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AgriLIFE EXTENSION
Texas A&M System

T • E • X • A • S Alfalfa Production

Texas Agricultural Extension Service • Zerle L. Carpenter, Director • The Texas A&M University System • College Station, Texas

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Alfalfa Production

Charles Stichler
Extension Agronomist

With a strong, stable livestock and dairy industry in Texas, quality forage is always in demand at a premium price. To meet this demand, producers may choose alfalfa to supplement their income and diversify their farming operations.

Alfalfa, often called the "queen of forages," when properly managed, will produce forage with the highest protein and total digestible nutrient of any hay crop grown. However, problems with soils, disease, stand life and excess moisture at harvest limit production to the dryer climates in the western part of the state.

Although alfalfa is well adapted to arid regions, it requires more water for profitable production than most agricultural crops. Alfalfa will tolerate drought for short periods of time with reduced yields, but plentiful water is a necessity. Many areas in central and west Texas have suitable climates with sufficient irrigation water to produce high quality, high yielding alfalfa.

How Alfalfa Grows

Alfalfa is a warm season perennial legume that can live for 30 years. The plant produces a deep tap root that may grow to a depth of 20 feet.

Alfalfa's rapid regrowth after each cutting and its over-wintering capability result from its ability to store food reserves in a well-developed root system. Alfalfa requires a minimum of 3 feet of good soil to develop the root system for good production and stand life. Alfalfa also requires proper management at harvest to prevent depletion of root carbohydrate reserves. Alfalfa is an excellent rotational crop because it increases soil organic matter content and its deep root system can improve soil tilth and increase moisture penetration. When properly inoculated with rhizobium bacteria at planting, nitrogen can be added to the soil if the last cutting is plowed into the soil as crop residue and the field is rotated to another crop.

Alfalfa is dormant to semi-dormant during the winter months. In the spring, or after a cutting, alfalfa stems grow from buds that develop from the plant's crown at, or slightly below, the soil surface. To prevent damage to the crown and developing new buds, a minimum cutting height of 2 inches is recommended.

Stems mature and flower at a height between 6 inches and 3 feet, depending upon available water, nutrients, weather conditions, disease and insects. Normally, alfalfa will begin to bloom 28 to 30 days after each cutting at a height of 1 1/2 to 2 feet.

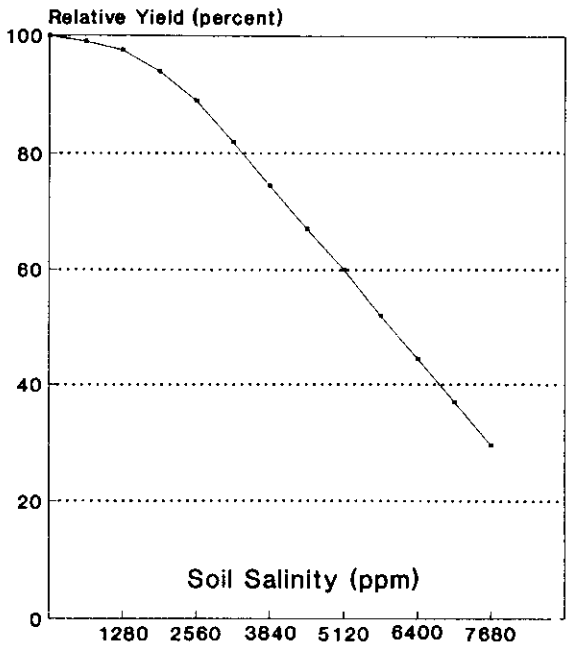
Pre-plant Considerations

Site selection

Alfalfa will produce maximum yields when planted on fertile, deep soils. However, some growers will attempt to plant alfalfa on rocky, shallow or saline soils (Figure 1).

Placed under these poor conditions, yields will be disappointing and stand decline will be accelerated.

Figure 1. Effect of salinity on production.



