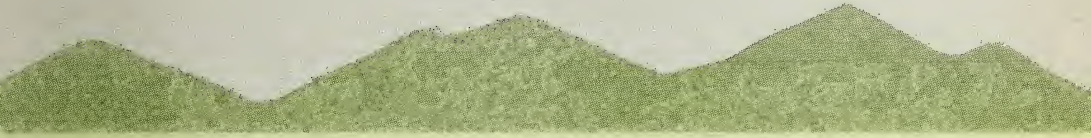




Division of Agricultural Sciences  
UNIVERSITY OF CALIFORNIA

# PRODUCTION OF

# RANGE CLOVERS



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CIRCULAR 458

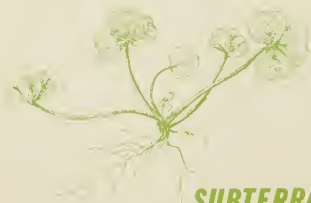
# Planting CLOVER



**ROSE**



**CRIMSON**



**SUBTERRANEAN**



**BUR**

## **Clovers have a high feed value**

They grow in most California climates and soils . . . do well on brush burns, annual type ranges, grainland . . . provide plentiful feed in spring . . . and make good dry feed in summer and fall.

## **Four sturdy and widely-adapted clovers . . .**

can be grown on livestock ranges to give your cattle improved forage. Prolific seed producers, they draw nitrogen from the air and thus enrich the soil.

## **This circular . . .**

tells how you can use one or more of these four clovers—rose, crimson, subterranean, bur—to improve rangeland. It tells how to seed, fertilize, and manage them. Details on each clover are in the second half of the circular.

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**JANUARY, 1957**

# can improve your rangeland forage

You can use annual reseeded clovers to provide an abundance of nutritious feed during the spring season and good dry feed during the summer and fall.

Rose, crimson, subterranean, and bur clovers are winter annual legumes. They germinate with the first substantial fall rains and grow slowly during winter. When the temperature starts to rise in late winter they begin rapid growth. The clovers bloom and set seed in late April and May. Then the plants dry and cure, casting their seeds which remain dormant until the fall rains begin. This pattern of growth makes these clovers particularly well adapted to California's climate of relatively warm, moist winters and hot, dry summers.

Among the four of them, these clovers do well over a wide range of soil types at elevations up to 3,000 feet and with an annual rainfall above 10 inches. They are prolific seed-producers under average conditions and usually produce some seed under quite unfavorable conditions. Consequently, after they are established, reasonable care assures their continuing on the range practically indefinitely.

## **Nitrogen from the Air**

These legumes are able to supply their own nitrogen from the air in the presence of the proper legume bacteria. This trait is particularly desirable in California, where almost all range soils do not contain enough nitrogen for abundant forage production. The nitrogen obtained from the air not only makes the clovers productive but also increases their protein content. It also improves

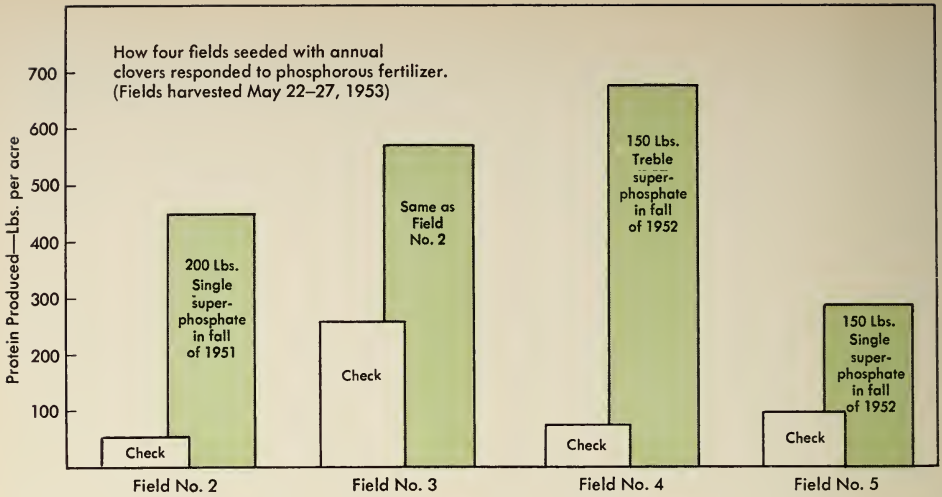
the amount and quality of feed produced by other plants growing with them.

These four clovers are well adapted for use in seeding annual-type range as well as abandoned grainland. On brush burns, rose clover—and in some cases one or more of the other clovers—should be included in the seed mixture. The clovers have also been successfully seeded with oats and barley under favorable moisture conditions. They furnish valuable forage in the grain stubble after harvest and during the following years.

Mixtures of annual clovers and perennial grasses on the better sites will lengthen the season of use by providing green feed earlier in the fall and later in the spring. Such dryland pastures make an ideal supplement to unimproved range.

## **Fertilization Is Important**

Soil fertility is an important factor in obtaining high production from the clovers. The two fertilizer elements that improve range legume growth most frequently are phosphorus and sulfur. More than three-quarters of California's foothill and terrace soils are deficient in phosphorus, and these make up the bulk of our range soils. The precise area needing sulfur is not known since more soils deficient in sulfur are now being identified. Extensive areas of sulfur-deficient soils lie along the eastern edge of the San Joaquin Valley and the western border of the Sacramento Valley. Some soils need both phosphorus and sulfur. Single superphosphate is a good remedy for these since it contains substantial



amounts of both (18-21% P<sub>2</sub>O<sub>5</sub> and 10-12% S).

