Once a good stand has been established, continued production and stand life depends on good management practices. Good management includes maintaining soil nutrients, applying manure judiciously, and controlling weeds and insects. Monitor diseases to estimate stand life and to determine resistance needed in future plantings. Finally, optimum production involves deciding when to rotate from stands that are no longer profitable.
Fertilize annually

**Determine needs**

Alfalfa has a relatively high demand for some nutrients compared to other commonly grown crops. Each ton of alfalfa dry matter harvested removes about 14 pounds of phosphate (P₂O₅) and 58 pounds of potash (K₂O). This is the nutrient equivalent of 150 pounds of a 0-10-40 fertilizer. Each ton of alfalfa also removes the calcium and magnesium found in about 100 pounds of aglime. See table 4 for a complete list of nutrients removed. Since many of these nutrients are supplied from the native soil reserves, basing a fertility program on removals is not recommended.

Soil tests are the most reliable method for preventing nutrient deficiencies. Visual symptoms (table 6 and pictures) can be used to help assess nutrient needs for future yield. However, by the time visual symptoms appear on a crop, nutrient deficiency may be so severe that significant yield losses have already occurred. Visual symptoms can also reflect environmental conditions, restricted root growth, diseases or other problems not related to a soil nutrient shortage.

Plant tissue analysis can determine the nutritional status of your crop before any visual symptoms appear. While this method does not measure nutrient amounts for making a fertilizer recommendation, combining tissue analysis with a soil test makes for a comprehensive nutrient management system.

**Table 4.** Pounds of nutrient removed per ton of alfalfa produced, dry matter basis.

<table>
<thead>
<tr>
<th>nutrient</th>
<th>dry matter removed (lb/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>phosphorus (P)</td>
<td>6</td>
</tr>
<tr>
<td>phosphate (P₂O₅)</td>
<td>14</td>
</tr>
<tr>
<td>potassium (K)</td>
<td>48</td>
</tr>
<tr>
<td>potash (K₂O)</td>
<td>58</td>
</tr>
<tr>
<td>calcium (Ca)</td>
<td>30</td>
</tr>
<tr>
<td>magnesium (Mg)</td>
<td>6</td>
</tr>
<tr>
<td>sulfur (S)</td>
<td>6</td>
</tr>
<tr>
<td>boron (B)</td>
<td>0.08</td>
</tr>
<tr>
<td>manganese (Mn)</td>
<td>0.12</td>
</tr>
<tr>
<td>iron (Fe)</td>
<td>0.33</td>
</tr>
<tr>
<td>zinc (Zn)</td>
<td>0.05</td>
</tr>
<tr>
<td>copper (Cu)</td>
<td>0.01</td>
</tr>
<tr>
<td>molybdenum (Mo)</td>
<td>0.002</td>
</tr>
</tbody>
</table>

**Table 5.** Sufficiency levels of nutrients, top 6 inches of alfalfa at first flower

<table>
<thead>
<tr>
<th>nutrient</th>
<th>low</th>
<th>sufficient</th>
<th>high</th>
</tr>
</thead>
<tbody>
<tr>
<td>nitrogen</td>
<td>&lt;2.50</td>
<td>2.50–4.00</td>
<td>&gt;4.00</td>
</tr>
<tr>
<td>phosphorus</td>
<td>&lt;0.25</td>
<td>0.25–0.45</td>
<td>&gt;0.45</td>
</tr>
<tr>
<td>potassium</td>
<td>&lt;2.25</td>
<td>2.25–3.40</td>
<td>&gt;3.40</td>
</tr>
<tr>
<td>calcium</td>
<td>&lt;0.70</td>
<td>0.70–2.50</td>
<td>&gt;2.50</td>
</tr>
<tr>
<td>magnesium</td>
<td>&lt;0.25</td>
<td>0.25–0.70</td>
<td>&gt;0.70</td>
</tr>
<tr>
<td>sulfur</td>
<td>&lt;0.25</td>
<td>0.25–0.50</td>
<td>&gt;0.50</td>
</tr>
<tr>
<td>boron</td>
<td>&lt;25</td>
<td>25–60</td>
<td>&gt;60</td>
</tr>
<tr>
<td>manganese</td>
<td>&lt;20</td>
<td>20–100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>iron</td>
<td>&lt;30</td>
<td>30–250</td>
<td>&gt;250</td>
</tr>
<tr>
<td>zinc</td>
<td>&lt;20</td>
<td>20–60</td>
<td>&gt;60</td>
</tr>
<tr>
<td>copper</td>
<td>&lt;3</td>
<td>3–30</td>
<td>&gt;30</td>
</tr>
<tr>
<td>molybdenum</td>
<td>&lt;1</td>
<td>1–5</td>
<td>&gt;5</td>
</tr>
</tbody>
</table>

**Advanced techniques**

**Tissue testing**

Tissue testing is very useful for assessing levels of sulfur and micronutrients. It can detect nutrient problems not easily detected with a standard soil test. Sample the top 6 inches of mature forage in areas of the field that are free of other problems (insect, disease, drought, shade, etc.). Follow specific sampling and data interpretation guidelines to avoid misinterpretation. See table 5 for a list of suggested sufficiency levels for the essential nutrients.
Phosphorus deficiency

Deficient plants have blue-green leaves and stunted growth. Leaflets often fold together, and the undersides may be red or purplish (left).

Potassium deficiency

Leaves of severely deficient plants turn completely yellow. Lower leaves of deficient plants are edged with white spots (left).

Sulfur deficiency

Stems are spindly with weak growth. Leaves turn light green (left). Symptoms are similar to nitrogen deficiency.

Boron deficiency

Deficient plants have yellowed leaves on shortened stems. Yellow coloring turns reddish to purplish between veins.

Table 6. Nutrient deficiency symptoms for alfalfa.

<table>
<thead>
<tr>
<th>nutrient</th>
<th>deficiency symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>nitrogen</td>
<td>Light green to yellow color, spindly growth.</td>
</tr>
<tr>
<td>phosphorus</td>
<td>Blue-green color, stiff, stunted and erect growth. Leaflets often fold together, and the undersides and stems may be red or purplish.</td>
</tr>
<tr>
<td>potassium</td>
<td>White spots around edge of leaf starting with lower leaves. In advanced cases leaves turn completely yellow and die.</td>
</tr>
<tr>
<td>calcium</td>
<td>Impaired root growth or rotting. Petioles collapse on youngest mature leaves.</td>
</tr>
<tr>
<td>magnesium</td>
<td>Interverinal chlorosis of lower leaves, margins initially remain green.</td>
</tr>
<tr>
<td>sulfur</td>
<td>Light green, similar to nitrogen deficiency, spindly stems and weak growth.</td>
</tr>
<tr>
<td>boron</td>
<td>Yellowing of leaves, shortened main stem growth between upper portion of shoots, dense top. Often confused with leafhopper damage.</td>
</tr>
<tr>
<td>manganese</td>
<td>Interverinal chlorosis of younger leaves.</td>
</tr>
<tr>
<td>iron</td>
<td>Interverinal chlorosis of youngest leaves, bleached appearance.</td>
</tr>
<tr>
<td>zinc</td>
<td>Reduced leaf size and upward curling of youngest leaves.</td>
</tr>
<tr>
<td>copper</td>
<td>Severe curvature of petioles, grayish spots in midleaf.</td>
</tr>
<tr>
<td>molybdenum</td>
<td>Pale green and stunted as with nitrogen deficiency.</td>
</tr>
</tbody>
</table>
Nitrogen

Alfalfa typically gets enough nitrogen from its symbiotic relationship with nitrogen-fixing *Rhizobium* bacteria and from soil organic matter, which releases nitrogen as it decomposes. On well-inoculated, established stands, topdressed nitrogen does not improve yields, quality, or stand vigor. Normally, adding nitrogen may lower yield and/or quality by stimulating growth of grasses and weeds. But in some cases, such as where soils have not been adequately limed, an application of 30 to 50 lb/acre of nitrogen can be used as a stop-gap measure to increase yields.

