MONTANA DEPARTMENT OF AGRICULTURE
ENVIRONMENTAL MANAGEMENT DIVISION
TECHNICAL SERVICES BUREAU
HELENA, MONTANA 59620

FORAGE LOSSES CAUSED BY COLUMBIAN GROUND SQUIRRELS IN IMPROVED PASTURE AND SECOND CUTTING ALFALFA

by

Steven F. Baril

ABSTRACT

One-inch mesh wire cylinders were placed in improved pasture and second cutting alfalfa to exclude Columbian ground squirrels. Forage production from within the cylinders was compared to that outside so that losses due to ground squirrel utilization could be estimated. Ground squirrel population numbers on the study plots were estimated using multiple mark recapture to calculate a mean Petersen index. On improved pasture, losses were 717 and 433 pounds per acre at ground squirrel densities of 76 and 190 squirrels per acre, respectively. These losses amounted to 9.2 and 6.6% of total potential forage production. On second cutting alfalfa, losses were 4.5 and 38.8 pounds per acre, or 2.3 and 14.0% of total potential forage production. Ground squirrel density was 12 animals per acre for the initial plot but could not be measured for the latter.

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INTRODUCTION

One reason given to justify the use of rodenticides is that of alleviating damage to crops caused by rodent pests. At this time very little information has been gathered to demonstrate the damage caused by rodents at various population levels, in various crops, and under different management practices and conditions.

In 1979 and 1981, the State of Montana was granted a Section 18 registration (Federal Insecticide Fungicide and Rodenticide Act) under which compound 1080 was applied to crops to control damage caused by Columbian ground squirrels. Under the terms of this program, granted by the Environmental Protection Agency, studies were conducted to determine damage caused by Columbian ground squirrels to barley and irrigated and nonirrigated alfalfa (Pallister 1979). On plots with high squirrel numbers losses in crop production were 5 - 12% in irrigated alfalfa, 21- 23% in dryland alfalfa, and 24% in irrigated barley. This study concluded that applications of 1080 resulted in substantial increases in crop production, considerably more than the economic cost of 1080 applications.

In 1980 and 1981, damage assessment studies were continued for the second alfalfa harvest and for improved pastures, crops for which data were lacking.

A review of information concerning estimates of ground squirrel damage to pasture and alfalfa showed that the available information is very scanty. Several studies have demonstrated the damage caused to rangeland by ground squirrels. Fitch and Bentley (1949) found that California ground squirrels stocked in experimental enclosures at a density of 12 squirrels per acre destroyed 35% of the total forage production (1,092 pounds per acre). A change in plant species composition also was attributed to ground squirrels. Sauer (1977), using exclusion cylinders to estimate ground squirrel damage, measured 1790 pounds of forage lost per acre due to ground squirrels at a density of 123 squirrels per acre. Shaw (1921) determined that a brooding female Columbian ground squirrel consumed 71 grams of vegetation per day. Recent work in Oregon indicates that ground squirrels destroyed an average 45% of the first cutting of alfalfa (deCalesta, pers. comm.). The relevant conclusion to be drawn from these studies is that ground squirrels do have the potential to take significant amounts of forage.

This report gives the results of studies conducted in 1980 and 1981 to determine forage losses on improved pasture and second cutting alfalfa caused by Columbian ground squirrels.

STUDY AREAS - Improved Pasture

Three improved pastures colonized by Columbian ground squirrels were selected for study in April 1981 on the State Prison Farm in Powell County, Montana (Table 1). Guidelines for selecting study sites included the following:

1. Sites met the criteria for improved pasture.*
2. Sites had been grazed during the previous year and were expected to be grazed during the study.
3. Fields were colonized moderately to heavily with Columbian ground squirrels.
4. Areas of homogeneous vegetation colonized by ground squirrels were present in the pastures as potential damage assessment study plots.
5. Rodent control was curtailed during the study.

*Improved pastures were defined as those consisting of native or introduced forage species that received periodic cultural treatments such as fertilization, mowing, irrigation, tillage, and burning.

Table 1. Descriptions of study fields and damage assessment plots.

FIELD NUMBER	CROP	PLOT NUMBER	PLOT DIMENSIONS(ft.)	PLOT AREA (ac.)	CROP COMPOSITION - MAJOR SPECIES
1	Imp. Pasture	1	120 X 120	0.72	Alfalfa 85%, Smooth brome 10%, Weedy forbs 5% (Canada thistle, Musk thistle, Sweetclover).
2	Imp. Pasture	2	65 X 140	0.21	Alfalfa 25%, Kentucky bluegrass 25%, Smooth brome 15%, Crested wheatgrass 10%, Intermediate wheatgrass 5%, Weedy forbs 20% (Canada thislte, Musk thistle, Sweetclover, Hanbane).
3	Imp. Pasture	3	80 X 80	0.15	Nebraska sedge 45%, Wire rush 25%, Ticklegrass 15%, Kentucky bluegrass 3%, Idaho fescue 2%, Blue wildrye 1%, Weedy forbs 10% (Wild rose, Canada thistle, Glandular willow - herb).
4	Second Cutting Alfalfa	4	*	3.77	Alfalfa 95%, Weedy forbs 5% (Tansy mustard, Musk thistle, Canada thistle).
5	Second Cutting Alfalfa	5	*	5.08	Alfalfa 95%, Weedy forbs 5% (Tansy mustard, Musk thistle).

