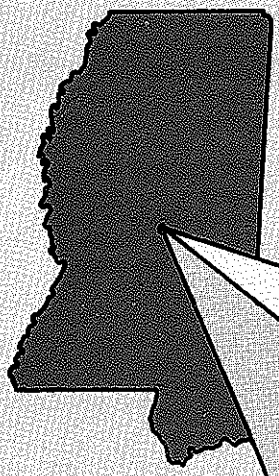
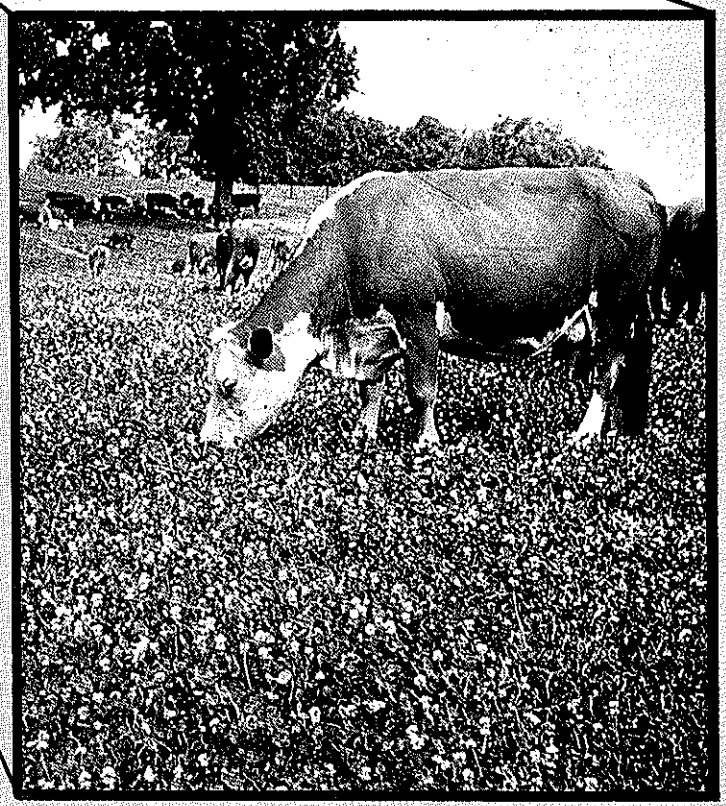
Bulletin 871 December 1978



White Clover Production in Mississippi



By
Vance H. Watson
and
William E. Knight

AR, SEA, USDA
in cooperation with

MAFES MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION
R. RODNEY FOIL, DIRECTOR MISSISSIPPI STATE, MS 39762

Mississippi State University
James D. McComas, President Louis N. Wise, Vice President

A Noble Past-A Promising Future
1878·CENTENNIAL·1978

Bulletin 871

White Clover Production in Mississippi

By
Vance H. Watson, Agronomist, MAFES
Department of Agronomy and
William E. Knight, Research Agronomist,
Crop Science and Engineering Research
Laboratory, AR, SEA, USDA

Crop Science and Engineering
Research Laboratory
AR, SEA, USDA
Mississippi State, Mississippi 39762

In cooperation with
Mississippi Agricultural and Forestry Experiment Station
Mississippi State University

December 1978

White Clover Production in Mississippi

Value of Clovers in Producing Milk and Beef

Browning (1) used lactating dairy cows to determine relative quality and production of irrigated pastures. Cows produced more milk year-round on pastures where clover furnished nitrogen than on heavily fertilized grass. Forage quality and production of ladino clover and ladino overseeded on Coastal bermudagrass with no added nitrogen were compared with those from Coastal fertilized with 500 lbs of ammonium nitrate per acre. Cows grazing the ladino clover for an entire year produced 61% more milk per acre than those grazing the fertilized Coastal. The Coastal-clover mixture produced 32% more milk per year than the Coastal. The Coastal-clover mix produced less dry matter than the fertilized Coastal from May 13 to Sept. 13, and milk production per acre on the mix was only 90% of that on the grass because of reduced carrying capacity. However, milk production per cow was higher on the Coastal-clover mix.

