Preference for Selected Forage Plantings by Captive White-tailed Deer

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Abstract: While researchers recently have begun to examine production and nutritional quality of forage plantings for white-tailed deer (*Odocoileus virginianus*), little research has been done to determine deer preference of commonly planted forages. Due to lack of research, some forages are being inappropriately recommended to supply forage during times of the year they are not productive or preferred. We employed a timed observational method to determine captive white-tailed deer use of commonly planted forages from 1989–1991 at the Auburn University Deer Research Facility near Auburn, Alabama. We recorded feeding activity of 10 deer foraging on 11 cool-season and 6 warm-season forages during 227 feeding intervals. Cool-season forages tested included 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, Tibbee crimson clover (*T. incarnatum*), Mt. Barker subterranean clover (*T. subterraneum*), and Redland II® red clover (*T. pratense*). Warm-season forages tested included Davis soybean (*Glycine max*), Quail Haven® soybean, combine cowpea (*Vigna unguiculata*), catjang pea (*V. sinensis*), velvetbean (*Stitzolobium deeringianium*), and American jointvetch (*Aeschynomene americana*). Deer preference was associated with growth stages of the forage species. Generally, forages received highest use when they were growing rapidly, relatively high in crude protein, and relatively low in neutral detergent fiber. Of the species tested, oats, rye, and wheat had greatest use from autumn through early winter, ryegrass and crimson clover had greatest use from winter to early spring, and ladino clovers from spring into summer. Soybeans were used throughout summer, and red clover from late spring to late summer. Our data can be used to develop planting regimes for deer in the Southeast based on management objectives that dictate when abundant, nutritious, and preferred forage is needed.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 48:55–68

Forage plantings are a traditional management technique extensively used for white-tailed deer throughout the Southeast. Landowners, hunting clubs, and wildlife agencies invest considerable resources annually to establish and maintain food plots for deer. While planted forages probably are used most commonly to attract deer for easier harvest, other possible benefits include supplementing forage supplies to increase herd quality or carrying capacity on a given area (especially if too little high quality forage is present at critical times), attracting deer for viewing, and improving public relations (Halls and Stransky 1968, Crawford 1984, Johnson et al. 1987). Growing interest has resulted in commercializing this management technique, with many blends and varieties of forage seed packaged and promoted specifically for use in food plots for deer. Inefficiently using management resources has resulted because some forages are being incorrectly promoted to supply forage for times of the year when they do not produce well or are not preferred compared with other planted forages.

After considering geographic location, soil type, and habitat type, identifying the best forages to plant for deer depends on management objectives (attracting deer to hunt, supplemental feeding) which dictate time of year when abundant, nutritious forage is needed (fall hunting season, during stress periods, year-round). Attributes to consider when evaluating forages include forage production, nutritional quality, deer use and preference, and economics. Even though food plantings are used extensively, little research in these areas has been published.

Some published studies are available concerning production (Davis 1961, Webb 1963, Lunceford 1986) and nutritional content of selected planted forages (Waer et al. 1992). A few published studies have examined relative use of forage plantings by deer using forage clipping techniques that compare areas open to foraging to protected (using exclosure cages) areas (Davis 1961, Webb 1963, Lunceford 1986). However, studies often generalize about what is the best forage to plant for an entire cool- or warm-season based on cumulative use per season, and determining preference using forage clipping methods can be difficult because of high variability often associated with these methods (Reid 1951, Petersen et al. 1958, Buckner and Burrus 1962, Waer 1992). Agronomists studying forage use by livestock often use an observational technique as an alternative to clipping methods (Burton 1947, Peterson et al. 1958, Hyder and Bement 1964). Extensive work has been done to determine preference of forages by sheep and cattle (Marten 1978), but little research has been done to adequately determine white-tailed deer preferences of commonly planted forages. Identifying which and when different forages are preferred is important because benefits provided by forage plantings depend on their timely use by deer. Determining deer preference seasonally for commonly planted forages will help answer the question of what to plant for the time of year of interest. We determined white-tailed deer preference for selected forage plantings using a timed observational method that recorded relative foraging of 10 captive deer. Observational feeding frequency data then were compared to forage availability and nutritional quality data to help understand deer preferences.

