Dear Valued Forage Producer,

The University of Minnesota Forage Team is proud to announce the third edition of the Forage Quarterly. Since spring is here, this issue focuses on establishment and early season management of forage production systems. In this edition we highlight seeding strategies, weed management, cover crops, insect control and identification.

We would like to take this time to highlight the contributors to this edition:

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Sincerely,
University of Minnesota Forage Team

**Alfalfa Assessment: Factors Leading to Winter Injury**

_Reagan Noland, Doug Holen, Craig Sheaffer, and M. Scott Wells._

A number of factors can contribute to winter damage of an alfalfa stand. These are all important to consider as spring assessments are made. The following elements may all play a role in winter survivability this year:

**Previous management:** The ability of a stand to overwinter starts with proper management decisions. Varieties must be selected by regional and climatic specificity to ensure the appropriate genetics are present for winter hardiness and disease resistance. Proactive fertility management as well as pest management, are also critical, as stressed plants are weaker, and are not efficiently synthesizing carbohydrates for winter storage. Although not a controllable factor, droughty fall conditions also reduce the storage of root reserves. Additionally, the timing of harvest events, especially in the fall can serve to either maintain or deplete root reserves critical for winter survival. No cutting is recom-
mended between September 1st and October 15th, ("critical harvest period") as this is a critical period of carbohydrate accumulation. The critical harvest period dates will vary depending on how far north you are located, but regardless of the date, it is critical that final harvest occurs 4 to 6 weeks before the average date of the first killing frost. Cutting during this period interferes with accumulation of food reserves because new growth is produced at the expense of winter reserves. It is also recommended to maintain a minimum 6 inches of standing growth or stubble to serve as a snow catchment for insulation.

**Lethal temperatures at crown depth:** A minimum 4 inches of snow is considered adequate to insulate the soil and prevent direct freezing damage to alfalfa. With little to no snow cover this year, soil temperatures (at 2 inches) reported from Waseca dropped as low as 2°F on four days in late February (Figure 1). Temperatures of 15-5°F at the crown are capable of causing winter injury. Depending on regional snow cover and minimum air temperatures, as well as degree of fall hardening, plant health, nutritive status, and soil moisture, stressed or vulnerable alfalfa stands may have suffered this form of winter injury this year.

**Breaking dormancy early:** Warm soil temperatures (>40°F) can cause alfalfa to deharden and break dormancy. If followed by extreme cold or icy weather, severe winter injury may result. In Waseca, soil temperatures (at 2 inches) reached 50-55 °F in mid-March, followed by air temperatures as low as 16 °F later in the month.

**Assessing Winter Injury:** Regardless of winter conditions, it is always recommended to make a close assessment of stand health each spring. Winter injury may not be immediately apparent. It may be indicated by slow or uneven spring growth, or could go undetected until after the first cut.

The most direct assessment of spring plant health is root color and turgidity. Dig a few plants from representative areas of the field, and split the taproot down the center as in Figure 2. Healthy roots should be off-white in color and turgid (firm and hydrated as shown on the left). Damaged or winterkilled roots will be dark, dehydrated, and “ropey” (as shown on the right).

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**Figure 1.** Minimum soil and air temperatures in Waseca, MN. January-February 2015.

**Figure 2.** Healthy alfalfa roots (on left) and damaged or winterkilled roots (on right).
Assessing Winter Injury (continued): Early assessments of overall stand health and production potential are achieved through stem counts per square foot:

- **>55 stems per square foot** = Density is not limiting to production
- **40-55 stems per square foot** = Some reduction has occurred, but adequate production is still likely
- **<40 stems per square foot** = May need to consider termination or supplementary options

If winter injury is a concern, it is also important to watch for slow or uneven regrowth, and monitor regrowth closely following the first cut. Reduced stem count or plant vigor may occur as a result of mild winter injury. Depending on plant health and severity of the damage, production may decrease throughout the year, or recover. Recognize that every stand and every field is different and could require specific assessment and management planning.

We will make alfalfa survival assessments by the end of April. Currently our alfalfa stands on the St. Paul campus are greening up nicely and given the mild winter we are not expecting injury in our plots that were management for maximum persistence. As always, we will know more by May.

Management Options: What to do?: As management options are considered, remember that injured alfalfa stands can exhibit delayed regrowth, but may be capable of recovering. Be careful not to rush into alternative options if the stand can be maintained for acceptable production. If action is required, carefully consider the cost and expected benefit of alternatives with regard to the situation. Supplemental forages such as teff, annual ryegrass, and small grains can be interseeded into a thin stand or used to cover the “bad spots” if present. If a large percentage of the stand has been damaged, termination and planting of silage corn or BMR sorghum may be more appropriate. See: Maximizing forage in winter injured and killed stands, Seeding in an Existing Alfalfa Stand and Emergency forages: warm season grasses for details on alternative options.

Alfalfa Establishment: A pathway to increased yield

*M. Scott Wells, Doug Holen, and Craig Sheaffer*

There are over 1-million acres of alfalfa in Minnesota and typical management involves the seeding year and 3 to 4 production years. Alfalfa management programs are designed to ensure highly productive alfalfa stands throughout the course of production. The goal of maximizing yield is not always realized. For example, the University of Minnesota Alfalfa Variety Trials report yields in the 6 to 7 ton/acre (dry matter) range, on average, across all locations over the last few years. In contrast, the statewide average hovers around 3 ton/acre (dry matter) (Figure 1). The natural question is why is there such a difference in yields between the UMN Alfalfa Variety Trials and the statewide averages? This question has been asked repeatedly, and there are several reasons that can explain the lower county yields. Dr. Michael Russelle (USDA-ARS, retired) stated that countywide yields typically include seeding and production-year alfalfa, thereby reducing yield expectations (Russelle, 2007). However, the inclusion of seeding and production-year alfalfa yields does not fully explain the

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**Figure 1.** Minnesota Ag News, 2013 (top) and 2014 (bottom) Hay County Estimates, USDA 2013 and 2014.
Alfalfa Establishment: A pathway to increased yield (Continued from page 3)
yield gap, and best management in both the seeding and production-years are critical in ensuring optimal yield, quality and persistence. For the remainder of this article we will focus the discussion on maximizing yield through best management related to establishing alfalfa.

