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Controlling Jointed Goatgrass

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This NebGuide covers identification and cultural and chemical control of jointed goatgrass in winter wheat.

Jointed goatgrass (*Aegilops cylindrica* L.) is a troublesome winter annual grass weed in the winter wheat-fallow production areas of western Nebraska. It was introduced from Russia into Kansas in contaminated winter wheat seed in the late 1880s. It first appeared in Nebraska in 1958 in Perkins County. Custom combines and grain trucks likely brought it to southwest Nebraska and the Panhandle.

In the nine major wheat producing counties of western Nebraska between 1990 and 1992, nearly 1,300 grain samples were collected from trucks delivering newly harvested wheat to grain elevators. Of the samples, 25 percent contained jointed goatgrass spikelets (joints), each spikelet containing one to four seeds. In Kimball, Cheyenne, Deuel, Keith, and Perkins counties more than 40 percent of the samples contained jointed goatgrass spikelets.

Jointed goatgrass and wheat are genetically related, having the D genome in common. This makes it difficult to distinguish jointed goatgrass in wheat during the early vegetative growth stages. It also makes selective control with herbicides difficult. Jointed goatgrass and wheat occasionally cross to produce a hybrid that is intermediate in form *(Figure 1)*. Hybrid seeds almost always are sterile; however, there are rare cases where fertile seeds are produced.

Jointed goatgrass may be distinguished from winter wheat by occasional hairs extending from the margin of the leaf blade, particularly near the collar or stem *(Figure 2)*. To confidently distinguish between vegetative jointed goatgrass and wheat, dig up a seedling and look for a spikelet attached to the root *(Figure 3)*. After heading, jointed goatgrass easily is identified. The spike (seed head) is a narrow cylinder composed of spikelets that contain two to four flowers. The glumes on the uppermost spikelets are long-awned. Each spikelet contains an average of two seeds *(Figure 4)*.

During combine harvesting, spikelets shatter and contaminate harvested winter wheat grain *(Figure 5)*, which then may be discounted. Discounts average 3 to 6 cents per bushel, but can be as high as $1 per bushel. Some elevators will not buy wheat heavily infested with jointed goatgrass spikelets. Spikelets not removed by grain cleaning are considered foreign matter and can reduce grain grade and/or test weight.

Figure 1. Winter wheat (left) and jointed goatgrass (center) occasionally cross to produce a hybrid (right) that is intermediate in form.

Figure 2. Hairs extend from the margin of the leaf blade of jointed goatgrass (left), particularly near the collar or stem, distinguishing it from winter wheat (right), which is hairless.

Figure 3. An effective method of distinguishing between vegetative jointed goatgrass and wheat is to dig up the plant and look for the spikelet (joint) attached to the root of jointed goatgrass.

Jointed goatgrass reduces winter wheat yields by competing for moisture, light, space and nutrients. At Akron, Colo., winter wheat yields declined by 28 percent when jointed goatgrass at a density of 15 plants per square yard emerged with wheat in the fall. When it emerged at the same density in early spring, wheat yields declined by 8 percent. At North Platte, winter wheat yields declined by 0.4 percent for every jointed goatgrass plant per square yard that emerged in the fall.

Winter wheat yields in northeast Colorado declined by 0.5 percent for each main stem or tiller per yard of row in late March. Because the number of tillers present in late March is related to the time of jointed goatgrass emergence, counting the tillers includes both the effect of density and time of emergence on yield.

The persistence of jointed goatgrass seeds must be considered when selecting control measures as they may remain viable in soil for five years *(Table I)*.

Table I. Jointed goatgrass seed viability in soil in the northern High Plains.*

Years after burial	*Viable seed (%)*
1	88
2	27
3	6
4	3
5	1

*From R.L. Anderson, 1995 Central Great Plains Jointed Goatgrass Conference.

