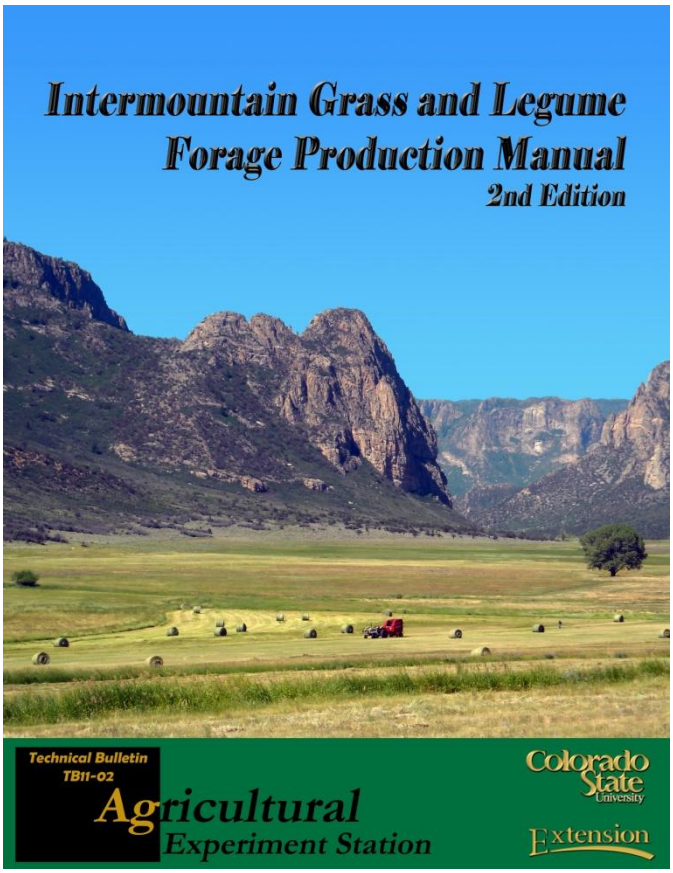

Compiled and Edited by

Calvin H. Pearson
Colorado State University
Western Colorado Research Center at Fruita
1910 L Road
Fruita, CO 81521

Joe E. Brummer
Colorado State University
Soil and Crop Sciences
Fort Collins, CO 80523

Bob Hammon
Melissa L. Franklin
Colorado State University
Tri River Area Extension
2775 Highway 50
Grand Junction, CO 81502

June 2011

Section II

Alfalfa

Chapter 13

Stand Establishment (Irrigated and Dryland)

Calvin H. Pearson and C.J. Mucklow

High yields of alfalfa cannot be obtained without a dense, vigorous plant stand (Fig. 1). Poor stands of alfalfa will often lead to low yields, a shortened stand life, more weeds, reduced forage quality, and low profits.

Careful and thorough advance planning is important when establishing alfalfa. Poor alfalfa stands are not easily remedied after planting and, in most cases, attempts to thicken existing alfalfa stands will fail.

Fig. 1. A dense, vigorous alfalfa stand is essential to obtain high yields.

Field Selection

Topography

Field topography varies widely in many fields. Level fields permit uniform water distribution and infiltration. Water that ponds in low spots can damage alfalfa stands.

Leveling is usually necessary in uneven fields. In areas where large soils cuts are made, less productive soil often occurs in those parts of the field. This may result in varied productivity across the field, and targeted, specific management may be necessary to improve yields in these less productive areas of the field.

Physical properties

Alfalfa grows best on well-drained, deep soils. These soils permit alfalfa to develop an extensive root system to explore a large soil volume so roots can obtain the water and nutrients needed to support a large, healthy plant. Soil compaction and other soil problems that restrict root growth will limit plant productivity.

When grown on soils with poor internal drainage and subsoil physical properties which restrict root growth, alfalfa is likely to experience an increased incidence of root rot diseases. A low soil-oxygen content that typically occurs in wet soils will adversely affect alfalfa growth.

To achieve optimum alfalfa establishment, production, and stand persistence, a well-drained soil is essential. However, satisfactory alfalfa production can be obtained on moderately well-drained soils when ideal soils do not exist.