*Odd shaped plots.

The three selected fields were designated as Fields 1, 2, and 3 and later contained Plots 1, 2, and 3, respectively.

Field 1 had been planted to alfalfa and grass, was flood irrigated, had received periodic fertilization, and was mowed yearly during late summer to remove rank vegetation. Beginning in July 1981 the field pastured a herd of dairy cattle; however, heavy rainfall during spring and early summer (111 - 190% of normal in Southwestern Montana (Montana Crop and Livestock Reporting Service 1981)), caused rapid forage growth which led to a decision to harvest a hay crop instead of pasturing cattle during that period. Consequently, livestock were not pastured on this field during the study.

Ground squirrels were present in light to moderate densities over most of this pasture but were absent in lower, subirrigated portions. High numbers of squirrels existed in high areas, along ditchbanks, and on roadsides adjacent to Field 1.

Field 2 was also an intensively managed pasture planted to alfalfa and grasses that received the same cultural treatments as Field 1. During early summer several bulls were pastured on this field but they were removed in late June when forage began to mat, and a hay crop was harvested. Ground squirrels were present in light densities over most of the field; however, high densities were present along field borders, in high spots and outside the field on hillsides.

Field 3 consisted primarily of native plant species and was burned in the spring as the only cultural treatment. This pasture was located in a small drainage valley and was subirrigated by a high water table as is evidenced by the forage species present (Table 1). Whether this field met the criteria of improved pasture is questionable; however, it was included in the study as a pasture that would be productive, received minimal management, and contained native species considered valuable as livestock forage (Booth 1950).

Ground squirrels were conspicuously absent from the subirrigated areas of Field 3 but were present in low numbers on higher gravel bars in the valley. High squirrel densities were present on the slopes of gravel terraces adjacent to this pasture and an assumption was made that these squirrels entered the pasture edges to feed on succulent vegetation.

Second Cutting Alfalfa

An alfalfa field populated by Columbian ground squirrels was selected for study in Lewis and Clark County, Montana in 1980. This field was flood irrigated until the first cutting and was not irrigated thereafter. Vegetation was primarily alfalfa with the exception of several species of weedy forbs that were present in areas heavily colonized by ground squirrels. Columbian ground squirrels were present in varying concentrations throughout the field with several areas having colonies with high densities.

METHODS - Improved Pasture

Plots with dimensions given in Table 1 were established in April and early May on all 3 pastures in areas of high ground squirrel density and were fenced to exclude cattle, On field 3, the plot did not contain ground squirrel burrows but was placed immediately adjacent to a heavily colonized hillside. The plot boundary was approximately 3 feet from areas of high density and it was assumed that ground squirrels would enter the subirrigated plot to feed on succulent vegetation present there. Exclusion cylinders

modeled after Sauer (1977) were placed equidistant in a grid over each plot. Basically, these exclusion cylinders are an extension of the livestock exclosure cages of Kingman et at. (1943), who excluded cattle from a known area, harvested the forage, and compared it with forage from an equal area outside the exclusion. Differences in forage weight between the two were assumed to be related to livestock grazing, and in this study to ground squirrel utilization. Cylinders were 42 inches in diameter, 3 feet high, and made of 1 inch mesh welded wire that excluded ground squirrels from an area of 1.07 yards^2 (0.9 m^2). Mathematically, each gram of vegetation from an area this size is equal to 10 pounds of vegetation per acre. Each cylinder was imbedded approximately 2 - 3 inches into the ground and anchored in place with 1/4 inch diameter metal rods.

Cylinders were left in place until July 16 - 28 at which time they were removed. At the time of removal, vegetation had begun to grow through the top of several cylinders on plots 1 and 2. Upon removal all vegetation inside the cylinders was clipped approximately 2 inches above ground using electric pruning shears. On second cutting alfalfa plots two equal areas of vegetation were cut outside the cylinder, one to the east and the other west. For improved pasture, vegetation was clipped from one equal area outside each cylinder exactly 1 meter south. All clipped forage was stored in onion sacks and air dried for at least 3 weeks then weighed to the nearest 0.1 gram. Mean differences in forage weight inside and outside the cylinders were analyzed statistically for each plot using a Student's T test for equality of paired means.

