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Influence of Prairie Dogs on Vegetation in Kansas Shortgrass Prairie

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Abstract: We quantified plant species richness, frequency, percent cover and percent bare ground on black-tailed prairie dog colonies and non-colonized areas in southwest Kansas in 1996 and 1997. In 1996 field sampling occurred after 12 months of below-average precipitation, while field sampling in 1997 occurred after 10 months of above-average precipitation. In 1996 prairie dog colonies were characterized by lower percentages of grass cover and higher percentages of forb cover than non-colonized sites, but there was no difference in percent bare ground. In 1997 percent grass cover, forb cover and bare ground was similar for prairie dog colonies and non-colonized areas. A preliminary analysis indicates that plant species richness of prairie dog colonies was similar to that of non-colonized areas. In 1996 four perennial grasses, two perennial forbs and one annual forb differed in frequency among the treatments. In 1997 seven perennial grasses, seven perennial forbs, six annual or biennial forbs and one annual grass differed in frequency among the treatments.

INTRODUCTION

A substantial portion of the research on black-tailed prairie dog *(Cynomys ludovicianus)* ecosystems has been conducted in a limited area of the Great Plains, namely the mixed-grass region of South Dakota (see Whicker and Detling 1988 for review), but the dynamics of prairie dog ecosystems in that bioregion may not be duplicated in areas with different climatic conditions and characteristic plant communities. There is a need to clarify how the dynamics of prairie dog ecosystems differ between bioregions. Further clarification is also needed on whether prairie dog ecosystems are a unique and essential community type for many species, or if prairie dog ecosystems are merely locations where biological components of grasslands assume altered levels of distribution and abundance. Here we report preliminary results of vegetation research that was conducted as part of a larger two-year study of the bird, plant, herpetile and insect diversity present at black-tailed prairie dog colonies and non-colonized areas in a shortgrass region of southwest Kansas. The species specific results we present here are limited to those species for which a significant difference was found among treatments. Identification of all specimens collected during sampling for this study has not been completed, and analysis of results will continue into the future. However, we believe these preliminary results are useful in understanding the influence of prairie dogs on vegetation in the shortgrass region of southwest Kansas.

STUDY SITE AND METHODS

Study sites were located at Cimarron National Grassland and adjacent private land in Morton County, southwest Kansas, USA. Cimarron National Grassland comprises more than 43,700 ha of land administered by the U.S. Forest Service. The majority of this land is characterized by a cover of perennial grasses and is utilized for cattle grazing. Most of the surrounding private land is utilized for the production of annual crops, though some areas remain in perennial grass cover and are used for cattle grazing. Study sites occupied areas with silty loam soils and slopes of 0 to 6%. Precipitation recorded at the Elkhart weather station in Morton County during the twelve months preceding the 1996 sampling period was 10.4 cm below the long-term mean of 44.9 cm. Precipitation during the twelve months preceding the 1997 sampling period was 23.21 cm above the long-term mean.

In 1996 eight of the largest prairie dog colonies and five non-colonized sites were selected for study. The criterion used to select non-colonized sites was a visual determination that buffalograss (*Buchloe dactyloides*), blue grama *(Bouteloua gracilis)*, or both species were the dominant grass at the non-colonized sites.

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Additionally, we randomly selected eight non-colonized sites from a list of potential sites that had soil types and slopes that were identical to the soil types and slopes that characterized the prairie dog colonies. We had no prior knowledge of what type of vegetation was growing at the random sites when they were selected. Study sites in 1996 varied in size from 32.4 ha to 64.8 ha. In 1997 thirteen prairie dog colonies, six shortgrass sites and the eight random sites were sampled. Study sites in 1997 varied in size from 6 to 80 ha.

Sampling was conducted using a 0.10 m^2 rectangular plot nested inside a 10.0 m^2 circular plot. Percent cover of live grass, live forbs, and of each species, and percent bare ground were estimated within the 0.10 m^2 plot. Frequency of occurrence of each species was quantified within both the 0.10 m^2 and the 10.0 m^2 plot. In 1996 sampling occurred at 40 randomly located points at each study site. In 1997 the number of randomly located points sampled at each site was proportional to the area of the site, thus only 20 points were sampled at some of the smaller prairie dog colonies while up to 60 points were sampled at some of the larger random sites. Species richness values for 1996 were calculated by determining the total number of species encountered at each study replicate. Species richness values for 1997 were calculated by determining the number of species encountered on a ten-plot basis at each study replicate. Plots within each study replicate were assigned to each group of ten on a random basis.

