Effects of Range Treatment with 2,4-D on Prairie Dog Diet

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Highlight: Two established prairie dog colonies in Montana were studied to determine the effect of range treatment with 2,4-D on prairie dogs' diet. One colony was sprayed with 2,4-D for 2 consecutive years and the other was not treated. There was a significant reduction in foliar cover by forbs and shrubs on the treated colony but no change on the untreated colony. Foliar cover by grass did not change significantly on either area. Prairie dog diet changed significantly from forbs to grass after forb coverage was reduced. Before spraying, prairie dogs ate 73% forbs and 5% grass. Afterward, they ate 9% forbs and 82% grass. The availability of these foods appeared to be responsible for the diet change. Despite the change in diet, the 2,4-D treatment appeared to have little detrimental effect on prairie dogs. They remained in good condition after treatment, as indicated by body weight, and there was no significant difference in prairie dog activity between the treated and untreated colonies. There was considerable variation in diet between the two colonies the first year, with the prairie dogs preferring grass in the untreated colony and forbs in the treated colony. However, in later years preference values were higher for grass than for forbs on both colonies.

Research findings on the diet of black-tailed prairie dogs (*Cynomys ludovicianus*) are divided into two groups. One group contends that forbs form the most important part of the prairie dog diet; the other group contends that grasses are more important. Clements et al. (1940) reported that prairie dogs on mixed prairie ate 15 species of forbs but no grass, signifying that the latter seemed to be a second choice. King (1955) suggested that forbs were among the most important species used for food. However, Kelso (1939) found that grasses comprised 61.6% of the prairie dogs' annual diet. Koford (1958) agreed that grasses formed the most important part of the diet but stated that prairie dogs probably could not survive on grass alone. He suggested that prairie dog populations could be limited by reducing the food supply at some undefined critical period of the year.

Reduction of forbs with herbicides has reduced some rodent populations. Keith et al. (1959) reported an 87% reduction in northern pocket gopher (*Thomomys talpoides*) numbers in western Colorado rangeland 1 year after treatment with 2,4-D [(2,4-dichlorophenoxy)acetic acid]. Tietjen et al. (1967) showed that declining numbers of pocket gophers on 2,4-D treated rangeland were due to starvation and were directly related to depletion of essential forbs. On the basis of these results, we proposed that 2,4-D treatment of shortgrass rangeland might have a similar detrimental effect on prairie dogs. This study evaluated the effects of 2,4-D on range vegetation

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Fig. 1. *Prairie dog town on Charles M. Russell National Wildlife Range near Lewistown, Mont., where influence of 2,4-D treatment on black-tailed prairie dog diets was studied from June, 1970, to 1972. Photo taken prior to herbicide application.*

within a prairie dog colony and on prairie dog diet and activity.

Methods

We conducted the study on the Charles M. Russell National Wildlife Range, Lewistown, Mont. This 384,966-ha refuge occupies 35 km along the Missouri River. This is a rugged area with high, grassy plateaus surrounded by ponderosa pine (*Pinus ponderosa*), gentle slopes with shrubs, and precipitous slopes of clay and shale. We studied two prairie dog colonies, each occupying 8 to 10 ha of rangeland (Fig. 1). One colony served as a control. We sprayed the treated colony on June 9, 1970, with a dimethylamine salt of 2,4-D, and again on July 9, 1970, with a butyl ester 2,4-D formulation to achieve a more complete kill of sagebrush (*Artemisia tridentata* and *A. frigida*) and a few recurring forbs such as knotweed (*Polygonum* sp.). We sprayed the colony a third time with the butyl ester formulation on June 10, 1971. Herbicide was applied on each date at 2.2 kg/ha in water at 46.8 liters/ha.

Ground cover was sampled on each colony by means of six permanent 20-m line transects. Canopy cover estimates were made at 1-m intervals following Daubenmire's (1959) method.

We determined diet by analyzing stomach contents of 30 prairie dogs shot on each colony: 10 on May 19, 1970 (pretreatment), 10 on May 19, 1971, and 10 on June 7, 1972. Stomachs were frozen until examined in the laboratory. Contents of each stomach were thoroughly mixed and a sample was placed in a microsieve for straining.