Hogg and Collins (5) reported that the cost of beef production on Louisiana S-1 white clover overseeded on Coastal bermudagrass was lower than for other overseeded legumes, and considerably lower than on Coastal alone fertilized with nitrogen. Hogg (4) reported later that no economic yield response can be expected from applying nitrogen to mixtures of clover and Coastal bermudagrass. Pund and Hogg (15) concluded that steers grazing irrigated Coastal bermudagrass-clover pastures produced higher average daily gains and more beef per acre at lower cost than those grazing irrigated and fertilized Coastal bermudagrass without clover.

Annual clovers have been used satisfactorily in the Southern region of the United States to extend the grazing season, increase forage production, improve forage quality and improve use of land resources (3, 9, 10, 11, 12, 13). Based on recent results (25) it may be both economical and practical to use perennial species of clover as annuals when seed of annuals are not available, or prices are prohibitive. This practice permits maximum benefits of forage production without consideration of management for stand longevity and persistence. Also, it is necessary to have both annual and perennial clovers if a clover-grass mix is desired on a 12-month basis. This can be accomplished by using red or white clover in conjunction with annual clovers.

White clover (*Trifolium repens* L.) is the most important perennial clover used for pasture in Mississippi. The first cultivation of white clover from seed was begun in the Netherlands in the latter half of the sixteenth century, and white clover was introduced into the United States by colonists from Europe. Livestock producers throughout its area of use recognize the many values of white clover as part of a pasture mixture. In addition to fixing nitrogen, its high forage quality throughout the year supplements the lower quality of grasses, resulting in improved animal performance through higher average daily gains, higher conception rates, higher calf crop percentages, improved milk flow and better herd health.

White clover is classed botanically as a perennial legume with prostrate growth habit, and a typical plant is composed of a short primary stem that gives rise to stolons (runners) six to eight weeks after germination (Figure 1). Taproots may reach a depth of 3 feet or more in the second year; however, the primary root usually dies in the second year and roots from the stolons then sustain the plant.

There is a great range in size of plants and plant parts within the white clover species. Leffel and Gibson (4) reported that larger white clover plants may be more than 1 square yard in area and 12-18 inches tall. The predominantly white flower color, sometimes with a pinkish hue, is responsible for the common name of the species. The round flower heads are composed of 20 to 150 individual perfect flowers. Flowering is enhanced by the long days and optimum temperatures for growth following the short days and low temperatures of winter.

Figure 1. Typical white clover plant with numerous stolons (runners) and taproot system. Inset: Round head of white clover showing numerous perfect florets.

GUIDELINES FOR PRODUCING WHITE CLOVER

Soil Selection

White clover is best adapted to well-drained silt loam and clay soils with a pH of 6.0 to 7.0, but can be grown on sandy soils with adequate soil moisture and fertility.

Fertilization

Soils should be tested for pH, phosphate and potash[1]. Apply lime to bring the pH to 6.0 or above before planting. Apply phosphate and potash to bring levels to medium or above.

Seedbed Preparation

A firm, moderately smooth seedbed is essential because white clover seed are small and may be buried too deeply if planted on a loose seedbed. The prepared seedbed should be rolled with a corrugated roller or other firming device before seeding.

Varieties

'Regal,' 'Louisiana S-1,' 'Arcadia,' 'Tillman' and 'Nolin's Improved' are recommended varieties for Mississippi. Regal, Tillman and Arcadia are ladino types. Louisiana S-1 and Nolin's Improved are intermediate types. Summer production of Louisiana

[1]In the absence of a soil test, refer to the latest Crop and Fertilizer Guideline for Mississippi. Your county agent has these, and they are available from MAFES Editorial Department, Mississippi State, MS 39762.

S-1 and Nolin's Improved is below that of other recommended varieties, but they are recommended because of superior reseeding ability.

Inoculation

Inoculate seed with the proper strain of *Rhizobium* immediately before planting. Inoculation is accomplished easily by placing up to 25 lbs of seed in a tub or other large container (Figure 2), adding enough sticking solution (sugar or syrup solution or commercial sticker) to dampen the seed and applying the inoculum while stirring the seed. Stirring should continue until each seed is coated and the seed do not stick together.

Table 1. Estimates of nitrogen fixed by selected legumes.

