

Weed Management in Rainfed Cropping Systems

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Weed management recommendations for the four phases of a three-year, summer-fallow cropping system.

Soil water is the most limiting resource to crop production in Nebraska. Much of western Nebraska adopted the summer fallow-winter wheat rotation to deal with this limitation. With herbicides instead of tillage to control weeds, and improved management of crop residue, much of western Nebraska has developed more intensive cropping systems. For example, growing two crops in three years with a winter wheat-corn-fallow rotation. For these more intensive cropping systems to be successful, there can be little tolerance for allowing weeds to use soil water.

There are four phases in a three-year cropping system involving summer fallow (*Figure 1*). The phases are: 1) winter wheat, 2) ecofallow-winter wheat stubble, 3) summer crop (corn, grain sorghum, proso millet, or sunflower), and 4) pre-winter wheat fallow. If adequate moisture is present in the spring after the summer crop, the rotation may be expanded to include a second, third, or even fourth summer crop. Be careful to avoid having all of the land in the same crop because this increases risk.

This rotation can decrease problems with winter annual weeds such as downy brome, jointed goatgrass, or feral rye. It is the least effective option with jointed goatgrass, which has a longer seed life. A single cycle through the rotation usually reduces these weeds but does not eliminate them. This NebGuide discusses weed management in each of these phases.

Weed Control in Winter Wheat (Phase I)

Controlling Broadleaf Winter Annuals in Wheat

Winter annual broadleaf weeds have the same life cycle as winter wheat and compete with the crop through most of its growing season, often causing greater yield losses than summer annual broadleaf weeds. It's estimated that if winter annual weeds are not controlled in a timely way, they can reduce wheat yields by 10 percent.

These weeds include field pennycress, blue mustard, tansy mustard, tumble mustard, and shepherdspurse. Fields should be checked early for these weeds since they are much easier to control when they are small and because the earlier they are controlled, the less impact they will have on crop yields. Once these weeds bolt or the stems elongate — usually

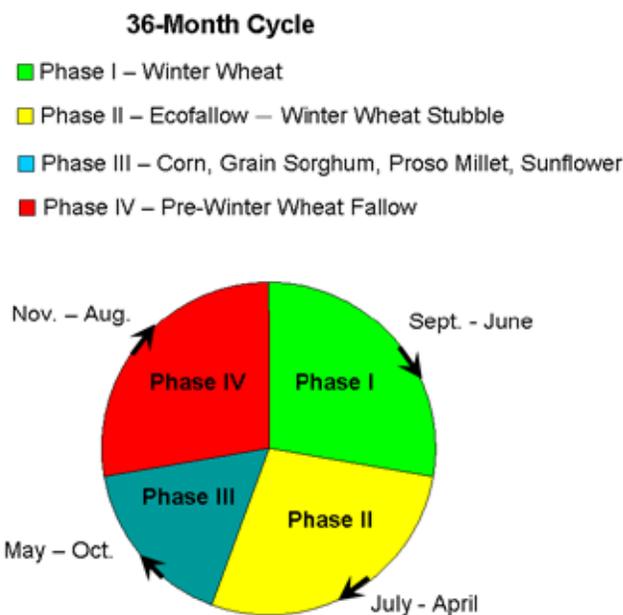


Figure 1. Four phases of a three-year, summer-fallow cropping system.

in late winter or very early spring, depending on weather and location — they are very difficult to control.

Blue mustard is the most difficult winter annual broadleaf weed to control because it bolts early. Applying an appropriate herbicide when the weed is still in the rosette stage provides good control. The most effective treatments have been Ally® (metsulfuron) + 2,4-D; Amber® (triasulfuron) + 2,4-D; Huskie® (pyrasolfotole + bromoxynil) + 2,4-D; Huskie + MCPA; Peak® (prosulfuron) + 2,4-D; and Starane® NXT (fluroxypyr + bromoxynil). Several other treatments are effective when application is timely. Check the latest edition of the UNL *Guide for Weed Management in Nebraska* (EC130), for weed response to postemergence herbicides in winter wheat. It's available at Extension offices and on the web at <http://extension.unl.edu/publications>.

