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RED CLOVER

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By David Heusinkveld

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RED CLOVER FOR ILLINOIS

RED CLOVER is one of the most important legume forage crops in Illinois. It fits well into corn-belt rotations and produces high-quality feed for stock. Not so exacting in its soil requirements as some of the other legume crops, it can be grown on many soil types.

Most of the red clover grown in Illinois is used as cured hay, but a considerable amount is also used for pastures, silage, and soil improvement. Red-clover seed is produced on many farms, but yields are often low. Unless a seed crop is desired, red clover is frequently grown with timothy, orchard grass, or other grasses. Clover-grass mixtures are proving entirely satisfactory for feeding livestock.

TYPES AND VARIETIES

There are two main types of red clover: medium red and mammoth red. These types are closely related. The seeds cannot be told apart; they are similar in size, shape, and color. But the plants can be distinguished by their different habits of growth (see pages 4-6). Soil requirements of mammoth and medium red are quite similar, but on poor and sandy soils mammoth often produces more growth in one cutting than does medium red in two cuttings.

Red clover is well adapted to Illinois. Good stands like this are usually obtained by following good farming practices. (Fig. 1)



Medium Red Clover

Nearly all red clover grown in Illinois is the medium red type. Medium red is a perennial; that is, under favorable conditions it continues to grow thru more than two seasons. On most Illinois farms, however, it is treated like a biennial (two-year) crop because of its place in the rotation. Also, insects and diseases often cause so much damage by the end of the second season that practically all the stand is gone. Only occasionally is red clover productive the third year.

In early stages of growth medium red clover is similar to mammoth. In the autumn of the first season it can be distinguished from mammoth by the fact that it produces stems and flowering heads while mammoth has only crown leaves. Medium red clover may produce a small amount of seed the first year if it isn't clipped.

During the second season two crops and an aftermath are produced; both crops may be cut for hay or the first cut for hay and the second left for a crop of seed. Usually the aftermath furnishes some pasture for livestock.

The time of blooming varies with the climate and the area where the clover is being grown. In central Illinois the first crop of the second season usually starts blooming about June 1 and is in full bloom by June 10.

The stems of medium red are finer than those of mammoth, and growth is less rank. The hay is therefore of better quality and higher feeding value than that obtained from mammoth.

Within recent years three strains of medium red clover, adapted to certain areas of the principal clover-growing region, have been given varietal names.¹ These are Midland, Cumberland, and Kenland.

Midland. This variety is particularly adapted to the central part of the corn belt. It may, however, be grown thruout all of Illinois except possibly the southern part, where southern anthracnose, a common disease of clover in this area, may cause serious damage.

¹ Altho red clover has been grown in this country for many years, the need for using adapted seed has not been generally recognized. It is only within recent years that a few superior strains have been developed and given varietal names.

Midland was originated by combining, in equal proportions, four old strains — one each from Ohio, Indiana, Illinois, and Iowa. It grows vigorously, is winter-hardy, and has some resistance to northern anthracnose — a disease that may attack red clover and cause some damage to the first crop in the second season.

Cumberland and Kenland. Cumberland originated as a composite made up of equal proportions of three superior strains, one each from Virginia, Kentucky, and Tennessee. Cumberland produces an abundance of above-ground growth and is somewhat resistant to southern anthracnose and crown rot. Kenland, the most recently named variety of red clover, is quite similar in origin and growth to Cumberland. It is, however, more resistant to southern anthracnose and will yield more forage than Cumberland when this disease is prevalent.

In tests at Urbana, Cumberland and Kenland have been more susceptible to northern anthracnose than Midland and other corn-belt strains. These two varieties are not recommended for general use in Illinois but they may be of value in southern Illinois and in other areas where southern anthracnose is likely to occur.

Seed supplies. Supplies of both Midland and Cumberland seed are becoming more abundant. A limited amount of seed is produced in regions where they are adapted. Considerable seed of both varieties is produced in several of the northwestern states under supervision of state crop improvement associations. Seed of Kenland is still scarce. As the acreage of this variety increases, more seed will become available.

Local strains. Thruout Illinois are strains of medium red clover that have grown in the same locality for so many years that they have become adapted to local conditions of soil and climate. Several of these strains are known by the name of the grower or by the name of the county where the seed is grown. These strains have not been widely used. However, because of their superior qualities, seed supplies of these strains should be increased for general use where adapted.

