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CRIMSON CLOVER

BY

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CRIMSON CLOVER

BY

J. F. DUGGAR.

SUMMARY.

Crimson clover is an annual soil-improving plant. It suits most soils in Alabama. The seed are sown in September among the growing plants and covered.

The plants in early bloom can be plowed under about April 1, as a fertilizer for cotton, corn, sweet potatoes, or other summer crop; or the clover can be cut for hay in the latter part of April and the stubble used as fertilizer.

The yields of summer crops following the plowing in of either the entire growth, or merely the stubble, of crimson clover have been much greater than where no crimson clover has been sown.

The condition most essential to success in growing crimson clover consists in inoculation. This is most certainly effected by sowing with the seed as much as practicable of the soil from a spot where crimson clover, red clover, white clover, or annual white clover, has recently grown successfully. The last mentioned occurs in nearly all parts of Alabama, but is not easy to find after May, when its white heads turn brown and the plant dies.

White clover and annual white clover can usually be found in old lawns and spots in pastures. Both are low plants with white heads on the end of the short flower stem, and both have leaves consisting of three roundish or heart-shaped leaflets each about the size of the finger nail of one's little finger.

Soil from lespedeza (Japan clover) does not inoculate crimson clover.

Soil has been found to be a more reliable method of inoculation than the use of artifical inoculating material, called pure cultures.

INTRODUCTION.

The most urgent need of southern agriculture is the enrichment of the soil. To improve southern soils the principal additions needed are (1) vegetable matter and (2) nitrogen. Crimson clover adds both vegetable matter and nitrogen to the soil on which it grows. In fact, this method of improving the soil by the growing of crimson clover seems to be the most generally practicable method that can be put into immediate effect by southern farmers. This is partly because crimson clover is suited to a wide range of soils, because usually the seed are cheap, and because the seed can be sown in September among the growing cotton plants without special preparation of the soil.

During each of the last fourteen years numerous experiments have been made at Auburn, both on gray sandy soil (Norfolk sandy loam) and on reddish loam (Cecil series). In addition to these accurately conducted experiments, tests have been made by farmers throughout the State under the direction of the writer. Many of these local tests, especially during the past few years, have been made in co-operation with the Bureau of Plant Industry of the U. S. Department of Agriculture. The conclusions here presented are based chiefly on experiments at Auburn and on local tests in Alabama, full data for which would be too voluminous for recording in this bulletin.

WHAT CRIMSON CLOVER IS.

Crimson clover is also known as scarlet clover, and its botanical name is *Trifolium incarnatum*. It is an annual plant, making its growth between September and May. The seed must be sown each year, for while this plant seeds freely here, yet these seed on dropping to the ground in May and June, germinate promptly, and the young plants are killed by the heat of summer. Crimson clover produces abundant crops of seed and farmers can save their own seed. To do this the seed must be flailed or threshed from the plants, and the seed still in the chaff sown without recleaning.

Crimson clover is a leguminous plant, or legume, and is ranked with the other cultivated legumes, cowpeas, velvet beans, vetches, red clover, etc., as a soil-improving plant.

HOW CRIMSON CLOVER IMPROVES THE SOIL.

Crimson clover improves the soil on which it grows by the following means:

(1) Since it grows during winter, its roots utilize any nitrates or other soluble plant food which would be washed or leached from the soil.

(2). On account of its winter growth it decreases surface washing of the soil.

(3). When either the stubble or the entire plant is plowed under, vegetable matter of a kind that readily rots is added to the soil.

(4). Crimson clover, like all the other soil-improving legumes, is able, when properly grown, to take nitrogen from the air to add it to the soil.

HOW LEGUMES ADD NITROGEN TO THE SOIL.

Crimson clover, like cowpeas, when grown under proper conditions, adds much nitrogen to each acre of soil. It takes this nitrogen from the air, where it is unavailable to corn, cotton, and most other farm crops. The only cultivated plants that can thus utilize the free nitrogen of the air for their own growth and for subsequent soil enrichment are the legumes, or leguminous plants, such as cowpeas, clovers, vetches, etc. Even these legumes cannot make use of the nitrogen of the air and cannot improve the soil except when they bear on their roots certain enlargements or bumps, called *tubercles or nodules.* (See Fig. 2.) Familiar examples of nodules are the roundish enlargements on the roots of cowpeas. Tubercles may be regarded as fertilizer factories for the manufacture of fertilizer nitrogen from the unlimited quantities of free, or gaseous, nitrogen in the air above. The air penetrates all cultivated and drained soils and thus comes into contact with the tubercles on the roots of leguminous plants, where it is used as the raw material for the manufacture of fertilizer nitrogen, an

element which costs 15 to 18 cents a pound when bought as cotton seed meal, nitrate of soda, ammonated guano, etc.

