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Alfalfa Establishment Guide

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Fig. 1. Thick and vigorous alfalfa stand. Photo by Marvin Hall.

High yielding, high-quality alfalfa often provides the foundation for profitable feeding programs for dairy and other livestock. Thick, vigorous stands are essential for high yields (Fig. 1). Obtaining such stands is dependent on proper seeding practices and favorable seedbed and environmental conditions. The key factors for obtaining thick, vigorous stands are proper soil pH and fertility, seedbed preparation, crop sequences that avoid herbicide residues from previous crops, selection of high-quality seed, seeding at the right time, good seeding techniques with equipment precisely adjusted for seeding rate and depth, and adequate control of weeds and insects.

Planning Ahead

Alfalfa stands continually thin over time and do not reseed naturally, so establishing an excellent stand is critical for long stand persistence. Preparation for alfalfa establishment should begin at least 1 year in advance; but ideally as much as 2 years prior to the actual seeding, especially for no-till seedings.

Site selection. Alfalfa has the potential to develop a deep root system and is best suited to deep soils that allow the roots to extract nutrients and water from a large volume of soil. Alfalfa roots can penetrate deeper than 15 ft in unrestricted soils which results in excellent drought tolerance. Soils in which rooting depth is limited by a shallow hardpan, shallow bedrock, or high water table are not well suited for alfalfa production. For alfalfa, soil depth should be at least 3 to 4 ft with no restrictions to root growth (Fig. 2). In drought prone areas, soils less than 3 ft deep may not supply enough moisture for good alfalfa production and stand survival. Alfalfa grows well under a wide range of soil textures if no other conditions are limiting. Medium-textured soils such as loams, silt loams, and sandy loams are ideal. Light-textured soils, such as coarse sands, are too drought prone for alfalfa unless irrigated. Heavy textured soils, such as clays, are often too wet to support healthy roots. Also, winter heaving of plants is more common on clay soils. Alfalfa will grow well in rocky soils if the rock exists as fragments and does not form solid layers that inhibit rooting depth. Rocks on the soil surface can be removed during stand establishment or pushed into the soil surface with a field roller.

Fig. 2. Productive alfalfa field. Photo by Marvin Hall.

Soils for alfalfa must have good surface and internal drainage. For optimum production and long stand persistence alfalfa should be planted on soils that have a drainage classification of well drained, moderately well drained, or somewhat excessively well drained. Alfalfa will not persist in poorly drained soils. Fungi that cause root rot diseases thrive in wet soils and can cause excessive stand loss. Alfalfa roots are also sensitive to low oxygen levels and will die if the soil is saturated or flooded for an extended period.

Subsoil color can give clues about the drainage of the site. Gray or mottled soil colors suggest poor drainage. Brown or red soil colors suggest good internal drainage. Information regarding soil depth and drainage class is provided in county soil survey manuals. These are available through the Natural Resources Conservation Service and contain aerial photographs and soil maps that show the locations of soils on a particular farm. Soil survey information is a valuable tool in assessing a site for alfalfa production.

Lime and fertility adjustments. A key to establishing and maintaining productive alfalfa is adequate fertilization based on soil test recommendations. Knowledge of soil pH and existing levels of nutrients can be used along with the field history to develop a sound fertility program. Soil samples should be taken to the depth of the plow layer for seedings to be made into a tilled seedbed. For no-till seedings, two sets of soil samples should be taken; one from the 0- to 2-inch depth to determine surface pH and fertility and a second to approximately 10 inches deep. The shallow sample is especially important for fields that are already planted to a no-till crop because surface applications of nitrogen fertilizers to no-till crops frequently cause this layer to be quite acidic.

Soils acidity is a major deterrent to high alfalfa production since it affects the utilization of other nutrients. Lime corrects soil acidity and supplies calcium and perhaps magnesium, depending upon the liming material used. Proper soil pH (6.5 to 7.0) not only increases the availability of essential plant nutrients but promotes the growth of desirable microorganisms and reduces the toxic effects of aluminum and manganese. Ideally, lime should be applied 6 to 12 months prior to seeding and thoroughly incorporated into the plow layer. With no-till seedings, surface applications should be made 1 to 2 years ahead of seeding to allow for movement into the soil profile. Research has shown that alfalfa yield in the seeding year is greater with incorporated than with surface-applied lime; but in succeeding years annual yields and 6-year total yields were not different due to liming method.

