ALFALFA

FOR FORAGE PRODUCTION IN ARIZONA

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Contents

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ALFALFA

For Forage Production in Arizona

Alfalfa is the most important forage crop grown under irrigation in Arizona. It is adapted to a wide variety of climatic and soil conditions.

Alfalfa accounts for about 230,000 acres or 18 percent of the total irrigated cropland. It is grown at elevations ranging from near sea level at Yuma to over 5000 feet in the northern counties. However, approximately 85 percent of the acreage is located in southern Arizona.

Forage yields of this palatable and nutritious forage crop range from 2 to 12 tons per acre. Length of growing season, variety, irrigation, management, temperature, quality of water, and soil fertility are factors accounting for most of this variation.

When alfalfa is managed properly and full stands are maintained, returns in dollars per acre make it competitive with most field crops in Arizona. Yields from other crops usually are increased when placed in the rotation following alfalfa. A common rotation would include alfalfa, cotton, sorghum, and small grain. Alfalfa improves soil structure, aeration, drainage, and increases the organic matter and nitrogen content.

The Alfalfa Plant

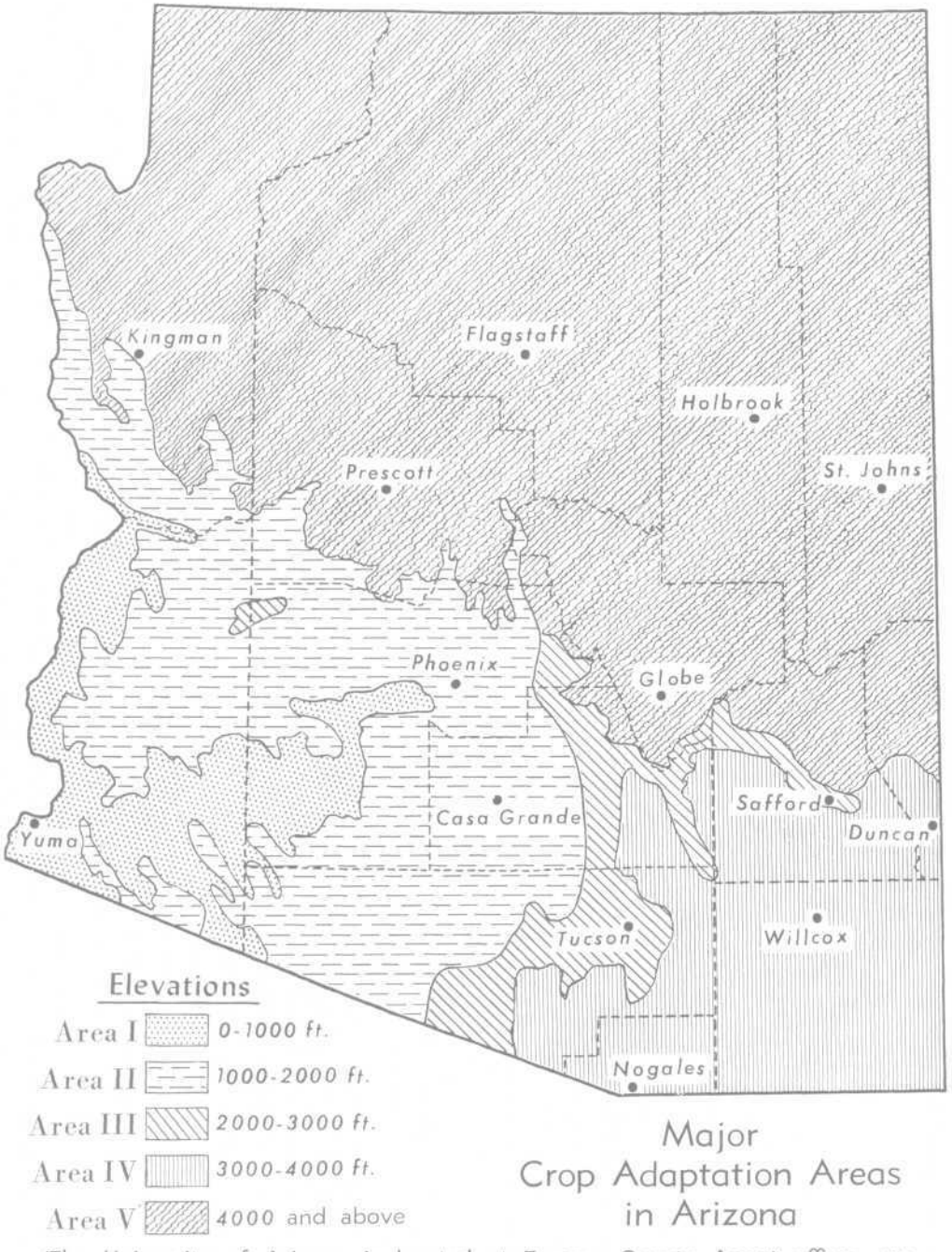
Alfalfa is a long-lived perennial legume. In some instances plants have lived for over 30 years.

After germination, seedlings usually emerge within three to seven days. The first leaves are the cotyledons which emerge from the soil by an arched hypocotyl (see drawing on page 5).

Alfalfa has a taproot system that penetrates deeply into the soil. It may reach to depths of 20 feet or more.

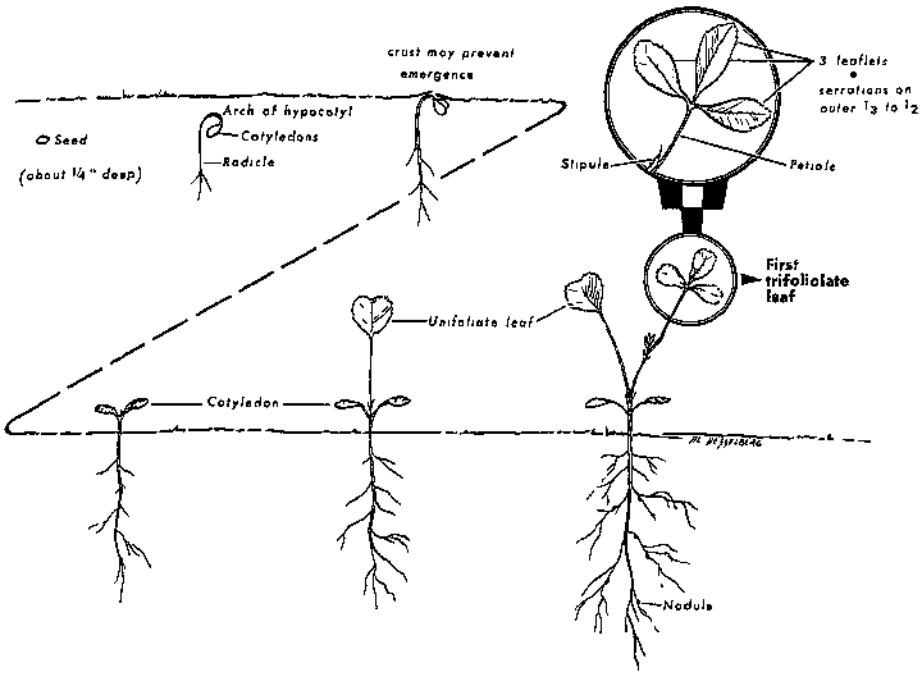
Stems generally develop from crown buds located at or near the soil surface. New growth may also arise from axillary buds, located on the stem. However, most axillary growth occurs after the main stems have reached maturity.

The leaves of alfalfa are composed of three leaflets and are arranged alternately



Major
Crop Adaptation Areas
in Arizona

(The University of Arizona is located at Tucson. County Agent offices are located in each county in the towns shown on the map.)



Early Growth of Alfalfa Plant

on the stem. Two small, leaf-like appendages (stipules) are located at the point of attachment of the leaf to the stem. The characteristic attachment of the leaflets and the typical notching of the upper one-third of each leaflet helps to differentiate alfalfa from certain other legumes.

The flowers are borne in clusters called racemes. Flower color may vary from yellow to purple depending on variety. The seed pod is normally coiled and may contain from one to several seeds. These seeds are kidney-shaped unless crowded in the pod.

Varieties

RECOMMENDED VARIETIES

For recommendations of alfalfa varieties refer to the current University of Arizona Bulletin A-4, Crop Varieties for Arizona.

Prior to 1900, farmers gave little concern to differences among varieties of alfalfa in the United States. As the crop became established in different areas, however, it was apparent that distinct types occurred because of variations in growth at different temperatures.

Alfalfa varieties may be divided into three rather broad groups: (1) Those which are non-winter-hardy; (2) Those intermediate in winter hardiness; and (3) Those which are very winter hardy.

NON-WINTER-HARDY GROUP

A group of alfalfas from Chile, North Africa, Peru, and Arabia was introduced into the United States for use in the Southwest. From these introductions improved varieties have been developed. Characteristics shared by these varieties include lack of cold tolerance with little or no winter dormancy, quick recovery after cutting, erect stems, and purple flowers. They are adapted for use in Areas I, II and III of Arizona. (See page 4.)

Moapa

Moapa originated from nine plants of African alfalfa that were resistant to the spotted alfalfa aphid. In other characteristics it is similar to African. Moapa was developed by personnel of the U. S. Department of Agriculture Crops and Entomology Research Divisions and the Nevada Agricultural Experiment Station. It was released jointly by the U. S. Department of Agriculture and the State Experiment Stations of Arizona, California, and Nevada in 1957.

Moapa is medium stemmed, high-yielding, highly resistant (but not immune) to the spotted alfalfa aphid. Varietal tests have shown that stands of Moapa persist better than those of other nondormant varieties. It is not resistant to crown- and root-rots, viruses, downy mildew, or the

Spotted aphid susceptible varieties (in borders B and D above) nearly destroyed by aphid infestation during first season. Moapa (border C) and Lahontan (border A) have successfully withstood spotted alfalfa aphid populations and have maintained full stands as contrasted to the susceptible varieties, Chilean and Hairy Peruvian. The latter have thin stands and are heavily infested with "grassy" weeds. (Photo taken in midsummer of the second season.)

stem nematode. It has resistance to two species of the root-knot nematode.