INOCULATION.

The interior of these tubercles is swarming with microscopic life, called germs or bacteria. These bacteria, which belong to the vegetable kingdom, may be regarded as the workmen in these fertilizer factories. A tubercle does not develop on the roots of any legume unless the right kind of germ, suited to that particular kind of plant, is present on the seed sown or in the soil, ready to enter the tiny root. For example, the writer has examined scores of samples of crimson clover plants from all parts of Alabama that had no tubercles on the roots. These clover plants without tubercles, were dwarfed, pale or yellowish, and showed the crop thus grown without tubercles to be complete failures. The greater part of several hundred failures with crimson clover which the writer has investigated have been found to be due to the absence of tubercles. (See Fig. 1.)

Failures of this character need not occur. There is a simple, invariably remedy. It is called *inoculation.* Inoculation of this kind means the supplying of suitable germs to the seed to be sown or to the soil where crimson clover is to be grown, so that these germs thus supplied may penetrate the roots of the young plant and cause tubercles to develop. If the proper germ for causing tubercles on clover be present in the soil there will be no need of artificial inoculation.

However, large numbers of local tests under our direction made in almost every county in Alabama, lead to the conclusion that throughout most of Alabama the clover germ is not already present in the soil. But this germ is present in soils where any true clover has grown for several years and borne tubercles. Hence, the surest method of inoculating crimson clover consists in sowing on the field where this legume is to grow some soil taken from around the roots of any true clover. One may use the upper two or three inches of such soil. The true clovers may be

known by the fact that they bear their seed in compact heads at the tip of the flower stem. This excludes Lespedeza, commonly called *Japan clover*, which in our tests *has proved unable to inoculate crimson clover.*

SECURING INOCULATING SOIL NEAR HOME.

Among the clovers, from spots of which the earth may be taken to inoculate crimson clover, are the following:

FIG. 1. *On the left, inoculated plant with severed root, showing tubercles; on the right, an average plant from an adjacent plot, not inoculated; there are no tubercles on the smaller plant.*

Crimson clover, red clover, white clover, and annual white or Carolina clover. Fortunately, careful search in April will usually be rewarded by finding the annual white clover in practically all parts of the State, in old lawns, old pastures, along roadsides, etc. Unfortunately, this clover dies in May, the white heads changing to brown and the plants soon disappearing until the next winter, or showing only a mass of short, slender, dead stems against the ground under the Lespedeza, or other summer growth.

White clover is not so widely distributed as the annual white clover, but the former may be found even up to midsummer in some parts of the State in old lawns and in old pastures where the soil is rich and moist.

DIRECTIONS FOR INOCULATING SOIL OR SEED.

The details of inoculation may vary according to the amount of soil available. If there is an abundance of soil it is only necessary to sow, immediately after the sowing of the seed and before covering the latter, at least one ton per acre of the inoculating soil. This method of inoculation may be made even more effective by combining it with the following method:

When there is only a limited amount of soil a gallon or more of it should be stirred into two or three times as much water; the seed should be thoroughly moistened with, or dipped into, this water and dried by mixing with another part of the very dry inoculating soil. Whatever soil remains should be sown broadcast before the seed are covered. This method is not well suited to seed as small as those of crimson clover. In this way a few pecks of suitable soil may partially inoculate the seed for an acre. A part of the seed would escape inoculation and plants from these would be small; the thinner stand of vigorous plants thus obtained would make the inoculated plants spread out more and grow not so tall as they would in a thick stand with all plants bearing tubercles. If much less than a ton of pulverized inoculating soil is used, one need expect only a *partial success* with crimson

clover the *first year*. By sowing seed a second year in succession on such a partially inoculated soil, without further inoculation, the second crop should be thoroughly inoculated.

START AT ONCE ON A SMALL SCALE.

