SEASONAL CHANGES IN NUTRITIVE VALUE OF DEER FOOD PLANTS IN SOUTH TEXAS[a]

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Abstract: Twenty-six native forage species were collected during each season of the year on the Chaparral Wildlife Management Area in the central portion of the Texas Rio Grande Plain and analyzed for percentage content of crude protein (CP), phosphorus (P) and *in vitro* dry matter digestibility (DMD). Average values for all species during spring, summer, fall and winter were: CP 18.4, 15.4, 16.6 and 17.1; P 0.23, 0.18, 0.19 and 0.19 DMD 61.7, 56.2, 53.3 and 61.1. Average CP of shrubs and forbs was 14 or greater during all seasons of the year, grasses varied from 12.5 in summer to 14.4 in winter, and *Opuntia lindheimeri* ranged from a low of 5.4 in winter to 13.3 in spring. P content varied from a low of 0.08 in *O. lindheimeri* during summer to a high of 0.33 for forbs in winter. Forbs were higher than other plant classes in P during all seasons of the year. *O. lindheimeri* had the highest DMD ($>$ 86.8) of all plants tested. Forbs had higher DMD values during all seasons of the year than shrubs and grasses. These data demonstrate the importance of having a diversity of vegetation on native rangeland to insure adequate nutrient levels for deer during all seasons of the year.

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Diet quality and quantity largely determine the optimum carrying capacity of any white-tailed deer range, since a healthy and productive deer herd depends upon a year-around availability of a sufficient quantity of digestible essential nutrients. However, little or no information is available on the comparative nutritive value of south Texas forage plants that are consumed by deer. The purpose of this research was to evaluate on a seasonal basis the nutritive value of 13 shrub species, 8 forbs, 4 grasses and 1 cactus of the south Texas Rio Grande Plain.

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METHODS

The study area, the Chaparral Wildlife Management Area, consisted of 6,073 ha of rangeland approximately 165 km southwest of San Antonio in the Rio Grande Plain. The area has been administered by the Texas Parks and Wildlife Department since 1969. The climate is moderate with mild winters and hot summers with an annual mean temperature of about 22 C. The mean annual rainfall is 75 cm and has varied from 50 to 117 cm during the period 1969-76.

All forage species sampled are listed in Table 1. Species sampled for analyses were determined from published studies (Chamrad and Box 1968; Everitt 1972; Arnold 1976), from examination of rumen contents of sacrified deer on the Chaparral Area and from U.S.D.A. Soil Conservation Service literature. Sampling was done during the first week of October 1974; January, April and July 1975. Some plant species were not available during all seasons but were sampled when available. Care was taken to clip only the current season's growth or, in the case of the winter collection, that from the previous growing season. Approximately 3 cm of the tips of shrub twigs were clipped.

Samples were oven-dried at 60 C for 48 hr and weighed to obtain dry matter content. They were then ground through a 2 mm screen in a Wiley Mill, Model 4 and stored in air-tight jars. All results presented are on a dry matter basis.

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Table 1. Mean seasonal *in vitro* dry matter digestibility of 26 south Texas deer food plants.[a]

