

WEEDS

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Weeds compete with alfalfa for water, nutrients, light, and space. If weeds are left uncontrolled, they can reduce alfalfa yields and weaken or even destroy the stand. Weeds also reduce the quality and value of alfalfa hay because most weeds—such as hare barley (commonly called foxtail), downy brome (cheatgrass), and green foxtail (bristlegrass)—can injure the mouths of livestock, rendering the forage less palatable. Others, such as fiddleneck and yellow starthistle, are poisonous and, if present in sufficient quantities, make the forage unsuitable for livestock consumption.

Weed control can be particularly challenging in the Intermountain Region because of long alfalfa stand life. Weeds invade the open areas that often occur in older depleted alfalfa stands. Weed control is problematic when fields remain in the same crop for many years and where few rotation crops are grown, two conditions that are common in many parts of the Intermountain Region.

WEED BIOLOGY

Effective weed management requires an understanding of weed biology. Weeds are classified according to their life cycle and fall into three groups: annuals, biennials, and perennials. Table 6.1 lists common weeds that occur in intermountain alfalfa fields.



Annual weeds emerge from seed, grow, flower, produce seed, and die within a year. Plants the next season must emerge from seed. Annual weeds are divided into winter and summer annual weeds, depending on growth pattern. Winter annual weeds germinate in the fall through early spring (October to March), when soil temperature and moisture are favorable. They grow rapidly in the spring and are usually a problem only in the first cutting of alfalfa. Summer annual weeds germinate as temperatures rise in the late spring (April to May) through summer, whenever soil moisture is adequate. Summer annual weeds are not a problem in the first cutting of established stands, but they appear in the second and later alfalfa cuttings. Only a few weeds in alfalfa are classified as biennials, which require 14 to 24 months to complete their life

Table 6.1. Problem weeds of alfalfa in the Intermountain Region of California.

COMMON NAME	BOTANICAL NAME	FAMILY
WINTER ANNUAL WEEDS		
Shepherdspurse	<i>Capsella bursa-pastoris</i>	Mustard
Flixweed	<i>Descurainia sophia</i>	Mustard
Tansymustard	<i>Descurainia pinnata</i>	Mustard
Tumble mustard/Jim Hill mustard	<i>Sisymbrium altissimum</i>	Mustard
Field pepperweed	<i>Lepidium campestre</i>	Mustard
Yellowflower pepperweed	<i>Lepidium perfoliatum</i>	Mustard
Prickly lettuce	<i>Lactuca serriola</i>	Lettuce
Downy brome (cheatgrass)	<i>Bromus tectorum</i>	Grass
Hare barley (foxtail)	<i>Hordeum leporinum</i>	Grass
Wild oats	<i>Avena fatua</i>	Grass
Volunteer cereals		Grass
SUMMER ANNUAL BROADLEAF WEEDS		
Pigweed	<i>Amaranthus spp.</i>	Amaranth
Lambsquarters	<i>Chenopodium album</i>	Goosefoot
Russian thistle	<i>Salsola iberica</i>	Goosefoot
Common sunflower	<i>Helianthus annuus</i>	Thistle
Dodder	<i>Cuscuta spp.</i>	Morningglory
Witchgrass	<i>Panicum capillare</i>	Grass
Green foxtail (bristlegrass)	<i>Setaria viridis</i>	Grass
Stinkgrass (lovegrass)	<i>Eragrostis cilianensis</i>	Grass
Barnyardgrass	<i>Echinochloa crus-galli</i>	Grass
Italian ryegrass	<i>Lolium multiflorum</i>	Grass
PERENNIAL AND BIENNIAL WEEDS		
Swamp knotweed	<i>Polygonum coccineum</i>	Buckwheat
Chicory	<i>Cichorium intybus</i>	Thistle
Common dandelion	<i>Taraxacum officinale</i>	Thistle
Cheeseweed	<i>Malva spp.</i>	Mallow
Canada thistle	<i>Cirsium arvense</i>	Thistle
Bull thistle	<i>Cirsium lanceolatum</i>	Thistle
Poverty sumpweed	<i>Iva axillaris</i>	Thistle
Buckhorn plantain	<i>Plantago lanceolata</i>	Plantain
Bulbous bluegrass	<i>Poa bulbosa</i>	Grass
Foxtail barley	<i>Hordeum jubatum</i>	Grass
Kentucky bluegrass	<i>Poa pratensis</i>	Grass
Squirreltail	<i>Sitanion hystrix</i>	Grass
Quackgrass	<i>Elytrigia repens</i>	Grass
Perennial ryegrass	<i>Lolium perenne</i>	Grass
Tall fescue	<i>Festuca spp.</i>	Grass
Muhly	<i>Muhlenbergia spp.</i>	Grass
Meadow foxtail	<i>Alopecurus pratensis</i>	Grass

cycle. In alfalfa, perennial weeds are much more common than biennials. They live for 3 years or longer. Some perennials, such as dandelion and plantain, reproduce from seed. Others, such as field bindweed, quackgrass, and Canada thistle, are creeping perennials with vegetative structures (stolons or rhizomes) that permit them to produce asexually, without seed.

WEED CONTROL

An integrated approach that employs cultural, mechanical, and chemical control is the most effective method for controlling weeds in alfalfa. (Table 6.2 gives an overview of herbicides registered for use in California alfalfa fields.) Controlling weeds in a thin, weak alfalfa stand is very difficult or even impossible. Agronomic practices that promote a dense vigorous stand of alfalfa are a primary component of any successful weed control program. These practices (which include management of planting date, fertilization, irrigation, and harvest) are explained in detail in other chapters of this book.

