Effects of Planting Date and Nitrogen Fertilization Rate on Selected White-tailed Deer Forages

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Abstract: We studied the effects of 3 planting dates (Sep, Oct, Nov) and 2 fertilization rates (the recommended nitrogen [N], phosphorus [P], and potassium [K] based on soil testing and twice the recommended N, with P and K) on rye (*Secale cereale*), oats (*Avena sativa*), and wheat (*Triticum aestivum*) planted for white-tailed deer (*Odocoileus virginianus*) from 1991 to 1993. Forage plantings established early (September) in the cool season produced the most forage during the season and maximized production during hunting season. Doubling the recommended rate of N fertilization increased forage production and maintained higher crude protein (CP) content throughout forage growth compared to forages fertilized according to soil test recommendations. Calcium (Ca) and P levels generally were unaffected by additional N fertilization.

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The use of forage plantings for white-tailed deer is becoming a widespread habitat management practice to produce quality deer (Johnson et al. 1987; Vanderhoof and Jacobson 1989; Waer et al. 1992, 1994; Feather and Fulbright 1995). Some advocate the use of forage plantings during late autumn and winter because native deer foods are diminishing in quantity and quality during this time. Researchers in the southeastern states have reported native food production ranging from 5 to 1,955 kg/ha in a variety of clearcuts, pine plantations, and mature forests from late-summer to late-winter (Harlow et al. 1975, Hurst 1979, Stransky 1980, Fenwood and Urbston 1984, Wentworth et al. 1985, Blair et al. 1987, Lewis 1989). During this same period, native deer foods across the eastern U.S. are low in crude protein, ranging from 5.4% to 8.3% (Billingsley and Arner 1970, Torgerson and Pfander 1971, Segelquist et al.

1972, Mautz et al. 1976, Fenwood and Urbston 1989). In comparison, planted forages produce 1,058 to 7,113 kg/ha and contain 8% to 30% crude protein (Johnson et al. 1987, Davis et al. 1988, Vanderhoof and Jacobson 1989, Waer et al. 1992). Research focusing on techniques for improving or maximizing production and nutritional content of planted forages is needed. Two possible techniques are adjusting planting dates (date of establishment) and fertilization rates.

Inability to plant on suggested planting dates is an important yield-limiting factor for winter wheat in the mid-South (Shah et al. 1994). Agronomic studies have reported planting before and after the suggested seeding period results in reduced grain yield and winter survival (Fowler 1983, Andrews et al. 1992, Bootsma et al. 1992, Winter and Musick 1993, Shah et al. 1994), and can increase the incidence of disease (i.e., leaf rust), which also decreases yield (Blue et al. 1990). These studies have investigated the effect of planting date with regard to grain yield and not forage production. Timing of forage production is an essential consideration when using agronomic plantings to provide supplemental forge to white-tailed deer and to attract deer for more efficient harvest.

Fertilization of native deer browse increases production and nutritional content, especially nitrogen fertilization to increase forage crude protein (Wood and Lindsey 1967, Bailey 1968, Abell and Gilbert 1974, Anderson et al. 1974, Dyess et al. 1994). Fertilization has been suggested as a way to reduce nutrient deficiencies in forages and to improve deer quality (Lay 1956, Jacobson 1984, Dyess et al. 1994). Therefore, it may be possible to improve the quality of planted forages and deer herds through use of fertilized, supplemental plantings. Fertilization of forage plantings usually is based on soil test recommendations, generalized recommendations from state agencies, or economic feasibility for agricultural situations (Adams et al. 1994). Application of additional N fertilization over recommended rates may improve small-grain forage production and nutritional content. The objectives of this study were to determine the effects of planting date and N fertilization rate on production and nutritional content of supplemental white-tailed deer forages.

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Materials and Methods

We conducted our study at the Piedmont Agricultural Experiment Substation, located 36 km northwest of Auburn in Camp Hill, Alabama. The area falls within the Piedmont physiographic region and is dominated by clay loam and sandy clay loam soils. Test plots were established inside a 152.2 × 16.7 × 2.4-m New Zealand style electrified enclosure to control access by deer. The enclosure was constructed parallel to and approximately 30 m from the woodland edge of a pasture.

