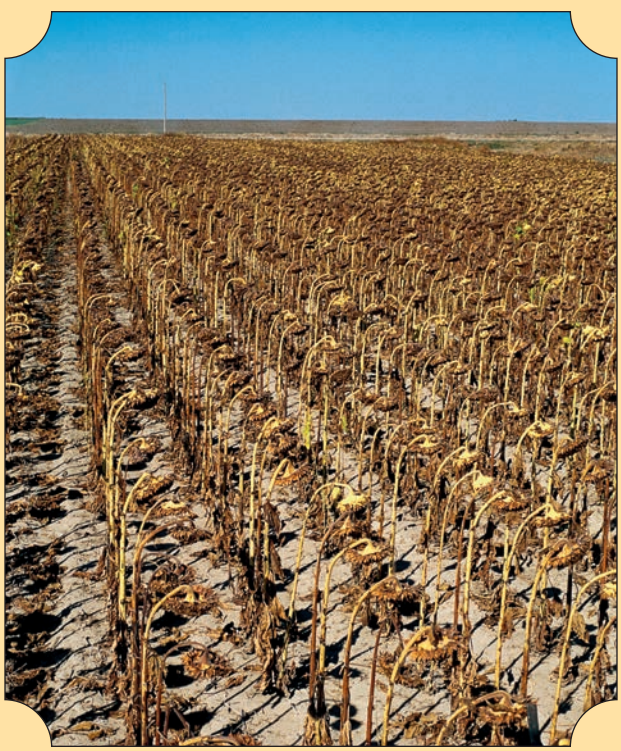
Weed Control In Sunflower

Special Supplement To *The Sunflower*



— Introduction —

A weed is defined as a misplaced plant. Historically, sunflower producers have had to deal with many misplaced plants in their fields. That was especially true a decade or more ago, when there were only two or three herbicide choices. More choices exist today, and growers are using a combination of herbicides and rotations to control troublesome weeds.

Not too long ago, sunflower growers depended on tillage for a large portion of their weed control. Since then reduced tillage has become the norm, and the crop has moved further west into drier areas where tillage isn't as feasible. Preplant burndown and postemerge herbicides for grasses and broadleaves have dramatically changed the sunflower weed control landscape.

In this special supplement to *The Sunflower*, we discuss some of the most troublesome weeds, herbicide choices, some issues related to the most common products, and grower strategies for controlling weeds in today's environment.

For the farmer, weed control is — after hybrid selection — likely the most critical production sunflower decision he makes. The National Sunflower Association has placed a great deal of emphasis on new herbicide labels by partially financing the registration costs of most of the products available today. It would be great to have more herbicide choices. Unfortunately, the number of new herbicide introductions has been minimal during the past decade — and we're not aware of anything in the near-term pipeline that might fit sunflower.

Attaining a sunflower herbicide label is often accidental. If a new herbicide introduction doesn't kill wild sunflower, then there is an opportunity for a potential sunflower label. Chemical companies do not generate herbicides specifically for a smaller-acreage crop like sunflower, so this industry is dependent upon some luck that a product might fit.

Roundup Ready® is not a likely reality for sunflower. This is mainly due to the regulatory hurdles related to potential pollen outcrossing to wild sunflower, a native plant in North America.

The National Sunflower Association has been conducting an intense fall field survey since 2002. Volunteers go into fields and assess production issues that may be impacting yields. Weed identification is a key category. Interestingly, the list of most troublesome weeds still finds kochia as the most common species. Grasses are much less of a problem, due largely to excellent postemergent herbicides. But other challenges — like Canada thistle and palmer amaranth — face growers today.

What has changed is the intensity of the weed populations. No longer is it common to find a field literally covered with weeds. Now, weeds are usually found in field skips or open areas, or are randomly scattered in sections of the field. The ability to control weeds has had a significant impact on sunflower yield enhancement. **— Larry Kleingartner** ■

Most Commonly Found Weeds in Sunflower — 2002 & 2009

Source: National Sunflower Association Field Surveys

	2002	2009		2002	2009
North Dakota —			*Kansas —*		
1.	Green foxtail	Canada thistle	1.	Puncture vine	Palmer amaranth
2.	Kochia	Kochia	2.	Volunteer grain	Volunteer grain
South Dakota —			*Colorado —*		
1.	Kochia	Redroot pigweed	1.	Russian thistle	Russian thistle
2.	Green foxtail	Kochia	2.	Kochia	Puncture vine
Minnesota —			*Texas —*		
1.	Green foxtail	Canada thistle	1.	Palmer amaranth	Palmer amaranth
2.	Kochia	Kochia	2.	Redroot pigweed	Russian thistle

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Storms & Stewardship

Tough Weather & Even Tougher Weeds Increase Need for Clearfield Stewardship

Growers across the country are accustomed to the uncertainty that comes with all the variables in producing crops. The tough weather of 2009 drove that home for sunflower growers in the Upper Midwest. Adding to the woes of weather is the ever-present pressure from tough weeds and diseases.