Since alfalfa production spans several years, it is important to start off with the highest productive stands possible. In the UMN Alfalfa Variety Trials, we adhere to the six following management strategies for optimal alfalfa establishment: (i.) field selection, (ii.) fertility management, (iii.) seeding dates, (iv.) field preparations and seeders, (v.) seeding depth, (vi.) seed-to-soil contact, and (vii.) seeding rates. Along with the aforementioned establishment strategies, selection of alfalfa varieties that have adequate fall dormancy and disease resistances, as well as purchasing high-quality pure alfalfa seed, is extremely important. For information on varieties please visit http://www.naaic.org/resource/stdtests.php and the UMN Alfalfa Variety Trials http://www.maes.umn.edu/sites/maes.umn.edu/files/2014 Alfalfa Final.pdf

**Field Selection:** Site selection is important since alfalfa prefers well-drained deep soils that do not follow alfalfa. Under ideal growing conditions, alfalfa roots can explore over 20 feet deep. When selecting fields try to avoid hilltops, shallow and highly eroded soils, and fields with low spots where water is known to pool (Picture 1). Wet soils not only reduce diffused Oxygen ($O_2$) but also benefit diseases and increase the risk of ice sheeting. In addition to locating well-drained, deep soils, following alfalfa in the rotation with newly seeded alfalfa is not advisable due to autotoxicity. Alfalfa produces toxins that not only reduce germination but also impair the development of taproots, thereby limiting the uptake of water and nutrients, which directly impacts yield and performance (Figure 2).

**Fertility Management:** After the field is selected, soil sampling and analysis will identify soil nutrient deficiencies. Since alfalfa has both perennial (e.g. aglime) and annual fertilizer (e.g. potash) needs, soil sampling yearly will provide detailed information on available nutrients. Fertility management ensures good stands and vigorous growth during the establishment years, while increasing productivity and persistence throughout the production years. Several parameters and nutrients are critical for optimal stand health, but for this discussion we will focus on soil pH, potassium, and phosphorus. For more details on nutrient management please visit http://www.extension.umn.edu/agriculture/nutrient-management/.

Maintenance of soil pH between 6.7 and 6.9 is extremely important since soil nutrients are most available (i.e. widest bars) to the alfalfa roots within that range (Figure 3). Since buffering soil pH can take time, it is advised that soil tests be performed...
Alfalfa Establishment: A pathway to increased yield (Continued from page 4)

and Ag-lime applied and incorporated 12 months prior to alfalfa seeding based on soil reports. This will allow adequate time for the lime treatment to neutralize soil acidity and ensure pH in the 6.7 - 6.9 range. Typically, the re-application of lime will not be needed during alfalfa’s life cycle.

Unlike soil pH, phosphorus (P) and potassium (K) levels need to be assessed throughout the alfalfa life cycle. Maintaining soil potassium and phosphorus in a non-limiting status, especially phosphorus, will improve alfalfa stand establishment, yield, and survival (i.e. persistence). Since alfalfa removes significant amounts of P and K (Table 1), fall soil sampling and analysis are needed on an annual basis to identify any P and K deficiencies. If prescribed by the soil test, P and K fertilizer can be applied in the spring.

**Seeding Dates:** When seeding alfalfa in Minnesota, there are two options for timing: spring and summer. Spring seeding dates of April 15th to May 15th are recommended for most of Minnesota. However, north of St. Cloud, later planting dates are advised (May 1st to May 30th). Late-summer seeding dates for southern Minnesota are August 1st to 15th and for northern MN July 20th to August 1st are recommended. Both seeding dates have pros and cons. See summary below (Table 2). The UMN Alfalfa Variety Trial seeds all alfalfa in the spring, mainly due to the available soil moisture and better overall growing conditions when compared to summer seeding dates.

**Field Preparations and Seeders:** Proper seedbed preparation is essential in providing adequate seed-to-soil contact and controlling perennial and annual weeds. Many establishment failures can be avoided by utilizing primary tillage (moldboard plowing or chiseling) followed by disking and secondary tillage (i.e. smoothing operation) in conjunction with cultipacker. Ideal soil conditions should be smooth, firm, and clod-free for optimal seed placement using drills and brillion seeders. When walking on soil prior to planting, the heel of your shoe should not sink more than 3/8 of an inch into the soil. If it does, then use a cultipacker to firm the surface. Providing a proper seedbed is achieved, the choice of planter type when operated correctly does not impact alfalfa yield (Figure 4).

**Seeding Depth:** Once the field is prepared and the seeder is properly calibrated, the number one cause of poor stand establishment is seeding depth. Seeding depth is an issue when seeding with a drill, and there is a direct relationship between stand establishment and seeding depth. Sandy soils are a bit

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### Table 1. Pounds of nutrient removed per ton of alfalfa produced, dry matter basis.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Dry matter removal (lb/ton)</th>
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<tbody>
<tr>
<td>Phosphorus (P)</td>
<td>6</td>
</tr>
<tr>
<td>Phosphate (P$_2$O$_5$)</td>
<td>14</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>48</td>
</tr>
<tr>
<td>Potash (K$_2$O)</td>
<td>58</td>
</tr>
</tbody>
</table>

Adapted from Alfalfa Management Guide.

### Table 2. Pros and Cons of spring and summer alfalfa seeding dates

<table>
<thead>
<tr>
<th>Seeding Dates</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>More soil moisture</td>
<td>Weed control</td>
</tr>
<tr>
<td></td>
<td>Longer growing season</td>
<td>Excessively wet springs</td>
</tr>
<tr>
<td></td>
<td>Enhanced germination</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooler temperatures</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>Herbicides typically not needed</td>
<td>Lack of available soil moisture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sclerotinia crown rot may be prevalent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Need 6 to 7 weeks of growth to survive the winter.</td>
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</tbody>
</table>
more forgiving, but it is a good idea to limit planting depth to ½ inch regardless of soil type (Figure 5). A good rule of thumb is that about 10% of the seeds should be visible on the soil surface.

**Seed-to-Soil Contact: A consequence of seedbed preparation:** The goal of providing a proper seedbed is to ensure good seed-to-soil contact. Since most forage seeds must absorb more than their own weight in water, good seed-to-soil is essential for uniform emergence. The water needed for germination is held by the soil particles, and the more particles in direct contact with the seed the quicker the seed can absorb water and germinate (Figure 6).

**Seeding Rates:** Seeding rates should be between 12 and 15 lb/acre. Prescribed seeding rates are designed to provide several times the seed needed to achieve optimal yield under ideal growing conditions, therefore, seeding rates above 15 lb/acre have no positive impact on yield (Table 3). The 12 to 15 lb/acre seeding rate will provide 23 plants per square foot during the first production year, assuming that best management strategies were observed.

