Evaluation of Annual Clovers in South Alabama

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Evaluation Of Annual Clovers In South Alabama

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INTRODUCTION

CLOVERS (*Trifolium* spp.) offer much potential for improving pastures in Alabama. Well-documented and desirable characteristics of clovers include: interaction with *Rhizobium* bacteria to fix substantial quantities of nitrogen, improved animal gains, and increased dry matter production of clover-grass mixtures in comparison with grass-only pastures.

Information about the seasonal distribution and relative dependability of growth of available clovers is needed to wisely select the best species for forage production. Clover yield data for various parts of the Southeast are available, but yield comparisons are typically among varieties within a given species, involve only a few clover species, or provide only total seasonal yield data. Some tests include the production of associated grasses, are conducted only at a single location, or do not evaluate dependability.

The objectives of this study were to: (1) during the seeding year, compare total dry matter production of several species of clover of current interest to producers in Alabama; (2) determine seasonal distribution of forage growth of these clovers during the seeding year; and (3) assess the dependability of these clovers during three seeding years at four locations in the southern half of Alabama.

MATERIALS AND METHODS

Seven clover species were compared in this study. The cultivar representing each species was chosen because of market availability and/or common usage in the region. A brief description of each entry follows.

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Yuchi arrowleaf is a reseeding annual clover developed for extended late spring grazing (2). Common ball clover is a reseeding annual that produces most of its yield in mid-spring (5). Bigbee berseem clover is a reseeding annual developed for growth in late winter through late spring (6). Tibbee crimson clover is an annual developed for early maturity and reseeding ability (4). Redland II red clover was developed for improved disease resistance (8), and generally is viewed as a short-lived perennial with good late-spring and summer yield potential (9). Regal is a ladino type of white clover selected for increased summer production and persistence as a perennial (3). Mt. Barker subterranean clover is a strongly reseeding annual (its seeds are produced underground) that is utilized extensively in Australia (7).

Forage trials were conducted in Alabama during 1985-88. Locations, soils, and seeding dates were as follows:

Gulf Coast Substation, Fairhope-Malbis sandy loam, October 18, 1985, November 12, 1986, November 12, 1987;

Monroeville Field, Monroeville- Lucedale sandy clay loam, October 11, 1986, November 13, 1987,

Black Belt Substation, Marion Junction- Sumter clay, September 26, 1985, October 23, 1986, September 16, 1987,

Plant Breeding Unit, Tallassee-Cahaba fine sandy loam, October 10, 1985, October 17, 1986, and October 1, 1987.

Plots were 5 x 20 feet and were seeded with a small plot drill into a well-prepared seedbed. All seed were inoculated with the appropriate *Rhizobium* strain, using a sticking agent, and pelleted in agricultural lime prior to planting. In 1985, seeding rates (unpelleted) were: 4 pounds per acre for white clover; 10 pounds per acre for red and subterranean clover; 15 pounds per acre for berseem clover; and 25 pounds per acre for crimson clover. In 1986 and 1987, the seeding rate was 30 pounds per acre pelleted seed for all species.

Forage was harvested at approximately 1-month intervals whenever harvestable forage accumulated on any plots. Yield data were combined into early-season (sum of February-March yields), mid-season (sum of April-May yields), and late-season (sum of June-July yields) to aid interpretation. Total yields are the sum of all harvests during a year.

Dependability was quantified using a stability analysis described by Eberhart and Russell (1). This analysis gives a regression coefficient (b) that describes species response to an improving environmental index (the mean of each species at an environment minus the mean of all species) and describes the variation from the regression (s^2) on the environmental index. For ease of interpretation, the standard deviation about the regression line(s) will be reported since it has the same units as yield.

A dependable species would respond to improving environments with increasing yields (high b values) and would respond predictably to improving environments (low s values), as illustrated in the graph.