Plants common on the prairie dog towns were collected and separated into leaf, stem, flower, and seed parts; each part was ground to simulate chewing and digestion, stained, and mounted on a slide. Plant fragments in the stomachs were identified by comparing their epidermal characteristics with those of the reference plants. We used the technique of Williams (1962) for staining reference plants and stomach contents. A slight modification was added: tissue was first cleared for 30 minutes in warm 1% sodium hypochlorite solution before treatment with mordant and hematoxylin. Iron-alum mordant and hematoxylin solution are described by Johansen (1940). Stained tissue was mounted in Apathy's modified gum syrup medium (Williams 1959).

A slide was examined from each stomach at 100 X magnification and each identifiable plant genus was recorded. A 10- × 10-mm eyepiece grid was used for quantitative estimates. We randomly selected 10 microscope fields on each slide and determined the number of grid squares filled by each plant genus. Thus, percentage by area of each species present was estimated. To determine which foods prairie dogs preferred, we calculated a preference index for each plant genus by dividing its percentage composition in the prairie dogs' diet by its percentage availability in the habitat (= canopy coverage for the genus divided by total canopy coverage for all plants) during the same sampling period.

To provide an index to the relative number of active burrows on each colony, we closed 100 prairie dog holes with soil plugs before and after treatment. Burrows were located by the nearest neighbor technique of Hansen and Remmenga (1961). Burrows were checked 48 hours later to determine the percent active (reopened by prairie dogs). As a check on their physical condition after treatment, we collected and weighed 20 prairie dogs from each colony on August 29, 1972. Whole body weights were analyzed by one-way analysis of variance. All other data were analyzed by Chi-square.

Results and Discussion

There was a highly significant reduction in coverage of forbs and shrubs ($P<.005$) on the treated colony but no significant change on the untreated colony ($P>.10$) (Table 1). Forb coverage decreased 60% on the treated area 1 month after the first spraying, and 28% on the untreated area. These reductions resulted partly from an increase in the percentage of bare ground between June and July as spring annual plants died. By 1972, forb coverage on the treated colony was reduced 67% from the pretreatment level, contrasted with no reduction on the untreated colony. Grass coverage did not change significantly on either area.

Initially, the treated site supported higher total ground cover than the untreated site (49% versus 29%). However, after treatment, the percentage of

Table 1. Foliar cover (%) on an area treated with 2.2 kg/ha of 2,4-D in June and July, 1970, and in June, 1971, and of an untreated area, both of which supported black-tailed prairie dog colonies near Lewistown, Mont.

Plant genus	Untreated area				Treated area: Pretreatment	Treated area: Post-treatment		
	6/70	7/70	5/71	6/72	6/70	7/70	5/71	6/72
Grasses:								
Agropyron	3.6	2.5	3.2	3.6	7.5	8.9	10.5	10.4
Bouteloua	0.4	T[a]	0.3	0.2	0.7	0.7	1.5	0.6
Poa	0.3	0.1	0	0	0.1	0	0	0
Others	0	0	0.2	T	0.3	T	T	T
Total	4.3	2.6	3.8	3.9	8.6	9.6	12.0	11.0
Forbs and shrubs:								
Artemisia	9.1	8.2	7.6	8.2	4.6	3.7	4.7	0.1
Astragalus	3.6	3.5	3.3	5.1	7.3	4.4	1.3	0.7
Atriplex	0.2	0.3	0.2	0.2	1.4	1.3	0.2	0
Chenopodium	0.8	0.5	0.2	0.4	0.4	0.1	T	0.3
Draba	0.1	0	T	0.1	0.6	0	0.1	0.5
Dyssodia	T	0	0.4	0.3	2.0	2.4	0	2.6
Euphorbia	0.3	0	T	0	0.8	0.1	0	0
Lactuca	0	T	0.1	0.1	0	0	T	T
Lappula	0.5	0	2.0	1.4	1.4	0.1	0.6	0.8
Lepidium	0.1	0	T	T	0.1	T	0	T
Melilotus	0	T	0.1	T	0.2	0	0.1	T
Monolepis	6.0	0.3	6.4	6.1	10.5	T	2.1	5.6
Opuntia	0.3	0.4	0.5	0.4	0	0	0	0
Plantago	3.1	3.4	0.2	2.0	4.2	1.7	T	T
Polygonum	1.0	1.2	0.2	0.8	1.1	1.4	0.7	1.1
Rosa	0	0	0	0	0.2	0.2	0.4	1.0
Sphaeralcea	T	0.2	0	0.2	T	T	0	0
Vicia	0.1	0.1	0.1	0.1	4.8	0.6	0.5	1.4
Total	25.2	18.1	21.0	25.2	39.6	16.0	10.7	14.1
Bare ground:	70.5	79.3	76.2	70.9	51.8	74.4	77.3	74.9

