B-1157

University of Wyoming
Cooperative Extension Service

Stephen D. Miller
Craig M. Alford
William L. Stump

FERAL RYE

A serious threat to high quality wheat

Introduction

Feral rye (*Secale cereale L.*), also known as volunteer rye, common rye, or cereal rye, is a winter annual grass that causes serious economic losses for Wyoming winter wheat producers through yield losses both from competition and contamination of harvested grain. Research has indicated the economic threshold for feral rye in winter wheat in the central Great Plains is five to six plants per square yard (Pester *et al.*, 2000). The presence of feral rye in harvested grain can result in dockage, grade reduction, and loss of wheat quality. Grain purchasers are increasingly concerned about feral rye in wheat, and recent federal grain standards have reduced the tolerable levels allowed in U.S. No. 1-, 2-, and 3-grade wheat.

Historically, rye was widely grown throughout the winter wheat geography of Wyoming from the 1920s to the 1950s as a cereal grain for human consumption and as a livestock forage. Since the 1950s rye acreage has declined dramatically as many growers switched to other crops, particularly winter wheat. Feral rye is classified as a weed because its seeds shatter, and seeds possess varying degrees of dormancy which allow the rye to volunteer freely.

Feral rye currently infests 20 to 25 percent of the winter wheat acreage in the state. It is believed that the current feral rye problem in winter wheat originated from rye plants that escaped these early cultivated uses. Growing winter wheat in a continuous wheat-fallow rotation has allowed the selection of rye plants with the most weedy characteristics such as greater shattering potential and longer seed dormancy (Lyon *et al.*, 2002).

Figure 1. Feral rye in winter wheat. Note the height difference between the two species.

Figure 2. Inflorescence of feral rye and winter wheat. Note the difference in awn length between the two species.

Identification

Feral rye grows from 24 to 40 inches tall, almost double the height of most wheat cultivars (Figure 1). Leaf blades are flat, 1/16- to 3/8-inch wide and rough with open sheaths. Blades are covered with short hairs and have prominent veins above and a midrib below. The leaves of feral rye are coarser and more blue in color than wheat. Rye ligules are short and rounded as opposed to wheat, which is irregular and fringed with minute hairs. Additionally, rye auricles are white, narrow, and whither early whereas wheat auricles are purple, curved, and always present. The roots of rye branch near the soil surface and can grow 5 to 6 feet deep (Weaver 1926).

The inflorescence of rye is a slender, 4- to 6-inch-long spike with a somewhat nodding appearance and short awns (Figure 2). The inflorescence contains one spikelet subtended by two narrow glumes at each rachis joint, and each spikelet contains three florets, two of which are fertile (Trainer and Bussan, 2002). The seed of feral rye is narrower than wheat and usually brownish-olive, bluish-green, or yellow in color (Figure 3). The blue pigment is in the aleurone, and the brown pigment in the pericarp.

Life History

Feral rye will germinate at soil temperatures as low as 33°F with optimum germination occurring at temperatures from 55 to 65°F. Feral rye germination generally ceases when soil temperatures exceed 85°F. Feral rye requires good soil-seed contact for germination and will germinate when imbibed water equals 50 to 60 percent of the dry seed weight (Nuttonson 1958).

Feral rye is capable of emerging from soil at depths as great as 6 inches under favorable soil and environmental conditions; however, optimum emergence occurs at soil depths of 1 to 2 inches (Table 1). Feral rye is more cold hardy than winter wheat and will grow longer in the fall and initiate growth earlier in the spring than the winter wheat crop which gives it a competitive advantage. Rye growth in the fall slows when soil temperatures drop below 40°F and resumes in the spring when temperatures near 40°F. Optimal growth occurs at temperatures from 60 to 70°F, and temperatures above 85°F can injure rye. Feral rye is a naturally cross-pollinated plant that heads seven to 10 days earlier than winter wheat (Figure 4). A single rye plant growing in a wheat field can produce up to 800 seeds (Anderson 1992).

Figure 3. Seeds of feral rye and winter wheat. Note the size difference in the seeds of the two species.

Figure 4. Cross pollination of feral rye plants in the field.

Several researchers (Neider 1994; Daugovish *et al.* 1999; Stump and Westra 2000) have reported that feral rye seed is relatively short-lived in soil with less than 5 percent of the seed maintaining viability for more than one or two years. However, most wheat fields in the state infested with feral rye have not seen rye grown for at least 50 years. How can this be? Recent research by Stump and Westra (2000) at Colorado State University found that a small proportion (less than 1 percent) of the feral rye seed underwent induced dormancy which allowed the seed bank to persist for at least four years. This small amount of seed may dramatically increase infestations during environmentally favorable (wet) years. Feral rye may also be introduced by planting contaminated wheat seed, not cleaning harvest equipment between fields, or by intensive rainstorms (gully washers) that move rye out of barrow ditches and infested fields into previously uninfested fields downstream.

