



Integrated Management of Feral Rye in Winter Wheat

A PACIFIC NORTHWEST EXTENSION PUBLICATION • PNW660

Introduction

Feral rye (*Secale cereale* L.), also known as volunteer or cereal rye, is a troublesome weed in winter wheat production in the low and intermediate rainfall zones of eastern Washington and Oregon and southern Idaho. Rye has been grown in the Pacific Northwest (PNW) for seed and cover, as well as for forage in hay production systems, pastures, and range. It has also been used in wildlife and soil conservation seed mixtures. Regional weed scientists think our current feral rye management problems in winter wheat originated when rye plants used for these other purposes escaped into cultivated fields. Since then, feral rye plants with the most “weedy” characteristics (for example, early seed shatter and long seed dormancy) have thrived in the winter wheat–fallow rotations of the region (Figure 1).

Feral rye persists as a weed because it typically matures, and most of its seed shatters, before winter wheat harvest. The presence of feral rye in wheat grain may result in dockage and other losses in wheat quality leading to grade reduction. Millers and bakers avoid buying wheat contaminated

with feral rye because the resulting flour has poor baking characteristics. Because of these concerns, winter wheat growers who continue to ignore their feral rye problems are sure to take notice at the elevator with decreased prices or even product rejection.

Biology

Feral rye and winter wheat are both winter annual grasses that reproduce by seed. Feral rye may germinate as late as mid-April and still have sufficient cold weather to vernalize (that is, promote flower development through exposure of young plants to cold temperatures) and produce seed. Feral rye resembles winter wheat in habit, but may be differentiated from wheat by several characteristics (Table 1, Figures 2–6).

In eastern Oregon, feral rye populations of 18 plants per square foot reduced winter wheat yield by 33 percent when allowed to compete with winter wheat until February, and 69 percent when allowed to compete with winter wheat until grain harvest in July (Rydrych 1977). In northeastern



Figure 1. Feral rye is a troublesome winter annual grass weed in Pacific Northwest winter wheat–fallow production regions.



Figure 2. Feral rye seed heads (left) are slender, longer, and somewhat nodding compared to winter wheat seed heads (right).

Table 1. Physical characteristics differentiating winter wheat from feral rye.

Plant part	Wheat	Feral rye
Stem	Erect and freely branching at base, 24–40 inches tall.	Larger and longer than wheat.
Leaf	Blade 0.4–0.8 inches wide, usually dark green.	Coarser and more bluish than wheat.
Ligule*	Membranous and fringed with minute hairs.	Membranous.
Auricle**	Purple changing to white, sharply curved, and always present	White, narrow, and wither early.
Seed head	From 2 to 5 inches long, oblong or elliptical in shape.	Slender, longer than wheat, and somewhat nodding.
Seed	Roughly egg-shaped and light brown to darker shades of red.	Narrower than wheat and usually brownish-olive to yellow.

*An outgrowth from the top of the leaf sheath.

**A small ear-like projection from the base of the leaf.

Colorado, winter wheat yields were reduced by 14 percent with feral rye populations as low as five plants per square foot (White et al. 2006). A single feral rye plant growing in a winter wheat field may produce 600 seeds, allowing even a small infestation to dramatically increase in density (Anderson 1998).

Research on the longevity of feral rye seed in soil found less than 20 percent of feral rye seed was still viable one year after deposition into the soil, and less than 5 percent was viable after two years (Stump and Westra 2000). However, farmer experience suggests that feral rye seed may lay dormant for 5–10 years or more. It is likely that 1–2 percent of feral rye seed exhibits extended dormancy. Feral rye seed has more seed dormancy and longevity than downy brome, but not as much as jointed goatgrass.

Feral rye can be introduced into wheat rotations by planting contaminated winter wheat seed or failing to clean the combine between infested and clean fields. The seed is also readily moved by water and animals. Weed scientists and growers believe that intense rainstorms (“gully washers”) move feral rye seed out of roadside ditches and field margins of infested fields into previously uninfested fields located downstream.