We evaluated 3 forages at 3 planting dates and 2 N fertilization rates to test effects of planting date and N fertilization rate on cool-season forage production and nutritional quality. During the 1991–92 cool season, we tested 3 small-grain forages: Wren's Abruzzi rye, Coker 820 oats, and Saluda wheat. We planted forages approximately 1 month apart on 9 September 1991, 8 October 1991, and 8 November 1991. During the 1992–93 cool season, we tested Wren's Abruzzi rye, Coker 820 oats, and Pioneer 2548 wheat, which were planted on 10 September 1992, 9 October 1992, and 19 November 1992. Composite soil samples were taken from study site prior to each cool-season test and analyzed for pH, N, P, and K by the Auburn University Soil Testing Laboratory. For each forage type/planting date combination, 2 fertilization rates (NPK- the recommended rate of N, P, and K based on soil test; and N_2PK- twice the recommended rate of N with the recommended rate of P and K based on soil test) were applied.

We arranged forage plots each season in a randomized block design within the enclosure. All treatment combinations were randomly allocated to a 6.1- × 1.53-m plot space within each of 4 replicates. Adjacent plot spaces were 1.53 m apart. Plots were limed according to soil test recommendations and fertilizer was applied by hand and mechanically tilled into the soil. Regarding N content of fertilizer treatments, ammonium nitrate (34-0-0) was applied at 134.5 kg/ha (120 lbs/A) to N_2PK plots and at 67.25 kg/ha (60 lbs/A) to NPK plots. We established and cultivated forages according to guidelines in the Alabama Planting Guide (Ala. Coop. Ext. Serv. 1988).

Forage within each plot was clipped at 5-week intervals, weather permitting, after planting. During the 1991–92 cool season, we clipped planting date 1 (SEP), planting date 2 (OCT), and planting date 3 (NOV) plots 6, 5, and 4 times, respectively. During the 1992–93 cool season, SEP, OCT, and NOV plots were clipped 5, 4, and 3 times, respectively. For each cool season, a 0.56- × 6.1-m cut was made down the middle of each plot (edges of plots were not sampled in order to minimize edge effect) at a height of 5 cm above ground. We used a push mower with a bag to collect clippings. After determining mass of the clippings (plot green weight), a 200- to 300-g subsample was weighed, placed in a cloth bag, dried in a forage dryer (55–65 C) for 3–5 days, and reweighed to determine percent dry matter (Boyer 1959, Waer et al. 1992). Production values for plots with <5 cm of vegetation were recorded as "trace," and a hand sample (approx. 100 g) was collected for nutritional analyses. Hand-clipped samples from such plots indicated as "trace" equalled approximately 10 kg/ha. After forage samples were clipped, each plot was mowed to a uniform height of approximately 5 cm to simulate grazing effects (forage plantings normally would be kept grazed down by deer) and to facilitate production determination for the next interval.

Production (kg/ha) of each plot was calculated by multiplying total plot green weight/area by percent dry matter of the subsample. Total plot production was the sum of all production values of the plot for the season. Forage subsamples were analyzed by the Auburn University Soil Testing Laboratory for crude protein (CP), calcium (Ca), and P content. We calculated means (dry-mass basis) of forage production estimates and nutritional contents for each treatment combination at each clipping. We compared forage production and nutritional quality at each clipping date by planting date, forage type, and N fertilization rate using a 3×3×2 factorial ANOVA at alpha = 0.05, with Tukey's test used to separate means (SAS Inst. 1987).

Results

Nutritional data were not obtained for clip 2 of 1992–93 SEP plots because subsamples were lost before nutritional analyses could be done. Nutritional data were not acquired for clip 1 of 1992–93 NOV plots because production was inadequate.