This project was supported by funds from the Federal Aid in Wildlife Restoration Act administered through the Alabama Department of Conservation and Natural Resources, Division of Game and Fish; U.S. Department of Defense, Fort Rucker Military Base; Alabama Agricultural Experiment Station Project No. ALA-13-0066; and Safari Club International, Birmingham Chapter. Appreciation is expressed to Don Ball for his contributions and to student workers who helped collect data. We followed an Auburn University approved animal welfare protocol (PRN 9405-R-0244) while conducting this study. This study was published as Alabama Agricultural Experiment Station Journal Series 15-923377.

Methods

The study was conducted at the Auburn University Deer Research Facility located near Auburn, Alabama. The area falls in the Piedmont physiographic region of Alabama and has sandy loam soils in the Pacolet series (McNutt 1981). Average annual rainfall is 142.5 cm (Natl. Weather Serv. 1992). Forages evaluated were established in plots within a 0.6-ha fenced clearing adjacent to a pen containing 10 captive deer.

We tested forages for 2 cool seasons (Sep to May) and 1 warm season (May to Oct) (Table 1). Cool- and warm-season forages tested are among those most

Table 1. Cool- and warm-season forage plantings evaluated in white-tailed deer preference trials from 1989–1991, Auburn, Alabama.

Season	Planted	Forages
Cool 1989–1990	18 Sep 89	Coker 820® oats
		Wren's Abruzzi rye
		Marshall (annual) ryegrass
		Pioneer 2551® wheat
		Civastro (forage) turnips
		Osceola ladino white clover
		Regal ladino white clover
		Imperial Whitetail® ladino white clover[a]
		Tibbee crimson clover
		Mt. Barker subterranean clover
Cool 1990–1991	9 Oct 90	Same as above[b] except Redland II® red clover replaced subterranean clover
Warm 1990	7 Apr 90	Davis soybean
		Quail Haven® soybean
		Combine cowpea
		Catjang pea
		Velvetbean
		American jointvetch
		(Ladino clovers)[c]

[a]Blend composed of 60% Regal and 40% California ladino clover.
[b]Ladino clovers are perennial and remained from the first year's planting; all other forages were replanted.
[c]Ladino clovers are considered cool-season plantings, but they persisted in minimal quantities during summer.

commonly planted for deer in Alabama and the Southeast, with the exception of forage turnips and American jointvetch.

We arranged forage plots in a randomized block design inside the 0.6-ha clearing. Three blocks (replicates) were positioned in the enclosure forming 3 parallel rows 6.1 m apart. Each forage was planted in a plot space once within each block. Blocking ensured all treatments in a replication were treated equally and accounted for bias from proximity of plots to the fence, observer, entry gate, or an edge. Seeds of each forage were drilled (14 rows per plot) within a 6.1 × 3.1-m plot randomly allocated to a space within a block. We used a different randomization plan for forages each season. Prior to planting, plots were limed and fertilized according to soil test recommendations for forages selected for planting. Forages then were established and cultivated for forage production according to recommendations of the Alabama Planting Guide (Ala. Coop. Ext. Serv. 1988). To remove effects of moisture stress on plant palatability, we irrigated all plots at a rate of 2.5 cm/week if rainfall fell below this amount or if plants showed signs of moisture stress. During the 1990 to 1991 cool season, red clover sample size was 2 because of weed contamination of 1 replicate. Circular exclosures 1 m^2 × 1.5 m high were constructed of 5.1 × 10.2-cm mesh welded wire thin enough to not shade enclosed forage. One cage was placed randomly in each plot to exclude deer.

We allowed 6 females and 4 males, ranging from 0.5 to 1.5 years of age at the beginning of the study, to graze forages, except in the second year, 1 adult male and 1 female were replaced with 1 male and 1 female fawn. Colored collars were placed on each deer to allow identification at a distance. Deer remained in their holding pen and were released on plots approximately 4 times a week during their normal feeding times. Because the holding pen was connected to the enclosure by a gate located at a corner of the enclosure, we scattered deer following release onto the plots to prevent favoring plots nearest the gate and to ensure all plots had an equal chance of exposure at the beginning of a feeding interval. Deer were allowed to feed 15 to 30 minutes and then were herded back into the holding pen. Consumption of the deer's normal pelleted feed during the study was limited by removing all food 12 to 14 hours prior to each feeding interval.

