Production and Nutritional Quality of Selected Plantings for White-tailed Deer

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Abstract: Forage production and nutritional quality were determined for 11 cool-season and 6 warm-season forages for white-tailed deer (*Odocoileus virginianus*) on a site in the Piedmont Plateau of Alabama from 1989 to 1991. Cool-season forages produced from 1,355 to 5,946 kg/ha (dry-matter basis) of forage per season containing from 56% to 84% total digestible nutrients (TDN), 8% to 30% crude protein (CP), 16% to 67% neutral detergent fiber (NDF), 0.15% to 2.34% calcium, 0.10% to 0.40% phosphorus, and 0.85% to 4.59% potassium per clipping. During summer 1990, warm-season forages produced from 1,757 to 2,744 kg/ha of forage (dry-matter basis) containing from 60% to 68% TDN, 18% to 29% CP, 25% to 40% NDF, 0.81% to 1.68% calcium, 0.13% to 0.31% phosphorus, and 0.99% to 2.38% potassium. Except among ladino clover varieties, distinct differences in production and nutritional quality were detected over the seasons. Management implications regarding planting choice are discussed.

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Few studies in the Southeast have examined production of forage plantings for white-tailed deer (Davis 1961, Webb 1963, Larson 1966, Segelquist and Rogers 1975, Lunceford 1986), and simultaneous evaluation of nutritional content of forages is lacking. While it often is suggested that establishing forage plantings for white-tailed deer results in higher quality forage in their diet (Halls 1973, Crawford 1984), little quantitative data on nutritional value of forage plantings are available. Besides facilitating deer harvest, availability of abundant, high quality forage could be important in many intensive management programs.

Because many have suggested using forage plantings for deer to compensate for deficiencies in native vegetation (Halls and Stransky 1968, Halls 1973, Short 1975), research that evaluates different forages is needed. This study was designed to determine the production and nutritional quality of selected forage plantings for white-tailed deer.

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Methods

The study was conducted at the Auburn University Deer Research Facility located near Auburn, Alabama. The area is located in the Piedmont physiographic region of Alabama and has sandy loam soils in the Pacolet series, typical of the Piedmont (McNutt 1981). Average annual rainfall is 142.5 cm (Natl. Weather Serv. 1992). Forages tested were planted in a 0.6-ha clearing.

During the 1989–90 cool-season (September through May), Coker 820® oats (*Avena sativa*), Wren's Abruzzi rye (*Secale cereale*), Marshall (annual) ryegrass (*Lolium multiflorum*), Pioneer 2551® wheat (*Triticum aestivum*), Civastro (forage) turnips (*Brassica napus*), Osceola ladino white clover (*Trifolium repens*), Regal ladino white clover, Imperial Whitetail® ladino white clover (blend composed of 60% Regal ladino clover and 40% California ladino clover), Tibbee crimson clover (*T. incarnatum*), and Mt. Barker subterranean clover (*T. subterraneum*) were tested. These same annual forages were established again during the 1990–91 cool-season, except for subterranean clover which performed unsatisfactorily in the 1989–90 test. Redland II® red clover (*T. pratense*), a drought tolerant, summer producer, replaced subterranean clover the second cool-season. The ladino clovers, which are perennials, remained from the first year's planting and did not require reestablishment. During the 1990 warm-season (May through October), Davis soybean (*Glycine max*), Quail Haven® soybean, Combine cowpea (*Vigna unquiculata*), catjang pea (*V. sinensis*), velvetbean (*Stitzolobium deeringianium*), American jointvetch (*Aeschynomene americana*), and the persisting perennial ladino clovers (Regal, Osceola, and Imperial Whitetail®) were evaluated.

Plots were limed and fertilized according to soil test recommendations for forages selected for planting. Plots were established and cultivated for forage production according to recommendations of the Alabama Planting Guide (Ala. Coop. Ext. Serv. 1988). Plots were arranged in a randomized block design, with 3 replicates of each forage established within 3 parallel rows 6.1 m apart. Seeds were drilled (14 rows per plot) within a 6.1- x 3.1-m plot randomly allocated to a space within a replicate. Plots were irrigated at a rate of 2.5 cm/week if rainfall fell below this amount or if plants showed signs of moisture stress. Forage tested for yield and nutritional quality was not browsed.