One-way analysis of variance and the Kruskal-Wallace non-parametric test using Statistical Analysis System procedure (SAS v. 6.11 1996), and a Tukey-type non-parametric multiple comparison (Zar 1996) were used to test for significant differences between the means of treatments. Analyses of data were conducted on species richness, percent cover of live grass and live forbs, percent bare ground, frequency of occurrence in 10.0 m^2 plots and frequency of occurrence in 0.10 m^2 plots. We accepted type I error at $\alpha = 0.05$ for analysis of variance and Kruskal-Wallace tests. A value of $Q > 2.39$ generated by the Tukey-type test indicated significant differences.

RESULTS

Table 1 lists mean ± SE percent cover of live grass, live forbs, percent bare ground, species richness, and the frequency of species in which significant differences were detected between means of treatments at prairie dog colonies, non-colonized shortgrass sites and non-colonized random sites in 1996. In 1996 percent cover of live grass was significantly higher on non-colonized random sites than on prairie dog colonies and percent cover of live forbs was significantly higher on prairie dog colonies than on both the non-colonized shortgrass sites and non-colonized random sites. There was no significant difference in percent bare ground or species richness between prairie dog colonies, non-colonized shortgrass sites and non-colonized random sites. The perennial grass *Aristida purpurea* was more frequently

Table 1. Mean ± SE percent cover of live grass, live forbs, percent bare ground, species richness and frequency of species in which significant differences were detected between means of treatments at prairie dog colonies, non-colonized shortgrass sites and non-colonized random sites in 1996.

	Prairie Dog Colonies (n = 8)	Shortgrass Sites (n =5)	Random Sites (n = 8)	P - value
	mean ± SE	mean ± SE	mean ± SE	
Percent Cover Live Grass	30.71 ± 1.79[a]	32.84 ± 1.23[a]	44.29 ± 2.19[b]	0
Percent Cover Live Forbs	18.31 ± 2.96[a]	7.63 ± 1.47[b]	7.11 ± 1.73[b]	0.004
Percent Bare Ground	30.11 ± 3.17[a]	28.25 1.95[a]	32.1 3.08[a]	0.703
Species Richness	43.63 ± 2.16[a]	43.4 ± 2.27[a]	46.63 ± 2.44[a]	0.555
Frequency in 10.0 m^2 Plots				
Ambrosia confertifolia	4.69 ± 3.00[ab]	10.66 ± 5.24[a]	1.25 ± 0.94[b]	0.034
Astragalus lotiflorus	1.56 ± 1.05[a]	0	9.38 ± 4.38[b]	0.019
Bouteloua curtipendula	0.31 ± 0.31[a]	4.00 ± 2.32[a]	61.88 ± 13.71[b]	0.002
Buchloe dactyloides	68.13 ± 6.96[ab]	87.36 ± 5.17[b]	38.44 ± 14.48[a]	0.048
Euphorbia glyptosperma	84.06 ± 8.00[a]	92.48 ± 5.18[a]	50.00 ± 11.88[b]	0.015
Frequency in 0.10 m^2 Plots				
Aristida purpurea	54.38 ± 8.95[a]	16.08 ± 4.00[b]	27.81 ± 7.70[b]	0.012
Bouteloua curtipendula	0.31 ± 0.31[a]	1.00 ± 0.61[a]	45.31 ± 11.92[b]	0.002
Bouteloua gracilis	53.75 ± 11.87[a]	87.48 ± 4.8[b]	40.00 ± 8.14[a]	0.016

encountered on prairie dog colonies than on non-colonized shortgrass and non-colonized random sites, and the annual forb *Euphorbia glyptosperma* was more frequently encountered on prairie dog colonies than on non-colonized shortgrass sites. The perennial grass *Bouteloua curtipendula* and the perennial forb *Astragalus lotiflorus* were more frequently encountered on non-colonized random sites than on prairie dog colonies, and the perennial grass *Bouteloua gracilis* was more frequently encountered on non-colonized shortgrass sites than on prairie dog colonies. The perennial grasses *Aristida purpurea*, *Bouteloua gracilis* and *Buchloe dactyloides*, the perennial forb *Ambrosia confertifolia*, and the annual forb *Euphorbia glyptosperma* were more frequently encountered on non-colonized shortgrass sites than on non-colonized random sites. The perennial grass *Bouteloua curtipendula* was more frequently encountered on non-colonized random sites than on non-colonized shortgrass sites.