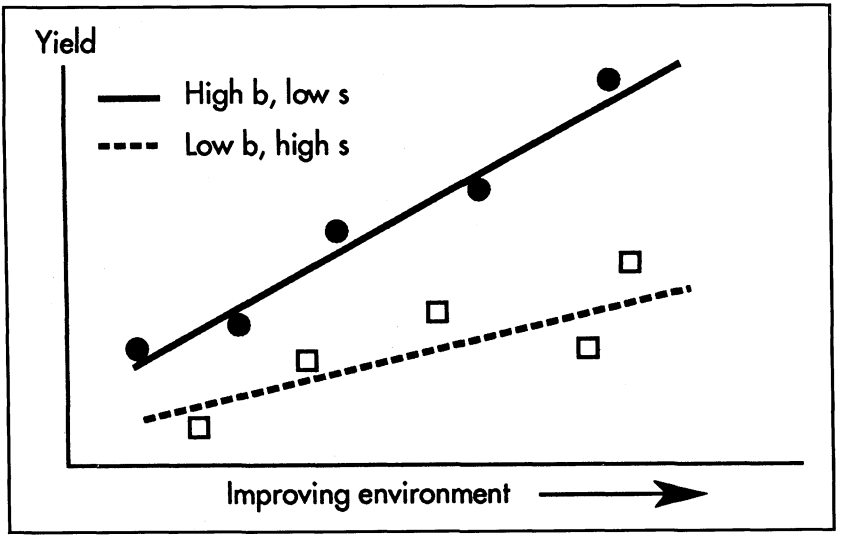
Clovers with a high b (regression coefficient) respond to improving environmental conditions with rapid increases in yield, while clovers with a low b do not. Clovers with a low s (standard deviation) respond predictably to improving environments (little scatter), while clovers with a high s do not. Clovers with a high s are viewed as undependable, and when graphed would show much scatter.

RESULTS AND DISCUSSION

Total Seasonal Production

There was wide variation in total yield among the clovers included in these tests at the four locations (tables 1-4). The highest yields overall were obtained at the Fairhope location in extreme south Alabama, table 1. This was attributed to a better rainfall distribution throughout the spring growing season, but especially in mid- and late spring when droughts often limit clover growth at other locations. At Fairhope, red clover was clearly the most productive in 1986, with good production in both 1987 and 1988. Berseem, white, arrowleaf, and crimson had high or intermediate total yields in all 3 years. Ball clover and subterranean clover yields were considerably lower than all other clovers at this location.

At Marion Junction, berseem clover was by far the most productive



Relationship of environmental factors to yield of clover varieties.

TABLE 1. SEASONAL YIELD DISTRIBUTION OF SEVEN CLOVERS GROWN AT FAIRHOPE, ALABAMA, FOR 3 YEARS

Species/year seeded	Dry matter yield/acre[1]			
	Feb.-Mar.	Apr.-May	June-July	Total
	Lb.	*Lb.*	*Lb.*	*Lb.*
1986				
Crimson	2,461	2,340	0	4,801
Berseem	1,694	4,385	0	6,078
Red	59	5,131	2,755	7,946
White	177	3,094	1,703	4,974
Arrowleaf	1,184	3,092	800	5,076
Ball	455	2,709	0	3,164
Subterranean	990	2,878	0	3,867
LSD (P≤0.05)	256	773	205	780
1987				
Crimson	2,236	1,447	0	3,683
Berseem	1,791	1,256	3,224	6,272
Red	0	2,864	2,171	5,034
White	0	3,066	3,014	6,080
Arrowleaf	648	1,923	1,874	4,445
Ball	0	3,105	0	3,106
Subterranean	0	2,659	0	2,659
LSD (P≤0.05)	254	1,287	366	1,245
1988				
Crimson	4,384	0	0	4,384
Berseem	3,355	794	0	4,149
Red	1,709	1,123	0	2,832
White	1,645	593	0	2,238
Arrowleaf	0	3,399	0	3,399
Ball	2,314	282	0	2,596
Subterranean	2,359	0	0	2,359
LSD (P≤0.05)	643	185	–	654

[1]Yields are summed for 2-month periods. Actual harvest dates were: February 26, April 3, May 16, and June 18, 1986; March 13, April 2, May 6, June 18, and June 30, 1987; February 21, March 17, April 7, and May 17, 1988.

in 1987, averaging over a ton more total dry matter yield than all other entries, table 2. Compared to the other clovers, berseem clover also yielded well in 1986. Red clover also produced well in 1986 and 1987, and crimson clover yielded well in 1986. Total subterranean clover yields were again lower than all other clover yields.