Deer foraging activities were recorded from a blind during feeding intervals. Location of each feeding deer was recorded by plot number at 3-minute intervals. If a particular deer did not enter the enclosure, returned to the holding pen, did not forage, or foraged on surrounding volunteer vegetation, its alternative activity was recorded during that 3-minute interval. We determined deer use of each plot during a feeding interval by dividing number of observations for each plot by total minutes elapsed during the interval. This calculation accounted for variation in number of feeding minutes among feeding intervals.

We clipped cool- and warm-season forage plots at 4- to 9-week intervals (depending on growth stages of the forage plants) after establishment throughout their growing seasons. Forage inside each exclosure cage was clipped at approximately 5 cm (2.5 cm for clovers) above ground level within each plot, and the mass was determined. A 200- to 300-g subsample was weighed, placed in a cloth bag, dried (55 to 60 C), and reweighed to determine production and nutritional content on a dry-mass basis (Boyer 1959, Short 1966, Wolf and Elmore 1975). For warm-season species, we used only plant portions (leaves, petioles, pods, and terminal stems ≤3 mm) commonly browsed by deer to calculate production and nutritional content. If insufficient production prevented clipping of cool- or warm-season forages, production values for plots were recorded as "trace." Hand clipping samples from such plots indicated "trace" equaled approximately 10 kg/ha. Vegetation samples (about 100 g) used for nutritional analyses were hand picked from "trace" plots.

After cool-season forages were clipped, each plot was mowed to a uniform height of approximately 5 cm (2.5 cm for clovers) to simulate grazing effects (forage plantings normally would be kept grazed down by wild deer) and to facilitate production determination for the next interval. We measured warm-season plots as "standing production" and did not mow them after each clipping. Unlike most cool-season forages, warm-season forages would die or not fully regrow if mowed near ground level. Exclosure cages were reassigned to another random location within each plot after clippings.

Vegetation subsamples were analyzed by the Auburn University Soil Testing Laboratory for percent crude protein (CP) and percent neutral detergent fiber (NDF). We calculated mean production (dry-mass basis), CP content, and NDF content for each forage at each clipping and mean observations/minute for each forage for each observation period (all feeding intervals between clippings). We compared means to test for statistical significance (alpha = 0.05) using analysis of variance (with Tukey's test to separate means), and we used an analysis of covariance to determine if production affected observations/minute (Proc GLM; SAS Inst. 1987).

Results

Observations, Production, and Nutritional Quality

Sixteen observation periods, including 7 to 21 feeding intervals each, were conducted over the 3 seasons (Fig. 1), resulting in 15,740 observations during 227 feeding intervals. An observation period preceded each clipping except the clipping on 10 July 1991. Throughout the study, the same amount of time was spent by deer eating volunteer vegetation (40.8%) within the enclosure as was spent eating planted forages (40.3%). This volunteer vegetation included blackberry (*Rubus spp.*), evening primrose (*Oenothera laciniata*), and bahiagrass (*Paspalum notatum*). Of the time spent foraging on volunteer vegetation, 46.2% occurred in spring and early summer. Deer spent 15.5% of the time not eating, and deer either left or did not enter the enclosure 3.4% of the time.

Forage production varied according to forage type, month, and season (Fig. 2). Crude protein levels of cool-season forages ranged from 8% to 30%