Mammoth Red Clover

Altho mammoth red is a perennial plant, it, like medium red clover, is usually treated as a biennial. It starts blooming 10 days or two weeks later than medium red and is in full bloom about when timothy is. At this time bumblebees and other pollinating insects are numerous, thus insuring pollination of the flowers.

In the fall of the first year mammoth red can be distinguished from medium red by its low crown growth and lack of flowering stems. Only one crop, either of hay or seed, is harvested the second year. The aftermath is scant and of little value as a fall pasture. Stands tend to thin out after a crop of hay or seed has been taken.

Mammoth red clover grows taller than medium red clover, and its stems are coarser, making it less desirable as hay.

At Urbana three named varieties of mammoth red—**Graham**, **Knollman**, and **Altaswede**—have been tested in comparison with commercial seed lots. In yield of forage Graham and Knollman are equal to or somewhat better than commercial seed lots. Altaswede, developed in Canada from foreign seed, is winter-hardy, but otherwise not adapted in central Illinois.

ADAPTED SEED NECESSARY

High-quality seed, adapted to the locality, is essential for profitable stands of red clover. Good red-clover seed is plump and bright, varies in color from yellow to purple, and is free from weed seeds. Seed of good quality usually germinates well, altho some hard seeds may be present. (Hard seeds are viable but require a longer time to germinate.) Some brown seeds, many of which are dead, are nearly always present. A high percentage of brown seeds is often found in old seed.

Red-clover seed grown in any locality for a number of seed generations is usually as good as or better than seed from other sources. Strains adapted to Iowa, Indiana, and Ohio are generally adapted in the same latitude in Illinois. Seed produced in the northwestern states from superior corn-belt strains keeps its desirable qualities when returned to its place of origin.

Strains developed in Canada and the northern states are winter-hardy, but in other ways they are not so well adapted to Illinois as strains grown in the central corn-belt states. Strains from the Pacific coast region of Oregon and Washington are not so hardy as many other strains grown in this country. European and South American strains generally are not winter-hardy, their yields of forage are not likely to be satisfactory, and stands are frequently lost.

SOIL MANAGEMENT

While adapted to a variety of soils, red clover thrives best on well-drained, moderately heavy loams that are somewhat moist but not too wet. It does not do well on sandy or gravelly soils unless an ample amount of moisture is present at all times. It is usually impossible to obtain good stands on soils that have been depleted of plant-food elements and organic matter. Thru good soil management, however, poor soils can be built up so that eventually red clover can again be grown.

Add Limestone Where Needed

Many failures of red clover that are laid to other causes may be due to too little lime in the soil. Red clover, however, is not so exacting in its lime requirements as are alfalfa and sweet clover. It makes its best growth on soils that are at or just below the neutral point. It does not always do well on moderately acid soils. On such soils clover-grass mixtures are more likely to be successful than pure clover plantings.

The degree of acidity which red clover can withstand depends mainly on the amount of plant food in the soil. With a good supply of available nutrient materials, clover can stand more acidity than if it is half-starved.

Winterkilling is more likely to occur on acid soil than on sweet soil. This is because plants growing on sweet soil have a chance to make good growth before cold weather.

Finely ground limestone is generally used to correct soil acidity. The amount needed is determined by testing soil samples taken from a number of spots in the field. Soil samples may be sent to the office of the county farm adviser, where tests are

made and recommendations given for the amount of limestone needed in order to get a good growth of various legumes.

Chemical Nutrients Necessary for Clover

Phosphorus and potassium are essential for the growth of red clover. An ample supply of phosphorus in the soil is especially helpful in establishing stands. A number of minor elements are also necessary for growth, but there is enough of these in most Illinois soils.

Soils vary greatly in the amounts of phosphorus and potassium present. Generally there is a greater deficiency in phosphorus than in potassium. A soil test will show whether there is a need for either or both of these elements.

A shortage of phosphorus may be corrected by the use of rock phosphate or superphosphate. If supplies of both phosphorus and potassium are too low, then muriate of potash, in addition to phosphorus, will be helpful. These potassium and phosphorus fertilizers may be applied with a drill when the clover is planted. Commercial fertilizers used for a cultivated crop often benefit the red clover crop that follows.

Manure Is Helpful

On many soils, especially poor and sandy soils, manure does much to insure good stands. The favorable effect of the manure is due largely to the minerals and organic matter it supplies. Most farmers use manure for the cultivated crop that comes before the clover. Both crops benefit from this practice.