	% of dry matter				
Forage species	*Spring*	*Fall*	*Summer*	*Winter*	*Mean*
A. berlandieri	46.4 e	35.5 ef	38.9 e	41.1 d	40.5
A. greggii	62.2 c	47.3 d	36.7 e	42.0 cd	47.0
A. rigidula	34.1 f	25.6 g	29.0 f	37.0 d	31.4
A. tortuosa	32.9 f	28.0 fg	36.9 e	31.9 e	32.4
Bumelia celastrina	47.9 e	40.3 e	47.0 cd	47.7 c	45.7
C. pallida	71.7 a	73.0 a	73.3 a	75.2 a	73.3
C. obovata	61.4 cd	60.4 b	42.3 de	47.8 c	60.0
C. obtusifolia	47.7 e	50.7 cd	44.4 de	38.8 d	45.4
E. antisyphlitica	66.4 bc	54.4 c	61.2 b	57.5 b	60.4
E. texana	62.4 cd	54.1 c	60.2 b	49.8 c	56.6
P. angustifolia	58.0 d	54.9 c	56.6 c	0.2 b	57.4
S. cuneifolia	61.4 c	55.5 c	56.0 c	58.8 b	57.9
Z. fagara	56.2 d	69.3 a	48.1 d	73.2 a	61.7
Mean	54.5	49.9	48.5	51.0	51.5
Forbs					
A. psilostachya	64.9 c	67.7 b	60.6 b	69.5 c	65.7
A. ramossissimus	68.0 bc	52.4 d	65.4 b	85.3 a	67.8
C. erecta	82.7 a	75.3 a	71.5 a	—	76.5
C. nuecensis	73.0 b	53.2 d	—	81.8 b	69.3
G. pulchella	68.7 bc	60.5 c	68.0 ab	90.7 a	72.0
Hermania texana	74.3 b	66.2 b	64.5 b	—	68.3
P. hysterophorus	57.2 d	65.9 bc	60.8 b	68.4 c	63.0
P. Viscosa	74.5 b	78.6 a	77.9 a	78.7 b	77.4
Mean	70.4	65.0	66.9	79.1	70.0
Grasses					
C. incertus	58.7 a	48.0 ab	57.1 a	54.4 a	54.5
C. cucullata	45.3 b	45.8 b	37.8 b	49.5 a	44.6
P. hallii	59.6 a	50.4 a	37.7 b	49.2 a	49.2
S. macrostachya	47.0 b	46.9 b	43.5 b	51.8 a	47.3
Mean	52.6	47.8	44.0	51.2	48.9
Cactus					
O. lindheimeri	94.8	86.8	86.8	90.5	89.7
Mean of all species	61.2	56.2	55.3	61.1	58.4

[a]Mean's within each season and plant class (i.e. shrubs, forbs, and grasses) followed by unlike letters are different ($P < 0.01$).

Digestion of plant samples was done in a Technician BD-40 block digestor using a modification of Technicon Industrial Method No. 369-759 (1975). Ammonia in the digest was determined using the procedure of Lauber (1976) and percent crude protein (CP) was calculated as percent N x 6.25. A modification of the procedure of Kallner (1975) was used to determine percent phosphorus (P) in the digest.

Percent *in vitro* digestible matter (DMD) was determined using a direct acidification modification (Newman 1972) of the Tlley and Terry (1963) technique. Rumen inoculum was collected from freshly killed white-tailed deer (*Odocoileus virginianus texanus*). Rumen fluid was strained through cheescloth into a pre-warmed (40 C) thermos and was used within an hour of collection. Estimated digestible energy (DE) content of the forages was calculated from DMD using the formula of Rittenhouse et al. (1971).

Data were punched on IBM computer cards and analyzed by analysis of variance and Duncan's Multiple Range Test (Little and Heth 1975) at the Data Processing Center of Texas A&M University.

RESULTS

Dry Matter Digestibility

The average DMD for all plants was greater (P <0.01) in spring and winter than in either summer or fall (Table 1). *O. lindheimeri* had the highest DMD during all seasons of the year with a range of 86.8 in the summer and fall to 94.8 in the spring.

Forbs were more digestible than shrubs or grasses with an overall average DMD of 70.0 compared to 51.5 and 48.9 for shrubs and grasses, respectively. *Commelina erecta* and *Physalis viscosa* had the highest DMD (> 70) during all seasons of the year. The forb species with the lowest DMD for spring, summer, fall and winter, respectively, were *Parthenium hysterophorus* (57.2), *Aphanostephus ramossissimus* (52.4), *P. hysterophorus* (60.8), and *Ambrosia psilostachya* (69.5). Forbs generally were highest in DMD during the winter.

Among shrub species, *Acacia rigidula* and *A. tortuosa* were the lowest in DMD during all seasons of the year with DMD never exceeding 37. The most digestible shrub species was *Celtis pallida,* varying from 71.7 in spring to 75.2 in winter. This species was as digestible or more so than many of the forbs. Shrubs were generally higher in DMD in the spring than in other seasons of the year although the average DMD of all species did not vary greatly during the seasons (54.5, 49.9, 48.5, 51.0 for spring, summer, fall and winter, respectively.

The 4 grass species were highest in DMD (52.6) in spring and lowest in fall (47.8). *Cenchrus incertus* and *Panicum halli* were generally higher in DMD during all seasons than *Chloris cuculatta* or *Setaria macrostachya.* Grasses were the least digestible (48.9) of all plant classes although they were higher in DMD than some selected shrub species, e.g. *A. rigidul, A. tortuosa* or *A. berlandieri.*

Crude Protein

On a seasonal basis mean CP of all species was highest in spring (18.4) lowest in summer (15.4) and intermediate in fall (16.6) and winter (17.1) (Table 2). Although *O. lindheimeri* had the highest DMD of all plants, it had the lowest CP of all plants during the summer (5.6) and winter (5.4) with an average for all 4 seasons of 8.6.

