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Colorado State University Cooperative Extension

no. .703

Alfalfa forage production in Colorado

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Quick Facts

- Alfalfa has the highest yield potential of any perennial forage crop grown in Colorado.
- Selection of an alfalfa variety first should be based on adequate winter hardiness and, secondly, on genetic resistance to insects and diseases.
- Soil tests should be conducted to determine fertilizer need.
- The best method to control weeds during stand establishment is to incorporate a herbicide prior to planting.
- Approximately 6 inches of water are required to produce 1 ton of cured hay.

Colorado harvests approximately 800,000 acres of alfalfa annually, valued at more than $150 million. Alfalfa has the highest yield potential of any perennial forage crop grown in Colorado. It can produce more than 1 ton of protein per acre annually. The nutritive value of alfalfa is unsurpassed by any forage crop.

Adaptation

Alfalfa is well adapted to a wide range of soil and climatic conditions. It is best adapted to deep, well-drained loam soils. Poor drainage promotes root and crown disease, inhibits nitrogen fixation and reduces winter survival. A soil pH between 6.5 and 8.0 is optimum for good forage production. Because of its extensive root system, particularly in deep soils, alfalfa is well adapted to irrigation. It is relatively drought tolerant; however, forage production will be in proportion to the amount of available water.

Variety Selection

Selection of an alfalfa variety is an important management decision. Selection first should be based on adequate winter hardiness and, secondly, on resistance to those diseases and insects that have the potential to reduce yields. Varieties best adapted to Colorado conditions require moderate winter hardiness. Non winter-hardy varieties often fail to over-winter while the extremely hardy varieties generally produce lower yields due to early fall dormancy and slower regrowth after cutting.

Genetic resistance to most of the prevelant Colorado pests has been incorporated into many of the newer varieties. The most important alfalfa diseases include phytophthora root rot, bacterial wilt and fusarium wilt. Insect pests include alfalfa weevils, potato leafhoppers, pea aphids, spotted alfalfa aphids and plant bugs. Alfalfa stem nematodes also cause economic damage to alfalfa and are a major concern in pest management programs. The best protection against these pests is genetic resistance, crop rotation and timely cutting. Select a variety that incorporates resistance to the type of pests important in your area. Most seed company advertising literature will provide accurate information about winter hardiness and pest resistance of the varieties the companies distribute.

Varietal characteristics cannot be determined by seed appearance. The best assurance of good seed, true to varietal characteristics, is to plant certified seed of an adapted variety. Certified seed usually is over $10 per acre more than poor seed. Since alfalfa is a perennial crop, this small additional investment is reclaimed many times over the life of the stand. An extra half ton or more per acre, per year, can be produced by using the correct variety for the growing conditions. The most recent *Alfalfa Variety Performance Tests: Progress Report,* published by the Colorado State University Experiment Station, may be used for variety yield information for specific areas of the state. Colorado yield trials have shown that the new varieties consistently out yield older varieties such as Ranger, Vernal, Dawson, Buffalo and Cody.

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Stand Establishment

A common cause of seeding failure is inadequate seedbed preparation. The seedbed should be firm enough to allow good seed-to-soil contact. A firm seedbed may be obtained by plowing, followed by a packing operation to firm the soil surface. A firm seedbed helps to retain moisture in the top 1 to 3 inches of soil and prevents excessive seeding depths.

If a preemergence herbicide is used, it should be incorporated with a disk prior to harrowing. For information regarding the choice of chemicals, refer to the section on weed control in this publication.

The most common method of seeding alfalfa is to use a grain drill with a small-seed attachment and packer wheels. Cultipacker-seeders with corrugated rollers also are ideal. Broadcast seeding on the soil surface is undesirable due to poor seed coverage and placement. However, if broadcast seeding is used, the seed should be covered with a harrow or drag and packed with a cultipacker to prevent excessive surface moisture loss.

One of the most important factors to consider during seeding is seed placement. The optimum depth for seeding alfalfa will vary with soil texture. Planting depth should be ¼ to ½ inch in heavy soils and ½ to 1½ inches in lighter soils. Excessive seeding depths will inhibit seedling emergence.