Manure used as a mulch helps to get good stands on soils that are subject to wind erosion.

Inoculation Is Important

Thru a process known as nitrogen fixation red-clover plants are able to change free nitrogen in the air to a form they can use immediately. Bacteria are the nitrogen-fixing agents. They form small nodules on the roots. Inoculation, the process of supplying bacteria, occurs naturally or may be done artificially.

Soils on which red clover has been grown for several years usually contain enough bacteria to provide natural inoculation. If a soil has not grown red clover, the seed should be inoculated artificially. Commercial inoculants sold by most seed dealers are usually satisfactory and the cost per acre is small.

Well-nodulated red clover is a vigorous gatherer of nitrogen; an entire crop, including tops and roots, often contains 100 pounds or more of this element to the acre. Part of this nitrogen remains in the soil for succeeding crops. Plants that are not nodulated are low in nitrogen. Instead of adding nitrogen to the soil, they take it out of the soil, and they usually do not survive.

RED CLOVER IN CROP ROTATIONS

Crop rotation is the growing of two or more crops in regular sequence on the same land. Its purpose is to make the best use of the plant food in the soil and, at the same time, keep the soil in condition that will give the best yields of the various crops. The rotation system that will give the best results depends upon the kind of soil and type of farming.

Value of Clover in Rotations

Red clover has several characteristics that make it a good legume to include in rotations with grain. It is adapted to a wide range of soil conditions and is excellent for hay and pastures either alone or in mixtures with grasses or other clovers. Medium red, the type usually grown in Illinois, produces two crops and an aftermath. Also, red clover adds nitrogen to the soil, provided considerable plant material is plowed under.

Possible Rotations

The best place for corn in a rotation is after the legume crop. One short-cycle rotation includes corn the first year; oats or wheat (clover seeding) the second year; and clover the third year. Tho this rotation provides less cash income than some others, it is good for maintaining organic matter and soil fertility.

In Illinois, where corn and soybeans are major farm crops, an excellent four-year rotation is: (1) corn; (2) soybeans;

(3) oats or wheat (clover seeding); and (4) clover. This rotation is adapted to fertile soils well supplied with organic matter.

Where winter wheat is the major grain crop, the rotation might be (1) wheat; (2) wheat (clover seeding); and (3) clover. If it is desired to grow corn or possibly oats once in the cycle, the rotation is: (1) corn; (2) oats or wheat (clover seeding); (3) clover; and (4) wheat (clover seeding).

These rotations are well adapted to either grain or mixed farming, since the clover makes excellent hay and pasture for livestock. Another year of hay or pasture may be added by seeding timothy or brome grass with the clover instead of seeding clover alone. If the clover should fail, soybeans may be substituted and cut for hay or left for seed, or corn may be planted. Altho crop rotations that include red clover help to maintain soil fertility, crop residues and manure must also be turned back into the soil.

ESTABLISHING STANDS

Value of Companion Crop

It is not absolutely necessary to seed clover with a companion crop (often called a nurse crop). Companion crops do, however, provide some revenue from the land while the clover is becoming established and they also prevent excessive weed growth. Usually the companion crop is allowed to mature and a crop of grain harvested. If a crop of grain is not desired, the field may be pastured moderately or cut for hay when the grain has reached the milk stage.

Time, Method, and Rate of Seeding

The time to seed red clover depends largely on climatic conditions and the grain crop with which it is sown. When planted in winter wheat, clover seed may be broadcast as early as February or the first part of March.

Seed scattered in winter wheat by one of the several types of broadcast seeders must be covered to insure germination. If the seeding is early (February or the beginning of March), alternate freezing and thawing will work the seeds into the soil.

After the freezing-and-thawing period has passed, seed may be covered by using the harrow, care being taken not to cover the seed too deep. Crosswise drilling or harrowing will not damage the wheat. If seedings are delayed until the soil has become dry, it is advisable to drill in the seed.

When grown with spring grain, clover is seeded at the same time as the grain. Grain drills with two compartments are commonly used. On all but sandy soils, clover seed should be planted shallow, less than 1 inch deep. The use of a corrugated roller on dry seedbeds before and after seeding often helps to get good stands. Seeds germinate more readily in a firm seedbed than in dry, porous soil, and the seedling plants have a better chance to get a good start.