Weed management in alfalfa involves two distinct phases: weed control in seedling alfalfa and weed con-

trol in established alfalfa. Control of perennial weeds occurs in seedling alfalfa and established alfalfa; it will be discussed last.

WEED CONTROL IN SEEDLING ALFALFA

Alfalfa is most vulnerable to weed competition when it is in the seedling stage. Alfalfa seedlings grow slowly and do not compete well with weeds, which are often more vigorous. Aside from the poor quality of a weedy first cutting, weeds in seedling alfalfa can severely reduce stand. In the absence of adequate control measures, severe weed infestations can cause stand establishment failures.

Cultural Control

Crop rotation can be effective for reducing weed populations in seedling alfalfa. Some weeds are more easily controlled in other crops than they are in alfalfa. For example, relatively inexpensive phenoxy herbicides control most broadleaf weeds in grain. By con-

Table 6.2. Time of application and method of activity for herbicides used in alfalfa.

Herbicide	CROP STAGE		TIME OF HERBICIDE APPLICATION			HERBICIDE ACTIVITY	
	Seedling Alfalfa	Established Alfalfa	Preplant	Before Weed Emergence	After Weed Emergence	Soil Active	Foliar Active
Eptam (EPTC)	Yes	Yes	Yes	Yes	No	Yes	No
Balan (benefin)	Yes	No	Yes	Yes	No	Yes	No
Butyrac, Butoxone (2,4-DB)	Yes	Yes	No	No	Yes	No	Yes
Buctril (bromoxynil)	Yes	No	No	No	Yes	No	Yes
Poast (sethoxydim)	Yes	Yes	No	No	Yes	No	Yes
Kerb (pronamide)	Yes	Yes	No	Yes	Yes	Yes	No
Gramoxone (paraquat)	Yes	Yes	Yes	No	Yes	No	Yes
Velpar (hexazinone)	Yes ¹	Yes	No	Yes	Yes	Yes	Some
Karmex, Direx (diuron)	No	Yes	No	Yes	Some	Yes	Slight
Lexone, Sencor (metribuzin)	No	Yes	No	Yes	Yes	Yes	Some
Treflan (trifluralin)	No	Yes	No	Yes	No	Yes	No

1. California registration only

Alfalfa is most vulnerable to weed competition when it is in the seedling stage.

trolling broadleaf weeds in a grain crop that precedes alfalfa, the weed infestation in a seedling alfalfa field is lessened. Similarly, weed infestations are generally low following high-value row crops which are often maintained nearly weed-free.

Further reduce weed problems in alfalfa by planting when weed populations are low and growing conditions are optimal for alfalfa. Low temperatures favor the growth of winter annual weeds over alfalfa; high temperatures favor summer annual weed growth. A window of opportunity for planting occurs in late summer. This is the time when summer annual weeds decline in number and vigor and before most winter annual weeds emerge. Summer annual weeds that emerge in the late summer go into a reproductive stage sooner than summer annual weeds that emerge in spring. During this stage the weeds compete less than usual with alfalfa. Summer annual weeds that emerge with the crop are subsequently killed by fall frosts. Therefore, plant during this window, when moderate temperatures favor alfalfa growth over the weeds. A similar window occurs in the spring, after most of the winter annual weeds have emerged but before summer annual weeds become troublesome.

Weed problems can be reduced by preirrigating and then cultivating with a harrow or disc after weed emergence. This does not completely eliminate weeds, but it reduces their population and makes other control measures more effective.

Healthy alfalfa is an excellent competitor with weeds. Therefore, a key to effective weed management is to maintain a dense, vigorous stand of alfalfa. Select an adapted alfalfa variety, and plant weed-free certified alfalfa seed. An adequate seeding rate and proper seedbed preparation help ensure a dense stand (see chapter 2). High alfalfa seeding rates enhance the competitiveness of alfalfa, but an excessive seeding rate is an expensive weed control method. Proper fertility

is also important in maximizing the competitiveness of seedling alfalfa.

Small-grain companion crops are sometimes used for weed control in seedling alfalfa. A companion crop replaces undesirable weedy species and is itself a desirable forage that, the grower hopes, is not too competitive. To avoid excessive competition with alfalfa, companion crop seeding rates should not exceed 20 pounds per acre. Such a low seeding rate can usually only suppress weeds, not provide complete control. (See chapter 2 for more information on companion crops.)

Early mowing or clipping can be an effective way to rescue an alfalfa planting that is heavily infested with weeds. Mowing tall weeds improves sunlight penetration into the canopy. Many weeds do not recover after cutting, which allows alfalfa to compete more successfully. Also, weeds are more palatable and nutritious when cut early. However, if some weed species, especially grasses, are cut too early (for example, prior to bloom), they recover after mowing and contaminate subsequent cuttings. Realize that early mowing depletes stored carbohydrate root reserves, reducing the vigor of alfalfa. So mow early only when weeds are overtopping and shading the alfalfa. After cutting early, lengthen the time interval between the first and second cuttings. This will allow sufficient time for root reserves to be replenished.

Table 6.3. Application times for herbicides registered for use in seedling alfalfa fields.