Commercial fertilizer or animal manure can be used to build soil nutrient levels before establishing alfalfa. Phosphorus level is especially critical during establishment. Phosphorus helps promote rapid root development and seedling establishment, especially on soils low to medium in this nutrient. The demand for potassium by young seedlings is relatively low. It becomes much more important for yield and persistence once stands are established. Direct contact between fertilizer and seed should be avoided as it may inhibit germination.

Fertilizer N application at establishment increases yields when soils are low in N (less than 15 ppm soil nitrate) or organic matter is less than 1.5%. However, when soil nitrate levels are greater than 15 ppm and conditions are favorable for effective nodulation (soil pH 6.2 to 7.5 and high populations of appropriate N fixing bacteria are present), using preplant N fertilizer during alfalfa

establishment does not increase yield and may have detrimental effects on N fixation.

Weed control and herbicide carryover. A strategy for weed management during alfalfa establishment needs to be developed and generally implemented long before the crop is seeded (Fig. 3). Residual herbicides from previous crops must also be considered in this strategy. Problems of triazine carryover may be encountered with alfalfa seedings following corn, and can be exacerbated by applying lime immediately prior to seeding the alfalfa.

Fig. 3. Canada thistle is a potential weed during alfalfa establishment. Photo courtesy of Oklahoma State University.

Weed control must be an integral part of the establishment program for spring plantings in the south and southeast. Excessive weed competition coupled with hot, dry temperatures make alfalfa establishment without an adequate weed control program difficult. Weed pressure is less of a problem for fall plantings unless the field has a history of annual ryegrass. Annual ryegrass is extremely aggressive and can cause serious stand thinning of new alfalfa stands. On conventionally tilled seedbeds, a preemergence herbicide should be incorporated into the soil before planting to prevent weed competition. Postemergence herbicides can be applied after weeds and alfalfa emerge if weeds are still a problem. On no-till planted stands, only postemergence herbicides can be used since preemergence herbicides cannot be incorporated into the soil.

Autotoxicity. In areas where alfalfa is planted in appropriate soils and managed properly, stands can often last five years with some remaining productive for 7 to 10 years. Alfalfa should not be replanted immediately after an old alfalfa stand. This is because alfalfa produces autotoxic chemicals that can damage new alfalfa seedlings. This autotoxicity causes poor establishment of alfalfa planted too soon after an old alfalfa stand. Autotoxicity can cause long-term yield reduction of new plants that do become established, although the plants may appear normal.

Attempts at thickening declining or thin stands of alfalfa are seldom successful due to autotoxicity from the old plants. Established alfalfa plants can severely reduce establishment and growth of new alfalfa seedlings emerging within an 8-inch radius from the old plant. This means that an old alfalfa stand as thin as 0.75 plants per square foot could inhibit establishment of new plants over 100% of the field surface. Research has shown that a one-year rotation out of alfalfa is sufficient for successful re-establishment of alfalfa in the same field.

Variety selection. The selection of an alfalfa variety is extremely important because it will affect production for the entire life of the stand. There is seldom a clear cut choice in alfalfa variety selection since many varieties may have similar performance for a given location. Decisions about which variety to use must be made in the context not only of individual farms but even individual fields.

Cost is often the main factor considered when choosing an alfalfa variety. However, cheap seed of older varieties can prove to be more expensive in the long run than more expensive newer varieties with improved characteristics. Since establishment costs are spread over the life of the stand, persistence is a primary consideration for profitability.

High-quality seed is essential for good alfalfa stands. Seed should have high varietal purity and seed quality. Many newer varieties provide superior agronomic characteristics that economically justify their selection over older, lower-cost varieties that have less disease and insect resistances and lower yield capabilities.

When selecting a variety it is important to match the site and the intended crop use. Some varieties are designed for hay production, some primarily for grazing, and some are dual purpose serving as both hay and pasture.

Alfalfa varieties are grouped according to their winter dormancy. Values of 2 or 3 are very winter-dormant and are grown in the northern U.S., while varieties with values of 8 or 9 do not go winter-dormant and are only grown in areas with warm winter growing seasons.

