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CRIMSON CLOVER in Alabama

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AUBURN UNIVERSITY

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CRIMSON CLOVER in Alabama

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CRIMSON CLOVER is widely grown in Alabama. An estimated one-fourth million acres are planted to crimson clover alone or in association with various grasses. This makes it one of the most extensively grown annual winter legumes in the State.

An important seed crop in Alabama, crimson is also an excellent winter grazing crop for all types of livestock. It is also used for silage, hay, and green manure. The reseeding varieties will volunteer year after year when fertilized and managed properly.

Crimson clover was grown in experiments in Alabama by Duggar *(5, 6, 7)* as early as 1896. In 1897, Duggar *(5)* recognized the potential of this legume and wrote "There is reason to believe that crimson clover will prove the most useful of all soil-improving plants for the cotton planter owning suitable soil." He conducted numerous experiments at Auburn and on farmers' fields throughout Alabama seeking methods to grow this crop successfully. Most of these plantings failed because of lack of inoculation. Duggar found that on land not previously in clover, inoculation was necessary for growth of this crop. Inoculum used in early experiments was imported from Germany. Later, soils on which clover had been grown were used for this purpose. In 1909, Duggar published a list of farmers from whom inoculated soil could be obtained for $1.00 per 200-pound sack *(7)*. He recommended that clover be fertilized with phosphorus, potash, and lime and that it be planted in September or October.

Duggar recognized the potential of crimson clover for pasturage, hay, and green manure. Since there was little interest in grazing crops at that time, his primary objective was the planting

of crimson in cotton middles to be turned the following spring for green manure. As a result of the work by Duggar, crimson clover was promoted as a green manure crop. However, it was not as well adapted to planting in cotton and corn middles as were vetch and Austrian winter peas. Therefore, crimson clover almost disappeared from Alabama farms between 1920 and 1935.

Because of the excellent growth occasionally made by crimson clover when conditions were favorable, the late Fred Stewart, first superintendent of the Tennessee Valley Substation, in 1934 began a new effort to grow it for forage. He found that early plantings on well fertilized, fallowed land were highly successful in producing early grazing. This led to a great revival of interest in this crop in Alabama.

The advent of reseeding strains of crimson clover in the early 1940's further increased interest in this legume. These reseeding strains made crimson clover much more useful in Alabama's expanding livestock program.

This bulletin presents summaries of recent research on crimson clover by the Auburn University Agricultural Experiment Station. Also included is information on phases of clover production on which no research was conducted. This information is based on experience of personnel on the Main Station, substations, and experiment fields of the Experiment Station and observations of Extension Service workers.

ADAPTATION

Crimson clover is adapted in all geographic areas of Alabama. It grows best on well-drained, fertile soils. Low or wet soils that are subject to overflow or soils with poor internal drainage, such as Susquehanna clay in the area surrounding the Black Belt, are not suited for this legume. Crimson will not grow on the calcareous or high-lime soils of the Black Belt because of iron deficiency. It is difficult to establish on extremely eroded hills and on the deep sandy soils of central and southern Alabama where it may suffer from drought, lack of nutrients, and poor inoculation.

SEEDBED PREPARATION and SEEDING

Earliest growth of crimson clover is produced by planting annually on a well prepared seedbed. Best results with new

plantings result when land is turned 6 to 8 weeks before planting and fallowed. This controls weeds and conserves moisture for germinating the seed and maintaining the seedlings during fall droughts. After turning, harrowing is needed when each crop of weeds emerges. Following the last harrowing, the soil is smoothed and firmed just before seeding.

Seed can be planted with a cultipacker seeder, grain drill, or broadcast seeder. About one-fourth inch is the correct depth. Whatever the method of seeding, it is important that the soil be firmed following seeding. When planting in grass sod, a light disking is done before seeding. After seeding, the soil is firmed with a roller or drag. If earliness is not desired, soil preparation with a disc harrow is sufficient following summer row crops.

VOLUNTEER STANDS

One of the good features of crimson clover is that the reseeding varieties will reseed from year to year. Several strains that have been selected for the high percentage of hard seed they produce are satisfactory reseeders. Grazing is usually 2 or 3 months later on reseeding stands than on clover planted annually on prepared seedbeds. Maintenance of a reseeding stand depends on fertility of the soil, intensity of grazing, competition from summer vegetation, and infestation of insects and diseases.

A crop of seed can normally be obtained when clover is grazed provided the animals are removed by April 1 in southern Alabama and April 15 in the northern part of the State. Success of seed production depends on rate of stocking and the season. For reseeding only it can be grazed later if not overgrazed. Overgrazing can prevent reseeding since cattle will eat the seedheads if the stocking rate is excessive.

To obtain reseeding stands in Bermuda or other summer grasses, close grazing or mowing in late summer is necessary. If mowed with a sickle-bar, heavy grass residues should be removed from the area. Summer grasses offer serious competition to young clover seedlings for light, moisture, and plant nutrients; and earliness of grazing will be affected by the amount of such competition. Light disking before frost is often beneficial in reducing grass competition and in getting an early stand.

DATE of PLANTING

Planting at the proper time is extremely important for this crop. The following planting dates are recommended:

	Prepared seedbed	On pasture sod
Northern Alabama	July 15-Aug. 15	Oct. 1-Oct. 15
Central Alabama	Aug. 15-Sept. 15	Oct. 15-Nov. 1
Southern Alabama	Sept. 5-Oct. 20	Oct. 20-Nov. 15

Late plantings, which usually suffer from fall droughts or early frosts, may produce poor stands or be poorly inoculated. Late-planted clover grows slowly in the seedling stage and produces grazing only in late winter or spring.

Type of seedbed is highly important in determining the best time to plant. Earlier plantings are possible on prepared seedbeds where competition from other plants is at a minimum. Plantings must be delayed on sods or following summer crops that deplete soil moisture in late summer. Seedings should be made immediately before or following good rains if possible.

