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ABSTRACT: Effectiveness of four cabbage baits was tested on Belding (Spermophilus beldingi) or Townsend (S. townsendi) ground squirrels. Ground squirrel activity reduction and number of above ground deaths/ 100 lb. bait applied were as follows: 0.00625% sodium monofluoroacetate - 94 1/2%, 2-1/3; 0.29% strychnine alkaloid - 86%, 17; 0.19% strychnine alkaloid - 73 1/2%, 10. A 0.8% zinc phosphide bait was not well accepted; activity was reduced 39%. Two cottontail rabbits (Sylvilagus nuttalli) and one badger (Taxidea taxus) were found dead in treatment fields after treatment.

In 1975 the Nevada State Department of Agriculture was granted authority to regulate and control vertebrate pests.

The primary vertebrate program, conducted by the Department, has been a ground squirrel control program in the northern portion of Nevada. Three species of ground squirrels are controlled by this program. These species are: Richardson (Spermophilus richardsoni), Belding (S. beldingi) and Townsend (S. townsendi) ground squirrels.

Historically, strychnine grain baits have been used to control ground squirrels in Northern Nevada. The effectiveness of these has been inconsistent due to poor acceptance by ground squirrels. Because of this, the Department utilizes a chopped cabbage bait with 0.29% strychnine alkaloid as the toxicant. During the 1976 control season approximately 25,000 kilograms (kg) (55,000 1b) of bait were sold.

At the end of the 1976 control season questionnaires were sent to bait purchasers to obtain information about various aspects of the program. Questionnaires returned (N = 84, 67% returned) indicated the program was well received and the bait effective. There were also reports of nontarget deaths which prompted the Department to examine alternate control materials.

In conjunction with the University of Nevada, tests were conducted from April 15 to May 3, 1977 at the University Ranch located approximately 65 kilometers (40 miles) north of Austin, Nevada. In these tests the following were examined: differences in above ground deaths between strychnine and sodium monofluoroacetate (1080) cabbage baits; effectiveness of a reduced strength strychnine cabbage bait; and effectiveness of a 0.8% zinc phosphide cabbage bait.

EXPERIMENTAL PROCEDURE

Twenty Belding ground squirrel burrow entrances were marked in each of three adjoining 15 hectare (ha) (40 acre) alfalfa (Medicago sativa) fields. Marked entrances were checked daily and "active" entrances smoothed down. Observation areas were set up in each field and ground squirrel activity recorded daily. In each observation area, five sweeps were made with a pair of 7 x 50 mm binoculars. The highest number of ground squirrels observed in a particular sweep was recorded. Treatments for each field were as follows: north field, 0.29% strychnine cabbage; middle field, control and south field, 0.00625% 1080 cabbage. One week after bait was applied the control field was treated with 0.19% strychnine cabbage.

Between 6:00 and 9:00 A.M. bait was hand broadcast from the bed of a truck at a rate of 11 kg/ha (10 lb/acre) in alternating 14 meter (m) (45 foot) swaths. Due to differences in ground squirrel populations among the fields, the amounts of bait applied were as follows: 1080 cabbage, 135 kg (300 lb); 0.19% strychnine cabbage, 70 kg (150 1b) and 0.29% strychnine cabbage 45 kg (100 1b).

The 0.8% zinc phosphide cabbage bait was hand broadcast in a one ha concentration of Townsend ground squirrels at 11 kg/ha (10 lb/acre). Twelve burrow entrances were marked and activity recorded.

RESULTS AND DISCUSSION

Control Effectiveness

The greatest reduction in ground squirrel activity occurred in the 1080 cabbage treatment area. The second greatest reduction in activity occurred in the 0.29% strychnine treatment area followed by the 0.19% strychnine area. The 0.8% zinc phosphide cabbage area had the smallest reduction in activity (Table 1). The control field showed a 38 percent reduction in above-ground activity. I feel this reduction was due to the proximity of the control observation area to the 0.29% strychnine treatment area. In support of this contention, one dead ground squirrel was found within the observation area the day following bait application.

Most dead squirrels were found the day bait was applied or the following day. No dead squirrels were found after four days post treatment. Maximum control therefore was probably achieved approximately four days after bait application. In some treatments this is illustrated by a continuing decline in ground squirrel activity following the initial reduction (Appendix 1). In computing post treatment activity the reduction in activity would have been higher if only the later observations were used in computations. For treatments where a continuing decline in activity was recorded the activity reduction estimates therefore are conservative.

