

ALFALFA

Queen of Forage Crops

Circular 497



EXTENSION SERVICE
Oklahoma A. and M. College
Shawnee, Brown, Director Stillwater, Okla.

SUMMARY

Alfalfa is the most important legume hay crop in Oklahoma. In 1947 this legume occupied 411,000 acres from which 799,900 tons of hay were harvested. Oklahoma also ranks second among the states in alfalfa seed production. In 1947 the state produced 14,400,000 pounds or more than 14 percent of the total amount of seed produced in the United States in that year.

The recommended varieties of alfalfa for Oklahoma are Oklahoma Common and Buffalo.

Alfalfa thrives best on medium textured soils such as sandy loams, loams, and silt loams. Deep, permeable, and well drained soils are most desirable.

Preparation of the land for alfalfa should be started early in order to secure a seedbed which is firm, free of weeds, and well supplied with moisture and plant nutrients.

Alfalfa should be seeded in the fall, preferably in late August or early September, if soil and moisture conditions are favorable for quick germination and rapid growth of the seedling plants.

If the soil is acid, a sufficient amount of finely ground limestone should be applied to neutralize the acidity and supply calcium for plant growth. The lime should be applied a year in advance of seeding the alfalfa if possible. On phosphorus-deficient soil an application of 200 to 250 pounds of superphosphate or 400 to 500 pounds of rock phosphate per acre should be made. The fertilizer will give best results when drilled in the row with the seed.

Alfalfa should be seeded with a drill in order to secure even distribution and uniform covering of the seed. It is important that the seed be inoculated before planting.

Alfalfa should be cut for hay when the plants are one-tenth to one-fourth in bloom. A good plan is to allow the alfalfa to wilt in the swath and then windrow it with a side delivery rake. As soon as the hay is sufficiently cured, it can be baled with a pick-up baler. Stationary balers are also used by some growers. Over-curing is one of the principal causes of low quality hay. The alfalfa should be baled as soon as the moisture content is reduced to 25 percent.

The setting of alfalfa seed is influenced by the character of growth of the alfalfa plants, amount of moisture in the soil, weather conditions at blooming time, and the presence of pollinating insects.

The method of harvesting alfalfa seed varies in different parts of the state. Some growers bind the alfalfa in loose bundles which are put into shocks of two to four bundles each. After curing, the alfalfa is threshed with a stationary thresher. Others harvest the seed crop by mowing, windrowing, and threshing from the windrow, using a pick-up combine. Direct combining is practiced to some extent, especially in the southwestern part of the state.

Alfalfa, The Queen of Forage Plants

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Introduction

Alfalfa means "best fodder" in Arabic, the language from which the crop received its name. Known botanically as *Medicago sativa*, alfalfa belongs to the large group of plants called the legume family. In England and most other European countries it is known as Lucerne, perhaps after Lake Lucerne in Switzerland where it was grown nearby at an early date.

Alfalfa is an herbaceous perennial. Its flowers are borne in loose bunches or racemes and are of a purplish color. The pods in which the seeds are produced are twisted spirally in one or two turns similar to the shell of a snail. Each pod contains several small seeds which are golden colored and kidney shaped. The stems are usually erect and generally reach a height of about 2½ feet. They rise from a semi-woody base known as the crown. The root system is characterized by a distinct tap root which in permeable soils extends to a depth of several feet. The leaves, each of which consists of three leaflets, are arranged alternately on the stem.

Origin of Alfalfa

Alfalfa is of very ancient origin and is one of the oldest crops cultivated by man. It is believed that the original home of this legume was in southwestern Asia from Mesopotamia northward across Persia and Turkistan to Siberia. It was probably planted in this region by half-civilized man ages before any history was written. One of the earliest written records of alfalfa, dating back to about 700 B. C., indicates that it was being grown on the palace grounds of the Babylonian King in the fertile valley of the Euphrates River. Alfalfa was thus developed in regions of limited rainfall and was usually found in river valleys where the soils were well supplied with lime and phosphorus. From this region it was introduced into the Mediterranean countries and later to America.

Alfalfa in Oklahoma

The planting of alfalfa in Oklahoma dates back to the beginning of agriculture in the state. The original seedings were made with seed from Kansas, Colorado, and other states to the north and northwest. Pioneers who came from these states brought small quantities of seed along with them, and additional shipments were

made later. From these early introductions, alfalfa had its beginning in the State. Farmers soon learned to save alfalfa seed, and subsequent plantings were made largely with locally grown seed. The acreage increased rapidly. By 1924, alfalfa occupied 240,000 acres in the state. For the 10-year period 1936-45 the average annual acreage was 275,000 acres. In 1947, alfalfa occupied 411,000 acres in the state.

Alfalfa is grown to some extent throughout Oklahoma, but the greatest concentration of acreage is in the western part of the state. Very little alfalfa is grown in the southeastern section.

Oklahoma ranks second in alfalfa seed production in the United States. For the ten-year period 1936-45, the average seed production in the state was 8,388,000 pounds, or nearly 12 percent of the total amount produced in the nation during the same period. Alfalfa seed production reached an all time high record in Oklahoma in 1947 when 14,400,000 pounds were harvested. This was more than 14 percent of the total amount of seed produced in the United States in that year. The distribution of alfalfa in Oklahoma is shown in Fig. 1.

Climatic conditions in western Oklahoma are favorable for alfalfa seed production, and nearly all of the seed crop is produced in that section of the state.

Value of Alfalfa

Alfalfa is the most important legume hay crop grown in Oklahoma. Well cured, high quality alfalfa hay is rich in protein, minerals, and vitamins. It is very palatable and is readily eaten by all

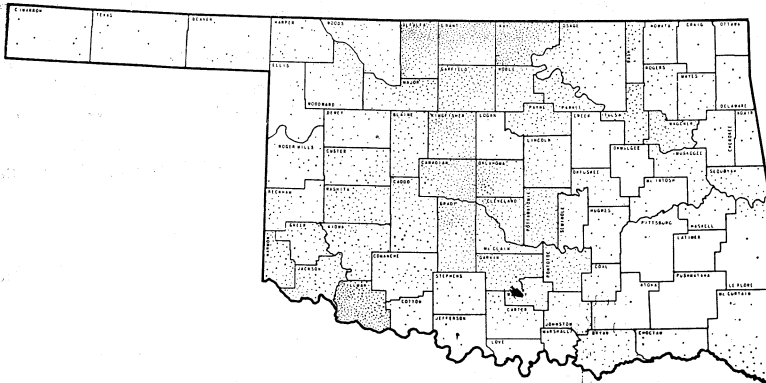


Fig. 1—Distribution of alfalfa in Oklahoma. This crop is grown mainly in the central and western parts of the state.

classes of livestock. Alfalfa hay is an excellent legume forage for dairy cows. It is also very satisfactory for wintering beef cows, feeder cattle, and breeding ewes.

VARIETIES OF ALFALFA

The alfalfas grown in the United States are divided into four groups: (1) common, (2) variegated, (3) Turkistan and (4) non-hardy types.

Oklahoma Common Alfalfa

The alfalfa grown in Oklahoma is a hardy strain of common alfalfa and is known as Oklahoma Common. It was brought into the territory from Kansas, Colorado and other states in the Northern Great Plains during the period of early settlement. It probably traces back to importations of alfalfa into California in 1852 which gradually spread eastward and northeastward to the Great Plains region. From this introduction of alfalfa several strains have gradually developed. Each strain is named chiefly after the state in which it is grown, as Oklahoma Common, Colorado Common or Arizona Common. All of these strains are purple flowered. They differ only in cold resistance and in their habits of growth in the fall and spring. These characteristics were acquired by natural selection in the region where the alfalfa has been grown for a long period of time.