Phosphate and potash

Alfalfa needs relatively large amounts of phosphate and potash. Adequate phosphorus is important for successful establishment and good root development. Potash is essential for maintaining yields, reducing susceptibility to certain diseases, and increasing winterhardiness and stand survival. In the eastern portion of the Midwest, potassium is likely the most limiting nutrient to alfalfa production. Phosphate and potash are relatively immobile when added to the soil. Phosphate bonds tightly on acidic clayey soils (pH < 5.5) and on very high pH soils (pH > 7.5) making it unavailable to plants. Potash can leach on some extremely sandy soils and on organic soils (peat or muck). Applications of phosphate and potash should be based on recommendations from a recent, well-calibrated soil test. Since alfalfa may take up more potassium than the plant needs, which creates animal health problems, do not topdress potash on soils testing very high for this nutrient. Forage tissue potassium levels should be monitored if luxury consumption of potassium is suspected.

Alfalfa absorbs most nutrients, including phosphate and potash, from the top 6 to 8 inches of soil. However, because phosphorus is immobile, alfalfa responds better to incorporated applications than to topdressed applications. Guidelines for annual phosphate and potash application include the following:

1. Apply topdress nutrients immediately after harvest and before regrowth resumes. Avoid contact with wet foliage.
2. Topdress following first cutting to stimulate second and third cutting regrowth or in early September to increase winterhardiness.
3. Avoid application when soils are soft (such as early spring) when physical damage to the alfalfa crown is likely.
4. Split the application to avoid salt damage if more than 500 lb/acre of material (irrespective of grade) is to be used in any year.
5. Base fertilizer purchases on cost per unit of plant food provided and need for all nutrients contained in fertilizer. For example, since there is no difference in nutrient availability with red versus white potash or with ortho- versus polyphosphate on most soils, the best choice is the least expensive product. Potassium-magnesium sulfate may be a superior potassium source where sulfur is needed and not supplied from another fertilizer material.
6. Foliar application should not be used for applying moderate to high rates of macronutrients, although it is an excellent method for applying micronutrients.
Secondary nutrients

Calcium and magnesium deficiencies are very rare, especially where soil pH has been maintained in the desired range for alfalfa. Symptoms of magnesium deficiency appear when the soil test drops below 50 to 100 ppm magnesium. Magnesium can drop below that level on acidic, sandy soils where repeated high amounts of potassium have been applied; on soils where only calcitic liming materials have been used; and on calcareous organic soils. The most economical way to avoid calcium or magnesium problems is to follow a good liming program with dolomitic limestone.

Sulfur deficiencies are likely when high sulfur-demanding crops such as alfalfa are grown on sandy soils or on other soils low in organic matter far from urbanized areas and which have not received manure within the last 2 years. Use of coal, fuel oil, and other fossil fuels in industrial areas releases sulfur into the atmosphere that is deposited on the land in precipitation. In general, precipitation contains enough sulfur to take care of crop needs in most regions (10 to 25 lb/acre each year). The amount of sulfur in manure depends on the kind of animal manure (table 7). Some subsoils, especially those that are acidic and clayey, may contain enough sulfur for high-yielding crops even though the plow layer may test low.

Where the sulfur need has been established, either elemental sulfur or sulfate forms can be used on alfalfa. Sulfate-sulfur is immediately available to the crop, whereas elemental sulfur must be biochemically converted to sulfate before it can be used. When applied at 25 to 50 lb/acre, sulfate-sulfur will generally be adequate for 1 or 2 years of alfalfa production. In contrast, elemental sulfur applied at the same rate should last for the term of the stand. Elemental sulfur converts to sulfate more rapidly when incorporated.

Micronutrients

Plants need only very small amounts of micronutrients for maximum growth. While a deficiency of any essential element will reduce plant growth, overapplication of micronutrients can produce a harmful level of these nutrients in the soil that is difficult to correct, especially on coarse-textured soils. Soil tests are available for some micronutrients, but plant analysis is generally more reliable for identifying micronutrient problems.

Boron is usually the only micronutrient that is needed in a fertilizer program for alfalfa. Boron management depends on the texture of the soil. Sandy soils do not hold boron as tightly as clayey soils. A high test in a sandy soil may be only medium in a silt loam. For alfalfa where the soil test is very low or low on medium-textured soils, apply 2 to 3 lb/acre boron once in the rotation. On sandy soils apply 0.5 to 1 lb/acre boron each year. Due to the low rate of material needed, boron is often mixed with other fertilizers such as potash. Do not apply boron near germinating seeds.

Alfalfa has a relatively high requirement for molybdenum. However, since molybdenum availability increases as pH increases, liming to optimal pH levels usually eliminates molybdenum problems. Manganese, zinc, iron, and copper are rarely deficient in alfalfa. In special situations where deficiencies are suspected, contact your county Extension office or consultant before treating.

### Table 7. Estimate of available sulfur from manure as affected by animal and manure type.

<table>
<thead>
<tr>
<th>kind of animal</th>
<th>sulfur content</th>
<th>total (lb/ton)</th>
<th>available</th>
<th>liquid (lb/1000 gal)</th>
<th>total</th>
<th>available</th>
</tr>
</thead>
<tbody>
<tr>
<td>dairy</td>
<td>solid</td>
<td>1.5</td>
<td>0.8</td>
<td>4.2</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>liquid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>beef</td>
<td>solid</td>
<td>1.7</td>
<td>0.9</td>
<td>4.8</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>liquid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>swine</td>
<td>solid</td>
<td>2.7</td>
<td>1.5</td>
<td>7.6</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>liquid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>poultry</td>
<td>solid</td>
<td>3.2</td>
<td>1.8</td>
<td>9.0</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>liquid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Irrigation**

Improper irrigation limits alfalfa yield more often than any other management factor in semi-arid areas. Water use is generally estimated as evapotranspiration (ET), the combined evaporated water from soil and plant surfaces. In alfalfa, ET normally varies from 0.1 to 0.35 inches per day (figure 16) producing a seasonal water use of 36 inches per year in the semi-arid Pacific Northwest and up to 72 inches in the Southwest.

Alfalfa yield is directly related to ET. Efficiency of water use is highest when the water supplied to plants approximates ET. In the Pacific Northwest it takes about 5 inches of water per acre to produce each ton of alfalfa. At 85% efficiency (15% of the water evaporates before reaching soil), the actual application would need to be about 6 inches.

Water for growth can come from stored soil water, irrigation and rain. In heavier soils, water in the soil profile from the previous fall's irrigation and winter and spring precipitation will reduce irrigation water needed during the season. Stored soil water may be crucial to high yields because of low water infiltration rates in heavy soils. Sandy soils have much less water-holding capacity but have higher water infiltration rates.

Plant stress can occur when available soil moisture falls below 50%. This lost yield can not be “made up” by irrigating more than necessary following the stress!

Border, corrugation (furrow), controlled flooding, and sprinkler irrigation can be used on alfalfa. Choose the method best suited to your slope, soil, water supply, and labor supply.

Irrigation scheduling is best accomplished by the water balance method, in which calculations of water inputs equal outputs, can be used to estimate the soil moisture condition. Use estimated water consumption provided by services such as AgriMet for irrigation scheduling where possible (www.usbr.gov). Use a soil probe or shovel to check soil moisture and verify the actual field conditions. The root zone should be filled with moisture just before the period of peak crop water use.

**Irrigation scheduling principles:**

1. Begin season with full soil water profile.
2. Monitor the soil profile weekly for moisture content.
3. Soil water should be depleted to about 50% of the available water in the top 2 feet before harvest. The interval between irrigation and harvest varies from 2 days in lighter textured sandy soil at high summer ET rate, to 13 days in heavier clay soils at low ET rates. The soil water reserve can be used for alfalfa growth when irrigation is halted for harvest or when the application rate can not keep up with ET.
4. Begin irrigating again as soon as harvest is removed to refill the soil profile. Stress during early regrowth will severely limit the next crop yield.