The benefits from phosphate fertilization of the clovers are illustrated by experiments performed on a red claypan soil (Placentia series) near Lincoln, Placer County. Inoculated rose, crimson, and subclover were planted just prior to fall rains. In three fields single superphosphate was applied at the rate of 150-200 pounds per acre and in another treble superphosphate was applied at the rate of 150 pounds per acre.

On the 498 acres improved in this manner, the carrying capacity was tripled in the following three-year test period. The increase in feed resulting from phosphorus fertilization is shown in the chart above. Protein contained in the feed was increased by two times in field 3 and up to nine times in field 4. This resulted from both the greater amount of feed produced and the increase in the protein percentage, from 9.0 per cent unfertilized to 13.1 per cent fertilized. The phosphorus content of the feed was also improved.

### Sulfur Improves Forage on Rose Clover Ranges

Treatment	Forage produced (dry basis) lbs./acre		Per cent rose clover in forage		Per cent protein in forage	
	1954	1955	1954	1955	1954	1955
<b>Resident Range (Filaree)</b>						
Unfertilized . . . . .	1,080	680	0	0	4.6	6.8
500 lbs./A. Gypsum . . . . .	1,120	730	0	0	6.0	6.8
<b>Seeded to Rose clover</b>						
Unfertilized . . . . .	1,970	1,540	29	38	8.5	10.1
500 lbs./A. Gypsum . . . . .	3,080	2,270	64	53	12.4	11.9

Data show how rose clover takes advantage of sulfur fertilization to increase forage production and protein on sulfur-deficient Snelling sandy loam in Stanislaus County. From a cooperative test with W. N. Hapelstine and R. J. Arkley.

The increased potential resulting from sulfur fertilization of adapted legumes on Snelling sandy loam is illustrated in the table on page 4. On this soil the volunteer range feed (mostly broadleaf filaree) produced an average of less than one-half ton of dry feed in the two-year test. Seeding rose clover doubled forage production. Fertilization of the rose clover seeding with 500 pounds of gypsum per acre increased feed as much again as did the rose clover seeding alone. Applying gypsum to the filaree range did not increase feed production appreciably. Introducing rose clover improved the protein content of the feed markedly, and gypsum fertilization further improved it. As a result of these and other tests, over 360 acres on this ranch have been similarly improved. The results not only show how important sulfur fertilization can be on specific soils, but also how important it is to have a plant such as rose

clover which can take advantage of the improved fertility.

### **Fertilize at Time of Seeding**

For the majority of range soils, from 200 to 500 pounds of single superphosphate will aid the establishment of range clovers. This material contains both phosphorus and sulfur. In areas where sulfur is the principal nutrient lacking, 200 to 400 pounds of gypsum per acre will satisfy the plants' needs. In areas of poor native growth the addition of 10 to 20 pounds of actual nitrogen per acre is helpful. See your local University of California Farm Advisor for information on soil nutrient deficiencies before deciding on the kind and amount of fertilizer materials to be used.

Range clovers should be refertilized every two or three years. Local experience will best determine the amount of fertilizer necessary to maintain a productive stand of clover.



This grain drill was used for placement of seed and fertilizer on a ranch in San Diego County.  
(Photo by Charles F. Walker)

## Seed and Fertilizer Placement

Within the past six years considerable information has been published concerning the success of Eastern experiments with the placement of fertilizers in pasture seedings. The practical importance of these principles is being tested in California.

The placement procedure consists of banding the seeds over drilled rows of fertilizer. This method has several advantages over broadcast methods. The emerging seedlings have immediate access to nutrients which may otherwise be unavailable in the soil, or if broadcast, may be scattered out of reach. Also, concentrating the fertilizer near the seed places it out of reach of many of the competing plants between the rows. Maximum efficiency is obtained by row placement of phosphorus fertilizer, much of which becomes fixed by soil colloids when broadcast and therefore unavailable to plants.

Various pieces of equipment have been used to achieve the same basic results. The simplest of these consists of an inexpensive modification of a grain drill with a fertilizer attachment and a grass seeder box. The fertilizer is dropped through the furrow openers as is commonly done when sowing grain. The furrow openers are set to deliver the fertilizer 1 to 2 inches below the surface of the closed furrow in rows 12 inches apart. The range seed mixture is then conveyed by tubing from the grass seeder box and dropped on the closed furrow 8 to 12 inches behind the fertilizer shoe. The seed is dropped from a height of about 3 inches so that the seed is concentrated in a band on the surface of the closed furrow and is either covered by subsequent rolling, press wheels, or drag chains. Inexpensive conversion kits for grain drills are available commercially.

## Seedbed and Seed Coverage

Seedbed preparation is desirable whenever possible prior to planting clo-

vers on rangeland just as it is with cultivated crops. It serves two purposes. It helps to eliminate competing plants which volunteer in all grass and woodland grass range plantings, and it provides the loose soil necessary for covering the seed.

Volunteer annual grasses and forbs grow faster than clovers under normal winter temperatures. This makes them strongly competitive with the clovers. Disking or plowing deep before fall rains will bury the seed crop of these volunteer weedy species. Disking after the first rains will destroy any germinating volunteers. Where competition is not likely to be severe a light single disking  $1\frac{1}{2}$  to 2 inches deep is sufficient to provide a surface mulch and seed coverage. This light disking will disturb only a portion of the sod, thus reducing the risk of soil washing in the winter.