[a] T = trace (< 0.1%).

Table 2. Percentage of active black-tailed prairie dog burrows in area treated with 2.2 kg/ha of 2,4-D in June and July, 1970, and in June, 1971, and in an untreated area near Lewistown, Mont.

Date of count	Burrows active (%): Untreated	Treated
Pretreatment		
June 8, 1970	80	52
Post-treatment		
Sept. 10, 1970	73	64
May 20, 1971	86	73
June 8, 1972	44	32

bare ground increased and ground cover was reduced to 25% in 1971. Total ground cover on the untreated area was between 25 and 29% all 3 years.

The 2,4-D treatment greatly altered the composition of the remaining forb and shrub vegetation. Before spraying, monolepis (*Monolepis* sp.), loco (*Astragalus* sp.), vetch (*Vicia* sp.), sagebrush, and plantain (*Plantago* sp.) provided the most cover on both areas (Table 1). By 1972, these species were still common on the untreated area but were rare on the treated area. On the treated area sagebrush and plantain decreased 99%, loco 91%, and vetch 70%. Some forbs recovered rapidly after treatment; knotweed increased 27% a month after the first spraying, and in 1972, rose (*Rosa* sp.) and

Table 3. Botanical composition (%) of stomach contents of black-tailed prairie dogs and resulting preference index by plant genus from an area treated with 2.2 kg/ha of 2,4-D in June and July, 1970, and in June, 1971, and from an untreated area near Lewistown, Mont.

Plant genus	Untreated area: May, 1970 Comp. (%)	Pref. index[a]	May, 1971 Comp. (%)	Pref. index[a]	June, 1972 Comp. (%)	Pref. index[a]	Treated area, Pretreatment: May, 1970 Comp. (%)	Pref. index[a]	Post-treatment: May, 1971 Comp. (%)	Pref. index[a]	June, 1972 Comp. (%)	Pref. index[a]
Grasses:												
Agropyron	54.5	4.5	28.8	2.2	20.9	1.7	4.6	0.3	52.2	1.1	54.3	1.3
Bouteloua	28.9	21.3	6.4	5.3	10.6	15.4	0.7	0.5	28.2	4.3	9.9	4.1
Poa	0	—	0	—	1.4	>4.1	0	—	1.8	>4.1	7.0	>17.6
Total	83.4	5.8	35.2	2.3	32.9	2.5	5.3	0.3	82.2	1.6	71.2	1.6
Forbs and shrubs:												
Artemisia	5.6	0.2	7.5	0.2	1.7	0.1	0.9	0.1	2.0	0.1	0.3	0.8
Astragalus	0	—	0.3	T[b]	0	—	3.9	0.3	0	—	2.6	0.9
Chenopodium	0	—	13.8	17.1	0.1	0.1	9.4	11.4	0.1	>0.2	0	—
Draba	0	—	1.0	>2.5	0	—	0	—	0.2	0.5	4.1	2.1
Euphorbia	0	—	1.6	>4.0	0	—	1.5	0.9	0	—	0	—
Lactuca	T	—	18.4	45.6	0	—	0	—	3.7	>8.4	1.6	>4.0
Lappula	0	—	1.7	0.2	0.2	T	0.1	T	T	T	T	T
Lepidium	1.9	5.6	4.7	>11.7	16.3	>47.4	0	—	T	—	2.1	>5.1
Monolepis	0	—	T	T	3.8	0.2	T	T	2.0	0.2	4.3	0.2
Plantago	0.4	T	1.1	1.4	30.1	4.4	54.3	6.3	1.1	>2.5	7.6	>18.4
Sphaeralcea	T	—	0.4	—	0.4	0.6	0.1	>0.5	T	—	0.1	—
Vicia	0	—	0	—	2.3	6.7	2.4	0.2	0	—	0	—
Total	7.9	0.1	50.5	0.6	54.9	0.6	72.6	0.9	9.1	0.2	22.7	0.4
Unidentified	8.7		14.3		12.2		22.1		8.7		6.1	

