

Weeds

(Richard Zollinger)

Weeds compete with sunflower, causing poor growth and yield losses. Yield loss from weed competition depends on weed species, time of infestation, weed density and climatic conditions. All weeds are competitors. However, in the northern region of the U.S., wild mustard, wild oats and kochia, which grow rapidly early in the season, appear more competitive than foxtail on a per-plant basis.

A comprehensive weed management program consisting of cultural and/or chemical controls is needed to maximize yields. Sunflower is a good competitor with weeds. However, this competitive advantage occurs only after plants are well-established. The first four weeks after emergence are most critical in determining weed competition damage, so early weed control is essential. Weeds competing longer than four weeks cause important yield loss even if they are removed. All chemical recommendations for weed control have a U.S. federal label unless otherwise specified. All recommended herbicides have federal registration at the time of printing, and rates listed are label rates at time of printing. Consult the current issue of NDSU Extension publication W-253, "North Dakota Weed Control Guide," or appropriate Extension publications from other states for current labeled products, rates and method of application.

WILD MUSTARD (*Sinapis arvensis*) is a major weed that infests sunflower. Wild mustard is not controlled by most of the herbicides commonly used in sunflower. Wild mustard emerges early and appears to be most competitive with sunflower when the early season is cool. The cool condition favors wild mustard, but not sunflower growth. Late seeding with seedbed tillage to control early emerged wild mustard can reduce infestations. However, wild mustard may continue to emerge with timely rains and remain a problem even with late seeding. Assert (imazamethabenz) is the only herbicide registered for use in conventional sunflower to control wild mustard. Wild mustard can be controlled easily in Clearfield sunflower with Beyond (imazamox) and in Express-resistant sunflower with

Express (tribenuron). Wild mustard is controlled effectively by herbicides used in other crops in the rotation. Wild mustard seed can remain viable in the soil for many years, so plants allowed to produce seed can cause an infestation for many subsequent years.

WILD OAT (*Avena fatua*) is another cool-season weed that is abundant in North Dakota and causes important yield losses, especially in early seeded sunflower. Wild oat germinates early in the spring, and germination and emergence generally stop when soil becomes warm. Delayed seeding reduces wild oat infestations. Wild oat can infest late-seeded sunflower when cool and moist conditions occur at or after seeding. Wild oat is controlled to various degrees by several registered herbicides (Table 12).

GREEN FOXTAIL (*Setaria viridis*) and **YELLOW FOXTAIL** (*Setaria lutescens*) are the most abundant grassy weeds in North Dakota. Both green and yellow foxtail occur throughout the state. Green foxtail has been more abundant, but yellow foxtail is the dominant species in many areas because herbicides giving less control of yellow foxtail have been used in crops. The two species have similar appearance, but yellow foxtail has a flat stem with long hairs at the base of the leaves, a more brushlike spike and a larger seed. Green foxtail has a round stem with no hair on the leaves. Foxtail is a warm-season plant, and germination and emergence do not occur until the soil reaches 60 degrees Fahrenheit. Many sunflower herbicides give excellent control of foxtail species (Table 12).

KOCHIA (*Kochia scoparia*) is considered the worst weed problem of sunflower in North Dakota. Kochia is a highly competitive weed that emerges during cool periods early in the spring or later with warm temperatures and adequate moisture. Most kochia has become resistant to ALS (acetolactate synthase) herbicides and no registered herbicides in sunflower give adequate control. Beyond herbicide in Clearfield sunflower is an ALS herbicide and will not control ALS-resistant kochia. Soil-applied Spartan (sulfentrazone) controls ALS-resistant and susceptible kochia when activated by sufficient moisture after application. Kochia seeds do not have a long residual life in the soil. Good control of kochia in the crop prior to sunflower emergence or control before seeding will reduce the kochia infestation.

