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G. Neil Rhodes Jr.

William P. Phillips Jr.

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Weed Management in Pastures and Hay Crops

Weed Management in Pastures and Hay Crops

*G. Neil Rhodes, Jr., Professor and Extension Weed Specialist, and William P. Phillips, Jr., Graduate Research Assistant
Plant Sciences*

Introduction

Tennessee has a long, proud tradition of a strong livestock industry. Each year livestock account for roughly half of our state's total agricultural receipts. The largest components of our livestock industry are cattle and calves. Clearly, cattle and calves are big business in Tennessee, and high-quality forages are essential inputs. Ninety-five percent of our pasture and hay is composed of cool-season grasses (85 percent tall fescue, 10 percent orchardgrass). Approximately 25 percent of this acreage has been renovated with Ladino and/or red clover. Forages, particularly cool-season grass pastures and hay fields, are the backbone of the beef industry.

Regardless of whether it is a fescue and legume pasture, a bermudagrass hay field or an alfalfa hay field, most annual and perennial broadleaf weeds reduce forage yield, palatability and quality. This is particularly true if heavy populations are not controlled on a timely basis and are allowed to reach maturity. In a pasture they also reduce grazing efficiency, which means cattle spend more time picking through and around weeds looking for grass and less time eating. The bottom line is that unmanaged weeds are one of several things contributing to lower average daily gain (ADG).

Weed life cycles

If we lived in a perfect world, all pasture and hay crop weeds would come up at one time and a producer could spray one time in the spring and be finished with his or her weed management program for the year! Unfortunately, we all know that this is not the case, because different weeds have different life cycles. Common weeds that occur in Tennessee forage crops can be divided into four categories based on their life cycle. Knowledge of weed life cycles is particularly important in the timing of herbicide applications. The four categories of weeds based on life cycle are:

Summer annuals

Plants that germinate from seed in the spring, flower and produce seed in mid to late summer, and die in the fall. Examples include large crabgrass, barnyardgrass, common cocklebur, spiny amaranth, spurge, ragweed and bitter sneezeweed.

Winter annuals

Plants that germinate from seed mostly in late summer through winter, flower and produce seed in late winter to spring, and die in late spring to early summer. Examples include annual ryegrass, little barley, hairy buttercup, chickweed, henbit, purple deadnettle and Carolina geranium.

Biennials

Plants that complete their life cycle over two growing seasons. They germinate and produce a vegetative rosette the first year. The second year, the plants bolt, flower, produce seed and die. Examples include musk thistle, bull thistle, wild carrot and common burdock.

Perennials

Plants that produce a vegetative structure (taproot, tuber, bulb, rhizome, etc.), which allows them to live for more than two years. Most perennials also reproduce from seed. Examples include johnsongrass, buckhorn plantain, horse-nettle, tall ironweed, goldenrod, brambles and black/honeylocust.

Alfalfa weed management

Production of high-quality alfalfa hay in Tennessee is dependent on a number of critical inputs, not the least of which is effective weed management. Alfalfa weed management begins with field selection. Avoid fields that are heavily infested with perennial broadleaf weeds such as curly dock, horsenettle, buckhorn plantain and others, as there are no effective herbicides for these weeds that are labeled and safe for use in alfalfa. Seedling alfalfa is particularly vulnerable to weed competition. Most weeds grow faster than seedling alfalfa and can quickly shade and overpower a new stand. This is particularly true for fall-seeded alfalfa. Winter annual weeds such as chickweed, henbit and purple deadnettle emerge with the alfalfa or shortly afterwards. Uncontrolled, these weeds not only starve the alfalfa of sunlight and nutrients, but they can worsen losses from crown rot. Spring-planted alfalfa, which is preferable to fall planting in most cases, especially in no-till, is subject to competition from grasses such as crabgrass and goosegrass; and broadleaf weeds such as ragweed, pigweed and cocklebur. While the threat of crown rot is much less in the spring, weeds in spring plantings must also be managed on a timely basis to be successful.

Herbicides recommended for use in alfalfa are listed in Table 1 on pages 3 and 4. Expected weed response for alfalfa herbicides can be found in Table 2 on page 4. Grazing and hay-cutting restrictions are listed in Table 3 on page 5.

**Table 1.
Herbicides for Alfalfa and Other Legume Hay Crops***

Crop and Application Timing	Herbicide	Rate/Acre Broadcast		Weeds Controlled, Remarks and Precautions
		Active Ingredient	Formulation	
Alfalfa-Preplant, No-Till	Gramoxone Inteon 2SL (Paraquat)	0.63-1.0 lbs.	2.5-4.0 pts.	Use to control most annual and some perennial weeds prior to seeding. In sod, best results have been obtained with a split application (1.25-2.5 pts./A, 10 days to 3 weeks prior to planting, followed by 1.25 pts./A at planting). Apply in a minimum of 10 gals. of water/A. Add nonionic surfactant at 2 pts. per 100 gal. of spray mix.
	Cornerstone/others** (Glyphosate 3ae)	0.75-2.25 lbs. (a.e.)	32-96 ozs. 3ae	For control of most annual weeds and better control of perennial weeds than Gramoxone Inteon. On most perennial weeds, glyphosate performs better in the fall than in the spring. See label for rates on individual weed species.
	Roundup PowerMax or Roundup WeatherMax** (Glyphosate 4.5ae)		22-64 ozs. 4.5ae	
Alfalfa, Birdsfoot Trefoil, Ladino or Red Clover - Seedling	Butyrac 200 2SC (2,4-DB)	1-1.5 lbs.	4-6 pts.	Controls small seedlings of musk thistle, turnips, cocklebur and ragweed. Does not control chickweed or henbit. Treat before weeds exceed 3 inches tall and when legume has two or more trifoliate leaves.
Alfalfa, Birdsfoot Trefoil, Ladino or Red Clover - Seedling or Established	Kerb 50WP (Pronamide)	0.75-1 lb.	1.5-2 lbs.	On pure alfalfa stands, use to control chickweed and several winter grasses such as ryegrass, cheat and annual bluegrass. Apply after legumes have reached the trifoliate stage. Do not apply if temperatures are above 55 F.
Alfalfa, Seedling or Established	Pursuit 2AS or 70DG (Imazethapyr)	0.063-0.094 lb.	4-6 ozs. 2AS or 1.44-2.16 ozs. 70DG	Apply overtop in seedling or established alfalfa to control several annual broadleaf weeds and some annual grasses. Higher rate required for grass control. Seedling alfalfa must be in the 2 trifoliate stage or larger. Apply before most weeds exceed 3 inches in height. Good control of pigweed, morningglory, cocklebur, foxtails and seedling johnsongrass. Always add nonionic surfactant at 1 qt./100 gal. of spray mix.
Alfalfa, SEEDLING or ESTABLISHED <u>Roundup Ready Varieties Only</u>	Roundup WeatherMax (Glyphosate 4.5ae)	0.75-1.5 lbs.	22-44 ozs.	Seedling alfalfa: Due to the biology and breeding constraints of alfalfa, up to 10 percent of the seedlings may not contain a Roundup Ready gene and will not survive the first application of this product. To eliminate the undesirable effects of stand gaps created by this loss of plants, a single application of a least 22 ozs./A should be applied at or before the 4 trifoliate growth stage. Later applications may be made at up to 44 ozs./A. In established stands, apply up to 44 ozs./A. Do not apply within 5 days of cutting of first-year or established stands. Do not apply more than a total of 4.1 qts/A for in-crop applications.
Alfalfa- Established	Butyrac 200 2SC (2,4-DB)	1-1.5 lbs.	4-6 pts.	Controls small seedlings of musk thistle, turnips, cocklebur and ragweed. Does not control chickweed, henbit, plantain or dock. Treat before weeds exceed 3 inches tall.
Alfalfa, Clover, Birdsfoot Trefoil - Seedling or Established	Poast 1.5E (Sethoxydim)	0.19-0.28 lb.	1-2.5 pts. 1.5E	Apply low rate overtop to seedling or established crop for control of crabgrass, goosegrass, foxtails and other annual grasses. Use higher rate for johnsongrass and bermudagrass. A second application may be needed for control of regrowth. Always add crop oil concentrate at 2 pts./A.
Alfalfa, Birdsfoot Trefoil - Seedling or Established	Select Max (Clethodim)	0.07 - 0.12 lb.	9 - 16 ozs.	Apply overtop to control crabgrass, fall panicum, broadleaf signalgrass or other annual grasses and johnsongrass. Use 9 to 16 ozs./A in seedling alfalfa and 12 to 16 ozs./A in established alfalfa for annual grasses. Use 12 ozs./A for johnsongrass or bermudagrass and follow with a second application if needed. See label. Always add crop oil concentrate at 1 qt./A.
Alfalfa - Dormant Fall-Seeded Established	Gramoxone Inteon 2SL (Paraquat)	0.19-0.31 lb. 0.25-0.5 lb.	0.75-1.25 pts. 1.0-2.0 pts.	Apply to dormant, pure alfalfa during late fall or winter months for control of chickweed, henbit, bluegrass and downy brome, and suppression of perennial grasses including orchardgrass, timothy, and smooth brome. Use a minimum of 10 gallons of water by ground, or 5 gallons of water by air. Always add a nonionic surfactant at 0.25% (1 qt. per 100 gallons of spray mix.) Application to alfalfa that is not dormant, or has broken dormancy, may result in stand and/or yield reductions. Replanting may be necessary. Green alfalfa foliage present at the time of application will be burned. Make only one application per season.
Alfalfa - Dormant Established	Sencor or Lexone 4 L or 75 DF (Metribuzin)	0.5-0.75 lb.	1-1.5 pts. 4L, or 0.67-1 lb. 75 DF	Apply to dormant pure alfalfa or alfalfa-grass mixtures to control chickweed, henbit and several other broadleaf weeds. A partial reduction in grass stand may occur. Do not apply after new growth starts.

