Nutritional Quality and White-tailed Deer Use of Warm-season Forages

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Abstract: We evaluated standing crop, nutritional quality, and use of 3 legumes planted to provide forage during summer, which is a nutritional stress period for white-tailed deer (*Odocoileus virginianus*) in southern Texas. Average standing crop of lablab (*Lablab purpureus*) from 861 to 2,250 kg/ha exceeded ($P \leq 0.05$) that of soybeans (*Glycine max*) and cowpeas (*Vigna sinsensis*). Phosphorus (P) of lablab and cowpeas exceeded ($P \leq 0.05$) soybeans. Lablab crude protein was not different from cowpeas and soybean crude protein, but soybean was greater ($P \leq 0.05$) than cowpea in 1990. In 1991, lablab and cowpea leaf crude protein was greater ($P \leq 0.05$) than soybean during August and October. Percent use of cowpeas and soybeans exceeded ($P \leq 0.05$) percent use of lablab in 1990. In 1991, lablab percent use was similar to that of cowpeas and soybeans during July–September and greater ($P \leq 0.05$) than cowpeas in November. Soybean percent use exceeded ($P \leq 0.05$) that of both other species in October, when only a few scattered soybean plants remained alive. The productivity and drought tolerance of lablab make it a desirable plant for summer food plots in southern Texas.

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White-tailed deer diet composition and quality vary seasonally in south Texas because of the influence of seasonal rainfall distribution and temperature patterns on vegetation dynamics. Precipitation in south Texas is bimodal with peaks in May

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and September (Thompson et al. 1979). Summers are relatively dry with mean daily maximum temperatures >35° C. Most forbs are cool-season plants, and forb standing crop in the western Rio Grande Plains is minimal during hot, dry summers (Barnes et al. 1990). Consequently, deer are primarily browsers during late summer and fall, whereas forbs constitute the bulk of diets in late winter, spring, and early summer (Davis 1951, Meyer et al. 1984). Nutritional value of plants is generally highest in the spring and lowest in the summer and fall (Varner et al. 1977, Meyer et al. 1984). Barnes (1988) concluded that late summer is the most stressful time for deer in south Texas because of low dry matter digestibility, digestible energy, and digestible protein in browse. Meyer et al. (1984) suggested that the low quality of late summer diets may limit white-tailed deer populations in south Texas.

Higginbotham and Kroll (1990) recommended planting food plots to supplement white-tailed deer during nutritional stress periods. Forages must persist during hot, dry weather to be useful for summer food plots in south Texas. Our goal was to determine which of 3 warm-season annual forages was the most persistent, palatable, and nutritious during late summer. Gonzalez (1987) evaluated lablab, a warm-season legume commonly planted in Australia, as an annual forage for cattle in south Texas and reported yields >6,600 kg/ha during late summer. Cowpeas and soybeans are commonly recommended for food plots in Texas (Davis 1990, Higginbotham and Kroll 1990). Our specific objectives were to determine: (1) standing crop, use by deer, crude protein, and P of "Rongai" lablab, "Chinese red" (1990), and "Iron and Clay" (1991) cowpeas and "Padre" (1990) and "Hartz 9190" (1991) soybeans planted in summer food plots, and (2) effects of fertilization with liquid iron on standing crop, use by deer, crude protein, and P of Rongai lablab, Chinese red cowpeas, and Padre soybeans.

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Methods

The study was conducted on El Tecomate Ranch in the western Rio Grande Plains in Starr County about 40 km north of Rio Grande City, Texas. The northern (809-ha) and southern (769-ha) portions of the ranch were separated by a 2.7-m tall woven-wire fence. Food plots were surrounded by a 3.2-m tall woven-wire fence. The top 1.2 m could be lowered to allow deer access to the plots. The soil of the study sites was a Ramadero loam, and the areas surrounding the sites included Ramadero loam and Copita loam soil. Dominant vegetation on the Ramadero loam soil was a honey mesquite (*Prosospis glandulosa*) mixed-brush community (Thompson et al. 1979). Blackbrush acacia (*Acacia rigidula*) and guajillo (*Acacia* *berlandieri*) dominated the Copita soils. Annual average rainfall is 43.2 cm, and average annual temperature is 16.4° C (Natl. Oceanic and Atmos. Admin. 1982).