While no one can control the weather, there are ways to control the problems of weeds and diseases. The Clearfield® Production System knocks back the biggest threats, but resistant weeds are beginning to emerge. Protecting this important technology through good stewardship practices will ensure that resistant weeds and diseases stay out of sunflower fields for growers across the country.

'Cold & Wet' Creates Challenges

A late spring, cool summer and early frost created a serious set of challenges for Upper Midwest sunflower growers this past season. From start to finish, many growers have been obliged to shift their practices to accommodate the forces of nature.

Dr. Kirk Howatt has been a weed researcher in cereals and oilseed crops at North Dakota State University for 10 years. He counseled many growers struggling with timing the regular functions of growing and harvesting sunflowers in 2009. "Even my own plots were seven to 10 days late for planting this year," Howatt notes. "Development lagged behind all season."

With pockets of frost hitting the region after Labor Day, plants had no chance to dry down to the recommended 30 to 35% moisture for preharvest herbicide application. Late-season treatments were tough to fit in because of delayed development and weather, thus increasing disease and weed pressure.

"Diseases and weeds thrived after initial frosts, allowing continued inoculum and seed production," Howatt says. "I had some growers [who] felt like the only thing that really grew this year was Sclerotinia. . . . The lack of those end-of-season glyphosate treatments could lead to a bumper crop of spring weeds."

The Clearfield Advantage

Howatt has been impressed with the impact of the Clearfield Production System on sunflower in North Dakota. Clearfield plus a soil-applied component can manage early emerging weeds, making the window for postemergent applications both broader and more flexible.

"With larger flushes of weeds like we may well see in the coming year, the Clearfield portfolio of products is a big help," he observes. "Not only does it provide good control of both broadleaf weeds and grasses, but the control can be achieved without losing marketability of nontransgenic varieties."

If wild sunflower and other weeds become herbicide-tolerant, the effectiveness of these technologies will diminish.

Eastern North Dakota farmer Anthony Thilmony stopped growing sunflower in the late 1990s and early 2000s because eastern black nightshade and marsh elder clogged his fields, and his choices for control were few and far between. With the introduction of Clearfield sunflower, Thilmony found a solution to his growing weed problem.

"When Clearfield sunflower [hybrids] were introduced, I tried them the first year and was totally impressed with control of the two main weeds I'm worried about; and this allowed me to keep sunflower in our rotation," Thilmony says.

A Historic Discovery & Beyond

The introduction of Clearfield sunflower provided growers with their first opportunity to control most broadleaf weeds with postemergent herbicide applications. As part of the Clearfield Production System, BASF Crop Protection introduced Beyond® herbicide, a member of the imidazolinone chemical family and an ALS inhibitor.

When Beyond herbicide is applied to Clearfield sunflower at the two- to four-leaf stage, growers see both contact and residual activity on broadleaf weeds and grasses, including kochia, marsh elder, cocklebur, Canada thistle, foxtail, volunteer cereals and non-Clearfield wild or volunteer sunflower. Beyond is labeled for use up to the eight-leaf stage, but performance is best when applied at the earlier stage.

Beyond also works well in no-till settings, which may be increasingly important after delayed seasons like 2009. Applications of Beyond may help growers get control of weeds and grasses that would otherwise survive because they were not tilled under preplant.

Because it is a highly effective system for controlling a wide variety of weeds, resistance to ALS inhibitors looms large as a threat to crops. Researchers have already found populations of kochia, pigweed, marsh elder and nightshade in North Dakota that are resistant to ALS inhibitors. To keep this problem from spreading, today's growers must practice technology stewardship to ensure that the benefits of the Clearfield Production System are available for generations to come.

Clearfield Sunflower Stewardship

If wild sunflower and other weeds become herbicide-tolerant, the effectiveness of these technologies for weed control will diminish. That's why growers using the Clearfield Production System need to be vigilant about responsible use

Ryan Bond and Chris Wharam, technical market manager and technical service representative, respectively, for BASF Crop Protection, contributed information for this article.

of the products. Good stewardship practices range from crop rotation to the use of non-ALS chemistries for herbicide resistance management.

The following are best practices for Clearfield sunflower stewardship:

• Always grow Clearfield sunflower in rotation with other non-Clearfield crops, such as wheat, corn or sunflower. Rotating crops breaks the cycle of continuous sunflower production and allows for use of alternative mode-of-action chemistries and different tillage options.

• Use alternative (non-ALS) mode-of-action herbicides such as a growth regulator or photosynthesis inhibitor with activity on sunflower in the rotational crop. The alternative mode-of-action helps control volunteer Clearfield sunflower and other ALS-resistant weeds. It also reduces the selection pressure of ALS-inhibiting herbicides from continuous dependence on the chemistry.

• Limit the sole reliance on ALS herbicides to no more than two out of four years in the same field. Whenever possible, use sequential herbicides or tank-mix partners with multiple modes-of-action on targeted weed species in the sunflower crop and in rotational crops.

