Foxtail Identification and Control in Georgia Pastures and Hayfields

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Foxtails (*Setaria* spp.) are invasive weeds in pastures and hayfields. The competitive growth of foxtails with pasture species causes stand thinning and reductions in hay yields. A distinguishing characteristic of these weeds is the cylindrical seedhead that resembles a fox's tail. Foxtails have comparable protein levels to many cultivated forages, and can be grazed during early vegetative growth. However, mature foxtail plants are less palatable to livestock and have poor digestibility.

Foxtail plants are also prolific seedhead producers that are concerning in polyculture with pasture species. The foxtail seedheads have sharp awns that can injure livestock. Hayfield growers may also be concerned about the economic impact of foxtails on yield and hay quality. Foxtail populations often outcompete hayfield grasses for light, water, and nutrients required to optimize yields. Foxtail seedheads are also contaminants of hay bales that may contribute to the transport of seed to new areas.

UGA extension

Identifying Annual and Perennial Foxtails in Pastures

The identification of foxtail species is critical for planning control programs in pastures and hayfields. Annual species found in Georgia include giant foxtails (*Setaria faberi*), green foxtails (*S. viridis*), and yellow foxtails (*S. pumila*). These species establish from seed in spring, exhibit vegetative growth in summer, and complete their lifecycles in autumn. Annual foxtails have a clumped growth habit with fibrous root systems (Figure 1). Giant foxtail seedheads are cylindrical panicles that often droop upon plant maturity (Figure 2). The seedheads of green and yellow foxtail have a linear, erect growth pattern.

Figure 1. Yellow foxtail fibrous roots.

Figure 2. A patch of giant foxtail. Note the drooping seedhead commonly found on mature plants.

Leaf blade characteristics differ among annual foxtails. Giant foxtail leaves may be covered with small hairs on the upper leaf surface, except near the leaf base. Green foxtail has a smooth leaf base with several soft hairs along the surface. Yellow foxtail is often covered with small hairs near the base but is smooth towards the upper surface (Figure 3). Annual foxtails do not have auricles, and the ligules are a fringe of hairs (Figure 4).

Figure 3. Fringe of hairs at the base of the yellow foxtail leaf.

Figure 4. Giant foxtail ligule.

Knotroot foxtail (*Setaria parviflora*) is a warm-season perennial with short rhizomes (Figures 5 and 6). This species may rapidly infest grazed pastures when forage competition is limited. The leaf may be covered with small hairs on the lower leaf surface, but the stem is usually smooth. Knotroot foxtail does not have auricles, and the ligule is a fringe of hairs. The seedhead is a cylindrical panicle, similar to other foxtails, but with a more compacted size than the annual species. Knotroot foxtail may germinate from seed or from rhizomes in spring. The rhizomatous growth contributes to the invasiveness of the species and persistence in pastures and hayfields.

Figure 5. Knotroot foxtail clump in a pasture.

Figure 6. Rhizomes of knotroot foxtail.

Cultural Control of Foxtails

Promoting competitive growth of pasture species with foxtail populations is critical for long-term successful control. Annual foxtails begin to germinate in early spring when soil temperatures reach approximately 60 degrees Fahrenheit. The lifecycle of these species is predictable, and therefore, growers can modify management programs to reduce spring establishment. For example, nitrogen fertilization should be reduced during peak germination in areas with a history of foxtail populations. Excessive nitrogen use in summer will also encourage seed production, dispersal, and survival.

Grazing may suppress foxtail populations and minimize competition with pasture species. Mechanical suppression through mowing can inhibit foxtail growth and limit the spread of seed in pastures. Actively growing foxtail plants will regenerate seedheads within about two weeks of mowing. Therefore, regular mowing may be needed for effective suppression in grazed pastures. Mowing does not eradicate foxtails, and seedhead suppression may only be temporary.

Practices that disturb the soil, such as aeration, sub-soiling, or tilling operations, should be conducted when pasture grasses are actively growing. Voids left in fields with exposed soil may permit foxtail invasion. Timing these operations during favorable periods for quick recovery promotes competition with foxtails. Controlling winter annual weeds in spring enhances the release of warm-season grasses, such as bermudagrass, that may reduce the establishment of foxtail seedlings. In tall fescue and cool-season forages, growers should reseed thinned areas to promote competition with foxtails establishing in spring.