RUSSIAN THISTLE (*Salsola iberia*) is most common in the drier western areas of North Dakota. Russian thistle germinates throughout the season. Germination is rapid, so light rains anytime will promote a new flush of Russian thistle growth. Competition data on losses from Russian thistle in sunflower are not available. The plants are normally small and competition usually is not expected. However, Russian thistle is drought tolerant and losses may be severe, even from a small number of plants under conditions of limited moisture.

OTHER WEEDS important in sunflower are wild buckwheat (*Polygonum convolvulus*), redroot pigweed (*Amaranthus retroflexus*), common lambsquarters (*Chenopodium album*), field bindweed (*Convolvulus arvensis*), Canada thistle (*Cirsium arvense*), cocklebur (*Xanthium strumarium*), marshelder (*Iva xanthifolia*), biennial wormwood (*Artemisia biennis*), nightshades (*Solanum spp.*) and wild sunflower. Some of these weeds are controlled partially by soil-applied trifluralin or Sonalan (ethalfluralin), but these products cannot be used in no-till sunflower production because of

Table 12. Relative effectiveness of herbicides for various weeds.

Herbicide	Green/yellow foxtail	Wild oat	Wild buckwheat	Comm. cockle bur	Kochia	Comm. lambsquarters	Marshelder	Wild mustard	Nightshade spp.	R. root pigweed	Russian thistle	Bien. wormwood	Canada thistle
Preplant herbicides													
Glyphosate	E	E	F-G	E	F-E	P-E	G-E	E	F-G	E	G-E	G-E	G-E
Paraquat	G	G	F	F-G	G-E	E	G	E	G-E	E	E	-	P
Soil-applied herbicides													
Eptam (EPTC)	E	G-E	F	P	F	F	N	P	F	G	P	N	N
Prowl (pendimethalin)	G-E	P	P	N	F	G	N	N	N	G	F-G	N	N
Sonalan (ethalfluralin)	E	P-F	P-F	N	F	E	N	N	P	G-E	G-E	N	N
Dual Magnum (s-metolachlor)	G-E	P	P	N	P	P-F	N	P	P	F-G	P	N	N
Spartan (sulfentrazone)	P	N	P-F	N	E	E	P-G	P-F	E	E	G-E	G-E	N
Trifluralin	E	P	P	N	F	G	N	N	N	F-G	F-G	N	N
POST-applied herbicides													
Assert (imazamethabenz)	P	G-E	F-G	P	N	P	N	E	N	P	P-F	N	N
Beyond* (imazamox)	E	E	P	G-E	E1	F	G-E	E	E	E	G-E	P	N
Poast (sethoxydim)	E	G-E1	N	N	N	N	N	N	N	N	N	N	N
Select (clethodim)	E	E	N	N	N	N	N	N	N	N	N	N	N

* = Clearfield sunflower.

1 = Herbicides will not control resistant biotypes.

E = Excellent, G = Good, F = Fair, P = Poor and N = None.

The ratings in the table indicate relative effectiveness, with effectiveness of each herbicide varying with environment and method of application.

their soil incorporation requirement. Pre-emergence Spartan controls most small-seeded broadleaf weeds and suppresses wild buckwheat, marshelder and foxtail. However, no herbicides are available for selective control of wild buckwheat, Canada thistle, field bindweed, cocklebur, marshelder or wild sunflower. Beyond in Clearfield sunflower controls most annual grass and broadleaf weeds except ALS-resistant weeds, including kochia, but has no activity on perennial broadleaf weeds. Weeds for which no herbicides are available need to be controlled in previous crops in rotation, or through tillage or the use of herbicides in or between other crops in the rotation.

The sunflower yield loss from individual weeds varies with the weed species, environment and time of weed emergence relative to the crop. Sunflower yield losses from several weeds at various infestations are presented in Figure 99. The values are averages from several years and losses from an individual weed would vary with conditions. A weed that emerges before the sunflower would be more competitive than one emerging after sunflower establishment, and an environment that favored the growth of the weed would cause a greater loss than if the environment favored the sunflower.