In the UMN Alfalfa Variety Trials, we seed at 13 lb/acre, which achieves the needed 23 to 25 plants per square foot in the first production year, thereby maximizing yield. Even though increased seeding rates have no impact on yield (assuming ideal conditions), planting extra seed can provide insurance to high seedling mortality in years when cool wet weather persists (Figure 7).

### Table 3. Effect of seeding rate on first-year alfalfa dry matter yields.

<table>
<thead>
<tr>
<th>Seeding rate (lb/acre)</th>
<th>Dry matter yield (ton/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>3.4</td>
</tr>
<tr>
<td>15</td>
<td>3.6</td>
</tr>
<tr>
<td>18</td>
<td>3.6</td>
</tr>
</tbody>
</table>

*Adapted from the Alfalfa Management Guide.*

Figure 4. Effect of seeding equipment on yield. Adapted from Alfalfa Management Guide.

Figure 5. Alfalfa emergence as determined by seeding depths and soil types. Alfalfa Management Guide.

Figure 6. The impacts of proper seed-to-soil contact. Soil particle (gray) and soil water (blue). The seed on the right will absorb the required 125% its mass in water quicker than the seed on the left.

Figure 7. Alfalfa stand density during the first 12 months. (Seeded at 12 lb/acre). Adapted from the Alfalfa Management Guide.
Alfalfa Establishment: A pathway to increased yield (Continued from page 6)

Summary: The above guidelines are followed in the UMN Alfalfa Variety Trials, and have ensured optimal yield year after year. We are confident that if you select fields of deep and well-drained soils, sample soils annually to mitigate soil nutrient deficiencies, spring seed in clod-free smooth but firm seedbeds with at least 13 lb-seed/acre, and plant seeds at no more than a ½ inch depth, you will have sufficient alfalfa plants to maximize your yields in the first production year.

Preparing for Successful Alfalfa/Grass Production in 2015

Doug Holen

Alfalfa fields continue to dominate the forage landscape across Midwestern states. Increasingly however is the practice of mixing an alfalfa variety with grass species creating “hay” fields popularized decades ago by beef producers and quite popular in Eastern U.S. dairy regions. While initial hay fields may have been evolutionary natural resulting from grasses filling in areas of lost alfalfa plants, today’s production is much more intensively managed. The reasons for mixing alfalfa and grasses include seeding year yield (tonnage), drying rate, persistence, animal intake and palatability, weed suppression, erosion control, in season manure applications/wheel traffic tolerance, and livestock bloat management in grazing systems. Once perceived as a low input/management forage crop, these have evolved into a highly productive cropping system. Unlike annual commodity crops where genetics and inputs are evaluated and selected each year, forage production is a three to six year commitment depending on a producer’s decision making and implementation of management practices combined with field rotations benefitting the farm as a whole system. It is because of this expanded commitment that management considerations need to be recognized, understood, and implemented. Critical to successful forage production are the genetics of varieties selected as well as grass species to be mixed. This is a strong production first step also including; stand establishment, harvesting schedules, fertility, and pest management.

Having a productive stand over years depends firstly on the mixture to be planted. The easy part is the alfalfa variety which is selected based on proven University yields over locations and years. Target and evaluate significant genetic traits such as; tonnage, quality, winterhardiness, fall dormancy, and pest resistances (insects/diseases). Producers commonly take the most time in deciding which grass (es) species to mix with the alfalfa. A common mistake is concentrating too long on which species instead of which variety. U of WI research shows that grass species has marginal effects on total season yield but rather variety selection is crucial. While it is understood that orchardgrass, tall and meadow fescue, and bromegrasses are dominate species to use in mixtures, varieties of these grasses should be chosen for yield, yield seasonal distribution, maturity matching alfalfa, winterhardiness, and disease resistance focused on rusts. Often producers determined which grass species to include and then settle for whichever varieties are available with the nearest retailers. Few producers realize that over 30 orchardgrass varieties are available and large genetic differences exist contributing to production success and failure depending on needs and expectations. Dr. Dan Undersander and the forage team at the U of WI have tremendous lists of yield and quality data specific to grass species and varieties in addition to seed companies and outlets. Maximizing the mixture is achieved with a goal of 30 to 40% of the stand comprised of grasses. The focus should be seeds per square foot planted vs. pounds per acre. Seeding rate recommendations are generally accepted as 60 to 75 seeds per square foot resulting in a final stand at the end of the first year of 30 to 35 plants in the same area to maximize yield. A rule of thumb has the alfalfa at 10 pounds per acre which is 47 seeds/ft² with the remainder grasses. It has been found that adding a low rate of annual ryegrass at seeding will significantly add to first cut yield while providing additional early weed competition and soil erosion control.

Seeding the hay mix is where many mistakes occur and unfortunately can cause annual problems with yield, weeds and stand longevity. While many planting methods and techniques are available to successfully establish the forage mix, three things are essential. Planting failures commonly are traced back to poor seed/soil contact, seed placed too deep, or soil pH problems not compatible to the mix created. Carefully select forage field locations understanding topography, drainage, soil types and pH matching genetics and management to them. Make certain seedbed preparations are optimized including soil

Picture 1. Alfalfa grass mixture.
Preparing for Successful Alfalfa/Grass Production in 2015 (Continued from page 7)

moisture, firmness, and residue management. Regardless of equipment used, check often to ensure your method is delivering the correct amount of seed uniformly at a target depth of ¼ inch. Larger equipment, faster planting speeds, varying soil types and residue are all complications in successful seed placement. Many producers over years have found it much easier to correctly plant a field then try to renovate a poorly established one. It is well documented that a field requiring "patching" or seed supplementing will never perform as well as the initial seeding operation.

An essential consideration important to alfalfa grass mixtures is cutting height. Target a remaining height of three to four inches at harvest. This unharvested material is essential as it serves as the photosynthetic base needed for regrowth and stand persistence over time. Other considerations include an annual fertility program including nitrogen and sulfur, harvesting quality, and pest management (diseases/insects). These differ somewhat from pure alfalfa stands and warrant understanding in order to maximize production. Other regions across the U.S. have well documented success with hay mixtures on a high percentage of the total forage acres. Planted and managed correctly, mixtures have multiple benefits by adding diversity to your operations in genetics and utility.