**Figure 16.** Average evapotranspiration (ET) for alfalfa cut four times. Plants were irrigated at maximum pivot capacity (6.5 gallons/minute, 85% efficiency). Note that in midsummer the amount of water applied is less than the amount lost by ET. This means the alfalfa must use soil moisture reserves or suffer reduced yield.
**Manure management**

Manure is a complete nutrient source, containing all of the major nutrients, secondary nutrients, and micronutrients. In addition, manure promotes biological activity in the soil and enhances the soil physical properties. While manure may be beneficial to soil, applying manure on alfalfa fields can create problems. Manure can burn leaves, reducing yield and quality. The mechanics of applying manure can compact soil and damage crowns which in turn lowers yields and shortens stand life. Also, nitrogen in manure can stimulate weed and grass growth.

If possible, spread manure on other crops that can benefit from the nitrogen. Alfalfa will use applied nitrogen but does not need it due to its ability to fix nitrogen. When too much manure and/or too little cropland force application of manure to alfalfa, top management practices are required.

When alfalfa fields are the only land available for spreading manure, use the following guidelines to reduce damage to the alfalfa stand:

1. Choose fields that have the most grass, usually the oldest stands, since these will benefit most from nitrogen in manure.
2. Apply no more than 3,000 gallons of liquid manure or 10 tons of solid manure per acre. Applying more may cause salt burn, and damage or suffocate plants. Use supplemental fertilizer if additional nutrients are required.
3. Spread manure immediately after removing a cutting so manure contacts the soil instead of the foliage. This reduces the risk of salt burn and minimizes palatability problems.
4. Adjust the spreader to break up large chunks of manure that can smother regrowth.
5. Spread manure only when soils are firm to limit soil compaction and to avoid damaging crowns.

**Weed management**

Weeds reduce alfalfa production during establishment by competing with and choking out young alfalfa seedlings. Weeds also invade established alfalfa fields and reduce forage quality and alfalfa yield. Effective weed control begins before seeding and continues throughout the life of the stand. The most important factor in weed management is to establish and maintain a vigorous alfalfa crop. Proper soil fertility and pH, seedbed preparation, varietal selection, and appropriate cutting schedules cannot be over-emphasized to prevent weed encroachment. If using a herbicide, remember that application timing and rates vary. Always read the product label for application instructions.

**Weed management before planting**

Most alfalfa stands are left in production for several years. The absence of tillage during the life of the stand naturally favors invasion by perennial weeds. It is very important to eliminate perennials before establishing alfalfa. Herbicides for perennial weed control may be applied in spring or fall. Fall application is recommended in most cases for more consistent control. Waiting to apply nonselective herbicides to perennial weeds at the proper growth stage in spring may delay alfalfa planting past the optimum time.

Herbicides for perennial weed control the year before seeding alfalfa include dicamba, glyphosate, 2,4-D, Stinger, Permit, and tank mixes of these herbicides. Carryover from dicamba and Stinger will damage alfalfa seedlings unless they are used far enough in advance of alfalfa planting. Consult labels for specific plant back recommendations.

One of the most serious perennial weed problems in alfalfa stands in northern states is quackgrass. Fall application of glyphosate is more effective than spring application. Quackgrass should be actively growing when glyphosate is applied.

**Weed management in the seeding year**

Tillage is an important part of a weed management program when establishing alfalfa. Thorough tillage helps uproot existing annual weeds and sets back established perennial weeds. Final tillage should be done as near planting as possible to allow alfalfa a head start on weed growth.

Alfalfa in the Midwest is often planted with a companion crop to control weeds and minimize soil erosion. Herbicides are seldom needed in these systems, especially if the small grain is harvested as silage. For direct-seeded alfalfa planted in the spring, herbicides for weed control are usually necessary. Several herbicides are currently labeled for use in new alfalfa seedings. This section describes the most commonly used options. Performance ratings for each herbicide are listed in table 8.
Direct-seeded plantings—preplant-incorporated treatments

**Eptam (EPTC)** is a preplant-incorporated herbicide that controls annual grasses and several broadleaf weeds. Eptam must be thoroughly incorporated to a depth of 2 to 3 inches. Incomplete incorporation may cause streaking and alfalfa injury or loss of herbicide. Incorporate with a tillage implement working the field in two different directions. Eptam can temporarily stunt alfalfa and the first leaves may not unfold properly. Injury may be more pronounced when applied under cool, wet weather, when high rates have been applied, or when poorly incorporated. Do not use Eptam if any atrazine was used in the previous 12 months as severe injury may result. Do not use Eptam if planting a forage grass crop with alfalfa as grass seedlings will be killed by Eptam.

**Treflan (trifluralin)** is a preplant-incorporated herbicide that controls annual grasses and some annual broadleaf weeds. Treflan will not control grass plants growing from rhizomes, such as quackgrass. Treflan must be incorporated to a depth of 2 to 3 inches. Incorporation may be delayed for up to 24 hours, but prompt incorporation is best. Incorporate with a tillage implement according to label directions. Do not use Treflan if planting a forage grass crop with alfalfa as grass seedlings will be killed by Treflan. Injury rarely occurs from Treflan applied at recommended rates.

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**Advanced techniques**

**Roundup Ready Alfalfa***

Roundup Ready alfalfa was developed by inserting the same gene into alfalfa that was used to develop other Roundup Ready crops. Roundup Ready alfalfa tolerates over-the-top applications of glyphosate. Tests at the University of Wisconsin have shown that Roundup Ready alfalfa can withstand repeated applications of glyphosate at high rates for several years.

Roundup Ready alfalfa is a powerful new tool in the growers’ arsenal. Weeds can now be effectively controlled in new seedings without the constraints of most current herbicides. Such constraints include narrow windows of application, relatively long pre-harvest intervals, risk of crop injury, requirement for soil incorporation, and/or narrow weed control spectrum.

Ninety percent or more of the seed in Roundup Ready alfalfa is glyphosate tolerant. This does mean that a small percentage of the alfalfa seedlings (less than 10%) will die with the first glyphosate application. Early application of glyphosate will remove these susceptible seedlings without affecting forage yield or stand. We do not recommend increasing seeding rates of Roundup Ready alfalfa to try to compensate for loss of susceptible seedlings.

Roundup Ready alfalfa allows farmers to seed alfalfa with oats as a cover crop and then apply glyphosate when the oats are 6 to 8 inches tall. This practice provides the benefits of reduced wind and water erosion and early weed control until the alfalfa is established and maintains the yield potential of the direct seeding method.

Roundup Ready alfalfa allows more flexibility and cost effectiveness when controlling weeds in established stands. Glyphosate controls a broader spectrum of weeds than most other herbicide programs, especially controlling winter annual and perennial weeds. Roundup Ready alfalfa also allows more flexibility in timing of herbicide application, and has fewer harvest restrictions and fewer rotation limitations compared with most currently available herbicides.

When rotating Roundup Ready alfalfa fields to other crops, use tillage and/or a herbicide such as 2,4-D or dicamba in the fall after the final alfalfa harvest.

*Pending approval of Roundup Ready alfalfa and label changes of Roundup.*
Direct-seeded plantings—postemergence treatments

**Buctril (bromoxynil)** is a postemergence contact herbicide that controls many common broadleaf weeds. For best results, treat when alfalfa has at least four trifoliate leaves and when weeds are 2 inches or less in height and have no more than four leaves. Buctril gives fair to good pigweed control if plants are small and actively growing when applied. Serious alfalfa injury may occur if the temperature exceeds 70°F within 3 days after application. Do not treat alfalfa stressed by moisture shortage or excess, insect injury, or other causes. Treated fields cannot be harvested or fed for 30 days after application.

**Butyrac (2,4-DB)** is a postemergence systemic herbicide that controls many annual broadleaf weeds but is weak on larger mustards and smartweed and will not control grasses. It suppresses some perennial broadleaf weeds. Apply when seedling weeds are small and actively growing. Correct timing is critical as control is less effective on larger weeds. Check the label for specific rates according to weed species and size. Treated forage cannot be harvested or grazed for 60 days after application.

Buctril can be tank-mixed with Butyrac to improve control when weeds in the mustard or smartweed family (which are sensitive to Buctril), and pigweed (which is more sensitive to Butyrac) are present. Forage treated with this combination cannot be harvested or fed for 60 days after application.