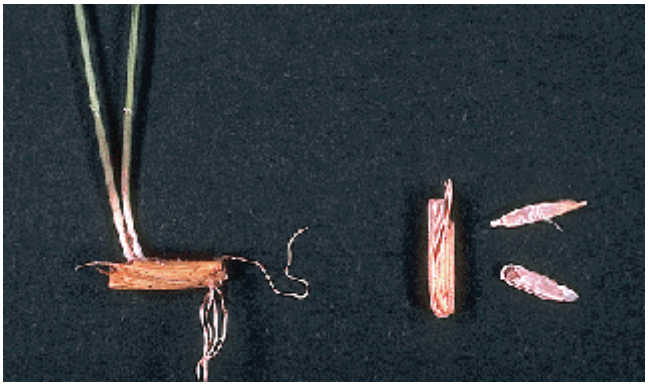

Figure 4. The jointed goatgrass spikelet (center) may contain one to four seeds (right) and each spikelet may produce multiple seedlings (left).

Figure 5. Winter wheat grain contaminated with jointed goatgrass spikelets (joints).

Control by Eliminating Seed Sources

Control begins with eliminating seed sources. The following practices can eliminate jointed goatgrass seed sources:

1. **Plant clean seed.** Jointed goatgrass spikelets often are found in fall-sown small grain seeds, especially winter wheat. It is almost impossible to separate all jointed goatgrass spikelets from winter wheat seeds. Growers, therefore should be knowledgeable about their winter wheat seed source or buy only certified seeds. Jointed goatgrass spikelets can be identified in wheat grain or seed samples by placing the sample into a pail, adding water, and stirring; wheat grain will sink and jointed goatgrass spikelets will float.
2. **Destroy jointed goatgrass before it produces seeds.** If plants reach the soft-dough stage their seeds probably will be viable. Jointed goatgrass may germinate as late as mid-April and still have sufficient cold weather to vernalize and produce seeds. Small plants, shorter than the wheat stubble, can produce viable seeds.
3. **Thoroughly clean combines and other machinery before moving from fields.** Harvest fields in rotation with warm-season crops first since jointed goatgrass control in these fields is better.
4. **Control jointed goatgrass in roadside ditches and other areas that may contaminate fields.** Cover all trucks transporting winter wheat grain to prevent jointed goatgrass spikelets from being blown out and deposited along roadsides.
5. **Run contaminated grain through a hammer mill before feeding to livestock.**

6. **Do not remove straw and chaff from infested fields as they spread jointed goatgrass seeds.**
7. **Spread manure from livestock and feed wheat grain or straw containing jointed goatgrass only on fields in 3- or 4-year rotations with winter wheat or on fields that do not include winter wheat in the rotation.**

Crop Rotation Offers Best Control

In a 7-year study conducted near Sidney, winter wheat rotations containing a late spring-planted crop such as proso millet or sunflower plus fallow provided about 99 percent jointed goatgrass control after two cycles of the rotation *(Table II)*. If jointed goatgrass eradication is the goal, avoid winter annual crops and early spring-planted crops for at least five years because of the length of jointed goatgrass seed viability. Jointed goatgrass eradication would then allow a return to winter wheat-fallow or continuous winter wheat.

Spring small grains must be seeded early to obtain maximum yield, thus jointed goatgrass seeds still have time to germinate and produce seeds. However, planting warm-season crops, tillage, herbicides, or both tillage and herbicides can control jointed goatgrass before planting. This ensures no new seeds are added to the weed seedbank. With corn or sorghum, atrazine can be used after winter wheat harvest. This reduces jointed goatgrass densities without tillage.

Table II. Jointed goatgrass densities over time as influenced by crop rotation at Sidney, Neb.†

Rotation	*1993-1994*	*1996-1997*
	——No. of plants per square yard —	
WW*-Fallow with fall tillage	8.6	9.6
WW-Fallow with atrazine	12	17
WW-Fallow-Fallow	1.4	0.01
WW-Sunflower-Fallow	0.7	0.15
WW-Proso millet-Fallow	0.9	0.07

†Duplicate field studies were initiated in September 1990 and 1991 when weed seeds at the rate of approximately 500,000 seeds/acre, or about 100 seeds/square yard, were spread and mechanically incorporated into plots prior to winter wheat seeding.
*WW = Winter wheat.