• Do not plant Clearfield sunflower on land with a history of heavy wild sunflower pressure. This helps reduce the threat of outcrossing Clearfield sunflower with wild sunflower.

• Control emerged wild sunflower in the field prior to planting Clearfield sunflower by using non-ALS burndown herbicides on no-till or minimum-till fields, or by tillage in conventional-till fields. Spraying glyphosate prior to planting eliminates any wild sunflower in the area that may be resistant to ALS-inhibiting herbicides, while also reducing the reliance on ALS herbicides in controlling wild sunflower.

• Spray a preplant or preemergence herbicide earlier in the season, prior to spraying Beyond herbicide. A soil-applied grass herbicide like Prowl® H2O can be used before spraying Beyond to increase weed control on targeted weed species and add another mode-of-action to the sunflower program to help prevent herbicide-tolerant weeds.

NDSU's Kirk Howatt continues to evaluate Clearfield seed varieties that will allow for improved control of troublesome weeds with Beyond. But until that time, he urges Clearfield sunflower growers to incorporate stewardship practices to keep weed populations low and herbicide efficacy high.

"We can't control the weather," Howatt notes. "So we have to control the way we use the trait." ■

Good Stewardship Also Key with ExpressSun

As when growing a Clearfield variety, sound stewardship also should be a top priority for growers planting an ExpressSun® sunflower variety in order to avoid outcrossing to wild sunflower and to preserve the system's integrity and productivity.

The ExpressSun trait system incorporates built-in tolerance to DuPont's Express® herbicide (with TotalSol™ soluble granules). As with Clearfield, the Express-tolerance trait is incorporated into sunflower hybrids by traditional plant breeding methods, so the hybrids are not considered to be "genetically modified." Express is a member of the sulfonylurea family of herbicides.

DuPont and Pioneer Hi-Bred International (which is owned by DuPont) offer the following stewardship advice regarding the use of ExpressSun hybrids:

• Always grow sunflower hybrids with the ExpressSun trait as part of a multi-year rotation with other crops.

• Use non-ALS/AHAS (non-group 2) mode-of-action herbicides in a tank mix with ALS/AHS herbicides — or as a sequential treatment in the rotational crop — to control wild and volunteer sunflower.

• Control wild sunflower in non-crop areas adjacent to ExpressSun trait sunflower fields through the use of non-ALS/AHAS herbicides and/or mowing prior to seedset.

• Use tillage to control emerged wild sunflower prior to planting hybrids with the ExpressSun trait, or by utilizing non-ALS/AHAS burndown herbicides, or use ALS/AHAS burndown herbicides in a tank mix with non-ALS/AHAS herbicides to provide control of sunflower.

• As practical, use ALS/AHAS herbicides in a tank mix with non-ALS/AHAS mode-of-action herbicides, or use ALS/AHAS herbicides in a sequential program that employs alternate modes of action to control wild and volunteer sunflower. ■

ExpressSun & Clearfield Hybrids for 2010

Seed companies indicate the following ExpressSun and Clearfield sunflower hybrids as available for 2010 planting. All are NuSun (mid-oleic) hybrids, except where otherwise noted. A "DM" or "DMR" designation indicates the hybrid carries resistance to downy mildew.

— ExpressSun Varieties —

Croplan Genetics
460 E,NS

Pioneer Hi-Bred International
P63N82
P63ME70
P64HE01 (high oleic)

Seeds 2000
Cobra
Firebird

— Clearfield Varieties —

CHS Sunflower
Royal Hybrid 400 CL (confection)

Croplan Genetics
551 CL,NS
555 CL,DMR,NS
564 CL,NS

Dahlgren & Company
9530CL (confection)

Legend Seeds
LSF 223NCL

Mycogen Seeds
8N270CLDM
8N358CL
8N358CLDM
8N386CL
8H288CLDM (high oleic)
8H419CL (high oleic)
8H419CLDM (high oleic)
8H449CLDM (high oleic)

Pannar Seeds
8466 NS/CL
8560 NS/CL

Proseed
CL 7001
CL 9001

Red River Commodities
2215 CL (confection)

Seeds 2000
Jaguar (confection)
Badger CL (conoil)
Barracuda
Blazer CL
Viper

Syngenta Seeds
3480 NS/CL/DM
3980 NS/CL
3880 CL

Triumph Seed
s680CL
6300 CL
660CL
859CL (high oleic)
s870CL (high oleic)

— Spartan —

The Workhorse Herbicide

Despite Some Early Bumps in the Road, Versatile Broadleaf Product Has Become a Mainstay for Sunflower Producers

There was a great deal of celebration when the first Section 18 label for Spartan® (Sulfentrazone) was approved in 1999 in multiple states. This was the first multi-spectrum broadleaf herbicide to be labeled for sunflower.

The need was great. Growers had few alternatives other than dinitroaniline herbicides like Treflan, Sonalan and Prowl. Issues of weed resistance to this herbicide family were popping up. There was an increasing interest in no-till, and producing sunflower under that system was a real challenge prior to Spartan.