The herbicide 2,4-D provides good control of many winter annual broadleaf weeds if application is timely, but only fair control of blue mustard. Adding a sulfonylurea (S.U.) herbicide improves control of many weeds and may provide residual control. This residual control can help with early emerging summer annuals such as kochia if they are not ALS-resistant. Always check rotation restrictions before selecting a

treatment. Replant options and rotational restrictions are listed in the *Guide for Weed Management in Nebraska* (EC130).

Winter wheat growers need to scout fields in late fall or winter to determine the need to control winter annual broadleaf weeds in late February or early March in the case of blue mustard or in March or early April for other winter annual broadleaf weeds. Once plants begin flowering, it's too late. If timed correctly, 2,4-D (8 oz/acre of LV4 ester or 16 oz/acre of 4 lb/gal amine) provides low-cost and effective control of many weeds. Check that wheat has at least four tillers before application or serious crop injury could result.

If winter annual broadleaf weeds are a regular problem, change the crop rotation and include a spring-seeded crop such as corn, sorghum, soybean, oat, proso millet, or sunflower in the rotation with winter wheat-fallow.

Controlling Summer Annual Broadleaves in Wheat

Survey your wheat fields regularly in the spring for weeds and, if necessary, select the herbicides or herbicide combinations best suited for the situation. Remember to always check replant options and rotation restrictions. Your herbicide selection may affect crop options next year, the following year, or even three or four years later for some products — or as soon as this summer if a storm wipes out the crop.

1. **Identify** problem weed(s).
2. **Spray** when weeds are small and actively growing. Spray at the proper winter wheat growth stage for the herbicide used.
3. **Use** proper spray equipment that is in good condition and not contaminated with previously used herbicides.
4. **Calibrate** the sprayer to ensure application accuracy.
5. **Read and follow** directions on the herbicide label.
6. **Know** your rotational plans to avoid herbicide carry-over problems to sensitive crops.
7. **Be aware** that crop disasters such as winter injury, hail, or disease occur and previously applied residual herbicides may limit recropping options.

Herbicides recommended for broadleaf weed control in winter wheat include Affinity[®] (Broadspec (thifensulfuron + tribenuron) + 2,4-D; Agility[™] SG (dicamba + thifensulfuron + tribenuron + metsulfuron); Aim[®] (carfentrazone) + 2,4-D; Ally XP + 2,4-D; Amber + 2,4-D; Amber + 2,4-D; 2,4-D; Banvel[®]/Clarity[®] (dicamba) + 2,4-D; Curtail[®] (clopyralid + 2,4-D); Finesse[®] (metsulfuron + chlorsulfuron) + 2,4-D; Harmony[®] Extra (thifensulfuron + tribenuron) + 2,4-D; Peak + 2,4-D; Rave[™] (triasulfuron + dicamba); Starane NXT (fluroxypyr); and WideMatch[®] (fluroxy + clopyralid). Some varieties are more sensitive to herbicides than others.

Herbicide combinations are recommended for managing the potential development of herbicide resistance. Ally, Amber, Express, Finesse, Harmony Extra, and Peak are sulfonyleurea herbicides and ALS-AHAS inhibitors. Resistance to ALS-AHAS inhibitors is well documented in weeds such as kochia, Russian thistle, and prickly lettuce.

Summer annual broadleaf weeds include those weeds that appear above the winter wheat canopy before and at harvest. They can make harvest extremely difficult and may necessitate a “harvest aid” treatment. However, the real damage to the crop has already occurred as these weeds compete with the wheat for space, nutrients, soil water, and light.

See the latest *Guide for Weed Management in Nebraska* (EC130) for more information.

Ecofallow or Winter Wheat Stubble (Phase II)

Controlling Weeds in Wheat Post Harvest

The effectiveness of post-harvest weed control is influenced by production practices associated with the previous wheat crop, such as winter wheat variety selection, fertilizer practices, row spacing, planting date, and seeding rate. Other factors influencing weed control include: weed size; cutting off weed tops with the combine; crop rotation; temperature when spraying; rain the day of spraying; streaks caused by sprayers; terraces; dust, straw, and chaff; and weed seed distribution. Less residue from a winter wheat crop also will make the next crop less competitive with weeds. Weeds under stress are very difficult to control. It's a general rule that for wheat grown in a three-year rotation, one can wait a maximum of 30 days after harvest to spray, but if the wheat was planted without an 11- to 14-month fallow period, it should be sprayed within 15 days after harvest. Each field should be examined separately. The key is to prevent weeds from using soil water and producing weed seeds.