The importance of getting a start of a small area thoroughly inoculated is obvious when we remember that soil from such a spot will suffice the next fall to inoculate several hundred times as large an area. Those who find any difficulty in securing any considerable amount of soil from a spot of red, crimson, white, or annual white clover, should sow only a small area of crimson clover, say one quarter or one acre. No pains nor expense should be spared to get this thoroughly inoculated by using a liberal amount of inoculating soil. This area should be fenced against stock. It may even be lightly dressed with stable manure, after the plants are well up, though this is not necessary nor practicable on large areas. This "starter" patch should not be located in an old garden spot, for fear of possible presence there of nut grass, root-knot organisms, or germs of plant diseases, which would thus be scattered over the entire farm in the soil from this spot used in future to inoculate larger areas. Especially avoid for this "starter" patch any spot where black-root, or wilt, of cotton occurs, or where cowpeas die permaturely, or where there are root-knot swellings on the roots of cotton, turnips, etc. Too much care cannot be taken to ascertain that the spot selected for a "starter" patch is free from all plant diseases.

This does not entirely prohibit the growing of crimson clover where certain plant diseases occur, provided the soil from such spots be not carried elsewhere as inoculating material. Crimson clover may again be sown the second fall on the area used the year before as a starter, not repeating the inoculation.

In brief, start with an area so small that it can be thoroughly inoculated; and, especially if it proves to be only

partially inoculated, again sow crimson clover there next season.

After one crimson clover crop, *well inoculated* as shown by abundance of tubercles, grown for one season on the "starter" patch, use soil from this to inoculate larger areas. Or, the next April locate in pastures, etc., spots of annual white clover in bloom, and place stakes at each corner of such spots, so that inoculating soil from these spots can be used the following September when the annual white clover is dead.

WHAT SOILS DO NOT NEED INOCULATION.

To sow crimson clover without inoculation means on most soils in Alabama complete failure. However, there are a few fields that do not require it. Such are fields where there have been, in the preceding year or two, successful growths of red, or crimson, or white, or other true clover, (not lespedeza).

BENEFITS OF INOCULATION TO CRIMSON CLOVER CROP.

There are two, viz., (1) increase in the yield of crimson clover, and (2), increased fertilizing effect of crimson clover, as shown in yields of subsequent crops of corn, sorghum, etc. All the experiments here mentioned were made on the Experiment Station Farm at Auburn. In all those mentioned in this section the inoculating material was soil from an older crimson clover field, applied broadcast at the rate of at least one ton per acre at the time of sowing the seed.

In May, 1903, on reddish sandy upland loam soil (Cecil series), where a moderate dressing of stable manure had been used on the preceding crop of small grain, the yields of crimson clover hay were as follows:

Inoculated	6100 lbs. per acre
Not inoculated	000 lbs. per acre
Gain from inoculation	6100 lbs. per acre

The inoculated plants were green, tall, and their roots were abundantly supplied with tubercles. The plants not inoculated were yellowish, not branched, two to four inches tall and there were no tubercles on the roots. There was not enough for cutting with scythe or sickle. Fig 1 shows the contrast between typical inoculated and non-inoculated plants.

In the fall of 1908, on poor, whitish, sandy, upland soil (Norfilk sandy loam), although too late for best success, a plot of crimson clover was inoculated with soil from an older crimson clover field, and another plot left without inoculation. These plots were not harvested, but the marked difference in appearance were as follows: The inoculated plants were green, thrifty, about 14 to 16 inches tall, and their roots were covered with tubercles; the yield was estimated at about one ton of hay per acre. The plants not inoculated had no tubercles, were yellowish, and had but one or two stems per plant, and were not tall enough to cut, most plants dying before blooming, or blooming at a height of only 2 to 6 inches.

PURE CULTURES, OR ARTIFICIAL INOCULATING MATERIAL.

In August, 1897, and in August 1898, the writer published results of inoculation of crimson clover by the use of pure cultures, or bottled material prepared in the laboratory. As these bulletins (Nos. 87 and 96 of the Alabama Experiment Station) are now out of print, some of the results of these earlier tests will we referred to here.

In both of the following tests the pure cultures used was imported from Germany under the name "Nitragin."

Results of inoculation experiments on crimson clover, using "Nitragin."

Date of Sowing	Kind of Experiment	Kind of Soil	Hay, per Acre		Increase from Inoculation
			Inoculated Yield	Not Inoculated Yield	
			Lbs.	*Lbs.*	*Lbs.*	*Per ct.*
Fall, 1896	In pots	Sandy, 20 years in cotton	.....	.....	.....	71
Fall, 1896	In pots	Sandy, 5 years since cleared .	.....	.....	.....	74
Fall, 1896	In pots	Woodland, sandy...	.....	.....	.....	326
Fall, 1896	In pots	Sandy, after cowpeas	.....	.....	.....	379
Fall, 1897	In field	Sandy, worn.....	4057	761	3296	433

Thus, it may be seen that when attempted inoculation with pure cultures is effective, the increase in crop is highly satisfactory. In the experiments tabulated above, inoculation in several instances increased the yield more than three-fold.