TIME OF APPLICATION	HERBICIDE
Preplant	Roundup (glyphosate)
Postemergence to weed	Gramoxone (paraquat)
Preplant	Balan (benefin)
Pre-emergence to weed	Eptam (EPTC)
	Mixture of Balan and Eptam
Postplant	Buctril (bromoxynil)
Postemergence to weed and alfalfa	Butyrac, Butoxone (2,4-DB)
	Kerb (pronamide)
	Poast (sethoxydim)
	Gramoxone (paraquat) ¹
Postplant	Velpar (hexazinone)
Newly established alfalfa	Gramoxone (paraquat)

1. Apply at a low rate; follow manufacturer's instructions.

Chemical Control

Cultural control practices alone are often insufficient to adequately control weeds in seedling alfalfa; they must be supplemented with herbicides. Several herbicides are registered for use in seedling alfalfa fields (Table 6.3). No single herbicide used in seedling alfalfa will control the entire spectrum of weeds in intermountain alfalfa fields (Table 6.4). Therefore, weed identification is fundamental to proper herbicide selection. *Weeds of the*

West (listed under Additional Reading at the end of this chapter) is an excellent weed identification reference.

Preplant foliar herbicides

Nonselective herbicides can control emerged weeds prior to the planting of alfalfa. Both glyphosate (Roundup) and paraquat (Gramoxone) are registered for this use. These herbicides control emerged weeds only; they do not control weeds that emerge after application. Preplant foliar herbicides are most effective

Table 6.4. Weed susceptibility to herbicides registered for use on seedling alfalfa¹

	PREPLANT		POSTEMERGENCE				
	BALAN	EPTAM	BUCTRIL	2,4-DB	KERB	POAST	GRAMOXONE
WINTER ANNUAL WEEDS							
Downy brome (cheatgrass)	P	C	N	N	C	P-C	C
Hare barley (foxtail)	P	P	N	N	C	P-C	C
Volunteer cereals	P	C	N	N	C	C	P-C
Fiddleneck	C	P	C	N-P	N	N	P-C
Flixweed	N	N	P	C	N	N	C
Tumble mustard	N	N	C	C	N	N	P
Shepherdspurse	N	P	C	C	N	N	P
Prickly lettuce	N	C	P-C	C	N	N	C
Clasping pepperweed	–	–	C	C	N	N	C
Filaree	C	C	N	C	P	N	P
SUMMER ANNUAL WEEDS							
Barnyardgrass	C	C	N	N	N	C	P
Green/yellow foxtail	C	C	N	N	P	C	C
Lovegrass	C	C	N	N	C	C	C
Witchgrass	C	C	N	N	C	C	C
Lambsquarters	C	C	C	C	N	N	P-C
Nightshade	N	C	C	C	N	N	C
Pigweed	C	C	P	C	N	N	P-C
Russian thistle	P	P	C	P	P	N	P
Knotweed	C	P	P	P	N-C	N	P
Dodder	N	N	N	N	P	N	P
PERENNIAL WEEDS							
Bulbous bluegrass	–	–	N	N	C	–	C
Foxtail barley	P	P	N	N	C	P	P
Kentucky bluegrass	–	–	N	N	C	P	P
Quackgrass	–	P	N	N	C	P	N
Field bindweed	N	N	N	N-P	–	N	N
Dandelion	–	–	N	CSO	N	N	P
Plantain	–	–	N	CSO	N	N	–

N = no control; P = partial control; C = control; – = no information available; CSO = control of seedling weeds only
 1. Weed susceptibility to Velpar is found in Table 6.5.

tive for early spring plantings where the seedbed is prepared in the fall and weeds emerge with winter rains. The field is treated, and then the alfalfa is drilled with a no-till or conventional drill, without disturbing the soil. Soil disturbance brings weed seeds to the surface, reducing the effectiveness of this treatment.

Preplant soil herbicides

EPTC (EPTAM) AND BENEFIN (BALAN)

These herbicides are used before planting and prior to weed and crop emergence. Do not use them when a small-grain companion crop is planted; it will be killed. Eptam and Balan are generally applied to the soil surface and mechanically incorporated into the soil. Eptam can also be injected into irrigation water. These herbicides are often applied and incorporated in the same pass. To minimize volatilization losses, avoid spraying Eptam onto moist soil. Herbicides can be incorporated with a power-driven rotary tiller or by discing twice, at right angles. Set power-driven tillers to the desired depth of incorporation; set discs or ground-driven tillers to twice as deep as the desired incorporation depth. For most annual weeds, incorporation depth should be 1 to 2 inches. When

Late application is the most common reason for postemergence herbicide failure.

using Eptam to control volunteer cereals, quackgrass, and wild oats, incorporation depth should be 2 to 3 inches. Balan is more expensive but more persistent than Eptam—the soil life of Balan is 3 to 5 months; that of Eptam is 1 to 2 months. Alfalfa is seldom injured from applications of Balan, but Eptam has caused stunted plants with malformed (cupped and clasped) leaves (color photo 6.1). However, crop injury is usually confined to alfalfa grown in coarse-textured soils, and symptoms are usually temporary. Postemergence applications of 2,4-DB following preplant Eptam applications can cause excessive injury because Eptam reduces the protective cuticle layer of

alfalfa, allowing it to absorb more 2,4-DB than it would otherwise.