TABLE 1. GREEN WEIGHT YIELDS OF CRIMSON CLOVER PLANTED AT VARIOUS DATES, BREWTON EXPERIMENT FIELD, 1952-58

Date of planting	Green weight production per acre							
	1952	1953	1954	1955	1956	1957	1958	7-year average
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
August 20	0	8,200	27,600	19,200	8,000	14,800	5,200	11,900
September 5	27,700	9,300	27,100	16,400	17,200	12,500	6,200	16,600
September 20	29,000	21,900	32,200	12,500	21,200	19,800	18,200	22,100
October 5	17,400	28,000	19,400	14,200	19,600	24,000	15,800	19,800
October 20	16,800	21,500	24,000	15,100	14,600	16,000	7,700	16,500
November 5	10,800	20,100	14,800	12,900	3,600	12,800	8,000	11,900
November 20	16,000	14,100	8,600	8,600	5,800	8,600	2,300	9,100
December 5	6,700	5,400	1,800	6,200	2,800	10,500	1,100	4,900

Data in Table 1 from an experiment conducted on the Brewton Experiment Field illustrate the importance of planting at the proper time. These plantings were made on prepared seedbeds.

RATE of SEEDING

Seeding rate for crimson clover is dependent on condition of the seedbed. As a general rule, the poorer the condition of the seedbed, the more seed should be used.

The purpose for which clover is grown may influence the

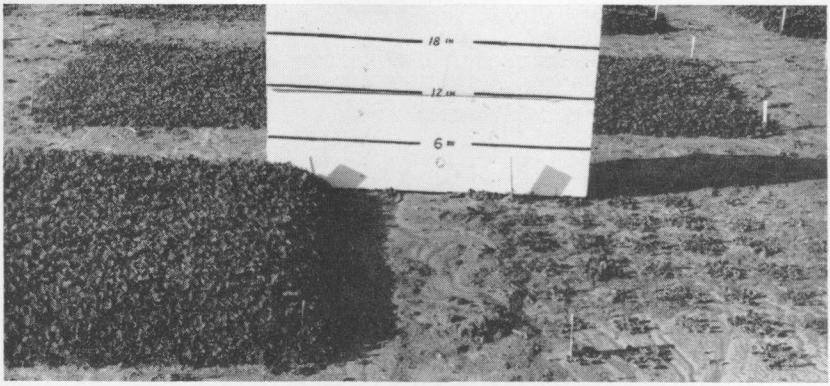

FIG. 1. Shown is comparative growth of crimson clover in spacings of ¾-inch (left) and 6 inches (right) on November 27, 1956, at Mississippi Agricultural Experiment Station. (From Lit. Ref. 9, used with permission of the authors.)

seeding rate desired. Knight and Hollowell *(9)* found a close relationship each year between stand density and early growth, Figure 1. Crimson clover in dense stands produced earlier fall and winter growth and greater forage yields than clover in thin stands. These workers found in 1956 that clover spaced at ¾-inch intervals produced an average of 10,634 pounds of green weight per acre by December 5, while a similar yield from a 6-inch spacing did not occur until March 1.

Results of 5 years of research on rate of seeding at the Brewton and Monroeville experiment fields are presented in Table 2. Clover in these tests was grown for green manure in an annual rotation of corn and crimson clover. Corn stalks were disked, seed were sown by hand, and the area firmed with a cultipacker. The seedbeds were not good because of the large amounts of

TABLE 2. GREEN WEIGHT YIELDS OF CRIMSON CLOVER SEEDED AT VARIOUS RATES, BREWTON AND MONROEVILLE EXPERIMENT FIELDS, 1952-56

Year	Green weight yields at three seeding rates					
	Brewton			Monroeville		
	10 lb.	20 lb.	30 lb.	10 lb.	20 lb.	30 lb.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
1952	9,200	11,800	13,500	8,500	16,700	20,400
1953	10,800	12,700	15,200	11,200	15,500	16,400
1954	5,700	9,100	11,800	16,800	23,800	32,200
1955	5,800	7,800	9,300	2,700	4,500	5,200
1956	11,700	15,700	16,700	17,200	25,000	27,000
AVERAGE	8,600	11,400	13,300	11,300	17,100	20,200

corn stalks on the surface. Each year at both locations yields increased as seeding rate was increased from 10 to 20 to 30 pounds per acre. Differences in growth were greater early in the season than when yields were measured.

The recommended seeding rate is 20 to 30 pounds per acre, with the higher rate desirable. Amount to use depends on condition of the seedbed, use to be made of the clover, price of seed, and companion crops planted with the clover. When planting with small grain or ryegrass, the clover seeding rate may be reduced to 15 to 20 pounds per acre.

INOCULATION

For healthy, vigorous growth, crimson clover must be properly inoculated, Figure 2. Inoculants are commercially available for use with clovers. These are mixtures that have proved effective on species of the legume group for which they are intended. The bacteria are dispersed in a carrier, usually peat soil, which is mixed with moistened seed to bring the bacteria into contact with the seed. Once coated with inoculum the seed should be planted as soon as possible. Inoculated seed that must be held for several days before planting should be protected from prolonged drying, heating, or exposure to sunlight. It is unwise

FIG. 2. Crimson clover must be properly inoculated for healthy, vigorous growth. Plot at right was inoculated, that at left not inoculated. Photo was made January 3, 1952, at the Experiment Station Plant Breeding Unit, Tallassee.

to rely on inoculum when the expiration date printed on the container has passed.

While nitrogen-fixing bacteria effective on clovers are extensively distributed in agricultural soils, they become diminished in soil where clovers are not grown and increase in numbers where clovers are prominent. For this reason proper seed inoculation is essential when planting crimson clover on new land or where clovers have not recently been grown. The small cost is repaid many times over in earlier and greater growth.

LIME REQUIREMENT

Most of the soils on which crimson clover is grown are acid and need lime for satisfactory production, Figures 3 and 4. Although tolerant of more acidity than some other legumes, such as alfalfa, sweet clover, Caley peas, and white clover, crimson responds to moderate lime applications on most soils having a pH of less than 5.7. The effect of lime on crimson forage yields in several experiments is presented in Table 3.

