EFFECTIVENESS OF REDUCED STRENGTH STRYCHNINE BAITS FOR GROUND SQUIRREL CONTROL

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ABSTRACT.

Three concentrations (0.1%, 0.2%, and 0.3% active ingredient) of strychnine-treated chopped cabbage bait were effective in reducing Richardson ground squirrel (*Spermophilus richardsonii nevadensis*) populations. Strychnine concentrations in the bait showed a significant ($P<0.05$) negative effect on the number of live ground squirrels observed aboveground after bait was applied. Adjusted percent reduction in aboveground ground squirrel counts were: 71%, 71%, and 88% respectively for the 0.1%, 0.2%, and 0.3% strychnine baits.

INTRODUCTION

Since 1975, the Nevada State Department of Agriculture has utilized a 0.3% strychnine-treated chopped cabbage bait to reduce ground squirrel damage to agricultural crops. The species causing damage are Richardson ground squirrel (*Spermophilus richardsonii nevadensis*), and to a lesser extent, Belding (*S. beldingi creber*) and Townsend (*S. Townsendii mollis*) ground squirrels.

Strychnine alkaloid is a fast-acting toxicant which causes frequent tetanic convulsions leading to death from respiratory failure (Timm 1983). These characteristics make it difficult for a poisoned ground squirrel to return to its burrow once it first feels the effects of the poison. A poisoned ground squirrel is probably more likely to be consumed by another animal if it dies aboveground rather than in its burrow. This is why strychnine can pose a greater hazard to predatory or scavenging animals than other toxicants which afford a poisoned ground squirrel more time to return to its burrow. A reduced strength bait should lower the hazard to non-target animals which eat poisoned ground squirrels.

I would like to thank Martin Larraneta, Larry Blalock, and Bill Jeffress for their assistance; the Winnemucca office of the Bureau of Land Management for giving permission to conduct the test; Don Book for his much appreciated statistical advice, and Linda Lesi for typing this paper.

STUDY AREA

This test was conducted on Bureau of Land Management rangeland located approximately 50 km (30 miles) north of Winnemucca, Nevada. The predominant plant species on the site was big bluegrass (*Poa ampla*). Other species included downy brome (*Bromus tectorum*), tumble mustard (*Sisymbrium altissimum*), filarie (*Erodium cicutarium*), and big sagebrush (*Artemisia tridentata*).

Mammalian predators observed near the site were coyote (*Canis latrans*) and badger (*Taxidea taxus*). Golden eagles (*Aquila chrysaetos*), common ravens (*Corvus corax*) and a burrowing owl (*Speotyto cunicularia*) were observed on or near the site.

METHODS

Four square plots of four ha (10 acres) each were set up with distances separating plots ranging from 100 m (110 yards) to 250 m (275 yards). The easternmost plot was designated the control plot because it contained more big sage than the other plots. I believe big sage would interfere with bait application though not with ground squirrel activity monitoring.

Ground squirrel activity was monitored for 6 days pretreatment and for 6 days posttreatment. Pretreatment monitoring dates were May 10, 21, 23, 24, 25, and 26, 1984. Bait was applied May 28, 1984. Posttreatment monitoring dates were June 1, 2, 5, 6, 7, and 8 1984. Two monitoring methods were used: aboveground counts of ground squirrels and examining marked burrows for activity signs (tracks, excavated soil, feces, and urine spots).

Aboveground counts were made from observation points set up in each plot (Fagerstone 1982). From the observation point, a plot was scanned 5 times with a pair of binoculars. The scan with the highest number of ground squirrels observed was recorded. Counts began between 7:35 a.m. and 8:00 a.m. each day and were conducted in the following order: 0.1% plot; control plot; 0.2% plot; 0.3% plot.

Sixty burrows spaced a minimum of 23 m (25 yards) apart, were marked in each plot. Marked burrows were checked each day and classified as active or inactive depending on whether ground squirrel activity signs were present or absent. After they were checked, burrow entrances were smoothed down to eliminate signs. After aboveground counts were completed, burrows were checked in the following order: 0.3% plot; 0.2% plot; control plot; and 0.1% plot. Approximately 2 hours were required to check marked burrows.

Approximately 1 tablespoon of bait was hand-broadcast within two to three feet of each burrow opening. When several burrows were in close proximity to each other (<0.5 m), the number of burrows baited was left to the discretion of the applicator. Four people walking abreast approximately 13 m (15 yards) apart applied bait. Bait application began at 5:15 a.m. and ended at 8:15 a.m. Baits were applied as follows: 0.1%, 0.2%, and 0.3%. Baits were formulated on-site prior to each application. Approximately 4,300 burrows were treated with 59 kg of bait. Bait application required approximately 8 man hours or 0.7 man hours/ha.