Spring planted alfalfa grown under irrigation can be planted with a small grain companion crop. The companion crop will provide additional income and will help control soil erosion and weeds during the year of establishment. The most widely used companion crop is oats. It should be planted with alfalfa at a rate of approximately 30 pounds per acre. The use of companion crops during the establishment of alfalfa requires careful management. Companion crops are *not* nurse crops. They compete vigorously with the alfalfa for nutrients, water and sunlight. Therefore, they should be harvested as early as possible to avoid excessive competition with young alfalfa plants. Companion crops grown for grain should be harvested as soon as they are mature. Residue and chaff from companion grain crops also can reduce alfalfa stands. Removal of these residues should be accomplished by collecting the loose straw behind the combine at harvest or by baling the straw shortly after grain harvest.

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

Seeding rates depend on the availability of soil moisture. Approximately 8 pounds of seed per acre is recommended for dryland conditions and 10 to 15 pounds per acre for irrigated conditions. These rates assume good quality seed, appropriate seedbed preparation, the use of a drill or cultipacker-type seeder, and adequate soil moisture at the time of planting. Seeding rates should be increased under more adverse conditions or when the seed is broadcast.

The seed should be inoculated with the strain of rhizobium bacteria appropriate for alfalfa to insure adequate nodulation for nitrogen fixation. Alfalfa forms a symbiotic relationship with the bacteria in the form of nodules. The nodules have the capacity to obtain nitrogen from the air and make it available to the plant. If the seed is not pre-inoculated it should be inoculated just prior to planting. The inoculum and the inoculated seed should be kept shaded and cool during storage. Seed inoculated more than 24 hours before planting should be re-inoculated. Pre-inoculated seed should be re-inoculated if more than one year past the date of inoculation or if seed was stored under excessively high temperatures.

The time of seeding will vary with soil type, elevation, moisture availability and farming practices. Most alfalfa is seeded in early spring, usually between April 15 and May 15. Late summer plantings often are successful, provided the seedlings become well established prior to freezing temperatures. Seedlings planted in the fall usually cannot build up enough food reserves to sustain life through the winter. Mid-summer plantings often are unsuccessful due to weed competition and lack of available moisture near the soil surface.

Fertility Management

The removal of alfalfa forage results in a continuous depletion of soil nutrients. Each ton of alfalfa hay contains about 50 pounds of nitrogen, 10 pounds of P_2O_5 (phosphorus) and 60 pounds of K_2O (potassium). A soil test prior to stand establishment is recommended to determine fertilizer needs. The soil test should be made at least two months prior to seeding to allow time to incorporate needed fertilizer into the soil.

Alfalfa seedlings are dependent upon available soil nitrogen until nodulation occurs. A small amount of soil nitrogen (15 to 20 pounds) will supply the seedling until nodules form. With good nodulation and actively functioning nitrogen-fixing bacteria, supplementary applications of nitrogen fertilizer are not needed. An excess of nitrogen at planting time actually is harmful because it inhibits nodulation and stimulates competition from weeds.

Phosphorus (P) is usually the most limiting nutrient in Colorado soils for alfalfa production. Since phosphorus does not move readily in soil, a three-year supply should be incorporated into the plow layer prior to seeding. A soil test should be used as a guide to determine the correct application rate. The suggested application rate based on the soil test is given in Table 1. Established stands may be top-dressed with phosphorus fertilizer if necessary because branch roots can take up nutrients near the soil surface. Fertilizer application normally should be done in the fall or early spring. However, if irrigation is available, it can be done following any harvest.

Colorado soils generally have adequate potassium (K) for alfalfa. However, coarse textured, shallow soils may be low in available K. A soil test is the best guide to K need (refer to Table 1).

Calcium, magnesium, zinc, iron, manganese, copper, boron, molybdenum and sulfur usually are not limiting factors for alfalfa production in Colorado. However, alfalfa is considered more responsive to sulfur than other commonly grown field crops. Soils most likely to show sulfur response are sandy and low in organic matter. The sulfur present in irrigation water is available to plants and should be considered when calculating sulfur needs. Soils can be supplied with sulfur by applications of gypsum or fertilizers, which contain sulfur as an impurity.

Table 1: Phosphorus and potassium recommendations.