Split treatments have a good history of effectiveness. With split treatments, apply the glyphosate product alone (adding surfactant, if needed, plus ammonium sulfate) as the first application in July or early August. Some glyphosate products include sufficient surfactant while many products require it to be added, so check the product label. For all glyphosate brands, add ammonium sulfate (spray grade) at 17 lb per 100 gallons of spray solution. The ammonium sulfate is the first item put into the spray tank after the water. Ammonium sulfate is especially helpful when stress conditions are present. Glyphosate has been formulated as the isopropylamine, trimethylsulfonium, ammonium, and potassium salts. In hard water spray carrier solutions, these counter ions are readily replaced by Ca, Mg, and Fe to form less readily absorbed salts. Adding ammonium sulfate prevents this replacement. Liquid ammonium sulfate, with or without a drift retardant, also is available.

It's difficult to recognize weed stress so it's wise to always add ammonium sulfate. Improve control by increasing the rate of glyphosate, but do not exceed label rates. Allow at least six hours for the glyphosate product to become rainfast — and longer with some weeds. Barnyardgrass may require as much as 24 hours without rain for maximum control. With glyphosate, use a spray volume of 5 to 10 gallons per acre and don't apply on days when temperatures are expected to reach or exceed 95°F.

The second part of the split treatment should be applied in September. It should contain at least 0.55 lb/ac of atrazine and possibly Gramoxone Max (paraquat) and a surfactant, depending on the amount and size of volunteer winter wheat, downy brome, or jointed goatgrass present.

The atrazine rate varies with soil and rainfall patterns. In southwest Nebraska, use at least 2 quarts per acre of atrazine unless the following crops or soil limit the rate to a lower amount. In the Panhandle, 0.5 quart per acre is often the maximum allowed in one season. The advantage of split treatments is that they provide excellent control of volunteer winter wheat and other winter annual grasses.

Control of volunteer wheat is especially helpful in reducing the spread of wheat streak mosaic disease. Using one quart or less of atrazine before September 10 allows winter wheat

to be planted 12 months later in most areas and soils. If sufficient soil water is available the following spring, corn could be planted, or if moisture is limited, the field could be fallowed and winter wheat could be planted in the fall.

It's essential that you watch closely and spray at the proper time to control weeds. Most labels state that weeds must be treated before they are 6 inches tall. If weeds are under severe drought stress, wait for rain and spray about a week later.

Summer Crop (Phase III)

Control any winter annual weeds early (including volunteer winter wheat) to keep them from using soil water, producing seed, and making it difficult to plant and establish the spring crop. A burndown herbicide such as glyphosate may be required. It is usually best to use the glyphosate alone. Combining it with UAN (urea ammonium nitrate) and/or preplant herbicides reduces its efficacy unless the rates of glyphosate are increased.

Some herbicides can be applied up to 28 days before planting and still provide excellent weed control. The advantage of early preplant is that you increase the probability of getting rainfall to activate the herbicide before weed seed germination. If rainfall does not occur, you can apply a burndown herbicide before crop emergence. Adding UAN fertilizer with these early preplant herbicides is an ideal time to apply nitrogen. This increases the odds that the nitrogen will be moved down into the soil profile and be available later in the season when the crop is getting its soil water at 3, 4, or 5 feet. Remember, any nutrient must be in soil solution to be available to the crop.

Corn

With Roundup Ready® corn it is much easier to control problem weeds, such as sandbur, in no-till corn. Roundup Ready corn works especially well with the low population of rainfed corn and such planting practices as skip-row.

The best weed management programs use a preplant or preemergence herbicide treatment followed by a post-emergence herbicide. Glyphosate is an effective post treatment, therefore, with low weed pressure consider using a two-thirds rate of the preplant or preemergence herbicide. With medium and heavy weed pressure it is usually best to use the full rate of these herbicides. Remember, the chemical companies will not stand behind reduced herbicide rates. Also, use a postemergence herbicide to control weeds when they are small. While a delayed treatment may control 100 percent of large weeds, yields will suffer.

Grain Sorghum

Grain sorghum planted in mid-May grows slowly for the first two to three weeks. Many early season weeds including lambsquarters, Pennsylvania smartweed, common sunflower, velvetleaf, and even foxtail grow faster than sorghum. For this reason early sorghum is less competitive with weeds than corn or soybean, emphasizing the need for early weed control.