**Sudangrass** has been used successfully as a cleanup crop prior to planting clovers. Since sudangrass is planted late in the spring, volunteer vegetation must be turned under prior to seed formation. Sudangrass exhausts soil moisture in the early summer, thereby preventing summer weeds from making any headway, and furnishes nutritious summer feed. Clover seed should be drilled into the sudan stubble without seedbed preparation. The reduced competition, the firm seedbed, and the protection of the stubble are ideal conditions for clover establishment. Summer fallow can be used where moisture or other conditions are not favorable to sudangrass. Where seed is sown on sod or grain stubble it should be tramped in by livestock.

**Controlled burning** of tall dense brush provides a desirable seedbed for clovers. Where such stands have been removed, remnants of grasses and weedy species are sparse. During the first year, while the seeded clovers are establishing themselves, there is little or no competition from resident plants, as there is with a seeding on the open range. In open

areas where, before burning, there was only grass or sparse brush, seeding is not likely to be so successful because of competition from volunteer plants. Although ash from burned brush provides some cover for broadcast clover seed, the ash is often blown away. Mechanical coverage is desirable where possible.

**Cover the seed** during or following the planting operation on cultivated seedbeds to protect it from birds, rodents, and ants. This practice provides the seed with a good tie to subsoil moisture and helps the young root to penetrate the soil. Clovers should not be seeded more than  $\frac{3}{4}$  inch deep. The desired depth may be obtained with a properly regulated drill on most soils, with a cultipacker seeder, or by broadcasting on a firm seedbed followed by rolling.

### Time of Seeding

October is the optimum month for seeding clovers over most of the area to which they are adapted. They make maximum use of the season's moisture when planted before the first fall rains. The clovers ordinarily contain hard seed which will germinate over a long time and protect against a prolonged drought following the first germinating rain. If your knowledge about the site indicates that competition from volunteer plants will counteract the advantage of early planting, then your best procedure is a light disking of a prepared seedbed after fall growth has started, followed by planting. Midwinter seedings have a chance of being moderately successful only during mild winters. In winters when heaving is a problem the early-planted clovers with vigorous root systems are better able to withstand the strains developed by alternate freezing and thawing of the surface soil.

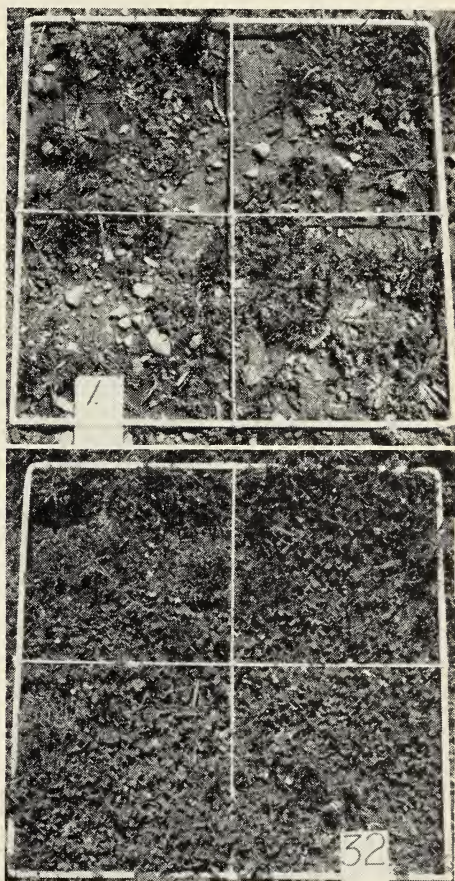
Although some early spring seedings have been successful when late rains occurred, spring seedings of winter annual clovers ordinarily have little insurance of success on dryland.

Where a limited amount of irrigation water is available, it can be profitably used in starting the clover earlier in the fall or in reducing the moisture stress of late winter or spring droughts.

### Inoculation Is Good Insurance

Inoculation of the clovers with nitrogen-fixing bacteria is good insurance for stand establishment. The proper strains of bacteria are frequently absent from the soil. Commercial inoculums currently available are reliable sources of legume bacteria.

Inoculation is done by placing the bacteria on the seed in a slurry just be-



How inoculation boosts forage. Subclover at top was not inoculated, averaged 60 pounds forage per acre; inoculated seed below averaged 1,460 pounds per acre.

fore planting. Care must be exercised not to wet the seed so much that it won't run freely through the seeder. Inoculation is easily accomplished by the use of a small concrete mixer, but also may be accomplished by hand mixing with a shovel.

The bacteria stimulate the roots into producing nodules in which the bacteria live. There they make free atmospheric nitrogen available to the plant. This process of nitrogen fixation by legumes produces high-protein forage, and improves the fertility of the soil as the legume roots die and decay.

Legume bacteria are easily killed by sunlight, drying, and high temperatures. Therefore you should cover inoculated seed as soon as possible after sowing. Fresh inoculum must be used. Look for the expiration date on the container. Clover inoculum is used for rose, crimson, and subclovers. Alfalfa inoculum is used for bur clover.

**Seed treatment** with a fungicide may be profitable where seedling diseases are a problem in obtaining stands. However, many fungicides, particularly those containing mercury, destroy legume bacteria when both are applied to the seed. When fungicide treated seeds are used, inoculation should be your last operation performed before planting, and the interval between inoculation and planting should be as short as possible. Seed treatment by fungicides does not interfere with inoculation by soil-borne legume bacteria.

### **Grazing Management**

Timely grazing is essential to insure permanent stands of clovers. Newly-seeded areas should be grazed as soon as the weeds and annual grasses are of pasturable height. By that time the cotyledons (seed leaves) of the clovers will have dropped off, and true leaflets will have formed. The plants will be 2 to 5 inches high. Graze the field to a uniform height of about 3 inches for a period no

longer than a month. In many instances this has required as many as three cows and their calves per acre. Take care to prevent trampling damage if the soil is wet.