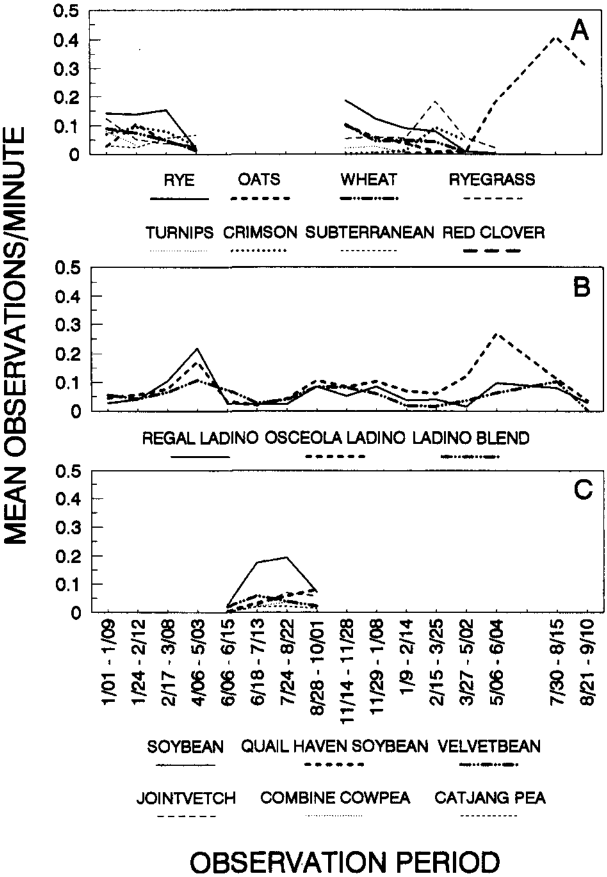

Figure 1. Mean observations/minute of forage selection by 10 captive white-tailed deer of cool-season forages (including ladino clovers) from 9 January 1990 to 14 May 1990; warm-season forages and ladino clovers from 18 June 1990 to 3 October 1990 and cool-season forages (including ladino clovers) from 28 November 1990 to 16 September 1991, Auburn, Alabama.

over clipping dates (Fig. 3A, B). Levels generally were highest in autumn through winter, but decreased as plants began reproductive growth. Crude protein content of warm-season forages varied from 18% to 29% and tended to decrease with plant maturity during late summer (Fig. 3C). Neutral detergent fiber of cool-season forages ranged from 16% to 67% during both years. Levels generally were lower in autumn and winter and increased in spring as plants matured. Neutral detergent fiber of warm-season forages ranged from 25% to 40% throughout summer and increased as plants matured in late summer.

Because all forages were planted in plots of equal size, availability on a horizontal level was equal. Therefore, mean observations/minute for each forage may reflect relative preference. Analysis of covariance revealed that availability on a vertical level (forage height or production) did affect mean observations/minute during the first ($P = 0.02$), third ($P = 0.0002$), and fourth ($P = 0.0022$) observation periods for the second cool-season (Fig. 1A). In these periods, crimson clover and red clover only exhibited "trace" production and would predict-

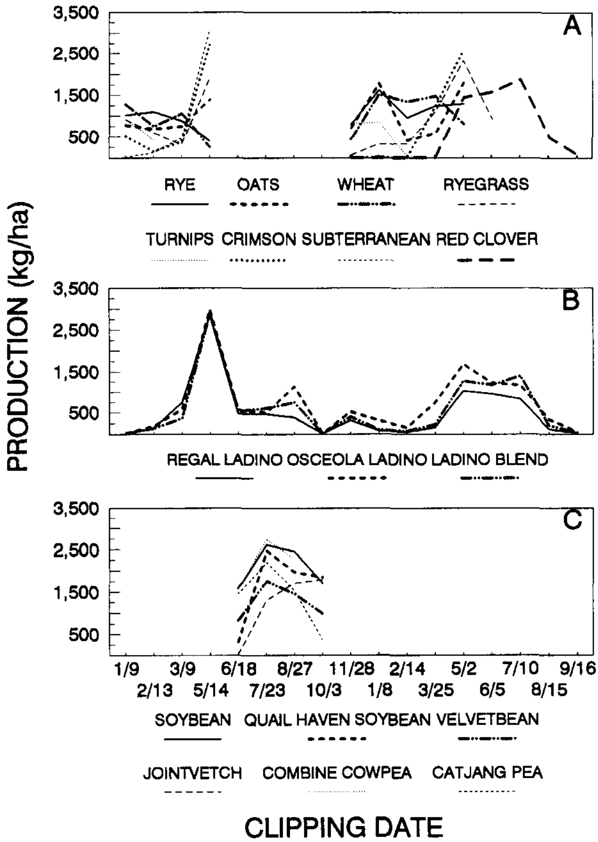

Figure 2. Production (kg/ha) of cool-season forages (including ladino clovers) from 9 January 1990 to 14 May 1990; warm-season forages and ladino clovers from 18 June 1990 to 3 October 1990 and cool-season forages (including ladino clovers) from 28 November 1990 to 16 September 1991, Auburn, Alabama.

ably have few observations. Once forages were established and producing, forage height may not be an important determinant of observations/minute.