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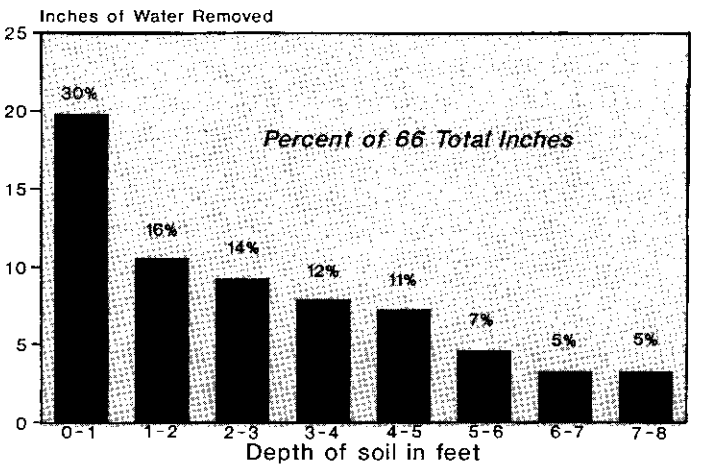
When planted in a suitable soil, alfalfa's tap root system has the ability to extract deep moisture from the soil profile (Figure 2).

A loamy soil at least 4 feet deep is ideal. Very sandy soils generally have low natural fertility and low water-holding capacity. Although clay soils are naturally fertile, they should be avoided because of slow water infiltration rates. Once wet, clay soils stay soft for extended periods and create harvesting problems. Select soils with good internal drainage, because alfalfa will not tolerate wet roots or standing water. Avoid fields with low spots or areas that stand water, small fields and unlevel or rocky fields that make irrigation and harvesting difficult. Also, rocky or caliche sites cannot hold sufficient water to prevent the alfalfa from becoming drought stressed between cuttings. For good production and reduced management problems, plant alfalfa in the best site possible.

Figure 2. Soil moisture depletion.



Consumptive Use of Water by Major Crops: USDA #29

Cotton root rot

Alfalfa is particularly sensitive to *Phymatotrichum* Root Rot or cotton root rot which can spread rapidly. Root rot usually will destroy the stand in 1 to 2 years, and is the main reason that alfalfa is not economically feasible in some areas of Texas.

Water management

Water and water management are the most important considerations in producing profitable alfalfa yields. Consistent yields of high quality forage cannot be produced without irrigation. Correct irrigation practices often will increase yields 15 to 50 percent over incorrectly irrigated fields. Irrigation planning prior to initial soil preparation is important and should follow these guidelines:

- Maintain a continuous supply of readily available soil moisture to produce maximum yields.

- Irrigate frequently with good quality water to avoid severe drying or water logging of the soil (usually twice between each cutting).

- Provide 50 to 70 acre-inches of water per acre per growing season, from mid-March to mid-October. Alfalfa needs 10 inches of water to produce a ton of forage.

For an approximation of the amount of alfalfa to plant and its proper irrigation, an example is given:

Problem:

If a well produces 300 gallons per minute, how many acres can be irrigated to meet the maximum daily usage of 0.35 inches per day?

Use the following formula:

- $\frac{\text{gallons per minute of the well}}{\text{450 (constant)}}$ = acre inches applied per hour

- $\frac{300}{450}$ = 0.66-acre inch per hour

- 0.66-acre inch x 24 hours = (15.84) 16-acre inches per day

- $\frac{\text{16-acre inches}}{\text{.35 maximum water use per day}}$ = 45.7 acres

- 45.7 acres x 85 percent efficiency for the irrigation system results in an estimated 38 acres of alfalfa

Answer:

A 300-gallon-per-minute well can adequately irrigate a 38-acre alfalfa field during its peak water use period of June, July and August.

Because of variability in weather and soil, irrigation scheduling should be determined using soil moisture testing devices such as gypsum blocks or tensiometers, or by regularly checking moisture (by feel) to a depth of at least 3 feet. If a producer guesses at his available soil moisture, over-watering or under-watering may result in water waste or reduced production, and lower his income.