It is almost impossible to harm a new seeding the first spring by "over-grazing." The important thing is to remove the stock well before the last spring rains to allow the seeded species to mature a seed crop. Graze the field again before the fall rains to trample the seed into the ground and so thicken up the stand.

A weed-free seeding in the ash of a brush burn becomes better established if you keep stock off the first season until the seeds begin to shatter. Annual legumes do well in burned areas because there is usually no competition from resident annuals. Where there is competition from annual grasses or sprouting brush, an early grazing is helpful.

### **Long-term Grazing Program**

No fixed rules can be outlined for a range domain such as California's with its wide variations in climate, soil, and elevation. A grazing-management plan must be based on individual ranch conditions, type and abundance of forage plants and their distribution over the given area, and practical necessities such as cross-fencing and stock-watering facilities.

Obviously, the seasonal green feed produced by winter rains should be converted into meat and wool while at its best. On the other hand, the perennials and better late-maturing annuals (such as the clovers and soft chess) should be allowed to set some seed and thus increase their percentage in the total forage. This requires a balanced grazing program.

**A three-year rotation** plan has been found practical and effective in improving the range. In carrying out such a plan, the rancher divides his range area into three fields, either by fencing or by herding to keep stock from certain por-



tions of the range. The plan must also include adequate watering facilities in each field. This is how it works:

The first year, the rancher grazes field number 1 early, and removes the stock before the surface soil moisture is exhausted in the spring, keeping the animals in the other two fields in turn.

The second year, he applies the same treatment to the second field, using the first and third fields for later grazing.

The third year, he applies this practice to the third field, turning the animals then into the first and second fields.

Such a grazing cycle should serve to keep a proper balance of forage species in all three fields.

The use of a mixture of annual clovers of varying growth habit allows a much greater latitude of adjustment of livestock use than is otherwise possible. Hence the application of the above plan can be quite flexible for mixtures.

### Feed Value Is High

The feed value of clovers is high compared to resident range feed especially in terms of their protein content. This is shown in the table on page 4 and in the table below.

The protein content of rose clover is somewhat less than that of bur clover, as shown by the following figures: lush vegetative stage—rose 24.9 per cent, bur 27.0; flowering—rose 12.6, bur 15.0; and dead ripe—rose 8.0, bur 13.9. The protein content of crimson and sub-clovers does not differ consistently from that of rose clover when grown under comparable conditions.

### Clovers Grow on Grain Land

All four clovers have been successfully grown in grain where seasonal moisture has been adequate. The clovers will not ordinarily grow as robustly when competing with cereals as when sown alone. But they provide a good aftermath feed to supplement the cereal stubble and they will volunteer in subsequent years, furnishing nutritious feed in the seasons when cereal is not sown as well as adding nitrogen to the soil to benefit subsequent grain crops. The clovers should be planted after the cereal, otherwise they will be buried too deep.

A Glenn County rancher seeds clovers by plane after a barley crop is harvested. Grazing sheep do an excellent job of "planting" the seed.

**Fertilizing with Phosphorus Increases Protein**

Forage	Treatment	Per cent (dry basis)						
		Protein	Fiber	Fat	Ash	Nitrogen-free extract	Phosphorus	Calcium
Clovers	Check	12.1	30.6	1.7	5.5	49.6	.098	1.37
	Fertilizer	14.3	30.8	1.7	4.9	48.5	.144	1.37
Resident annuals	Check	6.6	30.0	1.9	6.9	54.6	.103	1.56
	Fertilizer	8.2	29.2	1.8	7.1	53.7	.120	1.58
Total feed	Check	9.0	30.6	1.8	6.2	52.5	.099	1.46
	Fertilizer	13.1	30.6	1.6	5.3	49.4	.136	1.40

Data show effects of phosphorus fertilization on the composition (dry basis) of forage on range seeded with annual clovers. Average of 4 fields in Placer County. Forage was harvested in late May when clovers were mature but had not shattered.

## Pest Depredation

The depredations of pocket gophers, field mice, kangaroo rats, ground squirrels, rabbits, harvester ants and birds can severely affect initial establishment as well as subsequent maintenance of stands of clovers. These pests can be controlled by appropriate methods, but the economics of control under range conditions are still in the experimental stage.

## Clovers for Range Improvement

Annual reseeding clovers can provide your cattle with an abundance of nutri-

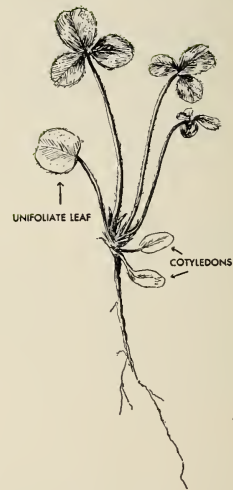
tious feed during the spring season, and good dry feed during the summer and fall. Mixtures of annual clovers and perennial grasses on the better sites will lengthen the season of use by providing green feed earlier in the fall and later in the spring. Such dryland pastures make an ideal supplement to unimproved range. Additional fall and winter green feed can be made available on native range by the application of fertilizer in the fall, using nitrogen alone, or in combination with phosphorus and/or sulfur depending on the particular soil.

# Rose Clover

...has proved to be the most widely adapted legume for range use in California. It will grow on soils where many other forage plants do not survive, and will even provide some forage under such unfavorable conditions. Since its introduction from Turkey in 1944, it has been planted on many thousands of acres.