Using Herbicides to Establish Alfalfa
Roger Becker

Alfalfa seeded with a companion crop is a traditional practice that has served Minnesota producers well. Many today seed alfalfa with forage grasses to potentially increase invotive digestible dry matter yield. More intense management of alfalfa often uses direct seeding (sometimes termed ‘solo’ seeding). The use of herbicides is generally most adapted to direct seeded alfalfa. Few herbicide options are available for application to alfalfa seeded with a companion crop or when seeded with forages grasses. Additionally, more selective options are available specific to individual weed species or groups of weed species for direct seeded alfalfa. Conversely, fewer weeds encroach during establishment when alfalfa is seeded with forage grasses, or with companion crops that are harvested for silage. In fields with high weed pressure, the slow initial growth and vigor of some forage grasses can leave an opening for annual grass and broadleaf weeds to invade. If severe competition occurs, no herbicide can selectively remove the annual grasses and not severely injure, or completely kill the forage grass seedlings. Similarly, no herbicides are labeled to remove broadleaf weeds in alfalfa that is seeded with forage grasses. Confusion arises because bromoxynil (Buctril, Moxy) is labeled to apply to CRP acres were alfalfa may be present with forage grasses. Forage grasses in these labeled CRP sites are not cleared for feeding to livestock.

We conducted extensive research to explore the use of grass active herbicides to remove oat companion crops in the 1990s in Minnesota. We termed this an ‘oat mulch’ system where by companion crops could be used to protect alfalfa seedlings from wind and water driven soil erosion and reduce weed encroachment during alfalfa establishment. Oat seeded with alfalfa was removed with sethoxydim (Poast, others) or clethodim products (Select, others) to mimic direct seeding while minimizing soil loss potential. By the mid-1990’s imazethapyr (Pursuit) followed by imazamox (Raptor) were labeled to remove oat, and more recently glyphosate tolerant lines (Roundup, others) are available for oat mulch systems. Using oat mulch systems make it possible to establish alfalfa with an oat companion crop in areas where erosion potential is a concern, yet oat competition is removed before long-term stand or vigor damage to alfalfa occurs. This technique also works well on sandy soil to prevent damage from blowing sand common when alfalfa is direct seeded on these soils. It is recommended that 1 to 1.5 bu/A bin-run oat seed be used to reduce costs. Higher seeding rates than 1.5 bu/A can increase the protective mulch cover and compete more effectively with weeds in severe conditions, but generally are not needed.

Oat should be sprayed targeting oats that are 4 to 6 inches in height, before considerable competition has occurred. If Raptor or Pursuit are used, move the application timing up to 4-inch oat as these products are slower to control oat, and under dry conditions, may not provide complete control of oat, especially when applied to oat taller than 4 inches. Oat is recommended because other small grains are not as easily controlled, and therefore may be more expensive to remove. Forage yield may be increased the establishment year by seeding a companion crop and harvesting it for silage. However, companion crops can compete with seedling alfalfa and like weeds, may impact alfalfa production before companion crops are harvested and in subsequent years. Direct or oat mulch seeding increases the production of alfalfa forage that is high in quality the establishment year. Although overall annual tonnage may be reduced, yields often are similar to those obtained with companion crops seeded and harvested for silage. Direct seeding can also result in increased alfalfa vigor and population density during establishment, especially when the alfalfa seedlings are stressed such as occurs when droughty during establishment. The rest of this article is a summary of herbicides labeled to establish alfalfa.

DISCLAIMER: The label on the product you are using always supersedes information in this article. Always refer to the product label for specific instructions and restriction.
Using Herbicides to Establish Alfalfa (Continued from page 8)

**Pre-plant Incorporated Control of Annual Grasses and Some Small-seeded Broadleaf Weeds**

Balan (benefin) preplant-incorporated gives good control of annual grasses, and fair to good control of pigweed and kochia. Wild oats, common ragweed, and wild mustard control is not adequate. Apply preplant incorporated to alfalfa, birdsfoot trefoil, and clover (red, alsike, and ladio). Use 2 lbs dry flowable/A on coarse and medium soils and 2.5 lbs dry flowable on fine textured soils. Generally ineffective on peat or muck soils. **No PHI stated**

Eptam (EPTC) should be applied preplant and incorporated immediately after application for annual grass and some broadleaf weed control in alfalfa, birdsfoot trefoil, and clovers (red, alsike, and ladio). The 3.5 to 4.5 pt rates give fair to good control of pigweed, lambsquarter, and velvetleaf. Wild oats and wild mustard generally are suppressed. The 2.25 pt rate may be used on alfalfa for annual grass control. EPTC rates are dependent on soil type, generally ineffective on peat or muck soils. Some alfalfa stand reduction and stunting may occur. First emerging leaves may stick together but seedlings usually recover after the first rain or irrigation. May be impregnated or applied in liquid fertilizer. Do not use on alfalfa if any atrazine has been applied the previous 12 months or serious injury may result. **No PHI stated**

Trust 4EC (trifluralin). Supplemental label on Agri-Solutions Trust formulation. Apply 1 to 1.5 pts/A preplant-incorporated to direct seed alfalfa. Rate is dependent on soil type. Some alfalfa stand reduction and stunting may occur. Trifluralin products are more economical and available than Balan, have a similar spectrum of weed control, but have slightly more injury potential than Balan. Most trifluralin formulations are not labeled for alfalfa establishment. **21 day PHI. Follow the PHI for applications to established alfalfa on the full label attached to the product container. The supplemental label for Trust does not does not state a PHI.**

**Post-emergence Control of Annual Grasses and Broadleaf Weeds and Oats in Oat-mulch Systems**

Roundup Ready Alfalfa. Roundup WeatherMAX, Roundup PowerMax provide rate-dependent, excellent control of seedling weeds and suppress many perennial weeds with minimal preharvest intervals. See label for species-specific use rates. **Not all glyphosate formulations are labeled for use on Roundup Ready alfalfa.** Up to 10% non-tolerant seed may be present so label states to apply 22 to 44 oz/A when newly seeded alfalfa is at or before the 3 to 4 trifoliate stage to avoid gaps from stand loss of susceptible alfalfa once plants are larger. This relative early application may require a second application to control weeds that may emerge after Roundup application, but before crop canopy closure. For this later application, apply 44 oz/A after the 5th trifoliate stage. Some growers compromise and apply 44 oz/A glyphosate at the 3 to 5 trifoliate stage, reducing the chance that a second application will be needed to control a new flush of weeds while minimizing the issue created with removing larger susceptible plants. Sequential applications must be at least 7 days apart. May apply up to 5.3 qts of 4.5 lb ae/gal formulations per year including any preplant burndown applications, up to 4.1 qts per year in crop, up to 44 fl oz product in any single application. **This is a transgenic crop. There is a technology fee estimated to be approximately $30 to $40 per acre. Applications to non-tolerant Roundup Ready alfalfa will cause severe crop damage or stand loss. 5 day PHI. Remove livestock before application, and a 5 day grazing reentry interval applies. Any in-crop applications must be at least 5 days before cutting.**