Percent changes in mean numbers of ground squirrels observed pretreatment to posttreatment were computed for each plot. Substantial changes, if any, in the control plot were removed from strychnine plots by adjusting posttreatment strychnine treatment means using the following formula:

$$\text{Adjusted posttreatment strychnine mean} = \frac{\text{posttreatment strychnine mean} \times \text{pretreatment control mean}}{\text{posttreatment control mean}}$$

Adjusted posttreatment means were then used to compute adjusted percent reductions in the number of ground squirrels observed in strychnine treatment plots.

Analysis of covariance was used to examine the effect of strychnine concentration on the number of ground squirrels observed.

The analysis of covariance model was:

$$Y = b_0 + b_1X + b_2D$$

where: Y = number of ground squirrels observed; X = strychnine percentage in bait; D = 0 for pretreatment count and 1 for posttreatment count and b_0, b_1, b_2 were the coefficients to be estimated.

RESULTS

Pretreatment examinations of marked burrows showed, with few exceptions, all marked burrows were active all 6 days. Posttreatment examinations of burrows also were generally classified active and did not reflect changes in ground squirrel populations on plots. Because of this, the marked burrow method was not used to estimate treatment effects.

The number of ground squirrels observed aboveground declined in all plots following bait application (Table 1). The percentage reductions were as follows: control plot 36%; 0.1% strychnine plot 81%; 0.2% strychnine plot 82%; and 0.3% strychnine plot 92%.

Table 1. Aboveground ground squirrel counts before and after application of strychnine-treated cabbage baits.

Treatment	PRETREATMENT daily counts						$\bar{X}$ (SE)	POSTTREATMENT daily counts						$\bar{X}$(SE)
control	15	16	6	16	11	8	12.0(1.8)	12	10	11	5	4	4	7.7(1.5)
0.1% strychnine	26	16	6	15	21	17	17.0(2.7)	6	4	3	1	2	3	3.2(0.7)
0.2% strychnine	20	31	16	24	19	9	19.8(3.0)	5	4	4	3	3	3	3.7(0.3)
0.3% strychnine	23	32	24	21	25	14	23.2(2.4)	4	1	3	1	2	0	1.8(0.6)

Adjusting posttreatment strychnine treatment means gave adjusted reductions of 71%, 71%, and 88% for the 0.1%, 0.2%, and 0.3% strychnine plots respectively.

The analysis of covariance regression equation shown in Figure 1 was statistically significant ($F_{2,45} = 42.08$). Partial regression coefficients indicated the percentage of strychnine had a significant ($T = -1.74$) negative effect on the number of ground squirrels observed and the pretreatment vs. posttreatment covariate had a highly significant ($T = -5.34$) negative effect on the number of ground squirrels observed.

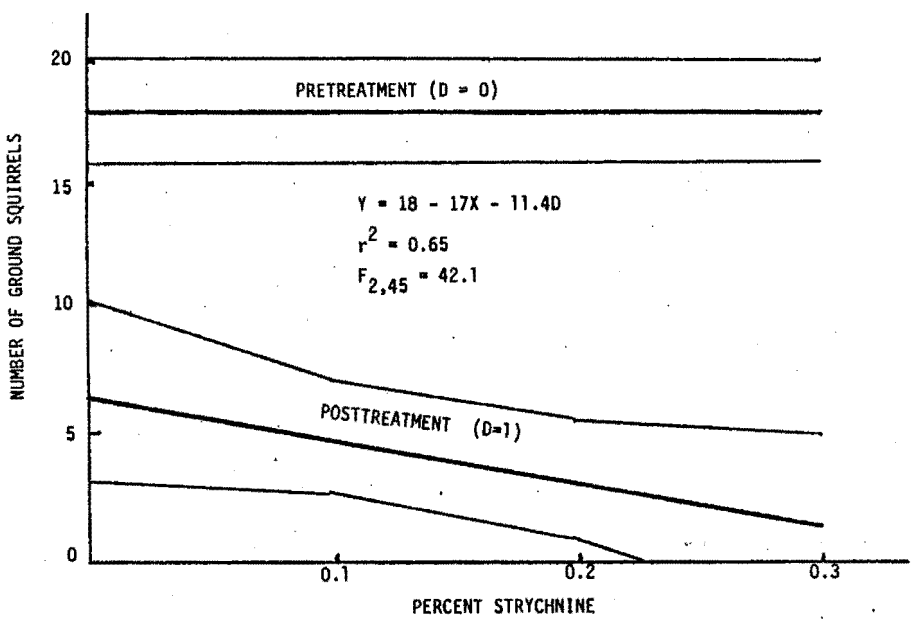

Fig. 1. Relationship between strychnine percentage in chopped cabbage bait and the number of ground squirrels observed. Regression lines are shown with 95% confidence limits.