At Tallassee, red clover, crimson clover, and arrowleaf clover were among the highest producing clovers in each year, table 3. Berseem clover also yielded well each year, and gave the highest total yield in 1986. White and ball clover total yields were intermediate at this location, and subterranean clover consistently produced low harvestable yields. Because of drought, only one harvest was made at this location in 1986.

Arrowleaf clover, crimson clover, and ball clover gave the highest total yields at Monroeville, table 4. Berseem clover also produced reasonably well, but red clover, white clover, and subterranean clover all yielded poorly.

TABLE 2. SEASONAL YIELD DISTRIBUTION OF SEVEN CLOVERS GROWN AT MARION JUNCTION, ALABAMA, FOR 2 YEARS

Species/year seeded	Dry matter yield/acre[1]			
	Feb.-Mar.	Apr.-May	June-July	Total
	Lb.	*Lb.*	*Lb.*	*Lb.*
1986				
Crimson	3,046	789	0	3,836
Berseem	1,779	2,024	0	3,803
Red	515	1,682	1,423	3,620
White	1,125	772	1,184	3,082
Arrowleaf	954	1,626	0	2,580
Ball	1,495	516	0	2,012
Subterranean	900	240	0	1,141
LSD (P≤0.5)	286	264	122	269
1987				
Crimson	0	2,767	0	2,767
Berseem	0	5,254	1,805	7,058
Red	0	778	3,605	4,382
White	0	872	2,370	3,242
Arrowleaf	0	2,350	772	3,122
Ball	0	2,881	463	3,344
Subterranean	0	405	0	405
LSD (P≤0.05)	–	476	483	514

[1]Yields are summed for 2-month periods. Actual harvest dates were: March 27, May 12, and June 11, 1986; April 8, May 8, June 10, and July 9, 1987.

Seasonal Distribution of Forage Yield

Because of the diversity of forage/livestock operations, growth from clovers can be utilized at different times. Thus, the clover with the highest total yield may not be the best choice if much of its growth occurs at a time when there is little need for it. Early-, mid-, and late-season yields are shown for each location, tables 1-4.

There were large differences in seasonal distribution among clovers. Crimson clover is clearly the best choice for early spring production. No other species averaged higher production at any location. In most locations and years, crimson clover early-season yield was significantly ($p<.05$) higher than any other clover. Berseem clover had higher early-season production than most other clover entries, making it useful for many livestock operations. Other clovers generally yielded poorly during the early season. Red clover was generally the poorest choice for early-season production.

Mid-season yields varied considerably among species at the various locations and years, but yields of most species were sufficient to support grazing. Selection of a clover for mid-season also probably should involve how that clover will produce in early or late season, and how early- or late-season production will augment livestock operations. Subterranean clover generally produced the least mid-season yield.

Red clover and white clover are clearly the best choices for late-season production. Late-season growth of clovers is highly dependent on

the clover species and upon rainfall, which tends to be a limiting factor in June and July in this region. Arrowleaf produced high late-season yields in two cases, and berseem clover produced high late-season yield