Other legumes and non-Roundup Ready alfalfa. Glyphosate (Roundup, others). Many glyphosate products can be used in clovers, vetches, trefoil and alfalfa NOT tolerant to glyphosate applied preharvest to remove a stand and in so doing, suppress or control perennial weeds. An example would be an older stand or in the spring after winter-kill is apparent, when stands are thinning and weeds are encroaching. For preharvest applications, the maximum rate is 44 oz/A (4.5 lb ae formulations) with a minimal preharvest interval before grazing or harvesting alfalfa of 36 hours (36 hour PHI). For other legumes, the maximum application rate is 32 oz/A and the minimum grazing or harvest interval is three days (3 day PHI). Glyphosate products can also be used before- or at-planting of these legumes as a burn-down such as in no-tillage or reduced-tillage systems.

**Post-emergence Dormant and Between-Cuttings Control of Annual Grasses and Broadleaf Weeds**

Gramoxone Max 3 SL (paraquat). Rates and pre-harvest interval vary by age of the alfalfa stand, and dormant vs. between cutting applications. See label for specific details. Apply 1.0 pt/A to first year alfalfa within 5 days after cutting before alfalfa regrowth reaches 2 inches. Weeds must have adequate foliage remaining to be controlled since is a contact herbicide. Can also be applied to fall seeded alfalfa (stands less than 1 year old) when dormant in the fall or following spring targeting winter annual weeds at 1.0 to 2.0 pt/A. Paraquat is a non-selective contact burn herbicide. Alfalfa foliage present at application will be burned. May be useful where late flushes of annual weeds occur, and for weeds where significant growth is below the cutting height. Will
Using Herbicides to Establish Alfalfa (Continued from page 9)

desiccate chickweeds, mustards, and seedling dandelions. Paraquat can also be used at 2.5 to 4.0 pts/A 3L at planting before crop emergence such as no-till seedings to burndown emerged weeds. Can also be applied to clovers, see label for specific use rates. Restricted use herbicide. In-crop applications, 30 day PHI except for fall applications, then the PHI is 60 days. Preplant burndown applications, 70 day PHI

**Pursuit (imazethapyr)** should be applied postemergence when seedling alfalfa or clovers are greater than the second trifoliolate stage and the majority of the weeds are 1 to 3 inches in height. Controls many annual grass and most broadleaf weeds in direct-seeded or oat-mulch systems. Will suppress some perennial weeds. Apply 3 to 6 oz/A Pursuit 2S and vary rate by weed species. Use a nonionic surfactant with greater than or equal to 80% active ingredient at the rate of 1 quart per 100 gallons of spray solution. Organo-silicon surfactants can be used instead of nonionic surfactants. Crop oil concentrate (COC) can be used at the rate of 1.25% v/v, or methylated seed oils (MSO) at 1% v/v. Use MSO when moisture stress is present. Always add UAN nitrogen at 1.25 to 2.5 gal/100 gallons of spray, or 12 to 15 lbs ammonium sulfate/100 gallons spray solution. Apply in 10 or more gpa carrier (ground) or 5 or more gpa (air). Imazethapyr can be applied to suppress oat at the 3- to 4-leaf stage to achieve direct seeded alfalfa or clovers in oat-mulch / inter-seeded oat systems. If replanting is necessary, do not replant for 4 months following Pursuit applications. Imazethapyr can be tank mixed with 2,4-DB, bromoxynil, clethodim, or sethoxydim. Imazethapyr can be applied postemergence at 4 to 6 fl oz/A. Apply when seedling alfalfa is in the second trifoliolate stage or larger and before weeds are greater 3 inches in height. A few sensitive weeds such as eastern black nightshade and redroot pigweed are labeled up to 5 inches in height at higher rates of Raptor. Controls annual grass and broadleaf weeds and will suppress some perennial weeds. Use a nonionic surfactant with greater than or equal to 80% active ingredient at the rate of 1 quart per 100 gallons of spray solution. Organo-silicon surfactants can be used instead of nonionic surfactants. Or, add crop oil concentrate (COC) or methylated seed oils (MSO) at 1-2% v/v, or a high surfactant oil concentrate (HSOC) at 0.5% v/v. Use MSO when moisture stress is present. Always add UAN nitrogen at 1.25 to 2.5 gal/100 gallons of spray, or 12 to 15 lbs ammonium sulfate/100 gallons spray solution. Can be tank mixed with bromoxynil, 2,4-DB, sethoxydim, or clethodim. Interseeded oat or suppression in oat-mulch systems in not mentioned on the Raptor label, but control of volunteer oat up to 3 inches in height or less is labeled. A 3-month restriction is required before replanting alfalfa back into the stand. No PHI. These no spraying restrictions with Raptor on any crop. Do not apply Pursuit or Raptor sequentially within 60 days of each other due to increased potential for alfalfa injury

**Post-emergence Control of Annual Grasses and Some Small-seeded Broadleaf Weeds**

Prowl H₂O (pendimethalin) can be applied postemergence at 1.1 to 2.1 pts/A to seedling alfalfa grown for hay/forage. Seedling alfalfa is defined on the label as planted in the spring or fall and has not gone through a first cutting/mowing. Higher rates can be used on established alfalfa. Will control or suppress many annual grasses, and some small-seeded annual broadleaf weeds. Apply after alfalfa has reached the 2nd trifoliolate stage to avoid injury but before alfalfa reaches 6 inches in height to avoid reduced weed control. Some stunting and chlorosis of alfalfa may occur. Postemergence applications require considerably more rainfall or irrigation after application for activation and are more susceptible to photodegradation and volatilization losses compared to preplant incorporated use in other crops and as such, control will be less complete than where Prowl can be incorporated. 28 day PHI for 2.1 pt/A or less for forage or hay