Seedling Identification

It can often be difficult to distinguish feral rye seedlings from wheat seedlings. When both seedlings emerge at the same time, the feral rye are often slightly larger than the wheat (Figure 3). Feral rye seedlings also tend to be somewhat reddish in color compared to the light green of wheat seedlings. The stems of feral rye typically have many fine hairs, while wheat stems have few hairs (Figure 4). A

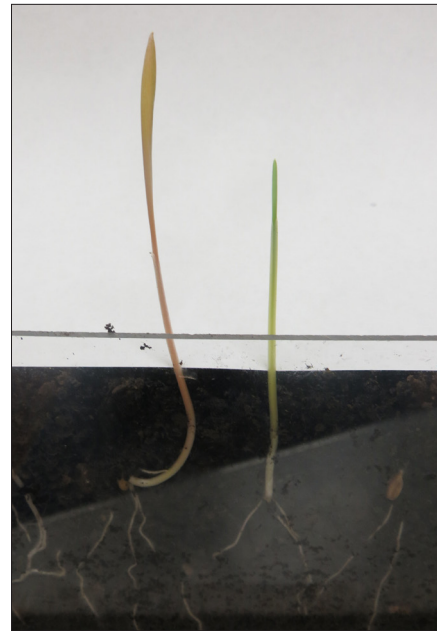


Figure 3. When emerging at the same time, feral rye seedlings (left) are often larger and more robust than winter wheat seedlings (right). Feral rye seedlings may also be more reddish in color than wheat seedlings.



Figure 4. The stems of feral rye seedlings (a) often have numerous fine hairs, while wheat stems (b) tend to have few or no hairs.



Figure 5. Winter wheat seedlings have sharply curved auricles that while present early in feral rye, often wither and are hard to see.

close look at the leaf collar (where the leaf and stem meet) can help differentiate the two: wheat seedlings (Figure 5) always have sharply-curved auricles (small ear-like projections from the base of the leaf) that is fringed with minute hairs, while rye may have them early on, but they often wither and are difficult to see. Feral rye seedlings have a membranous ligule (an outgrowth from the top of the leaf sheath), while in wheat the ligule is fringed with minute hairs but is not membranous (Figure 6).



Figure 6. The ligule of feral rye (left) is membranous, whereas in wheat (right) the membranous ligule is fringed with minute hairs.

Management

Preventive methods are a critical part of an integrated weed management system for feral rye. Eliminating potential seed sources for feral rye establishment in a field needs to be a top priority. Using the following guidelines will help ensure growers of management success.

1. Plant clean seed. Feral rye seed is often found in other small grain seed, especially winter wheat, as well as forage grass seed mixtures. Because it is very difficult to separate feral rye seed from winter wheat seed, the most effective control strategy is to be knowledgeable about your winter wheat seed source or buy only certified seed.
2. Destroy any feral rye before it produces seed in cultivated fields or summer fallow. For small infestations of feral rye, seed production can be prevented by pulling or breaking off the plants at ground level shortly after heading. Roguing needs to be done before the plants reach the soft dough stage in development when the seed becomes viable. After this point, the seed heads should be removed from the field and destroyed.
3. Thoroughly clean harvest, tillage, and mowing equipment before moving between fields known to have feral rye populations.
4. Make sure that all feral rye is managed in roadside ditches, field margins, and other areas that may contaminate production fields.

Crop Diversity

Feral rye is best controlled in rainfed winter wheat rotations that include broadleaf crops such as dry pea, chickpea, lentils, and canola, where Group 1 herbicides (ACC-ase inhibitors) such as Poast, Select, or Assure II can be used to target seedling feral rye. These same herbicides can be used in many irrigated broadleaf crops grown in rotation with winter wheat.

