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IMPACT OF THE BELDING'S GROUND SQUIRREL, *Spermophilus beldingi,* ON ALFALFA PRODUCTION IN NORTHEASTERN CALIFORNIA

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INTRODUCTION

Throughout the history of agriculture, man has competed with various animal species for the fruits of his labors. During the past 60 years, many research papers have dealt with the impact of field rodents and lagomorphs on agriculture. Damage has been estimated in various ways, from dollar values to cattle unit losses. In an early study, Shaw (1921) attempted to measure the amount of winter wheat loss due to Columbia ground squirrel. Grinnel and Dixon (1918) related ground squirrel damage to forage loss and cattle production.

Several rodent enclosure and exclosure studies have been conducted in an attempt to measure the impact of field rodents and rabbits. Most of the damage assessment investigations involved rangeland production. The species studied have included prairie dogs (Taylor 1924, 1930; Fitch 1947), ground squirrels (Taylor 1930, Fitch 1947, Kalmbach 1948, Fitch and Bentley 1949, Norris 1950, Howard et al. 1959), jack rabbits (Taylor 1930, Kalmbach 1948, Norris 1950), kangaroo rats (Kalmbach 1948, Reynolds and Glendening 1949, Fitch and Bentley 1949, Reynolds 1950, Norris 1950), and pocket gophers (Kalmbach 1948, Fitch and Bentley 1949).

Relatively few rodent damage assessment studies on agronomic crops, such as grain, alfalfa, and irrigated pasture, have been conducted in the western United States. Foster (1965) noted that a large overwintering population of Microtus severely reduced production of irrigated wheat grass in seed fields and plots.

The Belding ground squirrel (S. beldingi) is found in rangeland, pasture, and various agronomic crops. However, its impact on agricultural production has been measured only rarely, e.g., by Grinnel and Dixon (1918) and Sauer (1976, 1977). In California the effects of the Belding ground squirrel appear to be most severe in alfalfa. The present investigations were conducted to measure the impact of the Belding ground squirrel on alfalfa production in northeastern California.

MATERIALS AND METHODS

The study areas were in Modoc County, California. They were located on the Sharrow Ranch, Cedarville; the Cal Vada Ranch, four miles north of Cedarville; the Cockrell Ranch, Lake City; the Weber Ranch, six miles east of Alturas; and the Fisher Ranch, eight miles west of Alturas. The plots varied from two to forty acres. Predominant vegetation was alfalfa (Medicago sativa) accompanied by wheat grass (Agropyron sp.) and/or downy brome (Bromus tectorum).

Alfalfa fields were chosen for study based on three predetermined prerequisites: (1) the ground squirrel population was large enough to warrant a population reduction program; (2) the landowner did not plan to control the population; and (3) a low pocket gopher population was present, as evidenced by the low number of gopher mounds. Based on previous field observations, these criteria should provide fields with substantial ground squirrel populations which could be expected to cause severe damage if no control program were conducted.

Five to 36 rodent exclosure cylinders were placed in alfalfa fields for 44 to 71 days during the growing season before the first hay cutting (from mid-March to mid-June). All cylinders were 42 inches in diameter. They were made of 1-inch-square mesh, 16-gauge welded wire, 18 or 36 inches high, and secured to the ground by 1/4-inch-diameter metal rod stakes. A 42-inch diameter is a convenient size. Weight in grams of vegetation within the cylinder, multiplied by 10, equals the production in pounds per acre. Cylinders were placed along transect lines or scattered, depending on cylinder height and the likelihood of interfering with fanning practices and irrigation systems.

On the Sharrow Ranch, twelve 36-inch high open-top rodent exclosure cylinders were placed at 100-foot intervals along a single transect line at the eastern side (40 feet from the border) of the field. This single line was used as it did not interfere with sprinkler irrigation.

On the Cal Vada Ranch, three transect lines were established. One row of 36-inch tall open-top cylinders was at the eastern side of the field 40 feet from the border. One row of 18-inch tall cylinders with one-inch-mesh tops was placed 30 feet from and parallel to a power line which crossed the middle of the field. The third row of 36-inch tall open-top cylinders was set up in line with a power line. All rows of cylinders were parallel to one another and consisted of 12 cylinders at 100-foot spacings.