Legume	Nitrogen Fixed per acre
	lbs
Alfalfa	194
White Clover	179
Red Clover	114
Crimson Clover	94
Lespedeza	85
Vetch	80

Each acre of land has about 35,000 tons of free nitrogen in the air above it, and producers can take advantage of the nitrogen by growing legumes inoculated with the proper strain of *Rhizobium* (Figure 3). It is not possible to determine exactly how much nitrogen is fixed by the bacteria in the nodules on legume plant roots; however, different investigators have reported that white clover may fix up to 180 lbs per acre (Table 1).

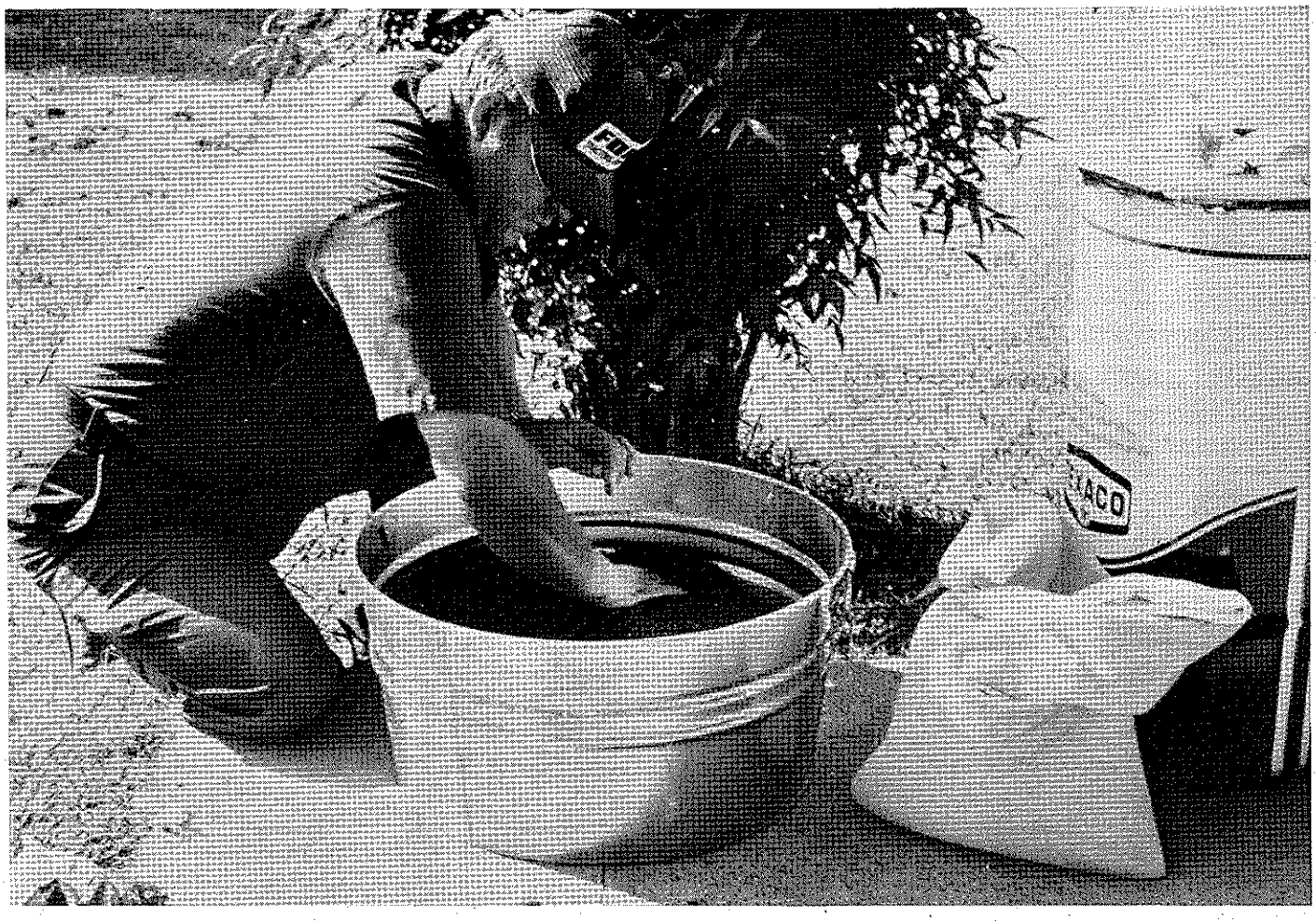


Figure 2. Sticking inoculant to the seed with sugar or syrup solutions or commercial stickers is essential to successful production of white clover. Apply just before planting to 25 pounds of seed or less at a time.