Spring-planted cereals such as spring wheat, oat, or barley, may also be used in rotation with winter wheat to control rye; however, when planted early to maximize grain yield, these crops may still provide opportunities for feral rye to germinate, vernalize, and produce seed. Planting these crops later in the spring can improve feral rye control if additional glyphosate burndown applications or tillage is done prior to planting, but grain yield potential will be diminished. Later-germinating feral rye is also less likely to produce seed.

In crop rotations using spring cereals, it is very important to kill feral rye with herbicides or tillage *before* planting the spring-seeded crop because selective herbicides to manage feral rye are limited (for spring wheat) or non-existent (for barley and oats). In the US Great Plains, where summer rainfall is prevalent, the use of late spring-planted crops such as corn or sunflower in the rotation with winter wheat has been very effective for managing feral rye and other winter annual grass weeds in winter wheat (Daugovish et al. 1999). In the PNW, where summer rainfall is often scarce, these crops are more difficult to successfully incorporate into rainfed crop rotations.

For tillage or herbicides to effectively control feral rye, crop residues (both long straw and fines, or chaff) must be distributed evenly rather than concentrated in narrow bands behind the combine. The disadvantages of tillage are that crop residues are destroyed and soil moisture is lost, which can lead to soil erosion. The advantages of adding a spring crop to the winter wheat rotation for feral rye control are lost if feral rye is allowed to produce seed in the non-winter wheat phases of the rotation.

The key aspect of crop rotation for the control of feral rye is to prevent any new seed production for at least two years between winter wheat crops. This is true for both rainfed and irrigated crop rotations. In rainfed cropping systems, for example, a three-year rotation of winter wheat–spring barley–fallow, where no feral rye is allowed to produce seed during the spring barley or fallow years, would limit the potential for feral rye growth. In low rainfall zones, where winter wheat–fallow is traditionally practiced, adding a spring-planted crop following winter wheat may have a high risk of failure. In this situation, some growers have found that a four-year rotation of winter wheat–fallow–winter canola–fallow has been very effective for controlling feral rye (Sowers et al. 2012). Researchers expect that spring wheat or spring barley could be substituted for winter canola in this four-year rotation with nearly similar results for feral rye control. In irrigated cropping systems, the insertion of two or three spring-seeded broadleaf crops between winter wheat crops can be very effective for controlling feral rye.

Fallow Management

For some PNW winter wheat growers, diversifying crop rotations is not a feasible option. Therefore, feral rye management during the fallow period must be improved. When selecting a fallow treatment, it is important to consider soil erosion from wind and water, equipment availability, and federal conservation program requirements.

Germination and subsequent control of rye seedlings are key to good fallow management of feral rye. After trying to eliminate all possible seed sources, the next step to controlling feral rye is to provide even distribution of the wheat crop residues during crop harvest. Feral rye seed will be spread with the fines, allowing for good seed-to-soil contact to encourage germination. Straw choppers on combines with straw walkers help spread the straw and make it easier to get good seed-to-soil contact later. Since rotary combines break up the straw, choppers are not usually needed.

After the crop residues have been adequately distributed, several other cultural practices may help control feral rye during the fallow period in a winter wheat–fallow rotation:

- Consider tillage, light disking, or harrowing immediately after harvest to “plant” feral rye seed for optimum germination during the fallow period.
- Use shallow, light tillage, or a glyphosate application in the fall following feral rye emergence to control seedlings. Herbicides are more effective than tillage when soil is moist and plants are actively growing. Unlike tillage, herbicides do not destroy additional crop residues. For tillage to work well, the soil must be dry and the air temperature must be warm enough (above 80°F) to desiccate plants within about 30 minutes.
- Apply glyphosate early in the summer fallow period when temperatures are low and the soil is wet, and delay tillage until temperatures are high and the soil is dry.
- Sweep or rodweed during the summer, using tillage as needed to control weeds and prepare the seedbed.
- Delay winter wheat planting by a week or ten days to increase the likelihood of catching a timely rain to help germinate feral rye seed, which can then be eliminated with herbicides or tillage before the winter wheat is planted.