**Poast Plus (sethoxydim)** and **Select 2 EC (clethodim)** are selective postemergence systemic herbicides that control most annual grasses present and suppress quackgrass in alfalfa. Apply to annual grasses at the heights indicated on the labels. Grasses must be actively growing for best results.

Alfalfa can be harvested 7 days after Poast Plus treatment if the forage is green chopped or ensiled, and 14 days after treatment if harvested as dry hay. Do not harvest for hay or silage or graze within 15 days after applying Select. Use Poast Plus or Select to control volunteer grains that emerge following wheat or oat harvest. Treat when cereals are 2 to 4 inches tall and before tillering has started.

### Table 8. Alfalfa tolerance and herbicide effectiveness in direct seedings.

*(Buctril is the only herbicide registered for use on alfalfa seeded with companion crops.)*

<table>
<thead>
<tr>
<th></th>
<th>Eptam (EPTC)</th>
<th>Treflan (trifluralin)</th>
<th>Buctril (bromoxynil)</th>
<th>Butyrac (2,4-DB)</th>
<th>Poast Plus (sethoxydim)</th>
<th>Pursuit (imazethapyr)</th>
<th>Raptor (imazamox)</th>
<th>Select (clethodim)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>alfalfa tolerance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>grasses</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>barnyard grass</td>
<td>F</td>
<td>G</td>
<td>F</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>foxtails</td>
<td>G</td>
<td>G</td>
<td>F</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>quackgrass</td>
<td>P</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>F/G</td>
<td>P/F</td>
<td>F</td>
<td>F/G</td>
</tr>
<tr>
<td>wild oats</td>
<td>F</td>
<td>P</td>
<td>F</td>
<td>N</td>
<td>G</td>
<td>F</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td><strong>broadleaves</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern black nightshade</td>
<td>P</td>
<td>P</td>
<td>F/G</td>
<td>F</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>N</td>
</tr>
<tr>
<td>hoary alyssum</td>
<td>G</td>
<td>N</td>
<td>F</td>
<td>F/G</td>
<td>F/G</td>
<td>F/G</td>
<td>F</td>
<td>N</td>
</tr>
<tr>
<td>kochia</td>
<td>F</td>
<td>G</td>
<td>F/G</td>
<td>F</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>N</td>
</tr>
<tr>
<td>lambsquarters</td>
<td>F</td>
<td>F</td>
<td>G</td>
<td>G</td>
<td>N</td>
<td>F</td>
<td>G</td>
<td>N</td>
</tr>
<tr>
<td>night-flowering catchfly</td>
<td>F/G</td>
<td>G</td>
<td>F/G</td>
<td>P</td>
<td>N</td>
<td>—</td>
<td>—</td>
<td>N</td>
</tr>
<tr>
<td>pigweed spp.</td>
<td>F/G</td>
<td>G</td>
<td>F/G</td>
<td>P</td>
<td>N</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ragweed, common</td>
<td>P</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>N</td>
<td>F</td>
<td>F</td>
<td>N</td>
</tr>
<tr>
<td>smartweed spp.</td>
<td>P</td>
<td>P</td>
<td>G</td>
<td>P</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>N</td>
</tr>
<tr>
<td>velvetleaf</td>
<td>F/G</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>N</td>
</tr>
<tr>
<td>wild mustard</td>
<td>P/F</td>
<td>N</td>
<td>G</td>
<td>F</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>N</td>
</tr>
</tbody>
</table>

*Source: Adapted from Doll, University of Wisconsin, and Becker, University of Minnesota, 2004.*

*Abbreviations: G = good; F = fair, P = poor; N = no control. Control ratings for annual seedlings only.*
Poast Plus and Select can be tank-mixed with Butyrac and applied to newly seeded alfalfa to control a mixture of grass and broadleaf weeds. With a tank mix, the possibility of crop injury increases because the oil concentrate increases Butyrac uptake. Use the rate of product as indicated for the weed species present. Do not add liquid fertilizer solution or ammonium sulfate when tank-mixing with Butyrac. Treated forage cannot be harvested or grazed for 60 days following application. It may be difficult to apply this tank mix at the proper time to adequately control both grasses and broadleaf weeds because each may not be at the best stage for control at the same time.

**Pursuit (imazethapyr)** can be applied postemergence when seedling alfalfa has two or more trifoliate leaves and the majority of the weeds are 1 to 3 inches in height. Pursuit controls many annual grass and broadleaf weeds and suppresses some perennial weeds. Pursuit can be tank-mixed with Buctril, Butyrac, or Poast Plus. Use a labelled adjuvant and a liquid fertilizer solution such as 28% nitrogen or 10-34-0 or ammonium sulfate to the spray solution. Following application, you must wait 30 days before grazing or harvesting and 4 months before replanting alfalfa back into the stand. Allow 60 days before grazing or harvesting if Butyrac is included.

**Raptor (imazamox)** is similar to Pursuit in both its chemistry and use guidelines. When applied to alfalfa with two or more trifoliate leaves and to weeds that are less than 3 inches tall, Raptor controls the same weeds as Pursuit with improved control of common lambsquarters and foxtail species. Alfalfa treated with Raptor can be harvested 20 days or more after application.

**Companion-crop seeded plantings**

**Buctril (bromoxynil)** can be used in companion seedings to control several broadleaf weeds. It is very effective on wild mustard and common lambsquarters. Buctril may cause serious alfalfa injury if the temperature exceeds 70°F within 3 days after application and if the alfalfa has fewer than four trifoliate leaves. Fields may be harvested 30 days after application.

**Weed management in established alfalfa**

Weeds encroach on alfalfa as stand growth slows due to poor fertility, disease and insect problems, and winter injury. Removing weeds from alfalfa seldom increases the tonnage of harvested forage. Rather, the proportion of alfalfa in the harvested forage increases. Whether this affects forage quality depends upon the weed species and their stage of growth. Dandelions and white cockle, for instance, do not influence forage quality and animal intake while weeds such as yellow rocket and hoary alyssum are unpalatable and decrease animal intake. The higher fiber content of grassy weeds also decreases intake. Refer to table 9 for a comparison of the relative impact of weeds on forage quality.

The decision to use herbicides for weed control in established alfalfa stands should be based on the degree of the weed infestation, the type of weeds present, and most importantly, the density of the existing alfalfa stand. Alfalfa stands 3 years or older should have at least 55 stems per square foot. For treatment to be economical, weed infestations must be severe enough and of species that reduce forage quality, and alfalfa stand density must be high enough to respond to the decreased competition upon weed removal. Alfalfa does not spread into open areas, so removing weeds in thin stands often means weed reinfestation. The cost of herbicide treatments such as Velpar and Sencor can generally be spread over 2 years because weeds will be suppressed for that length of time.

Table 10 compares the herbicides available for established stands. The following information describes the herbicides and when to apply them.

**Table 9. Impact of common weeds on forage quality.**

<table>
<thead>
<tr>
<th>Relative Seriousness</th>
<th>Serious</th>
<th>Moderate</th>
<th>Slight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Weeds</td>
<td>cocklebur</td>
<td>Eastern black nightshade</td>
<td>green foxtail</td>
</tr>
<tr>
<td></td>
<td>giant foxtail</td>
<td>giant ragweed</td>
<td>pennycress</td>
</tr>
<tr>
<td></td>
<td>smartweeds</td>
<td>yellow foxtail</td>
<td>shepherd’s purse</td>
</tr>
<tr>
<td></td>
<td>yellow foxtail</td>
<td></td>
<td>velvetleaf</td>
</tr>
<tr>
<td>Perennial Weeds</td>
<td>curly dock</td>
<td>hoary alyssum</td>
<td>Canada thistle</td>
</tr>
<tr>
<td></td>
<td>yellow rocket</td>
<td></td>
<td>quackgrass and other grasses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>dandelion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>white cockle</td>
</tr>
</tbody>
</table>

Source: Doll, University of Wisconsin, 1998
Butyrac (2,4-DB) may be applied to established stands to control several broadleaf weeds but is weak on larger mustards and smartweed and will not control grasses. It gives some suppression of perennial broadleaf weeds. Apply when seedling weeds are small and actively growing. Correct timing is critical as control is less effective on larger weeds. Check the label for specific rates according to weed species and size. Treated forage cannot be harvested or grazed for 30 days after application.