**Table 1. (cont.)
Herbicides for Alfalfa and Other Legume Hay Crops***

Crop and Application Timing	Herbicide	Rate/Acre Broadcast		Weeds Controlled, Remarks and Precautions
		Active Ingredient	Formulation	
Alfalfa – Established or First-Year Between Cuttings	Gramoxone Inteon 2SL (Paraquat)	0.25 lb.	1 pt.	Apply immediately after alfalfa hay is removed for control of many seedling broadleaf and annual grass weeds. Do not treat more than 5 days after cutting. Add surfactant at 1 pt./100 gal. of spray mix. Alfalfa foliage present at time of application will be burned. First year alfalfa stands and yields may be reduced if alfalfa is allowed to regrow more than 2 inches.

^aCoarse-textured soils

^bMedium-textured soils

^cFine-textured soils

*See Table for Grazing and Hay Cutting Restrictions

**NOTE: Several brands of glyphosate have become available in recent years. Products differ in terms of concentration, rates and addition of surfactant. Always read the label before application.

**Table 2.
Expected Weed Response to At-Planting and Postemergence Alfalfa Herbicides**

	Butyrac	Pursuit	Poast	Select Max	Gramoxone Inteon Between Cuttings
Annual grasses	0	7	9	9	7
Annual ryegrass	0	-----	8*	8*	NA
Chickweed	2	-----	0	0	NA
Cocklebur	8	8	0	0	6
Curly dock	1	-----	0	0	2
Deadnettle	1	-----	0	0	NA
Henbit	1	-----	0	0	NA
Johnsongrass, Rhizome	0	6	7	9	2
Johnsongrass, Seedling	0	7	9	9	6
Lambsquarters	4	5	0	0	6
Morningglory	8	8	0	0	7
Musk thistle	7**	-----	0	0	2
Nutsedge	1	3	0	0	2
Pigweed	6	9	0	0	7
Plantain	2	-----	0	0	2
Ragweed	6	7	0	0	7

*Fall application

**Newly-emerged seedlings

NA = Not applicable

KEY TO RESPONSE RATINGS: 0=No control; 10=100% control; ---=Data not available. Ratings are based on labeled rates of each herbicide, applied at the optimum timing for each weed.

Table 3.
Grazing and Cutting Restrictions for Alfalfa Herbicides – Lactating Dairy Animals (Days to Wait)

Herbicide	Grazing	Hay Cutting
Butyrac 200 Seedling Established	60 30	60 30
Gramoxone Inteon Between cuttings Dormant	30 60	30 60
Kerb	120	120
Poast	7	14
Pursuit	30	30
Roundup WeatherMax and other glyphosate formulations (burndown)	56	56
Roundup Weathermax In-crop, Roundup Ready Alfalfa	5	5
Select Max	15	15
Sencor/Lexone	28	28

Bermudagrass weed management

The popularity of bermudagrass hay production has increased in recent years in Tennessee. A number of producers have capitalized on the high-value market for horse hay. Many horse owners are willing to pay a premium for clean bermudagrass hay. This presents a challenge from the standpoint of weed management. This is particularly true for summer annual and warm-season perennial grass weeds. Weed problems are generally worse during the year of sprigging, as bermudagrass is often slow to achieve complete coverage. Complicating this is the fact that some of our more effective herbicides are for use only on established bermudagrass. Timely clipping is often a helpful weed management tool during the year of establishment.

Unlike in fescue and orchardgrass hay fields, the use of dormant herbicide applications may be needed. Unmanaged winter annual grasses, such as ryegrass and little barley, and winter annual broadleaves such as chickweed, henbit and deadnettle, will reduce the quality of the first hay cutting. Also, because they are still actively growing at the time of the initial spring nitrogen application, they will utilize a portion of the nitrogen intended for the bermudagrass.

Tall fescue and orchardgrass weed management

As previously mentioned, the bulk of Tennessee’s pastures and hayfields are composed of cool-season perennial grasses, which are established from seed.

New fall seedings

The preferred time to establish new plantings of tall fescue and orchardgrass is from August 15 to October 1. In the fall, cooler soil temperatures and shorter days trigger the germination of many winter annual weeds such as wild turnip, common chickweed, mouseear chickweed, henbit and deadnettle. Sometimes, particularly in conventionally prepared seedbeds, weed pressure can be sufficiently great so as to overcome the young grass. Each year, UT staff receive many calls in March and April asking for control recommendations for these weeds. Unfortunately this is too late. Producers are encouraged to begin scouting fields in early October for these weeds.

One of the more common weeds in new seedings is wild turnip, and it can be controlled easily with 2,4-D. ForeFront R&P or Milestone will be required for most other winter annuals. Producers are encouraged to handle young grass with care. A low rate of 2,4-D (1 to 1.5 pt/A) can be safely used on seedling grass; however, higher rates of 2,4-D and most other herbicides (such as Fore-

Often producers will seed grasses in the fall and then add legumes such as red and Ladino clover in February or March. If 2,4-D alone is applied in the fall, residues in the soil will be depleted by February and legumes may be seeded without any problems. However, keep in mind that several herbicides, such as those containing aminopyralid (ForeFront R&P and Milestone) or picloram (Grazon P+D), are persistent in soil, and planting of legumes must be delayed for at least one year.

Established pastures and hay fields

Once established, properly managed tall fescue and orchardgrass pastures and hay fields are competitive with many weeds. However, even with the best cultural management, certain annual and perennial weeds can be very troublesome. Unlike in bermudagrass, there are no safe and effective herbicides for the control of grass weeds in tall fescue and orchardgrass used for forage. However, the selection of broadleaf herbicides has greatly improved over the past decade, allowing for effective control of numerous perennial broadleaf weeds such as horsenettle and tall ironweed.