Red clover may be planted without a companion crop in May or June after it is too late to seed spring grains. Seeded in this way, clover may produce a good crop of hay the first season. Where weeds are abundant, however, the hay will be of poor quality and the stands are likely to be thin. When red clover is seeded alone, seedbed preparation and depth of planting are the same as when clover is seeded with spring grain.

Experiments have shown that it is not necessary to plant more than 10 pounds of red clover seed to the acre. Five pounds, on the other hand, is not enough. Many Illinois farmers use a bushel for 8 acres, planting at the rate of $7\frac{1}{2}$ pounds an acre.

MANAGEMENT THE FIRST SEASON

Red clover seeded with grain needs little attention the first year. Generally the companion crop is permitted to ripen and is harvested with a combine or binder. Occasionally a rank grain crop may have to be removed as a hay crop or it will smother the clover stand. After the grain crop has been taken off, the clover plants develop and give some pasturage. During very favorable seasons a crop of hay or a light crop of seed may be harvested.

Even tho red clover, planted with or without a companion crop, may give some forage or seed the first season, there are always hazards to be considered. Clipping after the first of Sep-

tember, for example, may result in winter-injury and loss of stands. Too heavy grazing in the fall may have the same results. Also, weeds may choke out the clover stands.

It is advisable to clip clover during August. If stands are weedy, clipping is especially important. The weeds should be allowed to make considerable growth and then clipped low. In this way more weeds are killed than if the cutter bar is raised several inches. Red-clover plants, however, recover from crown buds at the ground level and are not injured. Clippings should be taken off the field if sufficient to provide some feed or heavy enough to injure the stand. Field mice are likely to cause severe damage on fields where heavy fall growth has been clipped but not removed.

RED CLOVER AS HAY

On many farms red clover is the standard legume for hay. All classes of livestock readily eat red-clover hay. Its protein content is more than twice that of timothy but slightly less than that of alfalfa. When high-grade clover hay is fed to dairy cattle, the amount of grain concentrates necessary for good milk production is considerably less than when clover hay is not fed.

Illinois farmers often seed grasses with red clover. Yields of hay both from clover-grass mixtures and from pure clover are higher than from grasses alone. This is indicated by the following yields, which were obtained at Urbana:

	<i>Pounds of hay per acre</i>	
	<i>1944</i>	<i>1945</i>
Clover-timothy.....	5 300	5 520
Clover-orchard grass.....	4 920	4 360
Clover-bromegrass.....	5 500	5 880
Clover.....	5 180	6 040
Timothy.....	2 540	2 900
Orchard grass.....	1 320	1 340
Bromegrass.....	3 220	3 500

Grasses grown with legumes contain more nitrogen, and thus more protein, than grasses grown in pure stands. This fact is shown by chemical analyses, and is also apparent to the eye. Grasses growing with legumes are greener than grasses growing alone. This indicates that the legume provides nitrogen for the grass.



Clover-grass mixtures make excellent hay and are better for controlling erosion than red clover alone. This is a timothy mixture. (Fig. 2)

When to Harvest the Hay Crop

Most of the red-clover hay in Illinois comes from the first crop of the second season. For the best quality hay, this crop should be cut when the protein content is relatively high, leaves are intact, and the stems are green. The percentage of protein in clover hay is high when the first heads come in bloom and decreases each week until the plants are mature. The yield of hay per acre increases steadily from the time the first flowers appear until they are a few days past the full-bloom stage. The total amount of protein per acre is highest about the time half the heads are in bloom. For relatively high yields of both hay and protein, therefore, the first crop should be cut during the half-bloom to full-bloom stage.

Another advantage of cutting the first crop early is that the

yield of hay from the second crop will be increased. The second crop should be cut at the full-bloom stage. Hay will be of higher quality if cut at this stage than if the crop is allowed to become more mature.

Much of the red-clover hay produced in Illinois is cut too late to be of the highest quality. Corn and soybeans need cultivation when the first crop of clover should be cut for hay, and consequently farmers often delay cutting the clover until it has passed its best stage.

Methods of Harvesting the Hay Crop

One secret of making high quality hay lies in the curing process. Hay carefully cured in the sun so that it keeps most of its green leaves and original green color is high in carotene, which is the source of vitamin A.