Sencor (metribuzin) controls a broad range of annual and perennial weeds, including fair to good control of dandelion and quackgrass. Alfalfa must be established for at least 12 months before using Sencor. To avoid injury, apply in early spring after the ground is thawed and while alfalfa is still dormant, or impregnate the herbicide onto dry fertilizer and apply when alfalfa is less than 3 inches tall and the foliage is dry. Rates vary with soil type and weed infestation. Consult label for appropriate rates as well as for crop rotation restrictions. Treated alfalfa may be harvested or grazed 28 days after application.

Poast Plus (sethoxydim) or Select (clethodim) may be applied to established stands of alfalfa to suppress quackgrass or control annual grasses. Treat when quackgrass is 6 to 8 inches tall and when annual grasses are small and actively growing. Do not apply to grass-legume mixtures as forage grasses will be stunted or killed. Alfalfa treated with Poast Plus may be harvested after 7 days as green chop or haylage and after 14 days for dry hay. If treated with Select, alfalfa can be harvested, fed, or grazed after 15 days. Treatment can be applied in spring or after any harvest during the summer.

Velpar (hexazinone) controls a broad spectrum of annual and perennial weeds, including fair to good control of dandelion and quackgrass. Alfalfa should be established for 1 year or more prior to treatment. Apply Velpar in spring to dormant alfalfa or before new growth exceeds 1 to 2 inches. Treating taller alfalfa will severely injure plants. Rates vary according to weed types present and soil type. Consult the label for specific recommendations. Do not graze or feed treated hay for 30 days. Corn may be planted 1 year after treatment; for all other crops, including alfalfa, you must wait 2 years before planting. Fall-applied Velpar controls certain species (especially winter annuals) but is less effective on dandelion than spring applications. The uncertainty of winter survival of alfalfa also makes fall treatment a risky venture in most areas.

Table 10. Alfalfa tolerance and herbicide effectiveness on common weeds in established stands.

<table>
<thead>
<tr>
<th>alfalfa tolerance</th>
<th>Butyrac (2,4-DB)</th>
<th>Poast Plus (sethoxydim)</th>
<th>Select (clethodim)</th>
<th>Sencor (metribuzin)</th>
<th>Velpar (hexazinone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>annual weeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>field pennycress</td>
<td>F/G</td>
<td>G</td>
<td>G</td>
<td>F/G</td>
<td>F/G</td>
</tr>
<tr>
<td>foxtail spp.</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>night-flowering catchfly</td>
<td>P</td>
<td>N</td>
<td>N</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>shepherd’s purse</td>
<td>F/G</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Virginia pepperweed</td>
<td>F/G</td>
<td>N</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>biennial weeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>spotted knapweed</td>
<td>F</td>
<td>N</td>
<td>N</td>
<td>F</td>
<td>N</td>
</tr>
<tr>
<td>perennial weeds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada thistle</td>
<td>P</td>
<td>N</td>
<td>N</td>
<td>P</td>
<td>N</td>
</tr>
<tr>
<td>curly dock</td>
<td>P</td>
<td>N</td>
<td>N</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>dandelion</td>
<td>P</td>
<td>N</td>
<td>N</td>
<td>F/G</td>
<td>F/G</td>
</tr>
<tr>
<td>hemp dogbane</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>P</td>
<td>N</td>
</tr>
<tr>
<td>hoary alyssum</td>
<td>F</td>
<td>N</td>
<td>N</td>
<td>F/G</td>
<td>G</td>
</tr>
<tr>
<td>orange hawkweed</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>P</td>
<td>N</td>
</tr>
<tr>
<td>quackgrass</td>
<td>N</td>
<td>F/G</td>
<td>F/G</td>
<td>F/G</td>
<td>F/G</td>
</tr>
<tr>
<td>sowthistle, perennial</td>
<td>P</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>white cockle</td>
<td>P</td>
<td>N</td>
<td>N</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>wirestem muhly</td>
<td>N</td>
<td>F/G</td>
<td>F/G</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>yellow rocket</td>
<td>P</td>
<td>N</td>
<td>N</td>
<td>F/G</td>
<td>G</td>
</tr>
</tbody>
</table>

Source: Adapted from Becker, University of Minnesota, and Doll, University of Wisconsin, 2004
Abbreviations: G = good; F = fair; P = poor; N = no control.
Several diseases occur in alfalfa stands that can kill seedlings, limit yields, and shorten stand life. The occurrence and severity of diseases depends on environmental conditions, soil type, and crop management. Few economical control options are available for diseases once they’re present in a field, but knowing which diseases are present can help you select resistant varieties for future plantings.

**Anthracnose**

Anthracnose occurs most often under warm, moist conditions and causes yield losses of up to 25%. On susceptible plants, stems have large, sunken, oval- to diamond-shaped lesions. Large lesions are straw colored with brown borders. Lesions can enlarge and join together to girdle and kill one to several stems on a plant. Girdled stems may wilt suddenly and exhibit a “shepherd’s hook.” This should not be confused with frost damage. Dead stems are often scattered in the field with straw-colored to pearly white dead shoots. Infected crowns turn blue-black, produce fewer stems per plant, and the plant eventually dies. Moderate or higher resistance is available in many varieties.
**Aphanomyces root rot**

Aphanomyces root rot is an important disease of wet soils. It stunts and kills seedlings and causes a chronic root disease in established plants. Infected seedlings develop yellow cotyledons followed by chlorosis of other leaflets. Roots and stems initially appear gray and water-soaked, then turn light to dark brown. Seedlings become stunted but remain upright. Aphanomyces reduces root mass on established plants. Nodules are frequently absent or in some stage of decay. Infected plants exhibit symptoms similar to nitrogen deficiency and are slow to regrow following winter dormancy or harvest. For best results, select varieties with high levels of resistance to both aphanomyces and Phytophthora root rot. There are two races of aphanomyces. Most resistance is to Race 1; however, Race 2 occurs in some areas and is more virulent than Race 1. If you plant a resistant variety and still have the disease, select a variety with Race 2 resistance.

---

**Distribution and severity**

*Distribution of Aphanomyces*

- **severe**
- **moderate**
- **mild**

---

Comparison of susceptible (left) and resistant (right) varieties shows stunting and slight yellowing caused by aphanomyces.
Bacterial wilt symptoms begin to appear in the second and third year and may cause serious stand losses in 3- to 5-year-old stands. In early stages, affected plants turn yellow-green and are scattered throughout the stand. Severely infected plants are stunted with many spindly stems and small, distorted leaves. Diseased plants are most evident in regrowth after clipping. Cross sections of the taproot show a ring of yellowish brown discoloration near the outer edge. Most varieties are now resistant to this disease.
Common leaf spot and lepto leaf spot

Common leaf spot occurs primarily in first and second cuttings and in fall regrowth of most alfalfa stands. Disease severity depends on alfalfa conditions and varietal resistance. Symptoms appear as small, brown to black lesions—each less than 0.1 inch diameter—that rarely grow together. On the upper leaf surface, the lesions may have a small raised disc in the center. Leaves turn yellow and fall off. The disease causes yield reductions and lowered forage quality through leaf loss. Severely infected fields should be harvested early. Some varieties are moderately resistant.

Distribution and severity

Lepto leaf spot attacks young regrowth of alfalfa during spring and fall or midwinter in southern areas. Disease growth is particularly noticeable following cool, rainy periods. The lesions start as small, black spots and enlarge to 0.1 inch in diameter with light brown or tan centers. The lesions are usually surrounded by a yellow, chlorotic area. Lesions often enlarge and grow together. Yield and quality is lost through loss of dead leaves by wind or during harvesting. Resistant cultivars are not available.

Lepto leaf spot lesions have tan centers and are surrounded by a yellow halo. Lesions often enlarge and grow together.