Corn, grain sorghum and proso millet yields have increased when planted no-till into herbicide-treated winter wheat stubble after harvest (ecofallow). A disadvantage of planting no-till is that some jointed goatgrass spikelets on the soil surface may not germinate during the fallow period or seeds may not decay. Spikelets can be a problem later when they are covered with soil and germinate, and emerge in the following winter wheat crop. A disadvantage of tillage is crop residues are destroyed and soil moisture is lost. Maintaining crop residues through the high wind months of March, April and May before planting proso millet or sunflower is important in reducing soil loss and may be required for conservation compliance. Some producers use herbicides early to retain crop residues and tillage later to prepare the seedbed, incorporate herbicides and cultivate sunflower.

Cultural Methods for Jointed Goatgrass Control in Winter Wheat-Fallow Rotations

If crop rotation is not an attractive option, cultural practices that suppress or partially control jointed goatgrass include:

- burning crop residues
- deep moldboard plowing
- delaying winter wheat seeding in the fall following shallow tillage
- higher seeding rates
- narrower row spacing
- seeding competitive wheat varieties and
- placing nitrogen and phosphorus fertilizer as close to the developing wheat seedling as possible.

Tillage. The effects of plowing on jointed goatgrass seed distribution, seed depth and jointed goatgrass emergence are shown in *Tables III* and *IV.* Moldboard plowing buried the majority of jointed goatgrass seed deeper than four inches in the soil, which results in reduced and delayed emergence compared to shallower seed burial. Additional tillage after moldboard plowing probably will bring buried jointed goatgrass spikelets back toward the soil surface. However, this control measure is not widely practiced or recommended because of increased potential for soil erosion following moldboard plowing. Unfortunately, tillage operations that maintain crop residues also favor winter annual grasses. The last tillage operation should be within a day of winter wheat seeding to ensure germinated jointed goatgrass is killed.

Table III. Effect of tillage system on jointed goatgrass seeds (spikelets) distribution in soil at Archer, Wyo.*

Depth	*Moldboard plow*	*Chisel plow*
inches	———— % of spikelets ————	
0-2	17	72
2-4	20	17
4-6	23	11
>6	40	<1

*From S.D. Miller, 1995 Central Great Plains Jointed Goatgrass Conference.

Table IV. Seed depth and jointed goatgrass emergence at Archer, Wyo.*

	Days after planting		
Seed depth	*7*	*21*	*35*
inches	——— % of spikelets producing seedlings ———		
5	83	98	98
1	60	100	100
2	23	61	65
3	0	21	28
4	0	13	15
5	0	0	0

*From S.D. Miller, 1995 Central Great Plains Jointed Goatgrass Conference.

Sweep tillage immediately after harvest to plant downy brome for optimum seed germination has been successful; however, tillage following wheat harvest to reduce jointed goatgrass density has had only about a 20 percent success rate. Hot and dry conditions may make some soils too hard for tillage within three days of harvest.

For most tillage to work well, the soil must be dry and air temperatures must be warm enough to desiccate plants within 30 minutes. Herbicides are more effective than tillage in moist spring soils and do not destroy residues. Preventing jointed goatgrass from producing seeds during May and June is critical to prevent buildup of the soil seedbank. If jointed goatgrass is present in the spring, use tillage twice in April or apply glyphosate or products that contain glyphosate + 2,4-D or dicamba before jointed goatgrass heads.

Burning. Safety concerns, conservation compliance, air pollution and soil erosion limit burning as a control measure for jointed goatgrass. Burning wheat stubble after harvest in the state of Washington reduced the germination of seeds on

the soil surface by up to 90 percent. However, wheat residues in Washington typically are greater than in western Nebraska and they can fuel hotter and more sustained fire than is possible in western Nebraska.

Mowing. Mow between the flowering and soft dough stages. If done too early, new tillers will form and produce viable seeds. Rough ground and the presence of prostrate jointed goatgrass plants may limit mowing effectiveness.

Biological. Although selective biological control of annual bromes and jointed goatgrass has looked promising in the laboratory, little success has been observed in the field.