Clover should not lie in the swath until completely cured. If it does, it will lose many of its leaves when handled. Windrowing is the best way to speed up the drying and at the same time obtain high quality hay. The hay should be left in the swath until well wilted, then windrowed with side-delivery rake and left in the windrow until dry enough to put in the mow or bale. Partly cured hay should not be left in the swath overnight, since dew will cause considerable loss of green color. The advantages of windrowing are that (1) few leaves are lost, (2) most of the bright green color is kept, and (3) windrows are easily picked up by the hay loader and the pickup baler.

The mower, rake, and hay loader are commonly used for making hay. Increased labor costs and shortage of labor are changing haying operations. Tractors are being used more and more to operate the machines. Also, the pickup baler is beginning to take the place of the hay loader. A recent type of pickup baler requires only one operator for the entire process. The bales are smaller and are tied mechanically with twine instead of wire.

Hay should be reasonably dry when put in mows, stacks, or bales. If moisture content is high, spontaneous combustion may cause fires, resulting in the loss of farm buildings. To be safe from fire hazard and spoilage, hay should contain not more than 25 percent moisture, and preferably somewhat less.

RED CLOVER FOR PASTURES

Red clover is an excellent pasture for all kinds of livestock. Like alfalfa, however, it may cause bloat. A mixture of red clover and grasses is less likely to cause bloat than pure stands of clover. Timothy is usually seeded with red clover for pastures, altho a wide variety of grasses may be used.

During the fall of the first season, red clover may be pastured but *not too heavily*. Close grazing keeps red clover plants from making their normal fall growth. While making their growth, the plants take nitrogen and carbon dioxide from the air and manufacture food materials which are stored in the roots. The plants need these foods in order to endure low winter temperatures and start vigorous growth in the spring.

During the second season, after two crops of hay or one crop



All classes of livestock make good gains when pastured on clover-grass mixtures. Danger of bloat is less than on pastures of pure clover. Many kinds of grasses can be seeded with red clover. (Fig. 3)

of hay and a crop of seed have been harvested, the aftermath furnishes a limited amount of pasturage. Usually many plants die after a crop of seed has been cut and threshed.

RED-CLOVER SILAGE

Red-clover silage is palatable to all classes of livestock. It is especially valuable for dairy cows requiring high-protein rations. Clover keeps more of its carotene content when it is ensiled than when it is made into hay. Carotene, the source of vitamin A, gives a yellow color to milk.

For greatest feeding value, clover should be made into silage when the crop is well in bloom. Clover can be ensiled even when the weather is not ideal for curing hay. Clover ensiled when wet with rain will be low in dry matter.

Since red clover is relatively high in protein and low in sugar, it should be mixed with phosphoric acid, molasses, or ground shelled corn. Sixty to 80 pounds of molasses, 15 pounds of phosphoric acid, or 80 to 100 pounds of shelled corn should be used for each ton of green clover.¹

RED CLOVER FOR SEED

Insects Necessary for Pollination

Red-clover flowers are practically self-sterile. This means that very seldom will the pollen of a flower fertilize either that flower or any other flower on the same plant. For fertilization to take place it is necessary that pollen be transferred from the flowers of one plant to the flowers of another plant. A large number of pollinating insects is needed for the production of high yields of red-clover seed.

Several species of insects transfer red-clover pollen. Bumblebees and a number of species of wild bees are especially efficient. Opinions differ as to the value of honeybees as pollinators of red clover. Apparently when other sources of nectar and pollen are available red clover is not attractive to the honeybee.

¹ For a more complete discussion of directions for making silage, see Illinois Circular 605, "Grass and Legume Silages for Dairy Cattle."

Most Seed Produced Second Year From Second Crop

Red-clover plants produce seed whenever the plants are left long enough to mature. Occasionally clover sown in the spring, either alone or on a grain crop, will produce a light seed crop the first season. It is commonly thought that producing seed the first season will weaken or destroy clover stands. Loss of stands, however, is likely to be caused by improper fall management and not by the production of seed.

Even tho some seed may be produced the first season, most red-clover seed grown in Illinois is harvested the second season, usually from the second crop. The first crop of the second year can be harvested for seed; and occasionally, when conditions are very favorable, the first crop will even produce more than the second crop. Usually, however, the first crop is needed for hay or pasture. Also, seed-producing conditions are generally better for the second crop. For one thing, the weather during the blooming and ripening period is usually clear and dry. Also, there are generally more pollinating insects during July and August than earlier in the season, and at the same time fewer flowers of other plants to attract the insects. Harmful insects like the clover seed midge and the clover seed chalcid usually cause the least damage to the flowers and seed of the second crop. Finally, growth of the second crop is less rank than that of the first. This, too, favors seed production.