## How It Looks

Rose clover, *Trifolium hirtum* All., is a much branched, winter annual legume that grows 3 to 18 inches high. The spreading branches are densely covered with short, coarse hairs. Each leaf has three leaflets with a scattering of hairs over both surfaces and usually a small reddish mark a little above the center with a whitish mark flaring to the leaflet margins. The flower heads are rose-colored, spherical, about  $\frac{3}{4}$  inch across, and profusely hairy. The plant normally has an upright growth habit. The seeds are yellow, smooth, a little over  $\frac{1}{16}$  inch



long, and almost spherical in shape. The number of seeds per pound is 140,000.

## It Is Widely Adapted

It is adapted to a wide range of soil texture and soil depth. It does well on strongly acid to moderately alkaline soil conditions but does poorly on water-logged soils. Being a winter-growing annual it escapes summer drought. Commercial plantings succeed down to 10 inches annual rainfall. Since it blooms later than other annual clovers, it extends the green feed period. Climatically it is adapted to most of the range area of the state. Exceptions are found in the coastal fog belt, in areas receiving less

than 10 inches annual rainfall, and above 3,000 feet elevation.

### Livestock Like It

Cattle, sheep, and deer graze rose clover well even when it is completely dried up. It is also well liked by dove and quail.

### Rose Clover Reseeds Itself

An abundance of viable seed is produced by rose clover. Even under unfavorable conditions some seed is usually produced. One fall seeding establishes the crop. It then reseeds itself in subsequent years, increasing in density and production. A high percentage of each year's crop of seed is hard. These hard seeds do not germinate with the first fall rains, but remain dormant for a variable extended period of time. Sometimes a large portion of them do not germinate until the second year after production. Hard seeds provide insurance against stand-killing droughts or frost heaving after germinating rains. After a sufficient supply has built up in the soil it will tide the clover over a year of cultivation for a grain crop, or a year when the blooming clover is grazed or harvested for hay. Percentages of hard seed in several

samples of commercial rose clover seed are shown in the table below.

A livestock management practice favoring reseeding of rose clover is the removal of stock while enough soil moisture remains to make a seed crop, followed by summer grazing of the dry clover to shatter the seed and trample it into the soil.

### Plant It on Annual Type Ranges

Use from 1 to 10 pounds of seed per acre. Drill or broadcast the seed. If you are not in a hurry to get a stand, use the lower seeding rate. An original seeding of 1 pound per acre will generally develop into a solid stand in four or five years. The higher rate should provide a solid stand the second year. Depth of planting should not exceed  $\frac{3}{4}$  inch.

If the soil is extremely infertile and supporting practically no growth of native plants, use rose clover alone. If there is a fairly good cover of native weedy annual grasses and other types, use a mixture of 50 per cent rose clover, 25 per cent subclover, and 25 per cent crimson clover. (Bur clover is not recommended in this original mixture because if it is not already present on a range it is probably not adapted to the soil con-

**Hard Seed Percentage in Rose Clover Seed Samples Analyzed  
by the State Seed Laboratory**

Year		Hard seed	Germination	Total
1953	Average (20 samples) . . . . .	32.90	53.75	86.65
	Highest hard seed content . . . . .	58.00	39.00	97.00
	Lowest hard seed content . . . . .	15.00	42.00	57.00
1954	Average (7 samples) . . . . .	28.00	57.43	85.43
	Highest hard seed content . . . . .	56.00	37.00	93.00
	Lowest hard seed content . . . . .	17.00	69.00	86.00
1955	Average (7 samples) . . . . .	35.86	51.00	86.86
	Highest hard seed content . . . . .	47.00	45.00	92.00
	Lowest hard seed content . . . . .	25.00	57.00	82.00

ditions existing in that particular annual type range.)

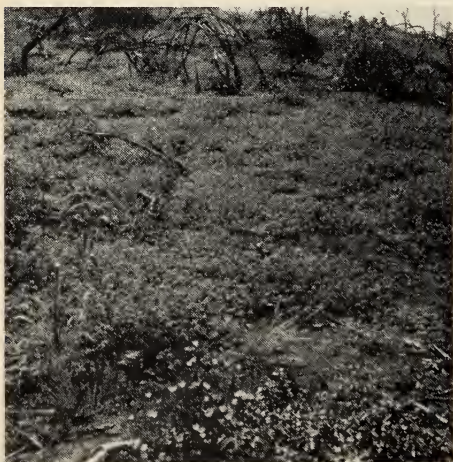
A mixture of winter annual legumes is desirable for two reasons: (1) Seasons vary tremendously in California, and rose clover may do better one year, and subclover another, on the same site. (2) Any field has some soil variation, and rose clover will occupy the poorer soil or better drained areas, while subclover will do well on the better soil or moister sections.

Do not be concerned if the field looks very weedy the first year. This is the result of the initial cultivation, which encourages weed seed germination. The field will take on a cleaner appearance each succeeding year if livestock use is handled as recommended.

### **On Brush Burns**

Include rose clover in the seeding mixture. It grows in the shade of tall grasses. No other range legume has proved to be so well adapted to such a great variety of soil types and climatic conditions.

Use 1 to 2 pounds of seed per acre. This is usually adequate when included in a general seed mix, such as harding, smilo, other annual clovers, and alfalfa. Inoculate the seed with a general clover



Rose clover seeded in a brush burn in Tulare County—elevation 3,000 feet.

inoculant just before mixing with other seeds. Rose clover, except in the early bloom stage, has some tolerance for sprays which may be used on brush seedlings following brush clearance.