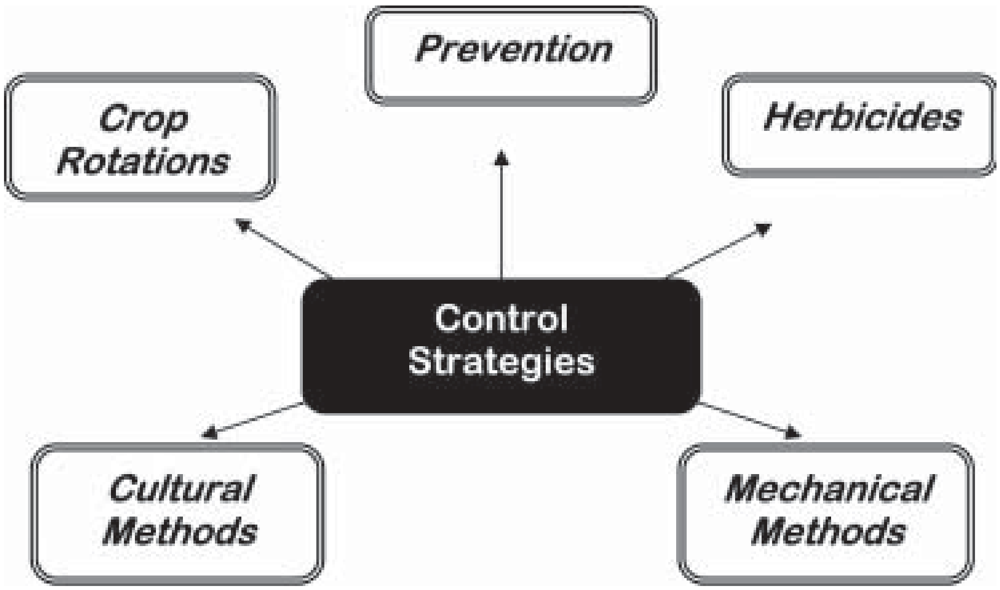
Control Strategies

Managing feral rye in winter wheat requires a systems approach that integrates multiple control strategies into a comprehensive management plan during a period of several years. Strategies include prevention, cultural, mechanical, and chemical methods (Figure 5).

Table 1. Influence of seed depth on feral rye emergence in a greenhouse.

	Days after sowing		
Depth of planting	7	14	21
Inches		*Percent emergence*	
0.5	70	85	88
1.0	75	90	96
2.0	50	90	100
4.0	7	30	55
6.0	0	4	10

Figure 5. These are various strategies that can be used to reduce feral rye densities. Integrating multiple strategies into a management plan will be more effective at reducing feral rye populations than using a single strategy.



Prevention

A critical aspect of feral rye management is to prevent seed entry into fields and to isolate minor infestations within a field when they occur.

1. Plant clean seed. Feral rye is often found in winter wheat seed. It is difficult to separate feral rye seed from winter wheat seed; therefore, growers should be knowledgeable about their winter wheat seed source. Planting wheat contaminated with feral rye rapidly expands infested areas and makes isolation difficult. Planting feral rye-free seed can prevent an initial infestation and reduce or help stop the spread of an already existing problem.

2. Cover truck beds with tarps. As a load of wheat contaminated with feral rye travels down the road, wheat seed which is heavier than feral rye migrates downward, resulting in more feral rye on top. Feral rye seed on top of a load can easily be blown out and fall along a roadside.

3. Make sure that all rye is kept out of roadside ditches and other areas that may contaminate a field. Once plants establish in these areas, rye can move into fields by way of precipitation runoff, farm implements, or animals. Mowing can provide a means of managing feral rye infestations in roadsides, fencerows, and non-crop areas. Mowing is only effective when feral rye is clipped before heading to prevent viable seed production. Mowing too late may allow feral rye to produce viable seed. However, mowing too early may allow feral rye to regrow and produce seed. Timing is essential with mowing and may require mowing twice to prevent feral rye from producing seed.

4. Thoroughly clean combines before moving them between infested and uninfested fields or areas in a field. Feral rye infestations commonly occur in patches or along field edges. Harvesting these areas separately from the remainder of a field will minimize feral rye spread.

Crop Rotations

Feral rye seed density in soil can be reduced by rotating from winter wheat to late-spring- and early summer-seeded crops (i.e. sunflower and proso millet) (Table 2). This strategy lengthens the interval between winter wheat planting, thus favoring the natural decline of seed in the soil. A four-year interval between winter wheat plantings has been slightly more effective in reducing feral rye seed densities in soil than a three-year interval.