There were no significant interactions for the effects of planting date and fertilization rate ($0.31 < F > 1.65$; $P > 0.202$). We found results regarding production and nutritional quality of the oat, wheat, and rye varieties similar to those reported in Waer et al. (1992). Therefore, we chose to report detailed results on effects of planting date and fertilization rate averaged over forage types.

Production

Planting Date. Most forage production by SEP and OCT plots occurred from November to March during the 1991–92 cool season. Total forage production (kg/ha) of SEP plots ($\bar{x}$ = 3,417, SE = 88, N = 24) and OCT plots ($\bar{x}$ = 3,365, SE = 88, N = 24) surpassed ($P < 0.001$) that of NOV plots ($\bar{x}$ = 2,400, SE = 88, N = 24). Forage production by SEP plots (1,190 kg/ha), OCT plots (1,250 kg/ha), and NOV plots (1,146 kg/ha) peaked in March (Fig. 1). Planting date 1 plots produced almost 3 times more forage than OCT plots in November ($P < 0.001$; Table 1). Forage production in SEP and OCT plots was approximately 5.5 and 6 times, respectively, greater than that in NOV plots in December ($P < 0.001$) and about 4 and 4.5 times, respectively, greater in February ($P < 0.001$).

Most production by forages in SEP and OCT plots occurred from November to February during the 1992–93 cool season, with SEP plots being the prominent producers. Planting date 3 plots generally produced trace amounts of forage until February, when production escalated. Total seasonal forage production (kg/ha) of SEP plots ($\bar{x}$ = 3,330, SE = 121, N = 24) exceeded that of OCT plots ($\bar{x}$ = 2,382, SE = 121, N = 24) and NOV plots ($\bar{x}$ = 1,014, SE = 121, N = 24), and forage production in OCT plots exceeded that in NOV plots ($P < 0.001$). Forage production of SEP plots peaked (1,049 kg/ha) in December, forage production of OCT plots peaked (1,125 kg/ha) in February, and forage production of NOV plots peaked (1,232 kg/ha) in March (Fig. 1). Forage production by SEP plots was 4 times greater than that of OCT plots in November and 4.5 times higher in December ($P < 0.001$; Table 2). Sometime during January, OCT plots switched positions with SEP plots and became top producer. During February ($P < 0.001$) and March ($P < 0.001$) OCT plots produced slightly more (1.3 times) forage than SEP plots.

Fertilization Rate. Production by forages in NPK- and N_2PK-fertilized plots increased during the 1991–92 cool season until March, when production began to decrease. Total production (kg/ha) of N_2PK-fertilized forages ($\bar{x}$ = 3,254, SE = 72, N = 36) was 14% greater ($P < 0.001$) than that of NPK-fertilized forages ($\bar{x}$ = 2,867, SE = 72, N = 36). Production by forages in N_2PK-fertilized plots was 25% higher