Burning

Burning frequently results in soil erosion. Also, fire is usually not hot enough at the soil surface to kill a high percentage of feral rye seed. Seed even partially covered by soil will not be killed by burning. Local no-burning statutes, large amounts of crop residue, air temperatures that are too high or low at the time of the burn, and the length of burn greatly limit fire as a potential weed control method.

Plowing

Moldboard plowing at least 6 inches deep will bury most feral rye seed from crop residues and control as much as

90 percent of the associated growth. Plowing is probably not as effective for managing feral rye as it is for downy brome because feral rye emerges better than downy brome when buried 2–6 inches deep. In addition, the longevity of feral rye seed viability increases as burial depth increases. To prevent bringing previously buried seed back to the soil surface where it will germinate, plowing should not be done every fallow period. This will also avoid the soil erosion from wind and water that plowing can cause.

Herbicides

The Clearfield production system was introduced in the fall of 2002. This program combines the use of Beyond herbicide with winter wheat cultivars containing one or two genes that confer tolerance to this herbicide. Wheat cultivars that contain the gene(s) may be treated with Beyond herbicide at the manufacturer-recommended time with minimal risk of injury to the crop. Winter wheat cultivars that do not contain the tolerance gene(s) are seriously injured or killed when treated with this herbicide.

In field studies conducted throughout the western United States winter wheat belt for many years, the Clearfield production system provided excellent control of jointed goatgrass and good control of downy brome when these grass weeds were treated with 4 ounces of product per acre in the fall or early spring (White et al. 2006). Postemergence applications of Beyond require adding an adjuvant and nitrogen fertilizer solution. Good control of feral rye required an early fall application with 5 ounces of product per acre. Optimum control of feral rye was achieved when the application was made before rye plants had produced a tiller. To prevent winter wheat injury, winter wheat plants had to have at least three leaves emerged.

No previous technology has provided this level of selective control of feral rye in winter wheat. However, grower experience with Beyond for feral rye control has been inconsistent. As a result of this inconsistent control, the Beyond label now claims only suppression of feral rye. Until the causes for the inconsistent results are better understood, growers are advised to use conservative estimates for feral rye control when deciding whether or not to use the Clearfield system in their operation.

Some growers have gone to split applications of Beyond herbicide to improve the level and consistency of feral rye control. Beyond is applied in the fall at 3 or 4 ounces per acre and again in the spring at 4 or 5 ounces per acre. A maximum of 8 ounces per acre of Beyond may be applied to Clearfield winter wheat in a single growing season, and no more than 6 ounces per acre may be applied in a single application. While split applications do improve feral rye control, the additional application and amount of herbicide increases cost compared to a single application.

In a field study conducted in eastern Washington, delaying spring applications of Beyond from late April to late May, either as part of a split application or with just a single application, improved feral rye control but reduced winter wheat yield (Table 2). Allowing feral rye to compete with wheat for up to an additional month further improved

Table 2. Effects of application timing on Beyond control of feral rye and winter wheat grain yields at the WSU Wilke Farm near Davenport, WA.

Application date(s)	Rate (oz/ac)	Feral rye control (%)	Wheat yield (bu/ac)
Oct. 16 + May 1	3 + 3	70	32
Nov. 7 + May 11	3 + 3	90	32
Apr. 19 + May 24	3 + 3	92	33
Nov. 7	5	14	27
Apr. 19	5	75	33
May 1	5	79	27
May 11	5	98	25
Untreated check	0	0	11

Source: I. Burke, unpublished data.

feral rye control, but also further reduced winter wheat yields. Similar results have been observed in field studies conducted in eastern Oregon (Daniel Ball, unpublished data).