African

African alfalfa was introduced into the United States in 1924. Its growth begins earlier in the spring and continues later in the fall than either Chilean or Hairy Peruvian. Its stems are somewhat coarser than Chilean, but not as coarse as Hairy Peruvian.

Six to ten cuttings per year may be obtained in southern Arizona, with proper management. African has shown some tolerance to the spotted alfalfa aphid. It is similar to Moapa in reaction to diseases, nematodes, and insects other than the spotted alfalfa aphid.

Other Non-Winter-Hardy Varieties

Other varieties in the non-winter-hardy group were important at one time in Arizona but are no longer recommended because of their susceptibility to the spotted alfalfa aphid. They are Arizona Common, Chilean 21-5, Chilean 21-5-5, and Hairy Peruvian.

INTERMEDIATE WINTER-HARDY GROUP

Seedlings and mature plants of the intermediate winter-hardy varieties can withstand lower temperatures than the non-hardy varieties. However, they will not withstand temperatures as low as varieties in the very winter-hardy group.

These varieties are characterized by fall and winter dormancy, tolerance to low temperatures, fine stems, purple flowers, and resistance to bacterial wilt. They are adapted primarily for use in Areas IV and V, but under certain conditions may be used in other areas.

Lahontan

Lahontan is a synthetic variety developed by personnel of the U. S. Department of Agriculture and the Nevada Agricultural Experiment Station. It was developed from five plants resistant to stem nematode and bacterial wilt. These parent plants were selected from the variety Nemestan which resulted from an increase of a stem-nematode-resistant introduction from Turkistan.

Lahontan is a high yielding and fine stemmed variety. It is highly resistant to the spotted alfalfa aphid, stem nematode, and bacterial wilt. It is susceptible to leafspot diseases under humid conditions, mosaic viruses, two species of the root-knot nematode, and at least one species of leafhoppers.

In trials at the Arizona Agricultural Experiment Station, stands of Lahontan have persisted longer than those of the non-dormant varieties. Because of its winter-dormant growth habit, Lahontan makes little vegetative growth during late fall and winter.

Zia

Zia was developed at the New Mexico Agricultural Experiment Station from 12 plants resistant to the spotted alfalfa aphid. One plant was selected from Turkistan, two from New Mexico Common, and nine from Lahontan.

Zia is highly resistant to the spotted alfalfa aphid and bacterial and fusarium wilts. Plants in this variety have wide crowns and an upright habit of growth.

Buffalo

Buffalo was developed by personnel of the Kansas Agricultural Experiment Station and the U. S. Department of Agriculture. It was selected from Kansas Common because of its resistance to bacterial wilt. It is not resistant to the spotted alfalfa aphid.

Cody

Cody was developed from 22 plants selected from Buffalo that were resistant to the spotted alfalfa aphid. In other characteristics it is similar to Buffalo.

VERY WINTER-HARDY GROUP

Varieties in the very winter-hardy group are characterized by early fall and late winter dormancy, tolerance to very low temperatures, and resistance to bacterial wilt. They are adapted for use in Area V.

These varieties were developed from crosses between purple- and yellow-flowered species. Intercrossing following hybridization resulted in a wide array of flower color such as purple, bronze, brown, green, greenish-yellow, yellow, and white.

Ranger

Ranger is a synthetic variety developed by personnel of the Nebraska Agricultural Experiment Station and the U. S. Department of Agriculture. It is a complex variety developed from selections from Russia, Turkistan, and India. Considerable variation in growth habit and flower color occurs.

Ranger is more winter hardy than Lahontan, but is susceptible to the spotted alfalfa aphid, leafhopper yellowing, leaf diseases, root- and crown-rots, and viruses.

Vernal

Vernal is a synthetic variety developed at the Wisconsin Agricultural Experiment Station with the U. S. Department of Agriculture cooperating. All parent plants of this variety were resistant to bacterial wilt and low temperatures, but differed widely in other characteristics.

Vernal is a broad-crowned variety with leafy, fine stems. It is less subject to yellowing from leafhopper feeding, and is less susceptible to leaf diseases than Ranger.

ALFALFA BLENDS

Alfalfa blends have been tested for many years and have not been found superior to the best variety used in the blend.

Selection of Seed

Establishing a stand of alfalfa represents a large investment, and the cost of seed is only a small percentage of the total. Use only alfalfa seed of high quality and of a *recommended* variety whether "home-grown" or purchased. See Bulletin A-4, "Crop Varieties for Arizona."

It is false economy to use seed of low quality. The use of *certified seed* indicates genetic purity, a minimum of weed seeds, and high germination. EVERY BAG OF ALFALFA SEED SOLD AT RETAIL, WHETHER CERTIFIED OR NOT, MUST BE LABELED WITH INFORMATION STATING WHERE GROWN, PURITY, AND GERMINATION.

A large percentage of hard seeds may occur in alfalfa. Hard seeds are live seeds that do not germinate during the normal time (5 to 7 days) allotted for a germination test because the seedcoat is impervious to water. When hard seeds are planted in the field they germinate, although they may be slow in doing so.

In some instances where stands are thin, or under dryland conditions, a certain amount of hard seed may be desirable in helping to improve the stand.

With delayed germination, weather conditions may become more favorable for the seeds to germinate, emerge, and grow.

When germination tests show that the hard-seed content is greater than 25 to 30 percent, the seed should be scarified. Scarification is a process that scratches the seed coat and makes it permeable to water. The hard seed content decreases while seeds are in storage.

Selection And Preparation of Land

Selection of Field

Alfalfa produces high yields on all soil types from sand to fine-textured clay. However, best yields are obtained on well-drained, deep loam soils that have a high capacity to absorb and hold water. Sandy soils will produce good crops of alfalfa when fertilized and irrigated adequately; however, consumptive use of water may be higher than on finer-textured soils.

Areas generally unsuited for alfalfa production are those having extremely compact or shallow soils, hardpans, or high water tables. Soils with a high water table for part of the season also may be unsuited for alfalfa production.

Alfalfa may be attacked by several different disease organisms (pathogens). Take care in selecting the alfalfa field, since stands will be harder to maintain in soils heavily infested with plant pathogens. Such pathogens may live in the soil and be responsible for disease in alfalfa or other crops. For example, the organisms responsible for root-rot in alfalfa also cause this disease in cotton.

Older alfalfa plants are more tolerant of a high salt concentration than are the seedlings. Salinity will retard germination, plant growth, and root penetration. A heavy irrigation before planting helps to leach salts out of the root zone of young plants. In some soils with a very high salinity, the leaching irrigation must be completed before seedbed preparation.

Early Preparation

Land leveling improves irrigation efficiency, reduces the labor requirement, and increases production. High spots in a field are likely to be less productive because they receive less irrigation water. Also, salts tend to accumulate in these areas. It usually is necessary to irrigate land after major leveling and filling so that high and low areas can be detected and corrected.

Preliminary cultural operations such as plowing, disking, harrowing, and leveling must be completed before borders are established. Compacted soil layers resulting from cultivation and the use of heavy equipment should be broken by sub-soiling (ripping or chiseling) before planting alfalfa.

When impermeable areas are close to the soil surface, root development is reduced and water movement is restricted. Where soil is deep enough or where compacted layers are present, deep plowing is often practiced. However, data are insufficient to indicate that deep plowing gives an added beneficial effect on soils in good physical condition.

One of the best methods of forming border ridges is the cross-check system where a dump scraper is used to collect soil from the full width of the border. This system leaves no furrows or ditches. After the scraper operation, a border disk may be used to straighten and shape the border ridges. Some growers use only the

A well-prepared seedbed

border disk, a method which is less expensive but which may leave a channel on each side of the border.

Normally, channels should be checked at intervals to facilitate the uniform advance of water down the borders. However, where the soil is not uniform and where borders are long and flat, the channels may be helpful in the even distribution of water. When checks are used, the operation of harvest machinery will be more difficult.

Flatten border ridges before seeding. Narrow, high ridges require more maintenance, and hay harvest from an area having such ridges is difficult. Even though more expensive initially, the scraper method of constructing border ridges saves irrigation labor, reduces the wear on harvest machinery, and results in more uniform stands of alfalfa.

When alfalfa is to be irrigated using corrugations, the seedbed is prepared and then planted. Corrugations usually are made immediately following seeding.

Seedbed Preparation

The seedbed should be mellow but firm. To obtain this type of seedbed and to maintain soil structure, tillage operations should be done when the soil has dried enough to prevent compaction. Also, the power requirement for tillage operations will be less. A seedbed which gives good contact between seed and soil particles enables moisture to move to the seed. This improves germination and early seedling growth.

The desired seedbed should be obtained by using a minimum number of tillage operations. Overworking and pulverizing the soil surface will result in excessive compaction which in turn adversely affects water penetration and often root growth.

Irrigation

The water requirement of alfalfa is high when compared with most crops because of alfalfa's rapid growth and the number of cuttings per season. After establishment, plants can withstand considerable drought. However, for maxi-

mum production, adequate moisture must be present.

Methods of Irrigating

Moisture may be applied by several different means. Most alfalfa in Arizona is irrigated by the border method. Corrugations, sometimes in combination with border ridges, are used where the stream size is limited or where soils are too shallow to permit leveling for border irrigation. Alfalfa is irrigated also by flooding from contour field ditches, flooding of basins, and sprinkling.

Regardless of the method of irrigation used, the system should be well designed and constructed because alfalfa stands usually are maintained for three or more years. It should permit uniform distribution of adequate applications of water with a minimum labor requirement. Also, ease of machine operation during harvesting should be considered.

Border Width

Where border irrigation is used, the width of the border normally is determined by (1) The amount of natural side fall; (2) The irrigating slope; (3) The size of stream available; and (4) The width of machinery to be used. Wide borders are desirable, but problems of water control are increased with increasing width. Water control is more difficult on steeper slopes, so border widths must be decreased accordingly.

Side fall within a border should be eliminated, but this is sometimes uneconomical or impractical. It should be limited to 0.1 foot within a border. Natural side fall thus may determine border ridge spacing.

Even distribution of the desired amount of water requires the correct size of stream per border. Since wide borders require greater stream size, a small irrigating stream may limit border width.