Eptam and Balan are more suited to a spring planting than a late summer or fall planting. They control a broad spectrum of summer annual weeds but do not control many of the problem winter annual weeds, such as those in the mustard family. Results have been somewhat erratic in the Intermountain Region, even on spring plantings. This may be due to inadequate incorporation procedures. Eptam and Balan can be tank-mixed at lower rates of each to expand the spectrum of weeds controlled. Consult manufacturer's instructions before mixing.

Postemergence herbicides

Postemergence herbicides are often used in preference to preplant herbicides because they allow the grower to evaluate the weed pressure, identify weed species prior to application, and select an herbicide according to its effectiveness on the weed species present. Proper application timing is critical because small weeds are much easier to control than large ones. Late application is the most common reason for postemergence herbicide failure. In general, apply postemergence herbicides when alfalfa reaches the minimum growth stage stated on the herbicide label. Figure 2.4 shows seedling alfalfa growth stages. Remember, that a true alfalfa leaf is trifoliolate (it has three leaflets attached to a single petiole); do not confuse cotyledons or unifoliolate leaves with true leaves, or you may apply the herbicide too soon.

2,4-DB (BUTYRAC, BUTOXONE) The herbicide 2,4-DB is very effective at controlling many of the broadleaf weeds that emerge with alfalfa in both spring and late summer or fall plantings. Only the amine formulation of 2,4-DB is currently available, and its performance is inferior to that of the ester formulation, which was used formerly. Research has indicated that the activity of 2,4-DB amine can be improved to a level comparable to that of the ester formulation by adding a nonionic surfactant at 0.25 percent (one quart per 100 gallons spray volume). Young, vigorously growing weeds are most susceptible. Apply when alfalfa has two to four trifoliolate leaves. The best control is obtained when several days of warm sunny weather follow 2,4-DB applications. Apply as soon as possible after an irrigation or rainfall. Irrigation or significant rainfall within 3 to 5 days after application can cause alfalfa injury (color

photo 6.2). Because of rain, spring applications of 2,4-DB can be difficult to accomplish in the Intermountain Region.

BROMOXYNIL (BUCTRIL) Like 2,4-DB, Buctril is used for broadleaf weed control in seedling alfalfa. Alfalfa must have a minimum of four trifoliolate leaves before it can be treated safely with Buctril. Weed size is critical when using this chemical. Be sure weeds are not taller than 3 inches and do not exceed the four-leaf stage. Do not apply when temperatures may exceed 80°F (27°C) during or following application; Buctril may injure alfalfa if the temperature is too high (color photo 6.3). Excessive injury can also occur in the Intermountain Region when an application follows a period of cool, overcast weather. For these reasons, applying Buctril in spring or summer can be difficult. A drawback of Buctril is that it does not completely control pigweed (especially if it is taller than 2 to 3 inches), a common summer annual weed in spring- and summer-planted alfalfa. However, it is more effective than 2,4-DB for fiddleneck and Russian thistle control. Combinations of Buctril and 2,4-DB can be effective for controlling a broader spectrum of weeds than either herbicide can control when used alone.

SETHOXYDIM (POAST) This chemical controls emerged grasses selectively, with no injury to seedling alfalfa or broadleaf weeds. Poast can be applied safely at any alfalfa growth stage; however, treatment is preferable when grasses are small, before the alfalfa canopy covers grass seedlings. For best results, apply Poast when grasses are growing vigorously, not when they are moisture-stressed. In addition to weedy grasses, Poast can control dense stands of volunteer cereals or an aggressive companion crop. Poast has not been widely used in the Intermountain Region, because problems with grass are not common in spring-planted seedling alfalfa. Hare barley (foxtail) and downy brome (cheatgrass) may appear in fall-planted fields, but under most conditions Poast provides only partial control of these weeds. (The product Poast Plus controls these weeds, but is not currently registered in California.) Poast will not control bluegrass species.

PRONAMIDE (KERB) Used in seedling alfalfa to control winter annual grasses and volunteer cereals,

Kerb is active in soil. It provides both pre-emergence and postemergence control of susceptible weeds. Kerb controls certain broadleaf weeds at high application rates, but not at the low rates used in alfalfa. (Higher rates are generally not cost-effective.) Inconsistent or incomplete weed control may occur in soils containing more than 4 percent organic matter. Kerb is safe for use on seedling alfalfa and may be applied to alfalfa with one to four trifoliolate leaves. Approximately ½ inch of rainfall or overhead irrigation is required after application to move the herbicide into the root zone. Greater quantities of water may wash Kerb too deep into the soil, resulting in poor weed control. The time span between application and incorporation is not as critical in cool temperatures (those below 55°F, or 13°C) as in warm temperatures. Kerb acts slowly, requiring as long as 60 days from the time of incorporation to kill many grasses. If a Kerb-treated field needs to be replanted, residual herbicide can injure emerging alfalfa seedlings.

PARAQUAT (GRAMOXONE) Do not apply Gramoxone to alfalfa with fewer than three trifoliolate leaves. As the manufacturer's label warns, stands will be reduced by application when alfalfa is too young; reduction can be so severe that replanting is necessary. The rate and safety of Gramoxone use increase when alfalfa reaches the six-trifoliolate leaf stage and again when the plant reaches the nine-trifoliolate-leaf stage. Alfalfa foliage present at the time of application will be burned; compared to young plants, more mature alfalfa is better able to withstand the injury. Do not use Gramoxone on a spring planting, because it does not control some of the common summer annual weeds (such as lambsquarters and pigweed) and because crop injury is likely. The best use for Gramoxone is on newly established alfalfa during the first dormant season after planting.