The above figures give the favorable side of inoculation with "Nitragin." Its use was, however, found impracticable because so often the germs in it were dead and inoculation did not result.

EXPERIENCE IN RECENT YEARS WITH PURE CULTURES OR ARTIFICAL INOCULATING MATERIAL.

In recent years the United States Department of Agriculture and a number of commercial firms have engaged in the manufacture of pure cultures, a special kind for the inoculation of each particular legume. At first these were sent out in the form of wisps of dried cotton, on which the proper germs were lodged. This Station had numerous tests of these cultures made on a great variety of soils. The result was a long list of failures, with few, if any, successes.

A later improvement was the sending of the cultures in liquid form in sealed tubes. The experience of this Station with these was, on the whole, unsatisfactory. For example,

attempts to inoculate crimson clover were made in the fall of 1908 with pure cultures from crimson clover, both from the Department and from a commercial firm. Parts of both plots were occupied by small pale plants without tubercles, and the spots that were inoculated may have accidentally secured their inoculation, by wind or surface water, from an adjacent check plot inoculated with soil. Both culture plots were distinctly inferior to the plot inoculated with soil.

Constant improvements are being made in the methods of manufacturing and distributing the pure cultures made by the U. S. Department of Agriculture. The improvement and the successes sometimes reported give reason to hope that in due time this may become the best means of inoculating legumes. Its advantages are convenience; economy of labor; avoidance of the danger that is inherent in the use of soil, namely, spreading disease germs, root-knot organisms, weed seeds, etc. The only objection to pure cultures is their frequent failures, at this and at other Experiment Station, to cause the formation of tubercles or the obvious fixation of nitrogen. Our experience compels us to advise that at present pure cultures be not relied upon as a means of inoculation. Inoculation with soil has never, in our experience, failed; pure cultures have often done so. Still less advisable generally is the purchase, at additional cost, of seed said to be inoculated.

CRIMSON CLOVER AS A FERTILIZER.

When grown largely for fertiizer, crimson clover may be disposed of as follows:

(1). It may be cut for hay, plowing under the stubble as a fertilizer.

(2). The entire growth may be plowed under as fertilizer.

(3). During the last few weeks of growth crimson clover may be grazed, probably without sacrificing a very large part of its fertilizing value.

At Auburn crimson clover is in full bloom and ready to be cut between April 15 and 30. Observation has indicated that at Auburn the first few days in April constitute a suitable average date for plowing under crimson clover that is to be followed by a cotton crop. At this date it should be just begining to bloom and 12 to 15 inches high. By plowing the entire growth under at this time, and allowing the land to settle for about two weeks, before planting cotton near the middle of April, the yield of cotton has ranged as high as one and one-half bales per acre on gray sandy upland, naturally poor. The cotton crop following crimson clover receives its quota of commercial fertilizers, which in this case should be especially rich in phosphoric acid.

By waiting until the clover should be in full bloom, say April 15, doubtless the amount of vegetable matter and nitrogen added to the soil would be greater than by plowing it under about the first of April.

Not all the land intended for cotton could have its preparation delayed until this date, but crimson clover can be followed by late cotton, by corn, sweet potatoes, sorghum, etc. Where it becomes necessary to plow under crimson clover before April 1, its fertilizing effect is greatly reduced.

If crimson clover is grown chiefly for fertilizer, with pasturage also as a consideration, the nearer it comes to the blooming stage before being pastured the greater the fertilizing effect.

The following table gives the results of several experiments at Auburn, showing the increase in the next crop due to crimson clover or crimson clover stubble.

Yield of sorghum hay grown after crimson clover stubble in 1901.

.....	*Yield Sorghum Hay Per Acre* Lbs.	*Increase* %
Yield crimson clover hay	2900	
Yield of sorghum hay after rye stubble	6460	
Yield of sorghum hay after crimson clover stubble	12710	
Increase due to clover stubble	6250	97

This shows that in 1901 on gray sandy land after crimson clover cut for hay, the yield of sorghum hay was practically twice as much as where the preceding crop was rye, used for hay.

On another field, also in 1901, on poor gray sandy soil, the results were as follows:

Yield of sorghum hay per acre grown after crimson clover and crimson clover stubble in 1901.