Chemical properties

A fertilizer management program should be developed well in advance of planting. This will require sampling the field and obtaining a soil analysis to determine the nutrient status of the field. Nutrient deficiencies are usually easily corrected with the appropriate fertilizer and application rate.

Some soils may contain toxic levels of elements (salts) that could limit the productivity of the field. Toxic chemicals in the soil or inadequate soil fertility that could adversely affect a new planting of alfalfa include herbicides, fertilizers, manure applications, or extensive soil leveling. High saline and sodic soils occur in western Colorado and other mountain west locations. Alfalfa is not highly salt tolerant and a 50% reduction in forage yield is possible when soil salinity reaches 8.8 mmhos/cm. Soil testing and field history information may assist in identifying a field that is not suitable for producing alfalfa. Sites that are saline or sodic should be avoided. The cost required to reclaim these sites is often high and should be thoroughly considered before starting a reclamation process.

Biological properties

Fields with severe weed problems may require an effective weed control effort before alfalfa can be successfully produced. Failure to do so may result in poor stand establishment, low yields, and reduced quality. Examples of problem weeds are field bindweed, Russian knapweed, buckhorn plantain, Canada and other thistles, quackgrass and other perennial grasses, and dandelion. It is important to control severe weed infestations prior to planting alfalfa. With the recent advent of Roundup-Ready® alfalfa, perennial weed problems may be controlled effectively with the application of Roundup herbicide into established alfalfa stands. Just how well this weed control strategy will work on various persistent perennial weeds will be determined in time.

Crop Rotation

Crop rotation affects alfalfa establishment. Alfalfa should never follow alfalfa. Problems with diseases, weeds, nematodes, and autotoxicity will usually result in unacceptable alfalfa plant stands and poor plant performance. Autotoxicity is the release of toxic chemical substances that inhibit germination and growth of the same plant species. Alfalfa possesses autotoxic properties.

To avoid autotoxicity, rotate to other crops for at least one year before alfalfa is reseeded. Fields that have a history of nematodes, high disease incidence, or hard to control weeds may require rotating to other crops for two or more years before alfalfa can be reseeded.

In northwest Colorado, growers have reported anecdotally a successful crop rotation of killing an older stand in late summer with Roundup, interseeding the field with oats the following year, and then planting back to alfalfa in late summer or spring of the following year. Make sure when attempting to kill an alfalfa stand using Roundup that the alfalfa is not a Roundup-Ready alfalfa variety. This crop rotation of alfalfa-oats-alfalfa is based on grower experience and no research has been conducted in northwest Colorado to verify the validity of this cropping system.

Field history information is particularly important to determine if any herbicides were applied previously that could persist in the soil long enough to cause damage to a new planting of alfalfa. Rotating to a grain crop following alfalfa has several advantages. Grains crops such as corn, wheat, barley, dry bean, and others will utilize the nitrogen released from the previous alfalfa crop. Broadleaf weed problems that may be present in alfalfa fields are readily controlled with herbicides when grain crops follow alfalfa. The severity of many alfalfa pathogenic diseases is significantly reduced when grain crops are grown for multiple years following alfalfa.

Seedbed Preparation

Field preparation for alfalfa should begin well ahead of planting, possibly even years before planting. The purposes of seedbed preparation are to eliminate or reduce constraints to root growth, control weeds, level the field for drainage, incorporate fertilizers, enhance harvesting and other field operations, promote good germination and crop emergence, and accommodate irrigation.

The desired seedbed for alfalfa should be smooth, firm, and free of large clods, but should not be powdery or fluffy (Fig. 2). The ideal seedbed should be firm, but soft or loose enough to see a foot print as shown in Fig. 3. A proper seedbed permits good seed-to-soil contact, uniform planting depth, promotes soil moisture movement to the seed, and minimizes soil crusting.

Fig. 2. The seedbed for alfalfa should be smooth, firm, and free of large clods.

We have encountered problems establishing uniform stands of alfalfa in western Colorado when the soil is too powdery. This problem occurs under furrow-irrigated conditions and alfalfa plants in the center of the bed are killed. This is thought to be caused by excessive salt accumulation in the center of the bed during irrigation. As water moves laterally from the furrow dissolved salts are carried by water to the center of the bed. As water evaporates, salt is concentrated in the center of the bed close to the soil surface.