Late Fall and Early Spring – Two of the most common and troublesome weeds in Tennessee's pastures and hay fields are buttercups and musk thistle. Historically, most recommendations for control of these two weeds have been in March and early April. However, University of Tennessee research affirms that buttercups and musk thistle may be controlled with 2,4-D ester at 1 qt/A in the fall (late October to mid December) provided that weather is favorable (3 days of daytime temperatures of 60 F). Some producers have found it easier to make applications in the fall rather than in the spring due to more favorable weather some years and less competition for time from other farm-related activities. Buckhorn plantain, a troublesome perennial weed, may also be controlled with 2,4-D but it will require a higher rate. For well-established buckhorn plantain, apply 2,4-D ester at 3 to 4 pt/A. A program that has worked well in areas heavily infested with buckhorn plantain is the "1 – 2 punch." In this program, apply 2,4-D in the fall and then, if necessary, apply again in March to early April.

Late Spring and Summer – Warmer soil temperatures in late spring trigger the germination of numerous annual broadleaves and the emergence of several perennials. Some are more easily controlled than others. Easy-to-control weeds (sensitive to 2,4-D amine) include common cocklebur, common ragweed and common lambsquarters. Pigweeds are also controlled with 2,4-D and most other pasture/grass hay herbicides, but in areas with a heavy seed bank (around hay rings and other areas where cattle congregate) producers will see new flushes of pigweeds with each rainfall. More difficult-to-control weeds include horsenettle, tall ironweed, beggarweed (tick clover), cudweed and oxeye daisy. ForeFront R&P or Grazon P+D will provide much better control of these weeds than will 2,4-D. Chaparral will also control buckbrush,

goldenrod and brambles in addition to most of the weeds controlled by ForeFront R&P. However, University of Tennessee research has shown that Chaparral will cause substantial yellowing and stunting on actively growing tall fescue. This is because one of the active ingredients in Chaparral is metsulfuron. Ally, Cimarron, Cimarron Plus and Escort also contain metsulfuron, and the same effects on tall fescue can be expected from these materials. Tall fescue should be established for at least 24 months before applying a metsulfuron-containing herbicide.

Spurge Control in Tall Fescue – Problems with nodding spurge (*Chamaesyce nutans*) in tall fescue pastures and hay fields have increased dramatically across Tennessee in recent years. The recent dry summers and their impact on grass stands have certainly helped create this situation. Nodding spurge is a summer annual broadleaf weed that generally appears in June in pastures or after first hay cutting in hay fields. Unfortunately, most all of the commonly used herbicides (2,4-D, ForeFront R&P, Grazon P+D, Milestone, Rangestar/Weedmaster, etc.) are ineffective on nodding spurge. Cimarron Plus (metsulfuron + chlorsulfuron) and other products containing metsulfuron, however, provide excellent control. Keep in mind that while Cimarron Plus is safe on bermudagrass and established orchardgrass, it causes noticeable temporary yellowing, stunting and seedhead suppression in tall fescue. Producers who are experiencing problems with nodding spurge and who are willing to accept the injury to tall fescue may want to consider applying Cimarron Plus at 0.2 to 0.3 oz/A. Add nonionic surfactant at the rate of 1 qt/100 gal of spray mixture.

The clover dilemma

The benefits of adding clovers (Ladino and red) to grass pastures and hay fields are well-documented. Not only do clovers contribute nitrogen to the soil, they also partially mitigate the negative effects of the tall fescue endophyte on ADG. Many producers are reluctant to spray for weeds due to concerns for loss of clovers. For fields with improved Ladino and red clovers, this concern is well-founded. Renovation with 2 lb of Ladino and 4 lb of red clover per acre costs approximately \$23. Unfortunately due to weed pressure, many fields across Tennessee could benefit from a timely application of a herbicide even if it means sacrificing clovers. This is particularly true if the only clover present is volunteer white Dutch clover.

UT research conducted in the mid-1990s confirmed that while practically any rate of 2,4-D will kill red clover, low rates (1 qt/A) will kill only approximately 20 percent of established Ladino clover. This rate of 2,4-D is enough to provide excellent control of buttercups and musk thistle. Essentially all other herbicides will remove both types of clover. Residues of certain herbicides (ForeFront R&P, Milestone, Chaparral and Grazon P+D) remain in the soil, making it necessary to wait approximately one year prior to reseeding clovers.

Herbicides recommended for grass pastures and hay fields are listed in Table 4. Expected weed response for grass pasture and hay field herbicides can be found in Tables 5 and 6. Recommended spot treatments for pastures are listed in Table 7. Grazing, hay cutting and slaughter restrictions are listed in Table 8.

Table 4. Herbicides for Grass Pastures and Hay Fields*

Crop and Application Timing	Herbicide	Rate/Acre Broadcast		Weeds Controlled, Remarks and Precautions
		Active Ingredient	Formulation	
Bermudagrass only Established, Dormant	Gramoxone Inteon 2SL (Paraquat)	0.25-0.5 lb.	1.0-2.0 pts.	Apply to dormant bermudagrass for control or suppression of emerged winter annual weeds. For control of little barley, apply before the mid-boot stage. Add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Bermudagrass only Established, Dormant	Roundup PowerMax 4.5 ae or Roundup WeatherMax 4.5 ae (glyphosate)	0.28-0.39 lb.	8-11 oz.	Apply 8-11 oz./A to Dormant bermudagrass in late winter to early spring. Higher rates may be used, but injury will occur if bermudagrass has broken dormancy. Applications may be made in late fall, also, if bermudagrass is dormant.
Bermudagrass only Established, Dormant	Prowl H2O (Pendimethalin)	1 -4 lb.	1.1-4.2 qt.	Apply to dormant, established bermudagrass prior to weed germination. Rainfall required for activation. Good control of several annual grasses and small-seeded broadleaf weeds. Use higher end of rate range for heavy weed pressure and/or longer residual control. May be tank-mixed with Gramoxone Inteon 2SL, Roundup PowerMax or Roundup WetherMax.
Bermudagrass only First-year or Established	Cimarron Plus 63WG (metsulfuron+Chlorsulfuron)a	0.06 + 0.019 oz. to 0.3+0.094 oz.	0.125-0.625 oz.	Bermudagrass should be established at least 60 days prior to application. Apply before weeds are 4 inches tall or in diameter. Rate depends upon target weeds. See label. Add nonionic surfactant at 1 to 2 pts./100 gal. of spray mix
Bermudagrass only Established	Maverick 75 DF or Outrider 75 DF (sulfosulfuron)	0.56-1.5 oz.	0.75-2 oz.	Apply overtop for control of johnsongrass and nutsedge. Does not control summer annual grasses nor most broadleaves. Always add nonionic surfactant at 1 qt./100 gal. of spray mix. Applications of 1.25 oz./A have performed well on 18-24 in. johnsongrass. Temporary bermudagrass stunting may occur. Grass may be grazed immediately; do not harvest for hay for 14 days.
Bermudagrass only Established	Pastora 71.2 WG (Nicosulfuron + metsulfuron)	0.56+0.15 oz. To 0.84+0.23 oz.	1-1.5 oz.	Pastora is a premixture of the active ingredients in Accent and Escort herbicides. Apply overtop to control johnsongrass, broadleaf signalgrass, barnyardgrass, fall panicum, foxtails and many broadleaf weeds. Does not control crabgrass nor dallisgrass. Always add nonionic surfactant at 1 qt./100 gal. of spray mix. Noticeable growth reduction and discoloration following application usually occurs, but bermudagrass will recover. Injury may be reduced by applying when bermudagrass has less than 2 in. of new growth following green-up, or within 7 days following hay harvest. Pastora has no grazing nor hay cutting restrictions.
Seedling Forage Grasses	Aim 2EC (carfentrazone)	0.016-0.023 lb.	1.0-1.5 oz.	Apply to seedling forage grasses no sooner than 7 days following emergence. Use for control of a limited number of broadleaved weeds, under 4 inches tall, such a pigweeds, black nightshade, lambsquarters, and velvetleaf. Do not make applications less than 7 days apart. Always add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Seedling Forage Grasses	2,4-D Amine 4L	0.5- 0.75 lb.	1- 1.5 pts.	Can be used on all forage grasses for control of buttercup, thistles, wild turnip, horseweed and plantain. Apply when weeds are less than 4 in. tall and actively growing. This treatment will kill clovers and other legumes in the seedling stage. Do not apply if seedling grasses do not show good vigor. Add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
First-Year and Established Forage Grasses	ForeFront R&P (Aminopyralid + 2,4-D)	0.06 + 0.5 – 0.11 + 0.87 lbs.	1.5 – 2.6 pts.	During the year of establishment, apply after grasses have begun to tiller, develop a good secondary root system, and show good vigor. Use for control of buttercups, thistles, cocklebur, pigweeds, bitter sneezeweed, horsenettle, tall ironweed, plantains, and several others. See label for individual weed rates. Will kill pasture legumes, but reseeding may be possible one year later (see label). Always add a nonionic surfactant at the rate of 1 qt. /100 gal. of spray mix.
First-Year and Established Forage Grasses	GrazonNext HL (Aminopyralid + 2,4-D)	0.06 + 0.5 – 0.11 + 0.87 lbs.	1.2-2.1 pts.	During the year of establishment, apply after grasses have begun to tiller, develop a good secondary root system, and show good vigor. Use for control of buttercups, thistles, cocklebur, pigweeds, bitter sneezeweed, horsenettle, tall ironweed, plantains, and several others. See label for individual weed rates. Will kill pasture legumes, but reseeding may be possible one year later (see label). Always add a nonionic surfactant at the rate of 1 qt. /100 gal. of spray mix. Note-New restrictions are in place for GrazonNext HL: <ul style="list-style-type: none"> Do not use grasses treated with GrazonNext HL in the preceeding 18 months for hay intended for export outside the United States. Do not use hay or straw from areas treated with GrazonNext HL within the preceeding 18 months, or maure from animals feeding on hay treated with GrazonNext HL, in compost. Do not use grasses treated within the preceeding 18 months for seed production.