Cool-season forages were established on 18 September 1989. Beginning in January, each plot was clipped to determine forage production and nutritional content at 4- to 9-week intervals (depending on stand height) until plants died. The following year cool-season forages were established on 10 October 1990 (poor soil moisture conditions prevented earlier planting) and clipped at 5- to 7-week intervals after planting until plants died. Forage from a randomly chosen area of 1 m^2 was clipped at approximately 5 cm (2.5 cm for clovers) above ground level within each plot and weighed. A 200- to 300-g subsample was weighed, placed in a cloth bag, dried in a forage dryer (55° to 60° C), and reweighed to determine forage production and nutritional content on a dry-matter basis (Boyer 1959, Short 1966, Wolf and Ellmore 1975). Warm-season forages were established on 7 April 1990 and clipped at 5- to 6-week intervals after planting until plants died. The same clipping procedure used on cool-season plots was used on warm-season plots, except only plant portions (leaves, petioles, pods, and terminal stems $\leq$3 mm) determined to have been browsed by captive deer in a concurrent study were reweighed from the 200- to 300-g subsample to calculate forage production and determine nutritional content. Other portions, especially large stems, were not determined to be readily consumed by the deer. Inclusion of large stems would inflate production estimates and dilute nutritional content values. Cool-season forages, in comparison, were browsed by the deer to near ground level, so any plant material clipped and collected in the subsample was used to calculate production and determine nutritional content. Thus, only using plant parts readily browsed by deer to determine production and nutritional content allowed for useful comparison of cool- and warm-season forages.

After the 1-m^2 samples from cool-season plots were clipped, each entire plot was mowed to a uniform height of approximately 5 cm (2.5 cm for clovers) to simulate grazing effects and to prepare plots for the next production sampling interval. Warm-season plots were measured as "standing production" during each production sampling period, and therefore, the entire plots were not mowed after each clipping. Unlike most cool-season forages, warm-season forages would not fully regrow after mowing and many would die if mowed near ground level.

If insufficient production prevented clipping of cool- or warm-season plots, production values for the plots were recorded as "trace." Hand clipping samples from such plots indicated "trace" was approximately 10 kg/ha. Vegetation samples (approx. 100 g) used for nutritional analyses were hand picked from "trace" plots.

Vegetation subsamples were analyzed by the Auburn University Soil Testing Laboratory for percent TDN, CP, NDF (considered the total forage fiber which includes cell constituents of cellulose, hemicellulose, lignin, and some silica), calcium, phosphorus, and potassium. Means of forage production estimates and nutritional contents were calculated for each forage at each clipping. Comparisons (Proc GLM; SAS Inst., Inc. 1987) were made to test for statistical significance ($\alpha = 0.05$). Tukey's Studentized Range Test was used to separate means while controlling type I experiment error rate (Day and Quinn 1989).

Results

Production and nutritional values were recorded on a dry-matter basis. The 1989–90 cool-season plots and the 1990 warm-season plots were clipped 4 times (Fig. 1). The 1990–91 cool-season plots were clipped 6 times plus 3 times during the warm growing season for ladino and red clovers that continued producing. During the second cool-season, red clover sample size was reduced to 2 because of weed contamination in 1 replicate.

Cool-Season Forage Production

From November to March of both years, small grains (rye, wheat, and oats) generally were significantly greater ($P < 0.05$) in forage production than other crops tested. Small-grain production ranged from 600 to 1,300 kg/ha from January to March the first year and from 400 to 1800 kg/ha from November to March the second year (Fig. 1A). Forage turnips exhibited early production, peaking near 900 kg/ha in January of the first year and in November and January of the second year. During the

