

CLEARFIELD* Production System for Sunflower



CLEARFIELD* Sunflower Technical Information Bulletin

- The CLEARFIELD* Production System for sunflower provides producers with new technology that will deliver broad-spectrum postemergence grass and broadleaf weed control.
- The CLEARFIELD* system combines high yielding sunflower hybrids from leading seed companies with **Beyond**[™] herbicide for superior postemergence weed control in all tillage systems.



BEYOND[™]
HERBICIDE | for CLEARFIELD* sunflowers



CLEARFIELD Sunflower Development

Application of **Beyond** herbicide in conventional sunflowers (non-CLEARFIELD) results in significant crop response and/or plant death. In contrast, CLEARFIELD sunflower hybrids possess genetic tolerance to **Beyond** herbicide.

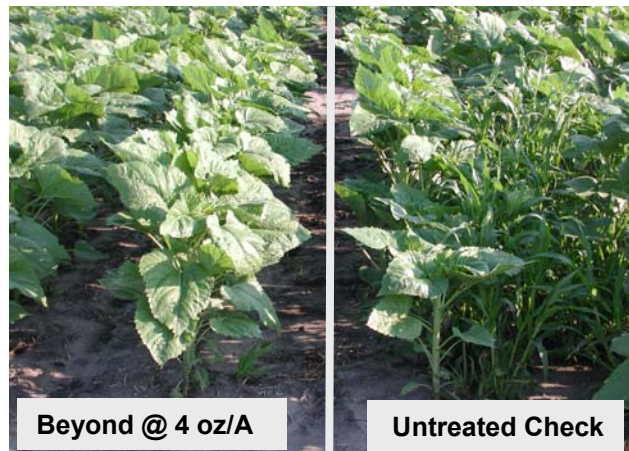
Many leading sunflower seed companies are actively developing CLEARFIELD sunflower hybrids. Oil and confection type CLEARFIELD sunflower hybrids with a wide area of adaptation are being developed. Oilseed type CLEARFIELD sunflower hybrids were introduced during the 2003 season. Confection type CLEARFIELD sunflower hybrids may be available as early as the 2006 season.



CLEARFIELD^{*}
production system | sunflower

The CLEARFIELD Sunflower Story

The CLEARFIELD* trait for sunflowers was discovered in 1997 by researchers at Kansas State University. The tolerance trait was first identified in a population of common (wild) sunflower that had arisen in a commercial soybean field after seven years of continuous use of ALS-inhibitor herbicides.



Dr. Jerry Miller, a USDA Sunflower geneticist, crossed the resistant wild sunflower to four USDA cultivated sunflower genetic stocks. The herbicide tolerance trait was maintained through several backcross generations and four new CLEARFIELD germplasm lines were made available to seed companies and plant breeders. By incorporating the tolerance trait from these germplasm lines into their most advanced breeding stock, plant breeders developed new, elite CLEARFIELD breeding lines and hybrids.

Researchers from North Dakota State University and officials from the National Sunflower Association recognized the benefits of the CLEARFIELD* production system for sunflowers early in the development of the technology. With the strong encouragement from the NSA, University, and growers, BASF and our seed partners began extensive herbicide tolerance, efficacy, and breeding programs. Field studies were established across the major sunflower growing regions in the US to identify best inbred parents, hybrids, and herbicide rates, application timing, and additives necessary to control the majority of weeds sunflower growers face. Herbicide tolerance trials established with seed companies developing CLEARFIELD sunflower hybrids ensure that finished hybrids have a minimum of 2X crop tolerance to **Beyond™** herbicide. The results of this collaborative research effort are now available to growers through the CLEARFIELD* production system.

The CLEARFIELD “Trait” in Sunflower



Tolerance to the imidazolinone family of herbicides is conferred by a single semi-dominant gene. For commercial herbicide tolerance expression, the gene must be homozygous. For this reason, CLEARFIELD Sunflower hybrid production requires the conversion of both the male and female parent lines. Additional genes may contribute to the tolerance observed in commercial hybrids.

CLEARFIELD sunflower hybrids are not cross-tolerant to the sulfonyleurea (SU) herbicides, which are also ALS or AHAS inhibitors.

Stewardship

CLEARFIELD* sunflower producers are asked to follow specific management practices that prevent or delay herbicide resistance and preserve the usefulness of this technology. These practices were developed by BASF and university researchers and should span across crops and years to promote sound herbicide resistance management.



Outcrossing via Gene Flow

University researchers have demonstrated that the herbicide tolerance trait in CLEARFIELD sunflower can move (outcross) into a wild sunflower population, transferring the tolerance trait into the resulting offspring which may exhibit resistance to **Beyond™** herbicide and other IMI herbicides. Although the chance of this occurring is low, it is not zero and must be managed. Following the listed stewardship practices identified below will minimize outcross populations and reduce the development of herbicide resistance to other weeds.