Table 4. (cont.) Herbicides for Grass Pastures and Hay Fields*

Crop and Application Timing	Herbicide	Rate/Acre Broadcast		Weeds Controlled, Remarks and Precautions
		Active Ingredient	Formulation	
First-Year and Established Forage Grasses	Grazon P+D (picloram + 2,4-D) For use only in approved TN counties.	0.14 + 0.5 – 0.2 + 0.75 lb.	2-3 pts.	This is a Restricted Use Pesticide (RUP) which requires a license to purchase and apply. Apply after newly seeded grasses have begun to tiller and develop a secondary root system (usually around the 4-leaf stage of grasses). Use for thistles, horsenettle, ragweed, cocklebur, buttercup and others. Will kill pasture legumes, but reseeding may be possible one year later. On most weeds apply in March to mid-summer when actively growing. Most perennials will require higher rates (see label). Always add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
First-Year and Established Forage Grasses	Milestone (aminopyralid)	0.063 – 0.011 lb	4 – 7 ozs.	During the year of establishment, apply after grasses have begun to tiller and develop a secondary root system and show good vigor. Use for control of buttercups, thistles, cocklebur, pigweeds, bitter sneezeweed, horsenettle, tall ironweed and several others. Weak on plantains, Control may be improved by tankmixing with 2,4-D. A limited number of weeds such as cocklebur and smartweed may be controlled with 3 oz/A. See label for individual weed rates. Will kill pasture legumes, but reseeding may be possible one year later. Always add a nonionic surfactant at the rate of 1 qt./100 gal of spray mix.
First-Year and Established Forage Grasses	Rage D-Tech (Carfentrazone + 2,4-D ester)	0.008+0.25 – 0.33+1.0 lb	2-3 pts.	Broader spectrum control than Carfentrazone (Aim) applied alone. May be applied to newly established grasses beginning at the 5-leaf stage. Add non-ionic surfactant at the rate of 1 qt./100 gal. of spray mix.
First-Year and Established Forage Grasses	Redeem R&P (triclopyr + clopyralid)	0.56+0.19- 0.84+0.28 lb.	2-3 pts.	For use when products containing 2,4-D are not an option. Apply after newly seeded grasses have begun to tiller and develop a secondary root system (usually around the 4-leaf stage of grasses). Use for thistles, ragweed, cocklebur, buttercup and others. Will kill pasture legumes, but reseeding is usually possible the next growing season. On most weeds apply in March to mid-summer when actively growing. Most perennials will require higher rates (see label). Always add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Established Grass and White Clover Mixtures	2,4-D Amine 4L OR 2,4-D Low Volatile Ester 4EC	0.75-1.0 lb.	1.5-2 pts.	Can be used on all established mixtures of grass and white clover. Apply in March to early April for control of buttercup, musk thistle, dandelion and plantain. Apply in June for control of cocklebur, bitter sneezeweed, pigweed, spiny amaranth and ragweed. NOTE: The amine formulation is less volatile than low volatile ester formulations, but is less effective on hard-to-control species such as thistles, plantain and other perennials. Add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Established, Grass and Annual Lespedeza Mixtures	2,4-D Amine 4L	0.5-0.75 lb.	1-1.5 pts.	Can be applied when lespedeza is 3 to 7 inches tall (normally mid-June). Earlier applications will result in more severe injury. Add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Established Forage Grasses	2,4-D Ester 4EC	2.0 lb.	2 qts.	For wild garlic control, apply in October to mid-November or March to mid-April when daytime temperature is at least 65 F. Repeat twice annually for 2 years to eliminate wild garlic. This same program is effective on buckhorn plantain. This rate of 2,4-D will kill all legumes, including established white clover. Add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Established Forage Grasses	PastureGard or PastureGard HL (triclopyr + fluroxypyr)	0.38 + 0.13 - 1.5 + 0.5	2-8 pts. PastureGard or 1-4 pts. PastureGard HL	Use when brush or woody plants have begun to establish in pasture. May be tank-mixed with other products to improve control of herbaceous weeds. Excellent control of sericea lespedeza. Especially good on blackberry and other woody plants. For woody plant control, apply in summer after plants have fully leafed out. For blackberry, apply in summer after fruit drop when good moisture is available. Usual broadcast rates for woody plant control: 3-4 pints/acre. May be used on fencerows and for individual plant treatments of trees and brush. Always add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Established Forage Grasses	Surmount (picloram + fluroxypyr) For use only in approved TN counties.	0.13 + 0.13- 0.5 + 0.5	1.5 – 6 pts.	This is a Restricted Use Pesticide (RUP) which requires a license to purchase and apply. Use for brush control plus residual broadleaf weed control. Especially good on blackberry, ironweed, horsenettle, thistles, etc. For woody plant control, apply in summer after plants have fully leafed out. For blackberry, apply in summer after fruit drop when good moisture is available. Usual broadcast rates for woody plant control: 3-4 pints/acre. Always add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Established Forage Grasses	Brash/Range Star/Weedmaster 3.87SL (Dicamba + 2,4-D Amine)	(0.125 + 0.36) to (0.5 + 1.4 lbs.)	1-4 pts.	Will usually give control of a wider range of weeds than either herbicide alone. Only partially effective on difficult-to-control perennials such as dock, brambles and horsenettle. High rates (see label) required for difficult-to-control species. Will kill all pasture legumes. Add nonionic surfactant at the rate of 1 qt./100 gal. of spray mix.
Sorghum-Sudangrass Hybrids - Postemergence	AAtrex 4L or 90WDG (Atrazine)	2.0 lbs.	2 qts. or 2.2 lbs.	Atrazine is a restricted use pesticide . Apply overtop once a stand is obtained and before weeds exceed 1.5 inches in height. Do not apply after crop is 12 inches in height. See label for surface and groundwater protection measures. Atrazine is not labeled on sweet sorghum.

*See Table for Grazing, Hay Cutting and Slaughter Restrictions.