Tillage practices for alfalfa vary from farm to farm. Many of the reasons for tillage

Fig. 3. An alfalfa seedbed should be firm, but soft or loose enough to readily make a complete footprint in the soil.

are shown in Table 1. Both primary and secondary tillage are typically used in seedbed preparation for alfalfa and are discussed below in more detail.

Primary tillage

Primary or deep tillage includes field operations that penetrate deep into the soil profile and are more vigorous and extensive than shallow tillage operations. Primary tillage involves the use of deep plowing, ripping, deep chiseling, and subsoiling.

Because alfalfa is a deep-rooted, perennial crop, soil compaction layers that restrict root growth should be eliminated prior to planting. Primary tillage operations

Table 1. Reasons for tillage.

1.	Managing surface residue.
2.	Controlling weeds.
3.	Reducing potential diseases and insect problems.
4.	Applying and incorporating fertilizer.
5.	Managing soil moisture, soil temperature, soil structure, soil compaction, soil aeration, and soil erosion.
6.	Preparing the soil for good seed-to-soil contact.
7.	Improving water management.
8.	Preparing the soil surface for other field operations.

that penetrate below the compaction zone and fracture the soil should be used. Soil compaction is most effectively eliminated when soil is dry.

Factors such as soil type, soil moisture, equipment used, type of soil compaction, and cropping history and management affect the depth and extent of the compaction. Because of the unique factors that lead to the development of soil compaction problems, the practices used to eliminate soil compaction may also need to be unique and specific.

Secondary tillage

Secondary tillage operations are conducted to prepare the final seedbed. Secondary tillage involves the use of disking, rollerharrowing, shallow chiseling, and harrowing.

Land leveling

Most alfalfa fields are intended to remain in production for several years. Leveling fields in preparation for planting alfalfa is often worthwhile. Many fields in western Colorado and other mountain locations are surface irrigated and need to be particularly level. Fields under other types of irrigation systems may also require leveling to prevent ponding and flooding from damaging the alfalfa stand and to facilitate proper harvest operations.

The amount and degree of leveling often dictates the type of equipment required and associated costs. Leveling may range from using a land plane or float, to setting precise slopes using laser land-leveling equipment.

Conservation tillage

Conventional tillage practices are used to plant most alfalfa in many locations in the mountain west. Alfalfa has also been successfully established with conservation tillage, but the use of this technology in our region has been limited. Increased use of conservation tillage to establish alfalfa and other crops under furrow-irrigated conditions depends on the availability of suitable conservation tillage and planting equipment, input costs such as fuel, and adequate producer knowledge and experience with this technology.

Producers who use conservation tillage when planting alfalfa should keep surface residue relatively large, spread the residue evenly, and use equipment that will perform properly when surface residue is present. In high residue conditions, conservation tillage planters must allow residue to flow freely through the equipment without plugging.

Crops planted at the same time as alfalfa are referred to as "companion crops"

Companion Crops

Historically, much of the alfalfa has been seeded in the spring. Typically, alfalfa and another crop, mainly oats, are planted together. Planting these two crops together is designed to aid in the establishment of alfalfa. The oat crop provides quick ground cover to reduce soil erosion, compete against weeds, prevent wind damage to young seedlings, reduce soil crusting, and increase forage production during the seeding year. Erosion and wind damage is a problem that occurs mainly when alfalfa is planted in sandy soils.

A companion crop will protect sensitive alfalfa seedlings from frost damage at lower temperatures and longer exposure times than alfalfa that is not planted with a companion crop. However, companion crops are often strong competitors against young alfalfa seedlings for nutrients, light, and water. Planting a companion crop often reduces alfalfa yields in the first cutting or two.

Killing the oat companion crop chemically at a juvenile growth stage minimizes competition from oats and increases alfalfa

yields during the establishment year. This technique has been used successfully on highly erodible land that did not have significant broadleaf weed problems.

Crops planted at the same time as alfalfa are often inaccurately referred to as "nurse crops." Because of the competitive nature of these crops they are more appropriately referred to as "companion crops." Companion crops produce an effect similar to weed competition, except companion crops are easier to eliminate than most weeds.