Oklahoma Common alfalfa is very winter hardy and drought resistant. It is often subjected to sudden and drastic changes in temperatures in winter. In January, 1947, temperatures dropped to 19 degrees below zero in Tillman County and as low as 24 to 27 degrees below zero in northwestern counties, yet there was no noticeable damage to the alfalfa in the state. The summers are dry and hot. Most of the alfalfa seed is produced in an area with an average annual rainfall of less than 30 inches. The average elevation in this area varies from slightly less than 1500 feet to more than 4000 feet.

Oklahoma Common alfalfa is similar in winter hardiness to Kansas Common, Colorado Common and the other strains of hardy common alfalfa grown in the central region of the United States. It has given satisfactory results in all areas where these alfalfas are adapted. Oklahoma Common alfalfa is recommended for planting throughout Oklahoma.

Approved Origin seed is the product of an alfalfa seed improvement program. It is specially selected and is produced from hardy parent stocks of Oklahoma Common alfalfa. The seed is all grown in the western and northwestern parts of the state. The fields are inspected before harvest. The seed is free of Johnson grass,

lodder, and bindweed seeds. Approved Origin seed is the best class of alfalfa seed produced in Oklahoma for general use.

Buffalo Alfalfa

Buffalo is a wilt-resistant strain of common alfalfa developed by the Kansas Experiment Station. In plant characteristics it is very similar to Oklahoma Common. The flower color varies from bluish purple to light blue. The plants are upright in growth habit and the stems are medium in size. Buffalo produces a medium to leafy quality of hay. The Kansas Station reports that Buffalo is slightly more winter hardy than Kansas Common and that it makes more rapid recovery after cutting.*

Buffalo alfalfa is recommended in Oklahoma primarily because of its high resistance to bacterial wilt. Where wilt is present, stands are maintained longer with Buffalo than with susceptible varieties. There is very little bacterial wilt in Oklahoma, but most of the surplus seed produced in the State is planted in areas where wilt is the most serious problem in alfalfa production. Consequently farmers in those areas prefer seed of wilt resistant varieties for planting.

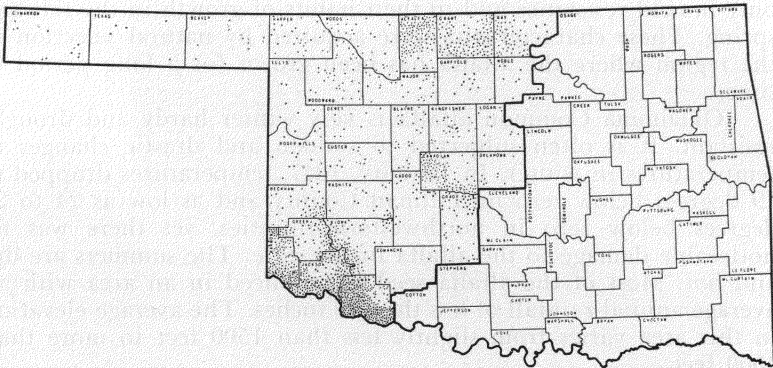


Fig. 2—Oklahoma Approved Origin Seed is all produced in western Oklahoma where the average annual rainfall varies from 32" to less than 20".

The Variegated Alfalfas

The variegated alfalfas have resulted from natural crosses between purple-flowered common alfalfa and the yellow-flowered species. The variegated types are similar to the common alfalfas but green, greenish-yellow, brown, and smoky flowers are not uncommon. Yellow flowers are also found occasionally in some

* Kansas Experiment Station Circular 226, Buffalo Alfalfa, April, 1945.

*Table 1. Average Annual Yields of Alfalfa Varieties. Experiment Station Farm, Stillwater. 4-year average.**

Variety	Yield in Tons of Cured Hay per Acre				
	1944	1945	1946	1947	Average
Oklahoma Common	4.58	4.55	5.92	5.94	5.25
Buffalo	----	----	5.91	5.93	5.92**
Kansas Common	4.24	3.91	5.95	5.96	5.01
Atlantic	4.62	4.44	6.51	6.53	5.52
Grimm	3.99	4.12	5.81	5.83	4.94
Ranger	4.14	3.93	5.93	5.95	4.99

* Unpublished data, Oklahoma Agricultural Experiment Station.
 ** Average of 2 years.

varieties. Most of the seed pods are similar to those of common, but some are sickle-shaped. The variegated alfalfas are more cold-resistant than the common alfalfas. This is due partly to the yellow-flowered ancestry and partly to natural selection.

Grimm is the best known variety of the variegated alfalfas. It is grown mainly in the northern states where cold resistance is an important factor. It is very susceptible to bacterial wilt. A few fields of Grimm have been planted in Oklahoma, but very little seed of this variety has been produced commercially in the State. In tests conducted by the Oklahoma Experiment Station, Grimm has produced lower yields of both seed and hay than Oklahoma Common. Grimm alfalfa is not recommended in Oklahoma.

The other varieties of this group of alfalfas include Ladak, Cossack, Baltic, Hardigan and Canadian Variegated. In general appearance, growth habit and cold resistance, these varieties are all similar to Grimm. With the exception of Ladak, none of the variegated alfalfas are resistant to bacterial wilt. They are not recommended in Oklahoma.

The Turkistan Alfalfas

The Turkistan alfalfas were imported from Turkistan in southwestern Asia. They include Turkistan, Hardistan and Orestan. These alfalfas are characterized by slow recovery after cutting, early fall dormancy, susceptibility to leaf-spot diseases and low yields of both hay and seed. They also make a lower and somewhat more spreading growth than the common alfalfas. The Turkistan alfalfas have considerable resistance to cold and bacterial wilt, but because of their low yields and susceptibility to leaf spot disease, they have not given satisfactory results either in Oklahoma or in regions where Oklahoma seed is sold for planting.

Argentine Alfalfa

Argentine alfalfa seed is frequently imported into the United States in large quantities and because of its lower price, some farmers are tempted to buy it for planting. Since Argentine alfalfa is produced over a wide range of climatic conditions and includes many different types, it varies considerably in winter hardiness. However, the great bulk of Argentine seed is produced in an area where climatic conditions are similar to those of Arizona and Florida. Tests conducted by the Oklahoma Agricultural Experiment Station have shown that Argentine alfalfa is considerably less winter hardy than Oklahoma Common. It has winter-killed badly on the Experiment Station Farm at Stillwater. Yields of both hay and seed have been much lower than those of Oklahoma Common. (See Table IV)

Table II. Yield of Argentine Alfalfa Compared to Oklahoma Common. Oklahoma Experiment Station Farm, Stillwater.*

Variety	Yield in Tons of Cured Hay per Acre			
	1927	1928	1929	Average
Oklahoma Common	4.69	2.75	3.92	3.78
Argentine	4.79	1.86	2.58	3.07
Difference in Yield	+ .10	— .89	—1.34	— .71

* Unpublished data, Oklahoma Agricultural Experiment Station.

The planting of Argentine alfalfa in Oklahoma would result in very serious injury to the good reputation of hardy Oklahoma Common alfalfa seed produced in the State. More than 60 per cent of the surplus seed produced in Oklahoma each year moves into the seed consuming areas of the Ohio Valley and Corn Belt regions for planting. Argentine alfalfa is not adapted in those regions. Alfalfa seed of Argentine origin is therefore not recommended for planting in Oklahoma.

