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A field evaluation of zinc phosphide bait

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Agricultural and Biological Sciences Division
Technical Services Bureau
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A FIELD EVALUATION OF ZINC PHOSPHIDE BAITS FOR CONTROLLING
RICHARDSON AND COLUMBIAN GROUND SQUIRRELS

by

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ABSTRACT

Field trials were conducted to determine the efficacy of zinc phosphide baits on Richardson and Columbian ground squirrels in Montana. The zinc phosphide grain formulations tested reduced Columbian ground squirrels an average of 47.8% on prebaited plots and 23.9% on plots without prebait when applied in May. In July, average reduction increased to 70.6% with prebaiting. Richardson ground squirrel activity was reduced an average 96.8% when bait was applied before vegetation green-up in the spring. Richardson ground squirrel activity was reduced 55.7% and 78.5%, respectively, for mid-spring (after vegetation green-up) and summer zinc phosphide grain baitings. Pelleted zinc phosphide baits resulted in an average Richardson ground squirrel reduction of 32.0%

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INTRODUCTION

Richardson (*Spermophilus richardsonii*) and Columbian (*S. columbianus*) ground squirrels can cause significant annual economic losses to Montana agriculture. Montana ranchers, farmers, and government agencies need a means of controlling these losses. Rodenticides, such as strychnine for above-ground uses and sodium monofluoroacetate (1080), traditionally used to reduce crop and equipment damage caused by field rodents are no longer available because of recent cancellations of these registrations by the U.S. Environmental Protection Agency. Burrow fumigants and anticoagulant rodenticides used in bait stations may effectively reduce damage on small areas but are not economical or are too labor intensive to use on the large acreages often populated by ground squirrels in Montana. Zinc phosphide, the only currently registered, alternative rodenticide that could economically be applied to larger acreages, has not proven to be effective or well accepted by the ground squirrel species in Montana (Matschke 1979; Baril 1980; Swick 1980; Sullivan and Sullins 1985). Some new formulations of zinc phosphide baits have been recently registered in Montana but not field tested under Montana conditions.

OBJECTIVE

The objective of this study was to test the efficacy of zinc phosphide baits on Richardson and Columbian ground squirrels at three stages of vegetative growth during the squirrels' active season. The vegetative growth stages in which the baits were tested included the period before vegetation green-up in the spring (Richardson only), and mid-spring and mid-summer periods for both species.

STUDY AREAS

The Columbian ground squirrel portion of this study was conducted on pasture or alfalfa fields located in Lewis and Clark County near Helena, Montana, and Flathead County near Kalispell, Montana.

The Richardson ground squirrel study plots were located on pasture, alfalfa, or winter wheat fields in Fergus County near Lewistown, Montana, and in Park County near Wilsall and Livingston, Montana.

Vegetation height on the study plots varied from bare ground to 4 inches. Daily temperatures ranged from the 30°F to 60°F during the early spring period. The mid-spring and summer periods ranged from lows of 40°F to 60°F to highs of 70°F to 90°F, respectively.

METHODS

Three formulations of zinc phosphide bait were tested for efficacy on Richardson and Columbian ground squirrels. Baits tested were: Hopkin's 2.0% zinc phosphide bait on hulled, rolled oats; Hopkin's 2.0% zinc phosphide pellets; and D & H Formula Rodent

Rid-R, a 2.0% zinc phosphide bait formulated on hulled, rolled, partially cooked oats.

The test baits were applied in March, April-May and July to compare efficacy over the range of the squirrels' activity season. The bait was applied to a total of 21 test plots. Six additional plots were used as nontreatment controls to monitor squirrel activity. Columbian plot 2 was prebaited with nontoxic oats twice, two days apart. Columbian plots 6 and 7 received no prebait. All other Columbian and Richardson plots were prebaited once, two days prior to bait application. All baits were applied by hand, using calibrated dippers, at the rate of one teaspoon (5g) of bait scattered on bare ground near each burrow.