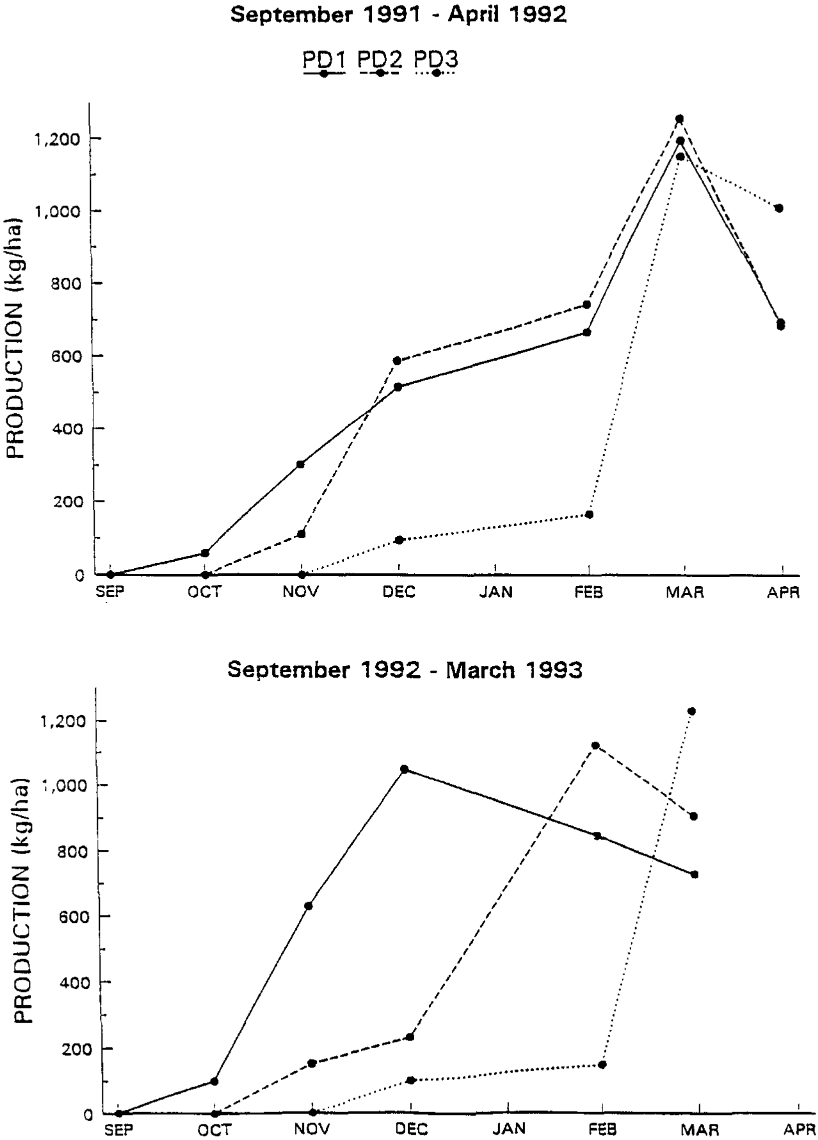

Figure 1. Production (kg/ha) by month of cool-season planting dates (PD1 = September-planted, PD2 = October planted, and PD3 = November planted) averaged over all crops (rye, oats, and wheat) and nitrogen fertilization rates (NPK, N_2PK), Camp Hill, Alabama, 1991–92—1992–93.

Table 1. Cool-season production (kg/ha) estimates for rye, oats, and wheat grouped by planting date and nitrogen rate, Camp Hill, Alabama, 1991–92.

Group	18 Oct			26 Nov			19 Dec			4 Feb			9 Mar			14 Apr		
	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N
Planting Date[a]																		
SEP	59	12	23	302	21	24	513	36	24	664	24	24	1190	43	24	691	43	24
				A[b]			A			A			A			B		
OCT				109	21	24	584	36	24	739	24	24	1250	43	24	683	43	24
				B			A			A			A			B		
NOV							93	37	23	163	24	24	1146	43	24	1003	43	24
							B			B			A			A		
Nitrogen Rate																		
NPK	72	17	12	202	21	24	387	30	35	464	20	36	1134	35	36	734	35	36
	A			A			A			B			B			B		
2NPK	44	18	11	209	21	24	415	30	36	579	20	36	1256	35	36	851	35	36
	A			A			A			A			A			A		

[a]SEP = 9 Sep 1991, OCT = 8 Oct 1991, NOV = 8 Nov 1991.

[b]Means within each column and group that share a letter do not differ ($P \geq 0.05$) based on Tukey's Studentized Range Test.

Table 2. Cool-season production (kg/ha) estimates for rye, oats, and wheat grouped by planting date and nitrogen rate, Camp Hill, Alabama, 1992–93.