**Post-emergence Control of Annual Broadleaf Weeds**

Buctril 2L, Buctril 4 EC, others (bromoxynil) controls most broadleaf weeds postemergence in seedling alfalfa. Apply 1 to 1.5 pts 2L or 0.5 to 0.75 pt 4EC formulations/A to seedling alfalfa in the fall or spring when the majority of the field has a minimum of 4 trifoliolate leaves. Unacceptable injury may occur to alfalfa in the 2 trifoliolate stage or smaller, typical with uneven stands or under weather conditions favoring leafburn. Broadleaf weeds should not exceed 2 inches in height, the 4-leaf stage or 1 inch in diameter, which ever comes first. The use of EPTC prior to bromoxynil applications may enhance alfalfa leaf burn. Use the low rate to control eastern black nightshade, cocklebur, lambsquarter, shepherdspurse, pennycress, smartweeds and wild buckwheat. Use the high rate of bromoxynil to control redroot pigweed, velvetleaf, ragweed, kochia, and wild mustard. Tank mix the low rate of bromoxynil with 1 qt/A 2,4-DB amine to improve kochia and pigweed control, but the more restric-
Using Herbicides to Establish Alfalfa (Continued from page 10)

tive 2,4-DB 60 day grazing restrictions apply. Reduced rates of bromoxynil (0.5 to 0.75 pt 2L/0.25 to 0.38 pt 4 EC) can also be tank mixed with the equivalent of 3 to 6 oz/A Pursuit 2S for broad spectrum broadleaf weed control. Do not apply to alfalfa under moisture, temperature, insect or disease stress or that has been stressed by other pesticide carryover or injury. Injury may occur if air temperature exceeds 80°F at or 3 days following application. Experiences in Minnesota have shown alfalfa injury associated with spring temperatures that are abnormally cold, or abnormally hot. Do not add surfactants or crop oil concentrate. 30 day PHI before cutting, feeding, or grazing spring applications, 60 day PHI for fall applications.

**Butyrac 200 (2,4-DB)** controls certain annual broadleaf weeds postemergence. Butyrac can be used to establish alfalfa or birdsfoot trefoil. Does not specify legume height at application. Apply 1 to 3 qt/A when weeds are less than 3 inches in height. Can add 0.25% v/v nonionic surfactant in dry, low humidity areas in seedling alfalfa. Can be tank-mixed with Poast or Buctril. Do not when alfalfa is drought stressed, or apply if temperatures are expected to exceed 90°F within three days after treatment. Do not add any wetting agents or detergents unless directed on the label. Do not apply forage grass/legume mixtures, except on Conservation Reserve Program government acres in which case, treated forage cannot be grazed or harvested if released. 60 day PHI

**Post-emergence Control of Annual Grasses and Oats in Oat-mulch Systems**

**Poast, Poast Plus (sethoxydim)** applied postemergence will control annual and suppress perennial grasses in direct-seeded or oat-mulch systems. Sedges and broadleaf weeds will not be controlled. Poast can be used on alfalfa, clovers, birdsfoot trefoil, and sainfoin, Poast Plus only on alfalfa. Use the following pts/A of Poast or fl oz/ A Poast Plus: 1/2 pt or 12 fl oz for wild proso millet, 1 pt or 24 fl oz for wild oat, foxtails, barnyardgrass, crabgrass, and fall panicum, and 1.5 pts or 36 fl oz for sandbur and volunteer small grains except interseeded oat, which requires only 0.75 pt or 15 fl oz. Sethoxydim will suppress, but not control quackgrass. Poast Plus is labeled at a reduced rate, 18 fl oz, and Poast at 0.75 pt/A for early application to control green and giant foxtail, barnyardgrass, and fall panicum. Always use with crop oil concentrate or Dash HC at 1pt/A. Depending on weed species, UAN or ammonium sulfate may also be needed (see label). Insure good alfalfa canopy spray penetration and grass coverage. Applications before first cutting generally give the best results. Do not use flood, whirl chamber, or CDA nozzles (poor coverage or canopy penetration) or selective application equipment. Do not add UAN or ammonium sulfate to 2,4-DB tank mixtures. 7 day PHI before feeding, grazing or cutting for forage (undried), or 14 day PHI before cutting for hay (dried). May be tank mixed with 2,4-DB if the more restrictive 60 day feeding, grazing and harvesting restrictions of 2,4-DB are followed.

**Select/Arrow 2 EC, (clethodim)** applied postemergence will control annual grasses in seedling alfalfa, birdsfoot trefoil, or sainfoin grown for forage or seed. Apply 6 to 16 fl oz/A. Use the higher rates when annual grass pressure is heavy or at the maximum height, or when perennial grasses are present. Always add crop oil concentrate containing at least 15 % emulsifier at 1 % v/v. UAN or ammonium sulfate may be added to improve control. Clethodim has no activity on sedges or broadleaf weeds. May be tank mixed with 2,4-DB products, or with Pursuit W, 70 DG, or 70W to control broadleaf weeds. With tank mixes, the most restrictive harvest interval must be followed. Crop oil concentrate must still be added for clethodim performance which will increase the risk of crop injury if tank mixed with 2,4-DB. When tank mixed with Pursuit, the minimum rate of clethodim is higher; then use Select/Arrow at 8 to 16 oz/A. 15 day PHI before grazing, feeding, or harvesting (cutting) for forage or hay

**Companion Crop Seedings**

**Buctril 2L or 4EC , others (bromoxynil)** applied postemergence controls most broadleaf weeds in companion seeded alfalfa. Apply after small grain emergence up to boot stage, alfalfa should have a minimum of 4 trifoliolate leaves at application. Broadleaf weeds should not exceed the 4-leaf stage or 2 inches in height or 1 inch in diameter, whichever comes first. Offers much less alfalfa injury potential than MCPA or 2,4-D amine. Cleared for wheat, barley, oats, rye, and triticate underseeded with alfalfa. 30 day PHI before cutting for feed or grazing spring treated underseeded alfalfa; 60 day PHI for fall treated underseeded alfalfa. Do not apply when underseeded alfalfa is under moisture, temperature, insect or disease stress or has been stressed by other pesticide carryover or application. Do not add a surfactant or crop oil when underseeded with alfalfa. Do not apply if temperatures are expected to exceed 80°F at or 3 days following application or unacceptable alfalfa injury may occur. Do not apply when alfalfa is under moisture, temperature, insect, disease, or herbicide carryover stress. Do not apply the tank mixture with 2,4-DB when underseeded to small grains (2,4-DB not cleared for application to small grains)

MCPA at 0.25 to 0.5 pt/A of the 4 lb ae formulations can be applied to seedling stands of alfalfa and
Using Herbicides to Establish Alfalfa (Continued from page 11)

clover (red, alsike or ladino) established with small grain companion crops for emergency control of mustards and other broadleaf weeds (check individual herbicide labels, not all products are labeled, labels vary on application instructions). Legumes are more tolerant of MCPA than 2,4-D, but do not use except for rescue situations to control severe infestations of broadleaf weeds that threaten legume seeding survival as serious legume injury can occur. Apply after the cereal crop is well tillered and 4 to 8 inches tall. The nurse crop and weeds should provide a canopy that will shield legumes from herbicide spray to reduce legume injury. Reduced sprayer pressure and lower spray volume to no more than 5 to 10 gpa to help minimize injury. Do not use ester formulations Do not use on vetch or sweet clover, which are very sensitive to MCPA Do not graze or forage meat animals on treated acres within 7 days of slaughter

DISCLAIMER: The label on the product you are using always supersedes information in this article. Always refer to the product label for specific instructions and restriction.