Preemergence Control of Annual Foxtails in Established Pastures and Hayfields

Growers may apply pendimethalin (Prowl H_2O) for preemergence control of annual foxtails in established alfalfa, bahiagrass, bermudagrass, and tall fescue pastures and hayfields (Table 1). The initial treatment should be applied when soil temperatures reach the low 50s in late winter or early spring. Prowl H_2O may be applied at 1.1 to 4.2 quarts per acre in established hayfields during a single application, with a cumulative total of 4.2 quarts per acre each year. Applications should be made before a rainfall to enhance soil incorporation and promote herbicide activation. In hayfields, split applications of Prowl H_2O are permitted between cuttings for bermudagrass and other labeled warm-season species that were initially treated in late winter. There is no pre-harvest interval or grazing restriction for Prowl H_2O. Sequential treatments applied at a six- to eight-week interval after the initial application may extend the length of residual control of annual foxtails through late summer. Prowl H_2O does not control knotroot foxtail and other perennial weeds transitioning from dormancy or establishing from rhizomes in spring.

Table 1. Herbicides for annual foxtail (green, giant, and yellow foxtail) control in hayfields.

Application Timing	WSSA Group[a]	Herbicide	Efficacy[b]	Labeled Species	Grazing Restriction (days after treatment)	Harvest Restriction (days after treatment)	Labeled Rate (product/acre)
preemergence	3	pendimethalin (Prowl H_2O 3.8SC)	F-G	Alfalfa Bahiagrass Bermudagrass Tall fescue	0 days	0 days	1.1 to 4.2 qt
	14	flumioxazin (Chateau 51WDG)	F	Alfalfa	25 days	25 days	2 to 4 oz
preemergence (pre-plant)	3	benefin (Balan 60DF)	G	Alfalfa	n/a	n/a	2 lb
	5	diuron (Direx 4L, Diuron 4L) diuron 80	G	Bermudagrass	n/a	n/a	0.8 to 2.4 qt 1 to 3 lb
	8	EPTC (Eptam 7L)		Alfalfa			3.5 pt
postemergence	1	clethodim (Select Max, others)	E	Alfalfa Perennial peanut	15 days	15 days	See label
		sethoxydim (Poast, others)	E	Alfalfa	7 days	14 days	See label
	2	imazamox (Raptor 1L)	G	Alfalfa	20 days	20 days	4 to 6 fl oz
		imazapic (Impose 2AS)	F-G	Bermudagrass Perennial peanut	See label	7 days	4 to 8 oz
		imazethapyr (Pursuit 70DG, 2EC)	G	Alfalfa	30 days	30 days	1.1 to 2.2 oz 3 to 6 fl oz
		nicosulfuron + metsulfuron (Pastora 71.2DF)	G	Bermudagrass	0 days	0 days	1 to 1.5 oz
	9	glyphosate (Roundup, Accord, others)	E	Bermudagrass	See label	See label	See label

[a]WSSA group numbers: 1 = Acetyl-CoA carboxylase (ACCase) inhibitor, 2 = acetolactate synthase (ALS) inhibitor, 3 = mitotic inhibitor, 5 = Photosystem II inhibitor, 8 = lipid synthesis inhibitor, 9 = EPSP synthase inhibitor, 14 = protoporphyrinogen oxidase (PPO) inhibitor.

[b]Excellent (E) = 90 to 100 percent control, Good (G) = 80 to 89 percent control, Fair (F) = 70 to 79 percent control.

Flumioxazin (Chateau) provides preemergence control of annual foxtails in alfalfa. Applications from 2 to 4 ounces of product per acre control annual broadleaf and grassy weeds. There is a 25-day grazing and harvesting restriction for alfalfa pastures. Growers can extend the length of control in alfalfa by using Chateau in early spring followed by a Prowl H_2O treatment after the first cutting in spring. Chateau is not permitted in fields containing mixtures of alfalfa with forage grasses due to excessive injury potential to grasses.

Preemergence Control of Annual Foxtails During Establishment of Pastures and Hayfields

Diuron (Direx, etc.) provides preemergence control of grassy weeds, including annual foxtails, during bermudagrass establishment (Table 1). Diuron may be applied from 0.8 to 2.4 pounds of active ingredient per acre immediately after sprigging bermudagrass. However, applications may temporarily injure actively growing bermudagrass and should not be used on hayfields during establishment from seed. Diuron is not labeled for other hayfield species or established bermudagrass forage.

Growers establishing alfalfa may use benefin (Balan) or EPTC (Eptam) as pre-plant treatments in spring. These herbicides provide preemergence control of foxtail and other annual weeds. Benefin and EPTC have the potential to reduce alfalfa yield during establishment. EPTC is generally less injurious to alfalfa than benefin at labeled use rates. There are no preemergence herbicides labeled for use during alfalfa establishment using no-till seeding methods or for the establishment of bahiagrass, perennial peanut, or tall fescue pastures or hayfields.