	16 Oct			19 Nov			18 Dec			2 Feb			22 Mar		
Group	$\bar{x}$	SE	*N*	$\bar{x}$	SE	*N*	$\bar{x}$	SE	*N*	$\bar{x}$	SE	*N*	$\bar{x}$	SE	*N*
Planting Date[a]															
SEP	100	0	24	631	48	24	1049	43	24	849	47	24	732	33	23
				A[b]			A			B			C		
OCT				153	48	24	232	43	24	1126	47	24	909	33	23
				B			B			A			B		
NOV							100	0	23	150	48		1232	46	15
							B			C		23	A		
Nitrogen Rate															
NPK	100	0	12	387	47	25	430	35	36	649	38	36	789	28	31
	A			A			A			B			B		
2NPK	100	0	12	396	49	24	491	35	36	785	39	35	1058	29	30
	A			A			A			A			A		

[a]SEP = 10 Sep 1992, OCT = 9 Oct 1992, NOV = 19 Nov 1992.

[b]Means within each column and group that share a letter do not differ ($P \geq 0.05$) based on Tukey's Studentized Range Test.

than forages in NPK-fertilized plots during February ($P < 0.001$), 11% higher in March ($P = 0.02$), and 16% higher in April ($P = 0.02$; Table 1).

Forage production by NPK- and N_2PK-fertilized plots steadily increased as the 1992–93 cool season progressed, but N_2PK-fertilized forages increased at a higher rate toward the end of the cool season. Total seasonal production (kg/ha) of forages in N_2PK-fertilized plots ($\bar{x} = 2,423$, SE = 121, $N = 36$) was 18% greater ($P = 0.01$) than forages in NPK-fertilized plots ($\bar{x} = 2061$, SE = 121, $N = 36$) during the 1992–93 cool season. Production by N_2PK-fertilized forages was slightly higher (20%) than that of NPK-fertilized forages during February ($P = 0.03$) and was almost 35% greater in March ($P < 0.001$; Table 2).

Nutritional Quality

Planting Date. Forages contained ≥18% CP for all months during the 1991–92 cool season except April (Table 3). In November, forages in SEP plots contained more CP than forages in OCT plots ($P < 0.001$). Forages in NOV plots contained more CP than forages in SEP and OCT plots during December ($P = 0.004$), February ($P < 0.001$), and March ($P < 0.001$). Forages contained ≥16% CP from October 1992 to March 1993 (Table 4). Levels peaked between 23% and 26% CP from November to December, then gradually declined as forages reached reproductive maturity in early spring. Forages in SEP and OCT plots generally were equal in CP, except during December when CP of forages in OCT plots exceeded ($P < 0.001$) that of SEP plots.

Calcium content of forages ranged from 0.21% to 0.34% during the 1991–92 cool season. Calcium of forages in OCT plots ($\bar{x} = 0.33\%$, SE = 0.01, $N = 24$) was greater than forages in SEP plots ($\bar{x} = 0.30\%$, SE = 0.01, $N = 24$; $P = 0.005$) during November. In March, Ca in SEP- ($\bar{x} = 0.31\%$, SE = 0.01, $N = 24$) and NOV-planted ($\bar{x} = 0.31\%$, SE = 0.01, $N = 24$, respectively) forages exceeded ($P = 0.007$) Ca of forages planted in OCT ($\bar{x} = 0.27\%$, SE = 0.008, $N = 24$). Calcium of forages in SEP plots ($\bar{x} = 0.28\%$, SE = 0.01, $N = 24$) was greater ($P < 0.001$) than forages in OCT ($\bar{x} = 0.21\%$, SE = 0.01, $N = 24$) and NOV plots ($\bar{x} = 0.21\%$, SE = 0.01, $N = 24$) during April. During the 1992–93 cool season, forage Ca ranged from 0.26% to 0.36%. Calcium of forages generally peaked in October and November and decreased during plant senescence. Forage Ca content generally showed no significant differences ($P > 0.09$) by planting date except in December, when OCT-planted forages ($\bar{x} = 0.33\%$, SE = 0.01, $N = 24$) exceeded ($P = 0.004$) SEP-planted forages ($\bar{x} = 0.25\%$, SE = 0.01, $N = 24$).