■ Weed Management

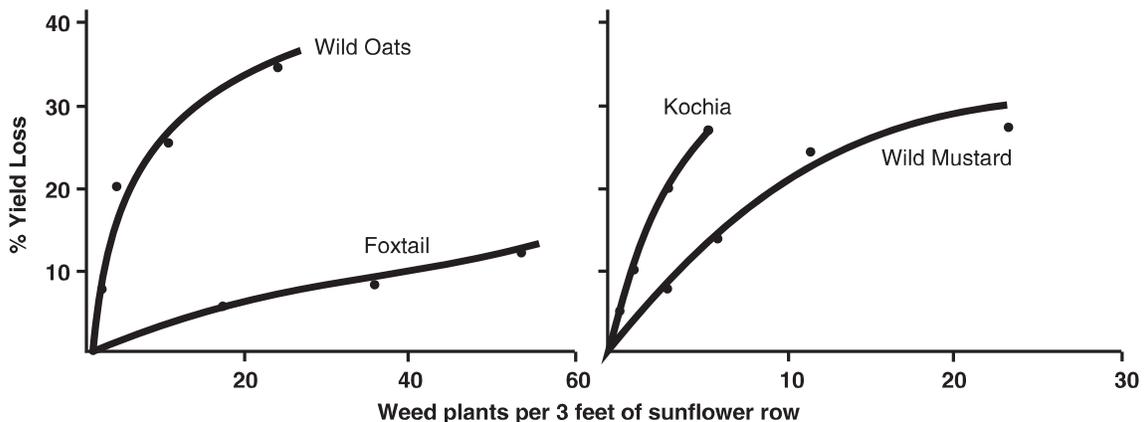
(Richard Zollinger)

Cultural

Cultural weed control requires an integrated system of tillage operations. Weeds must be controlled in other crops in the rotation to reduce the potential infestation level in sunflower. Preplant, pre-emergence and postemergence tillage practices all must be followed for effective weed control using only tillage. Poor timing or missing any tillage operation can reduce the effectiveness of the cultural weed control program drastically.

Preplant tillage can control one or more weed flushes. Sunflower should be planted immediately after the last tillage operation so the crop can germinate rapidly and compete more favorably. Weeds frequently emerge before sunflower, especially during cool weather. These weeds can be controlled by pre-emergence harrowing.

Postemergence mechanical weed control consists of harrowing and cultivating. Small weeds can be controlled by harrowing after the sunflower is in the four- to six-leaf stage (V-4 to V-6) and can resist burial and breaking (Figure 100). Postemergence harrowing should be done across rows and preferably on a warm, clear day to assure sufficient weed kill with the least damage to the sunflower. Sunflower seedlings, which are strongly rooted, can be harrowed three to five times during the four- to six-leaf stage (V-4 to V-6). The harrow should be kept free of trash. Spring tooth harrows are recommended; solid spike-tooth harrows should not be used, as excessive damage may result.



■ Figure 99. Percent reduction in sunflower seed yield from several weeds. (J.D. Nalewaja)



■ **Figure 100.** This field was harrowed before sunflower emergence and was being harrowed at about the four leaf stage to control seedling weeds. (GTA-Farmers Union)

The direction of travel during harrowing is determined by considering the stand, weed growth and herbicide treatment. Harrowing diagonally to the rows will give better in-the-row weed control than with the row harrowing. However, sunflower damage will occur from the tractor wheels with diagonal harrowing. Harrowing may be necessary if a soil-applied herbicide was not activated by rainfall, if a field previously treated with a herbicide has weeds resistant to the herbicide or if adverse climatic conditions reduce herbicide effectiveness. If the herbicide is band-applied, harrowing should be parallel to the rows to prevent dilution with untreated soil. A rotary hoe also is effective for postemergence weed control, but weeds must be just emerging for good control. Setting the harrow or “weighting” the rotary hoe to do the most damage to weeds and the least damage to sunflower can be accomplished on a “try-and-adjust” system. Postemergence harrowing will kill some sunflower (5 percent to 8 percent loss can be expected), so if this system of weed control is planned, the sunflower should be seeded at higher rates than normal.