HEXAZINONE (VELPAR) Like Gramoxone, Velpar can be used for weed control in seedling alfalfa, though crop safety is marginal. The advantages of Velpar are that it controls a broad spectrum of grass and broadleaf weeds and it is less expensive than most other herbicides for seedling alfalfa. Apply Velpar only to alfalfa plants that have lateral secondary growth and roots longer than 6 inches. Applications can be made only in the winter months, when alfalfa plants are not actively growing. Therefore, the use of Velpar

on first-year alfalfa in the Intermountain Region is restricted to dormant applications with low rates to newly established alfalfa planted by mid-August.

IMAZETHAPYR (PURSUIT) At the time of publication, January 1995, Pursuit is not registered in California. Pursuit, a postemergence herbicide, has been evaluated in field trials in the Intermountain Region and throughout California. It controls most of the winter and summer annual weeds encountered in intermountain seedling alfalfa fields, including filaree, pigweed, nightshade, and weeds in the mustard family (such as tansymustard, flixweed, tumble mustard, and shepherdspurse). It suppresses many grasses and therefore should not be applied when a cereal is planted as a companion crop to alfalfa. Only a few common broadleaf weeds escape control. Pursuit only stunts Russian thistle and lambsquarters, unless it is applied when these weeds are very small. This herbicide cannot control prickly lettuce and annual sowthistle. Pursuit is slow acting, especially when temperatures are cool. Susceptible weeds stop growing soon after application; they die within a few weeks. Pursuit has tremendous potential for weed control in seedling alfalfa fields; however, do not consider using this herbicide until it receives California registration.

WEED CONTROL IN ESTABLISHED ALFALFA

Weed management in established alfalfa can be divided into three categories: control of winter annual weeds, control of summer annual weeds, and control of perennial weeds.

Winter Annual Weed Control

Winter annual weeds emerge with fall and winter rain. Winter weather kills some species, but enough weeds usually either survive or emerge late to infest the first cutting of alfalfa and contaminate the hay. Cultural controls are largely ineffective, because alfalfa does not compete well with weeds that emerge before the crop breaks dormancy.

Light cultivation with a harrow (a spring-toothed

Herbicides are usually required for complete control of winter annual weeds.

harrow, spike-toothed harrow, or Danish tine harrow) to uproot winter annual weeds can be partially effective under some circumstances. Timing is critical. The field must be harrowed after most of the weeds have emerged but just prior to the time alfalfa breaks dormancy and resumes growth. If fields are cultivated too early, subsequent rains can germinate a new crop of weeds. Injury to alfalfa crown buds and regrowth increase when the field is harrowed too late. Damage to crowns increases their susceptibility to disease. Fields heavily infested with weeds can be mowed early, but with the same drawbacks discussed earlier (in the section on weed control in seedling alfalfa).

Herbicides are usually required for complete control of winter annual weeds. The herbicides diuron (Karmex or Direx), hexazinone (Velpar), metribuzin (Sencor or Lexone), and Gramoxone are registered for use in established alfalfa. Effective weed control programs for the Intermountain Region may use these herbicides alone or in combination. Factors to consider when selecting the proper herbicide or herbicide combination include the following:

- weed history
- soil texture
- soil organic matter
- likelihood of rainfall for incorporation of herbicides
- remaining stand life (Will the field be taken out of production after the current production season?)
- economics

These factors will be discussed later in this chapter in relation to specific herbicides.

Soil-active herbicides

VELPAR, KARMEX, AND SENCOR These three chemicals control a broad range of annual and perennial weeds (Table 6.5). These herbicides are soil active and inhibit photosynthesis in susceptible plants. Alfalfa must be established for at least one year before Karmex or Sencor can be applied. If alfalfa is not dor-

mant significant injury can occur (color photo 6.4). Soil-active herbicides must be incorporated into the soil by rainfall or sprinkler irrigation.

Velpar controls most winter annual weeds and suppresses many perennial weeds that infest intermountain alfalfa fields. In fact, of the soil-applied herbicides, Velpar has the broadest spectrum of activity. Its activity is similar to that of Sencor, but Velpar is more effective at controlling shepherdspurse, one of the most common weeds infesting alfalfa (Figure 6.1). It is even effective on soils high in organic matter, such as those in the Tulelake Basin. Velpar is more effective on emerged weeds than other soil-active herbicides, particularly when a nonionic surfactant is added. However, do not add surfactant after alfalfa growth begins, or significant crop injury may result. Use rates vary according to weed species and soil types; refer to herbicide labels for specific rate recommendations. Reduced rates of Velpar (such as 0.375 pound active ingredient per acre on sandy loam soil low in organic matter) have been used successfully where Velpar is used 2 or more years in succession. Velpar is persistent in soil. Do not plant other crops for at least two years following an application of Velpar.

Karmex, also sold as Direx, controls a broad spectrum of winter annual weeds in alfalfa. It is less expensive than Velpar but less effective on emerged weeds, particularly emerged grasses such as downy brome (cheatgrass). If the population of emerged weeds is large, tank-mix Karmex with Velpar or Gramoxone for improved control. (Karmex is frequently tank-mixed with Velpar at reduced rates of each. This broadens the weed spectrum controlled and reduces cost.) Do not apply Karmex to sandy soil.