Planting and Stand Establishment

Planting

An alfalfa seed bed should be firm and free of large clods. Plant the seed 1/4- to 1/2-inch deep for best emergence. Deeper planting will reduce seedling emergence and survival. Most experienced growers plant 25 to 35 pounds of seed per acre to ensure a stand. However, 20 pounds of seed at 50 percent emergence and survival should produce a stand of 50 plants per square foot. If conditions at planting are less than optimum, use the higher planting rates to ensure a stand.

Planting date

Alfalfa seed is small and the seedlings are small and delicate. Strive for optimum conditions at planting time. The best time to establish a stand is in the early fall, August 20 to October 1, for the following reasons:

- Warm temperatures are important for seedling growth. After mid-October, root and stem growth and crown development are reduced as air temperatures drop below 45 degrees F and soil temperatures drop below 50 degrees F. Alfalfa planted in a minimum soil temperature of 40 degrees F will take 6 days to germinate, while seed planted in 66 degree F soil will germinate in 2 days. During the first few weeks following germination, the optimum temperature for root growth is 69 to 76 degrees F. Seedlings that do not develop a crown prior to the winter months are subject to desiccation and death.

- Research conducted in California indicates that during the fall, with decreasing day-length, more energy or phytosynthate produced by the plant is directed to the root system. This produces greater root and crown development than in spring-planted alfalfa. Alfalfa responds to longer photo periods with increased stem and foliage growth, so spring-planted alfalfa may have poorly developed root systems and crowns.

Water demand is decreased in the fall because of reduced evaporation. The sun does not bake the soil, allowing better seedling emergence. The chance of rain to aid in establishment is also improved.

Late summer and early fall seeding is most successful because of the favorable weather conditions. The rainy season in most of Texas occurs in late August, September and October, resulting in "free water," high humidity and low daily evaporation rates. Irrigation water is more effective and the number of irrigations may be reduced.

- Weeds and grasses often emerge with alfalfa; however, in fall plantings they do not compete with the alfalfa before freezing. Fall-planted alfalfa will begin growing early in the spring and is able to outgrow most weeds. Winter weeds such as mustard or rescue grass can be a problem if planted in infested areas.

- Fall-planted alfalfa will out yield spring-planted alfalfa the first year it is established, and its initial growth is much faster.

- Fall-planted alfalfa will cover and protect the soil by spring and reduce damage from blowing soil. In contrast, strong spring winds may cause a complete failure in spring-planted fields.

Spring-planted alfalfa has many disadvantages: the insect problems are more severe; extra water is required to overcome the dry winds and low humidity; the nights are often cold; and sand storms and weeds can decimate a newly seeded field. In addition, first-year spring planted fields usually yield half the forage of first-year fall planted fields.

Planting a nurse crop, such as oats, with alfalfa in the spring will help to overcome the wind and blowing sand problems. However, caution is needed to not over-plant, or the nurse crop may compete with and kill the alfalfa seedlings.

Varieties

There are more than 200 patented varieties of alfalfa in the United States and as many as 15 new varieties are released each year. In addition, there are blends such as "common," "variety not stated," and public varieties from university research and breeding programs. Multi-leaflet (five to seven leaflets per leaf) varieties have also been developed. With so many different selections, alfalfa is categorized by groups according to primary characteristics: dormancy and response to cold. These characteristics separate varieties that are cold tolerant and those that maintain growth during periods of hot weather.

Winter-dormant varieties are generally grown in the north where the soil will freeze. This group suffers less root and crown damage from cold, and breaks dormancy late in the spring. These varieties generally are not recommended for Texas except in the northern part of the Panhandle.

Semi-dormant varieties seldom reach complete dormancy. This group is best suited to the southern United States and is the type recommended for central, most of west Texas and north Texas. These varieties often produce leaves near the crown all winter and occasionally grow during warm days.