With few alternatives in the market, it didn't take long for Spartan to go to the top of the sunflower herbicide list.

The history of Spartan has not been the smoothest. Section 18 labels have always been a challenge to acquire, especially in multiple states. In 2005 the product's manufacturer, FMC, encountered a production issue that shorted the market. There have been periodic crop damage and performance issues. But most of that has been worked out with research and field experience. Overall, the product has been a lifesaver for many sunflower producers. It is the most widely used sunflower herbicide today.

The key weed of interest has always been kochia. North Dakota State University weed scientist Rich Zollinger, who did much of the early work on the product, happily reported to the National Sunflower Association Board of Directors in 1998 that "Spartan literally 'smokes' kochia." That scenario continues today, with excellent control of kochia along with other small-seeded broadleaves.

Spartan was first available as a 75 DF dry product. In 2005 it was changed to a liquid formulation, Spartan 4-F, for easier mixing. Today, Spartan is teamed up with other herbicides in a premix for further ease of handling. "Spartan Charge" is designed for the no-till producer. This formulation has added carfentrazone-ethyl ("Aim") for faster preplant burndown of small susceptible broadleaf weeds such a 'puffball' kochia. "Spartan Advance" has glyphosate added to the formulation for broad-spectrum preplant burndown for no-till and conventional growers.

Use rates today are moderately lower than those during the early days of the product's introduction, and mechanical incorporation is not recommended. Also, the use of Spartan on soils with less than 1% organic matter has been restricted.

*Below: Symptoms of Spartan injury to a young sunflower plant. "Sunflower usually grows out of any damage — except on very light soil with little to no organic matter," notes North Dakota State University extension weed specialist Rich Zollinger. "Under those conditions, injury may be permanent, with slight to heavy stand loss. This is why application rate by soil type is **very** important." If there are wide fluctuations in soil type within a given field, Zollinger recommends using low rates of Spartan in light soil and higher rates in finer-textured soils.*

Photo: Bruce Due

Minimizing Crop Damage

Sam Lockhart, FMC technical support specialist, says FMC strongly advises growers to soil test to determine organic matter, soil type and soil pH. This is critical for determining an application rate. "One rate does not fit every soil type," says Lockhart. Reducing rates is necessary on soils with a pH of 7.0 and greater, and on sandier and low-organic soils (often including hilltops).

Another area of concern is that growers who use Spartan after planting ensure that they apply the product well before seedlings begin to emerge and that seed furrows are closed. Lockhart also recommends that seeds be planted 1.0 inch or deeper when using Spartan postplant/preemerge. He advises growers and certified crop advisors to closely follow the label-recommended rates based on soil types and other soil factors described above. He also advises using variable rate technology when possible. "It is usually the eroded hilltops that result in some seedling injury without dropping the rates in those areas of the field," Lockhart observes.

And if you do see seedling damage in parts of the field, like on hilltops? Bruce Due, Northern Plains district agronomist for Mycogen Seeds, says that in most cases the plants grow out of the injury and yield normally. "My experience is that the plants will be stunted,

FMC strongly advises growers to soil test to determine organic matter, soil type and soil pH before using Spartan.

but not behind in growth stages. An uninjured eight-leaf plant may be six inches tall, while an injured plant will still be in the eight-leaf stage but perhaps only four inches tall," Due states.

Rich Zollinger's experience is that sunflower usually grows out of any damage — but it depends on the rate and the organic matter level. If the rate is too high and the soil is very light with little or no organic matter, injury can be permanent with a stand reduction.

FMC's Lockhart agrees, saying that the injured plants usually grow out of the damage. The injured plant will be stunted and the leaves may be lighter in color — somewhat variegated and with dark lesions.

The bottom line is that everyone is doing a much better job of applying the proper Spartan rates in concert with soil types, and the damage issue has been greatly minimized since the introduction of the product.

Spartan has proven itself in weed control when timely rainfall occurs resulting in good incorporation. National Sunflower Association volunteers who participate in the annual sunflower crop survey seldom see a field with a kochia disaster. There may be a few plants here and there; but generally this weed has been put on the back burner as far as impacting yield. It is still the number one weed found in sunflower fields in most states, but the intensity of the weed population is greatly reduced when comparing it to the pre-Spartan days.

One of the major weeds in sunflower from southern Nebraska to Texas is Palmer amaranth. Spartan does a good job of controlling the various pigweeds, including Palmer amaranth. Lockhart says the key to controlling Palmer amaranth is moisture at planting for incorporation. A rain event (or irrigation) of at least 0.5 inch is critical for chemical activation. That is not always going to occur in that region, where the growing season is quite long and rain events can be greatly extended.