Common leaf spot lesions are small brown to black areas that rarely grow together.
Fusarium wilt is a vascular disease that causes gradual stand thinning. Initially, plants wilt and appear to recover overnight. As the disease progresses, leaves turn yellow then become bleached, often with a reddish tint on only one side of a plant. After several months the entire plant dies. Symptoms are similar to bacterial wilt but plants are not stunted. To diagnose Fusarium, cut a cross section of the root. The outer ring (stele) of the root is initially streaked a characteristic reddish-brown or brick red color. As the disease progresses the discoloration encircles the root and the plant dies. Practice good fertility and control pea aphids and potato leafhoppers to reduce the effects of this disease. Many varieties are resistant to Fusarium wilt.

Distribution and severity

Fusarium wilt

Disease bleaches the leaves and stems on plants scattered throughout the field. Symptoms are similar to bacterial wilt but affected plants are not stunted.

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Phytophthora root rot

Phytophthora root rot can kill seedlings and established plants in wet or slowly drained soils. The disease is especially prevalent among new seedlings in cool, wet soils. Infection occurs as plants emerge; they appear water-soaked and then collapse and wither. The disease appears on established plants in poorly drained soils and where water stands for 3 days or less. Plants wilt, then leaves, especially lower ones, turn yellow to reddish brown. Lesions develop on the roots. In severe cases, taproots may rot off at the depth of soil water saturation (frequently 1 to 6 inches below ground surface). Plants may die within 1 week of infection or linger on with reduced root mass and growth rate. Often Phytophthora root rot is not discovered until the soil dries and apparently healthy plants begin wilting because their rotted taproots are unable to supply adequate water. Many highly resistant varieties are available for poorly drained soils.

Crop rotation is of little value for Phytophthora root rot control because the fungus can survive indefinitely in the soil. However, good management practices can prolong the productivity and life of infected plants that survive the initial infection.

1. Maintain high soil fertility to promote extensive lateral root development above the diseased region of the root and to extend the life of the plant.
2. Avoid untimely cuttings that might stress the plants. Heavy rains immediately after cutting often result in severe infections. Do not cut, for example, between September 1 and October 15.
3. Control leaf-feeding insects, which can stress plants and make them more susceptible to Phytophthora.
4. Tilling and land-leveling, if practical, can reduce Phytophthora root rot by improving surface and subsurface drainage.

Distribution and severity

As the disease progresses (left to right), lesions develop and the taproot rots off.

Stems and leaves are bleached by Phytophthora.
Root-lesion nematodes reduce yield and thin stands. The parasitic nematodes are microscopic worms that feed on root hairs, feeder roots, and nitrogen-fixing nodules of alfalfa. Root-lesion nematodes reduce the alfalfa plant’s ability to take up soil nutrients and fix nitrogen. Plants appear unhealthy and stunted, usually in spotty areas within an otherwise healthy stand. Nematode populations can be reduced by rotating to row crops or fallowing for 2 months following incorporation of forage crop residue. Moderate resistance is available in some varieties.

Seedling death due to root-lesion nematodes.

Stunted plants and stand thinning caused by root-lesion nematodes.
Sclerotinia
crown and stem rot is most
damaging to seedling stands, espe-
cially those seeded in late summer.
The first symptoms appear in the fall
as small, brown spots on leaves and
stems. During the cool, wet weather
of early spring, the crown or lower
parts of individual stems soften,
discolor, and disintegrate. As infected
parts die, a white, fluffy mass grows
over the area and hard, black bodies,
known as sclerotia, form. These
bodies remain on the surface of the
stem or become imbedded in it. Infection
will spread if cool, wet weather
prevails during spring, causing rapid
thinning of stands. Spring planting
reduces incidence of the disease.
Plowing buries sclerotia and reduces
its ability to infect new plantings.
Some resistance is available in some
varieties.

Distribution and severity
Sclerotinia

Arrows point to white fluffy masses at the base of a stem.

Sclerotia on stem.

Softened and discolored stems.
**Spring black stem**

Spring black stem occurs in the northern United States during early spring and reduces forage yield and quality. Many small, dark brown spots develop on the lower leaves and stems. Leaves, especially lower ones, turn yellow, wither, and fall off. Lesions on stems enlarge and may blacken large areas near the base of the plant. Severe infestations girdle and kill the stem. The plant dies when infection spreads to the crown and roots. Cutting the stand at early stages of maturity will reduce leaf loss and disease prevalence. Currently available varieties have variable levels of resistance, but none are characterized for this disease.

**Distribution and severity**

*Spring black stem*

![Map of Spring black stem distribution](image)

Lesions may enlarge to girdle stems and kill the plant.

**Summer black stem**

Summer black stem occurs during hot, humid weather, reducing forage yield and quality. The disease first affects the base of the plant and progresses up the stem, causing leaves to fall off. Leaf spots are brown with irregular margins and often surrounded by a diffuse yellow margin. Reddish to chocolate brown oval lesions form on the stems and merge to discolor most of it. Early harvest may reduce losses. Currently available varieties have little resistance.

**Distribution and severity**

*Summer black stem*

![Map of Summer black stem distribution](image)

Leaf lesions (left) first appear on lower leaves.
Verticillium wilt

Verticillium wilt can reduce yields up to 50% beginning the second harvest year and severely shortens stand life. Early symptoms include v-shaped yellowing on leaflet tips, sometimes with leaflets rolling along their length. The disease progresses until all leaves are dead on a green stem. Initially, not all stems of a plant are affected. The disease slowly invades the crown and the plant dies over a period of months. Root vascular tissues may or may not show internal browning. Many varieties are resistant to this disease.

The following measures minimize the chances of introducing the fungus to an area and spreading the disease between and within fields.

1. Plant resistant varieties.

2. Practice crop rotation. Deep plow Verticillium-infested fields and do not plant alfalfa for 2 to 3 years, although a highly resistant variety could be planted sooner. Corn and small grains are important non-hosts. These crops should fit well into a rotation with alfalfa. Red clover is a questionable host, so don’t grow red clover on Verticillium-infested land.

3. Harvest non-infested fields first. Then harvest infested fields at the hard-bud or early flower stage. Early harvest can limit some yield and quality losses caused by Verticillium wilt and can slow the spread of the fungus in a field.

Distribution and severity

Verticillium wilt

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Insect management

Alfalfa blotch leafminer
The alfalfa blotch leafminer was first detected in the Midwest in 1996. Adults are small, black, hump-backed flies that emerge from overwintering pupae located on the surface of the soil. The first indication of their presence is the appearance of numerous pinholes (from a few to over 100) in the alfalfa leaflets. These pinholes are punctures made during egg laying, but the adults also feed on plant material that oozes from the punctures. Females lay one to three eggs per leaflet. Small yellow maggots hatch within the leaf and begin feeding between the upper and lower leaf surfaces. As the leafminers eat their way from the base of the leaflet toward the tip, the tunnel, or mine, they create widens as they mature. The resulting tunnels give the leaflets a blotchy appearance. When fully grown, the leafminers crawl out of the leaves, drop to the ground, and pupate. In the upper Midwest, a second generation of flies emerge in mid-July, and a third generation follows in late August.

Damaged leaves have reduced protein content and may fall off. Significant yield loss should only occur if damaged leaves drop or are shaken from the forage during harvest.

In the upper Midwest, harvest of the first crop normally controls the first generation. Development of the second and third generations, however, may not correspond as closely with cutting schedules and this could lead to more extensive injury in those cuttings. Insecticidal control may be warranted if at least 30% of the leaflets have pinhole injury. Delaying application until blotches are apparent on numerous plants will reduce insecticide effectiveness. Because the eggs hatch over an extended period and the adults are mobile, some insecticide trials have had marginal control results. Biological control of this pest is well established in the northeastern United States. It is anticipated that biological control will also be a major control factor in the Midwest as parasitized larvae were detected in Wisconsin in 1998.

Alfalfa weevil
Alfalfa weevil larvae chew and skeletonize leaves. Large larval populations may defoliate entire plants, giving the field a grayish cast. Damage normally only occurs to the first harvest but both larvae and adults may damage regrowth when populations are high, resulting in both yield and stand loss.