Intermediate and moderately non-winter-dormant varieties exhibit less dormancy and grow during the warm periods in the winter. This group is best suited to central Texas and the Trans-Pecos regions.

Non-winter-dormant and very non-winter-dormant varieties are best suited to relatively mild to semi-tropical winters. This group does well in the Trans-Pecos area, south and west. The non-dormant types often will begin growth too early and may be frozen back with late season cold. Because the plant is not dormant, it remains green during the winter and will cause early insect problems. If winter grazing is a consideration, the non-dormant type should be considered since it will grow during brief periods of warm weather.

Disease and insect resistance

Disease and insect resistance are inherited characteristics in alfalfa. Newer varieties

usually have more resistance to these pests. Look for resistance to aphids, Phytophthora Root Rot, scald, rhizoctonia stem and root canker, bacterial and fusarium wilt, southern anthracnose, common leaf spot and mildew. When selecting a variety, choose one with high disease and insect resistance. Named or patented varieties will state the resistance levels. Unknown varieties, varieties not stated, or common selections have no known or stated characteristics. Although the seed for these varieties may be less expensive initially, poor performance may prove costly. Selecting the right variety is important. Contact your county Extension agent and local growers for their opinion and experience with varieties sold in your area.

Seed inoculation

Alfalfa needs rhizobium bacteria nodulated roots for nitrogen fixation. Since most soils do not contain enough rhizobium bacteria for adequate nodulation, it is necessary to properly inoculate the seed before planting. Although many companies now inoculate seed prior to bagging, inoculum is available with instructions printed on the containers. Because the bacteria are easily killed by exposure to sunlight, heat and desiccation, inoculated seed should be kept cool and planted within 3 to 4 hours.

Seed bed preparation

Because alfalfa seed is small (220,000 per pound), and the stand will last 5 or more years, time and money spent to obtain a good stand and reduce harvesting problems are important. Deep chiseling to break up hard pans in the subsoil, land leveling to remove high spots or fill low areas, building borders for proper irrigation management, etc., will pay dividends later with an adequate stand, reduced irrigation costs and level fields for easier, efficient harvesting.

Planting equipment

A brillion seeder is the preferred planter for alfalfa; although, many growers successfully use a grain drill with a grass/alfalfa attachment. Set drill units as narrow as possible and plant the field at right angles in two directions. (For furrow planting this is impractical.) Growers often attach drag chains to ensure that the seed is covered and scattered. Broadcast seeding using an airplane or cyclone type seeder usually does not produce a satisfactory stand unless weather and soil conditions are ideal. Placing the seed at the proper depth is difficult without a planter. If necessary, rent the proper equipment or have the field planted by an experienced person. Achieving a good stand the first time is essential.

Fertilization

Pre-plant fertilization

Because of wide variations in soil mineral content, test soil to determine the nutrient status and needs of the field. Since fertilizer cannot be injected in the soil after establishment of the crop, pre-plant incorporate plant nutrients. If the soil pH is less than 6.5, adequate liming is also important.

Needs of seedling alfalfa include 15 to 25 pounds of available nitrogen for rapid, early growth and stand establishment. Phosphorus and potassium levels need to be maintained at medium to high soil levels for good establishment and growth. As a general recommendation, apply 100 to 200 pounds of 18-46-0 or 11-53-0 plus potassium (if needed) before seeding and eliminate the first year's fertilization.

Fertilization of mature stands

Alfalfa is best adapted to soils naturally high in calcium and potassium with a pH of 6.5 to 8.5. On acid soils with a pH of less than 6.5, liming is necessary to maintain stands, and production is often disappointing. These factors tend to limit profitable production to the western areas of the state.

Because of alfalfa's high production level, it has an unusually high plant nutrient requirement. Table 1, from the Pennsylvania Alfalfa Growers program, shows the pounds of nutrients-per-acre contained in and removed by alfalfa annually.