Effective weed control for the first 30 days will give sorghum a head start on weeds and pay big dividends in sorghum yields. Fortunately, there are several effective preplant and pre-emergence herbicides registered for use in sorghum. It is important to target annual grass weeds with a preplant or pre-emergence treatment as postemergence options are limited.

Essentially all sorghum seed is now treated with a safener required for use of most preplant or pre-emergence herbicides.

Atrazine (the only one of the group not requiring safened seed) provides fair control of many annual grasses and good control of broadleaf weeds except triazine-resistant ones. Bicep II Magnum/Cinch (*S*-metolachlor + atrazine + benoxacor); Bicep Lite II Magnum®/Cinch® ATZ Lite (*S*-metolachlor + atrazine + benoxacor); Bullet®/Lariat® (alachlor + atrazine); Degree Xtra® Herbicide (acetoachlor + atrazine); G-Max Lite™ (dimethenamid-P + atrazine); Guardsman Max® (dimethenamid-P + atrazine); Lexar® (*S*-metolachlor + atrazine + mesotrione); and Lumax® (*S*-metolachlor + mesotrione + atrazine) provide control of most annual grasses and broadleaf weeds. Check on application timing.

Large-seeded broadleaf weeds, including sunflower, cocklebur, velvetleaf, and morningglory, often are not adequately controlled with preplant or pre-emergence treatments and may require a post-emergence treatment. Application rates of these herbicides vary with soil properties. Check the product label or the UNL *Guide for Weed Management in Nebraska* (EC130).

Post-emergence treatments that provide broadleaf weed control include atrazine, Aim (carfentrazone); Banvel/Clarity (dicamba); 2,4-D; Buctril (bromoxynil) plus atrazine; Peak (proflurofen); Permit® (halosulfuron); and Yukon® (halosulfuron + dicamba, sodium). Many of these herbicides can be combined to broaden the spectrum of weeds controlled. Starane Ultra (fluroxypyr) controls many broadleaf weeds including kochia, both the triazine-resistant and ALS-resistant biotypes.

Paramount® (quinclorac) and Paramount plus atrazine provide post-emergence grass control, especially of green foxtail, and broadleaf weed control.

Herbicide application rate, sorghum and weed growth stage, and spray additives are all important in attaining maximum performance of post-emergence herbicides.

Proso Millet

Weed control in growing proso millet is currently limited to 2,4-D amine; Aim (carfentrazone); 2,4-D amine + Aim; and 2,4-D amine + Clarity or Peak. Proso can easily be injured by 2,4-D and/or dicamba. Add nonionic surfactant with treatments that include Aim (proflurofen) or Peak. Herbicides should be applied when proso is in the 3- to 5-leaf stage. There is no control for grassy weeds in proso, so pre-crop weed control and crop rotations that reduce these weed pressures are beneficial. Swathing makes weeds a much less serious harvest problem than they are in direct-harvested crops.

Sunflower

Sunflower is usually planted later and at lower densities than many other crops. It is slow to establish and good stands are difficult to obtain. Weeds that emerge and establish during this time can be very competitive and reduce sunflower yield potential tremendously; however, a good, even stand of sunflower is a strong competitor with weeds that emerge three or more weeks after sunflower emergence. Maintaining weed-free sunflower for the first three to four weeks after planting will minimize yield losses from weeds.

Pre-emergence herbicides that do not have to be incorporated include Dual Magnum (*S*-metolachlor + benoxacor), Prowl H₂O (pendimethalin), and Spartan (sulfentrazone) + Prowl H₂O or Dual Magnum. All of these herbicides need rainfall to activate and move them into the soil profile where weed seeds germinate. Prowl H₂O is most effective when adequate rainfall or irrigation is received within seven days of application.

Dual Magnum and Prowl H₂O, both soil-applied herbicides, primarily control grassy weeds such as foxtail, sandbur, stinkgrass, and witchgrass. These grass-control herbicides provide some level of control of small-seeded broadleaf weeds such as pigweed and lambsquarters. At higher use rates, they also can provide acceptable to poor control of kochia and Russian thistle. Spartan provides control of pigweed, kochia, Russian thistle, and lambsquarters. Spartan should be tank-mixed with a herbicide that will control grasses to obtain optimum weed control. Some crop injury has been reported from using Spartan. The injury is typically restricted to high pH, low organic matter soils.