Is there a place for Spartan as more seed companies move their hybrids to either a Clearfield® or ExpressSun® trait system? Lockhart says Spartan is a great companion herbicide with Beyond- and Express-resistant hybrids. Both Express and Beyond are ALS herbicides, and ALS-resistant kochia is best controlled by Spartan in sunflower. "It is really the best way to control resistant kochia, and it is a great combined herbicide package — something that sunflower has really never had [before]," he concludes. —

Larry Kleingartner ■

Spartan Charge Use Rate Table (Sunflower)

Fall, Preplant Burndown, Early Preplant & Preemergence

Broadcast Rate	Fluid Ounces Spartan Charge / Acre — *Soil Texture* —		
% Organic Matter	**Coarse**	**Medium**	**Fine**
<1.5	3.75 - 5.0	3.75 - 5.75	5.0 - 6.5
1.5-3.0	3.75 - 5.75	5.0 - 7.75	5.75 - 8.5
>3	5.0 - 7.75	5.75 - 8.5	7.75 - 10.2

Use higher rates for soils of pH less than 7.0 & lowest rate for pH greater than 7.0 within the rate range.

Source: Spartan Charge Label

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Photo: Don Lilleboe

Left: "Palmer amaranth will get just as tall or taller than the crop, no matter how tall the sunflower is. It just reaches for the sun," notes KSU weed scientist Phil Stahlman, shown here in a research plot on the Hays station.

Palmer Amaranth Flexing Its Muscle

Aggressive Pigweed Species with Long Germination Window Requires Close Attention in High Plains Sunflower Fields

Let there be no doubt: Palmer amaranth has become an increasingly "growing" weed problem in Kansas sunflower fields.

If you question that statement, consider the results of the annual National Sunflower Association crop survey. This coordinated survey — conducted each September and encompassing several key sunflower states and the Canadian province of Manitoba — has found Palmer amaranth to be the weed of highest incidence in Kansas sunflower fields for the past five years.

In 2005, Palmer amaranth populations were found in about 18% of the surveyed Kansas fields, with the next most common weed, puncture vine, observed in 9% of the fields. The next year, 2006, the incidence level for Palmer amaranth exploded to 66% of surveyed Kansas fields, while that of puncture vine crept up to only about 12%. The 2007 survey found Palmer amaranth in 88% of Kansas fields surveyed, with puncture vine jumping all the way to 75%. The following year, 2008, saw the Palmer amaranth incidence level climb to 92%, while puncture vine dropped to 64%. The 2009 NSA crop survey found Palmer amaranth in 90% of the surveyed Kansas sunflower fields, wile puncture vine was noted in just 20%.

Phil Stahlman is not the least bit surprised by these findings. "Palmer amaranth has become the most common of all the pigweed species in the southern and central Great Plains," says the Kansas State University weed scientist. Stahlman, who is based at KSU's Hays Agricultural Research Station, says he's viewed Palmer amaranth plants flowering when just two inches tall. He's also seen plants of this weed species growing to a seven- or eight-foot height.

Obviously aggressive, Palmer amaranth can be a serious competitor for sunflower, and numerous High Plains growers can attest to its impact on seed yields. In one trial where Stahlman compared hand-weeded plots to others with heavy Palmer amaranth pressure, this weed's presence slashed sunflower seed yields by 54%.

Palmer amaranth also threatens a crop like sunflower because it germinates over an extended period of time. "Even in midsummer, if conditions are right," Stahlman observes. It thus can be an issue for double-cropped sunflower fields as well as full-season ones, although the weed pressure typically is lower in second-crop 'flowers.

What are the sunflower grower's best options for controlling this increasingly prolific weed?

The program should begin in the rotation's preceding crops. "We probably have the best success following a Roundup Ready® crop, simply because of the effectiveness of the [glyphosate] in that crop," Stahlman says. If following wheat, as do a lot of Kansas 'flowers, a fall burndown with glyphosate or another product will set the stage for good control in the next year's sunflower.

In-season control of Palmer amaranth can be achieved with Beyond® or Express® if the sunflower hybrid being grown is a Clearfield® or ExpressSun® variety. If, however, the Palmer amaranth population should have ALS resistance (as is the case in a number of fields throughout Kansas), these products will not do the job. Beyond will have more residual control than Express, the KSU weed scientist adds — something to consider, given Palmer amaranth's long germination window.

As for the available preplant or preemerge herbicides, Spartan® is most consistent in performance and provides the best degree of control of Palmer amaranth, Stahlman observes. Dual® and Prowl® will provide partial control under the right conditions, but don't have the residual effect that Spartan does, he remarks. "Spartan is probably our preferred broadleaf weed control herbicide," Stahlman says. "But some growers are still using quite a bit of Prowl, and some are using Dual. It depends on the weed spectrum they're anticipating.

"We do need to stay on top of Palmer amaranth in sunflower, because it is such a highly competitive weed," emphasizes the Kansas weed scientist.

— Don Lilleboe ■

Other Soil-Incorporated Herbicides Still Needed

The advent of no-till and conservation tillage greatly changed herbicide use in sunflower. Prior to the first Spartan (Sulfentrazone) label in 1999, farmers were voicing the need for herbicides that did not require mechanical incorporation for activiation. Prowl (Pendimethalin) was the only choice at that time. However, it had limitations as a 'stand alone' herbicide, unable to control all of the broadleaf and grassy weeds that growers encountered. The need for mechanical soil incorporation reduced soil moisture in the critical top two inches.