Disease resistance is another important factor to consider when choosing a variety. Varieties with high ratings for root rot diseases such as Phytophthora crown rot should be used for sites that are occasionally wet or have marginal drainage since these areas tend to have higher disease problems than soils that are well drained.

Pure alfalfa stands are generally easier to manage for hay and silage production than alfalfa-grass mixtures. For example, there are several herbicides available for weed control in pure stands, but few are available for use in mixed alfalfa-grass stands. Cutting management may be more difficult with mixtures, especially if the recommended maturity for cutting the grass does not match that for alfalfa. In addition, if not properly managed, the grass portion of the mixture can become dominant and subsequently lower the feeding value of the hay or silage.

Alfalfa-grass mixtures require a high level of management to maintain a proper balance between the alfalfa and grass, but they offer some advantages over pure alfalfa stands:

1. Alfalfa fixes atmospheric N, reducing the need for N fertilizer, as compared to a grass alone.
2. Once established, alfalfa-grass mixtures are more competitive with weeds than pure stands.
3. Mixtures provide better protection against plant heaving and freezing and against soil erosion than pure alfalfa stands.
4. Mixtures are easier to cure as hay than pure alfalfa stands.
5. Mixtures tolerate wider variations in soil conditions.
6. The likelihood of bloat during grazing is less with mixtures and is unlikely to occur when the stand contains 40% or more grass.
7. Grasses reduce lodging of alfalfa.

Seeding Guidelines

Seeding at proper time. The two primary seeding periods for alfalfa are late February to early May and August to mid-October. Optimum dates within these ranges vary, depending on location. Spring seedings are most common in the northern half of the U.S. because spring moisture is generally adequate. However, seeding too early in cold, wet soils can result in poor germination, seedling loss due to fungal diseases, and weak stands. On the other hand, seeding too late in the spring can cause seedings to fail due to stress from high temperature and lack of moisture as well as weed competition.

Late-summer seedings are preferred in the South to allow seedling development during cooler weather. Advantages of late summer-early fall seedings include less competition from weeds, reduced spring workload, increased likelihood of drier soil that reduces the risk of soil compaction, and reduced likelihood of damping-off diseases.

Late summer-early fall alfalfa seedings need sufficient moisture and there must be adequate heat unit accumulation before a killing frost. Consequently,

these seedings should be made early enough to allow at least 6 weeks of growth before a killing frost. This means seeding July 20 to August 1 in areas such as the northern portions of Minnesota, Wisconsin, Michigan, and New York to as late as November 15 in parts of the southern and southwestern U.S. In Pennsylvania, each day planting was delayed after August 1 resulted in yield reductions of 158 lb/acre the following year.

Late summer-early fall seeded alfalfa is more susceptible to Sclerotinia crown and stem rot during establishment than spring seedings. New seedings may be completely destroyed when conditions are favorable for this disease development. In fields where Sclerotinia has been or is likely to be a problem, spring seedings are best or seedings should be made at the earliest possible date in late-summer so that seedlings are well established by the time infection would normally occur.

Seeding depth. Alfalfa seeds have a small supply of stored energy to support the developing seedling so proper seeding depth is very important. Seeds placed too deep are not likely to emerge. Seeds placed on the surface, at a shallow depth, or in a loose or cloddy seedbed often do not have adequate seed-soil contact. In those cases, dry soil conditions following seeding usually result in desiccation and death of the seedlings. Optimum seeding depth varies with soil type (sandy, clay, or loam), soil moisture, time of seeding, and firmness of seedbed.

A firm seedbed is essential for proper seed placement and for good seed-to-soil contact. Both of which are important for successful establishment. Alfalfa seed should be covered with enough soil to provide moist conditions for germination but not so deep that the shoot cannot reach the surface.

Seed-to-soil contact. Alfalfa seeds need to absorb at least their own weight in water before germination is initiated. The absorbed water generally moves into the seed from surrounding soil. Adequate seed-to-soil contact ensures rapid water movement into the seed. Field situations (cloddy or loose soil) that do not promote good seed-to-soil contact generally result in extended germination periods and sporadic emergence. The use of press wheels on a grain drill or cultipacking after seeding can improve seed-to-soil contact.