Table 2 lists the mean ± SE percent cover of live grass, live forbs, percent bare ground, species richness and the frequency of species in which significant differences were detected between means of treatments at prairie dog colonies, non-colonized shortgrass sites and non-colonized random sites in 1997. In 1997 there were no significant differences between prairie dog colonies, non-colonized shortgrass sites and non-colonized random sites in the percent cover of live grass, live forbs, percent bare ground and species richness. The perennial grasses *Aristida purpurea*, *Buchloe dactyloides* and *Schedonnardus paniculatus*, and the annual forbs *Euphorbia strictospora*, *Kochia scoparia*, *Plantago patagonica* and *Salsola* sp. were more frequently encountered on prairie dog colonies than on non-colonized random sites. The perennial grass *Schedonnardus paniculatus* and the perennial forb *Sphaeralcea coccinea* were more frequently encountered on prairie dog colonies than on non-colonized shortgrass sites. The perennial grasses *Andropogon saccharoides*, *Bouteloua curtipendula* and *Sporobolus cryptandrus*, the perennial forbs *Asclepias latifolia*, *Convolvulus equitans*, *Gaura coccinea* and *Psoralea tenuiflora*, the biennial forb *Tragopogon dubius*, and the annual forb *Astragalus nuttallianus* were more frequently encountered on the non-colonized random sites than on the prairie dog colonies. The perennial grass *Bouteloua gracilis*, the perennial forb *Oenothera triloba*, the biennial forb *Tragopogon dubius*, and the annual grass *Hordeum pusillum* were more frequently encountered on the non-colonized shortgrass sites than on the prairie dog colonies. The perennial forbs *Asclepias latifolia*, *Convolvulus equitans*, *Gaura coccinea*, *Mirabilis linearis* and *Psoralea tenuiflora* were more frequently encountered on the non-colonized random sites than on the non-colonized shortgrass sites. The perennial grasses *Bouteloua gracilis* and *Buchloe dactyloides*, the perennial forb *Oenothera triloba*, and the annual grass *Hordeum pusillum* were more frequently encountered on the non-colonized shortgrass sites than on the non-colonized random sites.

DISCUSSION

Research on prairie dog ecosystems in South Dakota mixed-grass prairie (Archer et al. 1987, Cid et al. 1991, Coppock et al. 1983) has demonstrated that colonization and habitation by prairie dogs in that region results in a displacement of many perennial grasses, a replacement of mid-height grasses by short-height grasses and an increase in abundance of annual forbs. Archer et al. (1987) and Coppock et al. (1983) both reported higher plant species richness on prairie dog colonies than non-colonized sites, but Cid et al. (1991) reported no difference in plant species richness. Archer et al. (1987) also reported an increase in bare ground after colonization by prairie dogs. Research conducted in the shortgrass region of eastern Colorado found higher species richness on prairie dog colonies than non-colonized areas, while individual species responses to prairie dog colonization that were reported were a reduction of *Bouteloua gracilis*, an increase of *Buchloe dactyloides* and no effect on *Sphaeralcea coccinea* (Bonham and Lerwick 1976).

Our preliminary results support many of the findings of previous studies. In 1997 four of the five species of annual forbs reported here had their highest frequencies on prairie dog colonies. Presumably these annual forbs are responding to increased opportunities for germination and growth that are provided by the soil mounding and spreading that results from the burrowing activities of prairie dogs. Like previous studies, our results indicate several perennial mid-height grasses (*Andropogon saccharoides*, *Bouteloua curtipendula* and *Sporobolus cryptandrus*) that presumably have a low tolerance for frequent clipping and were less frequently encountered on prairie dog colonies than non-colonized sites. Additionally, five of six perennial forbs had their highest frequencies on non-colonized sites when compared to prairie dog colonies. We also suspect that the tendency of these perennial forbs to be more frequently encountered on non-colonized sites demonstrates a low tolerance to frequent repeated clipping by prairie dogs. The two perennial grass species (*Aristida purpurea* in 1996 and 1997 and *Buchloe dactyloides* in 1997) that were more frequently encountered on prairie dog

Table 2. Mean ± SE percent cover of live grass, live forbs, percent bare ground, species richness and frequency of species in which significant differences were detected between means of treatments at prairie dog colonies, non-colonized shortgrass sites and non-colonized random sites in 1997.