Crops that can be successfully planted at the same time as alfalfa are oats, spring wheat, spring triticale, and spring peas. A companion crop selected for planting with alfalfa must be as non-competitive as possible. For this reason, some crops, such as winter wheat, are not usually suitable companion crops.

Alfalfa can be successfully established with an oat-pea crop while maintaining high yields and improving forage quality of the first cutting, as compared to seeding alfalfa with oats alone.

The decision to plant a companion crop should be based on specific criteria that will benefit stand establishment of alfalfa. Planting a companion crop merely because of tradition is not sufficient justification.

Companion crops can aid in the establishment of alfalfa

Companion crops are seeded at much lower rates than when planted alone. Traditionally, the seeding rate of oats used as a companion crop is 30-50% of the normal rate. This translates into a seeding rate of 30 to 50 pounds per acre. To optimize alfalfa yields and reduce weed competition the seeding rate of oats should be approximately 15 to 20 pounds per acre.

Because of its competitive nature, the companion crop should be harvested as hay or silage when it reaches the boot stage. When harvesting the companion crop care should be taken not to damage the young alfalfa stand.

Companion crops grown to maturity should be harvested as soon as they are mature. When the grain is harvested the remaining residue should also be removed or managed so that it does not create additional competition with the alfalfa.

Planting Practices

Seed inoculation

Rhizobium bacteria form small, almost inconspicuous, nodules on the roots of alfalfa plants. These bacteria convert atmospheric nitrogen into organic nitrogen that can be used by the plant. This process supplies the alfalfa plant with nitrogen needed for growth.

Many soils contain some *Rhizobium* bacteria, but some fields may not contain adequate numbers. To ensure that adequate numbers of *Rhizobium* bacteria are present, producers should plant inoculated seed. Seed of alfalfa is often preinoculated with *Rhizobium*. When purchasing seed, determine if the seed has been inoculated. If it has not been inoculated, treat the seed at planting using a suitable sticking agent. Seed should be re-inoculated if it has been longer than six months since originally inoculated or if storage conditions for the seed may have damaged the inoculum.

There are various types of *Rhizobium* bacteria inoculum. Be sure to purchase *Rhizobium* inoculum specific for alfalfa. Follow the instructions on the package for proper seed treating.

Seed treatment

Seedling diseases are not known to commonly occur in many locations in the mountain west. Situations occur occasionally when fungicidal seed coatings may be needed to protect seedlings during establishment. Fungicides are most effective

when seed is planted into cool, moist soils and these conditions persist for an extended period of time. While damping off conditions are quite rare; however, when they do occur stand losses can be severe. The use of fungicides is an inexpensive insurance policy to protect the investment that growers make when planting a new alfalfa crop.

Not all alfalfa seed sold is routinely treated with a fungicide. Use of seed treatments by seed companies varies. If you suspect a fungicide will be needed for successful establishment of your alfalfa, include treated seed as one of the criteria when purchasing seed for planting.

Planting depth

For seeds to germinate they must have air, water, and a favorable temperature. Once germinated, seedlings must be in a suitable growing medium for the root to anchor the plant and begin to obtain water and nutrients for growth. In field conditions, the growing medium is soil and seeds must have adequate seed-to-soil contact for seedlings to establish successfully.

Seeding depth of alfalfa is influenced by soil moisture, soil type, and seedbed conditions. Alfalfa seeds are small and they have a limited supply of stored energy that can be used during germination (Fig. 4).

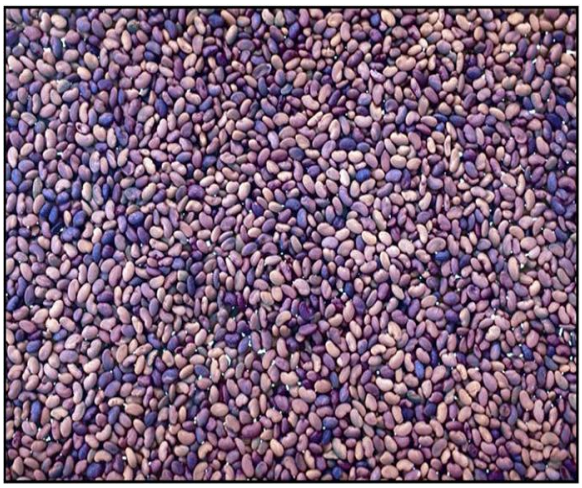

Fig. 4. Planting depth of alfalfa is important because the seed is small at 220,000 seeds per pound.