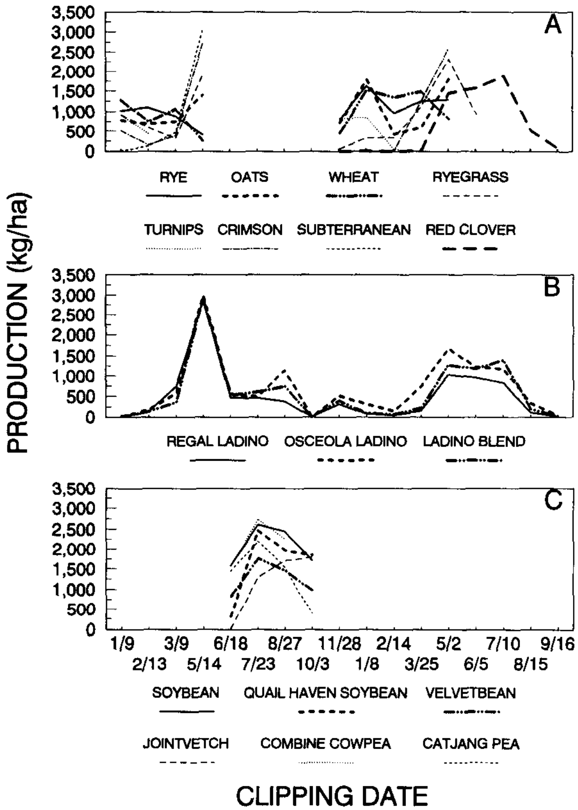

Figure 1. Production (kg/ha) of 1989–90 cool-season forages (including ladino clovers) from 9 January 1990 to 14 May 1990, 1990 warm-season forages and ladino clovers from 18 June 1990 to 3 October 1990, and 1990–91 cool-season forages (including ladino clovers) from 28 November 1990 to 16 September 1991, Auburn, Alabama.

first year, wheat production was significantly greater ($P < 0.05$) than oat production when measured on 9 January 1990, and rye production was significantly greater ($P < 0.05$) than oat production when measured on 13 February 1990. During the second year, no differences existed among the 3 forages until 14 February 1991 when wheat production was significantly greater ($P < 0.05$) than that of rye or oats, and rye production was significantly greater ($P < 0.05$) than oat production. Small grains matured and died by May.

Ryegrass, crimson clover, and subterranean clover peaked in May, producing 1,900 to 3,100 kg/ha of forage the first year and then maturing and dying in May/June (Fig. 1A). Ryegrass and crimson clover production peaked near 2,300 and 2,600 kg/ha, respectively, the second year. Crimson was the earliest producer of all clovers tested, providing 500 kg/ha of forage in January of the first year. Ryegrass also produced forage during January and February (600 to 900 kg/ha per clipping the first year and 350 kg/ha per clipping the second year).

Ladino clovers peaked in May, producing 2,900 kg/ha the first year dropping to 1,000 to 1,700 kg/ha the second year of perennial growth (Fig. 1B). No significant differences in production were detected among ladino clovers tested except on 15 August 1991 when Osceola ladino clover production was significantly greater ($P < 0.05$) than that of Regal ladino clover. During the second year, perennial ladino clovers had lower peak production but a more extended period of growth compared to the first year.

Red clover produced forage from March through September 1991, peaking near 1,900 kg/ha in July. Red clover production was greater than that of the ladino clovers during summer, but the difference generally was not significant ($P < 0.05$). The decreased sample size (2) of red clover may have masked significant differences in production among red and ladino clovers during that time.

Total production of cool-season forages was calculated by adding production estimates from each clipping for each forage (Table 1). Small grain, ryegrass, and forage turnip total production and second year was greater than that of the first year because clipping of these forages began in November and clipping the first year began in January. This greater production occurred even though the second year's plots were planted 3 weeks later than the first year's plots (late planting can decrease total production).

Warm-Season Forage Production

Soybean, Combine cowpea, and catjang pea provided most of the early warm-season forage in June (range 1,400 to 1,600 kg/ha) and were significantly greater in production than all other forages at this time ($P < 0.05$; Fig. 1C). Catjang pea and Combine cowpea produced well from mid-June to late August (range 1,450 to 2,750 kg/ha per clipping). They matured in late summer and essentially were gone by October. Soybean produced abundant forage (range 1,575 to 2,600 kg/ha over 4 clippings) throughout the summer.

Quail Haven® soybean, American jointvetch, and velvetbean were good mid- to late season producers. Quail Haven® soybean began production by July and

Table 1. Total production ($\bar{X} \pm$ SD; kg/ha) of cool-season forages, Auburn, Alabama, 1989–1991.