Figure 3. Root system of White Clover plant showing nodules containing nitrogen fixing bacteria. Nodules are active if the internal tissue is pink or red.

The cost of inoculation for 1 bushel of clover seed is about 90 cents. This will inoculate enough white clover seed for planting several acres.

Planting

White clover normally is planted one fourth-inch deep at 3 lbs of seed per acre in September and October. It can be planted as a pure stand but most producers prefer to grow it in combination with dallisgrass, tall fescue or the bermudagrasses (Figure 4).

Topseeding white clover into existing sods of dallisgrass, tall fescue or bermudagrass as a practical means of introducing it into grass sods is gaining in popularity as a way to provide high-quality, low-cost grazing in winter and spring. Practices include overseeding grass sods without soil preparation; seeding with various types of sod planters; or seeding in combination with varying degrees of sod disturbance by disk harrows, chain harrows and/or pasture renovators.

Table 2. Average dry matter yield of five varieties of white clover planted alone on a prepared seedbed or topseeded into tall fescue or Coastal bermudagrass with no nitrogen added.

Method of Seeding	Dry Matter Yield 1968	1969
	--------Lbs/A--------	
Prepared Seedbed	4030 c[1]	2752 c
Topseeded into Coastal	6169 a	4926 a
Topseeded into Tall Fescue	4985 b	3009 b

[1]Means in a column followed by a different letter differ at the 5% level of probability.

Advantages of topseeding are that (1) cost is lower than for planting on a prepared seedbed, (2) no additional land is required for producing clover grass mixes, (3) wetter soils can be grazed, (4) the requirement for stored feeds is reduced, (5) labor required for daily feeding is reduced and (6) high-quality forage is produced in winter and spring without applying commercial nitrogen.

Research with white clover topseeded into Coastal bermudagrass and tall fescue with no nitrogen applied has demonstrated that both clover-grass mixes produce more dry matter than clover alone (Table 2). The Coastal-white clover was more productive than the fescue-white clover, and all yield differences were significant at the 5% level of probability.

Disadvantages of topseeding are that some seeding may be required each year, and there usually will be a lack of grazing in fall and early winter.

Figure 4. White clover is popular grown with either bermudagrass (top) or tall fescue (bottom).

Weed Control

Weed control in white clover begins with use of good cultural practices such as using clean seed, fallowing, and planting at the proper time in fields that have low weed populations. Use of herbicides for controlling weeds in white clover has been limited; however, 2,4-DB applied at 0.5 to 1.0 lb per acre will control most broadleaf weeds if applied before the weeds are 3 inches tall.

Seed Production[2]

Seed set of white clover usually is heavy if there are numerous bees for cross pollination and if it is warm and dry during the flowering period. Ripe seed and heads in full bloom occur on the same plant because white clover blooms over a long period. The seed should be harvested when the greatest number of seed heads are light brown, usually 25 to 30 days after bloom.

Harvesting Hay

The fineness of growth and leafiness of white clover require minimum handling in haymaking to avoid excessive shattering of leaves.

Harvesting Seed

Seed of white clover are harvested from pastures or from

[2]*The only area in the Southeastern United States where significant amounts of white clover seed are harvested is in Louisiana.*

fields grown for seed only. Seed production from pastures requires early-season grazing or harvesting to reduce grass competition. Seed yields from pastures average 100 lbs per acre.

Most seed are harvested by cutting the crop with a mower and allowing it to cure in the swath or in small windrows. A high-speed, drum-type mower is most efficient in cutting the crop for combining. The cut crop should be handled as little as is possible because each handling causes shattering losses.

Artificial drying or drying by spreading the seed thinly under cover may improve the quality of seed. Rough cleaning reduces the time required for drying.