Deer density in the study area was determined during 1991 by helicopter census (DeYoung 1985). Estimated deer densities on the southern portion of the ranch were 10 deer/km^2 in February and 11 deer/km^2 in November. On the northern portion of the ranch, estimated deer densities were 17 deer/km^2 in February and 11 deer/km^2 in November.

Two experiments were conducted, 1 in 1990 and 1 in 1991. During April 1990, Rongai lablab, Chinese Red cowpeas, and Padre soybeans were planted in the southern portion of El Tecomate Ranch. The site was planted with a 4-row John Deere® flex planter with 0.91-m row spacings at 26–39 seeds/m of row for all 3 forages. The experimental design was a repeated measures split-plot with 3 0.7-ha blocks consisting of fertilizer treatment as whole plots, forage species as sub- plots, and sampling dates as repeated measures. A randomly selected 0.35-ha plot in each 0.7-ha experimental block was fertilized with Pharmacy 434® liquid iron [($CO_2$2 (NH_2-$FeSO_4$-$ZnSO_4$), Tide Chemical Co., Edinburgh, Texas] at 9.35 liters/ha.

In the first experiment, deer use was determined by randomly placing 3 1.2-m diameter, 1.2-m tall circular 5.1- x 2.2-cm welded wire enclosures in each treatment/species/block combination and clipping all plant material within a 0.8-m^2 (0.9- x 0.9-m) quadrat inside and 2 m outside each exclosure to ground level. Plant material was clipped on 24 May 1990, immediately before the fence was lowered to allow deer access to the food plots, and then was clipped again every 4 weeks thereafter for 5 months (May–Sep). Exclosures were rerandomized after each sampling date.

In the second experiment, 2 4.86-ha food plots about 3.2 km apart were planted during April and May 1991, 1 in the north portion and 1 in the south portion of the ranch. Each food plot was planted in a randomized, complete-block design with 4 1.22-ha replications. Each replication contained 0.41 ha of Rongai lablab, 0.41 ha of Hartz 9190 soybeans, and 0.41 ha of Iron and Clay cowpeas. Sites were planted with a 4-row John Deere® flex planter with 0.9-m row spacings at 15–21 seeds/m of row for all 3 forages. The planter was mounted behind a 1070 Case® tractor with a herbicide applicator that sprayed Prowl® (N-(1-ethylpropyl)-3,4-dimethyl, 2-6 dinitrobenesenamine, American Cyanamid, Wayne, N. J.) during planting in a mixture of 0.877 liters/ha of herbicide with 37.9 liters of water. There was a 4-row buffer on either side of each block. Rainfall was recorded with electronic rain gauges at each site.

Soybeans were replanted in the second and third blocks in the south end of the south plot and in all blocks on the north plot on 22 May 1991 because cut worms (*Hadena* spp.) damaged seedlings from the original planting and rain washed soil into furrows, resulting in low seedling emergence. Diazonon® (o,o-Diethl o-(z-isopropyl-4-methyl-6-pyrimidinyl) phosphorohiote, Ciba-Geigy, Greensboro, N. C.) was applied at 4.68 liters/ha to all plots during May to control cut worms.

Five circular welded wire exclosures/forage species similar to those used during 1990 were randomly placed in each species-block combination during 1991.

Sampling was conducted monthly from June (immediately before lowering the fence) to November 1991. Forage (leaves and stems) samples were dried to a constant mass at 40° C, weighed, ground in a Wiley mill with a 1-mm mesh screen, and leaves were analyzed for crude protein (% nitrogen [N] x 6.25) and P. Dry matter determinations were conducted at Texas A&M University-Kingsville, while N and P determinations were conducted at the Soil, Plant, and Water Testing Laboratory, Texas Agricultural Extension Service, Texas A&M University, College Station, Texas. Nitrogen was determined by the ammonia electrode method, P was determined colorimetrically (Parkinson and Allen 1975), and values are reported on a dry matter basis.