Planted too deep, alfalfa seed will not have the ability to emerge. Alfalfa seed that is planted too shallow and does not have adequate seed-to-soil contact will not germinate or seed that does germinate will desiccate quickly and die. Thus, correct placement of alfalfa seed in the soil is critical to seedling emergence and stand establishment.

In sandy soils and in dry soil conditions, alfalfa seed should be planted at a depth of ½- to 1-inch. In fine-textured soils, seed should be planted ¼- to ½-inch deep.

Planting rate

Achieving the proper initial plant stand is critical to the productivity of the crop. The plant population of alfalfa decreases over the life of the stand (Table 2). Thus, selecting the correct seeding rate is important.

Table 2. Change in plant stand with age.

Stand Age	Plant Population (plant per sq. ft.)
less than 1 year	more than 30
1 year	20
2 years	15-20
More than 3 years	10-20

Under favorable planting conditions, seeding rates should be between 10 and 15 pounds per acre for irrigated conditions and 8 to 12 pounds per acre for dryland conditions.

Planting 15 pounds of seed per acre will distribute 75 seeds per square foot. Seeding rates of up to 20 pounds per acre may be necessary in poor planting conditions.

Seed source

Seed used to establish an alfalfa stand should come from a reputable source. Use of certified seed ensures seed of known origin, germination, and seed purity. Seed should be purchased from reputable seed suppliers and companies that have demonstrated a commitment to seed quality, plant performance, and customer satisfaction.

Planting date

Alfalfa is seeded over a wide range of planting dates in the region (Fig. 5). Determining the appropriate planting date should be based on factors such as climate, water availability, crop rotation, weeds, and various management considerations.

Planting dates can be categorized into spring, summer, and fall plantings. They are discussed separately below.

Spring

Spring seeding should occur late enough

Fig. 5. Alfalfa is seeded over a wide range of planting dates and conditions in the mountain states.

so plants will not experience injury from freezing temperatures. At emergence, alfalfa is quite cold tolerant, but at the second trifoliate leaf stage seedlings are susceptible to freeze injury. Alfalfa seedlings subjected to just a few hours of temperatures below 26ºF may be killed. Conversely, planting should not be delayed too late in the spring. Plants with poorly developed root systems will not withstand hot/dry conditions. Also, alfalfa planted as early in the spring as possible will be better able to compete against summer weeds. Weed competition will likely increase throughout the summer months. Furthermore, yields during the seeding year from late spring plantings will be low.

Summer

Summer plantings are typically done at higher elevations, particularly those above 7,000 feet. Planting during the summer minimizes the risk of alfalfa seedlings experiencing freeze damage. Furthermore, some growers have found with planting at high elevations during summer there is an increased chance of afternoon thundershowers that improves germination and stand establishment of alfalfa.

Disadvantages of summer plantings are hot, dry weather that stresses young seedlings and makes maintaining adequate soil moisture difficult, competition from summer annual weeds, increased likelihood of soil crusting, and low yields during the seeding year.

Fall

The preferred time to plant alfalfa in many lower valley areas of the Intermountain West is from middle to late August. In actuality, fall plantings are really late summer plantings. Fall plantings offer some distinct advantages. Temperatures during this time of year favor rapid germination, emergence, and development of seedlings. Weed pressures are also lower during late August as compared to early spring or summer. Plants established at this time take advantage of favorable growing conditions that occur during the fall and spring of the next year. This results in alfalfa stands that establish quickly and produce high yields during the first full growing season.

Generally, alfalfa needs six weeks of favorable growing conditions to survive winter conditions (Fig. 6). Plants that have three to four inches of growth before the first killing frost will generally survive most winters without experiencing winter kill.

Irrigation

Sufficient water for seed germination and seedling growth is necessary for suc-

Fig. 6. Alfalfa needs six weeks of favorable growing conditions after planting to establish a new stand to survive the winter without injuring young plants.

cessful establishment of a new alfalfa stand. Irrigation is often necessary to provide a timely amount of water needed for establishing alfalfa stands (Fig. 7). The soil within the seed zone must remain moist for seeds to germinate and for young seedlings to establish. Frequent, light irrigations are usually preferred for stand establishment. Too much or too little water can be damaging to both seed germination and seedling growth.

