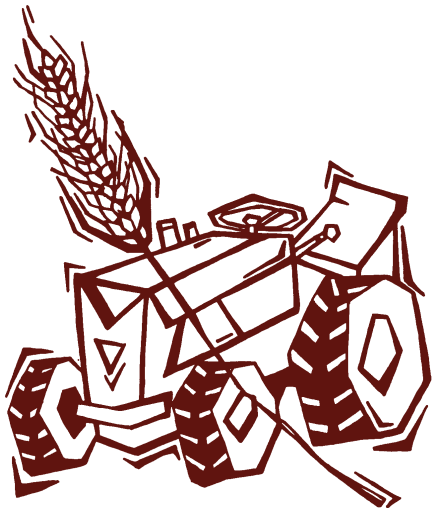

PRODUCTION

Alfalfa: Production and Management no. 0.703

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Quick Facts...

Variety selection should be based first on winter hardiness and secondly on disease and insect resistance.

Important considerations in stand establishment of alfalfa are site selection, seedbed preparation (or sod preparation if interseeding), weed control, seed placement, and time of seeding.

If there are no major nutrient limitations, alfalfa yields are directly proportional to the amount of water used by the crop.

Alfalfa is Colorado's most valuable forage crop, averaging about 3 million tons from 800,000 acres. Average annual value is $233 million. Alfalfa is produced throughout the state and performs well at elevations from 3,400 to 8,500 feet. It has the highest yield potential of any perennial forage crop grown in Colorado; average yields approach 4 tons per acre. Its nutritive value surpasses all other forage crops — often more than 1 ton of protein per acre.

Alfalfa is well adapted to a wide range of soil and climatic conditions. It prefers deep, well drained loam soils. Poor drainage promotes root and crown diseases, inhibits nitrogen fixation, and reduces winter survival. A soil pH between 6.5 and 8.0 is satisfactory for optimum forage production. It is relatively drought tolerant. However, forage production in any given season is directly proportional to the amount of water consumed by the crop.

Variety Selection

Variety selection is one of the most important alfalfa management decisions. Select a variety first on adequate winter hardiness and second on resistance to diseases and insects that could reduce yields at a particular site. Estimate winter hardiness from winter survival ratings determined by standardized field tests. Scores range from 1 (most winter hardy) to 6 (least winter hardy). Colorado conditions require moderate winter hardiness, or varieties with scores in the 2 to 4 range. Most commercial varieties released since 1997 have been tested. Alfalfa varieties also are rated for fall dormancy, a measure of fall regrowth potential. Fall dormancy ratings range from 1 (minimum fall regrowth) to 9 (maximum fall regrowth). Except for extremes (ratings of 1 or 9), fall dormancy of newer varieties is not necessarily related to winter hardiness. Many varieties with intermediate fall dormancy have adequate winter hardiness for most of Colorado.

The best protection against diseases and insects is genetic resistance. Except for alfalfa weevil, resistance to most of the common Colorado pests has been incorporated into many new varieties. Specific pests are discussed in fact sheet 0.706, *Alfalfa: Weeds, Diseases and Insects*.

Varietal characteristics cannot be determined by appearance of the seed. The best assurance of obtaining seed true to advertised characteristics is to plant certified seed. Even though certified seed usually is more costly, this cost is spread over several years and the yield advantage is realized each year of the stand life. An extra half ton or more per acre per year can be produced by using the correct variety for the growing conditions.

Several sources of information can assist growers in selecting a variety. Colorado State University Cooperative Extension agents often have the best insight into locally adapted varieties. Most seed companies, through their local dealers, also provide accurate information about the varieties they distribute.

Colorado State University Cooperative Extension

Complete descriptions of variety characteristics (including winter survival ratings for newer varieties) can be found on the North American Alfalfa Improvement Conference Web site (www.naaic.org). The Certified Alfalfa Seed Council (P.O. Box 1017, Davis, CA 95617-1017) publishes an annual summary of fall dormancy and pest resistance ratings for all varieties distributed in the United States. In addition, results from Colorado State variety performance tests are reported in December by the crops testing program (www.colostate.edu/Depts/SoilCrop/extension/CropVar).

Companion Crops

Spring-planted irrigated alfalfa often is seeded with a small-grain companion crop as an alternative to a pre-emergence herbicide. The companion crop provides additional income, weed control and protection from soil erosion while the alfalfa is becoming established. The most widely used companion crop is oats. Plant companion oats at about 30 pounds per acre.