We defined use as the difference between the dry mass of forage inside the exclosure and the dry mass of forage outside the exclosure. Percent use was defined as the use of a species (in each replication) divided by dry mass produced inside the exclosures (in each replication) multiplied by 100. Standing crop was defined as the total dry mass of forage inside the exclosures in all 4 replications and both sites.

Percent use, standing crop, crude protein and P data were analyzed by analysis of variance procedures with repeated measures (Milliken and Johnson 1984). Separate analyses were conducted for each sampling date or site if sampling date x species interactions were significant ($P \leq 0.05$). When there was a site x species interaction but the order of species was the same at each site, we averaged across sites and reported main effects. Tukey's HSD test was used to identify significantly different ($P \leq 0.05$) species means for all variables.

Results

Standing crop of lablab, averaged across May–September 1990, was greater ($P \leq 0.05$) than cowpeas and standing crop of both species exceeded ($P \leq 0.05$) that of soybeans (Tables 1, 2). Fertilization with liquid iron did not result in differences in mean forage standing crop, use by deer, crude protein, or P (Table 1). Most soybean plants died by August 1990, and most cowpeas died by September 1990.

In 1991, there was a date x species interaction for standing crop (Table 3). Standing crop of lablab was not significantly different than cowpeas in June and July, but lablab standing crop exceeded ($P \leq 0.05$) cowpeas during August– November (Table 4). Soybean standing crop was less ($P \leq 0.05$) than lablab and cowpea standing crop on all sampling dates, except in September.

Mean monthly percent use of cowpeas and soybeans were similar and percent use of both species exceeded ($P \leq 0.05$) percent use of lablab in 1990 (Tables 1, 2). In 1991, there was a date x species interaction for percent use (Table 3). Only a few, scattered soybean plants remained in October and these were heavily eaten resulting in greater ($P \leq 0.05$) percent use for soybeans than for lablab and cowpeas (Table 4). Lablab was more heavily ($P = 0.03$) eaten than cowpeas in November.

Table 1. Analysis of variance tables for mean standing crop (SC) (kg/ha), mean use (%), crude protein (CP) (%), and phosphous (P) (%) of fertilized (Pharmacy 434® liquid iron at 9.35 liters/ha) and nonfertilized Rongai lablab, Padre soybeans, and Chinese Red cowpeas, El Tecomate Ranch, Starr County, Texas, 1990.

	SC (kg/ha)		Use (%)		CP (%)		P (%)	
Source of variation	df	MS ($X10^3$)	df	MS	df	Ms	df	MS
Replication	2	134	2	232	2	0.2	2	4.4
Treatment (fertilizer)	1	486	1	23	1	0.4	1	0.9
Error (whole plot)	2	666	2	292	2	5.5	2	4.2
Species	2	6,312[a]	2	4,167[a]	2	26.5[b]	2	62.7[a]
Treatment × species	2	214	2	762	2	0.1	2	0.1
Error (sub-plot)	8	167	5	226	8	5.1	8	1.8
Date	4	3,820[a]	2	4,820[a]	2	70.0[a]	2	15.1[a]
Date × replication	8	131	4	71	4	2.1	4	0.2
Date × treatment	4	106	2	216	2	1.1	2	<0.1
Date × replication × treatment	8	149	4	334	4	0.6	4	0.3
Date × species	8	192	4	1,232	4	2.4	4	3.0[a]
Date × treatment × species	8	23	4	240	4	1.3	4	0.1
Error (date)	32	107	10	439	16	1.5	16	0.6

[a] $p \leq 0.05$.
[b] $p < 0.01$.

Table 2. Mean standing crop (kg/ha), use (%), crude protein (%), and phosphorus (%) of Rongai lablab, Padre soybeans, and Chinese Red cowpeas ($N = 6$), El Tecomate Ranch, Starr County, Texas, 1990.