Efficacy was determined by counting active ground squirrels pretreatment and posttreatment. Visual counts using binoculars were obtained on marked counting areas within treated and control plots. Three counts were made at five minute intervals on each plot for three consecutive days, two days before and after treatment. The highest three counts were averaged to provide pretreatment and posttreatment activity indices (AI) for each plot. Percent reduction in activity caused by baiting was computed as follows:

$$\text{Percent Reduction} = \frac{\text{Pretreatment AI} - \text{Posttreatment AI}}{\text{Pretreatment AI}} \times 100$$

In Activity

All treated sites were observed for ground squirrel and nontarget mortalities.

RESULTS

Pelleted Bait

Reduction in ground squirrel activity on Richardson plots 1,6,7, and 9 (Table 2) baited with zinc phosphide pellets varied from 11.8% to 52.7% and averaged 32%.

Oat Bait - Spring: Before Green-up

Richardson ground squirrel test plots 13 through 16 (Table 2) that were baited with zinc phosphide oats prior to vegetation green-up averaged 96.8% (range: 93.9% to 99.2%) reduction in activity.

The prebait was readily consumed within the same day of application. Consumption of the zinc phosphide bait was variable. Some bait spots were completely consumed. Most bait spots showed partial consumption. Some appeared untouched.

Table 1. Percent change in Columbian ground squirrel activity after application of 2.0% zinc phosphide bait.

Plot No.	Zinc Bait	Applic. Date	Applic. Site	% Change	Ave. % Change
1 ^a	Control	-	Pasture	-2.8	
2 ^b	Oats ^{d,f}	4/25/90	Pasture	-86.9	-86.9
3 ^b	Control	-	Alfalfa	-2.3	
4 ^b	Oats ^c	5/3/90	Alfalfa	-43.8	-47.8
5 ^b	Oats ^c	5/3/90	Pasture	-51.8	
6 ^b	Oats ^{c,e}	5/4/90	Pasture	-13.8	-23.9
7 ^b	Oats ^{c,e}	5/4/90	Pasture	-34.7	
8 ^b	Control	-	Pasture	-6.7	
9 ^b	Oats ^c	7/12/90	Pasture	-78.3	-70.6
10 ^b	Oats ^c	7/12/90	Alfalfa	-62.9	

a - Lewis and Clark County, MT; b - Flathead County, MT; c - D & H Formula Rodent Rid-R, 2.0% zinc phosphide on hulled, rolled oats; d - Hopkins Chemical Co., 2.0% zinc phosphide on hulled, rolled oats; e - No prebait applied; f - Two prebait applications.

Oat Bait - Mid-spring: After Green-up

Prebaited Richardson ground squirrel plots baited with zinc phosphide oats (plots 2,3,4, and 8, Table 2) averaged 55.7% (range: 42.3% to 75%) reduction in activity.

Columbian ground squirrel plots that were baited with zinc phosphide in the spring (plots 4 - 7, Table 1) resulted in an average reduction of 47.8% (range: 43.8% to 51.8%) and 23.9% (range: 13.0% to 34.7%), respectively, with and without prebaiting. One Columbian plot with sparse vegetation (plot 2, Table 1) was prebaited twice prior to bait application and yielded a 86.9% reduction in activity.

Prebait was consumed in variable amounts but was considered good for both species during the spring baiting period. Considerable amounts of zinc phosphide bait were still present after posttreatment activity counts were conducted.

Oat Bait - Summer

Prebaited plots treated in the summer with zinc phosphide oats averaged 78.5% (range: 76.4% to 80.5%) reduction for Richardson ground squirrels (plots 11 and 12, Table 2) and 70.6% (range: 62.9% to 78.3%) reduction for Columbian ground squirrels (plots 9 and 10, Table 1).

TABLE 2. Percent change in Richardson ground squirrel activity after application of 2.0% zinc phosphide bait.