A soil test is the best method for determining amount of lime needed. Generally, if the soil pH is less than 5.7, lime is needed and should be applied well in advance of seeding – about 1 ton

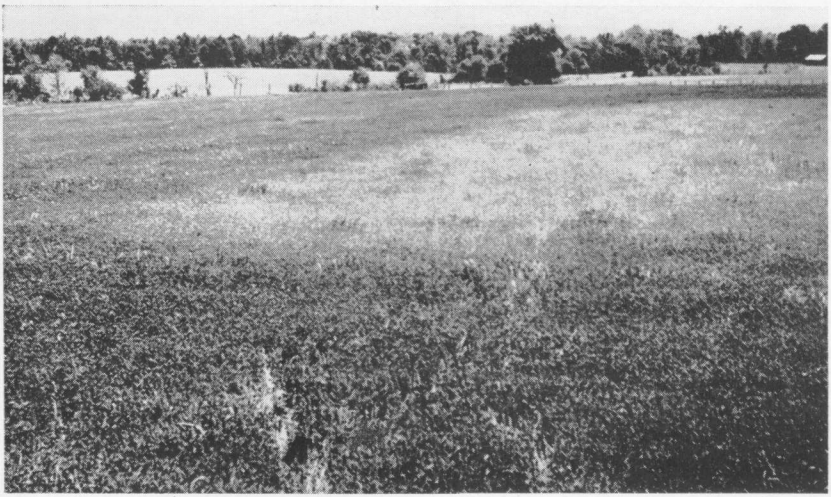

FIG. 3. Lime is needed on many soils for top crimson clover production. This photo, made May 7, 1959, in Talladega County, shows effect of lime. Area in right background had not been limed since clover establishment in 1947. Area at left and in foreground received 2 tons of lime per acre in fall of 1958.

FIG. 4. These clover plants are from unlimed (left) and limed areas shown in Figure 3. Plants from unlimed area were unthrifty and had small seed heads, whereas limed clover was vigorous and healthy. Field was grazed until April 15.

TABLE 3. EFFECT OF LIME ON FORAGE PRODUCTION OF CRIMSON CLOVER ON SEVERAL ALABAMA SOILS (DATA FROM LIT. REF. 1)

Limestone added per acre, lb.[1]	Dry forage per acre, average		Green forage per acre, average				
	Site 1[2] 1944-45	Site 2[3] 1952-53	Site 3[4] 1947-49	Site 4[5] 1947-49	Site 5[6] 1948-50	Site 6[7]	
						1942-45	1946-48
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	1,877	1,856	5,680	12,120	11,940	720	0
1,500	4,013	----	----	----	----	20,000	1,600
2,000	----	2,342	----	----	----	----	----
3,000	4,534	----	----	----	----	22,600	10,200
4,000	4,487	----	12,300	20,020	12,940	----	----
8,000	4,920				----		
pH of unlimed soil	5.3	6.5	5.1	5.8	5.5	5.7	5.7

[1] All plots received phosphate and potash.

[2] Norfolk sandy loam at Auburn that received borax.

[3] Kalmia fine sandy loam on Henderson Brothers' Farm at Millers Ferry.

[4] Hartsells very fine sandy loam that received boron, zinc, and manganese.

[5] Lloyd sandy clay loam that received boron, zinc, and manganese.

[6] Norfolk loamy sand near Auburn.

[7] Lime applied in 1941 to Norfolk sandy loam at Auburn.

per acre on sandy soils and 2 tons on heavy-textured soils. The lime need of soils that have reseeding stands should be determined about every 3 years.

FERTILIZATION

Crimson clover will produce satisfactory yields of forage on soils of medium fertility provided a good stand is established. However, it responds to fertilizer as well as to lime, Figure 5. The greatest response to fertilizer and lime has been obtained during the early period of growth. Early fall growth is especially important for grazing because forages of good quality are usually scarce at that time. Without adequate fertility, clover makes little growth until early spring, when it may grow rapidly for a short time.

Use of a soil test is recommended to determine the kind and amount of fertilizer to use. If a soil test is not made, 300 pounds of 0-14-14 per acre is suggested for soils previously well fertilized. On soils that have not been previously well fertilized, 400 pounds of 0-16-8 per acre is recommended. Clover grown alone needs no nitrogen fertilizer. However, when planted with cool-season grasses, such as ryegrass, rescue, or small grains, 50 pounds of nitrogen per acre is needed either before planting or soon after the grass comes up.

Reseeding stands of crimson clover should be fertilized each

FIG. 5. This 1923 photograph made at the old Atmore Experiment Field shows good growth of crimson clover that had lime, phosphorus, and manure applied (left) as contrasted with plot at right that was not fertilized or limed.

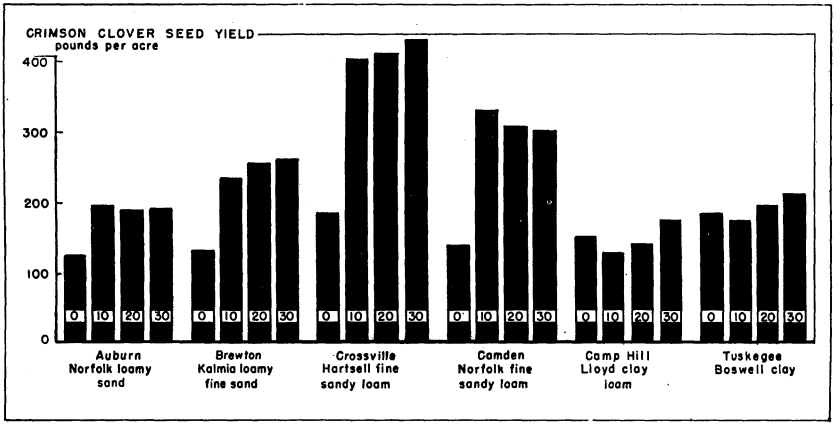

FIG. 6. Effect of applying 10, 20, or 30 pounds of borax per acre to crimson is illustrated by these seed yields on six Alabama soils during 1950 to 1954. No yields were obtained from Camp Hill in 1953-54, Camden in 1954, and Crossville in 1955 because of drought or early freeze. (From Lit. Ref. 11.)

fall with about 300 pounds of 0-14-14 or every other year with twice this amount. Failure to fertilize adequately will result in loss of stands on most soils.