SOIL ADAPTATION

Selection of soils suited to the growing of alfalfa is important in maintaining stands and obtaining good yields. Alfalfa has a rather wide range of adaptation to soils types, but medium textured soils such as sandy loams, loams and silt loams are most desirable. Where possible, very sandy soils and heavy clay soils should be avoided. The soil should be deep, permeable, and well drained. Because of the deep, penetrating character of its root system, al-

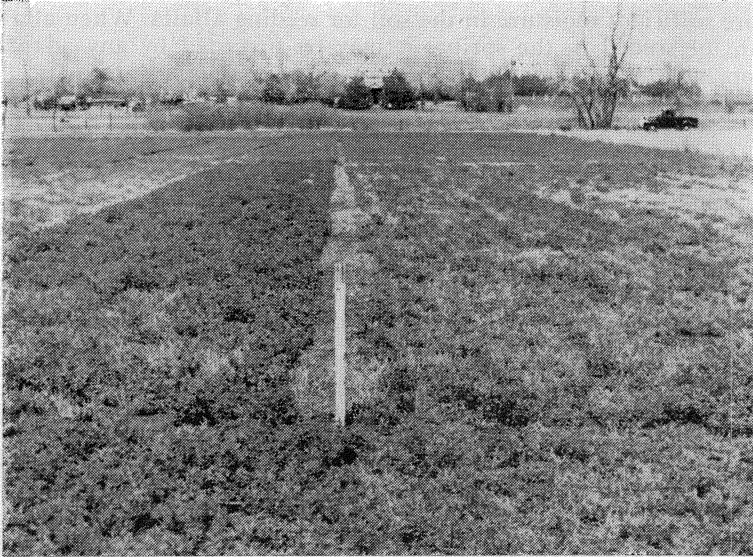


Fig. 3—Oklahoma Common Alfalfa (left) maintains a dense vigorous growth while Argentine Alfalfa (right) shows the effects of severe winter killing. Oklahoma Experiment Station Farm, Stillwater, Oklahoma.

alfalfa does not thrive in soils that have dense clay subsoils or bed rock near the surface. A permeable soil absorbs larger quantities of water and permits greater root penetration.

Alfalfa should be planted on soils that are well drained. Both surface and subsurface drainage are necessary in order to secure and maintain a satisfactory stand of this legume.

The most productive land on the farm should usually be selected for planting alfalfa. The crop is most commonly grown on river and creek bottom soils although it is successfully grown on the better upland soils in some sections of the state. The soil should be well supplied with lime, phosphorus, potassium and other minerals essential for plant growth.

PREPARATION OF THE LAND FOR ALFALFA

Crops to Precede Alfalfa

It is a good practice to precede alfalfa with a small grain crop, preferably spring oats, as less trouble will be encountered from volunteer plants. Wheat or barley may also precede alfalfa satisfactorily, if the volunteer growth can be destroyed before the alfalfa is seeded. In the Panhandle, summer fallow may be necessary to

store sufficient moisture in the soil for seeding alfalfa. When alfalfa is to be seeded in the spring, it may be preceded by any adapted crop, such as corn, cotton, sorghum, or a summer legume.

Preparing the Seedbed

The small size of alfalfa seed and the tender nature of the young plants make it necessary that the soil be in excellent condition at seeding time. Many of the failures to obtain a good stand of alfalfa can be traced directly to a poorly prepared seedbed.

The seedbed for alfalfa should be firm and compact, with sufficient loose soil on the surface to cover the seed. It should be well supplied with moisture and plant nutrients. The seedbed should also be free of weeds and volunteer small grain.

Preparation of the seedbed should be started early. The land should be plowed in early July, or as soon as the previous crop is harvested, to destroy weed growth and loosen the soil. This will permit greater absorption and deeper penetration of moisture. Early plowing will also provide more time for the decay of organic matter, which increases the availability of nitrogen, phosphorous, and other plant nutrients in the soil. During the summer and early fall, a field cultivator or other suitable implement should be used as often as necessary to control weeds, break crusts, and keep the soil in condition to absorb moisture. The land should be double disced or harrowed a few days before seeding time to destroy all undesirable vegetation such as weeds and volunteer small grain. A corrugated roller is also an excellent implement to use in pulverizing the soil and preparing a compact seedbed. A seedbed that is firm, moist, and well supplied with plant nutrients is very essential in securing and maintaining a satisfactory stand of alfalfa.

SOIL TREATMENTS FOR ALFALFA

Alfalfa can be grown successfully on much of the cultivated land in central and eastern Oklahoma by proper soil treatments. It is important that soil tests be made to determine what treatments, if any, are needed before planting the alfalfa.

Lime

Alfalfa has a very high requirement for lime (calcium). One ton of alfalfa hay contains the equivalent of approximately 80 pounds of lime. A sufficient amount of finely ground limestone should be applied on acid soils to neutralize the acidity and supply calcium for plant growth. The limestone should be applied a year before seeding the alfalfa, if possible. It should be spread evenly

over the land and thoroughly mixed with the soil to a depth of 4 to 6 inches. Lime may be applied on plowed land and harrowed or double-disked into the soil. When lime is applied on stubble or unplowed land, a disc or field cultivator should be used to mix it with the surface soil before the land is plowed. Many tests conducted by the Oklahoma Experiment Station in central and eastern Oklahoma have shown that limestone is an important factor in the successful growth of alfalfa on acid soils. On the Perkins farm near Stillwater, lime has increased the yield of alfalfa an average of 1,777 pounds of cured hay per acre each year during the eight-year period 1938-45. The increase was obtained at a cost of only 50 cents an acre annually for the lime. Lime and superphosphate increased the yield of alfalfa an average of 4,916 pounds, or nearly 2½ tons per acre annually, at a cost of only \$3.70 for the lime and phosphate.

*Table III. Effect of Lime, Phosphate Fertilizer, and Manure on Alfalfa Yields. Oklahoma Experiment Station, Perkins Farm, Stillwater. 8-year average, 1938-1945**

Treatment	Hay Yield (Pounds per Acre)	Increase in Hay Yields	Annual Cost of Treatment
Check	1994**	----	----
Lime	3443	1449	\$0.50
Superphosphate	4729	2735	3.20
Rock Phosphate	5316	3322	1.13
Manure	4832	2838	----
Lime and Superphosphate	6752	4758	3.70
Lime and Rock Phosphate	6702	4708	1.63
Lime, Manure and Superphosphate	7960	5966	3.70
Lime and Manure	6491	4495	----
Lime, Manure and Rock Phosphate	7786	5792	1.63
Lime, Superphosphate, and Potash	6867	4873	5.35

* Oklahoma Experiment Station mimeographed Circular M-112, "Soil Fertility Experiments," by Dr. Horace J. Harper, Professor of Soils.

** Average of 20 check plots.

Phosphate Fertilizer

When alfalfa is to be planted on land that is deficient in phosphorous, an application of phosphate fertilizer should be made. Tests conducted by the Oklahoma Experiment Station indicate that superphosphate and rock phosphate give similar results when applied in connection with the growth of alfalfa on phosphorus-deficient soils. Consequently, either superphosphate or rock phosphate may be used. The superphosphate should be applied at the rate of 200 to 250 pounds per acre. Rock phosphate may be applied at the rate of 400 to 500 pounds per acre. The fertilizer



Fig. 4—Lime alone increased the yield of alfalfa 1,777 pounds of cured hay per acre. Lime and phosphate increased the yield 4,916 pounds per acre annually. Oklahoma Experiment Station Farm, Perkins, Oklahoma.

should be drilled in the row with the seed. If a fertilizer drill is not available, the phosphate may be broadcast and disced into the soil in the final preparation of the seed-bed. Superphosphate may be broadcast on established stands of alfalfa each year at the rate of 150 pounds per acre. The application should usually be made about February 1st.