The recent release of 2-gene winter wheat cultivars may help with feral rye control. In the future, all new Clearfield winter wheat cultivars will contain these two genes for herbicide tolerance, which will improve crop safety and allow the use of additional surfactants, such as methylated seed oil (MSO), modified vegetable oil (MVO), or crop oil concentrate (COC), to improve control of feral rye and other difficult-to-manage weed species. These surfactants cannot be used with single gene cultivars without risking unacceptable crop injury (Figure 7).

Research conducted in western Nebraska and Wyoming demonstrated improved control of feral rye with Beyond herbicide when MCPA-ester was tank-mixed with Beyond (Kniss et al. 2011). MCPA-ester increased the uptake of Beyond and frequently increased control by an average of about 10 percent over Beyond treatments without MCPA-ester. Liquid fertilizer and surfactants are still required when adding MCPA to Beyond.

As with most technology, there are some concerns with exclusively using the Clearfield system to manage feral rye. One concern is the development of herbicide-resistant weeds. Beyond is a Group 2 herbicide, which means it is an ALS-inhibitor. Other herbicides in this group, such as Glean, Affinity Broadspec, and Pursuit (not registered for use in wheat), have a history of selecting for Group 2-resistant weeds within five years. Examples include Group 2-resistant Russian thistle, kochia, prickly lettuce, and pigweed species. Without adequate safeguards, it is likely that resistance to Beyond will occur in some feral rye populations in just a few years.

To avoid the herbicide resistance associated with Group 2 herbicides, crop-specific Clearfield stewardship programs have been developed. For wheat, the stewardship program 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 three-year rotation containing a spring-seeded crop and summer fallow. Growers in a winter wheat-fallow rotation are advised not to use the Clearfield system in more than two consecutive wheat crops, or rapid development of herbicide resistance in weeds may occur.

Growers should also be aware of the plant-back intervals on the Beyond label. These intervals can be as long as 26 months for crops such as canola and sugar beet.

Another option for controlling feral rye in winter wheat is to apply glyphosate with a rope-wick applicator. The feral rye should be 10–12 inches taller than the wheat for best



Figure 7. Tolerance of 1-gene (left) and 2-gene (right) Clearfield wheat cultivars to Beyond herbicide applied at 12 ounces per acre with MSO (two times the maximum labeled application rate; allowed for research demonstration only. Growers must follow the labeled rate requirements).



Figure 8. Feral rye is usually easy to locate in a winter wheat field after the boot stage because of its tall stature relative to most winter wheat varieties. The height differential between winter wheat and feral rye also provides an opportunity for selective chemical control with a rope-wick application of glyphosate.

results (Figure 8). In heavy stands of feral rye, the applicator should travel in both directions. Any contact between the rope wick and winter wheat or drip of herbicide on the crop will cause injury. The glyphosate should be mixed at a 33 percent concentration, which is 1 gallon of herbicide with 2 gallons of water. Surfactants may be needed for some glyphosate formulations.

Summary

Feral rye is a troublesome winter annual grass weed in PNW winter wheat production systems, particularly those that incorporate fallow periods. Crop rotation involving at least two years out of winter wheat have proven useful in the management of feral rye in winter wheat. When managed properly, the use of Clearfield wheat technology has also been useful as part of an integrated management strategy.

References

- Anderson, R.L. 1998. Ecological Characteristics of Three Winter Annual Grasses. *Weed Technology* 12 (3): 478-483.
- Daugovish, O., D.J. Lyon, and D.D. Baltensperger. 1999. Cropping Systems to Control Winter Annual Grasses in Winter Wheat (*Triticum aestivum*). *Weed Technology* 13 (1): 120-126.
- Kniss, A.R., D.J. Lyon, J.D. Vassios, and S.J. Nissen. 2011. MCPA Synergizes Imazamox Control of Feral Rye (*Secale cereale*). *Weed Technology* 25 (3): 303-309. <http://www.bioone.org/doi/full/10.1614/WT-D-10-00146.1>.
- Rydrych, D.J. 1977. Cereal Rye Control in Winter Wheat. Special Report, Oregon Agricultural Experiment Station 485: 27-29.