After postemergence harrowing, weed control for the remainder of the season depends on the row-crop cultivator. During the first cultivation, producers must take care not to cover the sunflower. One to three or more cultivations may be necessary, depending on the weed situation in the field. Lateral sunflower roots

are shallow and can be damaged easily by cultivating too deeply and too closely to the plants. Cultivation should be no closer to the row center than the leaf spread of the plants. During later cultivations, soil may be thrown into the row to bury weed seedlings and provide the sunflower extra support.

Registration of Spartan and Clearfield sunflower will allow and encourage no-till sunflower production. No-till farming increases dependence on chemicals and increases selection pressure for resistant weeds.

Chemical

The most effective weed management is accomplished by an integrated system that uses both cultural and chemical control. Preplant cultural practices to reduce weed seed populations, pre-emergence tillage and postemergence cultivation may be needed to supplement the herbicides under adverse climatic conditions and to control late-emerging weeds or weeds that are not controlled by herbicides. Herbicides vary in their effectiveness against various weeds (Table 12).

Preplant and Pre-emergence

GLYPHOSATE at 1 to 2 pt/A of 3 lb/gal concentrate (0.38 to 0.75 lb ai/A) is registered for the control of emerged weed seedlings before, during or after planting but before the crop emerges. Glyphosate is a nonselective, systemic, nonresidual herbicide, so treatment must be made before sunflower emergence and after weeds emerge. Several formulations are available, so follow label directions for rates, weed sizes, application volume and addition of nonionic surfactant.

PARAQUAT at 2.5 to 4 pt/A (0.63 to 1 lb ai/A) is registered for the control of emerged weed seedlings before, during or after planting but before the crop emerges. Paraquat is a nonselective contact herbicide, so treatment must be before sunflower emergence. However, application must be after weed emergence, as paraquat has no soil residual to control late-emerging weeds. A nonionic surfactant at 0.25 percent v/v should be added to the spray solution to increase spray droplet contact with the leaf surface and retention by the leaf. Spray should be applied at 20 gallons per acre by ground equipment or 5 gallons per acre by air. Paraquat is a restricted-use herbicide.

EPTAM (EPTC) at 2.5 to 3.5 pt/A (2 to 3 lb ai/A) applied before planting or at 4.5 to 5.25 pt/A or 20 to 22.55 lb 10G per acre applied after Oct. 15 controls some annual grass and broadleaf weed species. Eptam is degraded within three weeks after application. The 3 pound- per-acre rate spring applied occasionally has caused sunflower injury on coarse-textured, low organic matter soils. The risk of sunflower injury can be reduced by using lower rates on these soils. Immediate and thorough incorporation is essential, as the herbicide is volatile. A 15-minute delay in incorporation during warm weather with moist soil may result in significant vapor loss and poor weed control. Proper incorporation can be accomplished by tandem disking twice in cross directions (4 to 6 inches deep) or by any other method that thoroughly mixes the chemical within the top 3 inches of soil. Eptam generally gives good short-term weed control but is weak on wild mustard, Russian thistle, common cocklebur, smartweed and all perennial broadleaf weeds. Wild oat control is good.

PROWL or PROWL H20 (pendimethalin) at 2.4 to 3.6 pt/A EC, 2.1 to 3 pt/A ACS preplant incorporated or pre-emergence in no-till sunflower is registered for control of most grass and certain broadleaf weeds in sunflower. Prowl can be applied in the fall at 2.4 to 4.25 pt/A and incorporated when soil temperature is less than 45 degrees. Prowl is registered only as an incorporated treatment for conventionally tilled sunflower because of greater consistency of weed control and greater crop safety. Prowl plus Spartan controls many grass and broadleaf weeds in no-till sunflower. No-till sunflower is treated with higher rates of Prowl than conventionally tilled sunflower. The higher rates help overcome the reduced control from pre-emergence vs. PPI treatment and from Prowl being absorbed on the crop residue. Prowl is registered at 2.4 pt/A in no-till sunflower for coarse-textured soils with less than 3 percent organic matter and 3.6 pt/A for all other soils, including coarse-textured soils with greater than 3 percent organic matter.