DISCUSSION

In this test, it was obvious that the degree of activity at marked burrows had dropped drastically. For example, instead of innumerable tracks present, there would often be one or two sets of tracks at many openings. Similar reductions in urine spots and fecal pellets also were evident. The failure of the marked burrow system to reflect change in ground squirrel populations was due to lack of sensitivity in the classification scheme. It may be possible to increase sensitivity by changing the classification from active or inactive to a graded system of activity levels based on the amounts of signs present.

I attribute the primary cause of the covariate negative effect and the decline in the control plot to be weather factors (rain, clouds, wind) which reduced ground squirrel activity on all plots during the last 3 days of posttreatment censusing (Table 1). Weather factors have been shown to influence aboveground activity of ground squirrels (Turner 1972, Clark 1970, Clark and Denniston 1970). It is possible that part of the 36% reduction in ground squirrel activity in the control plot was due to some control plot squirrels eating bait in one or more of the adjoining plots. I do not believe this to be the case since no dead ground squirrels were found in the control plot, no animals were observed feeding on dead ground squirrels in the control plot, and the major decline in the control plot took place during the last 3 days of posttreatment censusing (Table 1) which were 8, 9, and 10 days after bait was applied. Past experience with strychnine cabbage bait has indicated that most mortality occurs within the first 2 days after bait is applied. This may be due to drying up of the bait as it lays exposed, making it unattractive to surviving ground squirrels and/or bait shyness in ground squirrels which consumed sublethal doses within 48 hours.

The three strychnine treatments reduced ground squirrel populations considerably in this test. Although strychnine concentration had a significant negative effect on the number of ground squirrels observed posttreatment, there were no statistically significant ($P<0.05$) differences among specific strychnine treatments. Further testing is needed to evaluate the efficacy of different strychnine concentrations.

A "Rule-of-thumb" for ground squirrel control programs is that 90% or greater reduction is necessary for effective control (Salmon et al. 1981, Stroud 1983). The desirability of a 90% or greater reduction is related to the recovery potential of the remaining ground squirrel population rather than to the difference in immediate damage reduction it affords over a 70% reduction for example. For illustration purposes, if you assume a postcontrol ground squirrel population doubles after each breeding cycle, a population reduced by 88% will return to approximately the precontrol level after three cycles and a population reduced by 70% would recover after about two cycles. A population reduced by 95% would take about five cycles to recover. For this reason, reducing strychnine concentration may not be advisable if 90% or more control is not achieved in future tests with reduced concentration baits.

In this test, each tablespoon of bait was scattered over approximately a three square foot area beside each burrow opening. This is the only application method the U. S. Environmental Protection Agency (EPA) currently allows for strychnine ground squirrel baits. Another method, no longer permitted, involved scattering bait in swaths, leaving an untreated area between each swath. In a typical application, bait would be broadcast over a 15 m wide swath with 45 m of untreated ground separating each treated swath. The overall application rate was usually 11.2 kg/ha (10 lbs/acre) or less. This method is no longer permitted because EPA probably perceived it to be more hazardous to non-target animals than the individual burrow baiting method. A comparison of these two methods may afford some insight as to their relative non-target animal hazards.

In this test, approximately 0.12 ha was covered with bait (three square feet/burrow times number of burrows treated) compared to 3.04 ha in a strip broadcast application where 25% of the total area would be baited. Bait density on the three feet of ground near a burrow also differs from bait density on a treated strip. In this test, bait density was 49.2 g/m^2 versus 4.5 g/m^2 on a treated strip. The application rate in this test was 4.9 kg/ha (4.3 lb/acre) versus a maximum of 11.2 kg/ha (10 lbs/acre) in the strip broadcast method. It appears that a non-target animal would be more likely to find bait in the strip broadcast

method since more bait is used and more area contains bait. Once contacted, however, the closer proximity of bait pieces in the burrow application method increases the likelihood of an animal consuming a lethal dose. The net effect of these differences is presently unknown. Additional testing is needed to evaluate the relative non-target species hazard of these two methods.

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