Early spring-planted crops (i.e. spring wheat, oats, or barley) are not as effective in reducing feral rye seed density in soil because they still provide an opportunity for some feral rye to germinate, vernalize, and produce seed. For late-spring-planted crops to be effective, feral rye and other weeds must be controlled before planting. This can be accomplished with either tillage or herbicides. In Wyoming, these late-spring-seeded crops have performed better when planted no-till into stubble than when planted into tilled ground because of greater moisture conservation.

Cultural Methods

Producers can improve winter wheat's competitiveness with feral rye using cultural practices that stimulate rapid emergence and vigorous seedling growth. For example, deep banding nitrogen fertilizer near wheat seeds at planting, planting larger-sized wheat seeds, increasing wheat seeding rates, reducing wheat-row spacing, and planting taller wheat cultivars that tiller profusely are all cultural practices that have been reported to improve wheat's competitiveness with weeds. However, relying solely on cultural practices is an ineffective approach towards managing feral rye in wheat because the results are not consistent over a period of years, and the effects vary with environmental conditions. For example, in years when feral rye emerges prior to winter wheat, these practices are largely not successful.

Since cultural techniques are used to suppress feral rye, surviving plants can still produce seeds. Multiple practices must be combined in an integrated management program and sustained over years to be effective against feral rye.

Mechanical Methods

Deep plowing can bury up to 90 percent of feral rye seeds on soil surfaces deep enough to reduce seedling density in winter wheat crops to follow. Shallow tillage after deep plowing will reduce the risk of bringing feral rye seeds back to the surface where they are capable of germinating. Since a small proportion of feral rye seed can remain viable for up to four years or more in soil, plowing more than once every four years minimizes the benefit of plowing.

Tillage or chemical control of feral rye during the fallow period can reduce subsequent populations in the winter wheat crop similarly

Table 2. Feral rye seed density in soil with a two-, three-, or four-year rotation at Archer, Wyoming.

Rotation	Feral rye	
	One-rotation cycle	Two-rotation cycles
	Seeds per acre	
Winter wheat (WW) – Fallow	165	239
WW – Sunflower – Fallow	28	9
WW – Millet – Fallow	18	4
WW – Sunflower – Millet – Fallow	9	0

Table 3. Reduction of feral rye populations on the wheat crop following three fallow techniques (adapted from Stump and Westra 2000).

Fallow treatment	Feral rye	
	Year 1	Year 2
	Percent	
Disk tillage	94	89
Sweep tillage	89	87
Chemical fallow	84	90

over a two-year period (Table 3). Feral rye reductions in the winter wheat crop range from 84 to 94 percent with the various fallow treatments. Environmental conditions, especially timing and amount of rainfall, are more important than fallow systems in reducing feral rye populations.

Good crop residue distribution following wheat harvest is important for promoting good soil-seed contact for feral rye germination during the fallow period. Straw choppers on combines with straw walkers help spread the straw and make it easier to get good soil-seed contact. Rotary combines break up the straw, so choppers are not needed. It is very important to spread the fines or chaff. Feral rye seed is spread with the fines, thus allowing good seed-soil contact even in chemical fallow situations.

Non-Selective Herbicides

Post-emergence, non-selective herbicides such as glyphosate or paraquat can control feral rye and other winter annual grasses found in fallow fields. Glyphosate and paraquat do not provide residual weed control, so any feral rye plants that emerge after treatment will not be controlled. When coming in contact with soil, both herbicides are inactivated; therefore, all plants should be emerged prior to application. The effectiveness of both herbicides on feral rye decreases as plant size and maturity increases. Glyphosate is a translocated herbicide that moves throughout a plant while paraquat is a contact herbicide that controls only those parts of a plant with which it comes into direct contact. When using these herbicides for burndown in no-till cropping systems, they should be applied early enough to allow complete feral rye control before planting subsequent crops. Check product labels or consult with a local crop consultant, University of Wyoming Cooperative Extension Service educator, or pesticide retailer for specific recommendations.

Glyphosate is labeled for feral rye control in wheat as a wiper application. This technique requires at least a 10-inch-height differential between the wheat and feral rye. Care must be taken to prevent any herbicide from contacting the wheat. Any herbicide that drops or otherwise contacts wheat will result in death. The wiper equipment should not be operated at speeds greater than 5 miles per hour. The performance of a wick applicator is often improved by reducing speeds to 2.5 to 3 miles per hour, especially in heavy feral rye stands. A wicking solution should contain 33 percent glyphosate (1 gallon) and 67 percent water (2 gallons). Do not use a surfactant or any other additive with this application.

Clearfield® Wheat Technology.

The Clearfield® wheat system recently developed by the BASF Corporation combines the use of Beyond™herbicide with a winter wheat cultivar containing the gene that confers tolerance, not resistance, to this herbicide. Wheat cultivars that contain this gene may be treated with Beyond™with minimal risk of injury. Winter wheat cultivars

Table 4. Feral rye control in "Above" Clearfield® winter wheat with Beyond™ herbicide.