Time of First Cutting Is Important

If the second crop is to be used for seed, the first crop should be removed not later than the full-bloom stage and before the heads have turned brown. Early cutting of the first crop gives the second crop a chance to develop rapidly and vigorously. Also, attacks of some harmful insects may be less severe.

Cutting the first crop of red clover one or two weeks after full bloom often reduces the seed yield of the second crop by nearly half. This was found in experiments at the Ohio and Michigan Agricultural Experiment Stations and in preliminary tests at the Illinois Station.

Harvesting the Seed Crop

Red clover for seed should be cut when the heads have turned brown and the seeds have become hard but before they start to shatter. Shriveled seed is usually caused by cutting the crop too early. Ripe clover may be cut any time of the day. If the plants are very dry, however, they should preferably be mowed when they are wet with dew, and windrowed before the heads become dry. This will keep the seed from shattering very badly. Clover may be windrowed with a bunching attachment on the mower or a side-delivery rake.

Several types of machines are used successfully to separate the seed from the pods. Special machines called clover hullers are used in some places. Grain separators with hulling attachments are also used. Grain combine harvesters, however, are rapidly taking the place of these older types of hulling machines. Combines operated in the field either as stationary or pickup machines are now commonly used to hull clover seed. Occasionally fields of standing clover are combined; however, a good job of hulling cannot be expected unless all the seed is ripe and the plants thoroly dry.

Clover Seed Should Be Cleaned

Clover seed used on the farm or offered for sale should be free from weed seeds, foreign matter, and immature and shriveled seeds. Fanning mills, properly operated, generally clean seed enough to meet most market requirements. Commercial seed dealers and grain elevators usually maintain seed-cleaning equipment. In some localities equipment mounted on trucks is used for custom seed-cleaning.

RED CLOVER FOR SOIL IMPROVEMENT

Like other legumes red clover takes nitrogen from the air and converts it into forms which can be used by the growing clover (see pages 8-9) and also by grasses growing with it. A 4-ton crop of clover hay may contain as much as 150 pounds of nitrogen, as well as 20 pounds of phosphorus and 120 pounds of potassium.



Turning under a clover crop is a good farming practice. Red clover enriches the soil with nitrogen, and also helps to maintain good tilth by mellowing and granulating the soil. (Fig. 4)

Of the total nitrogen in clover, two-thirds is in the plant above the ground and one-third is in the roots. When two crops of clover have been removed from the land, the nitrogen left in roots and stubble is about equal to that taken from the soil by the crop. Nitrogen is the only plant food that can be maintained just by properly rotating crops.

If the clover crop is to build up the nitrogen content of the soil, rather than merely keep it at the same level, more of the clover than just the roots and stubble must be returned to the soil. Whatever use is made of the clover crop, its value for soil improvement depends upon how much of the crop is returned to the land either as green manure or as barnyard manure and crop residues.

Besides enriching the soil with nitrogen, red clover mellows and granulates the soil and thus helps to keep it in good tilth. Since red clover is a sod-forming crop, it also protects the soil, reducing soil erosion. Clover-grass mixtures, however, protect the soil better than clover alone.

RED-CLOVER FAILURES

Recent years have seen an increasing number of entire or partial failures of red clover. Failure of a red-clover seeding to produce a good stand or an abundance of forage and seed may be due to one or more causes. The most common are: (1) unadapted or poor seed, (2) lack of inoculation, (3) wrong methods of seedbed preparation, (4) soil acidity and lack of plant nutrients, (5) competition of grain crops and weeds, (6) improper management the first season, (7) insects and diseases, (8) drouth, and (9) winterkilling. Clover failures in Illinois have been more frequently attributed to a lack of lime in the soil than to any other condition.

Good methods of farming will usually get rid of the first six causes for clover failures. Insects and diseases, drouth, and winterkilling are more or less beyond the control of man; yet they too may be partly controlled or combated.

Insects and diseases are present to some extent each year. Altho they seldom cause complete clover failures in Illinois, they doubtless cause partial loss of stands or reduce the yields and quality of forage and hay. Strains of red clover that are resistant to specific insects and diseases have considerable value.