Treflan (Trifluralin) and Sonalan (Ethalfuralin) were two common soil-applied herbicides prior to Spartan. Both need shallow incorporation. Eptam (EPTC) is another similar product requiring incorporation that controls most grasses and some broadleaf weeds.

As sunflower moved further west along the U.S. Highway 83 corridor from Canada to Texas, these herbicides no longer fit the need to conserve moisture via reduced or zero tillage. Producers in this low rainfall area could not tolerate drying out the top soil layer.

Dual Magnum® (S-metolachlor) was labeled on sunflower in 2004. It provides more flexibility since it does not need to be mechanically incorporated to be activated. However, the product does need rainfall or irrigation for incorporation — and tillage incorporation improves consistency of control. Dual's limitation in the northern states is the lack of control of wild mustard and wild oat.

Rates for these soil-applied products relate to soil texture. For Dual Magnum, rates are generally higher on fine-textured soils with a high organic matter, while some other herbicides require a lower rate on light soils.

These products continue to serve important markets in areas where conventional tillage predominates. They also have value as tank mixes. Richard Zollinger, NDSU extension weed specialist, likes Prowl in a Spartan tank mix. He finds that Prowl gives better season-long weed control compared to the other soil-incorporated products. He also finds that Dual does not perform as well in some of the northern areas due to high organic matter and fine-textured soils.

However, Dual tends to fit better in the High Plains. Phil Stahlman, Kansas State University weed scientist at Hays, recommends Dual as a tank mix with Spartan in his area. He finds better residual with Dual, and says a second benefit may be enhanced control of some of the difficult broadleaf weeds like Palmer amaranth. That, however, depends on a good rain event for incorporation.

Stahlman says the soil-incorporated herbicides other than Spartan have limitations for broadleaves. "These products are for grassy weed control. Using one of these products in combination with Spartan becomes an economic issue for the grower." Stahlman likes the added grass control that either Dual or Prowl provide in no-till or reduced tillage in combination with Spartan. He does not see much use of postemerge grass products in central Kansas sunflower since growers tend to expect the sunflower plant's aggressive growth to compete well with grassy weeds.

That may not be the case in the northern states where cool soil and air temperatures can delay early sunflower growth. Central North Dakota producer Tim DeKrey does not use either Dual or Prowl with his Spartan. He uses Spartan Advance right after he plants (handling grasses at that time), then follows up with a postemerge grass herbicide.

So what's the future of these soil incorporated herbicides? The simple answer is that they are important weed control tools for sunflower in a toolbox that is pretty thin to begin with. There are very few new developments in herbicides these days, with glyphosate dominating the weed control market. Sunflower growers want to hang on to every herbicide they have — and that includes the older soil-incorporated ones. **— Larry Kleingartner** ■

What's Available for '10

Listing of Herbicides Currently Labeled for Use in Sunflower

The following listing of herbicides and use recommendations comes from the *2010 Chemical Weed Control Guide* published by the Kansas State University Agricultural Experiment Station and Cooperative Extension Service.

Similar guides are published by universities in other major sunflower-producing states. While most of the information provided here would be applicable to other states as well as Kansas, growers in those states are encouraged to consult their own university's 2010 sunflower weed control information. Relevant websites for North Dakota, South Dakota, Nebraska — and Kansas — include:

- *North Dakota:* www.ndsu.edu/weeds/
- *South Dakota:* http://agbiopubs.sdstate.edu/pub_description.cfm?Item=FS525OS
- *Nebraska:* http://cropwatch.unl.edu/web/weed/home
- *Kansas:* www.agronomy.ksu.edu/extension/

The website of the National Sunflower Association also contains significant information on weed issues and control in sunflower. Go to www.sunflowernsa.com. Click on "Growers," then "Weeds."

As always, "the label is the law." Read and follow label directions when using any of these products.