Larvae are slate-colored when small, but bright green when full grown (¾ inch). They have a white stripe down the back and a black head. Although larvae are present from May well into the summer, peak feeding activity falls off by mid-June.

When full grown, the larvae spin silken cocoons on the plants, within the curl of fallen dead leaves, or within litter on the ground. Adults emerge in 1 to 2 weeks. They are dark
gray to brown snout beetles measuring $\frac{3}{16}$ inch in length. There is a distinct dark shield-like mark on the back. After feeding a short time, most leave the field and enter a resting period that lasts until fall. In the fall, they return to the alfalfa field and lay a few eggs before the onset of cold temperatures. In northernmost states, fall egg laying is insignificant; most eggs are laid the following spring. Begin checking alfalfa fields for signs of weevil feeding around mid-May in northernmost states and earlier farther south.

Treat fields when 40% of the plant tips of the first crop show obvious signs of damage. This does not mean 40% defoliation. If damage occurs within 7 to 10 days of the suggested harvest date, harvest the hay as soon as possible; otherwise, spray the field as soon as possible. Many weevil larvae are killed during harvesting.

An alternative approach for deciding when to treat involves comparing the control costs to the forage value. Use table 11 to find where these two values intersect for the number of alfalfa weevil larvae needed to justify chemical control.

If you’ve harvested early because of developing alfalfa weevil problems, or if substantial weevil damage has occurred, check the stubble carefully for signs of damage to new growth. Some fields may fail to green-up because adults and larvae consume new crown buds as fast as they are formed. Examine the stubble, the soil surface around alfalfa plants, and under leaf litter for larvae and adults. If they are present and if plants show no sign of regrowth within 3 or 4 days after harvest, spray the stubble as soon as possible.

Treat also if new growth has started and feeding damage is apparent on 50% of the growth and/or you find 6 to 8 weevils or more per square foot.

### Distribution and severity

#### Alfalfa weevil

![Map of distribution and severity](image)

**Table 11.** Economic thresholds for alfalfa weevil larvae in early bud stage alfalfa.

<table>
<thead>
<tr>
<th>control cost ($/acre)</th>
<th>forage value ($/ton)</th>
<th>average larvae/stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>7</td>
<td>4.0</td>
<td>3.3</td>
</tr>
<tr>
<td>8</td>
<td>4.6</td>
<td>3.6</td>
</tr>
<tr>
<td>9</td>
<td>5.2</td>
<td>4.2</td>
</tr>
<tr>
<td>10</td>
<td>5.8</td>
<td>4.7</td>
</tr>
<tr>
<td>11</td>
<td>6.3</td>
<td>5.2</td>
</tr>
<tr>
<td>12</td>
<td>6.9</td>
<td>5.6</td>
</tr>
<tr>
<td>13</td>
<td>7.4</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Source: Peterson, Danielson, and Higley, University of Nebraska, 1993
**Aphids**

Aphids cause stunting and yellowing of alfalfa resulting in yield loss. Heavily infested plants wilt during the hottest parts of the days.

Green pea aphids or the spotted alfalfa aphids, which are yellow and faintly dark spotted, congregate on stems and leaves and suck plant juice. Spotted alfalfa aphids have been uncommon in the upper Midwest for many years. Parasites and disease keep the pea aphid in check most years, though population explosions periodically occur. Pea aphids are a major problem in the hot and dry western United States. Treat pea aphids when numbers exceed 100 per sweep, particularly during dry periods.

**Distribution and severity**

**Pea aphid**

![Aphids congregate on leaves and stems to suck plant juice.](image)

**Blister beetles**

Blister beetles in alfalfa hay can cause sickness and death in livestock, particularly horses. Blister beetles contain cantharidin, a chemical irritant that can blister internal and external body tissues. Although there are few documented cases of fatalities in cattle and sheep, cantharidin-contaminated hay is deadly to horses. The amount of cantharidin necessary to kill a horse is 1 milligram per kilogram of horse weight. Blister beetles vary in toxicity depending on the species. It would require 100 striped blister beetles to kill a 1200 lb horse compared to 1100 of the less toxic black blister beetles.

Blister beetles are a serious problem in southern and western states, and an occasional problem in the upper Midwest, particularly during drought years or the year following drought. The several species present in the Midwest vary in size and color, but are easily recognized by their elongated, narrow, cylindrical, soft bodies. The “neck” area is narrower than on most beetles. Scouting is misleading because the beetles tend to cluster and will be concentrated in parts of the
field while absent from other parts. Sprays are generally not effective because cantharidin is a very stable compound and the dead beetles can be picked up in the hay. Because beetle populations tend to build throughout the season, especially in the south, horse owners should consider buying first-crop and early second-crop hay during high infestations of blister beetle. Harvesting fields prior to flowering and maintaining weed-free stands will reduce beetle populations.

**Distribution and severity**

*Blister beetles*

**Clover leaf weevil**

Clover leaf weevil larvae eat alfalfa leaves, usually beginning with the foliage around the base of the plant. Crop injury occurs mostly before the first cutting, but it is usually insignificant compared with the injury caused by the alfalfa weevil. Clover leaf weevils are active at night and on cloudy days. During sunny days, they hide around the base of the plant. Larvae are slate-colored when small, and bright green when full grown. They are similar in appearance to alfalfa weevil larvae except that the head is light brown and the white stripe down the center of the back is often edged with pink. Full-grown larvae are about ½ inch long.

Adult clover leaf weevils are two to three times larger than alfalfa weevils. They are ¾ inch long, dark brown flecked with black, and have a lighter colored stripe extending along each side of the wing covers. This insect normally leaves the fields shortly after the first cutting and returns in late summer to feed and lay eggs before winter. There is one generation per year and they overwinter mostly as partially grown larvae.

Treatment is rarely warranted for clover leaf weevil larvae. Management of alfalfa weevils will also control this insect. However, adult clover leaf weevils can cause damage by feeding on the green stems and regrowth after the first cutting. Large populations can cause extensive feeding damage, scarring the stems and rapidly consuming new foliage as it is produced. This type of injury is more common during dry springs when regrowth is slow and weevils are abundant. Treatment should be considered if plants do not begin to regrow in 3 to 4 days after cutting and weevils are present in the field.

**Distribution and severity**

*Clover leaf weevil*

| severe | moderate | mild |

Adult clover leaf weevils are dark brown flecked with black. Clover leaf weevil larvae are similar to alfalfa weevil larvae but have light brown heads rather than black. Clover leaf weevil larvae hide around the base of the plant during sunny days, preferring to feed at night and on cloudy days.
**Clover root curculio**

The clover root curculio is a potentially serious pest of alfalfa. Although this pest can be found in most alfalfa fields, high populations and serious damage have been localized and sporadic. However, even small populations may contribute to stand decline. At this time there is no reliable method of damage prediction or control.

Adults are black to dark brown, blunt-snouted weevils that are approximately 1/8 inch long and 1/16 inch wide. The surface of the beetle’s body is deeply “punctured.” Females lay eggs on the lower parts of stems, on lower leaves, or on the soil surface. Larvae hatch from these eggs and enter the soil through surface cracks. There is only one generation per year. Adults lay eggs in fall or spring, and hibernate over the winter. Eggs hatch in the spring, and egg-laying is usually complete by mid-June. New adults emerge in June and July and live about a year.

Adult curculios injure plants by chewing the margins of leaves, creating crescent-shaped notches, or by chewing the stems and leaf buds of young seedlings. Feeding damage can weaken seedlings, causing poor growth or death. Mature plants are not at risk unless populations are exceedingly high. Larvae do the greatest damage, and such damage can be cumulative over the years that a field exists. Newly hatched larvae feed on nodules and small rootlets and chew out portions of the main root. Feeding on the main root leaves long brown furrows and may partially girdle the plant. Damage from clover root curculios is believed to shorten stand life, contribute to winter kill, and provide an avenue for entry by disease organisms. No commercially acceptable control techniques are available. However, do not plant alfalfa back into old, infested alfalfa stands because curculio damage can destroy the new stand. Also, since adults migrate primarily by crawling from field to field, avoid seeding alfalfa next to older stands.