	Prairie Dog Colonies (n = 13)	Shortgrass Sites (n = 6)	Random Sites (n = 8)	P - value
	mean ± SE	mean ± SE	mean ± SE	
Percent Cover Live Grass	51.79 ± 3.10[a]	60.01 ± 2.90[a]	51.41 ± 0.68[a]	0.132
Percent Cover Live Forbs	10.56 ± 2.57[a]	6.37 ± 1.4[a]	10.01 ± 1.96[a]	0.329
Percent Bare Ground	32.68 ± 2.61[a]	27.06 ± 4.54[a]	33.44 ± 0.86[a]	0.098
Species Richness	28.45 ± 1.98[a]	27.68 ± 1.20[a]	30.18 ± 1.56[a]	0.698
Frequency in 10.0 m^2 Plots				
Andropogon saccharoides	4.87 ± 3.60[a]	16.3 ± 6.99[ab]	20.03 ± 7.37[b]	0.015
Aristida purpurea	86.99 ± 3.70[a]	72.08 ± 6.99[ab]	56.08 ± 8.86[b]	0.012
Asclepias latifolia	0.88 ± 0.88[a]	0.97 ± 0.62[a]	2.90 ± 21.16[b]	0.017
Bouteloua curtipendula	3.68 ± 2.66[a]	17.60 ± 10.05[ab]	57.55 ± 12.94[b]	0.001
Buchloe dactyloides	65.38 ± 8.23[a]	73.82 6.67[a]	32.1 11.82[b]	0.021
Convolvulus equitans	0.38 ± 0.38[a]	0.53 ± 0.53[a]	3.63 ± 1.37[b]	0.005
Euphorbia strictospora	8.96 ± 2.67[a]	2.60 ± 1.64[ab]	0.20 ± 0.20[b]	0.007
Gaura coccinea	11.08 ± 3.06[a]	6.83 ± 1.91[a]	25.48 ± 4.69[b]	0.006
Hordeum pusillum	14.26 ± 4.30[a]	45.48 ± 11.07[b]	6.79 ± 2.63[a]	0.017
Kochia scoparia	23.25 ± 5.28[a]	9.02 ± 4.27[ab]	2.80 ± 0.75[b]	0.004
Mirabilis linearis	4.71 ± 1.44[ab]	0.55 ± 0.55[b]	6.44 ± 2.12[a]	0.049
Oenothera triloba	3.08 ± 2.30[a]	5.72 ± 1.45[b]	1.26 ± 0.90[a]	0.014
Plantago patagonica	19.12 ± 4.64[a]	20.95 ± 11.01[ab]	3.05 ± 1.25[b]	0.048
Psoralea tenuiflora	11.92 ± 4.38[a]	18.35 ± 8.32[a]	43.81 ± 11.37[b]	0.015
Salsola sp.	10.89 ± 2.57[a]	1.45 ± 1.10[ab]	0.64 ± 0.45[b]	0.015
Schedonnardus paniculatus	66.19 ± 5.66[a]	25.73 ± 6.33[b]	22.48 ± 6.24[b]	0
Sporobolus cryptandrus	10.35 ± 4.40[a]	36.73 ± 10.94[b]	38.11 ± 8.55[b]	0.01
Tragopogon dubius	0.22 ± 0.22[a]	10.28 ± 4.32[b]	7.30 ± 2.73[b]	0.001
Frequency in 0.10 m^2 Plots				
Astragalus nuttallianus	0.22 ± 0.22[a]	0.55 ± 0.55[ab]	2.09 ± 0.82[b]	0.02
Bouteloua gracilis	37.81 ± 9.26[a]	81.00 ± 7.07[b]	41.88 ± 7.68[a]	0.012
Psoralea tenuiflora	0.66 ± 0.66[a]	1.42 ± 1.07[ab]	5.56 ± 3.78[b]	0.046
Sphaeralcea coccinea	35.12 ± 4.63[a]	14.28 ± 2.87[b]	23.94 ± 4.41[ab]	0.017

colonies when compared to non-colonized sites possess morphological adaptations that enable them to avoid or tolerate herbivory: *Aristida purpurea* is protected by an abundance of long, sharp-tipped awns, while *Buchloe dactyloides* is a low growing, stoloniferous species that is highly tolerant of grazing. We encountered *Bouteloua gracilis* more frequently on non-colonized shortgrass sites than on prairie dog colonies. This and our results for the perennial grass *Buchloe dactyloides* are similar to the results obtained by Bonham and Lerwick (1976). Bonham and Lerwick (1976) also reported that even though the perennial forb *Sphaeralcea coccinea* was regularly consumed by prairie dogs at their study site, it was apparently tolerant of this herbivory and did not differ in abundance between colonized and non-colonized sites. Further evidence for a tolerance to herbivory by *Sphaeralcea coccinea* is suggested by the higher frequency of this species in our study in 1997 on prairie dog colonies than on non-colonized shortgrass sites. In contrast to the findings of Archer et al. (1987) in South Dakota and Bonham and Lerwick (1976) in Colorado, we did not find a difference in species richness when prairie dog colonies were compared to non-colonized sites. We also did not find the increased amount of bare ground on prairie dog colonies that Archer et al. (1987) reported.

Our preliminary results and the results of studies in other areas of the Great Plains indicate that prairie dogs influence vegetation in ways that are common among different regions. Our results also demonstrate that the influence of prairie dogs on vegetation can differ between different regions of the Great Plains. We intend to further examine our data in an attempt to identify the influence, or lack of influence, of prairie dogs on species diversity, community similarity, percent cover of individual species, and frequency of occurrence of groups of species such as perennial grasses.

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