Aphanomyces Root Rot of Alfalfa: Widespread Distribution of Race 2
Deborah Samac

![Picture 1. Aphanomyce on alfalfa seedling.](image)

Strong seedling establishment in alfalfa is important to achieve the plant density needed to out-compete weeds and produce high biomass yields. But, establishing alfalfa can be challenging because alfalfa seeds and seedlings are vulnerable to several pathogens present in soil. Wet soil conditions favor the development of diseases caused by “water molds,” namely Phytophthora root rot (PRR), Aphanomyces root rot (ARR), and damping off (rotting). The pathogens causing these diseases produce mobile swimming spores called zoospores that require water for development and infection of alfalfa. When rain is excessive after sowing, stand establishment may fail due to seed and seedling rot caused by these pathogens. Both ARR and PRR can also attack adult plants under wet soil conditions.

Seedlings infected by ARR become stunted and chlorotic (yellow) before they wilt and die and infected seedlings usually remain upright. In adult plants the root mass is reduced and lateral roots have brown decay. A brown lesion on the taproot may mark the location where lateral roots were rotted off. Nodules are frequently absent or decaying. Foliage is stunted, becomes chlorotic and resembles symptoms of nitrogen deficiency. Infected plants are often slow to regrow or may fail to grow after harvest or winter dormancy. Chlorotic foliar symptoms occur in soils that are deficient in sulfur. So it is prudent to examine roots of plants for evidence of root rot as well as to test plant tissue or soil for sulfur content to determine the cause of the symptoms.

Seedlings infected by PRR collapse and decay rapidly. In established stands when soils remain wet PRR attacks lateral roots and the taproot. The rotted tissue turns dark brown-black forming a pencil point-like symptom and foliage turns yellow or reddish.

To help protect seedlings from seed rot and damping-off and PRR, the majority of alfalfa seed is treated with the systemic fungicide mefenoxam, (Apron XL®). However, Apron XL does not provide protection against ARR. Varieties with resistance to ARR are available, but the majority of varieties have resistance to only one race (race 1) of the pathogen. A recent survey of 45 alfalfa fields in Minnesota found that a second race (race 2) is widespread in the state and more common than race 1. The same situation has also been found in Wisconsin and New York. Evidence is mounting that additional races of ARR are present in alfalfa fields that can overcome race 1+2 resistance. Recently, the fungicide Stamina, which protects seedlings against ARR, was labeled for use as an alfalfa seed treatment and is being used along with Apron XL to help boost protection from soilborne pathogens.

A soil test is available to determine which races of ARR are present in soil. To have soil tested, contact Deborah Samac at dasamac@umn.edu.

Be on the Alert for Anthracnose on Alfalfa

Anthracnose is a serious stem and crown rot disease of alfalfa that kills individual plants and causes rapid stand decline. It has been controlled in the past by plant resistance, but new pathogen types have
Aphanomyces Root Rot of Alfalfa (Continued from page 12)

been found. The disease may be on the increase in the Midwest.

Disease Symptoms:
- Diamond-shaped lesions near the base of the stem.
- Lesions have a straw-colored center and brown border.
- Wilting and death of the stem causes formation of a “shepherd’s crook”.
- Plants with symptoms are scattered through a field.

Anthracnose is caused by *Colletotrichum trifolii*, a fungus that produces masses of tiny spores on infected stems and crowns. During periods of warm, rainy weather, spores are splashed from infected to healthy plants. Lesions develop on stems, causing stems to wilt and eventually die. The pathogen grows from stem tissue into the plant crown, and causes a crown rot, which ultimately kills the plant.

Please report disease observations to Deborah Samaac (dasamaac@umn.edu); (612) 625-1243.

Alfalfa Insects: What to look for, how and when

Bruce Potter

Most entomologists enjoy insects and many smile whenever they see an alfalfa field. Why? An alfalfa crop is usually home to large numbers of insects and a great diversity of species. Most of these insects are harmless or beneficial; lady beetles, for example. The pest species are generally found in numbers to few reduce alfalfa yield. Unfortunately, in some fields, in some years, populations of an insect pest reach levels that could cause economic yield loss. Because of these occasional bad actors, alfalfa should be scouted from green up through the last cutting.

Alfalfa insect populations and the pest species present will vary with weather and season. For example, the migrant potato leafhopper is Minnesota alfalfa's most consistent insect pest but rarely reaches damaging levels before the first cutting. The insects that most often cause first crop concerns in Minnesota include: alfalfa weevil, pea aphid, and plant bugs. Biological information, preferred scouting/sampling methods, and a scouting calendar for common Minnesota alfalfa pests insects are shown in Table 1.

Scouting tools: A 15-inch diameter, heavy-duty, sweep net is a necessary tool for scouting insects in alfalfa. Sweep nets are needed to quantify insect numbers when using economic thresholds for several key alfalfa insects and for the initial detection of most alfalfa insects. The sweep net can allow you to find insect pest populations early, before yield loss or obvious symptoms happen.

Sweep nets can be ordered from several on-line suppliers. When purchasing a sweep net: 1) Avoid the lightweight aerial nets designed to catch butterflies, 2) Specify heavy-duty, 3) A long handled net is better and marking the handle with inch increments will allow you to measure crop height with the same tool, 4) Aluminum handles are durable and light but metal can rub off on your hands, 5) Purchase a net that you can get purchase replacement parts for - if your net doesn’t wear out, you’re not using it right.

A 10X-15X hand lens, containers for saving specimens for later identification and identification guides are other important tools for alfalfa scouting.