### **On Grainland**

Rose clover has been seeded successfully with oats and barley in many field seedings where seasonal rainfall has been sufficient. For planting rose clover with a cereal, use 1 to 10 pounds of rose clover seed per acre. There are two common methods for planting: (1) seed the cereal first, then seed the rose clover by airplane; or (2) have an alfalfa seed box attached to the grain drill and seed the cereal and clover at the same time. Care should be taken not to bury the clover seed too deep.

The advantages of growing rose clover on grainland are: (1) It will do well on soil types that do not support a good growth of bur clover. (2) It will provide a good aftermath feed to supplement the cereal stubble. (3) It will volunteer in succeeding years and add nitrogen to the soil, thus aiding the grain crop.

### **On Abandoned Grainland**

Give rose clover the same treatment as that described for annual type ranges. Trials and experience generally throughout the state indicate that, to date, rose clover is the best winter annual legume to use to reclaim such land.

Gradually it builds up the soil to the point where it will support more and more growth of desirable forage plants. A striking example is a ranch in Santa Clara County where the soil had become very thin, and would not support vegetation. The soil was improved through use of rose clover, which built up the depleted nitrogen supply.

Summer annual weeds such as tarweed, star thistle, and turkey mullein are controlled by vigorous stands of rose clover. As it matures it uses up moisture



Tarweed flourishes in freshly disked area at left. At right a six-year-old stand of rose clover has practically eliminated undesirable weeds allowing soft chess and annual ryegrass to invade the area. (Sacramento County)

left by the earlier maturing annual grasses and thus leaves little for later maturing undesirable summer annuals.

Rose clover has been unusually free of the insect and disease pests which frequently afflict other forage plants. It is resistant to the spotted alfalfa aphid.

Seed is easily harvested directly by

the regular combine seed harvester. Seed is retained in the head for an adequate time so harvesting may be delayed until well after ripening. Many ranchers have expanded their acreage of rose clover with home grown seed.

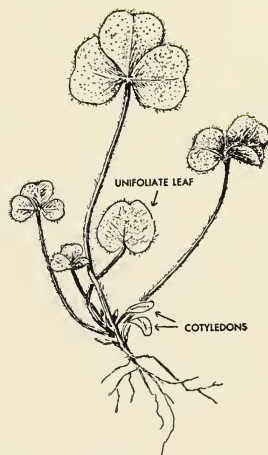
Certified seed is available in quantity at moderate prices.

## Crimson Clover

... is a colorful winter annual legume and a heavy producer on much range land. Introduced into the United States as early as 1819, it is now widely grown throughout the Southern and Pacific Coast states. Its use in California has increased rapidly since it was first tested for dryland use in 1944. However, it is not adapted over as wide a range of difficult conditions as is rose clover.

### How It Looks

Crimson clover, *Trifolium incarnatum* L., is an upright plant 6 to 30 inches high and has cylindrical heads about 2



inches long of bright crimson flowers. The stems and leaves are covered with soft hairs. The leaflets are usually unmarked although they occasionally have small dark-brown blotches next to the midvein. The seedling growth is slightly

more vigorous than rose clover, and its mature growth somewhat taller. It branches less and the individual plants cover less ground area than rose clover. The seed is yellow and shiny. Number of seeds per pound is 140,000, the same as for rose clover, but crimson clover seed is glossier and is shaped more like a football.

### **Adaptation**

Crimson clover thrives on both sandy and clay soils. It is about as tolerant to acid soils as rose clover. It does not do well on poorly drained or highly alkaline soils. It requires somewhat more rainfall than rose clover to survive, and consequently its range does not extend into desert conditions. It performs well on 15 or more inches of annual rainfall at elevations under 3,000 feet. On a Napa County ranch in the 20-inch rainfall zone, crimson clover has produced up to 9 animal unit months of feed per acre per year on a 210-acre field. This demonstrates its tremendous capacity to produce under favorable conditions.

Crimson clover is useful as a hay plant as well as for grazing. Its feed value is on a par with that of rose clover.

### **Crimson Clover Reseeds Itself**

It produces an abundant seed crop much of which is usually hard seed. These hard seeds germinate over a period of time insuring a stand if unfavorable moisture conditions cause the early germinating seeds to die. The so-called "reseeding" strains produced in the southeastern states have been selected for a moderately high hard seed content for that reason. Livestock management favoring reseeding of crimson clover is the same as that for rose clover.

### **Varieties**

Tests indicate that Dixie and similar "reseeding" varieties such as Autauga, Auburn, and Talledaga perform well in California. They bloom in the latter half of April and are one to two weeks earlier than the common crimson clover.

### **Useful on Annual Type Range**

Crimson clover is most frequently used in mixtures with rose clover and subclover in the proportion of  $\frac{1}{4}$  to  $\frac{1}{3}$  of the total. It also may be sown in mixtures in grain or in rotation with grain. It should be inoculated with the same inoculum as rose and subclover.



Crimson clover in this Napa County field provides a growing ration for steers during the spring and summer months.

## Diseases and Pests

Sooty blotch is a foliage disease that infects crimson clover near the coast. Symptoms are dark spots on the leaves which cause leaf loss during blooming and lower the value of the forage. Slime mold has also been observed on seedling crimson clover, but apparently has not caused serious damage.

Crimson clover is susceptible to the pea aphid and is considerably damaged

under a heavy infestation. It is also susceptible to the spotted alfalfa aphid.

## Seed Production

Seed of crimson clover is easy to grow and harvest. The plant is upright and may be harvested directly or from the windrow when at the proper stage of maturity. Since the seed shatters rather readily, overmaturity causes losses. Commercial seed is readily available and moderately priced.