Parameter and month	Lablab	Soybeans	Cowpeas
Mean standing crop (kg/ha)[a]	1,363A[b]	456C	788B
Mean use (%)[c]	9B	46A	31A
Mean crude protein (%)[d]	21AB	21A	19B
Mean phosphorus (%)			
May	0.30A	0.23B	0.30A
Jun	0.26A	0.16B	0.26A
Jul	0.26A	0.14B	0.30A
Aug	0.30A		0.30A
Sep[e]	0.27		

[a] Averaged across May–Sep.
[b] Means in a row not sharing the same letter were significantly ($P \leq 0.05$) different using Tukey's HSD.
[c] Averaged across Jun–Aug.
[d] Averaged across May–Jul.
[e] Lablab was the only forage with adequate mass for analysis.

Table 3. Analysis of variance tables for mean standing crop (SC) (kg/ha), mean use (%), crude protein (CP) (%), and phosphous (P) (%) of Rongai lablab, Hartz 9190 soybeans, and Iron and Clay cowpeas, El Tecomate Ranch, Starr County, Texas, 1991.

	SC (kg/ha)		Use (%)		CP(%)		P(%)	
Source of variation	df	MS ($X10^4$)	df	MS	df	MS	df	MS ($x10^{-3}$)
Site	1	659[b]	1	83	1	10[a]	1	13
Replication × site	6	4	6	806	6	1	6	3
Species × site	2	64[a]	2	806	2	14[a]	2	7[a]
Species	2	1,370[b]	2	2,316	2	24[b]	2	48[b]
Error (whole plot)	12	12	8	806	7	2	7	1
Date	4	558[b]	3	6,090[b]	4	118[b]	4	14[b]
Date × site	4	93[b]	3	469	4	6	4	2
Date × site × replication	24	10	18	606	24	4	24	1
Date × site × species	8	9	6	693	8	2	8	1
Date × species	8	30[a]	6	1,486[b]	8	23[b]	8	5[b]
Error (date)	48	11	24	361	28	5	28	1

[a] $p \leq 0.05$.
[b] $p < 0.01$.

Averaged across May–July sampling dates in 1990, lablab crude protein did not differ from cowpea and soybean, but soybeans had greater ($P \leq 0.05$) crude protein than cowpeas (Tables 1, 2). In August 1990, lablab crude protein ($\bar{x} = 20\%$, SE = 0.89) exceeded ($P = 0.03$) cowpeas ($\bar{x} = 17\%$, SE = 0.55). Crude protein of lablab was 17% (SE = 0.46) in September. The date x species interaction for crude protein was significant in 1991 (Table 3). In 1991, soybeans had greater ($P \leq 0.05$) leaf crude protein than the other species in June and the 3 species were not different in July (Table 4). During September, soybean leaf was lower ($P \leq 0.05$) than cowpea leaf crude protein. Soybean leaf was lower ($P \leq 0.05$) than both lablab and cowpea leaf crude protein during August and October.

Lablab and cowpeas had greater ($P \leq 0.05$) P than soybeans during 1990 and 1991 (Tables 1, 2, 3, and 4). There were significant ($P < 0.003$, $P = 0.001$) site x species interactions in June and August 1991, respectively. Lablab leaf P in June and August ($N = 4$, $\bar{x} = 0.41\%$, SE = 0.01; $\bar{x} = 0.34\%$, SE = 0.01, respectively) and cowpea leaf P ($\bar{x} = 0.43\%$, SE = 0.03; $\bar{x} = 0.34\%$, SE = 0.02, respectively) were not significantly different ($P > 0.5$), and soybean leaf P ($\bar{x} = 0.31\%$, SE = 0.01; $\bar{x} = 0.15\%$, SE = 0.01, respectively) was lower ($P \leq 0.05$ than both lablab and cowpea leaf P on El Tecomate North. In June, soybean leaf P ($\bar{x} = 0.30\%$, SE = 0.01) was similar to lablab ($\bar{x} = 0.29\%$, SE = 0.01) and cowpea ($\bar{x} = 0.35\%$, SE = 0.02) on El Tecomate South. In August, cowpea ($\bar{x} = 0.33\%$, SE = 0.01), lablab ($\bar{x} = 0.29\%$, SE = 0.01), and soybean leaf P ($\bar{x} = 0.19\%$, SE = 0.01) each differed significantly ($P \leq 0.05$).