Forbs were highest in CP (21.4) during the winter although only 6 of the 8 species were found during this season. *A. ramossissimus, Gaillardia pulchella* and *Coreopsis nuecensis* were lowest of the forb species in CP (< 12.9) during the spring, summer and fall. Other forb species were generally higher than 15.0 CP during any season they were found. *A. psilostachya* had the highest CP of all forbs in all seasons except winter.

Shrubs were highest in CP during spring (21.5), summer (18.1) and fall (18.5), but were lower than forbs during the winter (16.9 *vs.* 21.4). *C. pallida* had the highest CP content (> 23.5) of all plants tested during all seasons except winter. Even during this season it averaged 19.0 CP. *A. berlandieri* and *Porlieria angustifolia* ranged second and third in CP (> 17.4) among all shrub species in all seasons except winter. A. *greggii* had the highest winter CP (25.4) of all plants tested. *Schaefferia cuneifolia* had the lowest CP content of all shrubs except during spring. Except in a few cases, e.g. *Condalia obovata* in summer and *Ephedra antisyphlitica* in summer and winter, all shrub species contained more than 15.0 CP during any season of the year.

Among the grasses, *S. macrostachya,* had the highest CP during every season and varied from a low of 15.5 in summer to 20.4 in spring. Grasses were highest in CP in fall and winter and were slightly lower in spring and summer. *C. cucullata* had the lowest CP content of all grass species during all seasons except winter.

Phosphorus

The P level of all plants during spring (0.23) was significantly higher (P <0.01) than for summer, fall and winter, which were not different (P < 0.05) from each other (Table 3).

P content of *O. lindheimeri* was extremely low (< 0.09) during summer and winter, and lower in spring and fall than the majority of the other species tested. Its average P content for all 4 seasons was 0.14, the lowest seasonal average of all species.

Forbs were highest in P during spring (0.26) and winter (0.29) and lowest in summer (0.20). *A psilostachya* had the highest P (> 0.27) during all seasons of the year. Forbs with the lowest P content were *G. pulchella* and *P. viscosa* in the spring (0.22); *A. ramossissimus* in the summer (0.16) and fall (0.18); and *P. hysterophorus* in winter (0.22).

P content of shrubs for spring, summer, fall and winter, respectively, was 0.22, 0.15, 0.16 and 0.14. Shrubs with the highest seasonal P contents were *A. greggii* in spring (0.27)

Table 2. Mean seasonal crude protein of 26 south Texas deer food plants[a].

Forage species	% dry matter				
	Spring	*Summer*	*Fall*	*Winter*	*Mean*
Shrubs					
A. berlandieri	27.7 ab	21.4 abc	22.2 abc	21.4 a	23.2
A. greggii	23.3 abc	18.5 abcd	17.9 bc	25.4 a	21.0
A. rigidula	18.2 c	17.4 abcd	19.8 abc	16.5 ab	18.0
A. tortuosa	16.9 c	19.6 bcd	21.6 abc	16.7 ab	18.7
B. celastrina	17.7 c	15.9 abcd	15.1 b	15.6 ab	16.1
C. pallida	28.3 a	23.5 ab	24.5 a	19.0 a	23.8
C. obovata	23.8 abc	14.3 cd	17.1 bc	17.5 ab	18.2
C. obtusifolia	18.0 c	16.7 abcd	16.3 bc	11.7 b	15.7
E. antisyphlitica	16.4 ab	14.5 abc	17.8 a	14.6 b	15.8
E. texana	24.4 abc	20.4 abcd	17.1 bc	17.0 ab	19.7
P. angustifolia	26.1 abc	22.6 ab	18.8 abc	17.4 ab	21.2
S. cuneifolia	18.1 c	14.3 d	14.4 b	10.7 b	14.4
Z. fagara	21.0 bc	15.9 abcd	18.5 abc	16.9 ab	18.1
Mean	21.5	18.1	18.5	16.9	18.8
Forbs					
A. psilostachya	21.6 a	18.5 a	19.8 a	21.1 ab	21.2
A. ramossissimus	11.1 b	9.2 c	10.8 c	19.2 b	12.6
C. erecta	20.0 a	17.0 ab	16.0 a	—	17.7
C. nuecensis	10.3 b	9.9 bc	—	23.8 a	14.7
G. pulchella	12.0 b	10.7 bc	12.9 b	22.5 ab	14.5
H. texana	21.6 a	15.8 abc	16.6 a	—	18.0
P. hysterophorus	17.7 ab	13.8 abc	16.6 a	20.6 ab	17.4
P. viscosa	19.8 a	17.1 ab	19.9 a	21.0 ab	19.5
Mean	16.8	14.0	16.1	21.4	17.1
Grasses					
C. incertus	10.9 b	9.0 a	10.8 b	11.8 b	10.6
C. cucullata	8.7 b	9.6 a	10.0 b	15.1 a	10.9
P. hallii	10.5 b	13.8 a	12.7 a	12.2 a	12.3
S. macrostachya	20.4 a	15.5 a	18.8 a	18.8 a	18.3
Mean	12.5	12.0	13.1	14.4	13.0
Cactus					
O. lindheimeri	13.3	5.6	10.3	5.4	8.6
Mean of all species	18.4	15.4	16.6	17.1	16.9