Borax at 10 pounds per acre is required on clover grown for seed production *(11)*. This is especially important on sandy soils. Experiments on four sandy soils showed large increases in seed yields from 10 pounds of borax, Figure 6. However, clover on the two clay soils did not respond to borax. Forage yields were increased when the soil was deficient in boron. In most cases, however, vegetative growth was not affected by borax application.

VARIETIES

Common or commercial crimson clover has been tested by the Auburn University Agricultural Experiment Station since before 1890. Reseeding strains were selected in the early 1940's and caused greatly increased interest in crimson clover. Many reseeding strains resulting from natural selection or survival have been grown in Alabama.

Seven of the most popular varieties have been tested in recent years by this Station at three locations. Seasonal forage distribution was determined by clipping several times during the season, Table 4. In a second test at each location, the varieties

TABLE 4. YIELD OF DRY HERBAGE PER ACRE PRODUCED BY CRIMSON CLOVER VARIETIES SEEDED ANNUALLY AND CUT TWO OR MORE TIMES DURING THE GROWING SEASON AT THREE LOCATIONS

Variety	Alexandria, northern Alabama				Tallassee, central Alabama				Brewton, southern Alabama			
	3-yr. av.[1]		4-yr. av.[2]		3-yr. av.[1]		5-yr. av.[3]		3-yr. av.[1]		4-yr. av.[2]	
	Early growth	Total growth	Early growth	Total growth	Early growth	Total growth	Early growth	Total growth	Early growth	Total growth	Early growth	Total growth
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Auburn	1,336	2,554	----	----	1,686	3,262	1,448	3,837	653	2,174	----	----
Autauga	1,247	2,658	1,192	2,301	2,009	3,475	1,741	3,925	708	2,387	640	1,981
Chief	925	2,885	927	2,495	1,548	3,292	1,331	3,815	437	2,640	390	2,141
Common	565	2,534	635	2,214	976	3,090	1,055	3,795	555	2,799	515	2,282
Dixie	1,010	2,579	978	2,240	1,773	3,564	1,507	4,017	516	2,401	505	1,988
Kentucky	873	2,794	749	2,395	1,888	3,705	----	----	459	2,504	401	2,077
Talladega	506	2,329	568	2,069	----	----	----	----	470	2,612	465	2,166

[1] 1956-58.
[2] 1955-58.
[3] 1952, 1953, 1956, 1957, 1958.

TABLE 5. YIELD OF HAY PER ACRE PRODUCED BY CRIMSON CLOVER VARIETIES CUT ONCE IN THE HAY STAGE AT THREE LOCATIONS

Variety	Alexandria, northern Alabama		Tallassee, central Alabama			Brewton, southern Alabama	
	3-yr.[1] av.	4-yr.[2] av.	3-yr.[1] av.	4-yr.[2] av.	6-yr.[3] av.	3-yr.[1] av.	4-yr.[2] av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Auburn	3,681	3,294	3,837	3,670	3,759	2,768	2,683
Autauga	3,756	3,215	3,828	3,662	3,634	2,903	2,939
Chief	3,844	----	3,718	----	----	3,031	----
Common	3,548	3,401	3,154	3,150	3,709	3,008	3,094
Dixie	3,485	3,145	3,848	3,710	3,955	2,602	2,877
Kentucky	3,979	----	3,710	----	----	3,115	----
Talladega	3,671	3,357	----	----	----	3,191	3,316

[1] 1956-58.
[2] 1954, 1956-58.
[3] 1951, 1952, 1954, 1956-58.

were cut only once when most varieties were in full bloom, Table 5. Auburn, Autauga, and Dixie are earlier to reach full-flower than Talladega, commercial, Chief, and Kentucky, Table 6. There is an 8- to 10-day spread in maturity among varieties. The early-flowering varieties generally produced more early forage than the late-flowering ones, Figure 7. However, the magnitude of the difference among varieties in early forage production varies from year to year and is influenced by such factors as date of planting, soil moisture, temperature, and stand. (See chapter on Rate of Seeding.)

Chief, common, Talladega, and Kentucky generally produced the most forage when cut only once at the hay stage (full bloom).

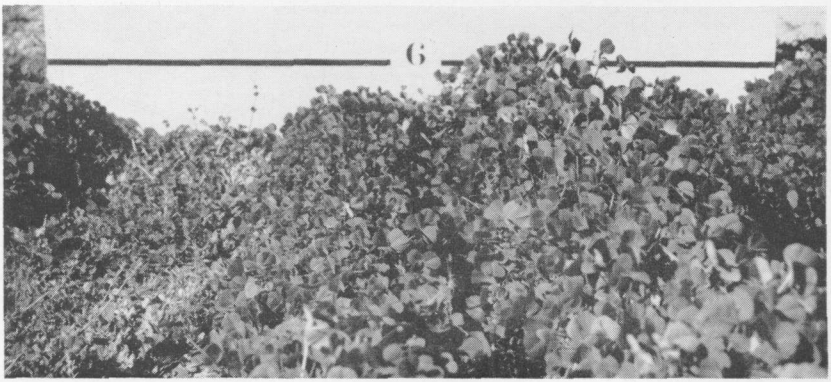

FIG. 7. Common (left) and Autauga varieties show differences in early growth. Photo was made March 2, 1959, at Plant Breeding Unit, Tallassee.

TABLE 6. VARIATION IN DATE OF MATURITY AMONG CRIMSON CLOVER VARIETIES, 1959

Variety	Alexandria, northern Alabama		Tallassee, central Alabama	
	Date of full bloom	Date of combine readiness	Date of full bloom	Date of combine readiness
Auburn	April 20	May 11	April 1	May 9
Autauga	April 20	May 11	April 5	May 12
Dixie	April 20	May 11	April 3	May 13
Talladega	April 26	May 18	April 6	May 15
Common	April 24	May 18	April 8	May 16
Chief	April 28	May 18	April 10	May 17

Differences in total production among varieties were small in most cases. These data indicate that Auburn, Autauga, and Dixie are slightly superior for early production.