	9 Jan 89–14 May 90	18 Jun 90–3 Oct 90	28 Nov 90–5 Jun 91
Rye	3414 ± 746 C[a]		5946 ± 880 AB
Oats	3611 ± 346 BC		5335 ± 581 ABC
Wheat	3345 ± 310 C		5649 ± 524 ABC
Ryegrass	3755 ± 530 ABC		5133 ± 1492 ABC
Turnips	1355 ± 194 D		1748 ± 509 D
Crimson clover	3769 ± 386 BC		3872 ± 491 BCD
Subterranean clover	3667 ± 236 BC		
Red clover			3090 ± 99 ABC
Regal ladino	3753 ± 465 ABC	1350 ± 302 A	2605 ± 152 CD
Osceola ladino	3778 ± 290 A	2221 ± 1293 A	4669 ± 406 A
Ladino blend	3422 ± 764 AB	1912 ± 547 A	3273 ± 532 ABC

[a]Means separated by Tukey's Studentized Range Test; those sharing a letter within a row are not significantly different ($P > 0.05$).

maintained from 1,900 to 2,500 kg/ha of forage per clipping through October. American jointvetch also began production in July, maintaining 1,295 to 1,785 kg/ha over 3 clippings through October. Velvetbean was intermediate in forage production, ranging from 825 to 1,750 kg/ha per clipping. Soybean, Quail Haven® soybean, and Combine cowpea production was significantly greater ($P < 0.05$) on 23 July 1990 than that of the ladino clovers (which persisted in minimal quantities during the warm-season). Soybean, Quail Haven® soybean, and American jointvetch production was significantly greater ($P < 0.05$) on 3 October 1990 than that of the ladino clovers.

Peak production for 1990 warm-season forages ranged from 2,744 kg/ha for Combine cowpea to 1,757 kg/ha for velvetbean. Peak production of most warm-season forages was generally greater than total production of the ladino clovers throughout the summer (18 Jun to 3 Oct; Table 1).

Cool-Season Nutritional Quality

Total digestible nutrients of cool-season forages ranged from 56% to 84% over the 2 years, decreasing as plants matured. Forage turnip TDN (range 71% to 84%) generally was significantly higher ($P < 0.05$) than that of all forages. Overall, rye, wheat, and oats (range 59% to 78% throughout the cool-seasons) did not differ significantly in TDN except on 9 March 1990 when oats (78%) was significantly higher ($P < 0.05$) than rye (69%) and wheat (71%) and on 14 May 1990 when oats (65%) and wheat (64%) were significantly higher ($P < 0.05$) than rye (60%). Ladino clover TDN ranged from 59% to 71% for the cool-season periods, not differing significantly ($P > 0.05$). Red clover TDN ranged from 56% to 72% during summer. Red clover TDN (59%) was significantly lower ($P < 0.05$) than that of ladino clovers (range 64% to 55%) on 10 July 1991.

Crude protein levels of cool-season forages ranged widely (8% to 30%) depending on clipping date (Fig. 2A,B). Levels were highest in fall through winter but decreased steadily as plants began reproductive growth. All forages contained >16% CP throughout fall and into winter. Ladino clovers remained between 19% and 28% CP throughout the study, not differing significantly ($P > 0.05$) during any clipping period. From February to May of both years, ladino and crimson clovers did not differ significantly ($P > 0.05$) in CP content. Ryegrass CP generally was significantly lower ($P < 0.05$) than that of crimson and ladino clovers from February through May.

Neutral detergent fiber of cool-season forages ranged from 16% to 67% during both years. Neutral detergent fiber generally was lower in fall and winter and increased in spring as plants matured. Throughout the seasons, small grains (range 31% to 62%) and ryegrass (range 28% to 67%) were generally higher in NDF than clovers (range 16% to 50%). Ladino clover NDF ranged from 19% to 44% during both cool-season periods, not differing significantly ($P > 0.05$). Red clover NDF (range 16% to 50% for the summer) generally was significantly higher ($P < 0.05$) than that of ladino clovers (range 28% to 32%) from July through September.