Companion crops are not nurse crops. Instead, they compete vigorously with young alfalfa plants for nutrients, water and sunlight. Manage them carefully during establishment. Harvest the companion crop as early as possible to avoid excessive competition with establishing alfalfa plants. Harvest grain crops as soon as they are mature. Residue and chaff also can reduce alfalfa stands, so collect these residues at harvest or bale them as soon as possible.

If lodging or evidence of excessive competition occurs prior to grain maturity, harvest the companion crop for hay or silage as soon as possible. Signs of excessive competition include stunting and yellowing of alfalfa plants within the stand. Generally, companion crops intended for hay or silage will not injure the establishing alfalfa if harvested just after heading.

Stand Establishment

The long-term productivity of an alfalfa field depends on successful establishment during the year it is seeded. To ensure the success of the seeding:

- Avoid planting alfalfa on sites with poor surface drainage or where a high water table (within 2 1/2 to 3 feet of the soil surface) exists for most of the growing season.
- Avoid sites infested with perennial or noxious weeds until the weed problem is eliminated.
- Rotate the field to a different crop for one season or fallow it for most of a growing season after the old stand is destroyed. Alfalfa leaves produce medicarpin, a toxin that accumulates in the soil and increases in potency during the life of a stand. This toxin decreases germination and growth of new alfalfa seedlings. Medicarpin dissipates under warm, moist soil conditions. Removing all top growth of the old stand before plowing it also reduces the potential for autotoxicity.

A common cause of seeding failure is inadequate seedbed preparation. Clean-tilled seedbed preparation loosens the upper soil profile and smooths and packs the surface. Loosening the profile removes hardpans and compacted zones, which restrict rooting depth and water movement. A smooth, firm surface allows for proper placement, adequate seed-soil contact, and the best possible moisture retention. As a rough guide to proper firmness, a heel print from walking across the surface should be less than one inch deep. These seedbed characteristics can be obtained by primary tillage (deep plowing or ripping), land leveling, and secondary tillage to break down clods and firm the surface. Secondary tillage operations consist of varying combinations of discing, harrowing and packing (cultipacker or mulcher). If a preplant-incorporate herbicide is used, incorporate it into the soil during seedbed preparation. (See 0.706.)

One of the most important factors is seed placement. The optimum depth for seeding alfalfa varies with soil texture. Planting depth should be 1/4 to 1/2 inch in heavy soils and 1/2 to 1 1/2 inches in lighter soils. Seeding too deep inhibits seedling emergence. For proper seed placement and adequate coverage, seed with a grain drill equipped with a small-seed attachment and packer wheels. Cultipacker-seeders with corrugated rollers also are ideal. Broadcast seeding on the soil surface is the least desirable method because of poor seed coverage and placement. If seed is broadcast, till with a harrow or cultipacker (mulcher) immediately after the seed is distributed. This provides better coverage and a moderate amount of packing to prevent excessive surface moisture loss.

Alfalfa also can be introduced directly into stands of other perennial forages (usually grasses) using interseeding (sod seeding). If successful, the productivity and quality of existing pastures can be improved greatly without tillage and the resulting risk of soil erosion during establishment. Most interseeding methods suppress vegetation to relieve competition from existing plants, followed by drill seeding. Broadcast methods are not recommended for interseeding because of the lack of precision in seed placement.

Suppression of existing vegetation is critical. If seeding occurs early enough in the spring (just after the onset of pasture regrowth), band application

of an herbicide over the drilled rows at the time of seeding can suppress the plants immediately around the developing seedlings. Later in the season, close grazing or clipping just prior to planting has been used with some success. A more involved method of suppression after spring regrowth has started is close grazing or clipping several weeks before planting, followed by herbicide application at planting. The interval between vegetation removal and planting allows the vegetation to regrow so it can be effectively suppressed by the herbicide. Glyphosate is the most common herbicide used to suppress vegetation.

Seeding Rates, Inoculation, and Timing

Recommended seeding rates vary greatly depending on environmental conditions and management. Eight to 12 pounds of seed per acre are suitable for dryland conditions. Ten to 18 pounds per acre are suggested for irrigated conditions. These rates assume average seed quality for certified seed and proper seedbed preparation. When drills or cultipacker-type seeders are used, seed at the lower end of these ranges. For broadcast seedings, the higher seeding rates are recommended. Six to 8 pounds per acre are recommended for interseeding into grass stands.