Stand Maintenance

Stands of white clover may persist for three or more years, depending on rainfall distribution in late spring and summer. Many producers help insure continuous stands by seeding at 1 lb per acre with an electrically-operated seeder mounted on the front of a tractor. They do this each fall when applying the phosphate and potash needed to maintain levels at medium or above.

WHITE CLOVER DISEASES AND INSECTS

Diseases

The most serious diseases of white clover are the stolon and root rots that may deplete stands seriously. Species of *Fusarium, Rhizoctonia, Colletotrichum, Leptodiscus, Curvularia,* and *Sclerotium* fungi are involved. Most of these organisms are part of a disease complex related to environmental factors.

Several viruses also infect white clover. Some viruses are spread by insects, and the degree of infestation may depend on the number and kinds of insects present. Symptoms include mild to severe mottling of leaves, destroying tissue between veins of leaves, and stunting of plants.

Insects

Insects that damage white clover include the clover leaf weevil, the lesser clover leaf weevil, lygus bugs, the potato leaf hopper, the garden fleahopper, the clover root curculio and the green June beetle.

The white clover seed crop in the South is threatened primarily by the lesser clover leaf and clover head weevils, *Hypera nigrirostris* F. and *Hypera meles* F., respectively. Larvae of these insects attack parts of the flowering head, stunting or destroying heads and preventing seed formation.

Nematodes

Species of root-knot nematodes are among the most common of the many kinds of nematodes that parasitize white clover. Root-knot nematodes cause root swellings or galls that resemble the nodules produced by nodule-forming bacteria.

PRODUCTION POTENTIAL OF WHITE CLOVER

Producers and researchers have been emphasizing better quality forage with better seasonal distribution as one means of better using land resources to produce food. Grazing systems also have been developed to minimize the amounts of feed harvested, stored and fed back to cattle. Recent economic studies in support of this research have stressed that yield alone does not necessarily make a practice economical; rather, it is the amount and quality of forage (measured in energy units) consumed and converted into beef or milk that is important (2, 6, 7, 8).

Most white clover is grown in mixtures with grasses for grazing. Close grazing affects white clover less than it does most annual clovers because new vegetative growth arises from the stolons that grow parallel to the soil. The succulent, highly nutritious forage is exceedingly palatable at all stages of growth to all classes of livestock. Plants may contain 25 to 30% crude protein when grazed at immature stages, 18 to 22% crude protein when harvested at a hay stage of growth. Crude protein content often is in excess of 15% even at maturity. Mixtures of white clover and grasses also make hay that is high in protein, minerals and vitamins.

Results of research in 1968 and 1969 demonstrated that clovers grown with Coastal bermudagrass produced much higher forage yields than grass grown alone with 200 lbs of nitrogen applied per acre each year (Table 3), and forage produced by the clover-grass mix-

tures was of higher quality and better seasonal distribution. Also, Coastal bermudagrass following crimson and arrowleaf clovers produced about 1 ton more of dry forage per acre than a grass check that received 200 lbs of nitrogen per acre.

White clover grown with bermudagrass or dallisgrass produced higher dry matter yields than the grasses grown alone fertilized with 120 lbs of nitrogen per acre (Table 4). Yield of white clover-tall fescue was higher than that of the fescue grown alone with 180 lbs of nitrogen applied. White clover-bahiagrass produced more than bahiagrass alone fertilized with 240 lbs of nitrogen per acre. Forage production of the clover-grass mixes also was more evenly distributed, and estimates of forage quality were higher than for the grasses grown alone.

Table 3. Yields of dry forage from selected clover species overseeded[1] in a Coastal bermudagrass sod, with comparisons, 1968-69 average.

Clover species	Yield		
	Clover	Grass	Total
	--------Lbs DM/A--------		
Crimson	2660	9770	12,430
Arrowleaf	2170	9170	11,340
Red	5600	4440	10,040
White	6520	3680	10,200
Check - Grass alone NoCo[2]		2340	2,340
Check - Grass alone N_1 CO[3]		7740	7,740

[1]Overseeded in a Coastal bermudagrass sod in September, 1967. Yields of annual clovers were from volunteer stands in 1969. Stands of red and white clovers were from initial seeding.
[2]NoCo = No nitrogen, no clover
[3]N_1 CO = 200# N/A annually, no clover.