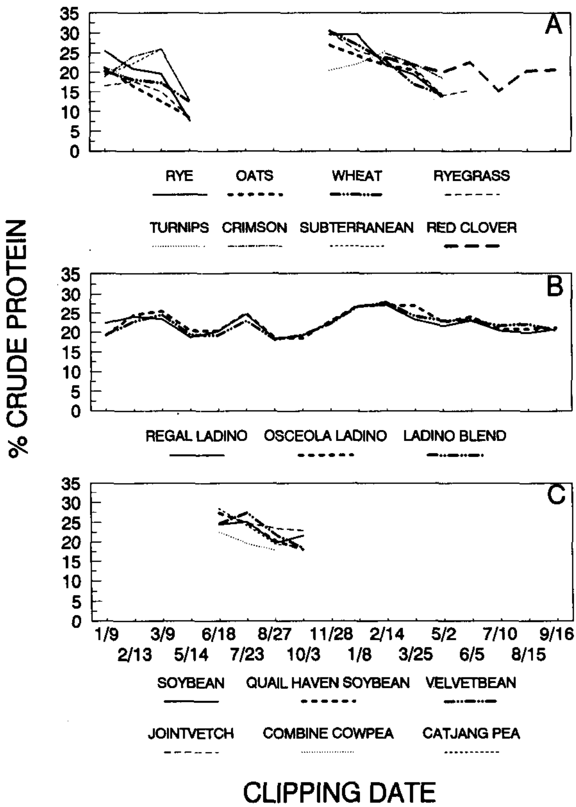

Figure 2. Percent crude protein of 1989–90 cool-season forages (including ladino clovers) from 9 January 1990 to 14 May 1990, 1990 warm-season forages and ladino clovers from 18 June 1990 to 3 October 1990, and 1990–91 cool-season forages (including ladino clovers) from 28 November 1990 to 16 September 1991, Auburn, Alabama.

Calcium content of forage turnips, crimson clover, subterranean clover, ladino clovers, and red clover ranged from 0.91% to 2.34% over the cool-seasons. Small grains and ryegrass generally were significantly lower ($P < 0.05$) in Ca content than the above forages and fluctuated from 0.15% to 0.69%, decreasing in spring. Ladino and red clovers did not differ significantly ($P > 0.05$) in Ca content for any clipping during the second year.

Phosphorus content of cool-season forages fluctuated between 0.10% and 0.44%, generally not differing significantly ($P > 0.05$). Levels were highest in fall through winter and decreased as plants matured in spring. Small grain P content ranged from 0.13% to 0.40%, and ryegrass P content ranged from 0.17% to 0.42%. Ladino clover P content ranged from 0.16% to 0.44% throughout both years. Red clover P content ranged from 0.23% to 0.36% the second year.

Potassium levels of cool-season forages varied between 0.85% and 4.59% over the 2 years, also decreasing as plants matured in spring or in summer for ladino and red clovers. Overall, K content of cool-season forages did not differ significantly ($P > 0.05$).

Warm-Season Nutritional Quality

Total digestible nutrients of 1990 warm-season forages and ladino clovers ranged from 60% to 68%. Overall, TDN did not differ significantly ($P > 0.05$) among forages, with the exception of all forages (range 64% to 67%) being significantly greater ($P < 0.05$) than Combine cowpea (60%) on 27 August 1990.

Crude protein content of warm-season forages varied from 18% to 29% for the summer and decreased with plant maturity during late summer (Fig. 2C). Ladino clover CP content remained between 18% and 25% during this time, not differing significantly ($P > 0.05$; Fig. 2B). Quail Haven® soybean and catjang pea were significantly higher ($P < 0.05$) in CP than ladino clovers on 18 June 1990. American jointvetch CP content was significantly higher ($P < 0.05$) than that of Combine cowpea and ladino clovers on 23 August 1990.

Neutral detergent fiber of warm-season forages remained between 25% and 40% throughout the summer and generally increased as plants matured in late summer. Ladino clover NDF content ranged from 22% to 33% during this period and did not differ significantly ($P > 0.05$). No significant differences in NDF content were detected among warm-season forages and ladino clovers except that American jointvetch (26%) was significantly lower ($P < 0.05$) than all other forages (range 27% to 40%) on 27 August 1990.

All warm-season forages were high in Ca, ranging from 0.81% to 1.68% over the summer, and generally did not differ significantly ($P > 0.05$). Ladino clover Ca content also was high during this time (range 1.13% to 1.62%), not differing significantly ($P > 0.05$).

Warm-season forages contained between 0.13% and 0.31% P throughout summer, with P levels generally increasing with plant maturity. Ladino clovers contained from 0.18% to 0.29% P during this period. Phosphorus content of warm-season forages and ladino clovers did not differ significantly throughout the summer except on 3 October 1990 when soybean (0.31%) was significantly higher ($P < 0.05$) in P content than Quail Haven® soybean (0.21%), velvetbean (0.20%), and American jointvetch (0.20%).