Prowl may be applied up to 30 days before seeding no-till sunflower. Spray volume greater than 20 gallons per acre should be used to aid penetration to the soil in fields with high amounts of crop residue. Prowl does not control emerged weeds, so either glyphosate or paraquat would be needed to control emerged

weeds in no-till sunflower prior to planting. Prowl has state registration for no-till sunflower in North Dakota, South Dakota and Minnesota.

SONALAN (ethalfuralin) at 1.5 to 3 pt/A (0.55 to 1.15 lb ai/A) preplant incorporated in the spring is registered for the control of annual grass and some small-seeded broadleaf weeds in sunflower. The granular formulation (Sonalan 10G) can be applied in the spring or fall between Oct. 10 and Dec. 31 at 5.5 to 11.5 lb 10G/A. Sonalan does not control wild mustard. The first incorporation into the soil may be delayed no longer than two days after application. The second incorporation should be delayed three to five days after the first. Sonalan has a shorter soil residual than trifluralin and is slightly more effective in controlling wild oats, Russian thistle and a few other broadleaf weeds. Sonalan is registered for tank mixtures with Eptam.

Recent labeling allows use of Sonalan in reduced-tillage systems for suppression of foxtail species. Sonalan 10G may be applied at 7.5 to 12.5 pounds per acre in the fall to small-grain stubble and incorporated once in the fall and once in the spring with a V-blade prior to planting sunflower. Sonalan 10G may be applied in the spring and incorporated twice using a V-blade. For spring applications, a delay of at least three weeks between incorporations should be observed unless a minimum of 0.5 inch of precipitation occurs after the first incorporation. The delay then may be shortened to 10 days. The incorporations should be made at approximately 5 mph using a V-blade implement with 12- to 32-inch-wide sweeps. Both incorporations should be no deeper than 2 to 2.5 inches.

DUAL MAGNUM (s-metolachlor) at 1 to 2 pt/A (0.95 to 1.9) preplant incorporated or preplant will control green foxtail and several other weeds, such as pigweed and lambsquarters. It will not control wild mustard or wild oats. Incorporation improves weed control and consistency of control. It requires soil moisture for activation and better weed management. Use higher rates for clay soils high in organic matter.

SPARTAN (sulfentrazone) at 3 to 8 fl oz F (1.5 to 4 oz ai/A) applied pre-emergence controls most annual small-seeded broadleaf weeds, such as kochia, pigweed species, lambsquarters, nightshade, smartweed, Russian thistle and biennial wormwood, and may suppress buckwheat, mustard, ragweed and Russian thistle. Spartan may provide some grass but no peren-

nial weed control. Adjust rate based on organic matter and use higher rates if applied up to 30 days prior to planting. Sunflower has good tolerance to Spartan on medium to fine-textured soils with organic matter above 3 percent. Crop injury may occur on soils with low organic matter and soil pH greater than 8.0, especially on calcareous outcropping. Do not use on coarse-textured soils with less than 1 percent organic matter. Closely furrow at planting to avoid injury. Poor growing conditions at and following sunflower emergence, cold temperatures, soil compaction or a rate too high based on soil type and organic matter may result in sunflower injury. Consistent weed control greatly depends on at least 0.75 inch rainfall shortly after application and before weeds emerge. Spartan is a PPO inhibitor mode-of-action herbicide in which no weed resistance has been documented.