Small grains (oats, rye, and wheat) generally had the greatest mean observations/minute among cool-season forages from November through February (Fig. 1A, B). During that time, small grains were approaching or attaining their peak production, ranging from 600 to 1,300 kg/ha from January to March the first year and from 400 to 1,800 kg/ha from November to March the second year (Fig. 2A). During this period they were at their highest CP levels (range 17% to 30%; Fig. 3A) and contained 36% to 46% NDF. Small grains matured and died by May. Forage turnip was used less than small grains, but was used moderately from November through early January (Fig. 1A) when it reached peak production (near 900 kg/ha in January the first year and in November and January the second year; Fig. 2A). Turnips contained 21% to 22% CP (Fig. 3A) and 16% to 26% NDF during their peak use.

Deer highly utilized ryegrass with small grains in January the first year and in December through March the second year (Fig. 1A). Ryegrass produced for-

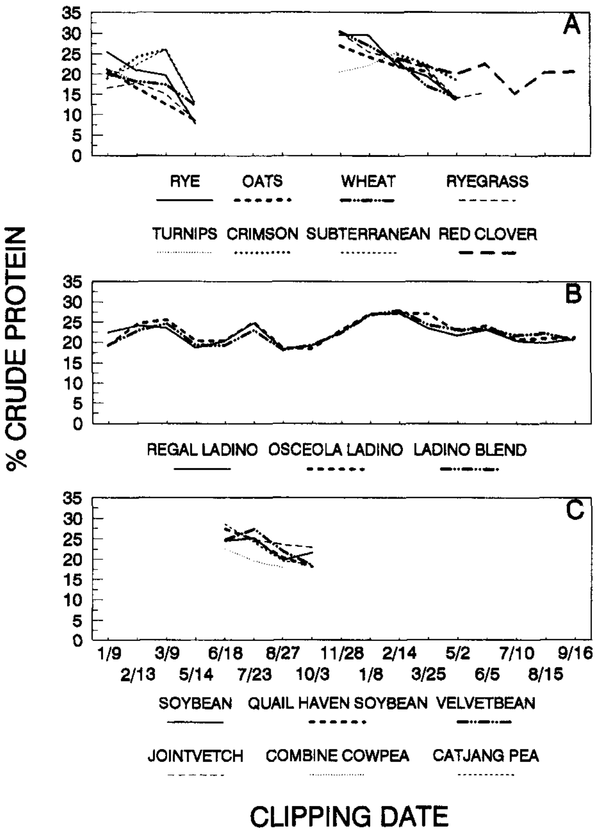

Figure 3. Percent crude protein of cool-season forages (including ladino clovers) from 9 January 1990 to 14 May 1990; warm-season forages and ladino clovers from 18 June 1990 to 3 October 1990 and cool-season forages (including ladino clovers) from 28 November 1990 to 16 September 1991, Auburn, Alabama.

age rapidly from January to March, ranging from 300 to 900 kg/ha per clipping the first year and from 300 to 1,100 kg/ha per clipping the second year (Fig. 2A), as it approached peak production in May. From January to March ryegrass contained its highest CP content (range 17% to 26%; Fig. 3A) and its lowest NDF content (range 28% to 34%). Ryegrass use was greater than that of small grains from mid-February to late March 1991 (Fig. 1A).

Crimson clover also was highly utilized from late January through March the first year and from February to March the second year (Fig. 1A). During those times, crimson clover was growing rapidly as it approached its peak production in May (Fig. 2A). Crimson clover contained its highest levels of CP (range 19% to 26%; Fig. 3A) and lowest levels of NDF (range 20% to 25%) from January to March. Crimson clover was the second most used forage from mid-February to late March 1991 (Fig. 1A). The other annual clover tested, subterranean, was used greatest from mid-February to early May of the first year (Fig. 1A) as it approached and attained peak production (Fig. 2A). At that time subterranean clover contained its highest level of CP (26% in March; Fig. 3A) and 22% to 34% NDF. However, deer use of rye, crimson clover, and ladino clovers from February to early March and of ladino clovers from April to early May was much greater than that of subterranean clover (Fig. 1A,B).

