be performed during regular working hours, to accommodate the grower's schedule so the grower may be present, if desired.



Growers must read the current BASF Insect Resistance Management Guide prior to planting for information on required IRM.

Visit <https://industries.basf.com/assets/north-america/us/en/Agriculture/Crop%20Protection/BCS/InsectResistanceManagementGuide.pdf> to access the guide.



INSECT RESISTANCE MANAGEMENT (IRM)

An effective IRM program is a critical component of the care and management of the TwinLink® and TwinLink Plus technology. We are committed to implementing effective IRM programs for TwinLink, TwinLink Plus and all future traits conferring insect resistance to crops. IRM plans can vary based on region, plant and animal biology, and environmental and farming conditions, as well as public and producer concerns. In the United States, IRM programs are mandated by the EPA as a condition of registration. The mandatory programs are developed and updated in cooperation with grower and industry groups, as well as with Extension, research and regulatory experts.

Although all IRM programs have multiple components, one of the most critical is the presence of a refuge. A refuge is simply a portion of farming landscape that is a host for insect pests, but does not contain the *Bacillus thuringiensis* (*Bt*) gene technology. The purpose of the refuge is to produce susceptible insects that have not been exposed to *Bt*. The susceptible insects (readily killed by the *Bt* cotton) will mate with the rare resistant insect (survives in the *Bt* cotton field), producing offspring that are susceptible. The goal of using refuges is to preserve the long-term effectiveness of the TwinLink traits.

Two very different types of refuges are possible for TwinLink and TwinLink Plus cotton: structured refuge and natural refuge. A structured refuge is a mandated area of non-*Bt* cotton that must be planted by growers. A natural refuge includes crops, other than those intentionally planted, to serve as a refuge, as well as non-crop vegetation, suitable to host target pests of TwinLink and TwinLink Plus cotton. Growers must read the directions before planting TwinLink and TwinLink Plus cotton and comply with required use of refuges.

Scouting crops for key pests is essential for obtaining maximal benefit of GLT and GLTP. Licensees must monitor fields on a consistent basis and use treatment thresholds developed for the area. Fields should be monitored at least once per week and more frequently when the pest threat is higher, such as when bollworm egg deposition in cotton is at its peak. BASF recommends the use of supplemental insecticide treatments to control any cotton pests that reach thresholds recommended by authorities in your locality. As with other *Bt* cotton products, GLT and GLTP are as susceptible as non-*Bt* cotton to non-lepidopteran pests, such as stink bugs, plant bugs, aphids and spider mites.

Growers in the states of Arizona, California, New Mexico and the following Texas counties: Brewster, Crane, Crockett, Culberson, El Paso, Hudspeth, Jeff Davis, Loving, Pecos, Presidio, Reeves, Terrell, Val Verde, Ward and Winkler must plant a structured refuge. The refuge size, configuration and management are described in detail in the Insect Resistance Management guide. Growers in these states are exempt from planting refuges IF their growing area has a Section 18 (Emergency Exemption) or 24(c) Special Local Need (SLN) due to the pink bollworm eradication program. Check with your local state Extension service for details.

Growers in the states of Alabama, Arkansas, Florida, Georgia, Kansas, Kentucky, Louisiana, Maryland, Missouri, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas (EXCEPT Brewster, Crane, Crockett, Culberson, El Paso, Hudspeth, Jeff Davis, Loving, Pecos, Presidio, Reeves, Terrell, Val Verde, Ward and Winkler counties) and Virginia can use a natural refuge.

No planting of TwinLink or TwinLink Plus cotton is permitted south of Route 60 (near Tampa) in Florida. Also, commercial planting of TwinLink or TwinLink Plus cotton is prohibited in Hawaii, Puerto Rico and the U.S. Virgin Islands. We are committed to the long-term viability of the *Bt* biotechnologies. You must do your part to implement the correct IRM plan on your farm. Failure to follow IRM requirements and to maintain a proper refuge may result in the loss of access to BASF biotechnologies.



SOURCE INFORMATION

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Grow Smart™ with BASF



Engenia Herbicide is a U.S. EPA Restricted Use Pesticide.

Additional state restrictions may apply. Always read and follow label directions.

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