COMPARISON with OTHER WINTER LEGUMES

Forage Production

Crimson clover is an excellent forage legume. Its popularity in recent years has been largely because of its usefulness as a forage, Figure 8. It has been compared extensively with other forage legumes by this Station since 1953. Langford *(10)* reported that crimson clover produced earlier and more total forage than any other winter legume tested. Table 7 presents the relative

FIG. 8. Crimson clover is an excellent grazing crop for hogs. The field scene shown here was photographed in Autauga County in April 1959.

TABLE 7. RELATIVE EARLY AND TOTAL YIELD OF OTHER WINTER LEGUMES AS COMPARED TO CRIMSON CLOVER, 1953-56 (FROM LIT. REF. 10)

Crop and number of tests	Relative yield	
	First harvest	Total
	Pct.	*Pct.*
Crimson clover	100	100
Ball clover, 18	17	72
Kenland red clover, 12	5	71
Rose clover, 5	14	71
Mike clover, 12	25	57
La. S-1 white clover, 10	8	57
Button clover, 13	19	56
Subterranean clover, 7	17	60
Hairy vetch, 18	85	88

yields of Ball, Kenland Red, Rose, Mike, La. S-1 White, Button, and Subterranean clovers and hairy vetch when compared with crimson. Hairy vetch was the only legume that compared favorably with crimson clover in performance as a forage. The other legumes grew much more slowly in the fall and winter and produced growth much later than crimson clover and vetch. Total production was also lower.

Green Manure

Since crimson clover was brought to this country from southern Europe about 1819, it has been highly regarded as a soil builder. It was used primarily as a green manure crop until recent years when livestock farming became important in the Southeast. However, larger seeded legumes such as vetch are better suited for soil building since they are generally easier to establish and require less seedbed preparation following row crops. When good stands of crimson are obtained, it compares favorably with the other legumes tested for green manure. It has produced about the same amount of growth as hairy and Monantha vetch, and more than Austrian winter peas, Table 8. Auburn Woollypod vetch produces earlier and more total growth than crimson clover or the other vetches. Crimson clover compares favorably with Warrior and Willamette vetches as a green manure crop.

As a green manure crop, crimson clover has also been compared with and found superior to Hungarian, Oregon (common), and Monala vetches; Caley, Dixie Wonder, and Papago peas; and blue, white, and yellow lupines. These crops were inferior be-

TABLE 8. GREEN WEIGHT PRODUCED BY FOUR WINTER LEGUMES GROWN FOR GREEN MANURE, SEVEN LOCATIONS[1]

Legume	Green weight per acre at seven locations							
	Tennessee Valley Substation 1931-45 (13)	Sand Mountain Substation 1933-45 (11)	Wiregrass Substation 1939-46 (5)	Alexandria Field 1931-44 (14)	Aliceville Field 1931-51 (21)	Monroeville Field 1931-51 (21)	Brewton Field 1931-51 (21)	Weighted average (106)
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Crimson clover	17,200	12,300	7,500	9,200	13,800	8,600	8,700	11,100
Hairy vetch	12,000	7,600	15,200	7,200	13,800	7,100	6,100	9,300
Monantha vetch	12,700	7,800	21,100	8,000	17,000	7,000	6,300	10,400
Austrian winter peas	10,500	5,800	15,300	6,700	8,300	3,400	5,000	6,800

[1] Numbers in parentheses are the number of years tests were conducted.

FIG. 9. Crimson is well adapted for use in orchards for grazing and green manure. Here cattle are grazing crimson clover in an Autauga County pecan orchard. The photograph was made April 1960.

cause of low production and/or susceptibility to cold, diseases, and nematodes.

Good crops of winter legumes turned for green manure will supply adequate nitrogen for summer row crops. Normally the green material will contain about 0.75 to 1.0 per cent nitrogen (2). On the dry weight basis, the nitrogen content usually is 3 to 3.5 per cent. Green material of lupines contains lower nitrogen percentages than the other winter legumes.

Crimson clover is an excellent green manure crop for use in pecan and other orchards, Figure 9. It may be allowed to reseed and does not need to be turned for the nitrogen to become available to the trees and grasses.

SEEDING MIXTURES

Increased yields and longer grazing season can be obtained by planting crimson clover in mixtures with adapted annual winter grasses, Figure 10. Although bloat in cattle is less common on crimson than on white clover, its incidence can be greatly reduced by planting grass with clover. Some grasses commonly used are ryegrass, rescuegrass, and small grains – oats, wheat,

FIG. 10. Beef cattle make good gains on crimson clover-winter grass mixtures. These cattle were on clover-grass pasture in Autauga County in April 1960.

and rye. Results of several experiments involving various combinations of these are presented in Table 9.

Annual ryegrass and rescuegrass seedlings develop at about the same rate as do those of crimson clover. Grazing can be maintained later in the spring by using these grasses with crimson clover and applying nitrogen to the mixture either before or soon after planting. Rescuegrass is susceptible to mildew and smut, which may seriously reduce yields in some years.

Small grains with crimson clover produce more early grazing than ryegrass or rescuegrass with crimson clover. Rye grows more rapidly in the fall than wheat or oats. Since rye matures earlier, it is less competitive than wheat and oats in the spring during the period of most rapid clover growth. Small grains are the most dependable crops available for producing fall and winter grazing. Because of competition from the small grain, crimson clover does not contribute much to the fall and winter forage produced from such mixtures, but it adds to the forage produced in the spring. The longest grazing season is obtained with a mixture of rye, ryegrass, and crimson clover, Figure 11.