Maximal use of ladino clovers by deer was from April through June (Fig. 1B) during the ladino clovers' peak production (Fig. 2B). Ladino clover production peaked near 2,900 kg/ha the first year and then dropped to 1,000 to 1,700 kg/ha during their second year of perennial growth (Fig. 2B). Ladino clovers exhibited variable growth (range 20 to 1,400 kg/ha per clipping) during summers. Ladino clovers also were preferred from early to mid-June as warm-season forages were establishing and in late September 1990 once warm-season forages had matured. Greatest use of ladino clovers in spring occurred when they were greater in CP (range 19% to 23%; Fig. 3B) than all other forages and lower in NDF (range 25% to 33%) than most other forages. While peak production and use of ladino clovers was high compared with other forages, it occurred during spring green-up when browse was plentiful and succulent. At that time, deer shifted most of their grazing pressure to volunteer vegetation even though ladino clover forage was available. No overall differences in forage production, CP, or NDF were detected among ladino clover varieties.

Deer highly used red clover from May through September (Fig. 1A), paralleling its peak production (Fig. 2A). Red clover produced forage from March through September 1991, peaking near 1,900 kg/ha in July. At that time, red clover contained 15% to 23% CP (Fig. 3A) and 33% to 50% NDF. Red clover tended to out-produce ladino clovers during summer, but the difference was not significant ($P > 0.05$). The decreased sample size (2) of red clover may have masked differences in production among red and ladino clovers during that time. Red clover was used approximately 4 times as much as ladino clovers from late July to mid-August 1991, but the difference was not significant ($P = 0.052$). Red clover was greater ($P = 0.007$) in mean observations/minute than ladino clovers from late August to mid-September. Use of red clover was strong due to its ability to produce forage during late summer when ladino clovers were stressed and other cool-season forages were dead.

During the 1990 warm season, soybean was used throughout summer (Fig. 1C). The only differences in mean observations/minute detected among warm-season forages were from mid-June to mid-July and from late July to late August when soybean was used more ($P = 0.0002$) than any other forage. During that time, soybean was producing abundant forage (range 1,575 to 2,600 kg/ha; Fig. 2C), contained 20% to 25% CP (Fig. 3C) and 28% to 33% NDF.

Velvetbean was the second most used forage in mid-June to mid-July (Fig. 1C). During that period, velvetbean was experiencing rapid growth as it approached its peak production in July (1,750 kg/ha; Fig. 2C), had the highest CP content (27%; Fig. 3C) of any forage, and contained 32% NDF. From late July to late August, deer highly used jointvetch and Quail Haven® soybean (Fig. 1C). Both of these forages were rapidly producing forage at that time (1,700 and 1,950 kg/ha, respectively; Fig. 2C). Jointvetch had the highest CP content (24%;

Fig. 3C) and lowest ($P < 0.0001$) NDF content (26%) of all forages during late July to late August. Quail Haven® soybean also had 1 of the highest CP contents (20%; Fig. 3C) and contained 31% NDF that same period. Quail Haven® soybean had high use during late August to early October (Fig. 1C). At that time, it was high in production (2,500 kg/ha; Fig. 2C), and contained 18% CP (Fig. 3C) and 34% NDF.

Catjang pea and Combine cowpea peaked in production from mid-June to late August (range 1,450 to 2,750 kg/ha per clipping; Fig. 2C), but most of their use occurred as they were decreasing production and forming seed pods, rather than increasing or peaking in growth (Fig. 1C). Their non-typical use occurred as they were decreasing in CP (range 18% to 19%; Fig. 3C) and increasing in NDF (range 29% to 40%). Observation revealed deer were feeding on seed pods of the peas more than on foliage; however, peas were the least used of all forages throughout summer.

Discussion

Many studies have used captive or tame deer to study deer food habits and assumed similar food choice between tame and wild deer (McMahan 1964, Healy 1971, Stormer and Bauer 1980, Crawford 1982). Most studies have used a few (1 to 3) tame deer to determine food habits for deer populations in general. Because individual preferences within a small sample of animals might bias results, we used 10 deer to help control this bias. It is our opinion that because captive deer had never fed on planted forages before, they were not biased towards certain forages, a behavior that might be exhibited by wild deer.