If harvesting operations are performed within each border, the size of the machine also may determine the border width. For greatest convenience, especially on narrow borders, the width of the border should be one to three feet less than a multiple of the mower width to allow for overlap in cutting.

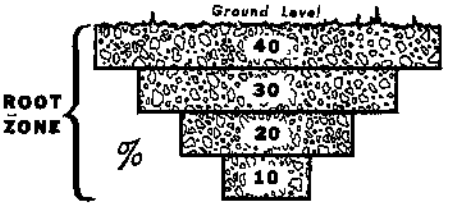
Border widths vary from 20 to more than 100 feet depending on the factors described above. These factors, and others, such as length of run, intake rate, and surface roughness are interrelated and affect the operation of the irrigation system.

Moisture Requirements

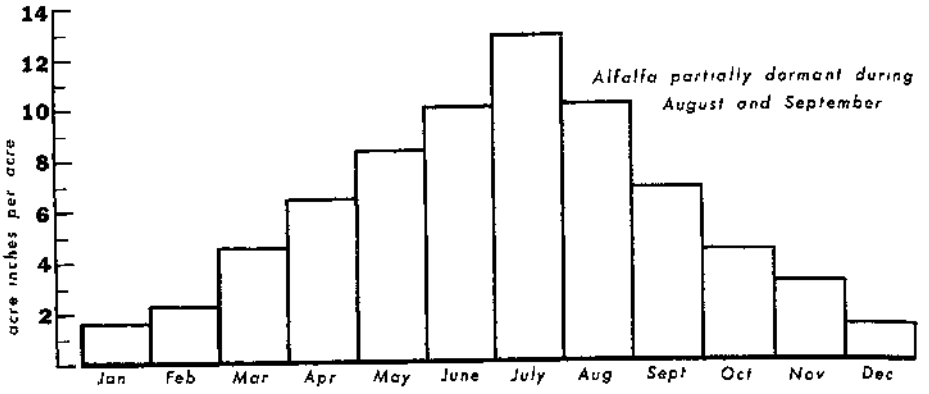
Crown and root development of alfalfa plants are influenced by moisture conditions of the soil The moisture supply at planting should be adequate to the depth of the root zone of mature plants. A supply of readily available moisture during the development of the plant is necessary, but excess moisture reduces aeration and may cause a shallow root system and small crowns. However, severe moisture stress in an attempt to force deep root development is not a good practice.

In deep soils with no impervious layers, alfalfa may draw moisture from depths of 10 feet or more as shown in the drawing below.

An estimate of the total moisture use by alfalfa on clay-loam soils in the Salt



Approximate percentage of total water requirements obtained by an alfalfa plant from each quarter of its root zone.



Estimated use of moisture by alfalfa on clay-loam soils near Mesa, Arizona.

River Valley is shown in the drawing above. "Total moisture use" includes evaporation from the surface of the soil following irrigation plus the water absorbed by plant roots.

Efficiency of Irrigation

The amount of additional water which must be delivered depends upon the efficiency of irrigation. In areas with high water tables, some of the moisture may be supplied from this source, and the amount of irrigation water required will be reduced.

For maximum yields, alfalfa needs sufficient water to grow continuously. Observe plants carefully for signs of moisture stress, especially on sandy soil or during hot weather. The most rapid use of water will occur during the summer. However, immediately following a cutting, less water is required until the foliage of the subsequent growth has made some development. Thus, with the natural variation in rate of use throughout the summer, plus variation caused by cutting the crop, it is difficult to plan and follow an irrigation schedule. To know *when* and *how much* to irrigate requires careful observation and experience.

The scheduling of irrigations is related directly to the necessity for periodic machine harvesting. Average clay-loam soils will require two irrigations between cuttings, but this may vary from one to three irrigations depending on the season, rainfall, and soil texture.

Moisture Stress

Moisture stress is indicated by a bluish-green color of the foliage, whereas a light green color indicates sufficient moisture. Alfalfa on sandy soils should be observed very closely for color changes.

A higher level of soil moisture is needed to sustain growth during hot weather than during cooler periods. One or two heavy irrigations during the winter will permit off-season use of water and give plants an early start in the spring. The moisture stored in the soil during the winter will be available to the plants during the months which follow. Also, filling the soil reservoir when plants are not growing rapidly may have a less detrimental effect than during the active growing season.

Irrigation Practices

Irrigation practices are important in the maintenance of stands. Many alfalfa stands are seriously depleted by scald injury. The exact nature of the injury is

complex, but a saturated soil condition for a prolonged period in hot weather is the primary cause.

Length of time that water stands on the field, and the temperature, are important factors influencing the amount of scald injury. Scald damage is greater on plants that have been cut just prior to irrigation. Excessive irrigation and poor drainage also foster such diseases as rhizoctonia and root-rots which deplete stands.

The tons of hay produced per acre-foot of water may be more important than the tons of hay per acre. Management and fertility practices which increase production also increase the efficiency with which plants use water. More hay is produced per acre-foot of water in the spring and early summer than in late summer and fall. A common practice in some parts of the state is to limit irrigation during mid-July to early September. This forces the alfalfa into a partial dormancy.

Plants in large areas of this field were killed by scald. This is a complex problem, but a saturated soil condition for a prolonged period in hot weather is primarily responsible.

Fertilization

Alfalfa requires large amounts of plant nutrients. For maximum effectiveness of the fertilizer, good seedbed preparation is necessary.

Phosphate

Alfalfa responds to supplemental phosphate fertilizers on most soils in Arizona. Research work and field demonstrations with alfalfa have shown that response to phosphorus occurs more often than for any other plant nutrient.

Phosphorus deficiencies occur throughout the state, but general areas may not be defined. Such deficiencies are common for given fields. In areas where additional phosphorus is needed, commercial phosphate fertilizers, except raw rock phosphate, give good results. Since each ton of alfalfa contains about 9 pounds of P_2O_5, enough phosphorus should be supplied to replace that removed by the crop.

Experimental results in southern Arizona have shown that a single 300-pound application of P_2O_5 may be made before seeding, to provide adequate phosphorus for three years. When such applications are made, work the fertilizer into the soil during seedbed preparation. If plant growth indicates the need for additional phosphorus, apply broadcast applications on the established stand. Annual applications may be made when it is not possible to apply all of the fertilizer required at the time of seeding.

At approximately the 10-percent-bloom stage of growth, or before new sprouts from the crown reach 4 inches in length, leaves and stems should contain about

0.18 percent or more phosphorus. If chemical analysis shows that alfalfa contains less phosphorus at this stage of growth, yield and phosphorus content usually are increased by a supplemental phosphorus application.

Nitrogen

Supplemental nitrogen seldom is recommended for alfalfa but occasionally may be used in the establishment of a new stand under adverse conditions. Nitrogen has a tendency to stimulate the growth of weeds which compete with young alfalfa seedlings. When nitrogen is used, the application rate should not exceed 25 to 40 pounds per acre.

Other Elements

Generally, potassium applications have failed to increase the yield of alfalfa in Arizona. Most analyses of plants have shown more than 1.5 percent of potassium. This amount in mature alfalfa indicates that potassium is not limiting growth.

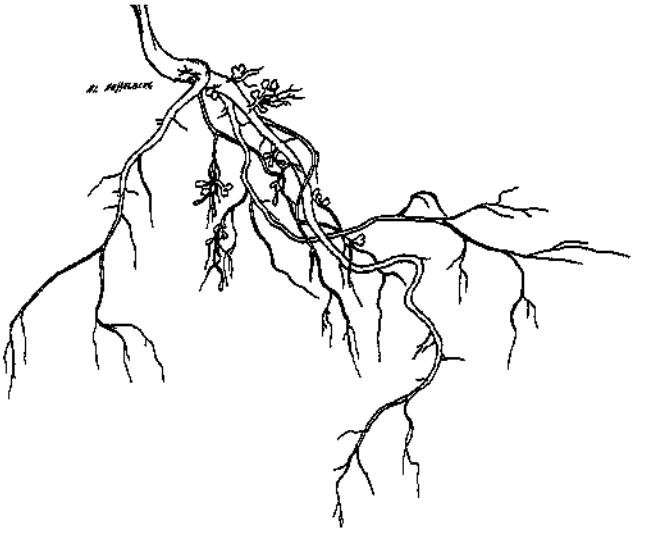
Boron and sulfur are inadequate for best alfalfa growth in some irrigated soils of the West. However, most irrigation waters used in Arizona contain sufficient boron for high alfalfa production. Sulfur deficiencies are not common in Arizona. Also, calcium appears to be present in adequate amounts in soils throughout the state.

Inoculation, Seeding And Stand Establishment

Inoculation, seeding, and stand establishment are critical and important steps in alfalfa production. Without a good stand, the production of alfalfa will not be profitable.

Inoculation of Seed

Alfalfa, like other legumes, is capable of obtaining its own nitrogen from the air through certain nitrogen-fixing bac-



Alfalfa, like other legumes, is capable of manufacturing its own nitrogen through certain nitrogen-fixing bacteria located in nodules on the roots.

teria located in nodules formed by root tissue. The only way to insure the presence of these organisms is to inoculate the seed. There are several kinds of organisms that are capable of forming nodules on the roots, but only certain of these *(Rhizobium)* will provide nitrogen for the alfalfa.

The *Rhizobium* bacteria may be supplied by inoculating the seed at or immediately prior to the time of planting or by buying seed that already contains the bacteria. Recently, a process has been developed whereby the appropriate *Rhizobium* bacteria are impregnated into the seed coat. Seeds that have been treated in this manner are called "Noculized" seed.

If you inoculate your own seed, be sure to use fresh inoculum. Containers usually are dated. Follow carefully the directions on the label.

In fields where alfalfa, sweet clover, or bur clover have been grown recently, there may be enough suitable bacteria in the soil to inoculate the new plantings. However, the cost of inoculating seed is so small that it is a good practice to inoculate.

Inoculation of alfalfa is especially important in Arizona because little nitrogen is available from the soil. Also, a large yield of alfalfa hay (12 tons) may require more than 500 pounds of nitrogen.