Preceding crop as fertilizer	Yield sorghum hay	Increase per acre	
	Lbs.	*Lbs.*	*%*
Rye stubble	5525		
Crimson clover stubble	9750	4425	76
Crimson clover, entire	10300	4775	86

This table shows that by plowing under crimson clover in April the yield of sorghum hay grown immediately after was nearly doubled. When the crimson clover was cut for hay the sorghum yield was increased by 76 percent. The yield of crimson clover hay on this stubble plot was 2741 pounds per acre, and the increase in sorghum hay due to the use of clover stubble as a fertilizer, was 4225 pounds per acre.

A third experiment on this line was made in 1903 on reddish loam soil which was naturally richer than the gray soil of the two experiments just mentioned. This reddish loam had also been helped by a light application of stable manure applied to the crop of small grain which preceded the crimson clover.

Under these favorable conditions the yield of crimson clover hay was 6100 pounds per acre. The adjacent plot had been treated exactly like the crimson clover plot as regards previous cropping and manuring.

Yield of sorghum hay per acre grown after crimson clover in 1903.

Preceding crop	Yield sorghum hay	Increase per acre.
	Lbs.	*Lbs.*
Winter and spring weeds	4400	
Crimson clover as fertilizer (stubble)	13000	8600

Here we have an extreme or maximum fertilizing effect

of the crimson clover stubble of 8600 pounds of sorghum hay per acre. By adding to this the yield of clover hay, 6100 pounds, we have a total of 14700 pounds per acre of the two kinds of hay, as the measure of the advantage of sowing the land in crimson clover as compared with permitting it to grow up in winter weeds.

Both the crimson clover hay and the sorghum hay when weighed were dry enough for safe storing in the barn. Even if we assume a shrinkage of 25 per cent in the barn we should have a total yield of more than 7 tons of hay per acre produced in one season and a gain of about 5 1–2 tens as the result of devoting the land to clover instead of to weeds.

CRIMSON CLOVER STUBBLE VERSUS ENTIRE GROWTH OF CRIMSON CLOVER.

In 1908 cotton was planted very late after oat stubble, after crimson clover stubble and after attempting to plow under the entire growth of mature and thoroughly dry crimson clover.

Only a part of the mature plants were covered by the plow, so that the full effects as fertilizer were not obtained. The late planting, the period of extremely unfavorable weather in August, when this late cotton suffered especially, and the necessity of preparing these plots before frost for another crop, obscured the full fertilizing effect of the crimson clover. In the part of the season for which records were kept the yields of seed cotton per acre were as follows::

After oat stubble ----------342 lbs.
After clover stubble ----------456 lbs.
After clover, entire growth ----------528 lbs.

The color and size of plants on these three plots gave promise of much larger yields and much greater differences, if the experiment could have been carried to a normal conclusion.

Measurements showed that the bolls were largest on the

plot where the entire growth of crimson clover was plowed under and smallest on the plants growing after oat stubble.

In one of the experiments described above the yield of sorghum hay after plowing under the entire growth of crimson clover was only 550 pounds greater than after plowing under crimson clover stubble, on land where the yield of crimson clover hay was 2741 pounds per acre.

In another experiment the superiority of the entire growth of crimson clover as a fertilizer over the stubble alone was measured by an increase of only 800 pounds per acre in the yield of sorghum hay. Here the yield of clover hay on the stubble plot was 1441 pounds per acre. Thus both experiments show that it was more profitable to cut the hay than to plow the entire growth under as a fertilizer for *sorghum.*

Doubtless the principal advantage of plowing under the entire growth, rather than the stubble, consists in the greater permanancy of the improvement in the land. The analysis of the entire plant of crimson clover, including the roots, and of the stubble alone, (Alabama Station Bulletin No. 96.), showed that only about 16 percent of the total nitrogen was contained in the stubble and roots of crimson clover. With stubble of the usual length, probably 20 percent or more of the nitrogen would be found in the stubble and roots. The conclusions suggested by considering together both field tests and analysis are the following:

(1). A greater immediate profit results from using only the stubble as a fertilizer.

(2). A much larger amount of nitrogen and of vegetable matter is added to the soil by plowing under the entire growth of crimson clover, and hence doubtless this course results in a greater and more permanent improvement of the soil.

(3). By plowing under the entire growth a farmer may prepare the land three or four weeks earlier than by waiting to cut the hay, thus making it practicable to grow cotton on a field where the entire growth is plowed under.