The activity of Sencor, also sold as Lexone, is similar to that of Velpar. It is commonly used in the last year of production of an alfalfa field, especially in fields where potatoes follow alfalfa. In addition to being labeled for use on alfalfa, Sencor is labeled for use on mixed stands of alfalfa and grasses. Low rates can be used to control weeds and to prevent excessive competition from grasses.

Foliar herbicides

GRAMOXONE AND 2,4-DB These two foliar herbicides are registered for use in established alfalfa. The herbicide 2,4-DB is comparatively expensive and controls only small broadleaf weeds. Alfalfa injury from 2,4-DB is more prevalent in established than in

seedling alfalfa. Therefore, in the Intermountain Region, limit its use to seedling alfalfa.

Gramoxone controls a range of winter annual weeds (Table 6.5) and is widely used in the Intermountain Region. Because Gramoxone is inactive in soil, it is well suited for use in the last year of an alfalfa stand. It is especially effective on winter annual grasses such as hare barley (foxtail) or downy brome (cheatgrass). Small, vigorously growing weeds are most susceptible,



(A)



(B)

Figure 6.1. (A) Shepherdspurse and (B) tansymustard are the most common winter annual weeds found in intermountain alfalfa fields.

Table 6.5. Weed susceptibility to herbicides registered for use on established alfalfa.

	SENCOR/		KARMEX/					EPTAM	2,4-DB
	VELPAR	LEXONE	GRAMOXONE	DIREX	TREFLAN	POAST	KERB		
WINTER ANNUAL WEEDS									
Shepherdspurse	C	C	P	C	N	N	N	P	P-C
Flixweed/Tansymustard	C	C	P-C	C	N	N	N	N	C
Jim Hill mustard	C	C	P	C	N	N	N	N	C
Field pepperweed	C	C	C	C	N	N	N	—	C
Yellowflower pepperweed	P-C	C	C	C	N	N	N	—	C
Downy brome (cheatgrass)	C	C	C	P	C	P-C	C	C	N
Hare barley (foxtail)	C	C	C	C	C	C	C	P	N
Wild oats	P-C	N	P	N-P	N	C	C	C	N
Volunteer cereals	P-C	P	C	C	N	C	C	C	N
	VELPAR	SENCOR/ LEXONE	GRAMOXONE ¹	KARMEX/ DIREX	TREFLAN	POAST	KERB	EPTAM	2,4-DB
SUMMER ANNUAL WEEDS									
Pigweed	C	C	N-P	C	P	N	N	C	C
Lambsquarters	P	P	N-P	C	P	N	N	C	C
Russian thistle	P	P	—	P	P	N	N	P	P
Common sunflower	—	—	—	—	—	—	—	—	C
Dodder	N	N	N-P	N	C	N	P	N	N
Prickly lettuce	C	C	P-C	P-C	N	N	N	P	C
Witchgrass	P	P	—	P	C	C	C	C	N
Green foxtail (bristlegrass)	N	P	N	P	C	C	P	C	N
Lovegrass (stinkgrass)	P	—	—	C	C	C	C	C	N
Barnyardgrass	P	C	P	P	C	C	N	C	N
	VELPAR	SENCOR/ LEXONE	GRAMOXONE	KARMEX/ DIREX	TREFLAN	POAST	KERB	EPTAM	2,4-DB
PERENNIAL WEEDS									
Swamp knotweed	—	—	N-P	—	N	N	N	—	P
Chicory	—	—	—	—	—	—	—	—	P
Common dandelion	N-P	P	—	—	N	N	—	—	C*
Cheeseweed	P*	P*	P	P	N	N	N	N	N
Canada thistle	N	N	P*	—	N	N	N	N	P*
Bull thistle	—	—	P*	—	N	N	N	N	C*
Povertyweed	—	—	—	—	—	—	—	—	—
Buckhorn plantain	N-P	—	—	N-P	N	N	N	—	C*
Bulbous bluegrass	P-C	C	C	P	P	—	C	—	N
Foxtail barley	P	C*	P-C	P-C*	—	—	C	P-C	N
Squirreltail	—	—	—	—	—	—	C	—	N
Kentucky bluegrass	P	P	P	—	N	P	C	—	N
Quackgrass	P*	—	N	P	N	P	C	P	N
Perennial ryegrass	—	—	—	—	—	—	C	—	N
Tall fescue	—	—	—	—	—	—	C	—	N
Muhly	—	—	—	—	—	—	C	—	N
Meadow foxtail	—	—	—	—	—	—	C	—	N

C = control; P = partial control; N = no control; * = control of seedling weeds only; — = no information available.

1. Gramoxone is not usually applied when summer weeds have emerged.

but weeds up to 6 inches tall can be treated.

Gramoxone is strictly a postemergence contact herbicide; once it comes into contact with soil, or with even a thick layer of dust on leaves, it is deactivated. For best results, apply it after most of the weeds have emerged (in March in most areas). However, never apply it after alfalfa has 2 inches of growth. Lassen County studies showed that treating alfalfa when it was 4 inches tall rather than 1 to 2 inches tall resulted in a 0.5-ton yield reduction.

Always add a nonionic surfactant with Gramoxone; otherwise, weed control will decrease significantly. The visible effects of Gramoxone are observable after approximately 4 days. An evaluation of control can be made after 7 days. If the growing point is not visibly desiccated, weeds may recover.