Pasture and Grass Hay Herbicide Residues - Precautions and Reminders

Certain pasture herbicides (ForeFront R&P, GrazonNext HL, Grazon P+D, Milestone and Surmount) contain active ingredients that may persist in treated soil, grass, harvested hay, and in cattle manure and urine. Numerous broad-leaf crops, garden vegetables and ornamentals are very sensitive to minute amounts of these active ingredients. Because of this, careful planning is required regarding use of treated pastures and hay, in the movement of animals that have been grazing in treated pastures or that have been fed treated hay, and in the use of manure from animals that have been grazing in treated pastures or that have been fed treated hay. **These herbicides are for use in permanent grass pastures and grass hay fields only. They should not be used in fields that will be rotated to broadleaf crops.**

Manure from animals that have been grazing treated pastures or that have been fed treated hay should not be used to fertilize broadleaf crops or home

gardens unless the animals have been withdrawn from treated pastures or hay (3 days for ForeFront R&P, GrazonNext HL and Milestone, 7 days for Grazon P+D and Surmount). Likewise, treated hay should not be used for mulch in vegetable production, gardens or landscape beds. Do not transfer animals that have been grazing treated pastures or that have been fed treated hay to fields that will be rotated to sensitive crops unless they have been withdrawn from treated pastures or hay (3 days for ForeFront R&P and Milestone, 7 days for Grazon P+D and Surmount).

Note-New restrictions are in place for GrazonNext HL: Do not use grasses treated with GrazonNext HL in the preceding 18 months for hay intended for export outside the United States. Do not use hay or straw from areas treated with GrazonNext HL within the preceding 18 months, or manure from animals feeding on hay treated with GrazonNext HL, in compost. Do not use grasses treated within the preceding 18 months for seed production.

Table 5. Expected Weed Response to Pasture Herbicides

	LATE WINTER TO EARLY SPRING APPLICATIONS							FALL (NOVEMBER TO EARLY DECEMBER) APPLICATIONS					
	2,4-D Ester	2,4-D Amine	ForeFront R&P/ GrazonNext HL	Grazon P+D*	Milestone	Redeem R&P	Brash/Range Star/ Weedmaster	2,4-D Ester	2,4-D Amine	Grazon P+D*	Milestone	Redeem R&P	Brash/Range Star/ Weedmaster
Bedstraw	3	3	9	9	9	----	3	2	2	9	9	----	2
Broadleaf plantain	8	7	8	8	2	8	9	8	7	8	2	8	9
Buckhorn plantain	7	6	7	7	2	8	8	7	6	8	2	8	8
Bull thistle	8	7	9	9	9	9	8	9	7	9	9	9	9
Buttercups	9	8	9	9	8	9	9	9	8	9	8	9	9
Carolina geranium	5	4	9	9	9	----	7	4	3	9	9	----	6
Common chickweed	2	1	----	8	----	8	5	3	2	9	----	9	8
Curly dock	4	3	9	9	9	----	4	5	3	9	9	----	6
Dandelion	9	8	9	9	9	8	8	9	8	9	9	8	8
Henbit	2	1	----	8	----	8	4	3	2	8	----	8	7
Horseweed	9	8	9	9	9	9	9	9	8	9	9	9	9
Musk thistle	8	7	9	9	9	9	7	9	8	9	9	9	8
Prickly lettuce	8	7	9	9	9	8	8	8	6	9	9	8	8
Red sorrel	3	3	----	8	----	7	5	3	3	8	----	8	6
Sowthistle	8	8	9	9	9	----	9	7	7	9	9	----	8
Wild garlic	8	6	6	5	4	----	6	8	6	5	5	----	6

Key to Response Ratings: 0=No control; 10=100% Control; -- = Data not available. Ratings are based on labeled rates of each herbicide, applied at the optimum time for each weed.

*For use only in approved TN counties.

Table 6. Expected Weed Response to Pasture Herbicides: Late Spring to Summer Applications

	2,4-D Ester	2,4-D Amine	ForeFront R&P/ Grazon Next HL	Grazon P+D*	Milestone	Redeem R&P	Brash/Range Star/ Weedmaster
Beggarweed	3	2	8	9	9	-----	4
Bitter sneezeweed	8	7	9	9	9	-----	8
Brambles	4	2	4	6	3	6	5
Chicory	5	4	-----	8	-----	8	8
Common cocklebur	9	9	9	9	9	9	9
Common lambsquarters	9	9	9	9	9	8	9
Cudweed	3	2	9	9	9	-----	6
Dogfennel	6	6	7	8	4	7	7
Goldenrod	6	4	5	8	4	6	7
Horsenettle	3	2	8	9	8	5	4
Jimsonweed	8	7	8	4	8	9	8
Maypop passionflower	0	0	4	4	3	0	0
Milkweed	3	2	-----	5	3	-----	6
Oxeye daisy	5	4	9	8	9	-----	8
Pigweeds	9	9	8	7	8	4	9
Pokeweed	5	4	8	4	8	2	6
Prickly pear	0	0	0	6	0	0	0
Prickly sida	4	4	8	5	8	-----	5
Purple (perilla) mint	8	7	8	7	8	-----	8
Ragweeds	9	8	9	9	9	9	9
Smartweed	7	5	9	-----	9	-----	8
Spiny amaranth	9	7	9	7	8	4	9
Sumpweed	9	8	-----	7	-----	8	9
Tall ironweed	7	6	8	6	8	6	7
Trumpetcreeper	0	0	0	0	0	0	0
White heath aster	7	5	-----	8	-----	-----	7
White snakeroot	6	6	9	8	9	-----	7
Wild carrot	7	7	8	8	6	8	7
Wingstem	8	7	9	8	9	-----	8

Key to Response Ratings: 0=No control; 10=100% Control; -- = Data not available. Ratings are based on labeled rates of each herbicide, applied at the optimum time for each weed.

*For use only in approved TN counties.

Table 7. Spot Treatments for Specific Weeds in Pastures*

Weed	Herbicide	Amount of Formulation Per		Remarks
		1 gal.	100 gal.	
Bermudagrass	Roundup Ultra 4L (Glyphosate)	5 Tbsp.	2 gal.	Apply a 2% mixture of Roundup Ultra in water to actively growing bermudagrass when seed heads are present. Retreatment may be required. See labels for other glyphosate formulations.
Brambles	Crossbow 3EC (2,4-D ester+ Triclopyr ester)	2.5 to 4 Tbsp.	1 to 1.5 gal.	Apply as a foliar spray to runoff in the spring after brambles are fully leafed. Complete coverage of leaves and green stems is needed.
	PastureGard/ PastureGard HL (triclopyr + fluroxypyr) + surfactant	1.3 to 2 oz. PastureGard or 0.67 to 1 oz. PastureGard HL + 4 tsp.	1 to 1.5 gal. PastureGard or 0.05 to 0.75 gal. PastureGard HL + 2 qt.	Apply as a foliar spray after fruit drop in summer. Apply when moisture is adequate. Spray to wet, avoiding runoff. Spray all leaves and branches
	Remedy Ultra 4EC (Triclopyr) + surfactant	4 tsp. + 4 tsp.	2 qt. + 2qt.	Apply as a foliar spray to thoroughly cover all leaves and green stems in the spring after brambles are fully leafed.
	Roundup Ultra 4L (Glyphosate)	2.5 to 4 Tbsp.	1 to 1.5 gal.	Apply as a foliar spray in late summer or early fall after berries have set or dropped. See labels for other glyphosate formulations.
Honeysuckle	2,4-D Amine 4L	2 Tbsp.	3 qts.	Apply as a foliar spray when plants are actively growing, prior to bloom stage. Thorough coverage is needed. Add a nonionic surfactant at the rate of 2 qts./100 gal. of spray mix (2 Tbsp./1 gal.).
	Remedy Ultra 4EC (Triclopyr) + surfactant	4 tsp. + 4 tsp.	2 qt. + 2qt.	Apply as a foliar spray when plants are actively growing, prior to bloom stage. Complete coverage is necessary.
	Roundup Ultra 4L (Glyphosate)	2.5 to 4 Tbsp.	1 to 1.5 gal.	Apply as a foliar spray when plants are actively growing, at or beyond the bloom stage. Use the higher rate for plants that have reached the woody stage. Thorough spray coverage is needed. See labels for other glyphosate formulations.
Ironweed	Crossbow 3EC (2,4-D ester+ Triclopyr ester)	2.5 to 4 Tbsp.	1 to 1.5 gal.	Apply as a foliar spray in late spring to early summer when plants are actively growing. Thorough coverage is needed.
	PastureGard/ PastureGard HL (triclopyr + fluroxypyr) + surfactant	1.3 to 2 oz. PastureGard or 0.67 to 1 oz. PastureGard HL + 4 tsp.	1 to 1.5 gal. PastureGard or 0.05 to 0.75 gal. PastureGard HL + 2 qt.	Apply as a foliar spraying late spring through early summer when plants are actively growing.