Forage P content ranged from 0.18% to 0.56% during the 1991–92 cool season. Phosphorus of forages in SEP plots ($\bar{x} = 0.27\%$, SE = 0.01, $N = 24$) exceeded ($P < 0.001$) forage P in OCT plots ($\bar{x} = 0.18\%$, SE = 0.01, $N = 24$) during November and forage P in OCT and NOV plots during December ($\bar{x} = 0.30\%$, SE = 0.01, $N = 24$ vs. $\bar{x} = 0.28\%$, SE = 0.01, $N = 24$ and $\bar{x} = 0.28\%$, SE = 0.01, $N = 23$, respectively; $P = 0.005$). Forage P content of SEP ($\bar{x} = 0.28\%$, SE = 0.01, $N = 24$) and OCT ($\bar{x} = 0.28\%$, SE = 0.01, $N = 24$) plots was greater than that in NOV plots ($\bar{x} = 0.26\%$, SE = 0.01, $N = 24$) in March ($P = 0.003$), and P of forages in OCT plots ($\bar{x} = 0.56\%$, SE = 0.19, $N = 24$) was greater ($P = 0.03$) than that in NOV plots ($\bar{x} = 0.49\%$, SE = 0.19, $N =$

Table 3. Crude protein content (%) of rye, oats, and wheat grouped by planting date and nitrogen rate, Camp Hill, Alabama, 1991–92.

Group	18 Oct			26 Nov			19 Dec			4 Feb			9 Mar			14 Apr		
	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N
Planting Date[a]																		
SEP	19	0.8	23	24	0.5	24	26	0.3	24	26	0.4	24	21	0.5	24	15	0.3	24
				A[b]			B			B			B			A		
OCT				21	0.5	24	26	0.3	24	26	0.4	24	22	0.5	24	16	0.3	24
				B			B			B			B			A		
NOV							28	0.4	23	28	0.4	24	24	0.5	24	16	0.3	24
							A			A			A			A		
Nitrogen Rate																		
NPK	18	1.2	12	23	0.5	24	27	0.3	35	25	0.3	36	20	0.5	36	14	0.3	36
	A			A			A			B			B			B		
2NPK	20	1.2	11	22	0.5	24	27	0.3	36	29	0.3	36	24	0.5	36	17	0.3	36
	A			A			A			A			A			A		

[a]SEP = 9 Sep 1991, OCT = 8 Oct 1991, NOV = 8 Nov 1991.

[b]Means within each column and group that share aletter do not differ ($P \geq 0.05$) based on Tukey's Studentized Range Test.

Table 4. Crude protein content (%) of rye, oats, and wheat grouped by planting date and nitrogen rate, Camp Hill, Alabama, 1992–93.

	16 Oct			19 Nov			18 Dec			2 Feb			22 Mar		
Group	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N	$\bar{x}$	SE	N
Planting Date[a]															
SEP	19	0.4	24	[b]			23 B[c]	0.5	24	20 B	0.4	24	17 B	0.4	23
OCT				26	0.6	24	26 A	0.5	24	21 B	0.4	24	16 B	0.4	22
NOV										24 A	0.4	23	19 A	0.4	15
Nitrogen Rate															
NPK	19 A	0.6	12	27 A	0.8	12	24 A	0.5	24	21 B	0.3	36	17 B	0.3	31
2NPK	19 A	0.6	12	25 A	0.8	12	25 A	0.5	24	22 A	0.3	35	18 A	0.3	30

[a] SEP = 10 Sep 1992, OCT = 9 Oct 1992, NOV = 19 Nov 1992.

[b] Subsamples for nutritional analyses were lost.

[c] Means within each column and group that share a letter do not differ ($P \geq 0.05$) based on Tukey's Studentized Range Test.

24) during April. During the 1992–93 cool season, forage P ranged from 0.26% to 0.33%, reaching a peak by December and gradually decreasing as forages matured. Phosphorus of SEP-planted forages ($\bar{x}$ = 0.31%, SE = 0.01%, N = 24) was greater (P = 0.02) than OCT-planted forages ($\bar{x}$ = 0.29%, SE = 0.01%, N = 24) during December.