When planting in heavier soils, crusting can be detrimental to alfalfa seedling emergence. Crusting can be caused by both rain and irrigation events. Producers should schedule irrigation amounts and frequency to allow for good soil moisture to permit seed imbibition and seedling emergence, while minimizing crusting that can inhibit alfalfa seedlings from emerging from the soil.

Fig. 7. Irrigation is often necessary to provide a timely amount of water needed for establishing alfalfa stands.

A fallacy continues to persist that withholding water will force roots to grow deep into the soil in search of water. Plants grow in response to a stimulus, such as water, not from the lack thereof.

Weed Control

Herbicides applied to crops grown prior to planting new alfalfa must be known and considered to avoid herbicide carry-over that could injure new alfalfa seedlings. A more thorough discussion of weed control practices is presented in Chapter 17 on weed control.

Planting Mixtures

Alfalfa-perennial grass mixtures are used to minimize bloat potential, decrease soil erosion, improve soil and water conservation, minimize frost heaving of alfalfa, reduce some weed problems, and provide insurance against stand failures. Alfalfa-grass mixtures require less nitrogen fertilizer than grass alone and mixtures result in a more uniform yield distribution during the growing season than grass monocultures.

Alfalfa lodging is often reduced when a grass is included in the stand because grasses help to support alfalfa plants. Additionally, alfalfa-grass mixtures often cure more quickly than pure alfalfa hay.

The decision to plant mixtures of alfalfa with other plant species will depend on the needs and objectives of the producer's forage system. Alfalfa-perennial grass mixtures are common in many areas of the region, although red clover and other legumes are also occasionally planted with alfalfa.

Many alfalfa-grass mixtures include orchardgrass. Previous research has shown that orchardgrass persists better under a frequent cutting schedule than several other grasses used in alfalfa-grass mixtures. Another grass that has been found to work well with alfalfa is meadow brome. This grass species exhibits good regrowth and is compatible in a mixture with alfalfa. A mixture of orchardgrass, meadow brome, and alfalfa as a three-way mixture has been recommended to some growers in northwest Colorado by Extension agents. Grazing-tolerant alfalfas grown in mixtures with some tall fescue varieties persist well with frequent cuttings.

Mixtures of alfalfa and grass will restrict the herbicides that can be used for weed control. Many herbicides used for weed control in pure alfalfa stands will damage or kill grasses.

Seeding Equipment and Methods

Numerous types of drills and seeding equipment can be used to plant alfalfa successfully. Equipment should properly distribute and place the seed across the field and at the proper depth and rate. Seeding equipment for alfalfa should also result in good seed-to-soil contact. Seed planted too deep, too shallow, distributed unevenly, and with poor seed-to-soil contact will result in fields with thin, spotty stands and reduced productivity compared to alfalfa stands that have uniform, high plant populations.

Reseeding

Occasionally, thin stands of alfalfa may occur and reseeding may be considered. Before reseeding, determine the cause of the poor stand and remedy the problem, otherwise reseeding will likely be futile.

If reseeding a thin stand is attempted, it should be done as soon as possible after the initial planting. Seeding alfalfa into thin stands that are older than one year is usually not successful. Competition from existing plants, and damage caused by diseases and insects make reseeding of alfalfa difficult under most conditions.

Timing of the First Cutting

Alfalfa should be well established before the first cutting. This will ensure that enough root reserves have accumulated to support alfalfa regrowth. Cutting when plants are too young and have not accumulated sufficient carbohydrates in the roots will reduce plant vigor of subsequent cuttings (Fig. 8). Seedling alfalfa should not be cut until plants have developed at least three stems.

If a weed infestation or other problems occur and early cutting becomes necessary, cutting height should be as high as possible. An attempt should be made to eliminate as much of the weed stand as possible while maintaining as much of the alfalfa stand as possible.

Fig. 8. Alfalfa seedlings should continue to grow until they have developed at least three stems before the first cutting is taken.

If a premature cutting is done, lengthen the interval between cuttings. Increasing the cutting interval will allow more time for plants to replenish root reserves and develop a larger root system.