Sowers, K., D. Roe, and B. Pan. 2012. Oilseed Production Case Studies in the Eastern Washington Low-to-Intermediate Rainfall Zone. *Washington State University Extension Publication* EM048E, 23-26. <https://pubs.wsu.edu/Item-Detail.aspx?ProductID=15493&SeriesCode=&CategoryID=&Keyword=048e>.

Stump, W.L. and P. Westra. 2000. The Seedbank Dynamics of Feral Rye *Secale cereale*. *Weed Technology* 14 (1): 7-14. <http://www.bioone.org/doi/full/10.1614/0890-037X%282000%29014%5B0007%3ATSDOFR%5D2.0.CO%3B2>.

White, A.D., D.J. Lyon, C. Mallory-Smith, C.R. Medlin, and J.P. Yenish. 2006. Feral Rye (*Secale cereale*) in Agricultural Production Systems. *Weed Technology* 20 (3): 815-823. <http://www.bioone.org/doi/full/10.1614/WT-05-129R1.1>.

Acknowledgments

This publication was adapted, with permission, from a University of Nebraska-Lincoln Extension guide titled "Rye Control in Winter Wheat" authored by Drew J. Lyon and Robert N. Klein (G1483, 2007).

The authors acknowledge the contributions made by Dr. Ian C. Burke, Washington State University, and Dr. Frank L. Young, USDA-ARS, to this publication.

Figures 1 and 8 are courtesy of Dale Whaley, WSU; Figures 3-5 are courtesy of Aaron Esser, WSU; Figure 2 is courtesy of University of Nebraska-Lincoln Extension; Figure 6 is by author Drew Lyon; and Figure 7 is courtesy of Daniel Ball, Oregon State University.

By **Drew J. Lyon**, Extension Small Grains Weed Science, Washington State University; **Andrew G. Hulting**, Extension Weed Science Specialist, Oregon State University; and **Don W. Morishita**, Extension Weed Science Specialist, University of Idaho.

Use pesticides with care. Apply them only to plants, animals, or sites as listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Pacific Northwest Extension publications are produced cooperatively by the three Pacific Northwest land-grant universities: Washington State University, Oregon State University, and the University of Idaho. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949, the PNW program has published more than 650 titles, preventing duplication of effort, broadening the availability of faculty specialists, and substantially reducing costs for the participating states.

Pacific Northwest Extension publications contain material written and produced for public distribution. You may reprint written material, provided you do not use it to endorse a commercial product. Please reference by title and credit Pacific Northwest Extension publications.

Copyright 2014 Washington State University.

Order information:

Washington State University Extension
<http://pubs.wsu.edu>
Fax 509-335-3006
Toll-free phone 800-723-1763
ext.pubs@wsu.edu

Oregon State University Extension Service
<http://extension.oregonstate.edu/catalog>
Fax 541-737-0817
Toll-free phone 800-561-6719
puborders@oregonstate.edu

University of Idaho Extension
<http://www.cals.uidaho.edu/edComm/catalog.asp>
Fax 208-885-4648
Phone 208-885-7982
calspubs@uidaho.edu

Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by Washington State University Extension, Oregon State University Extension Service, University of Idaho Extension, and the U.S. Department of Agriculture cooperating. WSU Extension programs, activities, materials, and policies comply with federal and state laws and regulations on nondiscrimination regarding race, sex, religion, age, color, creed, and national or ethnic origin; physical, mental, or sensory disability; marital status or sexual orientation; and status as a Vietnam-era or disabled veteran. Washington State University Extension, Oregon State University Extension Service, and University of Idaho Extension are Equal Opportunity Employers. Evidence of noncompliance may be reported through your local Extension office. Trade names have been used to simplify information; no endorsement is intended. Published April 2014.