Small grains and ryegrass should not be seeded at high rates when planted with crimson clover because the competition in early growth stages may prevent a good stand of crimson clover from surviving. Small grains may be mixed to give better dis-

TABLE 9. YIELDS OF CRIMSON CLOVER, SEVERAL WINTER ANNUAL GRASSES, AND VARIOUS COMBINATIONS AT SEVERAL LOCATIONS, 1953-57[1 2]

Crops and mixtures	Dry forage produced per acre, seven locations							
	Wiregrass Substation 1955-6 (1)	Lower Coastal Plain Substation 1953-6 (3)	Lower Coastal Plain Substation 1956-7 (1)	Piedmont Substation 1953-5 (2)	Tennessee Valley Substation 1955-6 (1)	Main Station 1955-6 (1)	Upper Coastal Plain Substation 1953-6 (3)	Average, six locations 1956-7 (6)
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Ryegrass-crimson clover	3,486	4,622	4,115	4,366	7,437	5,939	3,060	4,120
Ryegrass	2,959	3,662	2,510	3,812	7,136	6,021	2,840	----
Rye-ryegrass-crimson clover	3,428	----	4,801	----	7,362	7,463	----	4,775
Rye-ryegrass	3,409	----	2,589	----	6,923	7,147	----	----
Abruzzi rye	3,725	3,139	1,152	5,136	5,852	5,400	4,373	----
Oats	3,634	3,655	2,495	4,649	7,255	5,914	3,263	----
Crimson clover	----	2,859	2,416	3,186	----	----	2,172	2,464
Oats-crimson clover	----	4,378	----	4,642	----	----	3,905	----
Oats-woollypod vetch	----	4,318	----	4,521	----	----	----	----
Rye-crimson clover	----	4,249	----	5,409	----	----	4,613	----
Wheat-crimson clover	----	4,413	----	4,839	----	----	3,380	----
Rescue-crimson clover	----	4,479	----	4,519	----	----	2,954	----
Wheat	----	3,081	----	4,039	----	----	3,285	----

[1] Unpublished data from W. R. Langford, formerly of the Department of Agronomy and Soils, Auburn University Agricultural Experiment Station.

[2] Numbers in parentheses are the number of years tests were conducted.

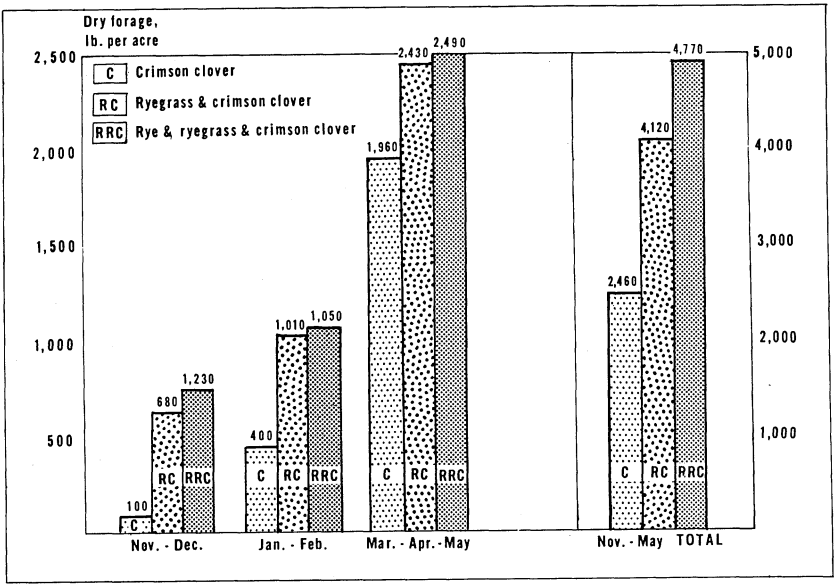

FIG. 11. The graph shows seasonal distribution of forage produced by crimson clover, crimson-ryegrass, and crimson-ryegrass-Abruzzi rye and total forage production for each. Data are from six Alabama locations during 1956-57.

tribution of grazing and to prevent excessive competition at any one time. Recommended seeding rates for mixtures containing crimson clover are:

20 pounds crimson clover, 20 pounds ryegrass
20 pounds crimson clover, 25 pounds rescuegrass
20 pounds crimson clover, 80 pounds oats, wheat, or rye
15 pounds crimson clover, 15 pounds ryegrass, 60 pounds oats, wheat, or rye

Crimson clover and ryegrass seed should not be planted as deep as small grain. They can be seeded with a grass seed attachment on a grain drill or in a separate operation following planting of the small grain.

ROTATIONS

Cropping systems that are adaptable to use with crimson clover depend on utilization to be made of the clover. Several 1-, 2-,

and 3-year rotations for use with crimson clover for grazing and for seed production are suggested below.

Reseeding Crimson Clover for Grazing or Seed Production

1-YEAR ROTATIONS

Crimson clover—Coastal Bermuda, common Bermuda, or crabgrass

Crimson clover—millet, Sudangrass, or grain sorghum

Clover Planted Annually for Grazing or Seed Production

1-YEAR ROTATIONS

Crimson clover—millet, Sudangrass, grain sorghum, or soybeans

2-YEAR ROTATIONS

Crimson clover—grain sorghum—small grain

Crimson clover—soybeans—cotton or corn

3-YEAR ROTATIONS

Crimson clover—grain sorghum—vetch—corn—cotton

Crimson clover—grain sorghum—small grain—soybeans—cotton or corn

Crimson clover—grain sorghum—vetch—corn—small grain

Crimson Clover for Green Manure

1-YEAR ROTATIONS

Crimson clover—corn

2-YEAR ROTATIONS

Crimson clover—corn—cotton

MANAGEMENT and USE

Forage

Crimson clover normally makes most of its growth in late winter and early spring. However, it grows rapidly when planted in early fall if moisture is adequate. It makes little growth during cold periods in winter and should not be overgrazed, especially under these conditions. Removal of all of the leaves will reduce the rate of recovery. Since this plant starts from a small seed each year, it has little or no root reserve of stored food to promote new growth after close grazing. Grazing should not be started until clover is 4 to 6 inches tall and it should never be grazed below 2 inches. This will often mean that livestock must be removed if the stocking rate is high or during periods of slow clover growth caused by cold or drought.

Although used primarily as a grazing crop in Alabama, crimson clover makes excellent hay when cut at the early to full bloom stage. It is not often cut for hay because it reaches the hay stage during a period of frequent rains and when farmers

are usually busy with other crops. Crimson cures slowly because of a high moisture content and the season of the year. It makes excellent silage.