CAUTION IN USING CRIMSON CLOVER HAY.

Cases have been reported where horses eating hay from very ripe crimson clover have had trouble from the formation of balls of matted hairs in the stomach. These hairs stiffen as the seed approaches maturity. It is believed that this trouble can be avoided by cutting the hay before it is past full bloom and by feeding partly on some other hay, if that from this clover is overripe.

DIRECTIONS FOR SEEDING CRIMSON CLOVER.

The amount of seed required is 15 pounds, or one peck, per acre. We have more frequently sown 20 pounds. The time of sowing at Auburn has varied from early in September to late in October. From a study of the results of our many experiments the conclusion is reached that safe dates at Auburn are at least as early as September 10, and as late as October 10. Sowing the latter half of September is preferred. If crimson clover seed are sown too early, the hot weather of September sometimes kills the sprouting seed, or the young plants before they become well rooted. If the sowing is postponed much beyond the 10th of October at Auburn, the stand is sometimes injured by the cold of a severe winter. The following dates are suggested as suitable periods for sowing in different parts of Alabama:

September 1 to September 30 in north Alabama,
September 10 to October 10 in central Alabama, and
September 20 to October 20 in south Alabama.

SOILS.

Crimson clover thrives on a wide range of soils from sandy to black-waxy, or prairie. In the sandy regions it does better on the loam soils or those containing a medium amount of clay. In regions of stiff soils it requires good drainage. On deep gray sands it is apt to fail, though where the stiffer subsoil is not too deep, it may succeed here. It is not wise to risk large areas of crimson clover on acid soils unless lime is used.

PREPARATIONS FOR SOWING.

At Auburn crimson clover has grown equally as well when sown among the growing cotton plants as when the land was thoroughly plowed and harrowed.

Sowing of crimson clover seed in the cotton field should be done immediately after the first or second picking to avoid knocking any of the seed cotton out of the bolls. This crop has repeatedly succeeded well when the seed were harrowed in among the stubble on a field that had received clean culture while growing a crop of drilled sorghum.

The sorghum stubble or the cotton stalks, are, however, inconvenient if it is desired to mow the clover for hay. When this clover is grown for hay the land should be plowed if possible several weeks before the time of planting, and repeatedly harrowed until the seedbed becomes fine and settled. If the seed must be planted soon after the land is plowed, a roller or drag, as well as a harrow, may be needed to compact the soil. The best time to sow the seed is while the soil is moist from a recent rain.

The inoculating soil is best sown broadcast, immediately after sowing the seed, using, if practicable, a ton of soil from a spot of red, crimson, white, or annual white clover. Always cover the inoculating soil promptly. In a few tests we have succeeded in making a successful inoculation by scattering the inoculating soil over the growing plants during a period of wet weather in the early part of winter.

It is essential that the crismon clover seed be well covered with one-half to one and one-half inches of soil. In all of our tests attempts to secure a stand by sowing without covering the seed have failed. Failure has occurred even when a heavy rain fell soon after the sowing. When the seed are sown on a well prepared seedbed, covering is best done with a spike-tooth, two-section harrow. When the seed are sown among the growing cotton plants they may be covered by using any shallow-working one-horse cultivating implement, such as a five-tooth cultivator, a spring-tooth one horse cultivator, a wide heel scrape, etc.

It is not easy to get a stand of crimson clover either on prepared or unprepared soil where there is a large amount of vegetation; hence, it is not usually easy to sow crimson clover seed in a corn field laid by early, nor on old pasture land, nor on weed land.

A field where drilled or broadcast cowpeas have recently been cut for hay is probably, next to a clean cotton field, the best place for sowing crimson clover. Here it is better to prepare the surface by the use of a disk harrow than by the use of a turn plow. After disking, the seed should be sown, the inoculating soil and fertilizer sown, and all covered with a spike-tooth harrow.

FERTILIZER.

Crimson clover, if thoroughly inoculated, adds considerable nitrogen to the soil. But it does not add phosphoric acid nor potash. If the soil be so poor as to require these two forms of plant food for the successful growth of crimson clover, they should be applied at the same time that the seed are sown. A suitable amount of acid phosphate is 200 to 300 pounds per acre. If the clover is to be removed from the land as hay, it may pay, especially on the sandier soils, to employ at the same time either 40 pounds of muriate of potash, or 160 pounds of kainit per acre. In sowing the crimson clover among the standing cotton plants on soils in fair condition we have often used no fertilizer and yet obtained a satisfactory growth. In making a start with crimson clover it is advisable to fertilize it with acid phosphate.