TABLE 3. SEASONAL YIELD DISTRIBUTION OF SEVEN CLOVERS GROWN AT TALLASSEE, ALABAMA, FOR 3 YEARS

Species/year seeded	Dry matter yield/acre[1]			
	Feb.-Mar.	Apr.-May	June-July	Total
	Lb.	*Lb.*	*Lb.*	*Lb.*
1986				
Crimson	0	2,567	0	2,567
Berseem	0	3,145	0	3,145
Red	0	2,496	0	2,496
White	0	1,850	0	1,850
Arrowleaf	0	2,439	0	2,439
Ball	0	2,582	0	2,582
Subterranean	0	1,905	0	1,905
LSD (P≤0.05)	0	1,041	–	1,041
1987				
Crimson	1,918	1,766	0	3,685
Berseem	1,331	751	142	2,225
Red	0	1,455	2,098	3,552
White	42	1,401	1,408	2,851
Arrowleaf	348	2,108	1,104	3,560
Ball	199	1,444	677	2,319
Subterranean	338	1,507	0	1,845
LSD (P≤0.05)	195	322	337	479
1988				
Crimson	1,510	1,307	0	2,817
Berseem	1,171	1,473	130	2,774
Red	0	2,455	1,040	3,495
White	0	2,430	1,139	3,569
Arrowleaf	0	2,792	153	2,945
Ball	0	2,304	69	2,373
Subterranean	0	946	0	946
LSD (P≤0.05)	136	484	168	520

[1]Yields are summed for 2-month periods. Actual harvest dates were: April 8, 1986; March 6, April 1, May 1, and June 5, 1987; March 8, April 6, May 1, and June 9, 1988.

TABLE 4. SEASONAL YIELD DISTRIBUTION OF SEVEN CLOVERS GROWN AT MONROEVILLE, ALABAMA, FOR 1 YEAR, 1987

Species	Dry matter yield/acre[1]			
	Feb.-Mar.	Apr.-May	June-July	Total
	Lb.	*Lb.*	*Lb.*	*Lb.*
Crimson	1,281	2,296	0	3,576
Berseem	1,113	1,866	0	2,979
Red	0	1,706	0	1,706
White	673	430	0	1,103
Arrowleaf	689	2,998	0	3,688
Ball	304	3,069	0	3,373
Subterranean	1,225	386	0	1,610
LSD (P≤0.05)	487	513	–	639

[1]Yields are summed for 2-month periods. Actual harvest dates were: March 5, March 26, April 7, and April 30, 1987.

in one instance. Subterranean clover and ball clover exhibited uniformly poor productivity in late season. Crimson clover failed to produce harvestable late-season yields at any location. In four of the nine environments (location x year combinations), none of the clovers made harvestable yields in late season due to drought.

Total Yield Dependability

Reliability of these clovers can be evaluated by utilizing a stability analysis developed for variety evaluation by plant breeders. Arrowleaf clover responded very predictably to improving environments (low s), exhibited increased total yields with improving environmental conditions (intermediate b), and had a fairly high mean yield, table 5. Arrowleaf clover produced intermediate or high yields in all nine environments, tables 1- 4.

Red clover, white clover, and berseem clover had high mean yields and responded well to improving environments (high b), but did not do so predictably (high s). Crimson clover had consistently high yields across environments and therefore does not appear to increase with improving environmental conditions (low b). Ball clover and subterranean clover had low total yields.

Seasonal Yield Dependability

Crimson clover and berseem clover both had high average yields in early season, and both responded to improving environmental conditions with rapid increases in yield (high b, table 5). No other clovers produced dependably in the early season.

In mid-season, berseem and red clover responded to improving environmental conditions with increasing yields (high b). However, as with most of the other clovers, production was somewhat erratic (high s). Generally, most clovers did produce adequate yields during mid-season.

In late season, red and white clovers produced high yields and responded to improving environments with rapid increases in yield (high b). Additionally, white clover was very predictable in its response to improving conditions (low s).