Dry matter production of five varieties of white clover evaluated in Mississippi in 1963-67 ranged from 2 to 5 tons per acre, depending on rainfall distribution and year (Table 5). Regal and Tillman produced the highest summer yields, and production was more evenly distributed than for the other varieties.

Dry matter yields of the 15 varieties and selections compared in production trials since 1975 have ranged from just over 6,000 to slightly less than 11,000 lbs per acre (Table 6). The advantage of the ladino types is shown clearly in the performance of Regal, Tillman, improved synthetics and experimental varieties. The advantage of superior persistence bred into Tillman and 'SC-NGP' was evident from second-year production when grown on a prepared seedbed (Table 7) and third-year production when grown with Coastal bermudagrass (Table 8).

Table 4. Yields of bermudagrass, dallisgrass, bahiagrass, and tall fescue grown alone and fertilized with varying rates of nitrogen, and grown with white clover without nitrogen fertilizer.

Nitrogen Lbs/Acre	Dry Matter Yield[1]			
	Bermudagrass	Dallisgrass	Bahiagrass	Tall Fescue
	----------Lbs/A----------			
0	2900	3274	3409	2425
60	4805	4062	3646	3299
120	5982	4386	5015	3858
180	6900	5166	5088	4497
240	7275	5907	5928	5818
white clover	6225	4680	7082	4597

[1]Dry matter yields represent a four-year average.
P_2O_5 and K_2O applied at a constant rate of 120 lbs per acre.

Table 5. Dry matter yield of five white clover varieties, 1963-1967 average.[1]

Variety	Dry Matter Yield					
	1963	1964	1965	1966	1967	5 yr Avg.
	----------Lbs/A----------					
Louisiana S-1	218	6212	5957	2952	3620	3791
Regal	3842	10364	9413	5992	3122	6546
Tillman	3463	9872	8549	4838	3416	6027
Espanso	4436	9368	7990	5030	3549	6074
Ladino	4151	8957	8514	5194	3012	5965
LSD (.05)	225	754	378	682	N.S.	

[1]P_2O_5 and K_2O applied in a single application of 120 lbs of each per acre annually.

Table 6. Dry matter yield of white clover grown on a prepared seedbed, by variety, 1975-1976.

Variety	Harvest Period			
	Winter[1]	Spring[2]	Summer[3]	Season Total
	----------Lbs DM/A----------			
Brown Loam (Miss. Expt)	1,321	5,239	2,488	9,048
California Ladino	1,215	5,289	2,397	8,901
Clarence	1,231	3,995	810	6,036
Florida XP-1	1,299	6,147	2,681	10,127
Idaho	1,322	4,760	1,463	7,545
KO 176 (Arcadia)	1,365	5,996	2,720	10,081
La S-1	1,269	4,900	1,778	7,947
Lucky	1,196	4,828	2,720	8,744
Merit	1,098	5,826	2,635	9,559
New Zealand	1,000	4,568	1,554	7,122
Nolin's Imp.	1,405	4,768	1,939	8,112
Regal	1,448	6,201	3,109	10,758
Sacramento	1,209	6,321	2,468	9,998
SC-NGP	1,297	5,727	2,999	10,023
Tillman	1,499	5,831	2,865	10,195
LSD (.05)	102	844	216	1002
C.V.%	19.5	15.3	20.9	7.8
Planted: Sept. 29, 1975				

[1]**Winter Harvests: Feb. 27, 1976; March 18, 1976**
[2]**Spring Harvests: April 5, 1976; April 29, 1976; May 25, 1976; June 15, 1976.**
[3]**Summer Harvests: June 29, 1976; July 15, 1976; Aug. 3, 1976; Aug. 27, 1976; Sept. 10, 1976.**

Table 7. First- and second-year dry matter yield of white clover seeded on a prepared seedbed in 1974.