Mark-recapture trapping was conducted on the plots just prior to cylinder harvest. Live traps were placed equidistant in a grid pattern over each plot and each captured squirrel was distinctly marked using nyanzol dye (Fritzwater 1943) so that recapture histories could be recorded. Trapping was conducted only during mornings and evenings to preclude mortalities from hot midday temperatures. On each plot traps were prebaited for 3 - 4 days then mark-recapture conducted. Each morning and evening trapping period together was considered as a trapping period. Mark-recapture was conducted for 3 trapping periods on each plot and recaptures recorded so that a mean Petersen estimate of population size and confidence intervals could be computed (Seber 1973).

Track surveys were conducted to record presence of larger herbivores. Small mammals surveys were not conducted because of the access of these animals inside and outside each cylinder.

RESULTS - Improved Pasture

Average forage weights inside and outside cylinders are given for each plot in Table 2 along with statistical significance. On improved pasture plots 1 and 2 average forage weights inside the cylinder were 71.7 and 43.3g. higher than outside. This represented losses of 9.2 and 6.6% of the total forage production, or 717 and 433 pounds per acre, respectively. Significance could be proven statistically only for plot 1. Plot 3 which did not appear to be utilized by ground squirrels showed greater mean forage weight outside the cylinders.

On plot 3 only 3 of the initially placed 9 cylinders were harvested, those from the edge of the plot closest to the ground squirrel colony. Initial impressions were that ground squirrels would enter this plot to feed from an adjacent heavily colonized hillside. Life trapping results and visual observations did not confirm this. A total of 4 juvenile ground squirrels were captured in 3 days, all on the plot boundary facing the heavily

Table 2. Average forage weight inside and outside exclusion cylinders, corresponding loss per acre, Columbian ground squirrel densities on the plot and corresponding densities per acre, improved pasture and second cutting alfalfa.

CROP	PLOT NO.	INSIDE CYLINDER	OUTSIDE CYLINDER	FORAGE LOSS (g.)	SIGNIFICANCE	FORAGE LOSS PER ACRE	SQUIRREL DENSITY/ PLOT*	SQUIRREL DENSITY/ ACRE
Improved Pasture	1	783.6	711.9	71.7	$\alpha = .025$	717 lbs.	55(41,69)	76
Improved Pasture	2	654.1	610.8	43.3	N.S.	433 lbs.	40(26,54)	190
Improved Pasture	3	465.2	514.8	+49.6	N.S.	N.A.	-0-	-0-
Second Cutting Alfalfa	4	198.1	193.6	4.5	N.S.	45 lbs.	46(38,54)	12
Second Cutting Alfalfa	5	276.6	237.8	38.8	$\alpha = .01$	388 lbs.	not measured	-0-

*95% confidence interval in parenthesis.

colonized hillside. These captures may represent squirrels attracted to the bait in the traps more than squirrels feeding in the plot. During visits squirrels were never observed on the plot nor were squirrel trails visible on the plot. For these reasons only 3 cylinders were harvested, and these may well represent a control situation.

Mark-recapture trapping indicated that plots 1 and 2 had Columbian ground squirrel populations of 55 and 40 animals. For comparison, these populations correspond to 76 and 190 ground squirrels per acre, respectively. At the time of indexing all population members were active including adult females, the first to go into estivation (Shaw 1925).

As a point of interest, nyanzol dye was satisfactory for marking squirrels in this study where small numbers of ground squirrels were marked. The pelage was dyed in dark bluish-black that was easily visible on field observations and, by dying various portions of their anatomy, individual squirrels could be recognized and their subsequent retrapping histories recorded.

Searches for herbivore tracks and droppings were negative at 3 intervals during the study. Only after the fence and exclusion cylinders had been removed were deer tracks seen in plot 1 only.

Second Cutting Alfalfa

For plots 4 and 5 the average difference in forage wieght inside the cylinders from that taken outside was 4.5 and 38.8 grams, respectively, a loss that may be attributable to ground squirrels. Only plot 5 showed a statistically significant difference, however. These differences amount to 2.3% and 14.0% of the total second cutting alfalfa production or a potential loss of 45 and 388 pounds per acre.

A mark-recapture population estimate was 46 Columbian ground squirrels for plot 4, or 12 animals per acre. It should be noted that visual counts of squirrels on plot4 conducted at the time of cylinder placement showed an average of 7.4 squirrels. Counts conducted one week later showed only 2.7 squirrels per count. Indications were that certain members of this population were beginning to estivate which may occur in mid July (Shaw 1925).