# Subclover

Subterranean clover, or subclover, is a low-growing winter annual with an unusual ability to plant its own seed by burying the seed heads in the ground. These characteristics make it very tolerant to heavy, close grazing.

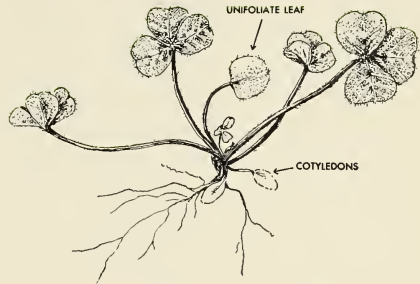
Subclover was first introduced into California by the late Professor W. W. Mackie of the U. C. Agronomy Department with seed obtained from Australia. Plantings were established in 1933 on the Russ ranches in Humboldt County. These plantings are still in existence. Subclover has since proven to be well adapted to the coastal climate, and the acreage of subclover in production in Humboldt County alone has been estimated at over 20,000 acres. It also does well in mixtures in the Central Valley and adjacent foothills.

Subclover has become the most valuable dryland legume in Australia since the application of superphosphate to subclover pastures became a recognized practice in the early 1920's. Subclover is not a native to Australia, but was introduced accidentally from the Mediterran-

ean region. Thus subclover travelled more than halfway around the world to reach California.

## How It Looks

Subclover, *Trifolium subterraneum* L., is a prostrate winter annual legume that produces runners up to four feet long under favorable conditions. The runners and leaves are covered with short hairs. The leaf has three leaflets, each usually having a whitish crescent across it and frequently having many scattered black flecks over it. The flowers are usually inconspicuous, occurring in groups of four creamy white or pinkish flowers. After flowering, the stalk supporting the head bends toward the ground, and the matured flowers turn backwards. At the tip of the flowering stalk a series of stiff forked bristles develop and reflex in turn. If the head is in contact with the soil at this time the bristles pull the seed head into the soil. The seeds are dark



purple, smooth, round, and about  $\frac{1}{8}$  inch in diameter. The number of seeds per pound is 65,000.

### **Adaptation**

Available subclover varieties (Mt. Barker and Tallarook) are adapted to areas with 16 or more inches annual rainfall, and up to an elevation of 3,000 feet. It makes a very heavy growth in the coastal fog belt and is the most tolerant clover to acid soil conditions. It makes substantial growth on soils having pH values down to pH 4.5. However, alkaline soils restrict the growth of subclover. In the Central Valley and adjacent foothill plantings with other annual clovers it is dominant in the moister sites, and forms an understory to the other clovers on the drier sites. Under intensive grazing it has been observed to become the dominant legume on the drier as well as moister sites.

### **Subclover Reseeds Itself**

Of the annual clovers, subclover has the best reseeding insurance in its mechanism for burying seed in the soil. For this reason it is difficult to graze out a stand of subclover. It is a prolific seed producer and a substantial amount of its production is hard seed. These seeds germinate over a period of time producing a stand even though seed germinating with the first rains die in a succeeding drought or freeze. Where subclover makes a lush growth, it reseeds better when grazed than when allowed to grow to the hay stage. This fact, however, is of no concern after two or three seasons of subclover production and a liberal supply of hard seed has been built up in the soil.

### **Varieties**

There are a large number of strains of subclover varying widely in their growth habit and time of maturity. They can be grouped by maturity as early, midseason and late. The early varieties

are stemmy, produce few leaves, and are poor forage producers, but are able to subsist in a short rainy season. Late varieties are leafy and good forage producers, but require a long rainy season. Midseason varieties are intermediate.

Mt. Barker, the most commonly used variety in California, is a midseason variety with excellent vigor and forage-producing characteristics where rainfall is 16 inches or more. It is distinguished by a red collar at the base of the flower. Tallarook, the other commercially available variety, is later and produces more forage than Mt. Barker. It has a green feed period two or three weeks longer than Mt. Barker under somewhat higher rainfall conditions. They are frequently sown together to use the advantages of each.

The very early maturing variety, Dwalganup, has been tested extensively in California. It has not proven a satisfactory producer because of its stemminess and lack of leaves. In 1941 a sheep fertility disease in West Australia was traced to a consumption of almost 100 per cent Dwalganup. When subclover consumption was reduced to approximately two-thirds of the diet this trouble disappeared. No significant recurrences have been reported in the last 10 years. No sheep fertility problems attributable to subclover have been reported in California.

Varieties of the early midseason maturity are currently under test in the more arid regions in order to extend the area of adaptation of subclover.

### **Inoculation**

A number of areas have been observed in the state where subclover will not grow without being inoculated with appropriate legume bacteria. In these areas inoculation, when used along with other proven production practices, can make the difference between stand failure and good forage production. Subclover should always be inoculated at the time



of planting. Once a stand has been successfully established, the bacteria will survive indefinitely as long as the subclover thrives. The legume bacteria group is the same as that used for rose, crimson, Ladino, red, alsike, and other true clovers (not bur, sweet or sour clovers).

### Mixtures

Subclover is usually sown in mixture with rose and crimson clovers. A satisfactory rate is three pounds of each per acre. Along the north coast in the fog belt, rose and crimson clover are omitted, and orchard-grass or tall fescue or a mixture of the two may be included. Where hardinggrass is adapted the above clover mixture can be sown along with hardinggrass at three pounds per acre. Sometimes subclover is sown at the rate of five pounds as the only legume with hardinggrass. The perennial grasses sown with the legumes increase total production, lengthen the green feed period, and stabilize year-to-year forage production.