When it is especially important on small areas to secure a good growth and thorough inoculation of the soil, it may even be advisable to apply stable manure, since stable manure will probably make a small amount of inoculating soil more effective than if the small amount of inoculating soil were applied to a soil deficient in vegetable matter. Stable manure should not be relied upon as a substitute for inoculation nor as a means of inoculation.

LIMING.

Most clovers prefer a soil rich in lime. If the soil should be so deficient in lime as to be acid it is advisable to use slacked lime for crimson clover. At Auburn on very poor gray sandy soil, not acid, but neutral, slacked lime at the rate of 1200 pounds per acre greatly increased the yield of crimson clover hay. On the same character of soil, but in a higher state of fertility, the effect of lime on crimson clover was not conspicious. There are large areas of acid soil in Alabama, especially in the southern part of the state and in the sandy "mountain" lands of north Alabama. On such acid soils it will probably pay to use, as a preparation for crimson clover, six to eight barrels of builder's lime per acre, first slacking the lime to a powder.

The lime is best harrowed into the soil before the seed are sown and should not be brought in immediate contact with the seed and fertilizer. To test a soil for acidity, press the soil in a natural damp condition against both sides of a narrow strip of blue litmus paper, which may be obtained from a druggist. If the blue litmus paper turns to a pinkish or reddish color the soil is acid, and a crop of crimson clover growing on it will probably be helped by lime.

VARIETIES OF CRIMSON CLOVER.

There is but one kind of crimson clover in general use in the United States. In a few localities another variety, called the white blooming crimson clover, or more properly white trifolium, is grown to a small extent. The white trifolium bears a long white head similiar in size and shape to the scarlet head of crimson clover. The white trifolium is several weeks later in reaching a suitable stage for cutting. At Auburn this white kind has usually grown a little taller and afforded a considerably larger yield of hay.

We have grown in Auburn three varieties having scarlet

heads and called early crimson, ordinary crimson, and late crimson; in 1909 these yielded practically two tons of hay each per acre, as follows:

Ordinary crimson ----------3888 pounds hay per acre.
Late crimson (S.P.I.No.21208) 4106 pounds hay per acre.
Early crimson (S.P.I.No.21282) 4288 pounds hay per acre.

In 1909 the yield of white trifolium was obviously greater than that of any other varieties, but the hay was ruined by continued rain. The date of mowing white trifolium averaged 22 days later than the date of cutting ordinary

FIG. 2. *On the right, a field of ordinary crimson clover in bloom; on the left, a field of late crimson clover, not yet in bloom.*

crimson clover. This disadvantage for a cover crop to precede cotton more than counteracts the larger yield of the white trifolium.

Early crimson clover was several days earlier than any other variety, which is a decided advantage in a winter cover crop, since it permits earlier preparation for the cotton or other summer crop.

YIELDS.

After the first year,—that is, after crimson clover has become thoroughly inoculated by using suitable soil the first year of its growth,—it is safe to count on at least one and one-fourth tons of hay per acre. Under favorable conditions the yield of hay should be nearly two tons per acre. In only two experiments at Auburn has the yield approach-

FIG. 3. *On the right, a mixture of crimson clover and Blue Stem wheat; on the left, a mixture of crimson clover and Red Rust Proof Oats; all ready for mowing.*

ed three tons of hay per acre, and in both cases this was on reddish clay loam where in preceding years some stable manure had been used.

PLANTS TO GROW WITH CRIMSON CLOVER.

For several years crimson clover has been sown broadcast in connection with either oats, wheat, rye, or beardless barley. The amount of clover seed used was 24 pounds per acre, when sown alone and also this amount in all combinations in 1909, but only 15 pounds per acre in all combinations in 1903. Oats were sown at the rate of 1 1–2 bushels per acre in 1903 and 2 bushels per acre in 1909. Blue stem wheat was sown at the rate of one bushel per acre in 1903 and 1 1–2 bushels per acre in 1909. Beardless barley was used at the rate of 1 1–2 bushels per acre in 1903 and 2 bushels per acre in 1909. Rye was sown at the rate of one bushel per acre. The following tables give the yield of hay:

Yield of hay per acre when oats, wheat, rye, or beardless barley was sown with crimson clover or with white trifolium.