TRIFLURALIN at 1 to 2 pt/A or 5 to 10 lb 10G/A (0.5 to 1 lb ai/A) is a preplant incorporated herbicide for grass and certain broadleaf weed control in sunflower. Incorporation should be by tandem disk or field cultivator twice in cross directions (4 to 6 inches deep) at about 6 mph. Thorough incorporation is essential for optimum, consistent weed control. Trifluralin is less volatile than EPTC (Eptam). Immediate soil incorporation is preferred, but with cold, dry soil and low wind, incorporation may be delayed up to 24 hours. The lower rate should be used on soils of coarse texture and low organic matter. Trifluralin gives seasonlong control of some annual grass and broadleaf weeds. Wild mustard is not controlled, and wild oat control is poor.

Postemergence

ASSERT (imazamethabenz) at 0.6 to 0.8 pt/A (0.19 to 0.25 lb ai/A) controls wild mustard in sunflower. Assert should be applied before sunflower exceeds 15 inches in height. Wild mustard should be in the rosette stage but prior to bloom. Sunflower injury may occur from Assert if applied during high temperatures and humidity.

POAST (sethoxydim) at 0.5 to 1.5 pt/A (0.1 to 0.3 lb ai/A) applied postemergence in sunflower controls annual grasses and suppresses quackgrass. Oil adjuvant should be included at 1 qt/A. Poast at 0.5 pt/A controls wild proso millet; at 1 pt/A controls volunteer corn, green and yellow foxtail, and barnyardgrass; and at 1.5 pt/A controls wild oats and volunteer cereals.

Quackgrass that is 6 to 8 inches tall can be suppressed with Poast at 1.5 pt/A. Quackgrass regrowth should be treated at 1 pt/A. Cultivation between 14 to 21 days after application will improve quackgrass control. The addition of 2 to 4 quarts per acre of liquid nitrogen solution or 2.5 pounds per acre of ammonium sulfate in addition to the oil adjuvant may increase control of volunteer corn, cereal grains and quackgrass. Sunflower should not be harvested before 70 days after application.

CLETHODIM (several trade names) at 6 to 8 fl oz or SELECT MAX (clethodim) at 9 to 32 fl oz/A (1 to 3.9 oz ai/A) applied postemergence in sunflower controls annual grasses, volunteer cereals and perennial grasses, including quackgrass. See label rates to control individual type of grasses. Oil adjuvant should be included at 1 qt/A. oz/A. Cultivation between 14 and 21 days after application will improve quackgrass control. The addition of 2 to 4 qt/A of liquid nitrogen solution or 2.5 lb/A of ammonium sulfate in addition to the oil adjuvant may increase grass control. Sunflowers should not be harvested before 70 days after application.

■ Herbicide-resistant Sunflower

Clearfield sunflower

BEYOND (imazamox) at 4 fl oz/A (0.5 oz ai/A) applied postemergence to Clearfield sunflower varieties from the two- to eight-leaf stage controls most annual grass and broadleaf weeds. Apply with NIS at 0.25 percent v/v alone or with UAN liquid fertilizer at 1 to 2 qt/A. Beyond will not control wild buckwheat, biennial wormwood, large common lambsquarters, Canada thistle or ALS-resistant weeds, including kochia. Clearfield sunflower can be planted on land previously treated with Assert or Pursuit to reduce or eliminate injury from long residual sulfonylurea herbicides. Clearfield sunflower may facilitate no-till sunflower production.

EXPRESS (tribenuron) at 0.25 to 0.5 oz/A (0.188 to 0.38 oz ai/A) applied postemergence to Express Sun sunflower varieties will control annual broadleaf weeds, including wild mustard. It will not control ALS-resistant weeds, including kochia or grass weeds.

Control or suppression of Canada thistle can be expected at the higher rate. Apply early postemergence to Express-resistant sunflower in the one-leaf stage

but prior to bud formation. Broadleaf weeds should be 3 inches or less in height. Apply with MSO-type oil adjuvants at 1 percent v/v. NIS or petroleum oil adjuvants are not prohibited.