### Subclover Controls Range Weeds

Medusa head, *Elymus caput-medusae* L., is a weedy unpalatable annual grass which has invaded much of our better foothill and coast range country. Seeding subclover has been observed to be the most successful means of controlling this undesirable invader. The recommended steps for medusa head infested range where cultivation is possible are: (1) plowing or discing the sod just before seed is set; (2) phosphorus or sulfur fertilizer as needed should be applied just prior to (3) fall seeding of subclover; (4) the newly seeded area should be grazed heavily for a short period in the early spring while any new medusa head is in the young leaf stage.

Hairy oatgrass, *Danthonia pilosa* R. Br., is a weedy unpalatable perennial which has invaded areas of the north-coast range. Experiments show that it, too, is controlled by vigorous subclover growth obtained by the above procedure. Goatgrass, *Aegilops triuncialis* L., will probably respond to the same treatment also.



Subclover pasture is good dryland milk producer in the north coast counties

## Diseases and Pests

No disease or insect depredations of subclover of consequence have been reported in California. It is not susceptible to the spotted alfalfa aphid.

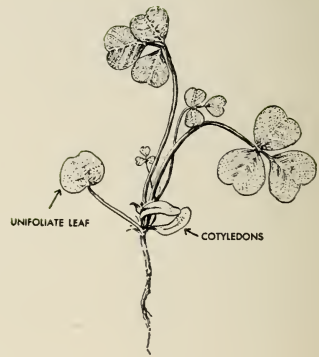
## Seed Production

Seed of subclover is more difficult to harvest than seed of rose or crimson clover since much of it is in the surface layer of soil. No seed is produced commercially in California at the present time. Most of the seed consumed here is

grown in Oregon or Australia. In the customary harvesting method most of the top growth on seed fields is mown and removed. Then the runners and seed heads are loosened from the soil with a harrow and windrowed with a power rotary brush. The material is usually elevated and hauled to a stationary thresher. The seed may also be threshed directly from the windrow with a combine harvester. Vacuum harvesters have also been used successfully.

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# Bur Clover



. . . was brought into California during the Mission Period (1769–1824) and has since become widely established. It is an unusual plant in that it is an aggressive immigrant which has increased the value of our range lands. Most alien invaders have tended to decrease range values. The green bur clover of winter and spring as well as the dried plants and burs of summer are valuable high-protein feed.

## How It Looks

Bur clover, *Medicago hispida* Gaertn., is not a true clover, but is an annual relative of alfalfa. It may be distinguished from the true clovers (*Trifolium* species) by the unequal length of its leaflet stalks. The central leaflet stalk is longer than the two lateral ones of each leaf, whereas in all cultivated and most native true clovers the leaflet stalks are of equal length. The stems are much branched and prostrate although in a thick stand they may become erect. The plants are hairless. Each leaf has three leaflets which are unmarked. The flowers are

yellow and occur in groups of 2 to 9. Seed pods usually have two or three flat coils with stiff hooked spines along the edges. Several varieties have been botanically identified on the basis of the length of the spines. Commercial seed lots frequently contain a mixture of these, but the long spined type is the most prevalent. The seeds are kidney shaped, about  $\frac{1}{12}$  inch long, brownish-yellow in color, and the number of seeds per pound is 140,000.

## Adaptation

Bur clover is adapted to most of the range in the state and volunteers widely, with the following limitations: It does not grow well on strongly acid soils nor under desert conditions, and it does not survive the winter at elevations much above 3,000 feet. Bur clover grows best on soils that have a good resident popu-

lation of redstem filaree. It is seldom present where broadleaf filaree dominates. The addition of phosphorus or sulfur to such soils does not favor the establishment of bur clover as it does rose, crimson, and subclovers. However, a heavy application of manure will help bur clover to establish on broadleaf filaree sites. Bur clover does not usually require seeding except where natural stands have been eliminated by cultivation, weed sprays, or the encroachment of brush.

### **Feed Value Outstanding**

Bur clover is an outstanding plant for its nutritive value at all stages of growth. Up to the bloom stage it usually contains above 20 per cent crude protein. As it matures the amount decreases as it does in all plants, but averages in the neighborhood of 15 per cent even when dry. In that stage animals consume the burs containing seed as well as the dry stems and leaves. This makes it a valuable supplement for other less nutritious range feed. Calcium and phosphorus are adequate, and digestibility is high even in the dry stage. Thus animals on dry feed that contains substantial amounts of bur clover make good gains.

### **Diseases and Pests**

Diseases are not a serious problem in bur clover production. However, two insect pests are important. The clover-seed

chalcis fly, which attacks alfalfa and red clover seed, also seriously damages bur clover seed. Estimates of seed damage have run as high as 75 per cent. No economical control is available for use against this insect on the range. It does not harm the forage.

The spotted alfalfa aphid, which has recently caused so much damage to irrigated alfalfa in California, also attacks bur clover. The seriousness of this threat to range forage production is not known at present.

### **Seed Production**

Until recent years much of the bur clover seed produced was harvested as an impurity with barley and other grain crops. Since the hormone-type weed sprays have come into widespread use in grain fields, this source of seed has been largely eliminated. Now bur clover is harvested from pasture lands where there is practically a pure stand. When a harvester is used the crop must be cut and cured carefully before all of the seeds are ripe, since the burs ripen over an extended period of time and drop off readily when ripe. Where suction type harvesters are used the crop is permitted to completely ripen before harvesting. Then the burs are easily lifted by the suction.

Seed of bur clover is available commercially, but the cost is often rather high.

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