Time of Seeding

The time of seeding alfalfa varies with elevation. In southern Arizona, at elevations of less than 3,000 feet, good stands have been established throughout most of the year. But the best results have been obtained with fall seedings. At elevations higher than 3,000 feet (see the map on Page 4.) seedings may be made during the spring, summer, and fall.

Seeding alfalfa in the fall has been most popular because a higher yield can be harvested during the following season. Also, normally there is less trouble from weeds.

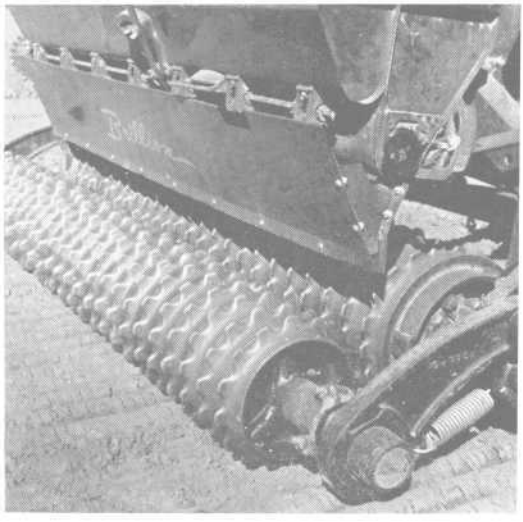
The time of making fall seedings varies with the location. In Areas IV and V, seedings should be made between August 15 and September 1. The latter date would be suitable for the lower elevations of these areas.

Seedings in Area III should be completed by October 1. October and November are the preferred months for fall seedings in Areas I and II. Make fall seedings early enough so that the young plants will become established before cold weather begins.

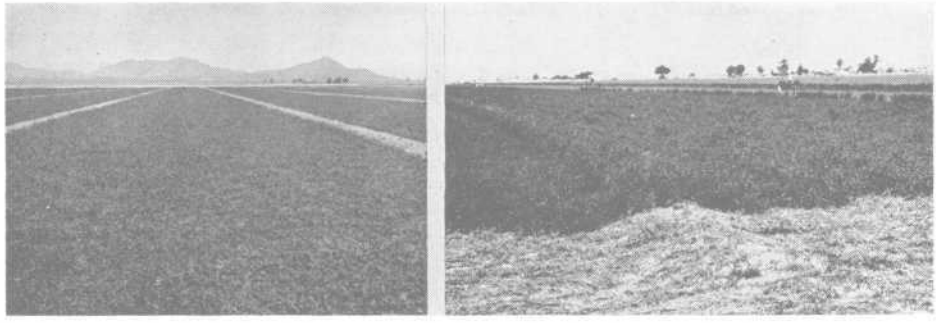
Methods of Seeding

Alfalfa may be seeded with a drill or cultipacker seeder, or it may be broadcast and covered. The use of a grain drill with legume and grass seeding attachment, or a cultipacker seeder, allows for more uniform distribution of seed and better control of the depth of seeding.

When a drill or cultipacker seeder is not available, broadcasting of the seed can be accomplished by a hand-operated



Cultipacker seeder in operation. (Seed is dropped between cultipackers.)



Seeding across borders smooths out ridges making them easier to cross with harvesting equipment. When border ridges are seeded (as in the photo at the right) production will be increased and weed control on the border ridges will be simplified.

cyclone seeder, by an end-gate seeder, or by airplane. Seeding by airplane is sometimes used when the planting is to be made on wet soil. The impact of the seed is usually sufficient to provide adequate coverage.

Seed may be planted in a moist seedbed or in dry soil and irrigated up. Irrigation before planting firms the seedbed and makes inoculation more effective. When alfalfa is planted in a dry seedbed and irrigated up, the seed should be placed as shallow as possible but still covered. When planting in a moist seedbed, plant the seed deep enough to be in contact with moist soil, but not deeper than ¼ to ½ inch in fine-textured soils and ½ to 1 inch in coarse-textured soils.

Young alfalfa seedlings have a limited supply of reserve foods and are not able to emerge when planted too deeply or when the soil surface crusts. When plants are irrigated up, additional light irrigations may be necessary to soften the crust to permit seedling emergence.

When alfalfa is planted in fields that are to be border irrigated, it should be seeded across the border ridges. Seeding in this manner will help smooth out the ridges, and they will be easier to cross with harvesting equipment. Since border ridges occupy a considerable portion of the field, total production will be increased, and the ridges will not become so heavily infested with weeds that compete for moisture, nutrients, and light.

Rate of Seeding

The seeding rate for alfalfa will depend on the seedbed, soil moisture, method of planting, and climatic factors. Less seed is required to give a uniform stand on a well-prepared seedbed than on one that is rough and cloddy.

There are approximately 220,000 alfalfa seeds per pound. If uniformly distributed, this number of seeds will give 5 plants per square foot when planted at the rate of one pound per acre, provided all seeds germinate and the seedlings grow.

Under ideal conditions, 3 to 5 pounds of seed would be sufficient for a perfect stand. However, with present seeding equipment and the hazards encountered, it is not practical to seed at such low rates.

Planting rates vary from 10 to 40 pounds, but when the seedbed has been properly prepared and improved techniques of seeding are used, 15 to 20 pounds of seed per acre is sufficient.

A companion crop will compete with young alfalfa plants for light, nutrients, and water.

Use of Companion Crop

Most alfalfa seedings in Arizona are made without a companion crop. In areas with sandy soils and considerable wind such as on the Yuma-Mesa, sand may blow to the extent that it will cut off or cover young alfalfa seedlings. Under such conditions, oats, barley, wheat, or rye may be seeded at 30 to 40 pounds with the alfalfa. A companion crop also may be used where weeds are a problem in establishment.

The companion crop will compete with young alfalfa plants for light, nutrients, and water. This competition will be greater when heavy seeding rates of small grains are used and when growth is excessive.

Thick stands, excessive growth or lodged grain form a canopy over alfalfa seedlings and reduce the light reaching the seedlings. Reduction of light may result in the death of some plants and may reduce subsequent growth and production of the remaining plants. If growth of the small grain plants is so vigorous or stands are so dense that the alfalfa seedlings become spindly, the small grains should be clipped.

Management of Alfalfa For Forage Production

Since alfalfa is a perennial plant, proper management is of utmost importance in the maintenance of a vigorous and long-lived stand. Dense, healthy stands resulting from good management practices are better able to ward off diseases, weeds, and winter injury than stands that have been weakened by poor management.

Alfalfa plants must manufacture and store sufficient food material in their roots and crowns to provide for regrowth after cutting. Many studies have indicated that the plants do not manufacture sufficient food to be self-supporting until they are about 8 to 10 inches tall.

Time of Cutting

Cut alfalfa at a time that will provide satisfactory yields of high quality hay and still allow the plants ample time to accumulate sufficient food reserves in the roots and crown for stand maintenance. When all factors are considered, the best time to cut alfalfa is when about one-fourth of the plants are flowering.

In southern Arizona, alfalfa continues to grow, but flowers sparingly, if at all, during the winter and early spring months when temperatures are cool and day lengths short. During this time, growth of the crown buds (shoots) at the base of the stem should be used as a guide for cutting. Some experimental work has shown that cutting should occur between the time that buds have initiated growth and when the shoots are two inches tall.

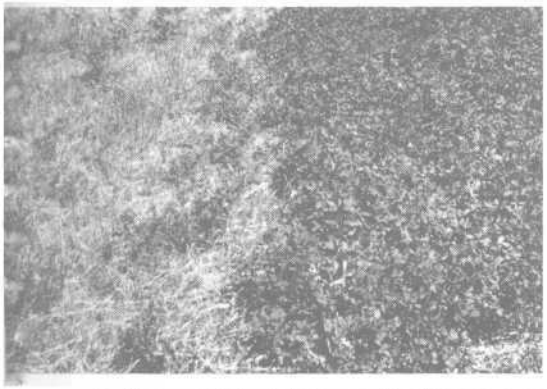
Higher quality forage is obtained when alfalfa is cut in the prebud or bud stages of growth, but highest yields are generally obtained by cutting the plants when they are in full bloom. Experiments at The University of Arizona and other Agricultural Experiment Stations have shown that a large percentage of the protein of alfalfa is contained in the leaves, and the highest percentage of leaves is obtained by cutting in the bud stages of growth.

Cutting repeatedly before plants flower depletes the food reserves and soon causes stands to deteriorate. Early cutting decreases the storage of food material and retards growth and development of the entire plant. Plants that have been weakened by cutting too frequently are more susceptible to diseases and injury from extreme temperatures.

Cutting at full bloom lowers the nutritive value of the hay because there is a decrease in protein and an increase in fiber resulting from changes in the plant tissue and the lower proportion of leaves to stem.

In areas of Arizona where winter killing may be a problem, the fall period is an important one for growth. Cutting alfalfa once or twice during late September and early October may weaken the plants and cause winter killing. Sufficient regrowth in the fall allows for production

The best time to cut alfalfa is when about one-fourth of the plants are flowering.



Full stand (at right) resulted from cutting alfalfa at the recommended stage of maturity. Depleted stand (at left) resulted from repeated cuttings in the bud stage.

and storage of large quantities of food reserves in the crown and roots. Therefore, the last cutting in the fall should be made about 25 to 30 days before the average date of the first killing frost.

Where alfalfa plants have been weakened or winter injured, it is best to delay the first cutting in the spring. Such plants usually are slow to start growth, and when growth is initiated there may be only a few stems per plant that grow. Early cutting of these plants may kill or keep them in a weakened condition.

In such instances, yield of hay will be low and the life of the stand shortened. By delaying the first cutting until full bloom, plants will have ample time to store reserve food material and heal the winter-injured spots. This practice improves the yield from succeeding cuttings.

Quality of Hay

High quality hay is green in color, leafy, and fine-stemmed. It is also free of molds, weeds, and other foreign material.

Protein and carotene are associated with leafiness and color. The leaves contain a much higher proportion of these food materials than do the stems.

The best method of haying will be the one that saves the most leaves and retains the largest amount of green color. Prolonged exposure of hay to sunlight bleaches the color, and heavy dews and rain on plants after cutting leaches the nutrients. Rainfall on partially cured hay causes more damage than on newly-mowed hay.