Table 7. Spot Treatments for Specific Weeds in Pastures* (continued)

Weed	Herbicide	Amount of Formulation Per 1 gal. 100 gal.		Remarks
Multiflora Rose	Crossbow 3EC (2,4-D ester+ Triclopyr ester)	2.5 to 4 Tbsp.	1 to 1.5 gal.	Apply as a foliar spray after plants have complete foliage. Apply when moisture is adequate. Spray to wet, avoiding runoff. Spray all leaves and branches.
	PastureGard/ PastureGard HL (triclopyr + fluroxypyr) + surfactant	1.3 to 2 oz. PastureGard or 0.67 to 1 oz. PastureGard HL + 4 tsp.	1 to 1.5 gal. PastureGard or 0.05 to 0.75 gal. PastureGard HL + 2 qt.	
	Remedy Ultra 4EC (Triclopyr) + surfactant	4 tsp. + 4 tsp.	2 qt. + 2 qt.	
	Roundup Ultra 4L (Glyphosate)	2.5 Tbsp.	1 gal.	Apply as a foliar spray in the summer after full bloom stage. Apply before Japanese beetles or other leaf-feeding insects damage leaves. Complete leaf coverage is needed. See labels for other glyphosate formulations.
Osage orange (bois d'arc) Locust, Sas- safras, Sumac, Sweetgum	Remedy Ultra 4EC (Triclopyr) + surfactant	4 tsp. + 4 tsp.	2 qt. + 2 qt.	Apply as a foliar spray following full leaf development. Thorough coverage of all foliage is necessary for control.
Thistle, Canada	Metsulfuron 60DF (various brands)	0.01 oz.	1 oz.	Apply as a foliar spray in the spring when plants are at least 6 to 10 inches tall and before flowering. Thorough coverage is needed. Add a nonionic surfactant at the rate of 1 to 2 qts./100 gal. (2 to 4 tsp./gal).
Thistle, Musk	2,4-D Ester 4EC OR 2,4-D Amine 4L	2 Tbsp.	3 qts.	Apply ester formulation as a foliar spray to the point of runoff to small plants, less than 6-8 inches tall in late winter to early spring, or in the fall. If treating regrowth following mowing in the summer, use the amine formulation to reduce vapor drift.
Yucca	Remedy Ultra 4EC (Triclopyr) in basal or crop oil	5 Tbsp.	2 gal.	Prepare a 2% (by volume) solution of Remedy Ultra in basal or crop oil. Thoroughly wet the center of the plant including growing point and leaf bases to the soil surface. Complete coverage of leaves is not necessary.

*See Table for Grazing, Hay Cutting and Slaughter Restrictions

Grazon P+D and Surmount Guidelines for Tennessee

Grazon P+D and Surmount are marketed in a limited number of counties in Tennessee. These counties were chosen because they have little or no acreage of cotton, tobacco and certain other sensitive crops, or because the counties have had a history of Grazon P+D use without non-target problem. The University of Tennessee does not recommend the use of Grazon P+D or Surmount outside of these counties. See figure on page 13. Grazon P+D and Surmount are safe on established cool-and warm-season grasses used for pasture and hay production. They provide good control of a number of broadleaf weeds. Both provide some residual control. The residual effect will depend on temperature, soil type, moisture and plant sensitivity. These products will kill all pasture legumes and re-seeding should not be attempted within one year of application.

Grazon P+D and Surmount are restricted-use pesticides, requiring applicators to have a commercial pesticide applicator certification card. They are restricted use due to the risk of injury to susceptible, non-target plants. Broadleaf crops, like cotton, tobacco, tomatoes and others, are very sensitive to both herbicides. Care must be taken in use of hay from fields treated with Grazon P+D or Surmount. Do not spread manure from animals that have grazed on or have been fed hay on fields where picloram-sensitive crops will be grown. Due to this sensitivity, it is recommended to use a sprayer dedicated to pasture applications only. Read and understand the label restrictions before using this product.

Check List for Grazon P+D and Surmount Use

If all of the following are answered as “satisfactory,” then an application of Grazon P+D or Surmount may be recommended.

Is the site located within one of the approved counties for this herbicide?

Does the applicator have a restricted-use applicator certification or use a custom applicator?

Is the site properly buffered from sensitive crops and other off-target species, including ornamentals?

Is there surface water (ponds or streams) on site? If so, does the applicator know to keep a 50-foot buffer?

Has the required personal protective equipment been prepared?

Are the wind conditions calm enough to prevent drift?

Is rain in the forecast? If so, the application should be delayed.

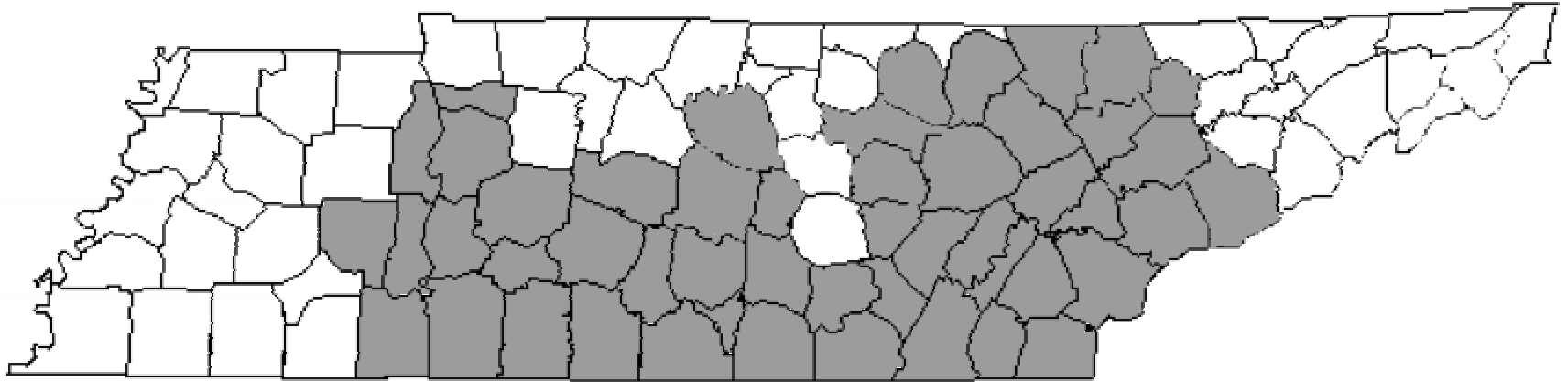
Does the applicator / land manager understand the grazing, haying and manure restrictions (see label)?

Is there a risk of surface runoff of the herbicide, including erosion? (e.g., does the site contain steep slopes with bare soil?) If so, the application is not recommended.

Is the site a permanent pasture? (If there is intention to rotate to any field crops, ornamentals, tobacco, vegetables or other vegetation, application is not recommended.)

Does the applicator understand the sprayer cleanout requirements?

**Tennessee Counties Approved for
Grazon P+D and Surmount Application***



*Shaded counties are approved for Grazon P+D and Surmount application.