Management and insecticides: Investments in scouting and basing any insecticide applications on economic thresholds pays. Although it might seem an easier approach, insurance insecticide applications do not always save crop yield but they often do waste crop input dollars. Insurance insecticides might actually make your alfalfa insect problems worse. They kill beneficial insects and the loss of biological control could flare other insect problems. Finally, insecticide overuse can lead to insecticide resistant insect populations. Always read and follow the insecticide label. Many insecticides are harmful to
honey bees. Avoid applications to blooming alfalfa or when honeybees are active! Notify beekeepers in the area if you must treat flowering alfalfa.

Some on-line suppliers of insect sweep nets and hand lenses.

- BioQuip Products [http://www.bioquip.com](http://www.bioquip.com)
- Ben Meadows [http://www.benmeadows.com](http://www.benmeadows.com)
- Forestry Suppliers [http://www.forestry-suppliers.com](http://www.forestry-suppliers.com)
- Great Lakes IPM, Inc. [http://www.greatlakesipm.com](http://www.greatlakesipm.com)
- Gempler's [http://www.gemplers.com](http://www.gemplers.com)

Alfalfa insect scouting and insect sampling techniques: The following alfalfa insect scouting guidelines are derived from Bill Hutchison's Alfalfa IPM: Sampling alfalfa insects. 1993. University of Minnesota Extension. They thoroughly explaining why and how to scout.

**Goals of sampling:** Correct identification and efficient sampling methods for beneficial and pest insects are two critical steps toward implementation of integrated pest management (IPM) programs. IPM includes the use of all feasible control tactics (e.g., crop rotation, resistant hybrids and chemical control) to manage pests within a profitable, yet environmentally sound production system. Efficient sampling methods are necessary for making accurate and timely evaluations of insect population (infestation) levels. These estimates can then be used for comparison with economic thresholds and consideration of appropriate management tactics.

**Early detection of economic insect populations:** Insect mortality can result from starvation, desiccation and exposure (conditions which often occur when alfalfa is cut), as well as from predators, parasites, disease and insecticide applications. Most insects are more vulnerable to each of these factors when they are young. The lowest labeled rates of insecticides can often provide effective control when treating young (immature) insects. Hence, early detection is advantageous. Nevertheless, control action is still appropriate only when yield and quality savings justify control costs.

**Sampling frequency:** For production of high yielding, high quality alfalfa, the crop should be checked weekly. In cooler weather, sampling can be done less frequently. In hot weather, however, sampling frequency should be increased (insects develop, feed and reproduce faster under warmer conditions). Shorter sampling intervals are also necessary as insect populations and/or damage approach economically damaging levels.

To view a video on insect sampling, visit [How to use a sweep net](http://www.bioquip.com).

Table 1. Biology and scouting calendar for Minnesota alfalfa insects.

<table>
<thead>
<tr>
<th>Insect Pest *</th>
<th>Over-winter stage in MN</th>
<th>Damaging Stage</th>
<th>Mouthparts</th>
<th>Feeding and crop damage</th>
<th>Threshold Sample Method**</th>
<th>1st crop</th>
<th>2nd crop</th>
<th>3rd crop</th>
<th>Late season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphid (Pea )</td>
<td>Egg</td>
<td>Adult / Nymph</td>
<td>Piercing-sucking</td>
<td>Phloem sap leaves/stems/ salive toxins Stunting/distortion/yellowing /sooty mold</td>
<td>/ stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aphid (Spotted alfalfa)</td>
<td>?</td>
<td>Adult / Nymph</td>
<td>Piercing-sucking</td>
<td>Phloem sap leaves/stems/ salive toxins Stunting/yellowing /sooty mold</td>
<td>/ stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aphid (Cowpea)</td>
<td>?</td>
<td>Adult / Nymph</td>
<td>Piercing-sucking</td>
<td>Phloem sap leaves/stems/ salive toxins Stunting/sooty mold</td>
<td>/ stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Alfalfa blotch leafminer</td>
<td>Adult</td>
<td>Larvae</td>
<td>Hooks/scraping</td>
<td>Sucking</td>
<td>Larval leaf mines / leaf drop Adult feeding &quot;pinholes&quot;</td>
<td>% leaflets damaged</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Alfalfa caterpillar</td>
<td>Pupa</td>
<td>Larvae</td>
<td>Chewing</td>
<td>Defoliation-general</td>
<td>/ sweep</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Blister beetle spp.</td>
<td>Larvae on grasshopper egg</td>
<td>Adult body (twin)</td>
<td>Chewing</td>
<td>Minimal injury to alfalfa/Toxic to horses Live &amp; dried beetles-camharadin toxin</td>
<td>Detect w/ sweeps</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cutworm (Variegated)</td>
<td>Migrant</td>
<td>Larvae</td>
<td>Chewing</td>
<td>Defoliation - especially regrowth</td>
<td>/ foot 2</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Grasshopper spp.</td>
<td>Egg</td>
<td>Adult / Nymph</td>
<td>Chewing</td>
<td>Defoliation-general</td>
<td>/ yard 2</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Plant Bug (Alfalfa)</td>
<td>Egg within plant stem</td>
<td>Adult / Nymph</td>
<td>Piercing-sucking</td>
<td>Phloem sap of leaf veins Stunting/distorted leaflet tips</td>
<td>/sweep</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Plant bug (Tarnished)</td>
<td>Adult leaf</td>
<td>Adult / Nymph</td>
<td>Piercing-sucking</td>
<td>Phloem sap of leaf veins Stunting/distorted leaflet tips</td>
<td>/sweep</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Potato leafhopper</td>
<td>Migrant</td>
<td>Adult / Nymph</td>
<td>Piercing-sucking</td>
<td>Phloem sap of leaves phloem damage/stunting/hopperburn</td>
<td>/sweep</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Meadow Spittlebug</td>
<td>Egg</td>
<td>Nymph</td>
<td>Piercing-sucking</td>
<td>Sap feeding on stems Distinctive spittle</td>
<td>/ foot 2</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Weevil (Alfalfa weevil)</td>
<td>Adult in leaf</td>
<td>Adult / Larvae</td>
<td>Chewing</td>
<td>Defoliation of new growth Delayed 2nd crop growth</td>
<td>% terminals /stem</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Weevil (Clover leaf)</td>
<td>Larvae/Egg</td>
<td>Adult / Larvae</td>
<td>Chewing</td>
<td>Defoliation - lower canopy</td>
<td>/ plant (crown)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

* Most common Minnesota pest specified in bold
** *Sweep nets can effectively be used for detection and identification of most alfalfa pest and beneficial insects.