Seeding rates. Recommended seeding rates for alfalfa vary from state to state, and in some cases even within states, due to differences in soils, climate, and establishment methods. It is common for no more than a third of the sown seed to produce seedlings and only half of those to survive the first year. Consequently, rates are usually given in ranges. For example, the recommended rate for pure seedings of alfalfa in Maryland is 15 to 18 lb/acre, Iowa 12 to 20 lb/acre, central California 20 to 30 lb/acre, and Southern California 25 to 35 lb/acre. Refer to local recommendations for the recommended seeding rate in your area.

Inoculation of alfalfa seeds. Alfalfa seed should be inoculated with the proper strains of N-fixing bacteria (*Sinorhizobium meliloti*) before seeding. Much of the alfalfa seed being marketed today is preinoculated. However, if the seed is not preinoculated or the seeding date is beyond the expiration date for the inoculant, the seed should be inoculated with fresh inoculant prior to seeding. It is critical that inoculant with the proper strain of sinorhizobium be used because a strong specific relationship exists between the bacteria and the alfalfa plant.

Heat, direct sunlight, and drying kill inoculant. Inoculant should be stored in a refrigerator and preinoculated seed should be stored in a cool, dry place from time of purchase until time of use. The seed dealer should also have stored the inoculant and seed in similar conditions. In addition, always check the expiration date before purchasing any inoculant materials or preinoculated seed.

Other seed treatments. Other alfalfa seed treatments include clay, lime, polymer, and gypsum coatings and application of fungicides. Lime-coated seed has been used beneficially in areas of acid soils to improve the environment immediately adjacent to the seed. However, on soils that are more suitable for alfalfa, it has not been helpful in improving stands or yields. The gypsum with molybdenum coating has been beneficial in the West where stands are difficult to establish. Seed treatments with a systemic fungicide such as metalaxyl

provides seedling protection against damping-off as well as seed and root rot organisms.

Seeding with or without a nurse crop. A nurse crop of small grain, primarily oat or a small grain-pea mixture is often used with spring seedings of alfalfa in the northern U.S. (Fig. 4). A nurse crop provides quicker ground cover than alfalfa seedlings alone and helps reduce wind and water erosion and weed invasion during alfalfa establishment. It also provides a usable crop for grain, bedding, silage, or pasture.

Fig. 4. Wheat nurse crop. Photo by Marvin Hall.

Spring-seeded small grains should not be sown heavier than 75% of the usually recommended rate to minimize competition with the alfalfa (Fig. 5). Top-dressing small grains with high rates of N should also be avoided. Early killing of the nurse crop with herbicides or removal as silage or pasture will usually favor alfalfa establishment. The nurse crop canopy adds a degree of difficulty when controlling insects that are feeding on the alfalfa.

Fig. 5. Nurse crop with small alfalfa seedlings. Photo courtesy of Oklahoma State University.

The decision to use a nurse crop during alfalfa establishment should be based on site-specific conditions including erosion potential, weed populations, and the individual producer's forage needs during the establishment year. Nurse crops are not commonly used in the southern United States.

Seeding Method

Seeding methods have been categorized by extent of soil tillage (tilled or no-tilled) prior to seeding.

Tilled seedbed. In tilled seedbeds, tillage tools are used to prepare the seedbed. The erosion potential of a field needs to be considered before choosing how the soil will be prepared. Primary tillage tools like the moldboard plow, chisel plow, or a heavy disk bury much of the surface residue, leaving bare soil subject to runoff and erosion, especially on sloping fields. The purposes of tillage are to loosen the soil, eliminate existing vegetation, bury surface weed seeds, incorporate lime and fertilizer into the soil, and provide a smooth surface for

harvesting operations. However, tillage increases soil moisture loss and soil erosion potential until the crop is established.

Tillage allows lime and fertilizer to be incorporated into the root zone to promote rapid plant establishment. It also allows incorporation of pre-emergence herbicides to prevent weed invasion during stand establishment. However, conventional tillage is a less desirable method for planting in rocky soil or on steep slopes since rocks will be plowed up or excessive soil erosion can occur.

Tillage that leaves too much surface residue or trash may result in too shallow seed placement due to seeding units riding on top of the residue. Cloddy or trashy seedbeds are usually too rough and/or uneven for uniform seed placement and are too coarse for good seed-soil contact. However, excessive soil tillage results in fluffy, powdery seedbeds that dry quickly or increase the potential for poor seedling emergence due to surface crusting following rainfall. Small clods or soil granules can help prevent soil crusting.