Potassium levels of warm-season forages ranged from 0.99% and 2.38%, decreasing with plant maturity. Ladino clovers contained from 1.50% to 2.34% K during this time. Generally, warm-season forages and ladino clovers did not differ significantly ($P > 0.05$) in K content.

Discussion

Evaluation of forages in this study involved plant characteristics independent of deer use. A concurrent study assessing deer preference for the forages indicated all forages were readily accepted during certain times of their respective growing seasons (Waer 1992).

Rye, wheat, oats, and forage turnips were the greatest forage producers during fall and winter (Fig. 1). This production period coincides with the deer hunting season in Alabama, which lasts from mid-October through January, and the late autumn-winter nutritional stress period experienced by white-tailed deer (Short 1975). While oats is a strong, early producer, it is considered more cold sensitive than rye or wheat, and many oat varieties can be more easily winter-killed than rye or wheat some years (Ball et al. 1991). Wheat had an extended, stable forage output. Ullrey et al. (1987) concluded that rye can be efficiently used by deer due to its protein and energy content and estimated digestibility. While forage turnips had significantly lower ($P < 0.05$) total production than all other crops, it concentrated its highly digestible growth (Fig. 1A) in a very short period from November through February; a desirable trait for attracting deer during hunting season.

Production of ryegrass, crimson clover, subterranean clover, and ladino clovers peaked during May (Fig. 1). While this peak was high compared to small-grain production, it occurred during spring green-up when browse is plentiful and nutritious. The majority of small grain, ryegrass, crimson clover, and subterranean clover production just after the peaks depicted in Figure 1 is reproductive growth, when physiological and structural changes in the plants make them less palatable (Heady 1964). Thus, consideration of productive output during this period of late growth until the plants are dead becomes less important. Crimson clover, recognized for high, early season (Feb to Mar) yield compared to other clovers and good reseeding potential (Pedersen and Ball 1991), began production in January. Ryegrass also began producing forage in January prior to the spring green-up in March and April. Ladino clovers, however, generally began producing during spring green-up. Subterranean clover had the greatest production among clovers the first cool-season but did not perform well other than spring. It has the potential to reseed well but often is considered a poor performer in Alabama (Pedersen and all 1991).

Red clover produced from May through September. Red clover is fairly drought tolerant compared to ladino clovers, and while it is a short-lived perennial, its second year's growth is not highly dependable if the plants have been subjected to severe stress (Ball et al. 1991). Even though red clover production was not significantly greater ($P > 0.05$) than that of ladino clovers during summer, a statistical separation of means may have been prevented by the decreased sample size of red clover resulting from weed contamination.

Warm-season forage production was abundant from June to October (Fig. 1C). Soybean maintained a high level of production throughout summer. Soybean is a forage readily accepted by deer as evidenced by extensive depredation in agricultural communities (Moore and Folk 1987). However, extensive soybean browsing (common with overpopulated herds) during the first week after sprouting can decrease total yields by 80%, rendering it useless as an abundant producer (DeCalesta and Schwendeman 1978). Quail Haven® soybean's delayed production, indeterminant growth, and winding, trailing growth form made it a competitive forage. Both Combine cowpea and catjang pea exhibited good early (Jun) to mid-season (Aug) production.

Because cool-season forages did not differ significantly in total production (except forage turnips), consideration for choosing forages for deer should be given on a monthly or seasonal basis. There were no detectable production differences among ladino clover varieties by date or season (Fig. 1B). Evaluation of warm-season forage peak production and ladino clover total production during summer indicated soybeans and peas generally were more productive than ladino clovers. The advantages of growing ladino clovers instead of soybeans or peas for summer forage would be the capability of planting ladino clovers in the fall and their potential for perennial existence (Ball et al. 1991). Ladino clovers are cool-season forages that happen to persist during the warm-season. While the perennial nature of ladino clovers is beneficial, drawbacks include its impaired ability to produce in droughty soils (Ball et al. 1991) such as those common in the Piedmont and especially the Coastal Plain of Alabama. If the planting site suitability is high (fertile, moist bottomlands), ladino clovers potentially can provide quality forage during spring, summer, and even a limited amount during the cool-season for a number of years.