In regions where crop production depends upon rainfall, drouths are likely to occur. While man cannot control drouth, he can partly control its effects. When soils become dry it may mean the difference between success and failure if a dry loose seedbed is cultipacked or a companion crop removed before the seedlings die.

Red clover stands are often winterkilled. Winterkilling caused by late summer planting, use of unadapted seed, or untimely clipping can be largely prevented. There is, however, little or nothing to be done about winterkilling caused by the weather. Alternate periods of mild and subzero temperatures, with no snow cover, are frequently disastrous to clover stands. Mulching a clover meadow with straw does provide some protection against the cold and also tends to prevent heaving, which may injure or even kill clover stands. On large fields, however, mulching is usually impractical.

INSECT PESTS OF RED CLOVER

Many insects feed on red clover, different kinds of insects varying in their preference for tops or roots. As previously stated, insects cause some damage and may reduce the yield of forage, but rarely cause complete failures. Among the insects attacking red clover, seven species are most commonly found.

Clover leaf weevil (*Hypera punctata* (Fab.)). The greenish larvae of the clover leaf weevil feed on red-clover leaves early in the spring. They may be found at the base of plants during the day, but they do most of their feeding at night. Their presence is indicated first by small holes in the leaves, and later by irregular patches eaten from the margins. During April and May a raggedness is sometimes very noticeable in the clover plants.

Seldom is an entire crop lost, but considerable injury may occur before the larvae are killed by a fungus disease to which they are very susceptible.

Lesser clover leaf weevil (*Hypera nigrirostris* (Fab.)). The adults and larvae commonly feed on red clover but they may also attack alsike clover. The larvae will attack newly forming buds and heads of the first crop. Buds may be blasted, and new heads may fail to develop. The larvae may also eat into the stem and even partially tunnel into it. The adults feed on the leaves, riddling them. Parasitic insects attacking the larvae apparently hold this pest in check.

Potato leafhopper (*Empoasca fabae* (Harris)). This leafhopper is a very small, quick-jumping, pale green insect that is not easily detected unless extremely abundant. It punctures the foliage of red clover and sucks out the juices, causing the leaves to turn reddish or yellow. The potato leafhopper, however, seldom does much damage to the well-adapted, native strains of medium red clover in Illinois. Red-clover strains developed in this country have hairy stems and leaves which enable them to resist leafhopper attacks much better than foreign red-clover strains whose stems and leaves are only slightly hairy.

Clover root borer (*Hylastinus obscurus* (Marsh.)). The clover root borer is one of the most destructive enemies of red clover; this pest, however, is not equally serious in all regions where red clover is grown. Rarely does the root borer work in plants before they are a year old. Then it tunnels in the roots, where it lays its eggs. The eggs, small larvae, and even the dark-brown adults may be found in the cavities. Because of their weakened root system, affected plants are apt to break off at the ground level. Also, the damage to the roots provides entrance for fungi that may cause crown and root rots. A badly infested field should be plowed as soon as possible after the first crop of hay is removed. With the death of the plant, the larvae also die.

Clover seed midge (*Dasyneura leguminicola* (Lint.)). This insect does much damage to the red-clover seed crop. It is a small fly that lays its eggs

in the blossoms. The tiny larvae injure the blossoms so that seeds are not formed. This pest can be controlled to a large extent by cutting the first crop before the larvae are mature. They will then die from lack of food. Early cutting of the first crop hastens the development of the seed crop, so that the flowering heads will be too far advanced for the second brood to cause much damage.

Clover seed chalcid (*Bruchophagus gibbus* (Boh.)). This small, wasp-like insect is very destructive to the seed crop. It lays its eggs in newly formed seeds. The larva develops inside the seed, eating it all except the coat. The adult emerges thru a small round hole in the coat. A practical aid in control is cutting or pasturing the first crop early so that a seed crop will be produced before there are very many of the insects.

Grape colaspis (*Colaspis flavida* (Say.)). The larvae of this insect are curve-bodied and short, having a length of $\frac{1}{8}$ to $\frac{1}{6}$ inch. They feed on the roots of red clover and many other plants. The adults are clay-yellow beetles about $\frac{3}{16}$ inch long. When good crop rotations are followed, this insect does little damage to the clover crop.

Corn planted on clover sod heavily infested with the larvae may be severely damaged. Reddening of seedling corn plants is usually a sign that the larvae are feeding on the corn roots. Late planting and the use of phosphate fertilizer at planting time will help to prevent losses to this crop.