**Grasshoppers**

Grasshoppers can overwinter as eggs or adults, depending upon the species. Populations tend to build during the season, followed by movement of the grasshoppers into cultivated crops from grassy or weedy areas where they overwintered. It is important to detect infestations while the grasshoppers are small and concentrated in overwintering sites. Several species can feed on alfalfa. Problems occur mainly in the western United States and during droughty years in the Midwest. Grasshoppers rarely cause economic damage in most areas of the Midwest and should be considered a minor pest.

Begin spot-checking overwintering sites during June. Estimate the number of grasshoppers per square yard while walking through these areas. Insecticide use is not suggested until populations reach 20 per square yard in field margins or 8 per square yard within an alfalfa field. If economically damaging infestations are detected while the grasshoppers are still concentrated, spot treat the area to protect alfalfa fields.

**Distribution and severity**

*Clover root curculio*

Long brown furrows on the taproot caused by curculio larvae feeding.
Plant bugs

Plant bugs extract plant sap with their tube-like mouths. High populations can stunt alfalfa growth or crinkle and pucker leaves. However, these symptoms may be caused by other factors so be sure to positively identify the problem before treating plants.

The two plant bugs that are particularly important to alfalfa production are the tarnished plant bug and the alfalfa plant bug. The adult tarnished plant bug is \( \frac{1}{4} \) inch long and brown. Nymphs are green with black spots on the back. Adult alfalfa plant bugs are \( \frac{3}{8} \) inch long and are light green. Nymphs are green with red eyes.

Treatment is suggested if there are three plant bug adults and/or nymphs per sweep on alfalfa that is less than 3 inches tall; treat when there are five or more adults and/or nymphs per sweep on taller alfalfa. If damage occurs within 7 to 10 days of the suggested harvest date, harvest the hay as soon as possible; otherwise spray the field as soon as possible.

Distribution and severity

Grasshoppers

Grasshoppers are best controlled when they are in field borders and before they move into the alfalfa.

Grasshoppers are best controlled when they are in field borders and before they move into the alfalfa.

Adult tarnished plant bugs are \( \frac{1}{4} \) inch long.

Alfalfa plant bugs are \( \frac{3}{8} \) inch long.

Crinkled leaves typical of plant bug damage.
Potato leafhoppers

Potato leafhoppers are mid- to late-season alfalfa pests that migrate to northcentral and eastern states from southern areas in late spring. First-crop alfalfa harvested at the proper time in the Midwest usually escapes damage. However, subsequent crops and new seedlings should be monitored for leafhoppers. These small (1/8 inch), green, wedge-shaped insects suck sap from plants and damage the phloem of leaves, restricting water and nutrient flow to the outer tip of the leaf. This creates a yellow wedge-shaped area on the tip of leaflets. Severely damaged plants will be stunted and chlorosis will appear on all leaves if leafhoppers are not controlled. Damage first appears along the edges of fields.

 Alfalfa stands suffer yield and quality losses before any yellowing is visible. To detect leafhoppers before symptoms appear, scout fields using an insect sweep net. Count adult and nymph leafhoppers in 10 sweeps covering several areas of the field. The decision to spray depends on the following factors:

1. Whether alfalfa is a new seeding or established stand. New seedings are most susceptible; damage in the first year can reduce yield for the life of the stand. It is particularly important to control potato leafhoppers on new seedings under a cover crop by either scouting and spraying or using a resistant variety, otherwise stands may die out.

2. Plant height. Taller plants are able to tolerate more leafhoppers.

3. Whether or not the variety has greater than 50% resistance to potato leafhopper. Leafhopper population growth is inhibited in highly resistant varieties. Resistant varieties suffer significantly less damage and require insecticide treatment less frequently than susceptible varieties.

Refer to figure 17 to determine appropriate action to take in alfalfa fields. These spray guidelines are based on average costs of insecticide treatment and average hay value. Growers should consider altering the action thresholds if treatment cost or hay value deviates greatly from average.

Distribution and severity

Severely damaged plants are stunted and chlorotic. Leafhopper burn appears first as yellow wedge-shaped areas on the tips of leaflets.

**Figure 17.** Economic action thresholds for control of potato leafhopper (PLH) in alfalfa.

*Source: Mark Sulc and Ron Hammond, The Ohio State University, 2004.*
**Spittlebugs**

Spittlebug nymphs appear in early May. These soft, orange or green bugs can be found in white spittle masses in leaf axils, and later in the clumps of new growth at tips of stems. They suck plant juices and stunt but do not yellow the alfalfa. Alfalfa can support a tremendous population of spittlebugs without yield loss and they usually have no economic impact. Treatment is suggested if there is an average of one spittlebug per alfalfa stem.

**Distribution and severity**

Spittlebugs

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**Variegated cutworm**

Variegated cutworm larvae feed on leaves and stems. Serious damage can occur on regrowth after the alfalfa is cut and larvae feed under the protection of drying windrows. They also can cut seedling plants in new stands. Larvae are variable in color, ranging from tan to greenish-yellow to almost black with a row of small yellow, dagger- or diamond-shaped spots down the center of the back. There are three to four generations a year.

Treatment should be considered if the hay does not begin to regrow in 4 to 7 days after cutting and larvae are present in the field.

**Distribution and severity**

Variegated cutworm

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**When to rotate from alfalfa**

To decide when to rotate from alfalfa, you’ll need to evaluate stand density and yield relative to your needs. You’ll also want to factor in rotation requirements, farm plan, total acreage of forage needed, and ability to reseed. Because most of these factors are farm specific, this section focuses on the relationship between stand density and yield.

Alfalfa has a tremendous ability to produce maximum yield over a wide range of stand densities. New seedings should have at least 25 to 30 plants per square foot the seeding year. Stands gradually thin and weeds may invade rapidly. Weedy stands force the choice of using herbicides, which increases production cost, or of harvesting much lower quality forage.

The decision to reseed new fields of alfalfa should be based on the yield potential of the stand, ideally using actual yields from the field. The next best method is to count stems when the alfalfa is 4 to 6 inches tall and use the data from figure 18 to estimate yield potential (assuming drought, soil fertility, or other conditions are not limiting yield). In the Midwest, the Northeast, and many irrigated fields in other regions, yields often begin to decline in the third year of production. Fields with reduced yields still cost about the same as high-yielding fields. This is because high-yielding fields require less herbicide to produce high-quality forage.

Plowing down more dense stands will produce nitrogen credits. There is also a rotational benefit to corn following alfalfa: it yields 10 to 15% more than corn following corn.
The best time to make stand decisions is in the fall. During the last growth period record stem density. Then dig a random sampling of plants and assess root health (see related advanced technique). Typically, stands that fall below 40 stems per square foot or three to four healthy plants per square foot are no longer profitable, although the critical yield range will vary with individual farming operations. Marginal stands that are healthy may be kept while fields with high levels of crown rot will decline rapidly and should be considered for rotation along with low yield potential fields.

### Advanced techniques

#### Stand evaluation

To evaluate stands, dig several alfalfa plants and look at the condition of the root. This will give an idea of stand vigor and future life span. Some crown rot will be visible in most older stands. Look for the number of crowns and roots with rot and the degree of infection. Categorize plants using a scale of 0–5 (compare to the photographs at right). Determine the percentage of plants in each category. Healthy stands have fewer than 30% of the plants in categories 3 and 4.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Winter Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Excellent</td>
</tr>
<tr>
<td>1</td>
<td>Excellent</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>Marginal to severe winter kill</td>
</tr>
<tr>
<td>4</td>
<td>Severe winter kill</td>
</tr>
<tr>
<td>5</td>
<td>Already dead</td>
</tr>
</tbody>
</table>

Individual plants with severe injury (greater than 50% rot) are not likely to survive another year. Stands with a high percentage of these plants should be considered for replacement.

**Figure 18.** Alfalfa stem count and yield potential.

![Graph of dry matter yield vs. stems per square foot](image)

**Source:** Undersander and Cosgrove, *University of Wisconsin, 1992*