TABLE 5. MEAN YIELDS AND ESTIMATES OF STABILITY BY SEASON FOR SEVEN CLOVERS GROWN IN SOUTHERN ALABAMA FOR 3 YEARS

Species and season	Mean yield/acre	b[1]	S^2_d[2]
	Lb.		
February-March			
Crimson	1,871	1.9°	225,059°
Berseem	1,359	1.3	153,167°
Red	254	0.7°	101,250°
White	407	0.8°	91,388°
Arrowleaf	425	0.2°	264,553°
Ball	530	1.1	108,807°
Subterranean	646	1.0	161,260°
LSD (P≤0.05)	290		
April-May			
Crimson	1,698	0.9	525,327°
Berseem	2,327	1.4	1,973,082°
Red	2,188	1.4	816,991°
White	1,612	1.0	665,301°
Arrowleaf	2,525	0.1°	452,226°
Ball	2,099	1.1	608,744°
Subterranean	1,214	1.1	569,663°
LSD (P≤0.05)	653		
June-July			
Crimson	0	0.0°	0
Berseem	589	1.7°	527,624°
Red	1,455	2.1°	503,017°
White	1,202	1.9°	69,930
Arrowleaf	522	1.1	116,327°
Ball	134	0.2°	70,582
Subterranean	0	0.0°	0
LSD (P≤0.05)	312		
Total			
Crimson	3,568	0.5	486,472°
Berseem	4,276	1.5	1,622,733°
Red	3,896	1.8°	641,109°
White	3,221	1.4	948,080°
Arrowleaf	3,472	0.8	249,862
Ball	2,763	0.3°	253,220
Subterranean	1,860	0.8	725,877°
LSD (P≤0.05)	612		

°P≤0.05 That B=1 OR S^2_d=0.

[1]b is a regression coefficient that describes species yield response to a varying environmental index (the mean of all species at an environment minus the grand mean).

[2]S^2_d is the variation from regression.

SUMMARY

Clovers have the reputation of being erratic in their production. These tests confirm the erratic performance of clovers in variable environments, primarily because of erratic rainfall. However, they also provide insight into which clovers may be best for particular applications.

Yuchi arrowleaf clover produced intermediate to high yields during mid- and late season in most environments, and was highly dependable

for total yield. Although arrowleaf clover rarely had the highest yield at any single harvest date, it usually produced growth across several harvest periods. This was most pronounced at the Plant Breeding Unit at Tallassee, where the cultivar Yuchi was developed. Arrowleaf clover is not adapted to alkaline soils such as those found at Marion Junction, and at that location its yield declined rapidly in late spring. Yuchi arrowleaf clover is dependable and a good choice for cattlemen needing forage growth in mid- to late season, except on alkaline soils.

Common ball clover generally was intermediate to low in yield and was not productive across harvest dates. However, in a few instances, ball clover was among the highest yielding clovers for one or two harvest dates. Therefore, it would not be a good choice for use in most livestock management schemes, but could be recognized as a "bonus" species when it, at times, volunteers from hard seed and subsequently produces forage.

Bigbee berseem clover produced significant early yield at all locations, but rarely equalled crimson clover for early-season yield. It had a large b for mid- and late-season yield, indicating a good response to improving environments. Its mid- and late-season production was inconsistent (high s). However, its mean mid-season yield was high, and in some environments good production throughout mid-season was observed, giving it the highest total mean yield. Bigbee berseem clover appears most useful for situations requiring early-season production with an opportunity for continued production into mid-spring. Due to its outstanding productivity at Marion Junction, it appears best suited to the alkaline soils of the Black Belt region of the Southeastern United States.

Tibbee crimson clover consistently had the highest early-season yields of all the clovers tested. In no instance did crimson clover produce measurable yield late in the season, and its yields were often low during mid-season. Crimson clover is thus the best early forage producer, but it is not suited for use as a long-term spring pasture. Its usefulness lies in providing early, high quality growth.

Redland II red clover was most frequently the highest yielder in late spring and early summer. It also was consistently low yielding in early season, and often produced poorly in mid-season. This species is used relatively little in the extreme Southeastern United States at present, but in view of its good performance in these tests, it deserves serious consideration by producers needing high-quality, late-season forage production.

Regal ladino white clover also gave high late-season production in some environments, but yields were usually not as high as for red

clover. It has traditionally provided perennial grazing from mid-spring to mid-summer, but has been viewed as being somewhat unreliable.

Mt. Barker subterranean clover was the poorest performing clover in these tests. Yields of this clover were intermediate or poor in all but one environment. However, the value of this species under grazing conditions may not have been assessed accurately in this study, since the plot harvesting techniques used would not have picked up all the forage produced by this low growing species. Furthermore, the value of subterranean clover's reseeding ability under grazing was not considered.

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