On the Weber and Fisher Ranches, cylinders were placed approximately equidistant from one another throughout the field. Ten 36-inch tall open-top cylinders were used on the 2.5 acre Weber Ranch. Three plots were laid out on the Fisher Ranch. Plot A was in a 2.2-acre field which was subirrigated. Plot B was in a 1.6-acre field which was usually flood irrigated, but was not irrigated in 1978. Plot

C was a wheel-line and set-line sprinkler-irrigated field of 15 acres. In field A of the Fisher Ranch, seven 36-inch tall cylinders with one-inch-mesh tops were used; field B, eight 36-inch tall cylinders with one-inch-mesh tops; and field C, ten 18-inch tall and four 36-inch tall cylinders, both having one-inch-mesh tops, were used. In all fields, except Fisher field B and the Cal Vada 18-inch tall cylinder row, some cylinders were eliminated due to squirrel entry. Table 1 lists the number of cylinders harvested and other pertinent data, including estimated losses in each plot.

Areas of gopher populations, as indicated by gopher mounds, were avoided during cylinder placement.

Alfalfa samples were usually collected one to two weeks prior to normal harvest. All vegetation was clipped at ground level using electric hedge shears powered by a portable generator. The Weber plot was harvested early (May 5) because cattle were going to be put on a pasture which was not fenced off from the test alfalfa field. Samples were air dried for two to five weeks and weighed to the nearest 0.1 gram. Samples and sample comparisons varied in the three-year study. In 1976, vegetation inside each cylinder was compared to an area of similar vegetation composition within 10 feet of each cylinder. In 1977 and 1978, cylinder samples were compared to the average of two outside samples, each five feet away from, and on opposite sides of, the cylinder. Vegetation production inside and outside cylinders was compared by analysis of variance.

To relate alfalfa damage to squirrel population density, two types of population estimates were used. In 1976 and 1977, visual population estimates were obtained by counting the number of squirrels in 100' x 100' census subplots within the field being assessed. The number of subplots was dependent on the size of the field being assessed and varied from two to six. Estimates of population density were based on squirrel counts made periodically during morning hours for a period of 30 minutes. In 1978, a Lincoln Index population estimate was made on the Fisher Ranch in fields A and B. Twenty-eight live traps (seven rows of four traps each) were placed in field A, and 20 live traps (five rows of four traps each) in field B. Traps were 6 x 6 x 19 inches and were constructed of one-inch-wire mesh. Traps were prebaited for one week using squirrel oat groats (a hulled lightly steamrolled oat). Squirrels were sexed, marked by toe clip, and released. Squirrels in the two fields were marked by different toe clips to indicate cross-over movement. The same traps and trap locations were used to recapture squirrels. Population estimates were not conducted in Fisher field C or on the Cockrell Ranch due to farming practices and harvest.

Day, night, and crepuscular visual observations were made in each study area to investigate the possible influence of other wildlife, such as jackrabbits and deer, or livestock. Total observation time was at least four hours per week for the entire study. In addition to visual observations, day and night trapping was conducted on the Weber Ranch and Fisher Ranch. On the Weber Ranch, fifty 6 x 6 x 19 inch, one-inch-mesh wire traps were prebaited with squirrel oat groats for one week and then set both day and night for three days and three nights. On the Fisher Ranch, traps used during the Lincoln Index were also set at night to detect the activity of other small mammals. Small rodents such as Peromyscus and Microtus were not considered in most of the trapping studies because such rodents pass readily through the one-inch-wire mesh of the cylinder. On the Fisher Ranch, however, 10 Sherman live traps, 20 rat snap traps, and 20 mouse snap traps were set in each of fields A and B for two consecutive nights to note any small rodent activity.

RESULTS

No attempt was made to quantitatively segregate the various plant species. Only total vegetation weights were recorded. Alfalfa was the dominant plant species. Table 1 lists the plot locations, number of cylinders sampled, plot size, test period, assessed damage, and squirrel density. Analysis of variance showed that all assessed losses were significant at the 5 percent level.

It has been reported previously that none of the cylinder designs used in this study significantly changed vegetation production within the cylinder (Sauer 1979).