	1906	1909	Average
	Lbs.	*Lbs.*	*Lbs.*
Crimson clover alone	2960	2713	2836
Crimson clover and Red rust proof oats	3280	5175	4228
Crimson clover and Blue stem wheat	3624	3918	3771
Crimson clover and Southern rye	2000		
Crimson clover and Beardless barley	3520	3872	3695
White trifolium		1200	poor stand
White trifolium and Blue stem wheat		2320	poor stand
White trifolium and Red rust proof oats		2600	poor stand

It is noteworthy that the yield has been increased whenever oats, wheat, or beardless barley has been sown with

crimson clover. Red Rust Proof oats have given the largest average yield, but this plant is a little too late to permit very early cutting of crimson clover. An acclimatized strain of the Blue Stem wheat is ready for hay at exactly the same time as ordinary crimson clover, and is probably the best combination for soils strong enough to grow wheat. Beardless barley ripens too early, and is too subject to winter killing to be recommended for growing with crimson clover. Rye can be sown with crimson clover for pasturage, but this makes an unsatisfactory combination for hay, the rye maturing too soon and being too coarse.

In other tests where the weights of hay could not be taken by reason of continued rain just after harvest, the following facts have been ascertained:

Burt oats are in condition for hay at the same time as crimson clover, and in regions where it is considered safe to sow this variety in the fall, Burt oats and crimson clover make a good combination for hay.

Cheat was too late in reaching the hay stage to be sown with crimson clover, and because of its weedy nature it should be avoided.

For sowing with white trifolium, Red Rust Proof oats are most satisfatory.

In growing crimson clover for hay or pasturage it is probably advisable to sow it with one of the grains as mentioned above. The consequent advantages are the following:

(1). An increased yield of hay, though this hay is somewhat lower in feeding value than pure crimson clover hay.

(2) The easier curing of the mixed hay.

Of course if crimson clover is grown chiefly as a fertilizer, no grain should be mixed with it. If it is intended chiefly for pasturage, it is well to sow it with either rye, turf oats, red rust proof oats, or wheat, using the ordinary

amount of seed grain per acre. This increases the amount and lengthens the period of pasturage.

WHERE TO GET SEED.

Crimson clover seed can be purchased from any Southern seedsmen and from most seedsmen in other parts of the United States. Among those who have supplied the Alabama Experiment Station with seed are the following:

Amzi Godden Seed Co., Birmingham, Ala.
Harvey Seed Co., Montgomery, Ala.
T. W. Wood & Co., Richmond, Va.
H. G. Hastings & Co., Atlanta, Ga.
Alexander Seed Co., Augusta, Ga.
Willett Seed Co., Augusta, Ga.

Usually the price of seed is $3 to $4 per bushel of 60 pounds. The partial failure of the last crop has about doubled the price. While this may discourage the planting of large areas in the fall of 1909, it should not keep any one from planting a small patch, say of one-fourth to one acre, largely for the purpose of securing inoculating soil with which to inoculate large areas next year.

The more thorough the inoculation on such "starter" patches and the thicker the stand there, the more effective will that soil be for purposes of inoculation a year later. Hence, not less than 20 pounds per acre should be sown on such small areas.

In view of the high price of seed, it may be advisable in the fall of 1909, for those who are prepared to sow large areas, *with thorough inoculation,* to reduce the amount of seed to 12 pounds per acre, an amount which is smaller than was used in any of our tests, but which has sometime been reported as giving a satisfactory stand.

WHERE TO GET INOCULATING SOIL.

Whenever possible get this in your own neighborhood. Most readers can find it by searching for white clover, or for the dead remains of annual white clover in old lawns and on the richer spots in old pastures.

Each of the parties mentioned below consents to furnish to each of a limited number of applicants, and for $1.00 per 200 pound sack, a single sack of soil from a patch of inoculated crimson or red clover. The Experiment Station has not inspected any of these fields and can give no guarantee as to the absence from them of disease germs, etc., nor any other guarantee.

Under no circumstances will the Alabama Experiment Station distribute any soil from its farm, for this is known to contain the organisms that produce various plant diseases and root-knot.

Name	*Postoffice*	*County*	*Railway*
J. O. Burleson	Decatur, R. F. D.	Morgan,	L. & N.
A. G. Diseker	Russellville	Franklin,	Southern
J. J. Edge	Loachapoka	Macon,	W. of Ala.
Yancey Swearington	Shorter	Macon,	W. of Ala.
D. W. Davis	Gordo	Pickens,	M. & O.
W. Tyrrell	Citronelle	Mobile,	M. & O.

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