Nutrient removal from various areas will differ slightly because of variations in soil type, varieties, fertility and management practices. These varying conditions point out the need for

regular soil testing to maintain soil fertility and production.

Fertility research from New Mexico State University shows that when plant nutrients are maintained at high levels, additional fertilizer will seldom show a yield increase. In contrast, if the nutrient status of a soil is low, applied fertilizer will produce a yield increase. Maintaining a high to medium soil nutrient level is necessary for consistent high yields.

Seedling alfalfa needs 20 to 30 pounds of nitrogen per acre; but once established, alfalfa will produce its own nitrogen when properly inoculated with rhizobium bacteria. To supply the other nutrients on heavier soils, research suggests that one application in the spring before the first irrigation is sufficient to maintain soil fertility. On sandy soils, spring and summer applications may be necessary because of poor nutrient holding capacity and low natural fertility.

Irrigation

A pre-plant irrigation is recommended to build soil moisture reserves. After irrigation, the field may need to be disked lightly to loosen soil and cover the seed during planting. Monitor the soil surface moisture to prevent the top few inches from drying out before the roots have reached deeper moisture. Established alfalfa is somewhat drought resistant.

Furrow irrigation

Generally, only one furrow irrigation after planting is needed until spring, unless the fall is dry and no winter snow or rainfall occurs. If the field receives a hard rain, or extremely dry conditions occur after planting, it may be necessary to irrigate the furrows to soften the surface crust and enhance seedling emergence. Seedlings are susceptible to drowning, so make every effort to drain excess water after irrigating.

Table 1. Nutrient content* of alfalfa at different yield levels.

Tons/Acre	N	P_2O_5	K_2O	Ca	Mg	S
Up to 4	203	51	229	88	15	16
4 to 5	226	66	301	108	19	20
5 to 6	313	78	352	132	24	25
6 to 7	373	92	423	145	26	29
7 to 8	429	108	503	167	30	34
Over 8	499	124	585	202	35	42

*Nutrient content is equal to pounds of nutrients removed from the soil annually.

Irrigation for mature stands

Alfalfa has a high water demand and proper water management is the most important key to high yields. On the average, alfalfa needs approximately 8 to 10 acre-inches of water for each ton of hay produced. This varies depending on the month and evapotransporation; soil type and texture; and location in the state. It also is important to maintain adequate moisture throughout the rooting zone. Yield is directly related to the amount of water received by the crop. In a study conducted by New Mexico State University and New Mexico Research Stations, Dr. H.E. Dregne plotted the relationship of yield and water (Figure 3).

Figure 3. Relative yield vs water.