When alfalfa is planted on soils which are low in nitrogen, and manure is not available, 100 to 150 pounds of a 2-12-6 or 4-12-4 fertilizer, in addition to the superphosphate or rock phosphate, will stimulate early vigorous growth of the alfalfa plants.

In tests conducted on the Experiment Station Farm at Stillwater, profitable increases in alfalfa hay yields have been obtained from applications of lime and phosphate fertilizer. The results of this test, which extends over a period of 9 years, are shown in Table II.

Table IV. *Alfalfa Fertility Test. Oklahoma Agricultural Experiment Station Farm, Stillwater. 9-year average.**

Treatment	Hay Yield (Pounds per Acre)	Increase in Hay Yields	Annual Cost of Treatment
No treatment	2227	----	----
Lime	3141	914	\$1.50
Superphosphate	4184	1957	3.60
Lime and Superphosphate	4750	2523	5.10

* Unpublished data supplied by Dr. H. F. Murphy, Head, Agronomy Department, Oklahoma A. & M. College.

Lime alone increased the yield 914 pounds of cured hay per acre. Phosphate fertilizer alone gave an increase of 1957 pounds. Lime and phosphate fertilizer increased the yield an average of 2523 pounds per acre.

Barnyard Manure

Barnyard manure applied at the rate of 6 to 8 loads an acre will usually produce a large increase in the yield of alfalfa in central and eastern Oklahoma. Manure alone has increased the yield an average of 1,990 pounds of cured hay an acre for 14 years on the Experiment Station farm at Stillwater. In another test, manure alone increased the yield of hay an average of 2,828 pounds annually for the 8-year period 1938-1945. It is especially valuable to apply on soils which are low in nitrogen to stimulate early, vigorous growth of the young alfalfa plants. The manure may be spread on the land and worked into the soil in the final preparation of the seedbed. Established stands of alfalfa may be top-dressed with light applications of manure each year. The application should usually be made in the late fall or winter.

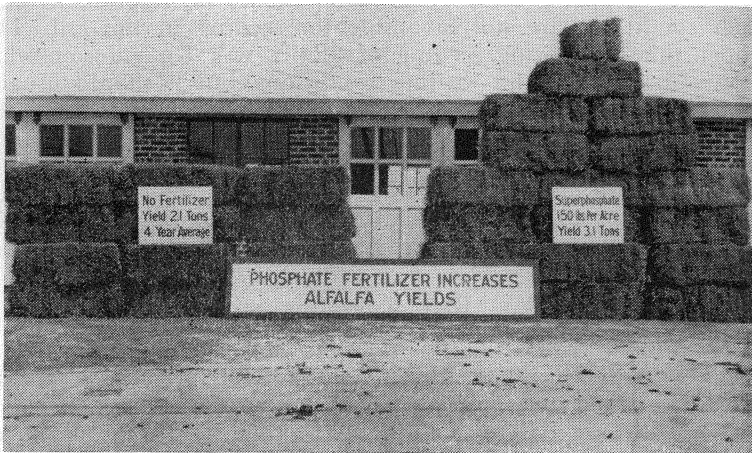


Fig. 5—On phosphorus deficient soils phosphate fertilizer increased alfalfa yields. Phosphate fertilizer alone increased the yield of alfalfa 1,957 pounds per acre. Phosphate fertilizer and lime increased the yield 2,871 pounds per acre, annually. See Table 2. (Oklahoma Experiment Station Farm, Stillwater, Oklahoma)

SEEDING

Time of Seeding

Fall seeding of alfalfa is desirable for all of the State when conditions are favorable. Fall seeding reduces the weed hazard often encountered with spring seeded alfalfa and in addition, a profitable crop can be obtained the first year. Alfalfa should usually be seeded as soon after August 25th as soil and moisture conditions are favorable. If seedbed preparation is started early and continued so as to control weeds and conserve moisture, the first good rain in late August or early September will provide sufficient moisture for seeding the alfalfa. If seeding can be done following the rain, quick germination will result and the roots will reach the sub-soil moisture before much drying has occurred. Alfalfa should be seeded only when soil and moisture conditions are favorable for quick germination and rapid growth of the seedling plants.

Lack of adequate soil moisture occasionally makes it unsafe to seed alfalfa in the fall. This is especially true in the western part of the state. Grasshopper infestations are also heavier in the western section, and fall seeded alfalfa is sometimes damaged by these insects. Spring seeding, however, should be resorted to only when conditions are not favorable for seeding in the fall. The proper time for spring seeding of alfalfa will depend somewhat upon soil moisture and weather conditions, but it should usually be done in late March or early April. With spring seeding, the difficulty of maintaining a stand the first summer is greater than from fall seeding, due largely to weeds. The weed hazard would be less serious on summer fallowed land. Spring seeded alfalfa rarely produces a profitable yield the first year and must usually be clipped several times during the season to check weed growth.

Rate of Seeding

A full stand of alfalfa is important in obtaining good yields of high quality hay and in controlling weed growth. If all the seeds germinated, one or two pounds per acre would be sufficient, but some of the seeds are not viable and others will be covered too deeply or may fall in dry soil and fail to germinate. Furthermore, plant diseases or unfavorable growing conditions may cause many of the young plants to die in the seedling stage. It is, therefore, advisable to sow a larger quantity of seed than would be necessary if every seed produced a vigorous plant. In eastern Oklahoma, the usual rate of seeding is 15 to 18 pounds per acre. In the western section, good stands are often secured with as low as 12 pounds per acre, when soil and moisture conditions are favorable.

Methods of Seeding

It is usually more difficult to obtain good stands of small seeded crops like alfalfa than of the larger seeded crops. It is important that the seeds be placed in close contact with the soil particles to hasten germination and make possible a rapid early growth of the seedling plants.

Alfalfa should be seeded with a drill in order to secure even distribution and uniform covering of the seed. An alfalfa drill or a regular grain drill with small seed attachment is satisfactory. The drill should be set to place the seed approximately one-half inch in depth. A corrugated roller or culti-packer used before and after drilling will make the soil surface firm and place the seed in closer contact with the soil particles.

Broadcasting is not a desirable method of seeding alfalfa. This method should be used only when a drill is not available. The seed should be covered with a drag harrow, followed by a packer.

Inoculation

Alfalfa, like all other legumes, thrives best when the nitrogen-fixing bacteria are present. These organisms may not be present in soils where alfalfa or sweet clover has not been grown recently.