Postemergence herbicides include Assure II/Targa (quizalopof), Poast (sethoxydim), and Beyond (imazamox). Express SG (tribenuron) and Poast are effective only on grassy weeds. Express SG is for ExpressSun hybrids. Beyond is labeled for use only in Clearfield sunflower hybrids. Clearfield sunflower hybrids contain a gene that confers tolerance, not resistance, to Beyond herbicide. Some slight crop injury (leaf yellowing and plant stunting) may be observed after applying Beyond herbicide to Clearfield sunflower hybrids, especially where overapplication occurs such as in spray overlaps or field ends. Injured plants often recover quickly. Non-Clearfield hybrids would be killed if treated with Beyond herbicide.

A soil-applied grass herbicide, such as Prowl H₂O or Dual Magnum, should be applied prior to application of Beyond. Beyond will control many broadleaf weeds that are troublesome in Nebraska sunflower fields, including pigweed, kochia, Russian thistle, and nightshade. Beyond (imazamox) inhibits ALS-AHAS synthesis in weeds and will not effectively control ALS-resistant kochia, Russian thistle, or prickly lettuce. There is also some concern about the risk of transferring the gene conferring tolerance to Beyond (imazamox) herbicide from commercial sunflower hybrids to wild sunflower. This technology should be avoided in fields with wild sunflower.

Pre-Wheat Fallow (Phase IV)

Reducing Tillage During Fallow Weed Control

The pre-wheat fallow period traditionally has been managed with tillage. Depending on rainfall amount and distribution, this has required four to eight tillage operations in most years. Each of these tillage operations can result in a soil water loss of 1/3 to 1/2 inch or more and the destruction of crop residue. *Table 1* shows the benefits of surface straw residue on the amount of water stored and the surface soil temperatures attained during a summer fallow period with limited precipitation.

We classify stored soil water as being 100 percent effective as a source of soil water for plants. In the spring when the soil is moist and air temperatures are low to moderate, it is impossible to kill weeds with tillage unless the weeds are buried, which also destroys the crop residue. About 89 percent of the water in snow that is captured is stored in the soil. A Colorado study even found that 70 percent of their snow came when the ground was not frozen and could be captured.

Spring is the most effective time to use herbicides instead of tillage to control weeds. When spring tillage buries the weeds, it also buries any crop residue. Some research has

Table 1. Benefit of surface straw residue during summer fallow related to stored soil water and soil temperature.

<i>Straw position</i>	<i>Water stored (inches)</i>	<i>Soil temp (°F)</i>
Bare soil	0.58	118
Straw flat	2.89	107
1/4 Standing, 3/4 flat	2.35	108
3/4 Standing, 1/4 flat	3.02	90

found that as rainfall events become less frequent in mid to late summer, soil water storage during summer fallow may be improved with a single, shallow tillage operation compared to using no-till exclusively. This improvement in soil water storage does not occur with long-term no-till with controlled traffic and crop residue with good coverage of the soil surface.

Most herbicide applications during fallow will eliminate two tillage operations. The most economical herbicide treatment is to use glyphosate with or without 2,4-D, depending on the weed species present. Always put spray grade ammonium sulfate at 17 lb per 100 gallons of spray solution in the tank before adding glyphosate. Surfactant may need to be added if the glyphosate does not contain a surfactant or enough surfactant. The surfactant is the last item added to the tank.

The cost for the spray grade ammonium sulfate, glyphosate, and surfactant may be as low as \$3.50 an acre. Reduced glyphosate costs make herbicides an even more likely choice for weed control throughout the fallow period. Use a drill capable of seeding into the crop residue. If the summer is dry and hot, the seeder may not be able to penetrate the soil deep enough to place the wheat seed in firm moist soil. This can be resolved by using one tillage operation which maintains the crop residue in late June to early July, depending on the weather and area in the state, to help eliminate the potential soil penetration problem. Using no-till from year to year will help build organic matter and soil structure.

If there is little or no crop residue, such as when the previous crop was removed for hay or silage, it won't work well to use herbicides for weed control for the entire fallow period. If you need to remove a crop for hay or silage, leave 6-8 rows of residue 12-20 rows apart, depending on the height of the crop, to protect the soil and crop residue from wind erosion and to trap snow.

This publication has been peer reviewed.

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**Index: Weeds
Field and Pasture**

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