Stewardship Practices for CLEARFIELD Sunflower

- Always grow CLEARFIELD sunflower in rotation with other crops, i.e. wheat/corn/sunflower.
 - Breaks the cycle of continuous sunflower production and allows use of alternate mode-of-action herbicides and tillage
 - Promotes good agronomics by reducing disease and insect pressure in sunflower
- Use alternate (non-ALS) mode-of-action herbicides with activity on sunflower in the rotational crop, i.e. growth regulator or photosynthesis inhibitor.
 - Reduces the selection pressure from continuous dependence on the ALS-inhibiting herbicide
 - Provides alternate mode-of-action to control volunteer CLEARFIELD sunflower and other ALS resistant weeds present
- Do not plant CLEARFIELD sunflower on land with a history of a heavy infestation of wild (common or prairie) sunflower.
 - Reduces the threat of outcrossing of CLEARFIELD sunflower with wild sunflower
- Control wild sunflower in adjacent areas to CLEARFIELD sunflower fields (road ditches, field borders, fence rows) through the use of non-ALS herbicides and/or mowing prior to seed set.
 - Minimizes the potential of cross-pollination of wild-type sunflowers with CLEARFIELD sunflowers
 - Promotes good sanitation practices by eliminating vectors for insects and disease
- Control emerged wild sunflower prior to planting CLEARFIELD sunflowers with non-ALS burndown herbicides (no-till/min-till) or tillage (conventional-till).
 - Reduces reliance on ALS herbicide in controlling wild sunflower
 - Eliminates any emerged naturally occurring biotype that may be resistant to ALS-inhibiting herbicides
- Limit the sole reliance on ALS herbicides to no more than 2 out of 4 years in the same field.
 - Where applicable, use sequential or tankmix partner herbicides with multiple modes-of-action on target weed species in the sunflower crop and in rotational crops

Beyond Herbicide Application Information

Beyond™ Rate:

- ✓ 4.0 oz per acre
- ✓ Only 1 application per season

Required Herbicide Additives:

- ✓ Nonionic surfactant
 - 1 qt / 100 gallons (0.25 % v/v)

AND

- ✓ Nitrogen Based Fertilizer
 - 28%, 32%, 10-34-0:1 - 2.5 gal/100 gallons (1 - 2.5 % v/v)
 - AMS: 12 - 15 lbs. / 100 gallons

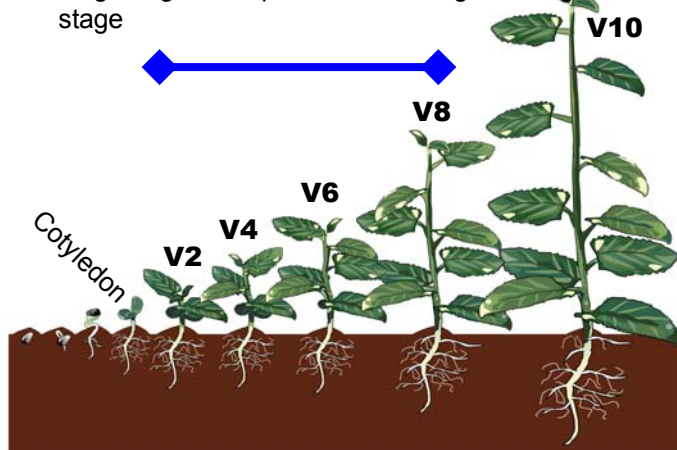
Application Method:

- ✓ Ground or Air
 - Apply in 10 - 20 gallons of water per acre with ground application and ≥ 5 GPA by air
 - Spray pressure: 20 - 40 psi
 - Use higher volume and pressure if dense weed pressure or heavy crop residue (no-till fields)
 - Always use flat fan or like nozzles with ground applications

Application Timing:

CLEARFIELD* Sunflower

- ✓ Apply **Beyond™** early postemergence from the V2 stage of growth up to and including the V8 growth stage



Weeds:

- ✓ Apply before broadleaf weeds exceed a height or width of 3"
- ✓ Apply before grass weeds exceed 4 – 5 leaves

Best Technical Recommendations For CLEARFIELD* Sunflower

Conventional Tillage:

- ➔ Prowl® 3.3 EC herbicide at 3.0 – 3.6 pts/A (Prowl® H2O herbicide at 3.0 pt/A) PPI followed by **Beyond @ 4 oz/A** applied Early POST

No-Till or Minimum-Till:

- ➔ Glyphosate burndown plus Prowl 3.3 EC at 3.6 pts/A (Prowl H2O at 3 pt/A) Preplant or Preemergence followed by **Beyond @ 4 oz/A** applied Early POST

Condensed* List of Weeds Controlled with Beyond in CLEARFIELD Sunflower

BROADLEAVES CONTROLLED			GRASSES CONTROLLED		
Beet, wild	Marshelder	Spurge, prostrate	Barley, wild	Darnel, Persian	Sandbur, field
Chickweed	Nightshade spp.	Sunflower, c.	Barnyardgrass	Foxtail, spp.	Shattercane
Cocklebur	Pigweed spp.	Sunflower, vol.	Blackgrass	Goosegrass	Signalgrass, bl
Jimsonweed	Puncturevine	Tansy mustard	Bromus, spp.	Goatgrass, J.	Stinkgrass
Kochia**	Purslane, c.	Velvetleaf	Canarygrass	Millet, proso	Vol. cereals
Lambsquarter	Radish, w.		Crabgrass, spp.	Oats, wild	Witchgrass
Mustard spp.	Smartweed spp.		Cupgrass, wooly	Panicum spp.	

* Refer to Beyond label for a complete list of weeds controlled and suppressed.

** Non ALS resistant biotypes

Yellow highlighted weeds require a sequential treatment of Prowl followed by Beyond for complete control