Chemical. Atrazine applied in late August and glyphosate will control jointed goatgrass in fallow. If jointed goatgrass seedlings are present when atrazine is applied, a contact herbicide such as glyphosate or paraquat must be added to the atrazine. The effectiveness of atrazine is reduced in dry falls when applied at low rates. Atrazine use may not be appropriate for some high pH, low organic matter soils in western Nebraska, especially in a winter wheat-fallow rotation.

Clearfield wheat. The Clearfield® Production System combines the use of Beyond® herbicide with a winter wheat cultivar containing the gene that confers tolerance to this herbicide. Wheat cultivars containing this gene may be treated with Beyond herbicide with minimal risk of injury to the crop. Winter wheat cultivars not containing the tolerance gene are seriously injured or killed when treated with this herbicide.

In field studies conducted in western Nebraska and throughout the western winter wheat belt, the Clearfield production system provided excellent control of jointed goatgrass when weeds were treated with 4 ounces of product per acre in fall or early spring. Postemergence applications of Beyond require adding an adjuvant and nitrogen fertilizer solution. To prevent wheat injury, wheat plants must have at least three leaves emerged. No previous technology has provided this level of selective control of jointed goatgrass in winter wheat.

As with most technology, there are some concerns with using the Clearfield system. One concern is the development of herbicide-resistant weeds. Beyond belongs to a class of herbicides known as ALS-inhibitors. Other herbicides in this class, such as Glean® and Pursuit®, have a history of quickly selecting for resistance in weed populations. Examples include ALS-resistant Russian thistle, kochia, prickly lettuce and pigweed species. Without adequate safeguards, it is likely that weeds resistant to Beyond will be common in just a few years.

To delay the onset of herbicide resistance, fields treated with Beyond should not be treated with another ALS-inhibitor such as Ally® or Peak®. If additional weed control is needed, for example to control warm-season broadleaf weeds like kochia or pigweed species, herbicides with a different mode-of-action should be used, such as those containing 2,4-D or dicamba.

The Clearfield stewardship program for wheat requires the use of certified seed. Growers are not allowed to save back any grain for seed. Growers should not use the Clearfield system more than twice every six years. This allows the system to be used every time that winter wheat is grown in a 3-year rotation containing a late-spring seeded crop and summer fallow. Growers in a winter wheat-fallow rotation are advised not to use the system in more than two consecutive wheat crops or rapid development of weed resistance may occur.

Developing a Weed Management Program

Good crop management programs are essential for successful weed control. Start with uniform crop residue distribution after harvest. Rotary combines break up the straw and spread fines, chaff and jointed goatgrass spikelets, allowing for good weed seed-soil contact with subsequent tillage.

After the crop residues have been adequately distributed, several other cultural practices may help control jointed goatgrass in a winter wheat-fallow rotation.

- Control weeds during the fallow period using appropriate tillage or herbicide options.
- Fertilize winter wheat in the fall and place fertilizer as close to the wheat seed as possible without causing injury. Broadcast applications often favor jointed goatgrass over winter wheat especially with spring applications.
- Plant adapted taller wheat varieties. They often are more competitive with jointed goatgrass.
- Use higher wheat seeding rates to increase the competitiveness of the winter wheat crop. Suggested rates are 60-90 lb/acre or 18-27 seeds/ft. of row.
- Delay planting if wind erosion is not a big problem for the soil type and terrain. This increases the chance of jointed goatgrass germination before planting. If a timely rain occurs, rodweed before winter wheat is planted to eliminate jointed wheatgrass. However, delaying planting can be risky as wheat yields decline after the optimum planting date.
- Plant later maturing tall varieties in fields infested with jointed goatgrass. These will be the last fields harvested, reducing the likelihood of spreading jointed goatgrass seeds to uninfested fields.
- Destroy small patches of dense jointed goatgrass with tillage or glyphosate to prevent seed production. In case of hail before harvest consider destroying the wheat with glyphosate as jointed goatgrass is more tolerant to hail than winter wheat.

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