Postemergence Control of Annual and Perennial Foxtails

Herbicide applications should be timed in late spring for postemergence control of foxtails in established hayfields. Imazapic (Impose) may be used to control foxtail in bermudagrass and perennial peanut. Bermudagrass may be treated with Impose at 4 to 8 ounces of product per acre when annual foxtails are actively growing in spring, but applications should not exceed 4 ounces of product per acre on perennial peanut. Growers may also use nicosulfuron plus metsulfuron (Pastora) at 1 to 1.25 ounces of product per acre for early postemergence control of annual foxtails in bermudagrass. Pastora and Impose are most effective on seedling foxtail, compared to mature plants that are tillered. Annual foxtails become more tolerant to herbicide applications after seedhead emergence, and sequential applications may be required for control. Both herbicides should include a non-ionic surfactant at 0.25 percent vol/vol of spray solution (that is, 1 quart per 100 gallons).

Pastora and Impose do not control knotroot foxtail. Research has shown tank-mixtures of glyphosate with Pastora can suppress knotroot foxtail in summer, but regrowth is often detected. Growers should consider making spot applications of glyphosate in a one-percent solution for controlling knotroot foxtail. For best results, delay glyphosate applications until fall. This timing will have better potential for glyphosate to control rhizomes than treatments in spring or summer. Failure to control belowground plant parts from glyphosate treatments may result in regrowth of knotroot foxtail in the following spring.

Bermudagrass growers have several challenges for maximizing the selectivity of herbicides for postemergence control of annual foxtails. Impose causes temporary injury to bermudagrass, such as yellowing of foliage and growth suppression for 20 to 40 days after applications in the summer. Impose can reduce the initial yield of bermudagrass by as much as 50 percent in the spring or early summer. Additionally, there is a seven-day harvest restriction after an Impose application in hayfields. Pastora has less potential to injure bermudagrass than Impose, but it is less efficacious on mature foxtail. Pastora may be applied seven days after cutting bermudagrass to control seedling foxtail, and there is no haying restriction after application. Both Impose and Pastora will severely injure alfalfa, bahiagrass, and tall fescue. Growers have no selective herbicides for foxtail control in bahiagrass, millet, or tall fescue. Spot treatments of glyphosate are recommended in these species for the control of foxtail.

In alfalfa and legumes, growers may use clethodim (Select Max, etc.), imazamox (Raptor), imazapic (Impose), imazethapyr (Pursuit), and sethoxydim (Poast, etc.) for postemergence foxtail control. Clethodim and sethoxydim control annual and perennial foxtails after emergence, but do not control broadleaf species. Alfalfa should not be grazed or harvested for 14 and 15 days after treatment of sethoxydim and clethodim, respectively. Clethodim will also control foxtails in perennial peanut. However, there is a 40-day cutting restriction following clethodim applications in perennial peanut hay. Imazamox, imazapic, and imazethapyr control annual foxtails and some broadleaf weeds, but do not control knotroot foxtail. Imazamox and imazethapyr have 20- and 30-day restrictions, respectively, for grazing and harvesting alfalfa for hay. These active ingredients are available in numerous products, many of which have different adjuvant requirements for applications. Growers should see product label for recommendations on the use of crop oils or non-ionic surfactants with treatments.

Herbicide Resistance

Herbicide resistance in annual foxtail species has been reported for ACCase-inhibitors (WSSA Group 1), ALS-inhibitors (WSSA Group 2), and dinitroanilines (WSSA Group 3) throughout the United States and Canada. Resistance develops from selection pressure by repeated use of the same herbicide or mode of action over years. Genetic differences among biotypes present in populations contribute to susceptibility levels to herbicides. As susceptible biotypes are controlled by a particular herbicide over years, resistant biotypes may spread in these fields. This type of selection pressure has shifted populations of annual foxtails from susceptible to resistant biotypes over time.

The development of foxtail resistance to preemergence applications of dinitroanilines (DNA) in grass pastures and hayfields is inevitable. Currently, Prowl H_2O is the only preemergence herbicide for controlling annual foxtails in warm-season grass pastures, and is the only herbicide that selectively controls foxtails in tall fescue. Pasture and hayfield growers should have an appreciation for the potential development of resistance to Prowl H_2O and other herbicides used for foxtail control. Herbicide rotation, along with sound cultural practices, will be critical for long-term successful control of foxtail species in Georgia pastures and hayfields.

All photos by Patrick McCullough.

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