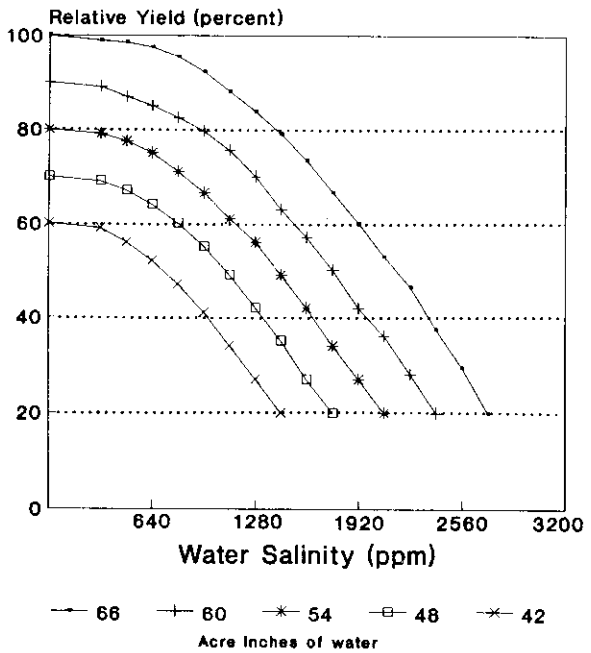


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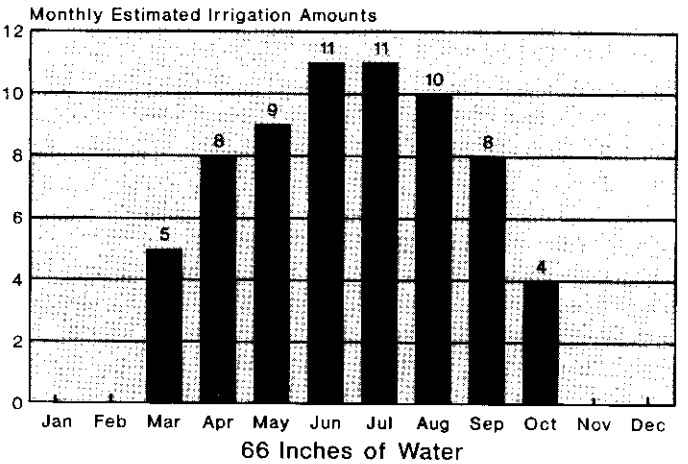
Figure 4 illustrates the average amount of irrigation water needed for west Texas.

Very closely related to water use by a crop is the salinity of the irrigation water and soil. As the salinity increases, the amount of water needed to maintain a given yield also increases. Figure 5 illustrates the estimated effect of different levels of saline irrigation water on alfalfa yields. Salt competes with the plants for water. As the salinity in the water and soil increases, more water is needed to overcome the droughty effects of salinity.

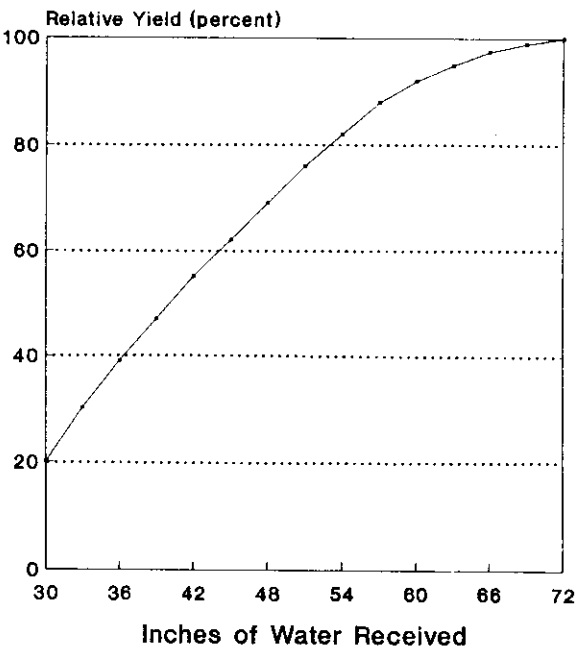
Figure 4. Average alfalfa irrigations.



Adapted from irrigation research in Arizona.

Although alfalfa will survive on low saline soils and poor quality irrigation water, yields will be reduced. When considering salinity problems, both the total salt content and the kinds of minerals that make up the total salt load are significant. For example, sodium ions are more harmful than calcium and magnesium, and chlorides are more harmful than sulfates. (For more information on salinity, refer to the

Figure 5. Salinity- water relationship: effects on alfalfa yields.



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Extension publication B-1677, *Managing Irrigation Water Salinity*.) Under medium saline conditions, alfalfa will have a normal appearance, but the plant's full growth potential is seldom attained and profitability is diminished. High saline levels will prevent stand establishment and eventually cause reduction of mature stands.

Timely harvest and proper irrigation management are critical for maximum yields. If alfalfa becomes stressed, stem growth will stop, and the plants will initiate flower buds. When water is applied, buds break at the crown and two different stages of growth are on the same plant. During the summer months, two irrigations are needed between cuttings: immediately after the hay is removed from the field, and 10 to 15 days after the cutting. This gives the soil a chance to dry out before cutting. Laying hay on wet ground can increase the drying time by as much as 3 days.