Anderson	Cannon	Grundy	Knox	Maury	Polk	Sevier	Wilson
Bedford	Coffee	Hamilton	Lawrence	McMinn	Putnam	Scott	
Benton	Cumberland	Hardin	Lewis	Meigs	Overton	Union	
Bledsoe	Decatur	Henderson	Lincoln	Monroe	Rhea	Van Buren	
Blount	Fentress	Hickman	Loudon	Moore	Roane	Wayne	
Bradley	Franklin	Houston	Marion	Morgan	Rutherford	White	
Campbell	Giles	Humphreys	Marshall	Perry	Sequatchie	Williamson	

Table 8. Hay Cutting and Animal Slaughter for Pasture Herbicides (Days to Wait or Withdraw Animals)

Herbicide	Beef Cattle, Non-Lactating Dairy Cattle and Other Livestock			Lactating Dairy Cattle		
	Grazing	Hay Cutting	Slaughter	Grazing	Hay Cutting	Slaughter
Aim	0	0	**N	0	0	**N
Metsulfuron	0	0	0	0	0	0
Crossbow*	0	7	3	14	1 yr.	3
ForeFront R&P/ GrazonNext HL	0	7	3	0	7	**N
Gramoxone Inteon SL (dorm. bermudagrass)	40	40	**N	40	40	**N
Grazon P+D (picloram + 2,4-D)	0	30	3	7	30	3
Milestone	0	0	3	0	0	3
Maverick/Outrider	0	14	**N	0	14	**N
Pastora	0	0	**N	0	0	**N
PastureGard/PastureGard HL (triclopyr + fluroxypyr)	0	14	3	Next growing season	14	3
Prowl H ₂ O (dorm. bermudagrass)	45	60	**N	45	60	**N
Rage D-Tech	0	30	3	7	30	3
Redeem R&P	0	7	3	14	1 yr.	3
Remedy	0***	7***	3	14***	1 yr.	3
Roundup PowerMax or WeatherMax (spot tmt.)	14	14	**N	14	14	**N
Roundup PowerMax or WeatherMax (spot tmt.)	0	0	**N	0	0	**N
Surmount (picloram + fluroxypyr)	0	30	3	Next growing season	30	3
2,4-D	0	30	3	7	30	3
Brash/Range Star/ Weedmaster	0	37	30	7	37	30

*2 gals./A or less

**N = no information on label

*** = 2 qt./A or less

Herbicide Stewardship Reminders

Residues of herbicides containing aminopyralid (ForeFront/GrazonNext, Milestone and Chaparral) or picloram (Grazon P+D) are relatively persistent in soil, grass and manure. Producers are therefore encouraged to plan ahead regarding use of treated pastures and hay, in the movement of animals that have been grazing in treated pastures or fed treated hay, and in the use of manure from animals that have been grazing in treated pastures or fed treated hay. These herbicides are for use in permanent grass pastures and grass hay fields only. They should not be used in fields that will be rotated to broadleaf crops.

Aminopyralid and picloram remain intact in treated pasture grasses or hay, and when these forages are consumed by animals, the chemical passes through their digestive and urinary systems without change and into the manure and urine. It takes some time for aminopyralid and picloram to pass through an animal. Because of this, manure from animals that have been grazing treated pastures or fed treated hay should not be used to fertilize broadleaf crops or home gardens, unless the animals have been withdrawn from treated pastures or hay for three days (aminopyralid) or seven days (picloram). Likewise, treated hay should not be used for mulch in vegetable production, gardens or landscape beds. Animals that have been grazing treated pastures or fed treated hay should not be moved to fields that will be rotated to sensitive crops unless they have been withdrawn from treated pastures or hay (three days for aminopyralid; seven days for picloram).

Aminopyralid and picloram are more difficult to rinse from a sprayer than most other pasture herbicides. It is particularly important to have a dedicated sprayer for these materials in pastures and hay fields and not to use this sprayer to apply other chemicals on sensitive crops. Also, producers are reminded to avoid spraying these and other herbicides in windy conditions where drift to adjacent cropland is likely.

We are very fortunate to have these highly effective tools for weed control in forages, and good product stewardship as described above will help to keep these materials available for the foreseeable future. As is the case with all agricultural chemicals, be sure to read, understand and follow all label directions.

Herbicide Drift: How It Can Happen, How to Prevent It

Spray drift can result in reduced weed control at the target field, damage to adjacent crops and desirable vegetation, environmental pollution, expensive fines and/or lawsuits, and bad publicity for our industry. Most of the calls UT staff receive concerning herbicide drift involve pasture herbicides.

Movement of small amounts of commonly used pasture herbicides (2,4-D, Banvel, Crossbow, ForeFront R&P, Grazon P+D, Milestone, etc.) away from treated fields can cause serious damage to sensitive crops such as cotton, tobacco, tomatoes and other vegetables, vineyards and ornamental nurseries. Two types of drift, physical and vapor, can occur. Physical drift is the movement of liquid spray droplets (usually the finer or smaller droplets) away from the target. Factors that increase the likelihood of drift include wind, high temperatures and a sprayer setup that produces high pressures and low application volume (a large number of small spray droplets). Vapor drift is most influenced by air temperature. Some chemicals volatilize (change from a liquid to a gas or vapor) readily at warm (85 F) temperatures. While less obvious than physical drift at the time of application, vapor drift can be just as damaging. Similarly, small amounts of herbicides such as 2,4-D in sprayers can create serious problems if the same sprayer is used to apply pesticides to crops such as tobacco, tomatoes, peppers, melons and other vegetables. It is strongly advisable to have a dedicated sprayer for pasture herbicides and not use this sprayer on sensitive crops.

The following are suggestions to reduce the likelihood of drift from herbicides:

1. Know adjoining farms and other properties well. Most producers are familiar with their neighbors and know if they grow sensitive crops. Check on when your neighbor, for example, plans to set tobacco or plant cotton, and which fields he or she plans to use this year. Information of this nature will allow you to plan accordingly for individual fields. Also, be familiar with locations of outdoor tobacco float beds, greenhouses, vineyards and container nursery operations.
2. Set up your sprayer to produce large droplets. High-volume (20 to 30 gallons per acre), low-pressure (20 psi or less) applications will reduce the number of “fines” or small spray droplets. One of the problems with low pressure in the past has been that flat-fan nozzles would not develop patterns adequately at low pressure. Manufacturers have made great advances during the last several years with the development of low-pressure, extended-range flat-fan tips and air-induction spray tips. If your farm supply store does not stock these tips, ask the dealer to order them for you.
3. Try to spray at a time of year when sensitive crops are not growing. This is often difficult to accomplish because the optimum time for weed control may occur when a sensitive crop is in the field. However, some weeds, such as musk thistle, may be treated after mid-October with 2,4-D. This would be a good approach for a field across the fence from your neighbor's tomatoes or tobacco, in that

you could treat at a time of year when the crop has already been harvested.

This should also be considered in areas where cole crops (broccoli, cauliflower, cabbage) are grown, as most producers in Tennessee grow spring crops rather than fall crops, of these sensitive vegetables.

4. Avoid spraying on windy days. Although this is common sense, it is one of the most effective ways to reduce physical drift. In general, calm conditions are more likely to be encountered either early or late in the day. Actually, a slight breeze blowing away from the sensitive field is one of the better situations for managing drift.
5. To reduce the risk of vapor drift, use the amine formulation of 2,4-D rather than the low-volatile ester formulation. This is particularly important with late spring to summer applications, when warm (85 F) temperatures are likely to be encountered at or shortly after spraying. The amine formulation is much less volatile than the low-volatile ester formulation. This is very important to remember, in that vapor drift will be worse under warm conditions, and that it can occur even a few days after application. Other temperature-sensitive herbicides include Banvel, Crossbow and Weedmaster. Drift-reduction measures such as low pressure, special nozzles, drift retardants, etc. do not reduce vapor drift.
6. Last but not least, read the herbicide label for drift reduction measures or restricted zones for application. Many herbicide labels contain specific warnings and suggest measures for reducing the likelihood of drift of the product. Some herbicides actually have restricted or buffer zone requirements. Application within that restricted area would be a violation of federal law.

Sprayer Calibration

Effective weed control with herbicides depends on applying the correct rate for a given weed situation. This depends on knowing how much material is coming out of the sprayer over a given area. This is why sprayer calibration is so important.

“Why bother calibrating at all? I usually just pour 5 gallons of 2,4-D in a full sprayer tank and spray until the tank is empty. The cockleburrs die.”

Without calibrating your sprayer, you do not know how much material you are applying per acre. You could be applying more than the maximum rate listed on the label, risking injury to the crop plus wasting money. You might not be applying enough, resulting in poor weed control. Also, if you decided to switch to another herbicide, the rate might be different.