Table 4. Temporal trends in standing crop (kg/ha) ($N = 8$), mean use (%), mean crude protein (%), and mean phosphorus (%) of Rongai Lablab, Hartz 9190 soybean, and Iron and Clay cowpea leaves, El Tecomate Ranch, Starr County, Texas, 1991. November mean use, crude protein, and phosphorus data were analyzed seperately because soybean mass was insufficient for analysis.

Parameter and month	Lablab	Soybeans	Cowpeas
Mean standing crop (kg/ha)			
Jun	980A[a]	214B	750A
Jul	2,250A	839B	2,006A
Aug	1,835A	411C	1,170B
Sep	1,170A	115B	484B
Oct	1,206A	34C	593B
Nov	861A	0C	423B
Mean use (%)			
Jul	4A	-13A	5A
Aug	9A	-13A	9A
Sep	19A	36A[b]	35A
Oct	18B	99A[b]	22B
Nov	40A		0B
Mean crude protein (%)			
Jun	28B	32A	27B
Jul	24A	25A	25A
Aug	24A	18B	25A
Sep	21AB	18B[b]	24A
Oct	25A	21B[c]	26A
Nov	22		22
Mean phosphorus (%)			
Jun[d]	0.35	0.31	0.39
Jul	0.34A	0.30B	0.36A
Aug[d]	0.31	0.17	0.34
Sep	0.35A	0.16B[b]	0.35A
Oct	0.37A	0.26B[c]	0.35A
Nov	0.31A		0.29A

[a] Means in a row not sharing the same letter were significantly ($P \leq 0.05$) different using Tukey's HSD.
[b] $N = 6$.
[c] $N = 3$.
[d] Site × species interaction was significant ($P \leq 0.05$) and seperate analyses were conducted for each site.

Discussion

Lablab and Iron and Clay cowpeas were palatable to deer and persisted during the late summer in southern Texas on sites that received rainfall 6.7 cm (El Tecomate North) and 15.2 cm (El Tecomate South) below the annual average. Soybeans were less tolerant of heat and dry weather than lablab and cowpeas, and soybean yield was reduced during 1991 by white-flies (*Aleyrodes* spp.). Susceptibility to damage by white-flies may limit usefulness of soybeans as a summer food-plot species in the lower Rio Grande Valley. Lack of use of soybeans by deer during July and August 1991 possibly resulted because white-flies left a residue on the leaves. Lablab and cowpeas appeared less susceptible to damage by white-flies.

Crude protein of lablab, cowpeas, and soybeans were greater than those reported for forbs (9.2% to 18.5%) eaten by deer in south Texas during summer (Varner et al. 1977). Because of their high crude protein, availability of food plots containing these forages during summer could increase crude protein of deer diets.

Site x species interactions for P and crude protein in 1991 possibly resulted in part from differences in soil fertility and rainfall between sites. On El Tecomate North, soil P ($\bar{x}$ = 196 *u*g/ml, SE = 17.9) in the upper 15 cm was greater than soil P ($\bar{x}$ = 71 *u*g/ml, SE = 14) on El Tecomate South (T. E. Fulbright, Caesar Kleberg Wild. Res. Inst. unpubl. data, 1991). Rainfall was 3.2 cm greater on El Tecomate North than on El Tecomate South during July and August 1991.

Conclusions

Lablab and Iron and Clay cowpeas appeared better adapted than soybeans for summer food plots in southern Texas. The productivity of lablab relative to cowpeas and the ability of the plant to tolerate long periods of dry weather (Fribourg et al. 1984) make it a desirable plant for summer food plots in drought-prone southern Texas. The equal (1991) or greater (1990) use of cowpeas than of lablab may justify including cowpeas in summer food plots for white-tailed deer.