Fertilization Rate. Forages exceeded 17% CP for all months during the 1991–92 cool season, except for the NPK rate during April (Table 3). In February and March, forages in N_2PK plots contained 4% more CP than NPK plots (P < 0.001). During the 1992–93 cool season, CP levels of forages ranged from 17% to 27% and peaked in November (Table 4). Forages in N_2PK-fertilized plots maintained higher CP content and CP content decreased at a slower rate than forages in NPK-fertilized plots. During February (P < 0.001) and March (P = 0.002), N_2PK-fertilized forages contained slightly more CP than NPK-fertilized forages.

Calcium of forages in N_2PK-fertilized plots exceeded that of forages in NPK-fertilized plots during March ($\bar{x}$ = 0.32%, SE = 0.01, N = 36 vs. $\bar{x}$ = 0.27%, SE = 0.01, N = 36; P < 0.001) and April ($\bar{x}$ = 0.25%, SE = 0.01, N = 36 vs. $\bar{x}$ = 0.21%, SE = 0.01, N = 36; P = 0.0004). During the 1992–93 cool season, forage Ca generally was unaffected by NPK and N_2PK fertilization, except during February (P < 0.001) and March (P < 0.001) when forages in N_2PK-fertilized plots ($\bar{x}$ = 0.29%, SE = 0.01, N = 3 and $\bar{x}$ = 0.33%, SE = 0.01, N = 31, respectively) contained more Ca than forages in NPK-fertilized plots ($\bar{x}$ = 0.27%, SE = 0.01, N = 36 and $\bar{x}$ = 0.29%, SE = 0.01, N = 30, respectively).

Forage P ranged from 0.18% to 0.54% during the 1991–92 cool season, peaking in April. Phosphorus of N_2PK-fertilized forages ($\bar{x}$ = 0.26%, SE = 0.01, N = 36) exceeded that of NPK-fertilized forages ($\bar{x}$ = 0.25%, SE = 0.01, N = 36) during February (P = 0.02). Forage P remained equal between fertilization rates and ranged from 0.22% to 0.36% during 1992–93 cool season. Phosphorus of forages peaked in November and gradually decreased, as forages matured, to a low in March. In March, NPK-fertilized forages ($\bar{x}$ = 0.23%, SE < 0.01, N = 30) contained more P than N_2PK-fertilized forages ($\bar{x}$ = 0.22%, SE < 0.01, N = 31; P = 0.04).

Discussion

Timing of forage production was influenced by planting date (Fig. 1). Production of SEP plots was concentrated from November through March, encompassing most deer hunting seasons and the late autumn-winter stress period experienced by white-tailed deer (Lay 1956, Short 1975). Majority of production by OCT plots occurred from December through March, encompassing part of most deer hunting seasons and the late autumn-winter stress period. Most production of NOV plots did not occur until February and March, after hunting season closes. Although OCT and NOV plots generally produced more forage than SEP plots from March through April, the majority of their production occurred during onset of spring green-up when high-quality, native vegetation becomes available to deer. The earlier planting date of SEP plots allowed the plots to produce more forage than OCT or NOV plots over a longer period of time (6 months). Establishing forge plantings late in the cool season probably is inefficient to landowners, hunting clubs, and state agencies who use forage plots as a management strategy to attract deer for more efficient harvest.

Fertilization of deer browse significantly increases production over non-fertilized deer browse (Thomas et al. 1964, Miller 1968, Dyess et al. 1994). We found that forages fertilized with N_2PK produced 14% more forage than NPK fertilized forages during the 1991–92 cool season and 18% more forage during the 1992–93 cool season. Doubling the N recommendation based on soil testing increased production of forage plantings by an average of 375 kg/ha.