[a]Means within each season and plant class (i.e. shrubs, forbs and grasses) followed by unlike letters are different ($P < 0.01$).

and winter (0.21), *Eysenhardtia texana* in summer (0.20) and *Zanthoxylum fagara* in fall (0.22). *P. angustifolia* had the lowest P content of all shrub species in all seasons except winter when *A. tortuosa* was lower (0.08). The majority of all shrub species contained less than 0.20 in all seasons of the year except spring.

Average P content of grasses for all seasons was similar to forbs (0.23) *vs.* 0.24). *C. incertus* was highest in P ($>$ 0.30) in all seasons except winter when *C. cucullata* was slightly higher at 0.26 *vs.* 0.24. *C. cucullata* had the lowest P of grass species in spring (0.17) and fall 0.19). *S. macrostachya* was the lowest in P in summer (0.24) and winter 0.16).

DISCUSSION

Generally, Texas forage plants have their highest nutritive value in spring and then gradually decrease in quality through the summer and fall and reach their lowest value in winter (Rector and Huston 1976). In contrast, our study showed that forbs, grasses and shrubs were generally as high in DMD, CP and P during the winter as they were in spring.

The extremely mild winter temperatures in the central and southern Rio Grande Plain of Texas will support almost year-round plant growth when adequate moisture is available. This was the case in this study when late fall and early winter precipitation

Table 3 Mean seasonal phosphorus content of 26 south Texas deer food plants[a].

Forage species	% dry matter Spring	Summer	Fall	Winter	Mean
Shrubs					
A. berlandieri	0.23 ab	0.16 ab	0.15 ab	0.14 ab	0.17
A. greggii	0.27 a	0.12 b	0.13 b	0.21 a	0.18
A. rigidula	0.21 ab	0.14 ab	0.15 ab	0.14 ab	0.16
A. tortuosa	0.18 ab	0.15 ab	0.14 ab	0.08 b	0.14
B. celastrina	0.17 b	0.17 ab	0.08 b	0.13 ab	0.14
C. pallida	0.25 ab	0.17 ab	0.17 ab	0.14 ab	0.18
C. obovata	0.21 ab	0.12 ab	0.17 ab	0.17 a	0.17
C. obtusifolia	0.21 ab	0.16 ab	0.16 ab	0.12 ab	0.16
E. antisyphlitica	0.22 ab	0.14 ab	0.18 ab	0.18 a	).18
E. texana	0.24 ab	0.20 a	0.20 a	0.16 ab	0.20
P. angustifolia	0.18 b	0.10 b	0.09 b	0.10 b	0.12
S. cuneifolia	0.20 ab	0.13 ab	0.15 ab	0.14 ab	0.16
Z. fagara	0.26 ab	0.16 ab	0.22 a	0.17 ab	0.20
Mean	0.22	0.15	0.16	0.14	0.17
Forbs					
A. psilostachya	0.32 a	0.27 a	0.30 a	0.35 a	0.31
A. ramossissimus	0.24 b	0.16 b	0.18 b	0.24 b	0.20
C. erecta	0.27 a	0.20 ab	0.20 b	—	0.23
C. nuecensis	0.26 ab	0.22 ab	—	0.33 a	0.27
G. pulchella	0.22 b	0.19 b	0.25 ab	0.35 a	0.25
H. Texana	0.31 a	0.24 ab	0.20 b	—	0.25
P. hysterophorus	0.25 b	0.18 b	0.21 b	0.22 b	0.21
P. viscosa	0.22 b	0.17 b	0.20 b	0.26 b	0.21
Mean	0.26	0.20	0.22	0.29	0.24
Grasses					
C. incertus	0.31 a	0.34 a	0.30 a	0.24 a	0.30
C. cucullata	0.17 b	0.25 b	0.19 b	0.25 a	0.22
P. hallii	0.25 ab	0.25 b	0.21 b	0.19 a	0.22
S. macrostachya	0.18 b	0.24 b	0.22 b	0.16 a	0.20
Mean	0.22	0.27	0.23	0.21	0.23
Cactus					
O. lindheimeri	0.22	0.08	0.17	0.09	0.14
Mean of all species	0.23	0.18	0.19	0.09	0.20