Gramoxone can be tank-mixed with low rates of a soil-active photosynthetic inhibitor. The addition of the photosynthetic inhibitor (Velpar, Karmex, or Sencor) retards the initial contact activity of Gramoxone. Tank mixing improves the effectiveness of Gramoxone and broadens the spectrum of weeds controlled. The combination of Gramoxone and a photosynthetic inhibitor is particularly well suited to application in March, when most weeds have emerged but rainfall may be insufficient to incorporate soil-active herbicides. As with Gramoxone alone, treatment must be made before alfalfa has 2 inches of growth. An application window of approximately 2 weeks usually occurs in March, depending on the year and location. The tank mix is effective when applied to soils high in organic matter where soil-active herbicides alone have sometimes failed.

Application timing for winter-weed control

Proper application timing is essential for effective weed control and for avoidance of crop injury (Table 6.6). Soil-active herbicides can be applied anytime between November and February, when alfalfa is dormant. However, treatments from late December to early January may be difficult because soil-active herbicides should not be applied to frozen or snow-covered ground. Although not common, applications in November to early December have several advantages. Because alfalfa is completely dormant, risk of injury is comparatively low. The likelihood of sufficient precipitation for incorporation of herbicides is greater and the cost is usually less (soil-active herbicides do not need

to be combined with Gramoxone). Weed control is often better because many of the winter annual weeds have not emerged or are very small. Disadvantages are that some weeds may escape treatment when rodent activity brings untreated soil to the surface. Also, areas treated with a soil-active herbicide cannot be reseeded, which may be necessary when winterkill of alfalfa is severe.

Provided soils have thawed and snow has melted, soil-active herbicides can also be applied in late January through February and as late as March in high-elevation valleys. This may be difficult when winters are severe. As soon as snow melts or soils thaw, alfalfa resumes growth. If herbicides are applied after alfalfa has broken dormancy, yellowing (chlorosis) of alfalfa and reduced yields occur (color photo 6.4). Symptoms of late treatment may not be apparent unless treated areas can be compared to untreated areas.

Apply Gramoxone, or tank mixes of Gramoxone and soil-active herbicides, in spring, before alfalfa has grown 2 inches. If growth is greater than 2 inches, do not use an herbicide; consider early mowing if weed infestation is severe.

SUMMER ANNUAL WEED CONTROL

A dense, vigorous alfalfa stand permits little light to reach below the canopy, preventing summer annual weeds from becoming established. Proper fertilization, irrigation, and production practices usually make an herbicide application unnecessary. Residual activity of winter herbicides in soil also helps lessen, but does not always eliminate, summer annual weed problems. For example, soil residual from Karmex controls lamb-squarters but is only partially effective for green foxtail (bristlegrass) control.

Occasionally, pigweed, lambsquarters, green foxtail, Russian thistle, and other weeds infest second and third cuttings. These weeds, with the possible exception of green foxtail, are usually a problem only in older, depleted stands. Green foxtail is an aggressive summer annual grass (Figure 6.2). It has been a major problem in the Central Valley of California for many years and is an increasing problem in some areas of the Intermountain Region. Trifluralin (Treflan TR-10) is

Table 6.6. Application times for herbicides registered for use in established alfalfa fields.¹

TIME	WINTER ANNUALS	SUMMER ANNUALS	PERENNIAL WEEDS
Nov.–Feb. (before fields turn green)	Velpar (with surfactant) Lexone/Sencor Karmex/Direx		Kerb
Feb.–Mar. (some weed growth before alfalfa shows any green)	Velpar (without surfactant) Lexone/Sencor Karmex/Direx Karmex/Direx plus Velpar		Karmex/Direx plus Velpar
Mar. (before alfalfa spring growth is 2 in. tall)	Gramoxone Gramoxone plus Velpar Gramoxone plus Lexone/Sencor Gramoxone plus Karmex/Direx		
Mar.–early May		Treflan TR-10	
May–Aug.		Poast	Poast

1. Slash (/) between herbicides means that the names cited are 2 different trade names for the same chemical.

very effective against green foxtail, barnyardgrass, and most common summer annual broadleaf weeds. Apply Treflan in March to early May, before summer annual weed emergence (actual date depends on area). Rainfall or overhead irrigation must follow within 3 days, or else reduced weed control may result. Because of the short growing season and small number of cuttings in the Intermountain Region, reducing the rates or using Treflan every other year is usually sufficient for excellent summer annual weed control.

Poast (discussed earlier, in the seedling section) can also be used to control green foxtail. After first or second cutting, apply Poast to emerged green foxtail prior to seedhead formation. Green foxtail should not be moisture-stressed at the time of application. Delay application until after an irrigation if grasses are moisture-stressed, but do not apply Poast if alfalfa growth prevents spray coverage of the grass.

PERENNIAL WEED CONTROL

Several perennial weeds—such as dandelion, quackgrass, bluegrass (both Kentucky and bulbous), and buckhorn plantain—commonly infest intermountain alfalfa fields. Perennial weed invasion is favored by the

lack of tillage during the life of an alfalfa stand. Perennial weeds can be extremely difficult to control in established alfalfa. This is especially true for perennial broadleaf weeds; to selectively remove a perennial broadleaf weed from a perennial broadleaf crop such as alfalfa is almost impossible.



Figure 6.2. Green foxtail (commonly called bristlegass) is an increasing problem in portions of the intermountain alfalfa production region.