Herbicide & Lbs/Ac Active Ingredient Needed	Formulated Product/Ac*	Comments / Limitations
	**Products often are available in several formulations or brand names, and label information may vary.*	
— Burndown, Preplant and/or Preemergence —		
EPTC 2 to 3	2.5 to 3.5 pt **Eptam 7E** or 10 to15 lbs **Eptam 20G**	Controls many grasses and certain broadleaf weeds. Apply just before planting and incorporate immediately. Use the low rate on light-textured soils.
Ethalfluralin 0.56 to 1.125	1.5 to 3 pt **Sonalan**	Controls grasses more effectively than broadleaf weeds. Apply before planting and incorporate within 48 hours. Can control shattercane. Follow label directions.
Glyphosate 0.38 to 0.75 lb/ac	1 to 2 pt of 3 lb ae/gal **Glyphosate**	Apply to control emerged weeds before or after sunflower planting but before crop emergence. Glyphosate products differ in concentration and adjuvant requirements. Refer to specific product labels for rate and adjuvant recommendations. Condition spray solution with 1 to 2% spray-grade ammonium sulfate by weight (8.5 to 17 lb/100 gal water) before adding glyphosate to the tank. Follow label directions.
S-metolachlor 0.95 to 1.91	1 to 2 pt **Dual Magnum** or **Charger Basic**	Controls grasses and some small-seeded broadleaf weeds pre-emergence. Can be applied from 30 days before planting to crop emergence. Can be incorporated shallowly, but deep incorporation or excessive soil disturbance at planting may result in poor weed control. Use lower rates on coarse soils with low organic matter and the higher rates on fine-textured soils with higher organic matter. Do not allow livestock to graze or feed in treated area.
Paraquat 0.63 to 1.0	2.5 to 4 pt **Gramoxone Inteon**	A restricted-use pesticide. Apply before crop emergence for control of emerged weeds. Paraquat is a contact herbicide and does not have soil activity. Always apply with a nonionic surfactant to 0.5% v/v.
Pendimethalin 0.5 to 1.5	1.2 to 3.6 pt **Pendimethalin 3.3*** or 1.5 to 3 pt **Prowl H_20**	Controls grass weeds more effectively than broadleaves. Pendimethalin can be applied from 60 days before planting until crop emergence. Incorporation generally improves weed control in conventional tillage systems. Extremely cool, wet weather following application and sunflower planting can result in problems with sunflower emergence and injury. Do not feed forage or allow livestock to graze in treated fields. Follow label directions. *(Con't)*

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Sulfentrazone 0.094 to 0.25	3 to 8 oz **Spartan 4F**	Apply in the fall, preplant or pre-emergence to sunflower for control of pigweeds, kochia, Russian thistle and certain other broadleaf weeds. The lower rates are for coarse-textured soils with low organic matter, and the higher rates are needed on fine-textured soils with higher organic matter content. Preplant treatments 14 days or more before planting have generally provided better weed control and crop tolerance than pre-emergence applications at planting time. Follow label directions.
Sulfentrazone + Carfentrazone 0.07 to 0.21 + 0.008 to 0.023	3 to 8.5 oz **Spartan Charge**	Apply in the fall, preplant or pre-emergence to sunflower for burndown and residual control of pigweeds, kochia and other broadleaf weeds. The lower rates are for coarse-textured soils with low organic matter, and the higher rates are needed on fine-textured soils with higher organic matter content. May be tank mixed with glyphosate for improved grass burndown activity.
Sulfentrazone + Glyphosate 0.09 to 0.16 + 0.49 to 0.84	21 to 36 oz **Spartan Advance**	Apply in the fall, preplant or pre-emergence to sunflower for burndown and residual control of pigweeds, kochia and other weeds. The lower rates are for coarse-textured soils with low organic matter, and the higher rates are needed on fine-textured soils with higher organic matter content. Supplemental glyphosate is recommended for adequate weed control with the lower Spartan Advance application rates.
Trifluralin 0.5 to 1	1 to 2 pt **Trifluralin 4E***	Controls grasses more effectively than broadleaf weeds. Apply before planting and incorporate within 24 hours. Can control shattercane. Follow label.
	— Postemergence —	
Clethodim 0.07 to 0.25	6 to 16 oz **Select**, **Arrow** or **Volunteer**, or 9 to 16 oz **Select Max**	Controls annual and perennial grasses. Apply when grasses are actively growing but before they exceed size limits listed on the label. Apply Select and comparable products with crop oil concentrate at 1% v/v. Apply Select Max with nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v plus ammonium sulfate at 2.5 to 4 lbs/ac. Weed control is reduced if applied when grasses are under drought stress. Do not apply within 70 days of harvest. Do not allow grazing or use treated plants for feed or forage.
Imazamox 0.031	4 oz **Beyond**	Apply to Clearfield sunflower only. Beyond will severely injure or kill non-Clearfield sunflower. Can be applied from the V2 through the V8 stage of sunflower for control of susceptible broadleaf weeds before they exceed 3 inches, and susceptible grasses before they exceed the 4- to 5-leaf stage. Apply with nonionic surfactant and nitrogen fertilizer additives. May not control ALS-resistant kochia, pigweed or shattercane biotypes. Temporary yellowing of sunflower plants may occur shortly after application of Beyond, especially when applied to crops growing under environmental stress. Do not plant corn, sorghum, cotton or non-Clearfield sunflower within 9 months of Beyond application.
Quizalofop 0.03 to 0.075	5 to 12 oz **Assure II** or **Targa**	Controls many annual and perennial grasses, including shattercane, volunteer corn and volunteer wheat. Apply with 1% v/v crop oil concentrate or 0.25% v/v nonionic surfactant. Weed control is reduced if applied when weeds are under drought stress. Do not graze or feed forage, hay or straw from treated areas to livestock. Do not apply within 60 days of sunflower harvest.
Sethoxydim 0.1 to 0.28	1 to 2 pt **Poast**	Controls annual and perennial grasses. Apply when grasses are growing actively but before they reach size limits listed on the label. Apply to annual grasses up to 8 inches, volunteer corn up to 20 inches, shattercane from 6 to 18 inches, volunteer wheat before tillering, and rhizome johnsongrass from 15 to 25 inches tall. Higher rates are recommended in the western third of Kansas than in the eastern part of the state. Always apply with crop oil concentrate or Dash. Weed control is reduced if applied when grasses are under drought stress. Do not apply within 70 days of harvest. Do not use treated plants for feed or forage. Follow label directions and precautions.
Tribenuron 0.0078 to 0.0156	0.25 to 0.5 oz **Express TS**	Apply to ExpressSun sunflower only. Express will severely injure or kill non-ExpressSun sunflower. Can be applied between the 1-leaf and the beginning of bud stage of sunflower growth for control of small, actively growing broadleaf weeds. Apply with methylated seed oil at 1% v/v. May not control ALS-resistant biotypes of kochia or pigweed. Temporary yellowing of