Application timing	Beyond™ rate per ounce of product per acre	
	4	5
	Percent	
EF (rye 1-3 leaf)	85	93
LF (rye 2 leaf + 1 to 2 tillers)	72	80
SP (rye 6-7 leaf > 3 tillers)	63	70

that do not contain the tolerance gene are seriously injured or killed when treated with this herbicide.

Currently two winter wheat varieties with herbicide tolerance to Beyond™are available to Wyoming producers. These varieties are "Above" and "AP502 CL." Both of them are from a TAM background. Additional varieties are being developed and will be released in the near future.

Beyond™should be applied early postemergence to Clearfield® wheat between the three-leaf stage and prior to jointing at rates of 4 to 6 ounces of product per acre. In Wyoming, good feral rye control required an early fall application of 5 ounces of product per acre prior to when feral rye had initiated tillering (Table 4).

To prevent wheat injury, Beyond™applications need to be made when winter wheat has at least three leaves, maximum daytime temperatures are greater than 40°F, and the proper adjuvant system is used. Current adjuvant recommendations include the addition of a non-ionic surfactant (NIS) and nitrogen fertilizer solution. The addition of a crop oil or a methylated seed oil (MSO) is not recommended because of the risk of crop injury (Table 5).

The Clearfield® stewardship program for wheat requires the use of certified seed. Growers are not allowed to hold back any grain for seed. Growers should not use the Clearfield® system for wheat more than once every three years. This allows the system to be used each time winter wheat is grown in a three-year rotation containing a late-spring-seeded crop and summer fallow. Growers in a winter wheat-fallow rotation are advised not to use the Clearfield® system in consecutive wheat crops, or weed resistance may rapidly develop.

Table 5. "Above" Clearfield® winter wheat injury with 6 ounces of Beyond™herbicide applied with two adjuvants at three timings.

Application timing	Adjuvant[1]	
	NIS	MSO
	Percent	
EF (2-leaf)	6	12
LF (3 leaf, 1 tillers)	0	4
SP (4-6 leaf, > 4 tillers)	0	0

[1] Both adjuvant systems applied with 28-0-0 UAN at 1.5 percent

References

Anderson, R.L. 1992. "Growth Characteristics of Winter Annual Grasses in Winter Wheat." *Weed Technology*: 7:717-722.

Daugovish, O., D.J. Lyon, and D.D. Baltensperger. 1999. "Cropping Systems to Control Winter Annual Grasses in Winter Wheat." *Weed Technology*: 13:120-126.

Lyon, D.J., R.N. Klein, and G.A. Wicks. 2002. "Rye Control in Winter Wheat." Nebraska Cooperative Extension Service Bulletin G02-1483A, 7 pp.

Neider, T.L. 1994. *Spring Crops for Winter Annual Grass Management in a Wheat-Fallow Rotation.* Master's Thesis, University of Wyoming, 46 pp.

Nuttonson, M.Y. 1958. *Rye-Climate Relationships and the Use of Phenology in Ascertaining the Thermal and Photothermal Requirements of Rye.* Washington, D.C., Am. Inst. Crop Ecol., 219 pp.

Pester, T.A., P. Westra, R.L. Anderson, D.J. Lyon, S.D. Miller, P. W. Stahlman, and G.A. Wicks. 2000. "Rye Interference and Economic Thresholds in Winter Wheat." *Weed Science*: 48:720-727.

Stump, W.L., and P. Westra. 2000. "The Seedbank Dynamics of Feral Rye (*Secale cereale*)." *Weed Technology*: 14:7-14.

Trainer, M., and A.J. Bussan. 2002. "Crop Weeds-Feral Rye." http://www.weeds.montana.edu/crop/feral-rye.htm, 6 pp.

Weaver, J.E. 1926. "Root Development of Field Crops." *Crop Production Practices.* McGraw-Hill, New York: 162-166.

Editor: Robert Waggener, Agricultural Communications and Technology, College of Agriculture, University of Wyoming

Issued in furtherance of cooperative extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Glen Whipple, director, Cooperative Extension Service, University of Wyoming, Laramie, Wyoming 82071.

Persons seeking admission, employment, or access to programs of the University of Wyoming shall be considered without regard to race, color, religion, sex, national origin, disability, age, political belief, veteran status, sexual orientation, and marital or familial status. Persons with disabilities who require alternative means for communication or program information (Braille, large print, audiotape, etc.) should contact their local UW CES office. To file a complaint, write to the UW Employment Practices/Affirmative Action Office, University of Wyoming, 1000 E. University Ave., Department 3434, Laramie, WY 82071-3434.