Green Manure

Annual winter legumes, such as crimson clover and vetch, are used widely for green manure ahead of corn. They may be used ahead of cotton if sufficient growth is made early enough to turn 2 or 3 weeks before cotton planting time. Early planting is desirable although not as essential for producing green manure as for grazing. A good growth of green manure will produce as much corn as 60 to 90 pounds of commercial nitrogen *(4)*. Corn needs no additional fertilizer when following a good crop of legumes properly fertilized with phosphorus and potash. Crops following green manure should not be planted for 2 weeks after turning because of danger of damage from certain insects.

Obtaining a good stand following a row crop is easier with vetch than with crimson clover and less seedbed preparation is required. If planted early enough to produce fall or winter growth, these crops may be grazed and still produce green manure by removing livestock in early spring. If needed for grazing, clover is worth more as forage than as green manure.

Seed Production

Production of good seed yields under Alabama conditions is another reason for the importance of crimson clover. If grown for seed only, early planting is not as necessary as for grazing. However, other phases of management are important.

Thin stands often result in excessively high weed seed content.

Seed yields will be greatly increased on most sandy soils by applying 10 pounds of borax annually *(11)*, Figure 6.

When used for both grazing and seed production, cattle should be removed by April 1 in southern and central Alabama and by April 15 in northern Alabama. The time to remove cattle may vary with season and intensity of grazing.

Beneficial and harmful insects may greatly influence seed yields. Bees are needed to pollinate clover. Clover head weevils must be controlled if good seed yields are to be produced. These factors are discussed in detail in the section on insects.

TABLE 10. EFFECT OF SEED MOISTURE CONTENT DURING STORAGE ON THE GERMINATION OF CRIMSON CLOVER SEED[1]

Initial seed moisture content	Germination				
	Initially	After 4 months	After 1 year	After 2 years	After 3 years
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
14.8	93.0	30.0	---	---	---
12.3	93.0	90.0	85.0	11.5	00.0
10.1	93.0	93.0	94.0	86.0	68.0

[1] Unpublished data of H. S. Ward, Jr., formerly of the Department of Botany and Plant Pathology, Auburn University Agricultural Experiment Station.

Seed are normally harvested direct with a combine when most of the seed heads are fully mature and the seed can be easily stripped between two fingers. Excessive wind or rain at this time can cause severe or total loss of seed by shattering. After combining, seed should be taken to a cleaning plant for removing green material and drying. If heated air is used for drying, the temperature of the drying air usually *should not exceed 110° F.*

Germination of seed after storage is dependent on seed moisture content, storage temperature, and time in storage. The effect of various seed moisture contents during storage on the germination of crimson clover seed is shown in Table 10. The *safe moisture content* for crimson clover seed stored in Alabama is 10 per cent.

INSECTS

Beneficial Insects

When crimson clover is grown for seed, it is important that bees be present for pollination, Table 11. Results of experiments by Blake *(3)* show that honey bees placed in or near clover

TABLE 11. YIELDS OF CRIMSON CLOVER SEED PER ACRE IN THE ABSENCE OR PRESENCE OF HONEY BEES, 1951-52 (DATA FROM LIT. REF. 3)

Treatment	Seed yields at three locations during 2 years					
	1951			1952		
	I	II	III	I	II	III
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Bees excluded	157	92	40	19	177	49
Bees present	541	601	575	300	1,196	308
Increase	*384*	*509*	*535*	*281*	*1,019*	*259*

fields will cause increases in seed yields, if the potential yield is high as a result of other good practices. Two colonies of bees per acre of clover are recommended. If the clover is well fertilized, moisture is not limiting, and cattle are removed early for good growth, three colonies of bees per acre will prove profitable. The bees should be placed in or along edges of the field, preferably in shaded areas, so the flight distance is as short as possible.

If the clover is not to be harvested for seed but is expected to reseed the next fall, bees are still needed to produce enough seed for the volunteer crop. Less than one colony of bees per acre will be enough under these circumstances, and in many areas, wild bees will be sufficient. In areas where there is a dearth of both wild and domestic bees, approximately one colony is needed per acre of crimson clover.

Where clover is to be used as a green manure crop and turned prior to seeding, there is no need for pollination.

Injurious Insects

Several species of insects are destructive to crimson clover in the seedling stage, but effective control measures are known for them. The insects that normally cause the most injury in young clover are the fall armyworm, several cutworms, yellow-striped armyworm, and the Hawaiian beet webworm.

Depending on clover size, 1 to 2 pounds of technical DDT or 2 to 4 pounds of toxaphene per acre will give satisfactory control of these pests. Either 10 to 20 pounds of 10 per cent DDT dust or equivalent amounts of DDT in sprays can be used.

Do not graze lactating dairy animals on clover treated with DDT or toxaphene. Other animals may be returned to DDT- or toxaphene-treated clover 7 days after treatment. Remove beef animals from treated clover 8 weeks before slaughter. On clover to be grazed by lactating dairy animals, 1 to 2 pounds technical methoxychlor may be used provided animals are kept off the clover for 7 days after treatment. Malathion at 1 to 2 pounds technical per acre may be used and cattle replaced 3 days after treatment; however, insect control is less effective than with DDT, toxaphene, or methoxychlor.

At least two species of clover head weevils attack crimson clover heads, and may drastically reduce seed yields. The lesser clover leaf weevil and a closely related species are the most im-

TABLE 12. CRIMSON CLOVER SEED YIELDS FOLLOWING INSECTICIDAL TREATMENTS FOR CONTROL OF THE CLOVER HEAD WEEVIL, FIVE EXPERIMENTS[1]

Treatment	Per acre seed yields with different insecticidal treatment						
	Dusts[2]			Granules[3]			Sprays[4]
	1958		1960	1959		1960	1960
	Exp. 1	Exp. 2	Exp. 5	Exp. 3	Exp. 4	Exp. 5	Exp. 5
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
No treatment	145	78	127	288	346	132	130
Sevin	317	134	----	550	436	----	----
Guthion	288	253	182	470	540	----	222
Heptachlor	343	218	157	716	646	240	----
Endrin	394	184	219	----	----	209	182
Malathion	----	----	182	545	376	----	201
Parathion	----	----	----	----	----	----	206
Aldrin	----	----	----	852	661	----	----
Dieldrin	----	----	----	----	----	208	----
DDT	----	----	222	----	----	----	200
Korlan	----	----	187	----	----	----	226
Methyl Trithion	----	----	----	----	----	----	226
Thiodan	----	----	----	----	----	----	215
Dimethoate	----	----	----	----	----	----	176
Dibrom	----	----	----	----	----	----	149