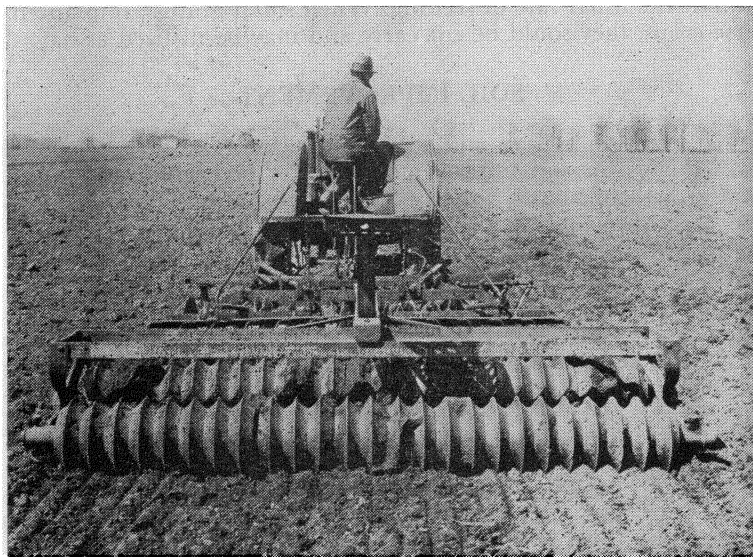


Fig. 6—A well-prepared, firm seedbed is essential in establishing a uniform stand of alfalfa. Using a packer before and after seeding will aid in placing the seed in close contact with the soil particles.

Consequently, alfalfa seed should be inoculated before planting. This insures the presence of the proper strain of bacteria for the fixation of nitrogen. Inoculation is also important in securing and maintaining a good stand of alfalfa. When inoculated, alfalfa makes better growth and fixes larger quantities of nitrogen in the soil. Commercial cultures of inoculating bacteria are usually available at local seed stores.

Use of Nurse Crops

The use of a nurse crop with alfalfa is not generally advisable and should be avoided wherever possible. On sandy soils, a nurse crop is sometimes beneficial in reducing wind erosion and protecting the alfalfa seedlings against the cutting action of blowing sand particles. A nurse crop will aid in controlling weeds in the spring but it will also take moisture and plant nutrients needed by the alfalfa.

Some farmers use millet as a nurse crop for fall seeded alfalfa, since it matures in the fall and will not compete with the alfalfa the following spring. Oats and barley are also good nurse crops for alfalfa. Wheat is sometimes used but it is less satisfactory than oats or barley. Rye is not satisfactory as a nurse crop for alfalfa.

Nurse crops, when used, should be seeded at not more than one-half the usual rate of seeding. When small grains are planted as nurse crops, they should be cut early and may be utilized as hay.

SOIL IMPROVEMENT

In addition to hay and seed production, alfalfa is one of the best legumes for soil improvement. Under favorable conditions, a good growth of alfalfa will fix 200 to 250 pounds of nitrogen per acre each year for the first three or four years after the stand is established. It also adds large quantities of organic matter, improves the physical condition of the soil, and is very effective in the control of erosion. It is an excellent legume to include in rotations with corn and wheat. Since alfalfa has a high mineral requirement, it removes large amounts of calcium, phosphorus, and potassium from the soil.

CROPS TO FOLLOW ALFALFA

In areas where corn is adapted, it is an excellent crop to follow alfalfa. In western Oklahoma, the forage sorghums are among the best crops to plant following alfalfa. These sorghums are very drought resistant and can be used for silage or dry forage. The grain sorghums may also be planted after alfalfa. It is usually safe to plant any adapted crop after the first year.

Wheat may be planted after alfalfa in central and western Oklahoma if proper management practices are followed. Shallow plowing of the land will limit the amount of soil nitrogen available the first year after alfalfa. In some cases, heavy vegetative growth of wheat may be controlled by late planting. Drilling the wheat in 14-to 16-inch rows will bring about a better balance between the number of plants per acre and the available nitrogen. Wide row spacing of the small grain is recommended the first and possibly the second year following alfalfa. If excessive growth develops, fall or spring pasturing may be advisable.

MEADOW MANAGEMENT

Late Fall Cutting

Proper management of alfalfa meadows in the fall reduces winter killing and aids in maintaining stands. An abundant supply of food in the roots of alfalfa plants in the fall is necessary to give high resistance to cold and to stimulate vigorous early growth the following spring. Plant food is manufactured in the leaves and stored in the roots. When alfalfa is cut late in the fall, and little or no new growth is made before winter, the plants will not have sufficient root reserves or surface protection for the winter period. This condition usually results in injury to the stand through winter killing, and a reduction in yield the following season. The last cutting should be made early enough to allow the late fall growth to reach a height of at least 8 to 10 inches and to supply the roots with an adequate amount of plant food for winter. This growth should be left on the plants throughout the fall season. Under average conditions, alfalfa should not be cut after September 25 in northern Oklahoma or October 1 in the southern part of the state.

Continuous Early Cutting

The proper time of cutting alfalfa is very important in securing maximum yields of hay and in maintaining stands. Continuous cutting of the alfalfa in the bud or very early bloom stage will result in lower yields of hay. It will also weaken the root systems of the plants, and shorten the life of the meadow.

Cultivating Alfalfa

Cultivation of alfalfa is not generally recommended. In most cases, it does not pay. It may be desirable in some instances to cultivate in order to loosen the surface of hard, dry soils to permit greater absorption of water. Some growers cultivate alfalfa when applications of phosphate fertilizer are made, to mix the fertilizer

with the surface soil. Alfalfa is also cultivated, in some cases, to reduce weed growth but if the meadow becomes weedy because of a thin stand, it should be plowed up. Cultivation may be effective in eliminating winter grasses which are found in many alfalfa fields. When these grasses are present, the cultivating should be done either before growth starts in the spring or immediately after the first cutting.

The best implements to use in cultivating alfalfa are the alfalfa renovator, a field cultivator equipped with alfalfa teeth, or a spring-tooth harow. The disc should not be used since it may split the crowns and injure the plants.

Reseeding Thin Stands

Reseeding an old alfalfa meadow where the stand is getting thin is not practical. The new seedlings will not be able to obtain sufficient moisture and plant nutrients to survive in competition with the older plants. Cultivation may, in some cases, reduce the growth of annual weeds, but it will not restore a stand of alfalfa. If the stand is getting thin the meadow should be plowed up. The land should then be planted to other suitable crops for 3 or 4 years, after which it may again be seeded to alfalfa. Under favorable conditions, it may be practical to reseed patches in a new meadow in the spring following fall seeding, but reseeding old stands is usually not successful.



Fig. 7—Alfalfa should be cut for hay when the plants are one-tenth to one-fourth in bloom.

MAKING ALFALFA HAY

When to Cut

High quality alfalfa hay is leafy and has a bright green color. Leafiness is important because the leaves contain nearly 75 percent of the total protein in the plant. A high percentage of green color indicates a high carotene or Vitamin A content. Leafy hay of bright green color is also higher in minerals and is more palatable than coarse, stemmy hay.

The stage of growth at which alfalfa is cut has a marked effect on the feeding value of hay the yield per acre, and the life of the meadow. Alfalfa cut in the bud or early bloom stage will be higher in feeding value than late-cut hay, largely because of the higher percentage of leaves. The largest yields of hay are obtained when the alfalfa is cut between the one-tenth and full bloom stages. Also, the highest yield of protein per acre is obtained when the crop is cut between these stages of maturity. There is a gradual decrease in the percentage of protein as the crop matures, but the yield per acre increases until the full bloom stage is reached.

Alfalfa should be cut when the plants are about one-tenth to one-fourth in bloom. At this stage of maturity the leaves constitute nearly 50 per cent of the total weight of the plants and the stems are reasonably soft and palatable. Also, maximum yields of high quality hay can be obtained without injury to the plants. Some growers remove the first, or first and second crops in the



Fig. 8—The side delivery rake is an excellent implement to use in windrowing alfalfa.

bud or very early bloom stage and leave the later cuttings until the alfalfa is nearly in full bloom. By following this practice, a better quality of hay is obtained from the early growth without serious injury to the stand. Continued cutting in the bud or very early bloom stage, however, will weaken the alfalfa plants and shorten the life of the meadow.