“That all makes sense, but calibrating is just so complicated. I don’t know where to start.” Sprayer calibration does not have to be complicated. Two different calibration methods are described step-by-step in the following section. Read through both, and decide which will work best for you and your situation.

Note: Calibrating should be done with clean water only, and never with a herbicide in the tank. Also, all nozzles should be checked for damage, wear and irregular patterns. Any nozzle that has an irregular pattern or has a measured flow rate that varies by more than 10 percent from a new nozzle of the same type should be replaced. Finally, it is important that you operate your nozzles within the range of pressures recommended by the manufacturer for optimum performance.

Note for boomless sprayers: To find the effective spray width for boomless sprayers, complete these steps: With the tractor stationary on a paved surface, turn on the sprayer and let it run for several seconds, until enough water has been sprayed to wet the pavement. Turn off the sprayer. Look at the wet area on the pavement and, beginning at the nozzle, decide how far out in each direction the pattern looks uniform, not spotty or lightly sprayed. Measure the width of the uniform spray pattern on the ground to determine effective width.

Known Area Method

This simple calibration technique requires that you have a field of known area in acres, or that you are able to mark off a known area of a few acres. This method works for most types of sprayers, and it is the best method for boomless sprayers. You must have a sprayer tank that has volume measurements on it or be able to measure the volume of water you are putting in it.

1. Fill the sprayer tank up to a known volume with water.
2. Choose a tractor gear and throttle setting that is comfortable and safe to operate in the desired field.
3. Using that gear and maintaining a constant throttle setting, spray the field of known size until the entire area has been covered. Try to avoid overlaps and missed areas, as these will create errors in your calibration.
4. Determine the amount of water used to spray the area by either (1) subtracting the amount left in the tank from what you started with or (2) measuring how much water is required to fill the tank back to the starting volume. Divide this number, the amount you sprayed, by the number of acres in the field. This is your application volume in gallons per acre.

5. Now that you know the volume per acre, check the herbicide label and Extension recommendations for the amount of herbicide recommended to control the target weed(s). Add this amount of herbicide to your sprayer tank for every acre's worth of gallons of water. (For best accuracy with liquid herbicides, first subtract the volume of herbicide per acre from the total gallons per acre. This gives the volume of water to add per acre, taking into consideration the volume taken up by the liquid herbicide.)

To clarify, work through the following example:

You have a field that is exactly 10 acres. Fill your 300-gallon sprayer tank with water. After choosing a gear and throttle setting, spray the 10-acre field. After covering the entire field, you determine that there are 120 gallons of water in the tank. Next, subtract 120 gallons from the initial 300 gallons, determining that 180 gallons have been applied to the 10-acre field. Divide 180 gallons by 10 acres, and determine that the application volume is 18 gallons per acre. Now, to treat a 16-acre field, multiply 18 gallons by 16 acres, determining that the total volume needed is 288 gallons. Based on the Extension recommendation, 1 pint of herbicide per acre is needed to control the target weed. Multiply 1 pint by 16 acres, determining that 16 pints, or 2 gallons, of herbicide is needed. Fill the sprayer tank approximately half way to 288 gallons with water, then add the 2 gallons of herbicide, and fill it up to 288 gallons with water.

1/128 Acre Method

This easy calibration method requires few calculations. Use the nozzle spacing on the boom to select a travel distance from the following table:

Nozzle Spacing in Inches	Course Length in Feet	Nozzle Spacing in Inches	Course Length in Feet
10	408	28	146
12	340	30	136
14	292	32	127
16	255	34	120
18	226	36	113
20	204	38	107
22	185	40	102
24	170	60	68
26	157	80	51

1. Using the length chosen in the previous table, lay off a straight line course in the field to be sprayed or on similar ground.
2. Choose a tractor gear and throttle setting that is comfortable and safe to use to spray the desired area.
3. Using the gear selected above and a constant throttle setting, drive the tractor back and forth over the distance at least three times, measuring the time it takes to travel the course. Be sure the tractor is up to speed before it crosses the start line and maintain constant speed until beyond the finish line. This step is much easier if you have someone stand at the start line and another person stand at the finish line to determine when the tractor crosses each line and to keep time. (The most accurate speed will be obtained if the sprayer is attached to the tractor, and the sprayer tank is half full).
4. Average the time required to travel the course.
5. Park the tractor and partially fill the spray tank with water.
6. Turn on the sprayer and adjust pressure until within the nozzle manufacturer's range.
7. Catch the output of one nozzle for the amount of time found in Step 4.
8. Measure this amount in ounces. The number of ounces collected equals the application volume in gallons per acre (GPA).
9. Use the GPA to calculate how much water and herbicide to add to the spray tank for the number of acres you intend to spray. This calculation was described in Step 5 in the "Known Area Method" section.

Here is an example problem:

The nozzle spacing on a boom is 20 inches. Based on the table, the course length should be 204 feet. Lay off a straight 204 foot course in the field to be sprayed. After driving the tractor over the course three times, determine that the average time is 46 seconds per pass. Next, park the tractor, turn on the sprayer, and catch the output from one nozzle for exactly 46 seconds. That amount is 13.5 fluid ounces, which equals an application volume of 13.5 gallons per acre. The field to be sprayed is 32 acres, so multiply 32 by 13.5 gallons and determine that 432 gallons of water should be added to the sprayer tank. The herbicide is a water-dispersible granule, and the label recommends 3 ounces per acre. Multiply 32 acres by 3 ounces of herbicide and see that 96 ounces, or 6 pounds, of the herbicide should be added to the tank.

Table 9. Herbicide Price List

Trade Name	Container Price (\$)	Formulation Rate Per Acre	Approx. Cost (\$) Per Acre
Aim	271.00/qt.	1 - 2 oz.	8.47 – 16.90
Cimarron Plus	147.00/10 oz.	0.125 – 0.5 oz.	1.84 – 7.35
ForeFront R&P	142.00/2.5 gal.	1.5 – 2.6 pt.	10.65 – 18.46
GrazonNext HL	99.00/2 gal.	1.2 - 2.1 pt.	7.43 – 13.00
Grazon P+D	82.00/2.5 gal.	2 – 3 pt.	8.20 – 12.45
Maverick	359.00/20 oz.	0.75 – 2.0 oz.	13.46 – 35.90
Milestone	97.00/qt.	3 – 7 oz.	9.10 – 21.22
Pastora	340.00/20 oz.	1 – 1.5 oz.	17.00 – 25.50
PastureGard	161.00/2.5 gal.	2 – 8 pt.	16.10 – 64.40
PastureGard HL	328.00/2.5 gal.	1 – 4 pt.	16.40- 65.60
Rage D-Tech	84.00/2.5 gal.	0.5 – 2 pt.	2.10 – 8.40
Range Star	68.00/2.5 gal.	1 – 4 pt.	3.40 – 13.60
Remedy Ultra	70.00/gal.	-----	-----
Surmount	156.00/2.5 gal.	1.5 – 6 pt.	11.70 – 46.80
2, 4-D Amine	45.00/2.5 gal.	1 – 4 pt.	2.25 – 9.00
2, 4-D Ester	57.00/2.5 gal.	1 – 4 pt.	2.85 – 11.40

Note: These are estimates of retail prices of commonly-used pasture herbicides and they are intended for use for planning purposes only. They do not include any volume discounts, rebates, etc. Consult your agricultural chemical supplier for current, local prices.



Professor Joe Burns spent his career educating forage producers in Tennessee and across the Southeast. Joe was a nationally renowned forage specialist with University of Tennessee Extension. Professor Burns served in this role for 37 years before retiring in 1992. During his career, he was honored as the Tennessee Man of the Year in Agriculture by *Progressive Farmer* magazine, and was awarded both the Merit Award and the Distinguished Grasslander Award from the American Forage and Grassland Council. Joe was well-known not only for his knowledge, but also for his kind and encouraging attitude. He was a role model and mentor for many faculty at UT and producers across the state.

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