Sequential applications are allowed but observe a 14-day interval between applications and do not exceed 1 oz/A during any growing season. Allow a 70-day preharvest interval. Express Sun application may help facilitate no-till sunflower production.

■ Preharvest Application

GRAMOXONE INTEON (paraquat) at 1.5 to 2 pt/A (0.375 to 0.5 lb ai/A) can be used as a harvest aid in oilseed sunflower. Application should be made when the backside of the sunflower heads is yellow, bracts are turning brown and seed moisture is less than 35 percent. Paraquat can be used on both confectionary and oilseed hybrid cultivars. Apply with a nonionic surfactant at 1 to 2 pints per 100 gallon of water. A seven-day interval must elapse between application and harvest. Paraquat is a restricted-use herbicide.

DREXEL DEFOL (sodium chlorate) at 1 to 2 gal/A (6 to 12 lb ai/A) can be used as a desiccant with both oilseed and confectionary sunflower. Application should be made when the backside of the sunflower heads is yellow, bracts are turning brown and seed moisture is less than 35 percent. Apply at 20 to 30 gallons per acre by ground and 5 to 10 gallons per acre by air.

Roundup Preharvest Application in Sunflower

Monsanto has issued a Supplemental label allowing certain applications of glyphosate (Roundup) for control of annual and perennial weeds in sunflower. Apply no more than a total of 22 fl oz of the 4.5 lb. acid equivalent/gal formulation at preharvest. See label for rates suggested.

For preharvest use in sunflower, apply for weed control, NOT crop desiccation when sunflower plants are physiologically mature. Apply when the backsides of sunflower heads are yellow and bracts are turning brown and seed moisture is less than 35%. Generally the dry chaffy material from the disk flowers on the head can be easily rubbed off by hand and expose the seeds at this stage of maturity. Allow a minimum of 7 day preharvest interval (PHI) for sunflower following application.

For post-harvest weed control, the products may be applied after harvest of sunflower. Higher rates may be required for control of large weeds, which were growing in the crops at the time of harvest. Tank mixtures with 2,4-D or dicamba may be used after harvest.

Always follow the pesticide label when applying any product to sunflower.

■ Control of Volunteer Sunflower in Crops

Crops following sunflower often are infested with volunteer sunflower plants. In small grains, 2,4-D and MCPA at rates of at least 1 pt/A are needed for consistent control. Bromoxynil plus MCPA at 0.5 pt/A + 0.5 pt/A has given excellent, consistent volunteer sunflower control. Dicamba plus MCPA at 4 fl oz/A + 0.5 pt/A has given good control. Several sulfonylurea herbicides plus 2,4-D or MCPA, and Curtail or Curtail M also control sunflower. Sunflower can emerge from deep in the soil, and these late-emerging plants may escape an early herbicide application. However, delaying treatment until all sunflower emerge may result in poor control and some yield loss from competition. Some judgment is needed to determine the proper time for application, and two applications may be needed in some situations.

In corn, preplant Hornet (flumetsulam plus clopyralid), postemergence bromoxynil, Basagran (bentazon), dicamba, Distinct (dicamba + diflufenzopyr), Hornet, Callisto (mesotrione), Permit (halosulfuron), NorthStar (dicamba + primisulfuron) and Option (foramsulfuron) control volunteer sunflower. Volunteer sunflower also can be controlled with glyphosate in Roundup Ready corn.

In soybean, preplant Pursuit Plus (imazethapyr + pendimethalin), Gangster (flumioxazin + clorasulam), postemergence bentazon, Result (bentazon + sethoxydim), FirstRate (clorasulam), Pursuit (imazethapyr), Raptor (imazamox) and glyphosate in Roundup Ready soybean will control volunteer sunflower.

Refer to the herbicide label or the most current edition of the “North Dakota Weed Control Guide,” NDSU Extension publication W-253, for rates, adjuvants and application guidelines.