Seeding rates vary with environmental conditions and management. Time of seeding depends on the local climate, which is largely a function of elevation.

Alfalfa forms a symbiotic relationship with *Rhizobium* bacteria, which enables the plant to convert nitrogen from the air to plant-available nitrogen. The bacteria must invade plant roots to form nodules, where the actual conversion occurs. *Rhizobium* can be applied directly to seed to promote nodulation. This procedure is called inoculation. Commercial seed generally is preinoculated. Packaged inoculant also can be purchased for direct treatment of seed just prior to planting. Use packaged inoculant with seed that has not been preinoculated or with preinoculated seed that has been stored for extended periods or under excessively high temperatures.

Time of seeding depends on the local climate, which is largely a function of elevation. At elevations up to 7,000 feet, most alfalfa is seeded in the spring, usually between April 1 and May 15. Late-summer seeding often is successful, if planting occurs late enough so seedlings are not exposed to excessively high temperatures and early enough so they have enough time to develop an adequate root system and build enough reserves to sustain them through the winter. For most sites under 7,000 feet, optimum dates for late-summer plantings are within four to five weeks before the average date of the first killing frost. At higher elevations, spring plantings usually occur after May 1 because of low temperatures or snow cover. Early to mid-summer plantings also can be used at higher elevations because temperatures are favorable for alfalfa establishment throughout this period.

Fertilizer Management

Alfalfa continuously depletes soil nutrients. Each ton of hay contains about 50 pounds of nitrogen, 10 pounds of phosphorus (P_2O_5) and 60 pounds of potassium (K_2O). Because production and stand viability are promoted by adequate levels of nutrients, determine soil nutrient status, especially phosphorus, before stand establishment. Monitor it annually throughout the life of the stand.

Test soils at least two months before planting alfalfa to determine fertilizer needs. Monitor soil nutrients annually throughout the life of the stand.

For new seedings, test soils at least two months before planting to determine fertilizer needs. This allows adequate time to obtain test results and incorporate fertilizer into the soil. Test soils on existing stands annually, preferably in the fall. This permits nutrient deficiencies to be corrected with topdress fertilizer applications during the fall or early spring. (See 0.537, *Fertilizing Alfalfa and Grasses*.)

Alfalfa seedlings depend on available soil nitrogen until nodulation occurs. A small amount will supply them until nodules form. Excess nitrogen at

planting actually is harmful because it inhibits nodulation and stimulates competition from weeds. With good nodulation, supplemental nitrogen is not needed for mature, well-established stands.

Phosphorus (P) is usually the most limiting nutrient in Colorado soils for alfalfa production. Because P does not move readily in soil, incorporate a three-year supply into the plow layer prior to seeding. Top dressing can maintain adequate levels in established stands if soil test results indicate a deficiency.

For Colorado alfalfa production, nutrient deficiencies other than P are rare. Colorado soils generally have adequate potassium (K) for alfalfa. However, coarse-textured, shallow soils may be low in available K. Calcium, magnesium, zinc, iron, manganese, copper, boron and molybdenum generally are not limiting. Alfalfa has a relatively high sulfur (S) requirement, which results in occasional deficiencies when it is grown on soils low in organic matter. Irrigation water, depending on the source, may contain enough S to meet plant requirements. If the potential for S deficiencies exists, water analysis in addition to soil testing is an important fertilizer management tool for alfalfa.

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Irrigation Management

The water required to produce alfalfa includes the moisture transpired by the plant plus soil surface evaporation. This requirement commonly is termed evapotranspiration (ET) or consumptive use. It is expressed as inches of water used per unit of time (day, month or season). Factors affecting ET are solar radiation, temperature, wind velocity, humidity and growth stage of the crop (which reflects ground cover). Generally, water use is highest when days are long and sunny, temperatures are high, wind movement is rapid, humidity is low, and plant growth fully covers the ground. Thus, highest water use for well-developed canopies occurs in June, July and August. Lowest water use occurs in April and May.

Alfalfa is relatively drought tolerant, but its growth does depend on available soil water. Therefore, in any given setting, dry matter yield is proportional to the amount of water used by the crop, provided there are no major nutrient limitations. A good rule of thumb to estimate water needs is that each ton of cured hay consumes approximately 6 inches of water. In Colorado, seasonal precipitation is limited. If little or no irrigation water is applied, annual yields will be low. If optimum water is supplied through irrigation, yields of 4 to 8 tons per acre are possible.