[1] Unpublished data contributed by Sidney B. Hays, formerly of the Zoology-Entomology Department, Auburn University Agricultural Experiment Station. Experiments conducted in Autauga and Talladega counties.
[2] Dusts applied at full bloom stage, one application at 25 pounds per acre.
[3] Granules applied in March, 2 pounds technical material per acre.
[4] Sprays applied at full bloom, ½ pound technical material per acre.

portant of the weevils that attack clover heads. Research at this Station has shown that good control of these weevils may be obtained by treating clover fields in early spring before the clover blooms, using 1 pound of technical heptachlor, endrin, or dieldrin in granular formulation, Tables 12 and 13. Twenty pounds of 5 per cent granules per acre is the correct amount. **Lactating dairy cattle must be kept off clover fields treated with these materials;** however, all grazing animals must be kept off clover after blooming begins if a good seed crop is to be made. Treatment of clover when it is in 50 per cent bloom with either 20 pounds of 2½ per cent heptachlor or 5 per cent DDT, or 25 pounds of 2 per cent endrin or 2 per cent parathion dust per acre is also effective. Equivalent amounts as sprays may be used. **Do not allow cattle to graze for the remainder of the season following application of any of these insecticides except parathion.**

Several species of mites attack crimson clover. They include the clover mite, strawberry mite, and the two-spotted mite. They can be controlled with dusts of 5 per cent malathion or 1 per cent parathion or equivalent amounts as sprays.

TABLE 13. CRIMSON CLOVER SEED PRODUCED WHEN TREATED WITH HEPTACHLOR[1] AT FOUR DATES DURING 1959-60, AUTAUGA COUNTY[2]

Date of treatment	Seed yield per acre	
	1959	1960
	Lb.	*Lb.*
March 22 (pre-bloom)	715	240
April 7 (10% bloom)	561	198
April 18 (50% bloom)	854	187
April 25 (90% bloom)	507	204
Untreated	288	132

[1] Two pounds of technical material per acre.

[2] Unpublished data contributed by Sidney B. Hays, formerly of the Zoology-Entomology Department, Auburn University Agricultural Experiment Station.

Caution

The insecticides recommended for control of clover head weevil are highly toxic to honey bees. Honey bees are essential for clover seed production; therefore, these insecticides should be applied early in the morning or late in the evening when bees are not working on the blossoms. Care should also be taken to avoid dusting or spraying in or near bee yards.

DISEASES

Although crimson clover is attacked by several diseases in Alabama, no one disease consistently causes great damage. A brief description of these diseases follows.

Major Diseases in Alabama

Crown and Stem Rot, caused by a soil-borne fungus, *Sclerotinia trifoliorum,* is widespread throughout the State, Figure 12. In addition to crimson clover, alfalfa, Ladino clover, and medium red clover are also susceptible to the disease. It is most destructive during the winter on seedlings, although plants of all ages are susceptible. It can develop and spread quickly and is recognized by circular, scalded patches of dead and dying plants in affected fields. Grazing tends to reduce the amount of damage from the disease. Knight (*8*) found more damage in thick stands than in thin ones and found that clipping the forage reduced the damage. Rotations using grass crops resistant to the fungus also can be an effective way of checking the disease.

FIG. 12. Dead and dying crimson clover plants show effects of crown and stem rot, a disease that is widespread throughout Alabama. The bare spot shown is part of a circular area of dead plants, which is characteristic of crimson clover fields where the disease is present. The photograph was made March 1958 at the Plant Breeding Unit, Tallassee.

Sooty Blotch may occur during late winter and early spring. It is caused by a fungus, *Cymadothea trifolii*, which produces dark-brown or black angular blotches that are more prevalent on the lower surface. The organism can cause partial defoliation, although such leaf loss is usually of minor consequence. No great loss will occur if affected areas are mowed or grazed before severe leaf damage occurs. The regrowth will probably have less disease.

Minor Diseases in Alabama

Although considered of minor consequence throughout the State, the following described diseases can cause considerable damage to crimson clover in localized areas:

Southern Anthracnose is caused by a fungus organism, *Colletotrichum trifolii*. Anthracnose occurs as small dark spots on the stems, petioles, and flower stalks. Girdling of these plant tissues by the fungus can cause wilting and browning above the girdle. Frequently the organism attacks the upper part of the taproot and crown, resulting in a taproot decay or crown rot that weak-

ens or kills affected plants. The development of resistant varieties offers the most promise of control.

Rust, caused by the fungus *Uromyces trifolii fallens,* may induce major damage on leaves and petioles. If pustules of brown rust are abundant and well developed, the upper leaf surface becomes reddish-brown to yellow, and the leaf then curls or withers and dies. The attacked petioles may result in a decreased supply of nutrients to the leaves.

Mosaic is a virus disease that occurs commonly on crimson clover leaves. Its symptoms are leaf curling, crinkling, and mottling. Size of leaves may be reduced. Severely affected plants may be dwarfed or weakened and unable to withstand prolonged drought or severe cold temperatures.

Root Knot, caused by the nematode *Meloidogyne* sp., is prevalent in most of the sandy soils in this State. Attack by this organism results in plants with yellow and stunted top growth and with knots, or galls, on the roots. Rotations, using crops resistant to nematode attack, will deplete nematode populations in infested soils.

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DEC 20 '62

Crimson Clover is widely grown in Alabama, using know-how provided by research of Auburn University Agricultural Experiment Station. Studies dating back to 1896 have been done in all parts of the State (see map below) to learn best methods of production. In the early research, crimson was tried as a soil builder. Later emphasis was shifted to growing it as a forage crop. The cover photograph made April 21, 1960, shows Autauga reseeding crimson on the farm of William E. Mathews, III, in Autauga County. Growing in Coastal Bermudagrass sod, the clover was planted in 1951 and has reseeded each year. The grass was established in 1954 as a perennial hay crop. It is clipped close in the fall to ensure a good stand of crimson.