Curing

The aim in curing alfalfa hay is to reduce the moisture content to not more than 25 percent so it will keep in storage. The curing should be done so as to preserve a bright green color and save as many of the leaves as possible. In most cases, the best method is to let the alfalfa wilt in the swath and then put it into small, loose windrows. Air will circulate through the windrows, complete the curing, and reduce the amount of bleaching compared to curing in the swath. The loss of leaves is also reduced since the hay is raked into the windrow before the leaves are dry enough to shatter. The side delivery rake is more satisfactory than the sulky rake for windrowing alfalfa, since the windrows are smaller and less compact, which facilitates aeration and drying.

Over-curing is probably the most common cause of poor quality in alfalfa hay. Loss of color through bleaching and shattering of leaves are often due to this cause. Windrowing the alfalfa after it has wilted in the swath will slow down the curing process and reduce the danger of over-curing. An adequate amount of



Fig. 9—The modern pickup baler picks up the alfalfa and bales it direct from the windrow.

equipment available for handling the acreage of alfalfa grown on the farm is also an important factor in the proper curing of the crop.

The most common method of handling alfalfa hay after curing is to bale it direct from the windrow. With the advent of the pick-up baler, this practice has become quite general throughout the main alfalfa section of Oklahoma. The alfalfa can be handled rapidly and there is a minimum loss of leaves from shattering. Where a stationary baler is used, the alfalfa is moved direct from the windrow to the baler with a sweep rake. The alfalfa may also be bunched, put into cocks and baled with a portable baler. After the alfalfa is baled, it is stored in a barn or stacked where it can be protected. If only a small acreage is grown and if a baler is not available, the loose hay may be stored in the barn or stacked in the field.

BARN-CURED HAY

The artificial curing of hay in the barn is becoming a common practice in some states. This method is particularly valuable in areas where weather conditions frequently make it impossible to cut the alfalfa at the right time and cure it satisfactorily in the field. Curing in the barn is accomplished by means of a mechanical hay drier. Hay that is to be barn-cured should be cut in the morning soon after the dew is off and allowed to dry for 4 to 5 hours in the field. The alfalfa may be left in the swath for the entire period, or it may be left in the swath for 2 hours and then raked into windrows for another 2 or 3 hours. This field curing for 4 or 5 hours on a clear day, will reduce the moisture content of the hay from 75 per cent to approximately 45 percent. The hay should then be removed from the field and placed in the barn, to complete the curing. It is spread evenly over the mow floor, piling it to a depth of not more than 7 or 8 feet.

The drier consists of a blower-type fan with a system of air ducts built on the barn floor. The fan draws fresh air through an intake in the outside wall and blows it into the duct system where it is discharged through slots at the bottom edges of the ducts. This gives an even distribution of air through the hay. The fresh outside air, which is forced through the hay mow, absorbs the moisture from the hay. The saturated air escapes through doors, windows, and other openings. When the moisture content of the hay is reduced to 20 percent, it can be stored safely.

The main advantage of barn-curing is that it saves the leaves and preserves the green color, the main sources of protein and carotene in the hay. Hay driers are especially valuable on dairy farms where high quality hay is essential in maintaining maxi-

mum milk production and keeping the cows in good physical condition.

The barn curing system is relatively simple to construct. It must, however, be properly designed for the particular barn in which it is to be used in order to insure satisfactory operation.

ALFALFA SILAGE

Alfalfa is used for silage only to a very limited extent in Oklahoma. Where weather conditions are favorable, it is usually advisable to cure the alfalfa for hay rather than put it into the silo. It is more difficult to make good silage from alfalfa than from corn or sorghums. This is due largely to the fact that alfalfa is relatively low in carbohydrates (starch and sugar) and high in protein. Good silage can be made from alfalfa, however, by proper handling. Freshly cut alfalfa usually contains 75 to 80 per cent of moisture. The moisture content should be reduced to between 60 and 70 per cent by letting the alfalfa partially wilt before putting it into the silo.

When freshly cut alfalfa is put into the silo, a carbohydrate material, such as molasses or ground corn, should be added in order to stimulate the fermentation and bacterial activity necessary to make good silage. Molasses is often used for this purpose. Alfalfa cut in the bud or early bloom stage will require more molasses because of its higher water and lower carbohydrate content than alfalfa cut later. The amount of molasses to be added will vary from 60 to 80 pounds per ton of green alfalfa. Corn and cob meal may also be used at the rate of 200 to 250 pounds per ton.

When alfalfa silage is properly made, nearly all of the feeding value of the plant is preserved.

PASTURING ALFALFA

While alfalfa is grown primarily for hay, it is used to some extent for pasture. When properly grazed it produces excellent yields of high quality forage.

Alfalfa is regarded as one of the best pasture plants for hogs and many farmers plant it specially for this purpose. It provides pasturage during a longer season than most other forage crops, starting early in the spring and remaining green and succulent in late fall. Alfalfa is also used to some extent for grazing cattle and sheep.

Great care should be used in pasturing alfalfa in order to avoid injury to the stand. It should be pastured only when the ground is dry and should not be grazed too closely. The grazing should be regulated to maintain a top growth of at least 4 to 6

inches. In the fall, the alfalfa should be allowed to reach a height of 6 to 8 inches in order to permit the plants to build up root reserves for winter protection.

When alfalfa is used mainly for hay production, it is usually not grazed during the growing season. The late fall growth may be utilized for winter pasture after it has been killed by cold weather. At least part of this growth, however, should be left for protection of the roots of the alfalfa plants during the winter.

When cattle and sheep are pastured on alfalfa there is always danger of bloating. The animals should be fed grain or hay as a supplementary feed and should never be turned on alfalfa when hungry. Plenty of salt and water should be available at all times. It is never safe to turn cattle or sheep on alfalfa when the plants are wet with dew or rain. These practices, if carefully observed, will reduce, but not entirely eliminate, the danger of bloat in cattle and sheep when pastured on alfalfa.

HOW ALFALFA SEED IS PRODUCED

The setting of alfalfa seed is influenced by soil moisture, character of growth of the alfalfa plants, general climatic conditions, current weather conditions, spacing of the plants, and insect activity.

The proper amount of soil moisture has long been regarded as one of the essential conditions for successful alfalfa seed production. While there should be sufficient moisture for the plants to function properly during the time of blooming and seed forming, the best crops of seed are produced when the supply of soil moisture is somewhat limited. An excessive amount of moisture in the soil promotes rapid, vigorous growth of the alfalfa plants. Such plants are soft and tender and are generally not good seed producers. A slow to moderate rate of growth of the plants is more conducive to the setting of good crops of seed. Extreme vegetative growth tends to reduce blooming.

While alfalfa has a rather wide adaptation as to climate for hay production, the setting and maturing of seed is materially influenced by weather conditions. The most important seed producing areas are in regions of moderate to low rainfall. Weather conditions during the blooming period are of greatest importance in seed setting. The best crops of seed are generally set during periods when there is little rainfall and when there is an abundance of sunshine. Cloudy, rainy or cold weather during the blooming period is not favorable for the setting of seed. In Oklahoma, nearly all of the alfalfa seed is produced in the western part of the State where the average annual rainfall varies from 32 inches to less than 20 inches.