Phosphorus (P) soil test ppm	Phosphorus fertilizer needed* lbs/A P_2O_5
0-3 very low	250
4-7 low	200
8-11 medium	150
12-15 high	100
> 15 very high	0
Potassium (K) soil test ppm	**Potassium fertilizer needed* lbs/A K_2O**
0-60 low	200
61-120 medium	100
> 120 high	0

**Recommendations are for a three-year period of production. If the field will be maintained for only one year, one-half the indicated rate should be applied. Soils should be tested annually to insure adequate P levels.*

Weed Control

Weeds in new or established stands of alfalfa reduce forage quality and yield. The major weed problems in established stands are winter annuals such as tansy and blue mustard, downy bromegrass and wild salsify. Perennial weeds that also can cause problems include dandelions, perennial foxtail and quackgrass.

The best method of weed control during establishment is to incorporate a herbicide prior to planting. This helps to insure a good solid stand that will out compete most weed species. Two common herbicides used on new seedlings are Eptam (EPTC) and Balan (benefin). Both herbicides should be applied to the soil surface and incorporated into the top 2 to 3 inches. If Eptam is used, it should be incorporated within minutes of application, whereas, Balan can be incorporated within eight hours after application.

Solid stands of established alfalfa will out compete most weeds. If weed problems become widespread throughout the field, re-establishment should be considered an alternative to herbicides. Herbicides used on established alfalfa include Chem-Hoe FL-4 (IPC), Sinbar (terbacil), Sencor or Lexone (metribuzin), Velpar and Kerb (pronamide). The reference, *Weed Control In Alfalfa*, published by the Cooperative Extension Service, Colorado State University, provides further information. Label directions always should be followed when applying herbicides.

Disease Control

Disease losses usually are not dramatic in Colorado. They normally develop over several years, which makes diagnosis difficult. Diseases affecting mature plants reduce plant vigor, lower yields and are a major cause of poor winter survival. Once the plant has contracted a disease no cure exists, so genetic resistance is the best protection.

Such seedling diseases as seedling blight and damping off can be problems during cool, wet weather. Fungicide seed treatments help reduce the incidence of seedling disease. However, if *Rhizobium* inoculant is used with a fungicide, it should be applied just prior to planting and after the fungicide treatment.

Two types of diseases attack mature alfalfa stands. These are root and crown diseases and foliar diseases. Foliar diseases usually are not major factors in reducing yields in Colorado. The best methods to control foliar diseases are the use of disease resistant varieties, crop rotation and timely harvest. Most new varieties have incorporated some foliar disease resistance. Periodic surveys of alfalfa fields will determine the presence and severity of foliar diseases. If excessive leaf dropping occurs in the lower canopy, the alfalfa should be harvested immediately to minimize further loss and reduce disease pressure. Under most conditions, crop rotation and harvesting at the 1/10 bloom stage will control foliar diseases in Colorado.

Such root and crown diseases as bacterial wilt, fusarium wilt and phytophthora root rot are prevalent in Colorado. Most varieties contain genetic resistance to bacterial wilt.

The alfalfa stem nematode is caused by a microscopic round worm that enters the plant on the developing bud tissue. It occurs in the West Slope, Front Range, High Plains and Arkansas Valley regions in Colorado. The initial symptoms of infection include stunting, swelling of the stem tissue and shortened internodes. Some affected shoots appear white in color with very little stunting. This condition is called "white flagging" and is especially prominent on the re-growth after the first cutting. White flagging and stand loss usually are the first symptoms readily recognized as nematode damage. Crop rotation with non-host crops such as small grains, dry beans or corn usually reduces the nematode population below detection levels. However, re-contamination with machinery, animals and irrigation water can quickly re-infest the field.

Insect Control

Insect pests that attack alfalfa may cause devastating effects if left unchecked. Some insect problems can be avoided by selecting varieties with insect resistance. Other insects only can be controlled by use of proper insecticides. The most serious insect problems are caused by alfalfa weevils, army worms, aphids, cutworms, alfalfa caterpillars, webworms and leafhoppers. Fields

should be monitored periodically to detect a build-up of insect populations. If excessive insects are observed, the crop should be sprayed with an appropriate insecticide or harvested immediately. Positive identification of the insect pests may be made by local extension agents. Most insect problems can be controlled by timely harvest.