[a] Preference index values, based on vegetation data for the same period and colony (Table 1), were calculated as: (average % composition in stomachs) ÷ (relative percentage ground cover).

[b] T = trace (< 0.1%).

dogweed (*Dyssodia* sp.) provided greater cover than before treatment.

There was no significant difference ($P>.10$) in the number of active burrows between the treated and untreated colonies (Table 2), although the untreated area always had a slightly higher percentage of active burrows than the treated colony. In both colonies the percentage of active burrows decreased in the last year ($P<.05$), probably because of the unusually cold spring weather. According to Koford (1958), a delay in spring plant growth may create a food shortage at a critical time (during breeding), causing high pre- and postnatal mortality. The open-hole test is satisfactory for measuring activity, but it cannot be used as a population index, since prairie dogs may clean out more holes than they actually occupy. Koford (1958) suggests that the number of active prairie dog burrows is not a reliable index to population numbers; instead, it is an index to food availability. The index did confirm visual observations that prairie dogs remained on the treated area.

Seventeen plant genera were identified in the stomach contents from both colonies (Table 3). Genera comprising less than 1% of the diet in any year are not listed in the table and include threeawn (*Aristida* sp.) and pigweed (*Amaranthus* sp.).

On the treated area, prairie dog diet changed significantly ($P<.005$) from forbs to grasses after forb coverage was reduced. Before treatment, forbs made up 73% of the diet (Table 3). After treatment, forbs decreased to 9% of the diet in 1971 and 23% in 1972. Grasses in the diet increased from 5% before treatment to 82% after treatment. The availability of these foods appeared to be responsible for this diet change. Plantain and goosefoot (*Chenopodium* sp.) were highly preferred before treatment, comprising 64% of the diet. Plantain alone accounted for 54%. A year after spraying, these forbs made up only about 1% of the diet.

Despite the change in diet, the prairie dogs remained in the colony and appeared to be in good physical condition. Body weight averaged 994 g and did not differ significantly between the treated and untreated areas. This indicates that the reduction in forb coverage did not cause starvation or a decrease in breeding such as Keith et al. (1959) found in pocket gophers.

Diet was highly variable between the two colonies and from year to year. Before spraying, prairie dogs on the treated area ate 5% grass and 73% forbs, while on the untreated area they ate 83% grass and 8% forbs. Prairie dogs selectively sought grasses on the untreated colony, as indicated by a preference value of 5.8. On the treated colony, the amounts eaten more closely approached the amounts available; the preference value for forbs was 0.9, for grasses, 0.3. We do not know the reason for the difference in diet between the colonies. However, the treated area supported more vegetative cover at the start of the study, which perhaps encouraged the prairie dogs to eat a wider variety of food items, including more forbs. Prairie dogs from the treated area averaged five plant genera per stomach while those on the untreated area averaged only three to four genera. In the last 2 years of the study, the percentage of grass in the diet of prairie dogs from the untreated colony dropped from 83% to about 35%.

In all but one sampling period, the preference values were higher for grass than for forbs (Table 3). However, when a variety of food was available, prairie dogs also preferred a few forb species including plantain, goosefoot, pepperweed (*Lepidium* sp.) and wild lettuce (*Lactuca* sp.).

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