Feasibility of additional N fertilization depends on budgets of state wildlife agencies, landowners, and hunting clubs, availability of openings for use as forage plots, and deer densities. Double-fertilized plots produced an average of 16%, or 435 kg/ha, more forage over NPK plots at an additional cost of $19.27/ha. On areas where establishment of forage plantings is limited by availability of cleared openings and deer densities are high, additional N fertilization can be an efficient, economical alternative to creating costly additional openings. For example, by fertilizing 3.5 ha of supplemental plantings with 67.25 kg/ha of additional N, at a cost of $67.44, the same amount of forage can be produced as from creating and establishing a new, 1-ha planting at a fraction of the cost. This technique may not be an alternative in areas where deer densities are low and the extra fertilization may produce more forage than can be consumed by deer before senescence decreases palatability. On the other hand, this technique may be beneficial to hunting clubs or state agencies leasing timber industry lands because they are often limited by space available for forage plantings. These factors must be considered by landowners, land managers, and biologists in determining whether this technique will benefit their objectives. In either case, forage plantings should be strategically located to maximize availability to the deer herd because deer do not shift their home range in the presence of forage plantings (Carlock et al. 1993, Vanderhoof and Jacobsen 1993).

During autumn and winter, most native vegetation is deficient in phosphorous and protein (Lay 1956, Halls and Stransky 1968, Short and Newsom 1969). Throughout autumn and winter, CP levels of forages used in our tests during both cool seasons exceeded 18%. This level provides ample nutrition for adult deer during the cool season when only maintenance levels (6%–7% CP) are needed, and falls within the CP range needed by young growing deer and fawns (13%–20%; French et al. 1956, McEwen et al. 1957, Ullrey et al. 1967). Forages fertilized with N_2PK retained higher CP levels than NPK-fertilized forges during winter. As forages planted for deer mature, CP and digestibility decreases and neutral detergent fiber increases, possibly decreasing palatability (Waer et al. 1992). Therefore, it may be possible to increase palatability and digestibility by increasing the N component of recommended fertilization rates.

During both cool seasons, forages contained adequate levels of P to meet minimum requirements of deer (0.14%–0.19%; Grasman and Hellgren 1993), but contained less than the minimum requirements for Ca (0.40%–0.64%; Ullrey 1981). Several physiological factors can be affected when deer do not meet the minimum Ca requirement. Deer receiving Ca levels below the minimum requirement exhibit smaller weight gains, weaker bone structure, and lower specific gravity in antlers (Ullrey et al. 1973). In addition, Ca required for antler ossification is often derived from the skeleton and the diet (Meister 1956). Therefore, it is important to provide forages containing adequate levels of Ca so deer may replenish Ca that was derived from bone tissue for antler growth, and promote adequate and normal body growth, bone development, and antler formation. Nitrogen fertilization generally had little effect on forage mineral content.

Fertilizing forage plantings with higher-than-recommended N rates has potential advantages. The increased forage production and CP content derived from additional N fertilization could help alleviate problems experienced with quality deer management. Nutrition directly influences antler development (Ullrey 1981) and body weight (Jacobson et al. 1977, Jacobson 1984). As early as November, deer may be consuming forages deficient in nutrients and energy (Short 1975). This is important in areas where fawns are born late in the season. Protein deficiencies in newborn fawns can result in increased mortality, stunted growth, and delayed antler formation from malnutrition (McEwen et al. 1957, Verme 1962, Murphy and Coates 1966, Short and Newsom 1969). In addition, does require an abundance of nutritious forage during lactation and to replenish body reserves after lactation (Short and Newsom 1969). Providing a source of high-quality forage may facilitate adequate development of fawns from autumn through winter and improve body and antler development of adult deer from spring through summer.

Management Implications

Small grains should be established early in the cool season (Sep in Alabama) to maximize forage production during deer hunting season. Small grains planted early in the cool-season may produce up to 908 kg/ha more forage than small grains established later in the cool season. If forage planting establishment is limited by space, N should be applied at twice the recommended rate based on soil testing. Using a combination of small grains (rye, wheat, and oats) guards against poor production of a single forage type during unfavorable conditions and provides a variety of nutritious and productive forage. Soil tests should be made prior to planting establishment on 2-year intervals. Planting sites should be limed according to soil test recommendations to maintain soil pH at levels allowing forages to maximize nutrient uptake.

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