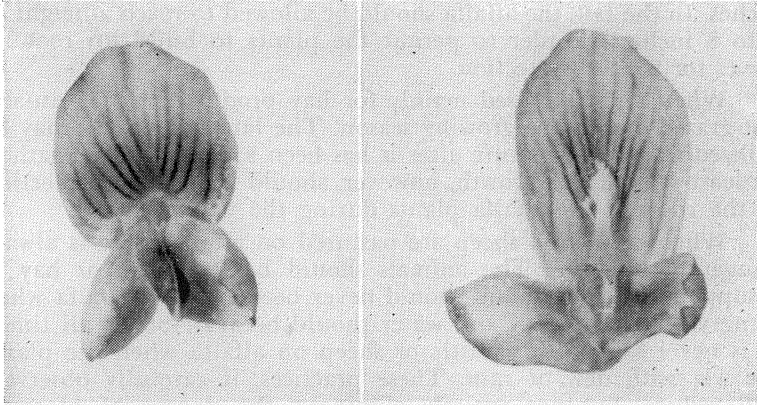


Fig. 10—Alfalfa will set very little seed unless the flowers are tripped. Nearly all of the tripping is done by insects. Left, an untripped flower; right, a flower that has been tripped.

Pollination of Alfalfa by Insects

Alfalfa has a very strange and unusual mechanism for setting seed. It does not naturally set seed like most other plants. The male and female parts of the flower are completely inclosed by the two lower petals, which overlap to form the keel (See Figure 10.) Pollen can neither get in nor out, although alfalfa is naturally cross-fertilized. Breaking or ripping the keel open so as to expose the reproductive parts of the flower is called "tripping." Tripping is necessary for cross-pollination and without it very little seed is set. The Nebraska Station found that on the average less than 5 per cent of the alfalfa flowers set seed without tripping.*

Tripping of the flowers and transfer of pollen to the stigma is accomplished largely by beneficial insects. These include honey bees, wild bees and a few other insects. The structure of the alfalfa bloom is especially adapted for pollination by bees.

Honey bees are very effective agents in tripping alfalfa blooms in areas where they collect pollen. The *Nomia* or alkali bee is also one of the most important tripping insects in areas where its nesting sites are located. The *Megachile* or ground bee is very effective in tripping alfalfa blooms but the populations of this insect are usually small and widely scattered. Bumble bees are also effective tripping agents when collecting pollen, but they are never present in large numbers.

Insects are not active during stormy, cloudy, or rainy weather

* Nebraska Agricultural Experiment Station, Bulletin No. 331, Alfalfa in Nebraska by H. M. Tysdal and T. A. Kesselbach.

and very little alfalfa seed is set during such periods. Warm, sunny weather during the blooming period and the presence of tripping insects in sufficient numbers to trip the blooms are essential for the production of good yields of seed.

If insects are not present for tripping or if weather conditions are not favorable for seed setting, the grower may be confronted with the question of whether to leave the alfalfa for a seed crop or cut it for hay. It is well to observe the alfalfa closely as it comes into bloom to determine if the flowers are setting pods or if they are falling from the stem—a condition known as “stripping.” If a fairly high percentage of the blooms are setting seed pods, it may be left for a seed crop. If the flowers appear to be falling, and if seed pods are not forming, it may be best to cut the alfalfa for hay. The few days required to make the observation will probably not greatly decrease the quality of the hay if it is cut immediately.

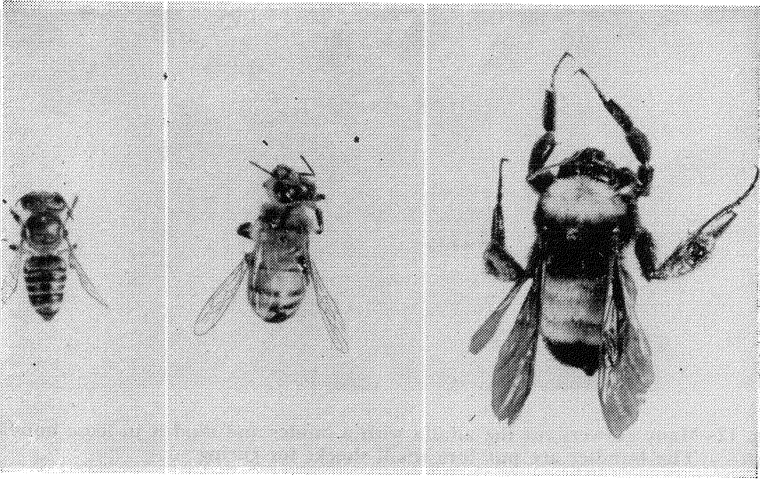


Fig. 11—Three type of bees which are important in tripping alfalfa flowers. Left, the *Megachile*, commonly known as the leaf cutter or ground bee. It is very effective, tripping about 90 percent of the flowers visited. Center, the Honey Bee. If large numbers are present they may do considerable tripping. Right, the Bumble Bee. Never very numerous but trips from 30 to 80 percent of the alfalfa flowers visited.

HARVESTING ALFALFA SEED

When to Harvest

In order to produce high quality seed, it is necessary to harvest at the proper time. Since alfalfa seed pods do not all ripen at the same time, the grower must decide when a majority of them are ready for harvest. Alfalfa should usually be cut for seed when two-thirds of the pods are brown in color. Well filled pods that are turning yellow will mature after the alfalfa is cut. If cutting is delayed beyond this period, considerable losses of seed from shattering may occur.



Fig. 12—Many growers cut the alfalfa with a binder and bind it in loose bundles. The bundles are put into small shocks for curing.

Methods of Harvesting

Methods of harvesting alfalfa seed vary in different parts of the State and among different growers even in the same section. Many growers cut the alfalfa with a binder and bind it in loose bundles. The bundles are put into small shocks for curing. A shock usually contains only 2 to 4 bundles. As soon as the alfalfa is properly cured, the bundles are hauled on canvas covered wagons or slips to a thresher. This method is used extensively in southwest Oklahoma. It is one of the safest and best methods, especially when rain occurs during harvest time. Some growers mow the alfalfa and put it into windrows with a side delivery rake. The alfalfa is then threshed from the windrows, using a combine with pick-up at-

tachment. The main disadvantage of windrowing is the danger of wind damage. A strong wind may roll the alfalfa into tangled masses, causing heavy losses of seed from shattering and increasing the difficulty of threshing.

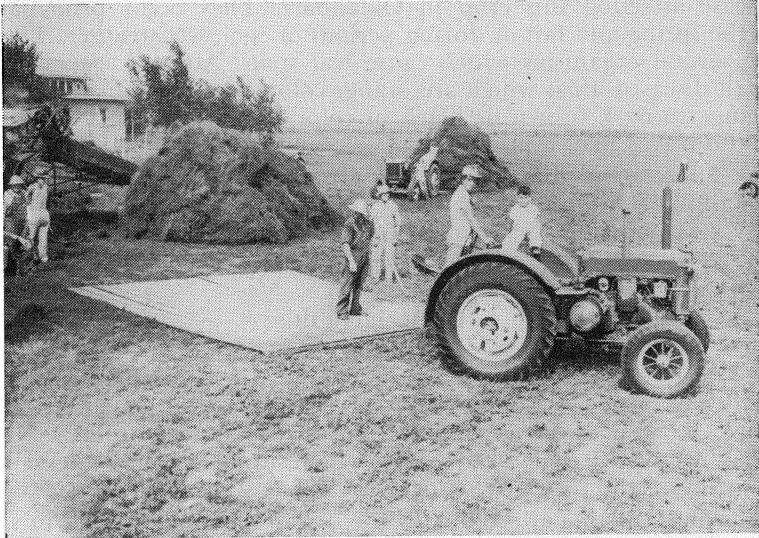


Fig. 13—Hauling alfalfa to the thresher.