1974-75 Yields (First Year)

Variety	Season of Harvest and No. of Harvests				
	Winter	Spring	Summer	Fall	Total
	1	3	3	1	8
	----------Lbs/A----------				
Regal	1291	4253	2579	478	8601
Tillman	1376	4487	2474	534	8871
SC Nematode Res.	1158	4101	2179	442	7877
Nolin's Imp.	1210	3313	946	93	5562
Brown Loam Exp.	450	3850	1462	313	6075
LSD (.05)					872
C.V.%					7.2

1975-76 Yields (Second Year)

Variety	Season of Harvest and No. of Harvests				
	Winter	Spring	Summer	Fall	Total
	1	3	2	2	8
	----------Lbs/A----------				
Regal	490	3267	867	1202	5827
Tillman	405	3501	1012	1311	6229
SC Nematode Res.	522	3451	938	1241	6152
Nolin's Imp.	321	3134	750	958	5164
Brown Loam Exp.	436	3084	785	1042	5346
LSD (.05)	N.S.	N.S.	N.S.	130	N.S.
C.V.%	17.9	12.7	14.1	6.9	10.9

Table 8. First-, second- and third-year dry matter yield of white clovers overseeded on Coastal bermudagrass in 1974.[1]

1974-75 Yields (First Year)

	No. of Harvests and Yield Component		
	7	5	—
Variety	Clover	Grass	Total
	Lbs DM/A		
Regal	5,360	1,768	7,128
Tillman	6,079	1,546	7,625
SC Nematode Res.	5,421	1,609	7,030
Nolin's Imp.	3,366	2,931	6,298
Brown Loam	2,683	2,196	4,879
Grass (CK)	—	6,827	6,827
LSD (.05)	397	341	807
C.V.%	5.6	8.0	8.1

1975-76 Yields (Second Year)

	No. of Harvests and Yield Component		
	7	5	—
Variety	Clover	Grass	Total
	Lbs DM/A		
Regal	9,318	1,472	10,790
Tillman	9,314	1,035	10,349
SC Nematode Res.	9,801	894	10,695
Nolin's Imp.	4,324	3,110	7,434
Brown Loam	7,217	2,207	9,424
Grass (CK)	—	6,745	6,745
LSD (.05)	1,003	470	1,098
C.V.%	8.9	12.9	8.4

1976-77 Yields (Third Year)

	No. of Harvests and Yield Component		
	7	5	—
Variety	Clover	Grass	Total
	Lbs DM/A		
Regal	3,766	4,494	8,260
Tillman	4,625	3,804	8,429
SC Nematode Res.	4,904	4,186	9,090
Nolin's Imp.	1,411	5,222	6,633
Brown Loam	2,804	4,880	7,683
Grass (CK)	—	7,233	7,233
LSD (.05)	1,342	1,245	1,227
C.V.%	25.4	16.6	10.3

[1]Clover-grass mixtures received 400 lbs/A 0-24-24 applied annually in the fall. Grass check plots received 200 lbs/A N applied as ammonium nitrate in split applications and 400 lbs/A 0-24-24 applied in the fall.

DESCRIPTION OF WHITE CLOVER VARIETIES

Common is the usual designation for white clovers without a variety name. These types are intermediate in size and usually are referred to in Mississippi as white 'Dutch' clover.

Louisiana S-1 is an intermediate type released in 1952 by the Louisiana Agricultural Experiment Station. It is widely used in the lower half of the Gulf States because it reseeds and persists. Short drought stress causes prolific flowering.

Ladino is a common reference to several strains of white clover with large leaflets. More than one half of the white clover acreage in the United States is seeded to the large types. The large types do not flower as profusely or bloom as early as the intermediate types.

'Espanso' is the largest white clover available and is a selection made in Italy for uniformity of type, maximum size and yield, and resistance to low temperatures and drought. It is not grown widely in Mississippi.

'Merit' was released in 1970 by the Iowa Agricultural Experiment Station and is a 30-clone synthetic selected for resistance to leafhopper damage and drought. It is winter-hardy and has performed well in Mississippi trials.

Regal was released in 1962 by Auburn University and is a five-clone synthetic selected for persistence and summer production. It is highly popular with livestock producers in Mississippi. Production data show that it produces two to four times the summer yield of Louisiana S-1.

Tillman is a large type released in 1965 by the USDA and the South Carolina Agricultural Experiment Station. It is a six-clone synthetic with improvements added to Regal for summer production, persistence, disease resistance, sparse flowering and profuse stolon branching. It performs very well in Mississippi.

Nolin's Improved is a naturalized variety that originated on the farm of W. T. Nolin, Hamburg, La. It is adapted to the conditions of Louisiana and the lower South, and behaves as a reseeding or volunteering winter annual.