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sunflower plants may occur shortly after application of Express — especially when applied to crops growing under environmental stress. Do not apply within 70 days of sunflower harvest. Do not feed forage from treated areas or allow livestock grazing within 7 days of application. Allow 30 days between application and feeding hay from treated areas to livestock.

— Harvest Aids —

Glyphosate 0.75 lb ae	22 oz **Roundup WeatherMax**, **Roundup Original Max** or **Roundup PowerMax**	Apply by ground or aerial equipment to control annual and perennial weeds and help facilitate harvest. Apply when sunflower seeds reach physiological maturity (when seed moisture is 35% or less). For many sunflower varieties, this stage is when the backs of heads are yellow and bracts are turning brown. Allow a minimum of 7 days between treatment and harvest for livestock feeding.
Paraquat 0.3 to 0.5	1.2 to 2 pt **Gramoxone Inteon**	A restricted-use pesticide. Always apply with nonionic surfactant. Apply with ground or aerial equipment 7 to 21 days before harvest to desiccate sunflower plants, broadleaf weeds and grasses. Apply when sunflower seeds reach physiological maturity (when seed moisture is 35% or less). For many varieties, this stage is when backs of heads are yellow and bracts are turning brown. Do not allow grazing of treated areas or feed treated forage.
Saflufenacil 0.022 to 0.044	1 to 2 oz **Sharpen**	Apply by ground or aerial equipment to desiccate sunflower in order to facilitate earlier harvest. Apply when sunflower reaches physiological maturity (when seed moisture is less than 35%). For many sunflower varieties, this stage is when the backs of heads are yellow and bracts are turning brown. Apply with 1% v/v methylated seed oil plus 1.25 to 2.5% v/v liquid urea ammonium nitrate fertilizer or ammonium sulfate at 8.5 to 17 lbs/100 gal of spray solution. Allow a minimum of 7 days between treatment and sunflower harvest. Do not apply on sunflower grown for seed production.
Sodium chlorate 6	1 gal **Defol 6**	Apply by ground or aerial equipment to facilitate harvest and reduce moisture in mature seed heads. Apply 7 or more days before harvest when seed heads are fully mature. Do not allow grazing of treated fields or feed treated forage. ■

Avoiding Crop Injury When Using 'Assert' for Mustard

Numerous producers have applied the postemergent herbicide Assert® to control infestations of wild mustard in their sunflower. And it works. Grower experience and university studies through the years have confirmed the effectiveness of Assert on mustard when applied at the proper stage of sunflower growth and under the right environmental conditions.

Below: Symptoms of Assert injury to a young sunflower plant.

Photo: Rich Zollinger / NDSU

For growers using a Clearfield or ExpressSun variety, Beyond and Express will do a good job of controlling wild mustard. With non-herbicide-tolerant varieties, however, the only option other than Assert is Spartan — and Spartan only suppresses mustard (40-50% control, according to NDSU).

While Assert is an important component of the sunflower herbicide arsenal, use of this product also carries risk of serious crop injury — particularly if applied under high temperature and high humidity. Variety, growth stage, weather conditions, humidity, spray volume and additives all can influence the herbicide's safety for sunflower. Damage can range from plant stunting to head deformation.

North Dakota State University advises applying Assert only when air temperature (Fahrenheit) *plus* relative humidity totals less than 150. NDSU also cautions against using Assert on sunflower that is under drought or heat stress.

Recent years' research by Brian Jenks, weed scientist with the NDSU North Central Research Extension Center at Minot, has investigated several facets of sunflower crop injury and yield after treatment with this herbicide. In 2009 specifically, Jenks looked at Assert when applied with NIS, compared to a tank mix with a grass herbicide (Select®) and oil adjuvant (MSO); at the influence of an early application (four- to six-leaf stage) versus a late one (10-leaf stage); and at the effect of spray boom height above the sunflower canopy. Study results can be viewed at www.ag.ndsu.edu/NorthCentralREC/weed-science-research. ■