Nutritional content data indicated quality varied among all forages, except among ladino clover varieties. Analysis of percent TDN, and indirectly NDF, revealed that all forages were quite digestible during their productive periods. Once small grains, ryegrass, annual clovers, and warm-season forages matured, they became fibrous and much less digestible. According to Torgerson and Pfander (1971), Snider and Asplund (1974), and Short (1975), as plants mature they decrease in digestibility, protein, mineral, and carbohydrate content and increase in cell wall constituents and lignification. Lignin, which is indigestible, can increase as much as 20% in cell walls (Robbins 1983). Examination of NDF and CP values for forages tested showed increases in cell wall structural components and decreases in CP contents as plants matured, suggesting a potential decrease in palatability.

Crude protein especially is needed by deer during lactation, the month prior to initiation of antler development, during fawn growth, for winter preparation, and during the late autumn-winter stress period (Lay 1956, Short 1966). Forages evaluated in this test generally exceeded minimum CP requirements of deer during the times when most deer use of the specific forages would occur. Minimum CP requirements of deer reported in the literature are 3.8% to 10% for maintenance, 6% to 10% for optimal antler development, 13% to 17% for optimal growth and development, and 14% to 22% for fawns after weaning and for lactating does (French et al. 1956, McEwen et al. 1957, Ullrey et al. 1967, Holter et al. 1979). Small grain CP content generally was above 25% in fall (during lactation and fawn development in Alabama) and above 15% during winter (when only maintenance levels are required). Ladino clover CP content never fell below 18% (encompassing most all optimal requirements throughout the year), and warm-season forage CP content never fell below 17% (supplying more than adequate CP needed for antler and body growth). Red clover CP content ranged from 15% to 22% from May through September (meeting minimum CP requirements for body and antler growth and fawning). Crimson clover (18% to 26%), subterranean clover (19% to 26%), and ryegrass (15% to 30%) contained sufficient CP levels for growth, development, and maintenance from fall to winter.

Evaluation of mineral analyses data indicated similar patterns. Calcium levels in forage turnips, crimson clover, subterranean clover, red clover, ladino clovers, and all warm-season forages never fell below 0.80%, which was well above the requirement of 0.40% to 0.64% suggested for optimal growth and development of deer (McEwen et al. 1957, Ullrey et al. 1973, Ullrey 1981). Small grains and ryegrass fluctuated around and even fell below these optimal requirements by spring. However, because these requirements reportedly are for optimal growth and development, Ca levels in small grains and ryegrass during their most productive period from fall through winter probably exceeded maintenance requirements. Phosphorus levels of all forages fluctuated and generally were less than suggested requirements of 0.28% to 0.56% (McEwen et al. 1957, Ullrey et al. 1975, Ullrey 1981). Because P often is deficient in southern forests all year except spring (Lay 1956), soil test recommendations are important to ensure proper amounts of lime and fertilizer are applied to optimize phosphorus availability. Potassium requirements have not been determined for deer, but reference has been made to the needs of rabbits, sheep, and cattle at 0.50% to ≥0.60% (Torgerson and Pfander 1971). All forages exceeded these levels, and most remained above 1% throughout the seasons. According to Robbins (1983), K deficiencies are rare in wildlife.

Choosing forages to plant for deer depends upon management objectives. If attracting deer for harvest during hunting is desired, then forages that produce well from early fall through winter should be used. If year-round, intensive management or supplemental feeding is the objective, then forages which will provide an adequate quantity and quality of forage during specific time periods should be selected. No single forage thus far has been identified that meets all nutritional requirements of deer. However, combinations of forages can be used to produce abundant, quality forage during all seasons, especially during the late autumn-winter stress period. Small grains could be used from fall through winter, crimson clover or ryegrass from winter through early spring, ladino clovers from spring into summer, and red clover and soybeans from spring through summer. If clover mixtures are appropriate, blends of ladino, red, and annual clovers might be used to derive advantages from each clover type. Competition should be considered if mixtures are used. Vangilder et al. (1982) stresses the danger of judging forage quality by a single criterion, and suggests forages not be ranked low in quality because they do not meet all nutritional needs of deer. Thus, white-tailed deer forage plantings should be developed based on individual characteristics of individual crops. A combination of forages can be chosen that supplies quality forage during critical periods or year-round.

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