[a]Means within each season and plant class (i.e. shrubs, forbs and grasses) followed by unlike letters are different ($P < 0.01$).

prior to the January 1975 plant collection was approximately 4 cm above the previous 10-year average. Since precipitation combined with other favorable climactic factors will cause initiation of new plant growth (Ansotegui and Lesperance 1973) which is of higher nutritive value than mature forage (Sullivan 1969) these factors could account for our findings of high levels of CP, P, and DMD during the winter. These data indicate that in the southern Rio Grande Plain, mild winters with average or above precipitation would not be periods of nutritional stress for deer. The stress periods would more likely be in the summer and fall, particularly if they are hot and dry, as they are in many years. Conversely, during cold, dry winters, we would expect forage quality to be at its lowest as occurs in other regions of Texas and the U.S.

Raleigh (1970) and Vavra and Raleigh (1976) have demonstrated the feasibility of coordinating beef cattle management with changes in nutritive value of the range forage resource. This management principle has not been extensively applied to big game until recently (Wallmo 1977) since the nutrient content of deer food plants is generally not known. In addition, definitive information on the nutrient requirements of deer in various physiological states and under various climatic conditions is not readily available. However, there is probably enough published information on deer nutrient requirements or from extrapolation of requirements of similar ruminant species to allow big game managers to make management decisions as more information on nutritive value of deer food plants becomes available.

Food habits of deer in south Texas have been studied on a seasonal (Chamrad and Box 1968; Drawe 1968; Drawe and Box 1968; Everitt and Drawe 1974) and a year-round (Arnold 1976) basis. These studies identified some important south Texas deer food plants which should be analyzed for their nutritive value. On a year-round basis *O. lindheimeri* represented 21.1 percent, shrub species, 32.7 percent, forbs 26.6 percent, and grass 8.3 percent of the diet (Arnold 1976). Pricklypear was used more heavily during the June-September period and again October to January. Forbs received the highest use during spring months (March-May) and shrub species were used intensively all year. Most published studies have indicated that grass makes up a relatively small percentage (usually $<$ 8 percent) of deer diets in south Texas. However, during certain seasons of the year grass may be an important source of nutrients for deer. For example, in our study, grasses as a group contained the highest level of P during the summer and fall (0.27 and 0.23) as compared to forbs (0.20 and 0.22), shrubs (0.15 and 0.16) or *O. lindheimeri* (0.08 and 0.17).

P requirements of white-tailed deer are not well defined. White-tailed bucks will survive on rations containing 0.25 P; however, best antler growth was obtained on rations containing 0.56 P (Magruder et al. 1957). None of the 26 forage species analyzed approached this level of P during any season of the year. Highest P level in this study was 0.35 in *A. psilostachya* and *G. pulchella* during winter. Verne and Ullrey (1972) reported approximately 0.35 P was necessary to support maximum gain, bone-strength and antler development of white-tailed bucks from weaning to 1 year of age. Even this level of P was attained only by the 2 plants previously mentioned. Although deer will probably select a diet higher in nutritive value than that obtained from analysis of clipped forage plants (Longhurst et al. 1968) it is possible that P may be a limiting nutrient in south Texas particularly for maximum antler growth. This possible deficiency would be aggravated by an overpopulation of deer, which occurs in many south Texas counties, or by competition from sheep or goats. In either case, plants with the highest P content (i.e. forbs) are highly preferred by deer and would probably disappear first.