Haying operations which follow cutting should always be done to retain leaves and to preserve quality of forage. Overdrying is probably the most common cause for the loss of leaves. Leaves shatter easily from hay which is handled when too dry. Because of this, much of the hay is baled at night or in the early morning in southern Arizona.

Fresh-cut alfalfa may contain from 70 to 80 percent moisture depending on stage of growth, soil moisture, and atmospheric conditions at the time of cutting. Generally, the most satisfactory method of curing has been to allow the hay to wilt in the swath and then windrow it for completion of the curing process. Windrow alfalfa after the plants have thoroughly wilted, but before the leaves are dry.

The curing is slowed down in the windrow, and the chances of overcuring are lessened. Hay cured in this manner will contain a high percentage of protein and carotene. If the hay does become too dry before windrowing, rake only at night or early morning when humidity is highest.

The time required for curing in the windrow will depend on weather conditions and whether or not the hay will be baled, chopped, or stored as long hay. Even though alfalfa is cut at the proper stage of growth, windrowing or baling at too high or too low a moisture content will cause poor quality hay.

Windrowing should be done after the plants have thoroughly wilted, but before the leaves are too dry.

Methods of Harvesting and Preserving Forage

Baling

There are several methods of harvesting and storing alfalfa hay, but the most common practice in Arizona is to bale from the windrow. Baling facilitates handling, storage, and shipment which makes the hay more convenient for selling and feeding. Alfalfa is baled in two-wire- and three-wire-tied bales. Most truckers prefer the larger three-wire bales since they make for a more compact load.

The most common method of harvesting and storing alfalfa in Arizona is to bale from the windrow.

The quality of baled hay may vary widely depending primarily on the curing conditions and the moisture content at the time of baling. When baling is done, the stems must have dried enough to prevent spoilage, but not to the point where excessive shattering of leaves occurs. Hay intended for baling should contain no more than 16 to 20 percent moisture. When baled too wet, there is the possibility of heating and consequent loss of nutrients, especially carotene.

Meters are available to check the moisture content and can be used as a guide for determining the time to rake and bale hay. Experienced hay makers often twist a small amount of hay in the hands and if it is tough, the moisture content is probably too high for baling.

Another method sometimes used to determine the moisture content is to scrape the stems with the thumbnail. If

the outer layer is easily scraped off, the moisture content probably is too high for safe baling.

Crushing

The "hay crusher" or "hay crimper" can mow and crush or crimp the stems in one operation. Crushed hay dries more uniformly and the time required for drying may be reduced. Some growers believe that the use of the crusher improves quality. However, the operation of this machine is slower and more expensive than a regular mowing machine.

Stacking of baled hay so as to be readily accessible for marketing (roadsiding) is a common practice in Arizona.

Hay Swathers Or Windrowers

Swathers mow and windrow the forage in one operation. Some of these machines also have a crimper attachment which crimps or crushes the hay in the same operation. Swathers have their own engine and are self-propelled.

The hay swather reduces handling of

The 'hay crusher' or 'hay crimper' conditions the alfalfa thus reducing the time required for drying.

Swathers mow and windrow the forage in one operation.

Field chopping of cured hay may be practical when used on the farm where produced.

the hay and saves labor. It also allows for cleaner hay because in many instances raking will throw soil particles on the cut forage.

Since swathers put freshly-cut hay directly into windrows, the curing time is increased. This factor may hinder their use when drying conditions are unfavorable, but will give more uniform drying of stems and leaves under good drying conditions.

Field Chopping

When alfalfa hay is to be used on the farm where produced, chopping of cured hay in the field may be practical. The chopped hay usually is blown into covered wagons and hauled to the storage area.

Advantages for chopped hay include: (1) There is less waste since stock will consume both leaves and stems; (2) Chopped forage requires less storage space

than long hay; and (3) Chopping may be a more economical way of handling hay.

Since chopped hay packs tightly, it must have a low moisture content at the time of storage. Also, after storing, chopped hay has little chance to lose further moisture. Therefore, complete curing is required prior to storage to prevent heating, spoilage, or spontaneous combustion. Chopping hay into longer lengths will lessen the possibility of heating and spoilage since longer lengths do not pack as closely.

Pelleting and Wafering

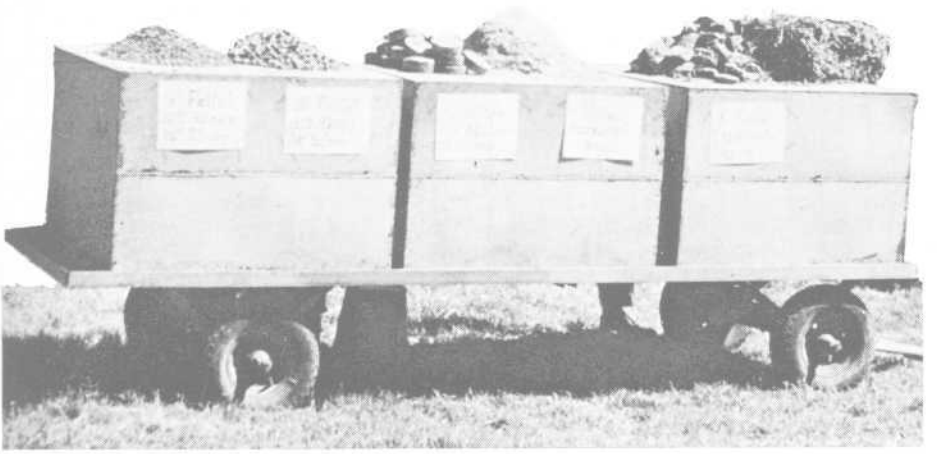
Recently, pelleting and wafering of forages have received considerable attention. These processes place the hay in a more compact and convenient form for handling and feeding. After compacting, the roughage can be handled mechanically with a drag, conveyor belt, or other means permitting relatively gentle handling. Hours of labor are saved by mechanical handling, and the more compact product helps to reduce transportation costs.

Limited experimental results have indicated that cows consume as much or more roughage in the pelleted or wafered form as they do of baled hay. Studies by the Dairy Department at The University of Arizona indicate, however, that butterfat production may be reduced a moderate amount by feeding pelleted forages.

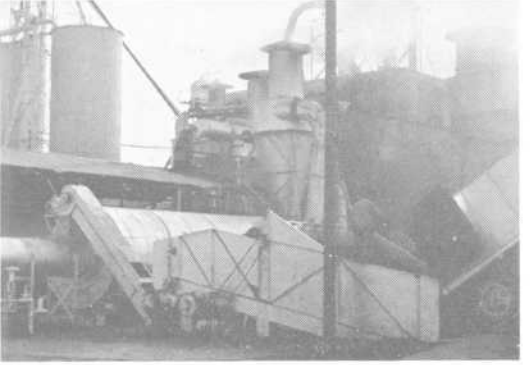
Alfalfa Meal

Alfalfa meal is made from either sun-cured or artificially-dehydrated alfalfa. The quality of meal from sun-cured alfalfa is entirely dependent upon the quality of the hay used. Alfalfa meal made from artificially-dehydrated alfalfa also varies in quality, but in most instances it is higher than meal made from sun-cured alfalfa.

The American Dehydrators Association has established a set of trade rules which specify that dehydrated alfalfa meal must be dried rapidly by artificial means at a temperature about 212° F., and that no sun-cured alfalfa be mixed with the product. These rules were established to insure a more uniform product of high quality.



Pelleting and wafering puts alfalfa hay in a more compact and convenient form for handling and feeding.



Dehydration (see plant above) is one of the best ways of processing forage to save the food value of the crop.

Alfalfa to be dehydrated for meal usually is cut in the pre-bud or bud stages of growth. Cutting at these stages of growth may not be a problem with maintenance of stands when alfalfa is used in short rotations. Generally, one or two cuttings a year may be harvested for dehydration without damaging the stand, provided the other cuttings are harvested for hay or seed.

Dehydration is one of the best ways of processing forage to save the food value of the crop. This process allows for a maximum leaf percentage, a high carotene level, and high protein content.

Dehydrating mills usually purchase alfalfa standing in the field, and payment is based on the hay yield or the tonnage of meal produced. The price paid for the alfalfa varies, but normally is about the price of alfalfa hay less the cutting, raking, and baling costs. Dehydrating plants generally own the harvesting equipment or contract for harvesting and delivery of the green alfalfa.

Silage

Preserving alfalfa as silage is one of the best ways of retaining its high food value. Since very few leaves are lost, most of the protein and carotene are preserved when alfalfa is ensiled properly.

For silage, cut alfalfa at the same time as for hay (about one-fourth bloom). Forage chopped or cut in fine pieces of about ½ inch will pack well into the silo. It should contain from 65 to 68 percent moisture when placed in the silo. This moisture content is usually obtained after the alfalfa has been allowed to wilt slightly.

Alfalfa placed in the silo at the time of mowing contains too high a moisture content and produces a foul-smelling, unpalatable silage. Material that is too dry, however, will not pack thoroughly, and air pockets will form. This condition results in a loss of nutrients and may cause the silage to mold.

The making of good silage from alfalfa requires more care and consideration than the making of silage from corn and sorghums. The protein content of alfalfa is high, but the carbohydrate level is low. Therefore, proper bacterial action and fermentation require that the moisture content must be near optimum.

When the moisture content is below 60 percent, water may be added, whereas if the moisture content is over 70 percent some type of dry feed may be added to reduce the moisture percentage. The proportion of dry material to add will depend on the moisture content.

Molasses or some other carbohydrate material often is used with alfalfa for silage. These additives will increase the carbohydrate content and provide sufficient sugar to insure bacterial action and proper fermentation for preserving the silage. When molasses is used, 60 to 80 pounds usually are added for each ton of green forage.

Chemicals such as sodium metabisulphite have been used to help preserve silage. However, when the forage is ensiled at the proper moisture content the addition of such preservatives is unnecessary.

Green-chopping (Soiling)

Green-chopping, as a method of harvesting alfalfa in Arizona, has recently declined in importance. It involves daily harvest where the alfalfa is mowed, chopped, and blown directly into trailers or trucks for delivery to the feed lot. In some instances, the forage is cut and windrowed before being chopped.