Sprinklers

Irrigation with a sprinkler requires more intense management than furrow irrigation or flooding. It is essential to have the system pattern and efficiency tested to determine the actual amount of water delivered to the crop. Research shows that large quantities of water evaporate before reaching the crop if droplet size is too small. In addition, water will rapidly evaporate from the top 3 inches of soil. Therefore, apply enough water to wet the profile deeply on each pass. A serious problem with center pivot irrigation is that the water intake rate on many soils is too slow to absorb the amount of water needed by alfalfa. After a sufficient quantity is applied, the rest simply runs off. However, less water applied per application means more water lost to evaporation, less water available for plant growth and higher cost. Sprinkler irrigation requires suitable soils, high management level and considerable planning to maintain profitable yields.

Pest Management

Insects

Because of the complexity of insect management and the number of pests involved, refer to Extension publication B-1401, *Managing Insect and Mite Pests of Legumes, Grasses and Forage Crops in Texas*. This publication describes the insects and offers control suggestions.

Diseases

Cotton root rot, caused by the fungus *phytotrichum omnivorum*, is the most destructive alfalfa disease in Texas. The soilborne fungus is widely distributed throughout the state and is a major factor in defining the production areas. The disease is more active in warm weather and is recognized by increasingly large areas of dead or dying plants. The bark on roots will slough and the main root will rot. On newly infected plants, a purplish discoloration often will be evident under the bark just below the soil line. On dead plants, the brownish, root-like strands of the fungus often are visible on the outside of the root. No effective control is known, nor are there resistant varieties.

Crown rots, dry rot, fusarium wilt, phytophthora root rot, fusarium root rot, rhizoctonia stem blight and anthracnose are diseases of the roots and crowns. After 3 years, alfalfa plants start dying from a host of problems, usually initiated by damage to the plant from equipment or hoof action of livestock. The crown is split and organisms enter the root, infection occurs and the plants slowly decline. Resistant varieties are the only control of these diseases.

Foliar and stem diseases often occur during extended periods of cool or warm (depending on the organism), wet or overcast conditions. Several fungi and bacteria can cause these problems to occur often but these diseases seldom cause severe problems. The best control method is a resistant variety.

Harvesting to Maintain Quality Production and Stand

The frequency of harvest influences total seasonal yields, quality of forage produced and the ability of an alfalfa stand to persist over a long period of time. The number of cuttings per season is related to genetic characteristics of the variety as well as climate and management. The interrelationships between yield, quality, stand persistence and harvest frequency, to-

gether with the effect of other management practices, make it difficult to arrive at an exact recommendation for different growing areas. However, guidelines are based on the maturity stage of the plant.

Alfalfa quality factors

High quality alfalfa hay must be both palatable and nutritious. The stage of maturity at harvest has by far the greatest influence on alfalfa quality, assuming that other factors can be controlled in the hay harvesting process. The factors which influence alfalfa quality can be summarized as follows:

- **Maturity stage** of the plant is the best indicator to initiate harvest. Pre-bud, 1/10 bloom, full bloom or seed pod stage are terms used to describe the different stages of maturity. Fields cut in the pre-bud stage have the highest leaf to stem ratio and produce the highest quality hay. Leaves are more digestible and higher in protein than stems. As plants mature, the stems become larger, lower leaves often fall from the plant and the leaf to stem ratio decreases, resulting in a decline of digestible protein and an increase in fiber. However, repeated cuttings initiated in the pre-bud stage will reduce yields, increase the cost of production, reduce root reserves and may shorten the life of the alfalfa stand through die-out or weed invasion. Alfalfa cut at 50 percent bloom stage or later will produce higher yields but has reduced feeding value. Studies indicate that alfalfa cut at 1/10 bloom is the best compromise between yield and quality without seriously reducing plant vigor and stand life.