Table 1. Changes in ground squirrel activity with different chopped cabbage bait

Treatment	Pre-treatment Observation Days	Pre-treatment Mean	Pre-treatment (Range)	Post-treatment Observation Days	Post-treatment Mean	Post-treatment (Range)	Activity Reduction
Number Active Burrows							
1080	4	19.8	(19-20)	4	1.5	(1 - 3)	92%
.29% Strychnine	4	14.8	(15-18)	4	2.0	(1 - 3)	86%
Control	4	17.8	(15-20)	6	18.2	(17 - 19)	0%
.19% Strychnine	6	18.2	(17-19)	6	6.2	(5 - 9)	66%
.8% Zinc Phosphide	7	12.0	(12)	7	7.3	(6 - 10)	39%
Number Squirrels Observed							
1080	4	13.0	(12-15)	6	0.3	(0 - 1)	97%
.29% Strychnine	4	11.8	(9-13)	6	1.7	(1 - 4)	86%
Control	4	7.5	(6- 9)	6	4.7	(4 - 5)	38%
.19% Strychnine	6	4.7	(4- 5)	7	0.9	(0 - 2)	81%

The percent reduction in the number of ground squirrels observed in the 0.19% strychnine treatment may have been higher if the pre-treatment population had not been reduced somewhat by the application of 0.29% strychnine treatment one week earlier.

Both of the strychnine baits effectively reduced ground squirrel numbers in the treatment areas. The 1080 bait appeared to be the most effective bait applied.

These three baits were applied when the alfalfa in the test fields had greened up and was about 5 cm (2 in) in height. Since alfalfa is known to be highly preferred by ground squirrels (Sauer, 1976) the acceptance of these cabbage baits attests to their attractiveness.

Zinc phosphide cabbage bait was not well accepted. Casual observation did not reveal a drastic reduction in above ground activity after bait application, however, burrow activity was reduced by about 40 percent (Table 1).

Zinc phosphide cabbage bait may pose a potential hazard to the bait formulator and applicator since phosphine gas is given off when moist baits are used (Clark, 1975). In this test, even though all mixing was done out of doors, the characteristic garlic-like odor of zinc phosphide was always present. During the last few minutes of bait distribution the other person involved and I experienced mild headaches which lasted about ten minutes. Though a headache is not listed as a symptom of zinc phosphide poisoning (Clark, 1975) our headaches may have resulted from inhaling very low levels of phosphine gas during formulation and distribution.

Above Ground Deaths

The numbers of dead ground squirrels recovered above ground in each treatment area were as follows: 0.29% strychnine, 17; 0.19% strychnine, 15; and 0.00625% 1080, 7. Since ground squirrel populations differed in each field, relating the numbers of dead squirrels recovered to the amount of bait applied gives a more meaningful comparison of differences in above ground deaths. The numbers of dead ground squirrels recovered for each 100 lb. of bait applied were as follows: 0.29% strychnine, 17; 0.19% strychnine, 10; and 0.00625% 1080, two and one-third. From these data the 1080 bait appears to cause fewer ground squirrels to die above ground than either of the strychnine baits.

Nontarget Deaths

Carcasses of nontarget species were not recovered; therefore, strychnine poisoning though likely cannot be proven. Five days after treatment two dead cottontail rabbits (Sylvilagus nuttalli) were found in the 1080 treatment field. Since cottontails generally feed in or near cover (Chapman, 1975) cottontail bait consumption can be reduced by not applying bait within one swath width of brush bordered edges of a field. A one swath width interval would not reduce bait availability to ground squirrels.

Four days after the 0.19% strychnine bait was applied a dead badger (Taxidea taxus) was found in the treatment field. This badger resided in the treatment fields and ground squirrels probably comprised most, if not all, of its diet. When the 0.19% strychnine bait was applied the remaining concentration of unpoisoned ground squirrels in the area was removed. The chances of the badger consuming a dead or dying ground squirrel were thus increased.

This badger resided in the treatment fields and its burrows destroyed or covered alfalfa and represented a hazard to farm equipment. Despite the fact that the badger's diet consisted of ground squirrels this beneficial aspect was probably outweighed by the actual and potential damage caused by its burrowing activities.

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Appendix 1. Pre-and post-treatment ground squirrel activity.

	Date	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	4/25	5/3
North Field	No Active Burrows	10	16	15	18	*	8**	3	1	2	2	***	
0.29% Strychnine Cabbage	No Squirrels Observed	9	12	13	13	*	4	1	2	1	1	***	1
Middle Field Control	No Active Burrows	15	18	20	18		19	18	19	18	18	17	
	No Squirrels Observed	6	7	9	8		5	4	5	5	4	5	
South Field 1080 Cabbage	No Active Burrows	19	20	20	20	*	19**	3	1	1	1	***	
	No Squirrels Observed	13	12	15	12	*	1	1	0	0	0	***	0

	Date	4/20	4/21	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29	4/30	5/1	5/2	5/3
Middle Field	No Active Burrows	19	18	19	18	18	17	*	11**	9	7	6	5	5	5
0.19% Strychnine Cabbage	No Squirrels Observed	5	4	5	5	4	5	*	0	1	0	1	2	1	1
.8% Zinc Phosphide	No Active Burrows	12	12	12	12	12	12	*	10	6	7	7	7	7	7

* Bait applied.
** Count not valid; burrows not checked on previous day.
*** Count not made.

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