For a high quality green-chop product, continued production, and stand maintenance, cut the alfalfa at the same stage as when harvested for hay.

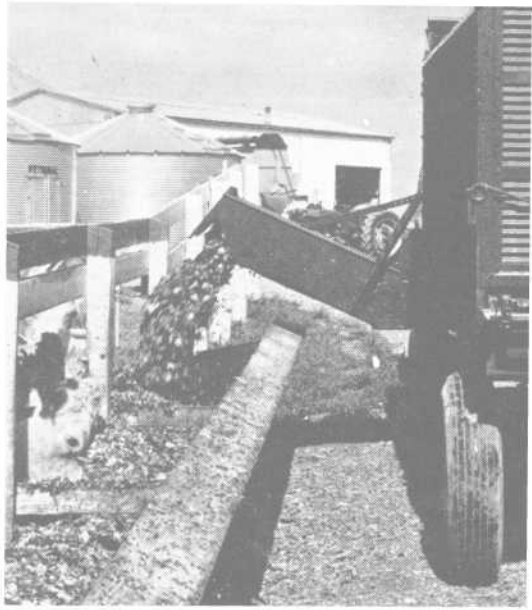
Many growers have been highly satisfied with the results obtained from green-chopped alfalfa. The following are advantages of this system over other methods of harvesting.

(1) A consistently high quality feed is available for the animals each day.

(2) Protein and carotene losses are at a minimum.

(3) There is no waste from trampling and manure spots as when pastured.

(4) The cost of fencing may be eliminated.



In green chopping, alfalfa is mowed, chopped, and blown directly into trailers or trucks for delivery to the feedlot (as above).

For a high quality green-chop product cut alfalfa at the same stage as when harvested for hay.

(5) Quick removal of forage allows regrowth to be initiated immediately.

(6) It allows the alfalfa a sufficient period for recovery that is essential for maintenance of dense stands.

(7) Production usually is higher than when pastured.

(8) The incidence of bloat is greatly reduced though not eliminated. The feeding of dry hay with the green-chopped alfalfa further reduces the possibility of bloat.

Any system of harvesting has its shortcomings, and the green-chop system is no exception. The economic operation of this system is limited to larger units since it requires a large investment in machinery and some extra labor. Also, daily harvesting is often inconvenient.

Maintenance costs for the machinery are high, and equipment failure or unexpected rains can cause interruptions in feeding. For these reasons, a reserve supply of silage or some other roughage must be available.

Unless an entire field can be harvested in a relatively short period of time, management of the alfalfa may be a problem. Also, before harvesting machinery can be used, the soil must be sufficiently dry to avoid compaction.

Pasturing

Alfalfa is an excellent legume for pasture. Its seasonal distribution, palatability, total yield, and carrying capacity are equalled by few forage crops.

Alfalfa is sensitive to different management treatments and must be grazed properly. When pasturing alfalfa, as with cutting for hay, the plants need a sufficiently long recovery period to accumulate reserve food material. With close and continuous or frequent grazing, plants do not have sufficient time to build up a supply of reserve food. Thus, some plants will die and stands will be thinned.

During the winter, thousands of sheep are brought to southern Arizona from the range and are grazed on alfalfa.

Rotation or daily-ration (strip-grazing) systems of grazing should be used with alfalfa. For maximum production and high-quality forage, a period of about 25 to 30 days is usually needed between each grazing. Most dairymen who have used the daily-ration grazing method have been highly satisfied. This system allows the cattle only the amount of pasture that they will eat in one day.

Strip-grazing is very efficient since there is less waste from trampling and manure spots, forage production is usually high, milk production is more uniform, and there is less incidence of bloat. Two irrigations can be made between grazings, and most soils still have sufficient time to dry out.

Strip-grazing requires more labor for moving fences than other systems of grazing, and grazing must not be done when the soil is wet. With increased animal traffic per unit area, soil puddling and compaction are likely to be increased.

Alfalfa may be grazed throughout the entire season, but fall and winter grazing is most common. During the winter, thousands of sheep are brought to southern Arizona from the range and are grazed on alfalfa.

Small grains, especially barley and oats, are sometimes seeded in a thin stand of

alfalfa in the fall, and the mixture pastured. This practice increases production of forage for grazing and reduces the bloat hazard. The first cutting of hay in the spring is a mixture of small grain and alfalfa, but it has good feed value.

Plant breeders are attempting to develop varieties of alfalfa that are better suited for grazing. Alfalfas commonly grown for hay have an upright habit of growth, and stock may graze them too closely unless properly managed. Alfalfas with a creeping or prostrate habit of growth show promise for pasture. Plants capable of producing stems from the roots, or roots from stems, would be desirable.

Bloat Hazard

There always is a danger of bloat when cattle or sheep are pastured on alfalfa. The occurrence is greatly reduced, however, if certain precautionary measures are followed. These measures include:

(1) Give cattle a fill of dry cereal or grass hay before turning into alfalfa.

(2) Allow stock to graze only a short time each day until they become accustomed to the pasture.

(3) Provide dry hay or straw in a rack in the field.

(4) Mow a swath of alfalfa in the field and allow it to dry before turning the stock into pasture.

(5) Keep a good supply of water and salt readily accessible at all times.

(6) Hold the stock on grass pasture overnight before turning on alfalfa.

Weed Control

Alfalfa, when grown in thick stands, is a highly competitive crop. The heavy shade produced by alfalfa plants, plus frequent mowing, usually control most weeds.

Maintenance of a good stand of alfalfa is the best insurance against weed infestation. Thin stands should be plowed under, or the stand reestablished. Proper seedbed preparation, fertilization, harvesting, and insect and disease control favor the growth of alfalfa and therefore increase its ability to compete with weeds.

Effective weed control in other crops in the rotation will reduce weeds in alfalfa. Cultivated row crops in the rotation are very helpful. Many weeds which cannot be controlled with herbicides in alfalfa can be reduced by treatment in other crops.

For example, 2,4-D can be used to control London rocket (a mustard) in small grains. Dalapon helps to control Johnson grass in cotton and sorghum. Annual grasses in cotton can be controlled with monuron and diuron.

Avoid planting alfalfa in areas severely infested with wild oats, since this weed provides excessive competition with alfalfa seedlings.

Time of Planting

Planting alfalfa at the optimum time also helps to control weeds. When alfalfa is seeded too early in the lower valleys, summer-annual weeds are a problem. On the other hand, seeding too late often results in an infestation of winter-annual weeds. In the lower valleys an alfalfa variety which grows during the winter will have fewer weeds than a winter-dormant variety.

Planting high quality or certified alfalfa

seed is extremely important. Such weeds as silversheath knotweed are often introduced into a stand by planting alfalfa seed containing these weed seeds.

If vigorous growth of alfalfa cannot be maintained during mid-summer, annual weeds become a serious problem unless irrigation is withheld. Areas at the end of the field should be mowed, sprayed or cultivated to control weeds. When weeds become established on border ridges disk them or spray them with a herbicide.

Use of Herbicides

Apply one pound of the ammonium salt of DNBP per acre in seedling stands of alfalfa when competition with annual broadleaved weeds becomes severe.

Alfalfa may be a weed in other crops that follow. Plow under alfalfa early to allow time for additional cultivation before the next crop is planted. If volunteer alfalfa is a problem, spray it with 2,4,5-T before the seedbed is prepared for the next crop.

Harmful Insects

Alfalfa is infested by many insects in Arizona. Some of the principal insect pests are general feeders on several crops, while others limit their feeding to alfalfa. Control of these pests is imperative for seed production and many times is necessary on hay crops. Harmful insect populations often build up on alfalfa, migrate to cotton, melons and other crops in adjacent fields causing further damage, and then migrate back to alfalfa. For specific controls, see Bulletin A-14, Arizona Insect Control Recommendations.

The insects discussed individually below are considered to be the major ones attacking alfalfa for forage in Arizona. Other insects which are occasionally troublesome and may need to be controlled in some fields include cutworms, grasshoppers, thrips, webworms, alfalfa butterfly, beet armyworm, saltmarsh caterpillar, red harvester ant, serpentine leaf miner, and Egyptian alfalfa weevil.

Spotted Alfalfa Aphid

(Therioaphis maculata, Buckton)

The rapid spread of the spotted alfalfa aphid into the major alfalfa-growing areas has caused great concern and still is a potential threat to the alfalfa industry. This aphid prefers alfalfa but often occurs on bur clover and occasionally is found on sour, sweet, and berseem clovers.

Spotted Alfalfa Aphid

When aphids are present, the nymphs and adults are found mostly on the undersides of the leaves. The leaves become dry and fall from the stem as a result of aphid feeding. This loss of leaves reduces the yield and quality of hay.

When aphids are abundant, large amounts of honeydew are produced, falling on the leaves and stems, making baling difficult or nearly impossible. A black fungus also grows on the honeydew and reduces the quality of hay. Defoliation of plants by aphids retards regrowth of the plants following cutting.

The spotted alfalfa aphid is a small insect about one-third the size of the pea aphid. It is easily distinguished from other aphids by six rows of black spots on the back. Many adult females are winged, and the veins of the wings are conspicuously darkened. The optimum temperature for development and reproduction is from 90° to 100° F. Within this temperature range, the aphids produce an average or four to five young per day.

The most effective control for the spotted alfalfa aphid is through the use of resistant varieties. In susceptible varieties, established plants may be weakened, and new plantings frequently are killed to the extent that reseeding becomes necessary.

Natural enemies of the aphid are effective in suppressing this insect. Lady beetles are by far the most numerous and effective of all predators, although adult collop beetles, lacewing fly larvae, syrphid fly larvae, various predaceous bugs, and predaceous mites are present and of some value in reducing aphid populations.

Three species of old world parasites of the spotted alfalfa aphid have been released in Arizona. Two of these species, *Trioxys utilis,* Muesebeck and *Praon palitans,* Muesebeck have become widely established and are important in controlling the spotted alfalfa aphid. Some species of fungi also have been effective in reducing aphid populations.

Pea Aphid

(Macrosiphum pisi, Harris)

The adult pea aphid is a small, bright-green insect about one-sixth of an inch long and about one-third as wide. Typically, it lives and feeds in groups and frequently produces large populations on the upper parts of the stems. Under optimum conditions, this aphid completes its life cycle in 7 to 12 days and may give rise to 15 to 20 generations a year.