Squirrel population densities varied among the study plots and within each plot. Visual observation population estimates were: Weber Ranch, 44 adults per acre; Sharrow Ranch, 23 to 40 adults per acre; Cal Vada Ranch, 57 to 113 adults and young per acre. Lincoln Index estimates were 134; and 91 adults and young per acre on Fisher A and B, respectively.

The impact on alfalfa by nonsquirrel herbivore wildlife and stray domestic stock is believed to be minimal in the test sites. Visual observation on the Weber, Cockrell, and Cal Vada Ranches revealed some deer (Odocoileus hemionus) in the fields where damage was being assessed. Very few tracks were found, however, indicating little use of the areas. On the Fisher Ranch, no deer were seen but occasional tracks were found indicating some use. On the Sharrow Ranch, neither deer nor evidences of them were found in the plot area.

Other animals were seen near the plots. These included blacktailed jack rabbits (Lepus californicus), marmots (Marmota flaviventris), Douglas ground squirrels (Spermophilus beecheyi douglasii), Peromyscus sp., Kangaroo rats (Dipodomys sp.), and porcupines (Erithizon dorsatum). These animals were seen only occasionally, and their impact is believed to be minimal. One woodrat (Neotoma fuscipes) and one Douglas ground squirrel were caught on the Weber Ranch. During daytime trapping on the Weber plot, however, 200 Oregon ground squirrels were trapped and removed. On the Fisher Ranch, fields A and B, the only nonsquirrel animal caught was a long-tailed weasel (Mustela frenata). A total of three and ten Peromyscus were caught in the small rodent traps in fields A and B, respectively. During the Lincoln Index trapping process (marking and recapture), a total of 248 and 131 Oregon

Table 1. Damage assessment plots, location, time period, and estimated alfalfa losses due to Belding ground squirrels in Northeastern California.

Ranch (Location)	No. of Cylinders	Plot Size (Acres)	Irrigation System	Test Period Dates	Days	Production lbs./A (Dry Weight) In Cyl.	Out Cyl.	Loss (lbs./A)	Squirrel Population Density
Weber (Alturas)	5	2.5	Flood	3-22 to 5-5-76	44	2,065	1,704	361*	44[1/]
Sharrow (Cedarville)	8	20	Sprinkle	3-23 to 5-25-76	62	4,570	3,270	1,300*	23-40[1/]
Cockrell (Lake City)	6	8	Dryland	4-21 to 6-9-77	48	2,306	1,856	450*	--
Cal Vada (Cedarville)	22	40	Sprinkle	4-18 to 6-8-77	51	3,441	2,716	725*	57-113[2/]
Fisher A (Alturas)	6	2.2	Sub-irrigated	3-29 to 6-8-78	71	5,889	4,738	1,151*	134[2/]
Fisher B (Alturas)	8	1.6	Dryland	4-5 to 6-8-78	64	6,291	3,866	2,425*	91[2/]
Fisher C (Alturas)	8	15	Sprinkle	3-29 to 6-13-78	69	5,203	4,313	890*	--

[1/]Population estimates were made on adults only.

[2/]population estimates were made on adults and young.

*Mean differences (Toss) are significant at the 5% level.

ground squirrels were trapped in Fisher Ranch fields A and B, respectively. All observations and trapping indicate the Belding ground squirrel was the predominant species.

DISCUSSION

Data obtained in the present study indicate that the Belding ground squirrel can reduce alfalfa production by an average of 1,100 pounds per acre of first cutting alfalfa.

The previous studies (Sauer 1976), as well as the present study, suggest the amount of vegetation consumed is probably a very small percentage of the assessed damage. Damage in the field is a composite of trampling, runaway development, squirrel mounds, vegetation clipping, and forage eaten.

Koford (1958) discussed some of the shortcomings of exclosure and enclosure damage assessment studies. The relatively luxuriant growth of plants immediately after exclusion of animals results, in part, from the animals' previous modification of the soil. In cultivated and fertilized alfalfa fields, such animal modifications and their influence on production is probably minimal. Exclusion cylinders placed as controls in nonsquirrel areas reported by Sauer (1979) support this assumption and indicate minimal growth enhancement due to exclusion cylinders.

This study indicates that the Belding ground squirrel, if uncontrolled, can significantly reduce the yield of first-cutting alfalfa in northeastern California.

The influence of herbivores other than the Belding ground squirrels on the assessed damage in this study was small because few such animals were present.

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