The final seedbed must be smooth enough for easy machinery operation since hay harvesting and other operations require many trips over the field each year. After the final disking, the field can be firmed and smoothed using a roller or cultipacker. Soil firmness can be judged by walking across the seedbed. On properly firmed soil, an adult's footprint should be about ¼ inch deep. If the seedbed is too soft the seed will be planted too deep and if the seedbed is too hard or cloddy the seed may not make good soil contact, which impairs germination.

Broadcast seeding. Broadcast seeding is a loosely defined term that refers to many seeding techniques, all of which involve broadcasting the seed on the soil surface. Broadcast seeding is contrasted with techniques that place the seed in distinct rows.

· Cultipacker seedings. Cultipacker seeders consist of two sets of corrugated rollers with seed-metering boxes mounted between them (Fig. 6). The first set of rollers firms the soil into shallow corrugations behind which seed is dropped. The second set of rollers splits the ridges of the corrugations, covering the seed and firming the soil around it. These seeders have been a common method for seeding alfalfa on tilled seedbeds for many years because they facilitate achievement of proper seeding depth and good seed-to-soil contact.

Fig. 6. Cultipacker seeder. Photo by Mike Collins.

On medium- and heavier-textured soils, some of the seeds remain on the top and sides of the ridges as well as at the bottom of the corrugations. Since these corrugations are split by the second set of rollers, the seed is distributed across a range of depths not exceeding 1 inch. On sandy soils, most of the seed falls to the bottom of the corrugations, and deeper coverage is obtained. Using cultipacker seeders on heavy soils that have been finely tilled increases the potential for crusting. In addition, using cultipacker seeders when heavy crop residues are present may limit soil coverage and reduce seed-to-soil contact.

· Other broadcast seedings. The principles of a cultipacker seeding (shallow seeding depth and good seed-to-soil contact) can be accomplished without the specific use of a cultipacker seeder. A cultipacker can be used to firm the tilled soil into shallow corrugations. Seed can then be broadcast on the soil using any of several methods. The seed is then covered by another trip across the field with the cultipacker. Broadcasting methods include spinner seeders, grain drills having small-seeded legume and grass seed attachments, large-capacity sprayers, or broadcasting from an aircraft. Grain drills with boxes for small seeds often drop the seed from a height of about 24 inches. If using a grain drill, seeding should be done with the disks raised out of the soil to avoid placing the seed too deep. Distributing the seed through sprayers is a relatively new

technique often referred to as fluid or suspension seeding. This can be an effective way of broadcasting seed uniformly over large areas in a short time, usually by custom applicators. However, the placement and efficacy of legume inoculant after fluid seeding has been questioned.

On pivot-irrigated acreage in the west it is common to broadcast alfalfa with fertilizer through an air-flow fertilizer spreader. This is generally followed by a roller harrow with the S-tines barely touching the soil and then irrigation. This seeding technique has been most successful with seeding rates greater than 20 lb/acre.

Seeding in rows. Grain drills with boxes for small seeds and seed tubes extending to ground level can accurately meter the seed, but controlling the depth of seeding can be difficult. A considerable amount of seed may be covered too deeply, especially if the furrow openers (disks, shovels, or hoes) are set too deeply and the seed is dropped before or near the openers. Seed that falls beneath soil thrown up by the openers are usually covered with too much soil for the seedlings to emerge. If the seed furrow is too deep, seed falling in the furrow may be too deep for emergence, especially if additional soil is washed into the furrow by rain. Higher seeding rates should be used to compensate for these losses.

Drills with presswheels generally provide excellent results if a uniform shallow depth can be maintained. They also work better than cultipacker seeders when some crop residue remains on the soil surface. Drills without presswheels should be followed with a cultipacker to ensure adequate seed-to-soil contact. In some areas producers lightly harrow rather than cultipack, but harrowing doesn't provide the desired seed-to-soil contact that cultipacking does.

No-till seedbed. Technology and equipment are available to establish excellent alfalfa stands consistently without tillage (Fig. 7). No-till seeding not only reduces soil erosion but also conserves soil moisture for germination and new seedling growth. Additional benefits are reduced fuel, labor, and time requirements, the existence of a seedbed that does not need additional firming and avoidance of the problem of soil crusting that is frequently encountered with tilled seedbeds. On soils where stones and rocks are a problem, no-till allows stones to remain on or below the soil surface, thus reducing the need to pick them before and/or after seeding. However, no-till seedings do not permit the soil surface to be smoothed to facilitate harvesting and may exacerbate Sclerotina crown and stem rot.