Pea Aphid

Initial infestations are believed to start from winged females which give birth to living young. Winged forms are produced when overcrowding occurs, and by other factors not fully understood. Dispersal of winged forms becomes widespread in alfalfa-growing areas, and aphids are noticeable on the terminal parts of alfalfa plants beginning in March.

The pea aphid usually is a serious problem in southern Arizona in the spring, especially during extended periods of cool weather. Small populations have been observed on alfalfa in Arizona during the summer and winter months, but these are well below economic levels.

The small, soft-bodied insect sticks its beak into the stems, leaves, flowers, and pods of its host and sucks out the juice. Damage varies from cupping and curling of alfalfa leaves to severe burning of the foliage and subsequent death of the plant. Severity of damage, therefore, is proportional to the number of aphids feeding on the plant. The pea aphid also transmits viruses which cause damage to alfalfa.

Leafhoppers

(Mostly *Aceratagallia curvata, Oman* and *Empoasca* spp.)

Leafhoppers are small, elongated, wedge-shaped insects that vary from one-sixteenth to five-eighths inch in length.

Leafhoppers hop or fly when disturbed and may be seen easily when you walk through an infested alfalfa field.

Many species of leafhoppers inhabit alfalfa fields, but only a few are considered of economic importance in Arizona. Populations are highest during July, August and September. Plants that are stressed for water are preferred by this insect.

Leafhopper damage to alfalfa varies from flecking of leaves caused by the mouth parts during feeding, to yellowing of the leaves and severe stunting of the entire plant. Young seedlings may be killed by leafhopper feeding. These insects are also implicated in the transmission of certain virus diseases of alfalfa.

Three-cornered Alfalfa Hopper

(Spissistilus festinus, Say)

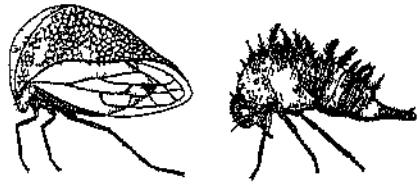
Nymphs and adults of the three-cornered alfalfa hopper feed on alfalfa by inserting their needle-like mouthparts into the stem and sucking out juices. They may feed up and down the stem or puncture it regularly to form a circular ring or girdle.

Girdling hinders the movement of food material and water. It also weakens the stems and causes them to break. Girdling may cause the leaves to turn a reddish-purple color. Some damage also is caused by deposition of eggs within the stems.

Adults of the three-cornered alfalfa hopper are thick-bodied, triangular insects about one-fourth inch long, and are light green in color. They frequently change to a pale brown when older. The nymphs are grayish-white and soft bodied, with "saw-tooth" projections along the back.

Each female may lay as many as 100 eggs during a period of several weeks. Eggs hatch in two to six weeks depending on the temperature. Nymphs are well protected since they feed at the base of the stems. Adults are strong fliers and move about continually.

This insect normally overwinters in the adult stage, but in some instances lives through the winter in the egg stage. There are three to four generations a year in southern Arizona.



Adult Nymph

Three-Cornered Alfalfa Hopper

Omnivorous Leaf Roller

(Platanota stultana, Wlsm.)

This leaf roller is common in Arizona and sometimes causes severe damage to alfalfa from July to October. Most of the upper leaves are rolled together, thereby hindering plant growth and preventing normal flowering. The yellowish to brownish-green larvae are found within these tight clusters of leaves. Mature larvae are one-half inch long and have an irregular stripe running down the full length of the back.

Eggs are pale green and generally are laid on the upper portion of the plant in flat clusters that overlap like shingles. Upon hatching, the larvae form a protective housing by wrapping terminal leaves together with silk. Within this housing the worms feed and transform into pupae. Six to seven weeks are required for this insect to complete a generation.

In southern Arizona several predators and parasites aid in reducing the larval population.

Alfalfa seed production also may be affected by these pests. Other important insect pests of seed crops include the corn ear worm, clover seed chalcid, lygus bugs, spider mites, stink bugs, and crickets.

Diseases of Alfalfa

Pathogens causing diseases in alfalfa in Arizona may be bacteria, fungi, viruses, or nematodes. Often more than one will attack a plant at the same time.

All diseases of alfalfa grown in Arizona can be assigned to two classes: (1) those caused by pathogens attacking root and crown tissue such as the crown- and root-rot fungi and the bacterial wilt organism, and (2) those caused by pathogens attacking leaves and stems.

Leaf spots, mildews, rusts and most viruses primarily infect the leaves and stems. Viruses usually are carried from diseased to healthy plants by insects which have fed on diseased plants.

The most destructive diseases of alfalfa are those caused by the soil-inhabiting pathogens and certain viruses. Leaf spots, mildews and mosaic viruses do not appear to greatly influence stand or forage yield.

Disease Symptoms

Alfalfa plants which are attacked by different pathogens often show similar symptoms.

Diseases in which symptoms appear in the roots, crowns, or crown buds.

- Root- and crown-rots
- Crown-bud-rots
- Bacterial wilt
- Dwarf

Diseases in which symptoms appear in leaves and stems.

- Black stem
- Leaf spots
- Mildews
- Mosaics, Phyllody, Witch's-broom and Dwarf
- Bacterial wilt

DISEASES CAUSED BY PATHOGENS ATTACKING ROOT AND CROWN TISSUE

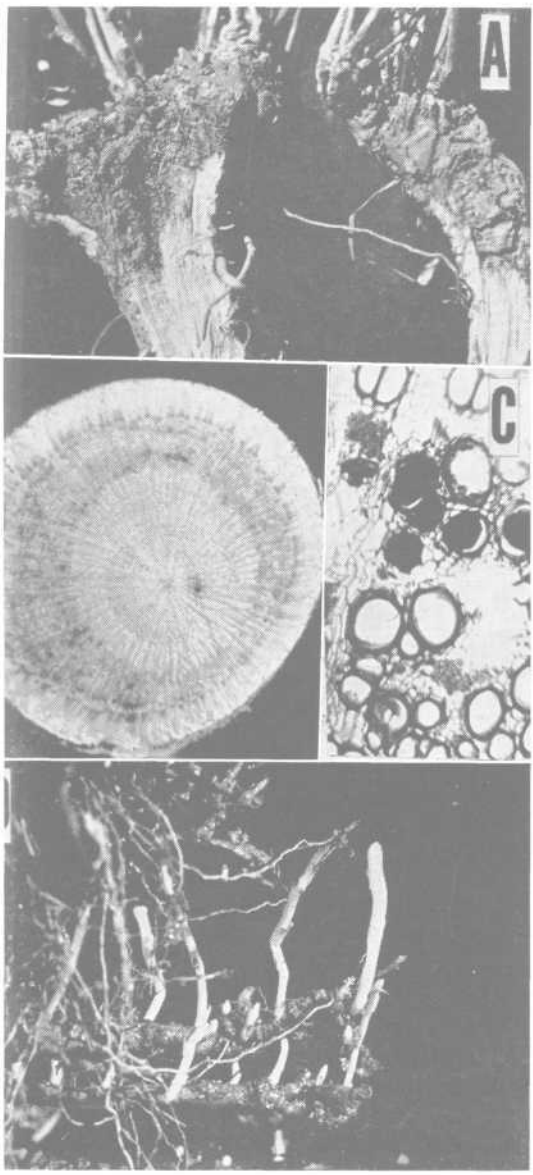
Root-, Crown-, and Crown-Bud-Rots

Several fungi and bacteria are responsible for the symptoms involved in crown-rot, root-rot and crown-bud-rot. Often these diseases occur together in individual plants so that it is impossible to determine which pathogen initiated stand decline.

Decline usually begins near the end of the second year or the early part of the third in central and southern Arizona. Thinning and decline of stands have been noted earlier because of attacks by specific pathogens.

Symptoms

Early symptoms are general yellowing of the stem tips or entire shoots. Later symptoms are drying out and browning of the plant tissue particularly at or below the soil level. Frequently large areas of



A: Crowns of alfalfa plants showing brown-black, punky deterioration because of attack by crown- and root-rot fungi and bacteria.

B: Cross-section of an alfalfa root in which yellow-brown dot-like areas as well as yellow wood are present. These symptoms may result from crown- and root-rot fungi and bacteria or from such pathogens as the bacterial wilt organism (Corynebacterium insidiosum) and Dwarf disease virus (Morsus suffodiens).

C: A small area of a cross-section of an alfalfa root showing some of the details of the symptoms caused by various pathogens mentioned under B. The large black-dot-like regions are water and mineral conducting vessels (xylem) filled with a gum-like deposit, as a result of disease. The large holes are xylem vessels which have not become plugged. All of the vessels in a healthy root would be in this condition.

D: Short spindly shoots of an alfalfa plant having symptoms caused by the crown- and root-rot complex of pathogens. The new shoot at right shows very little evidence of disease, but the one next to it (left) is discolored for about one-half the distance from the tip.

dead or dying plants appear in a stand. Roots of such plants may show brownish-black streaks when the outer covering (bark) is removed. These streaks appear as pinhead-sized dots when diseased roots are cut crosswise.

The water-conducting vessels become clogged by deposits of gum-like material and growth of the plant is stunted. Diseased plants often produce short, spindly and weakened shoots before they die.

Fungi found in the crown- and root-rot complexes in Arizona are Cotton (Texas) root-rot fungus *(Phymatotrichum omnivorum)*, species of *Fusarium, Rhizoctonia, Stemphylium, Stagonospora,* and *Diplodia.*

Control

No effective methods of control are known for the majority of pathogens involved in the crown- and root-rot complexes in Arizona.

Chemicals such as soil fumigants or fertilizers will not control the alfalfa root- and crown-rot disease pathogens. Alfalfa roots penetrate deeply into the soil and probably are "out of reach" of any chemicals applied to the soil surface.

Suggestions which may help to reduce losses and prolong the life of a stand are:

(1) A well-planned crop rotation which includes sorghum, barley, and vegetables provides one of the best means of controlling diseases of the root and crown. Do not follow one susceptible crop with another in the rotation.