*A dense vigorous stand is
by far the best defense
against perennial weeds*

Proper site selection is a key component of perennial weed control. Avoid planting alfalfa in fields heavily infested with perennial weeds such as quackgrass, dandelion, or Canada thistle. Prior to planting alfalfa, control these weeds through crop rotation, mechanical control, or with nonselective herbicides. An application of Roundup in the fall, prior to planting alfalfa, is effective. Plowing or multiple discings prior to planting can also control noncreeping perennial weeds, such as dandelion or buckhorn plantain. Also, avoid planting in fields with poor drainage, because poor drainage will retard alfalfa growth but help many weed species to thrive.

After clean fields are attained, the best approach for dealing with perennial weeds is to prevent them from reinvading. Sound cultural practices that maximize the competitive ability of alfalfa can minimize or delay encroachment by perennial weeds. A dense vigorous stand is by far the best defense against perennial weeds, because perennials first get a foothold in thin or weak areas of a field. Since most perennial weeds can be controlled in their seedling stage by using herbicides registered for use in alfalfa fields, annual herbicide applications prevent or delay perennial weed infestations.

Once perennial weeds become established in alfalfa, control options are limited. One option is to live with the weeds. Fortunately, perennial weeds do not always reduce the dietary value of the forage. For example, dandelions do not significantly detract from nutritional quality, though they do turn black after curing. This detracts from the alfalfa's appearance and reduces its price. When cut early, quackgrass-infested alfalfa is often marketed to feed stores as alfalfa-grass mixed hay. However, most buyers of dairy-quality hay will not purchase weed-infested alfalfa, so some method of controlling established perennials in alfalfa is needed.

Soil-active herbicides suppress some perennial weeds (such as dandelion, quackgrass, and bluegrass)

after they become established. Velpar is usually the most effective. Kerb, applied at high rates (for example, 1.5 pounds active ingredient per acre), controls quackgrass and Kentucky bluegrass. However, these rates are generally cost-prohibitive for alfalfa production. They are recommended only for spot treatment of isolated grass patches or when pockets of perennial grasses are observed in a relatively young field. Kerb applications should be made before mid-February, when temperatures are cool and subsequent rainfall is ordinarily sufficient to incorporate the chemical into the soil.

Foliar-active herbicides have limited usefulness for controlling perennial weeds. Poast suppresses quackgrass, but repeated applications are needed to achieve measurable control. This treatment is expensive for the degree of control achieved. Therefore, treat quackgrass with Poast only in the year of establishment, before the rhizomes (underground stems) become too large and difficult to kill. Roundup is effective for spot treatment of most perennial weeds but is not recommended for widespread infestations; label restrictions permit no more than 10 percent of a field to be treated. Also, significant alfalfa injury can result if Roundup is applied when alfalfa is not completely dormant (color photo 6.5).

THE ECONOMICS OF CHEMICAL WEED CONTROL

Opting to treat alfalfa with herbicides can be a difficult management decision. Several factors must be considered: weeds species, their infestation level, alfalfa stand density, herbicide cost, alfalfa market, and probability of successful weed control. For treatment to be economical, weed infestations must be severe enough to reduce quality or alfalfa stand density. The value of improved forage quality or stand density must exceed the cost of treatment. In addition, the alfalfa stand density must be high enough to respond to the decreased competition after weeds are controlled. Herbicide applications to sparse, severely weed-infested stands will increase forage quality but can decrease total forage yield. Alfalfa does not spread into open areas, so removing weeds in sparse stands often results in reinfestation.

The anticipated market for alfalfa hay sometimes determines if treatment is economical. For example,

herbicides may be unnecessary when hay is fed to livestock (cattle or horses) on the ranch and weed infestations are not too severe. Those who buy for dairies or feed stores, however, tolerate few weeds. If the market demands high quality, herbicide treatment is usually justified. Herbicide treatment during stand establishment is often justified by an increase in alfalfa stand density. Herbicides not only provide the immediate benefit of weed control, but they also reduce weed seed reserves in the soil. Because of the depletion of weed seeds in the soil, herbicide application every other year may be sufficient in some intermountain alfalfa fields. This is often the case when seedling alfalfa fields are treated during the establishment year. A benefit of weed control that is difficult to measure is the reduction in weeds that occurs in subsequent crops.

ADDITIONAL READING

- Kempen, H. M. 1993. Alfalfa, forage. In *Growers weed management guide*, 3-18. Fresno, CA: Thompson Publications.
- Mitich, L. W. 1985. Agronomic crops. In E. A. Kertz and F. O. Colbert (eds.), *Principles of weed control in California*, 231-75. Fresno, CA: Thompson Publications.
- Mitich, L. W., H. Agamalian, C. Bell, M. Canevari, B. Fischer, G. Kyser, W. T. Lanini, V. Marble, R. Norris, S. Orloff, J. Orr, J. Schmierer, and R. Vargas. 1990. *Weed control in seedling and established alfalfa in California*. Oakland: University of California Division of Agriculture and Natural Resources, Leaflet 21431.
- Undersander, D., N. Martin, D. Cosgrove, K. Kelling, M. Schmitt, J. Wedberg, R. Becker, C. Grau, and J. Doll. 1991. *Alfalfa management guide*. Madison, WI: American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America.
- Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, and R. Parker. 1992. *Weeds of the west*. Newark, CA: Western Society of Weed Science in cooperation with the Western United States Land Grant Universities Cooperative Extension Services.