Caution should be used when explaining animal preference because it is based on many factors including forage palatability, a complex phenomenon determined by animal, plant, and environmental variables (Heady 1964, Marten 1978). Many factors contributed to selections made by our deer. Only trends regarding production and nutritional content are highlighted to help explain deer preference. In our study, animal interactions did not affect preference; deer of different age and sex classes fed together and did not prevent each other from feeding on a particular plot. Restricting observation periods to 15–30 minutes and withholding food prior to release on the plots helped to ensure feeding was the primary activity. Limited grazing time reduced the effect use can have on forage production, forage palatability, and plant selection.

Statistical overlap occurred among most means for each observation period. Experimental error associated with the observational method was high (coefficient of variation ranged 112% to 412% among observation periods), thereby preventing further statistical separation of means. However, by examining mean observations/minute of each forage and its subsequent production and nutritional content during observation periods, trends are evident regarding relative deer use of forages tested.

Deer use obviously was related to forage productivity. Forages typically had specific times of the year of maximal production, and these were times deer most often used them. Our data showed that timing of forage production can be more important than cumulative seasonal production. Furthermore, amount of forage production not only depends on forage species or variety, but perhaps more importantly on site characteristics and weather conditions which differ among areas. Forage varieties adapted to specific areas or soil types should be selected for planting. Differences among varieties of the same forage species regarding deer preference may exist, but the only varieties tested were among ladino clovers and soybeans.

Nutritional qualities (CP and NDF) of plants may help explain forage choice by deer. Forages evaluated in this test exceeded minimum CP requirements of deer during times when most deer use occurred. 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 autumn (during lactation and fawn growth in Alabama) and above 15% during winter (when only maintenance levels are required). Ladino clover CP content never fell below 18% (exceeding most all optimal requirements throughout the year), and CP content of all warm-season forages never fell below 17% (supplying more than adequate CP 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 (range 18% to 26%), subterranean clover (range 19% to 26%), and ryegrass (range 15% to 30%) contained sufficient CP levels for growth, development, and maintenance from autumn through winter. Greatest use occurred when forages were near or at their highest CP levels, which coincided with peak production.

Once small grains, ryegrass, annual clovers, and warm-season forages matured, they became more fibrous. Subsequently, deer use shifted to other forages containing less fiber and more protein. 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. Examining NDF and CP values for forages tested showed increases in cell wall structural components and decreases in CP contents as plants matured.

Few overall differences existed among nutritional quality of forages tested because all forages easily met nutritional requirements of deer during times when most use of the forages occurred. This implies that timing of production and deer preference may be more important than nutritional quality when evaluating individual forages. Because nutritional content of native forages often does not meet nutritional demands of deer in many areas of the Southeast (Halls and Stransky 1968, Short 1975, Thill and Morris 1983), planted forages could potentially correct this problem. However, planting sufficient area to significantly impact a deer population may be cost prohibitive.

Management Implications

Our data suggest a pattern in captive-deer use of planted forages; deer use increased as forages approached or attained peak production, had high CP levels, and contained relatively low NDF. A "prime" time can be identified for different forage types when they are productive, nutritious, and preferred. This "prime" time falls during a specific period of the year. Thus, forages can be chosen according to management objectives (attracting deer to hunt, supplemental feeding during specific periods, or year round), which dictate when forage is needed (autumn, winter, spring, summer). While deer probably would use most any commonly planted forage, they exhibit temporal preferences when given a choice. Of forages we tested, deer used greatest amounts of small grains from autumn through early winter, ryegrass and crimson clover from winter to early spring, and ladino clovers from spring into summer. Deer used soybeans throughout summer and red clover from late spring to late summer.

Recent popularity in the commercial sale of seed varieties and mixtures for forage plantings for deer has resulted in ineffective and inefficient use of limited management resources. Some commercially packaged seeds are incorrectly promoted to supply abundant, preferred forage for an entire year or season or for times of the year when they are not productive or preferred compared with other planted forages. Contrary to some producer's claims, no single forage was identified that can provide abundant, nutritious, and preferred forage all year long. Combinations or varieties of forages adapted to the soils of the area of interest can be chosen to maximize forage quantity, quality, and use under different weather or site conditions for extended periods of time. Knowledge of patterns of deer preference might aid landowners in holding deer on their own property or in providing optimal supplemental forage at desired times. Results from this study may be used to develop planting regimes in accordance with management objectives that dictate when abundant, nutritious, and preferred forage is needed.

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