- **Leafiness** is important because 65 to 75 percent of the protein and digestible nutri ents is found in the leaves. It is the most important observable quality factor. Alfalfa leaves, on the average, contain about 25 to 30 percent protein, while the stems contain only about 12 percent when harvested at the 1/10 stage of maturity. In general, alfalfa past the 1/10 bloom stage loses leaves rapidly (leaf shatter) as maturity increases. Leaf shatter also occurs during raking and baling. Loss of leaves during harvest results in reduced quality and yield. The loss of leaves may lower the feeding value as much as 50 percent and may reduce yields as much as 30 percent. Alfalfa produces more leaves in the spring and fall than in the summer. To maintain high protein levels (leafiness) throughout the year, make mid-summer cuttings when alfalfa is in the late bud stage rather than 1/10 bloom.

- **Foreign matter** in hay refers to weeds, straw, old hay stubble, rocks and other materials which have little or no feeding value. Weeds are the most common type of contaminant. Hay quality is lowered as the foreign matter content increases.

- **Soundness** in alfalfa hay refers to the treatment the hay receives during harvesting, curing and storage. High quality alfalfa must be free of objectionable odors, mold, dust and excessive leaf shatter, and must be dry without evidence of heating.

- **Green color** as an indicator of quality, is overrated. However, since most hay is still judged by color, every attempt should be made to maintain the green color. A bright green color indicates high vitamin A content, and proper curing without moisture damage and overheating during storage.

Harvesting practices

Hay quality is often reduced during the harvesting process. To retain the nutritious value of alfalfa, consider the following harvest suggestions:

- Harvest at the proper growth stage: 1/10 bloom in spring and fall; pre-bud in mid-summer.

- Do not rake and bale when the hay is too dry. The leaves of alfalfa are attached to the stem at a single point — the petiole. When the hay is too dry, the petiole and leaves become very brittle. Turning, raking or baling hay at that time will cause serious leaf shatter.

  In a California harvesting study that compared raking alfalfa at 40 to 50 percent moisture with raking dry hay at 15 to 18 percent moisture, the drier raked hay produced 25 percent less yield and 30 percent less nutrients than the hay with a higher moisture content. In the study, the proper

baling time was when free dew moisture evaporated from the top of the windrow, but before the interior of the windrow was dry enough to shatter leaves. Hay that was raked properly but baled dry had a 4 percent less yield and a 7 percent loss in protein when compared to properly raked and properly baled hay. Hay that was raked dry and baled dry yielded 35 percent less and had 40 percent less protein than properly handled hay. Experienced hay producers wait for windrowed hay to absorb dew moisture in the early morning to "stick" the leaves before raking and/or baling.

- Do not rake excessively to decrease the drying time. The less that alfalfa is moved after cutting, the better.

- Do not make the windrows too small and tight. Air is unable to move in and out and poor drying results.

- Set conditioner rollers properly to crush the stems, otherwise the windrow is not uniform. Increase drying time to prevent wet "slugs" from being baled.

- Avoid cutting alfalfa when the ground is wet. This increases drying time and the chance of moldy hay.

Drying agents and preservatives

In the past several years, there has been an increase in the number of drying agents and hay preservatives on the market. Some of these products are beneficial in shortening the drying and harvesting time, however, some are ineffective. Because of the extra expense for the product, cost of equipment, water hauling, increased level of management and inconsistent results, acceptance of these products has been slow. Yet, some large producers with full-time harvesting crews find these products useful to keep harvesting schedules on time.

Drying agents are made of combinations of salts and other products to dissolve the wax on the alfalfa's stem. These agents are sprayed on during cutting.

Hay preservatives are generally of two types: weak acids or chemicals to prevent mold growth; and oxygen-depleting materials to reduce the oxygen in the bale and prevent fungal and bacterial growth. With these products, hay can be baled with 16 to 25 percent moisture, depending upon the size of the bale and its eventual usage. High moisture may turn hay brown and be objectionable to the horse industry, but some dairymen and cattle feeders prefer the moister, softer hay.

Individual producers must evaluate these products relative to their own particular marketing and production situation.

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