Dietary CP needed for maximum weight gain of fawns from weaning to 100 days after weaning was estimated by Ullrey et al. (1967) to be 13 percent for females and 20 percent for males. French et al. (1956) reported that male fawns need from 13 to 16 CP for optimum growth. Minimum level of CP to maintain rumen function appears to be from 6 to 7 (Dietz 1965; Murphy and Coates 1966). A CP level of 16 probably represents an adequate year-round level in deer diets, recognizing that requirements may fluctuate with changes in climatic factors and/or physiological state (Verme and Ullrey 1972).

In this study, most shrubs and forbs contained CP in amounts that would be adequate during all seasons of the year. In any event, deer in south Texas would likely have available to them forb and/or shrub species considered to be adequate in CP any time during the year. As with phosphorus, poor range condition could result in the disappearance of preferred plants causing a protein deficiency. Except for *S. macrostachya*, the grass species evaluated would have to be considered borderline to inadequate sources of CP for deer. *O. lindheimeri* would also have to be considered a poor source of CP for deer since during the summer and winter its CP content probably would not support rumen function.

Using studies reported by Blaxter (1962), Silver et al. (1969) and others, Moen (1973) concluded that the basal metabolic rate (BMR) of white-tailed deer is approximately 70 kcal of metabolizable energy or 83 kcal of digestible energy (DE) per day per kg of metabolic body weight (W 0.75). Since BMR does not include energy required for gestation, lactation, growth, locomotion or thermo-regulation, Moen (1973) reported that BMR x 2 to 2.3 would more accurately represent energy needs required for these activities. Consequently, the energy requirement for a 50 kg doe would be from 3,120 to 3,590 kcal DE/day and for a 65 kg buck, approximately 3,800 kcal per day. Estimated DE requirements using this formula are probably low and should be considered as minimum when compared to other deer data (Ullrey et al. 1969 and 1970) and published requirements of sheep. A 50 kg ewe requires 2,420 kcal DE/day for maintenance and 4,360 kcal DE/day for lactation (NRC 1975). However, until more definitive information on energy requirements of deer under south Texas conditions become available these estimates can be used in making management decisions on a more objective basis (Wallmo et al. 1977).

DE content of forages (Table 4) in conjunction with the estimated daily forage intake of mule (*O. hemionus*) and/or white-tailed deer of approximately 22 g/kg of body weight (Nichol 1938; Allredge 1974) allows an approximation of actual DE intake of different size deer. Based upon these estimations of DE and intake, the average DE content of the

Table 4. Estimated digestible energy content of four classes of deer food plants in south Texas[a].

	Kcal DE/kg dry matter				
	Spring	*Summer*	*Fall*	*Winter*	*Mean*
Shrubs (x, 13 species)	2,252	2,076	2,023	2,118	2,137
Forbs (x, 8 species)	2,855	2,650	2,722	3,185	2,840
Grasses (x, 4 species)	2,179	1,996	1,852	2,126	2,038
O. lindheimeri	3,782	3,477	3,478	3,619	3,589
Mean	2,506	2,316	2,281	2,502	2,399

[a]Estimated from DMD values (Table 1) using formulas of Rittenhouse et al. (1971).

13 shrub species was not adequate to meet estimated energy requirements of bucks or does. Forb species were adequate in DE for does in spring and winter and for bucks in spring, fall and winter. Unfortunately, during summer when forage quality was at its lowest, does in South Texas are under peak lactational stress and even though they undoubtedly increase intake when lactating, they still probably catabolize body fat to compensate for insufficient energy intake. In addition, during this season, bucks are in a period of maximum antler growth, therefore energy, in addition, to P could be a factor that limits maximum antler growth. Grasses, like shrubs, were apparently an inadequate source of energy for both sexes in all seasons of the year. *O. lindheimeri, C. pallida* and *P. viscosa* were the only plant species that alone would be adequate sources of DE for both sexes throughout the year. The extremely high DE content of *O. lindheimeri* should explain the high utilization of this particular species in all reported deer food habit studies in south Texas. However, this species, while an excellent source of energy, is deficient in both CP and P during all seasons of the year. Other plants must supply CP and P so that deer can make efficient use of the energy available from this species.

These data demonstrate the need for a diversity of plant species in well managed deer habitat. No one plant species or group of species was completely adequate in CP, P and DMD (or DE) during any season of the year. Forbs appear to be good sources of both energy and P, while shrub species appear to be important as CP sources. Grasses may be an important source of P, and *O. lindheimeri* certainly has to be considered an important factor in meeting the energy requirement of white-tailed deer in south Texas.

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