Several factors determine the amount of irrigation required over a growing season. The first is total consumptive use demand, or the total evapotranspiration that occurs during the growing season. This is approximately equal to the yield potential in tons per acre times 6 inches per ton. A portion of this demand is satisfied by available soil moisture at the beginning of the growing season and any additional soil moisture from precipitation (the effective precipitation). The remaining consumptive use demand is the net irrigation requirement. The actual irrigation requirement is the net requirement divided by the irrigation efficiency for the particular system.

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Alfalfa roots can extend 8 to 12 feet deep in most soils. If the crop is adequately irrigated, it will get most of its water from the upper 4 to 6 feet. Irrigation scheduling usually strives to maintain adequate moisture in this upper portion for as much of the growing season as possible. An adequate level of soil moisture is defined as more than 50 percent of the available water capacity of the soil. Soil texture and depth influence the water capacity of any given site.

Effective irrigation management must consider each of the water use and irrigation variables noted above. The most sophisticated programs are designed to supply the crop's demand for supplemental irrigation water by determining how much water is required at each application and the timing of applications.

References

Publications available from The Other Bookstore, 115 General Services Bldg., Colorado State University, Fort Collins, CO 80523-4061; 970-491-6198:

XCM-173, Best Management Practices for Irrigation Management*, 1994.*

0.305, Legume Seed Inoculants*. 1996.*

0.537, Fertilizing Alfalfa and Grasses*. 1996.*

0.705, Hay Preservation Systems.

0.706, Alfalfa: Weeds, Insects and Diseases*. 1999.*

4.707, Irrigation Scheduling: The Water-Balance Approach. 1993.

4.708, Irrigation Scheduling*. 1993.*

Web Sites:

North American Alfalfa Improvement Conference: www.naaic.org

Colorado State University crop variety trials: www.colostate.edu/Depts/SoilCrop/extension/CropVar

XCM-173, *Best Management Practices for Irrigation Management*, provides a comprehensive review of all aspects of irrigation management practices. Irrigation scheduling is covered in 4.707, *Irrigation Scheduling: The Water-Balance Approach,* and 4.708, *Irrigation Scheduling.*

Harvest Timing

In Colorado, alfalfa is harvested once or several times a season, depending on growing conditions and climate. With irrigation, two cuttings are possible at most high-elevation sites. Three or four harvests usually are taken throughout the eastern plains and in the lower-elevation intermountain and plateau regions. Unless subirrigated conditions exist, nonirrigated alfalfa normally is restricted to one harvest in late spring or early summer because of limited water. For any site where multiple harvests are possible, the number of cuttings in a year depends largely on the crop's stage of development at each harvest. If the crop is harvested at an earlier stage of development (e.g., bud stage rather than bloom stage) during each regrowth cycle, more harvests can be made in a single growing season.

Schedule harvests on the basis of a particular stage of development during each growth cycle, rather than on some duration of time between cuttings. As alfalfa matures, yield increases and quality declines. Early bud is the earliest recommended growth stage for harvest. Earlier cutting limits the plant's ability to recharge energy reserves (stored in roots) to generate regrowth and maintain the plant over the winter. The latest desirable stage for harvest is around full bloom, when growth rates begin to decline. Harvesting each time the crop reaches the bud stage maximizes forage quality. Allowing the crop to reach full bloom before harvesting maximizes yield.

The best growth stage for harvest depends on production goals and potential markets. If highest quality is the primary consideration, harvest at the bud stage during each regrowth cycle. Many growers, however, produce alfalfa hay that is sold or fed on the basis of less than premium quality standards. For these producers, the optimum growth stages for harvest are mid- to late bloom, because higher yields can be obtained and quality is still acceptable. Although hay sold on the basis of yield alone generally sells for a lower price, harvest costs are sometimes lower because fewer cuttings may be required with longer intervals between cuttings.

Alfalfa grown in Colorado below 7,000 feet can be harvested in late summer or early fall with little concern for timing relative to the first killing frost (28 degrees F). Regardless of the amount of regrowth at the time of frost, fall conditions almost always are mild enough to allow for adequate recharge of reserves. Above 7,000 feet, it generally is best not to cut within four weeks of the average date of the first killing frost. For all locations, regrowth after the final cutting can be grazed without damaging overwintering ability, provided that some stubble (3 to 4 inches) is left to provide soil cover.

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