'Sacramento' blooms about three weeks earlier than other varieties and maintains bloom through the season. It is merchandised by the Berger and Plate Co.

'Lucky' is a new synthetic variety developed in Oregon for absence of leaf-marking. It has not been a top performer in Mississippi under initial testing.

Arcadia is a synthetic variety developed by Northrup, King and Co. It was originally tested as KO-176, and performance in Mississippi is similar to that of Regal and Tillman.

'Clarence' is an Australian variety of the intermediate type. It is totally unadapted in Mississippi.

Brown Loam (Mississippi Experimental) was selected by N. C. Edwards at the MAFES Brown Loam Branch at Raymond, Miss. It currently is being evaluated in several trials. Twenty-seven clones isolated after a four-month drought in 1976 are under evaluation as the base for a synthetic variety (Figure 5).

Figure 5. Nursery of drought tolerant clones of white clover selected by N. C. Edwards of the Brown Loam Experiment Station.

LITERATURE CITED

1. Browning, C. B. 1963. A comparison of irrigated ladino clover, Coastal bermuda, and a Coastal bermuda-ladino clover mixture for summer grazing by dairy cows. Miss. Agric. Exp. Stn. Inf. Sheet 834, 2 pp.
2. Dillard, J. G. 1972. The place for annual legumes in the Southeast: an economist viewpoint. Rep. 29th South. Past. For. Crop Impr. Conf. Plant Sci. Res. Div., Agric. Res. Serv., U.S. Dept. of Agric. (Rep.) PSR-39-72, pp. 105-111.
3. Donnelly, E. D., and Cope, J. T., Jr. 1961. Crimson clover in Alabama. Ala. Agric. Exp. Stn. Bull. 335, 31 pp.
4. Hogg, P. G. 1967. The effect of nitrogen fertilization and frequency of harvest on yields and clover content of irrigated white clover. Miss. Agric. Exp. Stn. Inf. Sheet 993, 2 pp.
5. Hogg, P. G. and Collins, J. C. 1965. Beef production of Coastal bermuda and legumes and nitrogen on heavy clay soils in the Mississippi Delta. Miss. Agric. Exp. Sta. Inf. Sheet 889, 1 pp.
6. Jacobs, V. E. 1973. Forage production economics. Chap. 3. *In* M. E. Heath, D. S. Metcalfe, and R. F. Barnes. Forages. Iowa State University Press. Ames, Iowa.
7. _____. 1974. An economic approach to forage yield measurement and evaluation. Chap. 23. *In* D. A. Mays ed. Forage Fertilization. Am. Soc. Agron., Madison, Wis.
8. _____ and J. A. Stricker. 1975. Economic comparisons of legume nitrogen and fertilizer nitrogen in pastures. Agronomy Abstracts p. 89.
9. Knight, W. E. 1967. Effect of seeding rate, fall disking, and nitrogen level on stand establishment of crimson clover in a grass sod. Agron. J. 59: 33-36.
10. _____. 1970. Productivity of crimson and arrowleaf clovers grown in a Coastal bermudagrass sod. Agron. J. 62: 773-775.
11. _____. 1971. Influence of spring mowing on reseeding and productivity of selected annual clovers in grass sod. Agron. J. 63: 418-420.
12. _____. 1971. Productivity and yield distribution of selected red and white clover managed as annuals. Miss. Agric. Exp. Stn. Inf. Sheet 1150, 2 pp.
13. _____ and E. A. Hollowell. 1973. Crimson clover. *In* Adv. Agron. Vol. 25: 47-76.
14. Leffel, R. C. and P. B. Gibson. 1973. White clover in Forages 3rd edition. Iowa State Univ. Press p. 167-176.
15. Pund, W. A., and P. G. Hogg. 1969. Management and utilization of irrigated Coastal bermudagrass with high levels of nitrogen fertilization vs white clover on Sharkey clay. Miss. Agric. Exp. Stn. Inf. Sheet 1062, 2 pp.

Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the Mississippi Agricultural and Forestry Experiment Station or the USDA and does not imply its approval to the exclusion of other products that also may be suitable.

Lithograph
Central Duplicating
Mississippi State University