Severe insect problems are most likely to occur early in the growing season. Insecticides usually are more effective if applied when daytime temperatures are above 60 degrees and insects are active. When spraying dense stands, at least 12 to 15 gallons per acre should be applied to insure the chemical penetrates the canopy. Under such conditions aerial applications may not give satisfactory results. For spraying re-growth, less gallons are required and either ground or aerial spray equipment may be used.

Irrigation Management

The water requirement to produce alfalfa includes the moisture transpired by the plant plus soil surface evaporation. This water requirement commonly is termed "evapotranspiration" (ET) or "consumptive use" and is expressed as inches of water used per unit of time (per day, per month or per season). Several factors, including solar radiation, temperature, wind velocity, humidity and growth stage will effect the ET rate. Generally, the water requirement is highest when days are long and sunny, temperatures are high, wind movement is rapid, humidity is low, and plants are growing actively. The highest water requirements occur during July and August.

The alfalfa root system can penetrate the soil to depths of 8 to 12 feet in most soil profiles. If the crop is adequately irrigated, alfalfa will obtain approximately 70 percent of its water needs from the upper half of the root zone, 20 percent from the third quarter, and 10 percent from the bottom quarter. During the growing season, irrigation normally only supplies water to the upper 4 feet of the soil profile. Irrigation during the fall or spring can supply water to deeper portions of the soil profile where it can be stored for use during the next growing season. The soil texture and depth will influence water availability and storage patterns.

Alfalfa is relatively drought tolerant and will produce dry matter yields in proportion to the amount of available water. Hence, if little or no irrigation water is applied, annual yields will be low; conversely, if optimum water supplies are available, yields of 4 to 8 tons per acre are feasible in Colorado. The actual amount of water to apply will depend on several factors, including the amount of precipitation, the water holding capacity of the soil, the climatic conditions and yield goal. A good rule of thumb is approximately 6 inches of water will produce 1 ton of cured hay. The efficiency of application will affect the amount of water to apply. If sprinkler irrigation system is 75 percent efficient (three fourths of the water applied remains available for evaporation and transpiration), one third more water than is calculated must be applied. For example, if yield goal for one cutting is 2 ton, the crop will need approximately 12 inches of water. Assuming a field received 3 inches of rainfall, 9 additional inches of water is needed. If the irrigation system is 75 percent efficient, approximately 12 inches of irrigation water should be applied to fulfill the water requirement.

Crop appearance also is a good indicator of moisture needs. An alfalfa crop that is growing rapidly with adequate water will be light green. When moisture becomes limiting, the crop will turn darker green. The color change occurs when 25 to 30 percent of the available soil moisture remains. Irrigation water should be applied after the color change but before wilting occurs. If the water holding capacity of the soil is known, the amount of water to apply to bring the soil to field capacity can be calculated.

Alfalfa is susceptible to damage by over-irrigation. Damage occurs because disease incidence increases (mainly phytophthora root rot), which results in loss of the stand.

Harvest Management

Due to the wide range of growing environments in Colorado, the number of forage harvests will depend on the specific location. Growing season length and soil moisture availability will affect the number of harvests annually. The three major factors to consider to manage alfalfa are yield levels, forage quality and stand longevity. Attaining the highest degree of all these goals is not possible; therefore, the producer must make critical management decisions.

The highest dry matter yields per cutting are achieved when the crop is in full bloom. Forage quality and yield are maximized when cut in the pre-bud state (Figure 1). However, cutting alfalfa during the pre-bud stage will deplete the stand due to reduced carbohydrate root reserves needed for plant maintenance and regrowth. To maximize forage quality and insure adequate root reserves for re-growth, cut alfalfa when the crop is in the late bud to 1/10 bloom stage. This will provide adequate time for plant recovery during each cycle of regrowth.

No more than one cutting should be taken within six weeks of the average date of the first killing frost (28° F). This period enables the plant to store root reserves needed for winter survival. If considerable topgrowth occurs prior to the killing frost, consider harvesting the crop soon after the frost. This growth can also be grazed, provided that some stubble (3 to 4 inches) is left to provide soil cover.

Figure 1: Relative quantity of fiber and protein as related to time of harvest.