Fig. 7. No-till alfalfa seeding. Photo by Marvin Hall.

No-till seeding equipment. The are many types of no-till seeding machines marketed. While they differ widely in price and design, all can produce satisfactory stands when properly adjusted and operated. Features that make no-till seeders more reliable include:

1. Adequate weight to allow proper soil penetration.
2. Rolling or power-driven coulters to cut through thatch or mulch covers.
3. Double-disc or other types of seed placement units that line up precisely with the slit created by the cutting coulter.
4. Depth bands, wheels, or another method for controlling seed depth on each seeding unit.
5. Independently operating units to follow the soil terrain.
6. Presswheels to ensure good seed-to-soil contact (Fig. 8).

Fig. 8. Press wheels improve seed-to-soil contact. Photo by Marvin Hall.

The importance of presswheels increases as clay content of the soil and soil moisture decrease; with clay soils high in moisture, presswheels can even be detrimental. In these cases it may be desirable to remove the presswheel and leave the furrow open for the seed to germinate and to develop at the bottom of the open slit. If the slit is closed with a press-wheel, the seed may be covered too deeply and be unable to emerge.

Fig. 9. No-till seeding into a killed sod. Photo by Mike Collins.

Killing vegetation prior to no-till seeding. No-till seedings can be made into a variety of ground covers (Fig. 9). Late summer seeding into small grain stubble is one of the more common methods and one that has great flexibility in terms of matching seeding dates, soils, and weather conditions. Following harvest of the small grain, allow 2 to 3 weeks for as many weed seeds to germinate as practical so that maximum weed kill will be accomplished with application of a nonselective herbicide. A second herbicide application should be made at seeding if another flush of weeds has germinated. Seeding can be made anytime within a 3- to 6-week period when soil moisture and other conditions are favorable. Since soil tillage is not required, seedings can be made much sooner following a rain, and more soil moisture will remain for the new seeding than with a tilled seedbed. The stubble reduces soil erosion and provides protection for the seedlings from intense sunlight and damage from blowing sand or soil particles.

When an old sod is destroyed with herbicides in preparation for no-till alfalfa seeding, the food supply and habitat of the insect population are drastically reduced. Young no-till alfalfa seedlings may then become the insect's major food supply. Stands established in killed sods are often improved when insecticides are applied at seeding.

Broadcast frost seedings. Alfalfa seed may be broadcast in late winter on the soil surface of fall-sown cereals. Freezing and thawing action (honeycombing of the soil surface with ice crystals) along with rain can cover seed with soil and create good seed-to-soil contact. Frost seeding may be successful only during short periods when soil and climatic conditions are right. If sowing is delayed until after freezing and surfaces are dry, frost seeding is not recommended.

Management of New Seedings

Alfalfa planted at the proper depth, and with optimum moisture and temperature, will begin emerging in less than one week. Seed planted deeper than one half inch will emerge more slowly and seed planted deeper than one inch may never emerge.

If proper planting methods are used and weather conditions are optimum, 25 to 30 plants per square foot should be visible within 30 days. Alfalfa stands thin rapidly during the first year and more slowly in subsequent years. Both crown size and the number of stems per plant tend to increase as neighboring plants die.

Optimizing growth of new alfalfa seedlings by minimizing weed and insect pest competition, maintaining optimum soil fertility and employing optimum harvest management will pay dividends over the life of the alfalfa stand (Fig. 10). Weeds often invade new plantings, and the stand may be reduced if weeds are not controlled. Clipping such stands may be necessary, but it should not be done too early, or only the tops of the weeds will be removed, leaving active buds on the stubble to produce new branches and even more competition. Sufficient weed growth should be allowed so that most active buds are removed when clipped. Alfalfa can regrow from crown buds and is usually not seriously damaged by low cutting. Clipping too frequently can reduce seedling development as well as alfalfa yields the following year.

Fig. 10. Alfalfa leaves with yellowing caused by potato leafhopper. Photo courtesy of Alfalfa Alliance.

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