DISCUSSION

On improved pasture plots 1, 2, and 3 average potential forage yields as computed from dry weights inside exclusion cylinders were 7836, 6541, and 4652 pounds per acre respectively. There is some difficulty in assigning an economic value to pasture herbage primarily because of the variety of uses and management practices encountered. If it can be assumed however, that pasture herbage has a similar value to grass hay, then the average value of a ton of hay, $47.00 (Montana Agricultural Statistic, August 1981 average value for all hay other than alfalfa), can be applied to pasture production. Therefore, a 9.2% and 6.6% loss of herbage caused by Columbian ground squirrels on plots 1 and 2 would amount to $16.84 and $10.18 in lost herbage per acre, respectively. Considering 1981 prices for strychnine baits ($.85 - $1.00/lb.), time and effort involved to bait (approximately 0.5 man hours per acre) (Sullivan and Baril 1981, Albert and Record 1979), and an average of 1 - 2 pounds of bait needed per acre, it appears that the damage caused on improved pasture plots 1 and 2 would economically justify ground squirrel control.

It should be pointed out that the squirrel population numbers encountered on plots 1 and 2 represent maximum densities for the field. An estimate of damage cannot, therefore, be made for the entire field where

ground squirrel numbers were actually low.

The high amounts of precipitation in late spring and early summer and subsequent good growing conditions probably caused above average production on improved pasture plots in 1981. It is not known to what extent, or if, this rapid growth may have obscurred damage caused by ground squirrels. It may be safe to assume that, under the favorable growing conditions of 1981, the amount of forage utilized by ground squirrels would represent a smaller percentage of total production than in a less favorable year.

Plot 3 did not appear to be utilized as a feeding area by ground squirrels even though a dense colony was present on the plot boundary. Vegetation in this plot was markedly different than plots 1 and 2 and represented the subirrigated nature of this area of the pasture. Whether the wetland adapted plants such as Carex sp. and Juncus sp. that were abundant on this plot are ever utilized as a Columbian ground squirrel food source is not known.

On second cutting alfalfa (plots 4 and 5), losses of 45 and 388 pounds per acre correspond to an economic loss of $1.24 and $10.67 per acre, respectively.* Pallister (1979) reported 92 pounds per acre of second cutting alfalfa lost due to Columbian ground squirrels at a density of 37.21 squirrels per acre; the loss to first cutting alfalfa was 717.6 pounds per acre. In alfalfa, much of the damage may occur to the first cutting. Much of the feeding activity of squirrels may occur early in spring by adults and in early summer by emerging young of the year. After the first cutting, many older members of the population may begin to estivate as was suspected in this study. This and the added result of young dispersing from natal areas may have gradually reduced the population on the study plots with resulting reduction in damage. Obviously, any conclusions on economic damage to alfalfa by ground squirrels should account for damage to first and second cuttings.

The exclusion cylinder method for assessing ground squirrel damage is adequate on small areas such as the plots used in this study. Cylinders are, however, very expensive in terms of materials and manpower and should probably be limited to small areas. As Sauer (1977) stated, they should be used in areas of homogeneous vegetation, a difficult requirement to meet under the diverse growing conditions of Western Montana pastures and haylands. As was also noted during this study, ground squirrel concentrations vary markedly over a given field and the data obtained from small plots usually cannot be extrapolated over the entire field. Sauer (1977) placed one cylinder on each acre of vegetation (4 cylinders on a 4 acre plot) and made conclusions on the reliability of this method. Given the heterogeneity of squirrel populations and plant species composition even in homogeneous appearing stands, it is doubtful that 1 cylinder per acre is adequate to reliably estimate damage in Montana. The variability of results from individual cylinders in this study and that of Pallister (1979) and the difficulty in attaining statistical significance support this.

Pallister's (1979) study and this study do document that Columbian ground squirrels cause significant damage to Montana crops. The results apply to a particular environment resulting from weather conditions, number of ground squirrels, and management conditions on the study site. Generalizations cannot be made concerning damage to individual crop types that can be expected from various degrees of Columbian ground squirrel infestation. Work should continue in this area so that ground squirrel numbers can be related to expected damage and control efforts economically justified.

*Based on a value of $55.00 per ton for alfalfa hay (Montana Crop and Livestock Reporting Services 1981).

RECOMMENDATIONS

Future rodent damage work should include investigations that will define economic versus noneconomic populations, describe the range of population levels that can be encountered in Montana, develop simple population indexing methods, and correlate damage with population numbers. Studies that may help accomplish this are:

1. Attempt to correlate population numbers (obtained by mark-recapture estimates) with easily observed characteristics such as burrow counts, visual counts, active burrows, etc. If easily observed characteristics correlate with population numbers, as they should, then a simple method for population indexing may be possible.
2. Conduct a survey by trained aides to observe and describe the range of population levels that can be expected in Montana. Such a survey may help define the terms "light" versus "serious" infestations, for example.
3. Continue damage studies to correlate crop damage with various rodent population levels. Such studies might be simply conducted by comparing, for a particular crop, yields in fields managed to control rodents versus fields not managed.

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