The alfalfa is sometimes cut and left in the swath for curing. It is then threshed direct from the swath, using a combine with pick-up attachment the same width as the cutter bar on the mower.

In some areas, direct combining of alfalfa seed is a common practice. In other areas, this method is used only when the crop is poor and seed yields are low. Seed harvested by direct combining will contain parts of green leaves, stems, and some green seed with a high moisture content. It should be re-cleaned immediately to remove all foreign material. The re-cleaned seed should then be spread out for drying and to prevent damage from heating.

DISEASES OF ALFALFA

Leaf Spots

The leaf spots cause more damage to alfalfa than any other disease affecting this crop in Oklahoma. They occur principally in the spring and fall or during periods of cool, wet weather. There are several organisms which cause leaf spots. Affected leaves have small diseased areas which are orange-colored at first, but gradually change to dark brown or black in color. In some cases, shedding of the leaves may result.

There is no direct means of control. If the disease is severe, the alfalfa should be cut a little earlier than usual to save as many leaves as possible. Removing infected material from the field will also give the next crop a better chance to escape serious injury.

Bacterial Wilt

Bacterial wilt is the most destructive disease of alfalfa in the United States. Fortunately, there is very little wilt in Oklahoma, but since Oklahoma grown seed moves into areas where wilt is a very serious problem it is desirable that wilt resistant strains be used for planting in the seed producing areas of the state.

Alfalfa plants affected with the disease become dwarfed in size



Fig. 14—Threshing alfalfa with a stationary threshing machine.

and unthrifty in appearance. The stems are short, and usually excessive in number. The leaves are small, yellowish in color, and often curled or cup-shaped. In hot weather, severely affected plants may show wilting. When the root of a diseased plant is cut across, a yellow or orange-colored ring can be observed under the bark, which slips off easily.

The bacteria causing the disease live in the soil. They may be spread from affected to healthy plants by mowers and other farm machinery, by drainage water, or by soil blowing. The disease organisms are not carried on the seed, and seed treatment is of no value as a control measure. The only means of control at the present time is to plant a wilt-resistant variety. Buffalo alfalfa, a selection from Kansas Common, is highly resistant to bacterial wilt, and is recommended in Oklahoma, particularly in seed producing areas.

Root Rot

A root rot disease, commonly known as Cotton Root Rot, is found in Oklahoma in the two tiers of counties extending along the Red River. In addition to cotton, the disease attacks alfalfa, sweet clover, and most summer legumes. Winter legumes such as Vetch and Austrian winter peas, are not seriously affected, since the disease is active only in hot summer weather.

Root rot usually occurs in well defined areas or patches in the field. The disease is characterized by a widespread dying of plants from July onward. The patches of dead plants vary from a few square yards to an acre or more in size. The roots of affected plants are shrunken and decayed and the plants are easily pulled out of the soil. The main roots are covered with fine, brownish-colored strands by which the disease is easily identified.

Root rot is caused by a fungus which is known to live in the soil for many years. Seed treatment is not effective in the control of the disease. Alfalfa should not be planted in a soil which is infected with the root rot organism.

Rust

Alfalfa leaf rust is a form of rust which affects alfalfa only. It is of minor importance in Oklahoma. In years when summer rainfall is above normal, the disease may develop during the latter part of the growing season. Affected leaves develop small brown spots which consist of masses of powdery rust spores. Control of this disease is the same as for leaf spots.

INSECTS INJURIOUS TO ALFALFA

The most important insects injurious to alfalfa in Oklahoma are the grasshopper, pea aphid, variegated cutworm, garden webworm, clover seed chalcid, *Lygus* bug, clover leaf weevil, blister beetle, leaf hopper, and alfalfa caterpillar.

Grasshoppers

When grasshoppers are numerous, they do considerable damage to both old and new stands of alfalfa. The most effective control for grasshopper is the proper spreading of poison bran bait. The bait is prepared by mixing 100 pounds of bran and three equal volumes of sawdust, 24 pounds of sodium fluosilicate, and a sufficient amount of water to make a crumbly mixture. This will require about 20 to 30 gallons. The poison bait should be spread thinly over infested areas very early in the morning. Infested areas may also be sprayed with Chlordan, or with Toxaphene. When established fields of alfalfa are sprayed with either of these chemicals, the application should be made immediately after a cutting of hay. Directions for mixing and using Chlordan and Toxaphene are given in Extension Circular 483, "New Insecticides for Grasshopper Control." Regardless of the materials used, an effort should be made to control grasshoppers when they first appear in the spring.

Pea Aphid

The pea aphid is a small, metallic green, soft bodied insect which attacks alfalfa, vetch, and peas. The insect inserts its beak into the stems and leaves of the alfalfa plants and sucks the plant sap. Plants which are attacked by large numbers of pea aphids become stunted in growth and have an unthrifty appearance. In severe attacks plants wilt badly. Soon the leaves will turn yellow, and frequently the plants die.

The eggs of pea aphids hatch in late February or early March and the insects attack the first growth of alfalfa before it is ready to cut for hay. Infestations usually start in small circular areas scattered over the field. These initial areas enlarge rapidly and soon merge so that the infestation may cover the entire field.

Most outbreaks of pea aphids are eventually brought under control by natural parasites and predators, although often this is not accomplished until after severe damage has been done. If the alfalfa is large enough to be removed by raking, and if the infestation is severe, mowing is recommended. Because of possible poisonous residues left on the plants, none of the new insecticides are yet being recommended for controlling the pea aphid.

Lygus Bug

The Lygus bug is one of the most injurious insects in some states where alfalfa seed is produced. There are several species of the Lygus bug, one of which has been found in western Oklahoma; however, the insect is of minor importance in the State at the present time.

In tests conducted by the Oklahoma Experiment Station, the Lygus bug has been effectively controlled by dusting with a 5 percent DDT dust at the rate of 20 pounds per acre, but the increase in seed yield was not sufficient to pay the cost of dusting. Where alfalfa is dusted, however, the application should be made after the flower buds have formed but before the first blooms appear. Dusting should not be done after the plants start blooming since DDT will kill the pollinating insects which are essential in seed production.

CAUTION: Alfalfa which has been dusted with DDT for insect control should not be fed to livestock.

Variegated Cutworm

There are several species of variegated cutworms which feed on alfalfa, often defoliating the plants. Most of the insects feed at night and hide under surface litter or in the soil during the day. Consequently, alfalfa fields may be severely damaged before the insects are discovered. Variegated cutworms are usually most serious in June.

The most effective control of variegated cutworms is poison bran bait, the same as is recommended for grasshopper control.

The Garden Webworm and Alfalfa Webworm

The garden webworm and alfalfa webworm are sometimes injurious to alfalfa in Oklahoma. The insects eat the leaves and spin webs which may completely cover the alfalfa plants. As soon as webs are observed in the field, the alfalfa should be carefully examined for the presence of webworms. If they are numerous, the alfalfa should be cut immediately, otherwise the hay crop may be lost.

Clover Seed Chalcid

The clover seed chalcid is a serious insect pest of alfalfa in areas where seed is produced. The young of this tiny wasp eat the inside of the seed, leaving only a thin seed coat.

Spraying or dusting is of no value. To protect the next year's seed crop, the screenings from threshing should be utilized as livestock feed or destroyed. All old alfalfa around the edges of fields and on waste lands should be destroyed since it provides protection for over-wintering insects which may cause damage the following year.



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