The effects of summer food plots on deer nutrition in southern Texas are unknown. In Louisiana, cool-season and warm-season food plots did not result in increased body size or antler development in white-tailed deer (Johnson and Dancak 1993). In a separate study in poorer quality habitat with cattle present, food plots resulted in greater body and antler size of yearling white-tailed deer (Johnson et al. 1987). These studies were conducted in high-rainfall habitats where availability of moisture is normally not limiting to plant growth. In our study area, the normal precipitation deficiency (mean annual rainfall—mean potential evapotranspiration) is -91 cm (Texas Agric. Ext. Serv. and Texas Agric. Exp. Sta., not dated) and herbaceous plants are often not available to deer in summer (Barnes et al. 1990). Because of the potential differences in responses of deer to food plots in dissimilar habitats, research on the effects of warm-season food plots on white-tailed deer nutrition in the semi-arid environment of south Texas is warranted.

Literature Cited

Barnes, T. G. 1988. Digestion dynamics in white-tailed deer. Ph.D. Thesis, Texas A&M Univ., College Station. 153pp.

———, L. W. Varner, L. H. Blankenship, T. J. Fillinger, and S. C. Heineman. 1990. Macro and trace mineral content of selected south Texas deer forages. J. Range Manage. 43:220–223.

Davis, E. 1990. Deer management in the South Texas Plains. Texas Parks and Wildl. Dep., Fed. Aid. Rep. Ser. No. 27. 32pp.

Davis, R. B. 1951. The food habits of white-tailed deer on the cattle stocked, liveoak-mesquite ranges of the King Ranch, as determined by analysis of deer rumen content. M. S. Thesis, Texas A&M College, College Station, 97pp.

DeYoung, C. A. 1985. Accuracy of helicopter surveys of deer in south Texas. Wildl. Soc. Bu. 13:145–149.

Fribourg, H. A., J. R. Overton, W. W. McNeill, E. W. Culvahouse, M. J. Montgomery, M. Smith, R. J. Carlisle, and N. W. Robinson. 1984. Evaluations of the potential of hyacinth bean as an annual warm-season forage in the mid-South. Agron. J. 76: 905–910.

Gonzalez, C. L. 1987. Screening and establishment of forage legumes in south Texas. J. Rio Grande Valley Hort. Soc. 40:39–53.

Higginbotham, B. J. and J. C. Kroll. 1990. Supplemental forage management for East Texas white-tailed deer. Tex. Agric. Ext. Serv., L – 2457. 5 pp.

Johnson, M. D. and K. D. Dancak. 1993. Effects of food plots on white-tailed deer in Kisatchie National Forest. J. Range Manage. 46:110–114.

———, B. W. DeLany, S. P. Lynch, J. A. Zeno, S. R. Schultz, T. W. Keegan, and B. D. Nelson. 1987. Effects of cool-season agronomic forages on white-tailed deer. Wildl. Soc. Bu. 15:330–339.

Meyer, M. W., R. D. Brown, and M. W. Graham. 1984. Protein and energy content of white-tailed deer diets in the Texas Coastal Bend. J. Wildl. Manage. 48:527–534.

Milliken, G. A. and D. E. Johnson. 1984. Analysis of messy data. Van Nostrand Reinhold. New York, N.Y., 473pp.

National Oceanic and Atmospheric Administration. 1982. Monthly normals of temperature, precipitation, and heating and cooling degree days 1951–80: Texas. Dep. Commerce. Washington, D.C. 80pp.

Parkinson, J. A. and S. E. Allen. 1975. A wet oxidation procedure suitable for the determination of nitrogen and mineral nutrients in biological material. Comm. Soil Sci. and Plant Anal. 6:1–11.

Thompson, C. M., R. R. Sanders, and D. Williams 1979. Soil survey of Starr County, Texas. U.S. Dep. Agric., Soil Conserv. Serv., Washington, D. C. 62pp.

Varner, L. W., L. H. Blankenship, and G. W. Lynch. 1977. Seasonal changes in nutritive value of deer food plants in south Texas. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 31:99–106.