(2) Keep "traffic" to a minimum. Heavy equipment and grazing damage the alfalfa crowns and increase the chances for crown- and root-rot attacks.

Bacterial Wilt

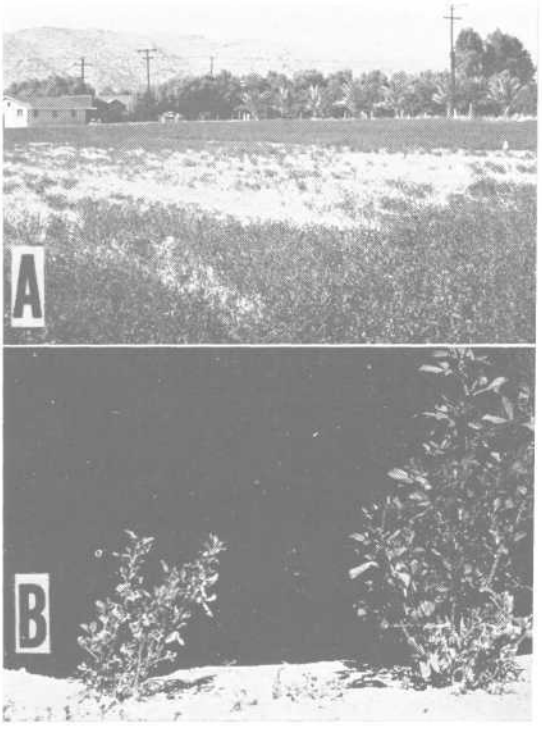
Symptoms of bacterial wilt include yellowing and stunting of aerial portions of plants. Yellowing is especially evident after the first and second cuttings in the spring. Stems of new growth are weak, and leaflets are smaller than normal and usually are cupped upward. Eventually, thinning and decline of the stand occur. (See color photos, page 36)

When bark of the root is removed, deep yellow-brownish streaks are noticeable. This is in contrast to the almost white appearance of a normal root with bark removed. The production of a watery-like material in the infected root is especially noticeable during the cooler periods of the year. Roots affected by bacterial wilt show virtually the same symptoms as those attacked by the crown- and root-rot pathogens.

Control

(1) The use of wilt-resistant varieties is recommended. Lahontan, Ranger, and Buffalo are resistant whereas Moapa has some resistance. African, Chilean, and Hairy Peruvian are susceptible.

(2) Rotation with other crops for four to five years will aid in reducing losses from wilt since alfalfa is the only major field crop in Arizona affected by this pathogen.



A: Large area of diseased, partially diseased and dead alfalfa plants. These areas are usually a result of attacks by the Cotton Root-rot fungus (Phymatotrichum omnivorum) in complexes with other soil pathogens such as species of Rhizoctonia, Fusarium and others. It is not uncommon to find well-developed, green-colored plants within the diseased plant areas.

B: (At left): Stunted plant of Hairy Peruvian alfalfa, showing very little evidence of necrosis (death) or chlorosis (discoloration). Symptoms in which a plant is stunted but retains a normal or greener than normal color are usually associated with infections by the Alfalfa Dwarf virus.

B: (At right): A non-infected, non-stunted, Hairy Peruvian plant.

DISEASES CAUSED BY PATHOGENS ATTACKING LEAVES AND STEMS

Dwarf

Alfalfa may be attacked periodically by the virus causing dwarf disease. Spread of the dwarf virus from diseased to healthy plants is chiefly by "sharpshooter" leafhoppers. Plants infected with the virus are stunted, much the same as in bacterial wilt. Color of the foliage is usually as green or greener than normal rather than yellow as in bacterial wilt.

Other symptoms on the leaflets and stems are similar to those in wilt-diseased plants. Color symptoms are not always reliable since other factors such as water stress and nematodes may also cause similar symptoms. Diseased plants eventually die as a result of weakened crown buds which fail to produce sufficient top growth to permit normal manufacture of food.

Control

Control of dwarf is difficult because of numerous plants other than alfalfa which carry the virus. Many of these plants such as Bermuda grass, dallis grass, and Johnson grass become infected but go unnoticed because the virus, although present, causes no visual symptoms. These plants are called "'symptomless carriers."

Since most grape varieties also are susceptible to the dwarf virus, plantings of alfalfa near vineyards should be avoided.

Other Virus Diseases

There are several mosaic and other viruses that attack alfalfa. These pathogens cause a wide variety of reactions, varying from no visible effects to stunting, absence of flowering, and replacement of flowers with leafy structures (phyllody). Roots, leaves and stems are affected as viruses spread throughout the plant.

In many instances, there is no direct loss from these "virus attacks" in alfalfa. Growers should be concerned about such infections, however, because these viruses have a wide range of other host plants. Perennial weeds, ornamentals, and other crops may serve as reservoirs for such viruses. It is now believed that "virus attacks" make alfalfa and other plants more susceptible to such diseases as the crown- and root-rot complexes.

Control

No methods for control of mosaic and other viruses in alfalfa are known at present.

Downy Mildew

Attacks by the fungus which causes downy mildew vary in intensity from year to year. Frequently, mildew will thrive when rains occur during cool months and such conditions are followed by comparatively warmer periods. Infected leaflets become yellow on their upper surfaces. A fine, pink-purplish (white in early stages), powdery, cottony growth may be observed on the lower surfaces of leaflets.

Control

Control of foliage diseases of this nature is based on cutting management. Usually after one or two early cuttings, leaf pathogens do not develop further since conditions become unfavorable for their growth.

Other Stem and Foliage Diseases

Certain pathogens causing leaf spots, rust, and black-stem attack alfalfa plants. These diseases rarely occur in epidemic proportions.

Nematodes

Stem Nematode

Damage from stem nematode may be severe in limited local areas, but varies from year to year. Crown buds, crowns and the base of the stem are deformed.

Often the crown buds enlarge and fail to produce satisfactory growth. Foliage may turn yellow and the entire plant appear stunted. Symptoms of damage are best observed in the spring. When infestations are not severe, damage is less noticeable after the first cutting.

Control

(1) Infested areas should be seeded with resistant varieties such as Lahontan where adapted.

(2) Employ rotations with non-susceptible crops for periods of several years. Most plants other than alfalfa are not susceptible.

Root-Knot Nematode

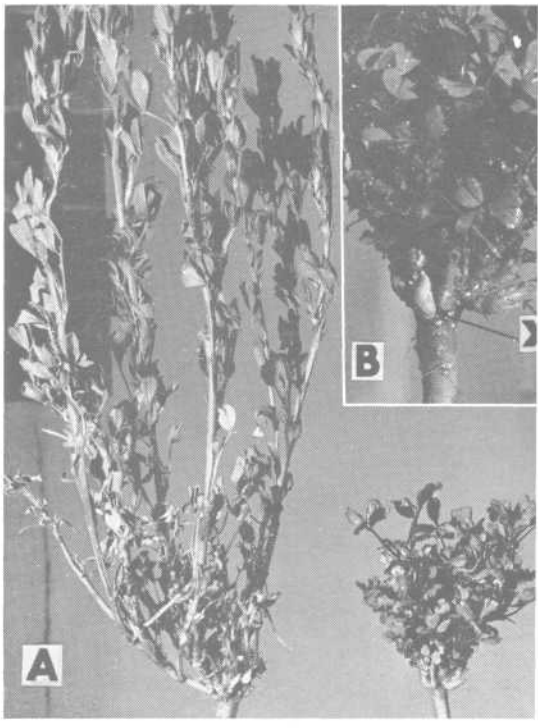
These small worm-like organisms attack alfalfa roots especially in coarse-textured soils.

Symptoms of infected plants consist of enlargements on the roots. Yellowing and stunting of the plant are also typical symptoms.

Control

(1) Use resistant varieties. Moapa and African are resistant to two species of this nematode commonly found in Arizona.

(2) Use rotations with crops which are less susceptible than alfalfa.



Healthy and stem-nematode infected alfalfa plants.

A: (At left): Non-infected plant showing the typical erect and normal-size shoots, as well as the small, pointed, normal, white buds in the crown.

A: (At right): Stunted, rosetted plant resulting from attacks by the stem nematode. Enlarged, odd - shaped crown-buds are present. These are more evident in the insert (B) above.

B: Crown buds of a stem-nematode infected alfalfa plant. At "x" and arrows, enlargement and distortion of the crown-buds are obvious.

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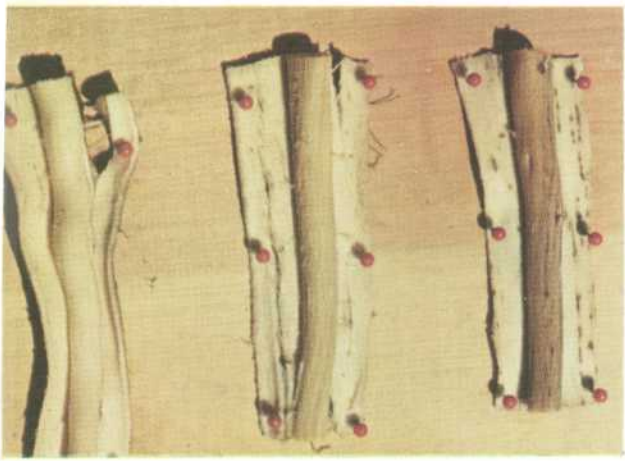

Upper left: A third-year stand of Hairy Peruvian alfalfa, thinned as a result of attack of the bacterial-wilt pathogen (yellowed stunted plants) and some of the root-rot fungi.

Upper right: A chlorotic (yellowed) plant of Chilean 21-5 alfalfa; a typical situation in attacks by the alfalfa bacterial-wilt organism.

Lower left: Roots of healthy and bacterial-wilt-infected alfalfa (unidentified variety). At left, a root of normal structure and color (generally white) from a non-infected plant. Center and Right, roots invaded by the bacterial-wilt pathogen showing the typical symptoms of yellow-brown woody cylinder, brown-dark-brown streaks under the outer bark (peeled back) and on the surface of the woody cylinder.

Lower right: A shoot tip from an alfalfa plant infected with the Downy Mildew fungus (Peronospora trifoliorum). The light green to yellow blotches on the upper leaf surfaces are highly indicative of this disease.