RED-CLOVER DISEASES

A number of diseases may attack red clover, but they seldom cause much loss in Illinois before the end of the second season. One or more diseases may be present during the life of the crop.

Leaf diseases. Several kinds of leaf diseases may be found in a clover field. There may be spotting, discolored areas, or leaves entirely blackened. Usually these diseases are most severe on leaves at the base of the plant, where conditions are most ideal for fungus development.

Powdery mildew, *Erysiphe polygoni* DC., is a leaf disease occurring on red clover and also on other clovers. It appears as a white to light-gray powdery dust on the leaves of infected plants. It is likely to be most common when rainfall is light. Severe infections may reduce both yield and quality of hay. Experiments have shown that hay heavily infected with the disease may be fed to animals without hurting them. No practical method of controlling the disease has been found. However, thru selection of resistant plants it is possible to build up clover strains that are highly resistant to the disease.

Northern anthracnose (*Kabatiella caulivora* (Kirchn.) Karak.). This disease occurs most often in the northern part of the red-clover growing region, but it may occur thruout all of Illinois. It can be readily recognized by the dark-colored injuries on the stems, petioles (leaf stems), and leaves.

These parts may finally be completely girdled, as the spots grow larger and spread together. Girdling of the affected parts causes them to wilt and finally die. Plants that have been attacked by the disease have a scorched appearance: the foliage droops, becomes almost black, and is very dry.

In central Illinois this disease generally appears in late May or early June. It develops rapidly when the temperature is cool and humidity is high. It does not kill the plants, but severe infection reduces the yield and quality of the first crop of hay. Even tho the first crop may be badly infected, the second crop is apt to be entirely or almost free from the disease and produce a crop of hay or seed. There are not yet any practical measures that will control the disease. Varieties and strains differ considerably in their resistance, but none is entirely immune. It is probable that thru selection and breeding, red-clover strains highly resistant to the disease will be developed.

Southern anthracnose (*Colletotrichum trifolii* Bain & Essary). This disease is confined largely to the southern part of the clover belt. In Illinois it is most apt to occur in the southern part of the state but in unusual seasons it may occur almost anywhere.

The symptoms are very like those of northern anthracnose. The disease develops rapidly during midsummer when the temperatures are relatively high. The fungus attacks the new shoots of the second crop; these in turn may infect the crown and roots. When the entire plant is infected, it quickly dies.

This disease has caused an enormous amount of damage in the southern part of the clover belt. Many stands of clover have been completely killed, resulting in the loss of either a crop of forage or a crop of seed. Cumberland and Kenland, varieties developed within recent years, are partially resistant to this disease but very susceptible to northern anthracnose.

Other red-clover diseases. There are several mosaic diseases of red clover which are caused by viruses transmitted by aphids and leafhoppers. These diseases cause mottling of the leaves and sometimes dwarfing of the plants. Within recent years crown and root rots have caused considerable damage to red-clover stands in their second year of growth. Very little is known about the mosaics and crown and root rots, and measures for their control have not been developed.

Black-stem disease and rust are fungus diseases that may cause damage when conditions are right for their development.

*Some of the more important points
covered in this Circular are
summarized on the next page.*

RED CLOVER is one of the important forage and soil-improving crops in Illinois. It fits well into crop rotations adapted to grain or mixed farming. It makes excellent hay and pasture for livestock, especially if it is grown with timothy or other grasses. Altho less exacting in its soil requirements than some of the other legumes, it thrives best on well-drained soils containing good supplies of lime, organic matter, and plant nutrients.

Time to sow. Red clover is usually sown in late February or early March on winter wheat or in March or April with a spring grain. Late-spring or early-summer seedings, without grain, are generally successful if the soil has plenty of moisture.

Cutting for hay and seed. The first crop of the second year produces the most hay. The second crop usually yields the most seed. For high-quality hay, the first crop should be cut before the full-bloom stage. Also, if the first crop is cut early, the seed crop is usually larger than if the first cutting has been delayed.

Curing hay. One secret of making high-quality hay is to cure it properly. Clover left in the swath until dry loses many of its leaves when handled. Windrowing when the hay is well wilted in the swath is necessary to prevent loss of leaves and color. The practice of baling windrowed hay is increasing thruout Illinois.

Insects and diseases. Every year red clover is damaged by insects and diseases. While an entire crop is seldom lost during the first season, the stand is likely to run out by the end of the second season.