Plot No.	Zinc Bait	Applic. Date	Applic. Site	% Change	Ave. % Change
13 ^b	Oats ^d	4/3/91	Pasture	-97.0	-96.8
14 ^b	Oats ^d	4/3/91	Pasture	-99.2	
15 ^b	Oats ^d	4/3/91	Pasture	-93.9	
16 ^b	Oats ^d	4/3/91	Pasture	-97.2	
17 ^b	Control	-	Pasture	5.6	
1 ^a	Pellets ^c	4/7/90	Alfalfa	-12.8	-32.0
6 ^a	Pellets ^c	4/8/90	Alfalfa	-11.8	
7 ^a	Pellets ^c	4/8/90	Wheat	-52.7	
9 ^a	Pellets ^c	4/8/90	Wheat	-50.8	
2 ^a	Oats ^d	4/7/90	Alfalfa	-42.3	-55.7
3 ^a	Oats ^d	4/7/90	Alfalfa	-46.6	
8 ^a	Oats ^d	4/8/90	Alfalfa	-59.0	
4 ^a	Oats ^d	4/8/90	Pasture	-75.0	
5 ^a	Control	-	Pasture	5.8	
11 ^b	Oats ^d	7/13/90	Grass hay	-76.4	-78.5
12 ^b	Oats ^d	7/13/90	Grass hay	-80.5	
10 ^b	Control	-	Grass hay	13.3	

a - Fergus County, MT; b - Park County, MT; c - Hopkins Chemical Co., 2.0% zinc phosphide pellets; d - Hopkins Chemical Co., 2.0% zinc phosphide on hulled, rolled oats.

On each study plot prebait was completely consumed prior to bait application. Considerable amounts of zinc phosphide bait were still present at the end of the study period.

DISCUSSION

The pelleted zinc phosphide formulation tested in this study proved least effective in average percent reduction of ground squirrel activity. These results agree with previous Montana studies (Sullivan and Sullins 1985; Baril 1980) that have shown pelleted baits to be poorly accepted by ground squirrels. Since green vegetation and seeds comprise the majority of both ground squirrel species' diets, pellets appear not to be

preferred in field conditions where alternative food sources are available. Pelleted bait did appear to be more effective in the wheat field plots (52.7% and 50.8% reduction) compared to the alfalfa plots (12.8% and 11.8% reduction). The wheat plants were small and provided little forage particularly near the burrows where the squirrels had cropped it down. The alfalfa plants had broken dormancy and provided the squirrels sufficient forage to compete with the test bait. However, efficacy was still far below that considered adequate to reduce rodent caused damage.

One possible reason for poor pellet acceptance may be in the choice of the type of material used as prebait. All prebaited plots in this study were prebaited with nontoxic oats following product label directions. Since the purpose of prebaiting is to accustom the target species to a new food source, the same material used as the bait carrier should be used as the prebait. Using nontoxic pellets as prebait may increase the acceptance of pelleted baits.

The value of prebaiting zinc phosphide grain baits was demonstrated on the Columbian plots. Those plots receiving no oat prebait (plots 6 and 7) averaged 23.9% reduction in activity. Columbian plots baited during the same time period with prebait (Columbian plots 4 and 5) averaged 47.8% reduction in activity. Although consumption of the prebait was good and acceptance increased, efficacy was still not sufficient to adequately reduce rodent caused damage. Apparently, there is some aversion, perhaps odor or taste, to the zinc phosphide by both species.

A comparison of efficacy with and without prebaiting was not made for Richardson ground squirrels in this study, but other Montana studies have shown the increased acceptance of zinc phosphide baits after prebaiting (Swick 1980; Sullins 1979a,b).

One of the Columbian plots (plot 2) was prebaited twice prior to bait application and resulted in 86.9% reduction in activity. However, very sparse vegetation which limited alternate food sources was likely an important factor in obtaining good efficacy on this plot.

Prebaiting twice would triple the labor required in an operational rodent control program and may not be practical or acceptable by applicators when baiting large acreages. Further study may be needed to determine the economics and effectiveness of multiple prebait applications before application of zinc phosphide baits.

Richardson ground squirrel control operations conducted after the squirrels emerge from hibernation (February - March) but prior to spring green-up (April - May) has been a common practice in Montana. This usually resulted in good control of Richardsons when strychnine grain baits were used before the cancellation of this use. Application of zinc phosphide oat bait during this period resulted in the best efficacy of the bait trials conducted. This time period is probably the best choice when zinc phosphide bait is used for Richardson ground squirrel control in Montana.

In practice, however, pregreen-up is one of the most difficult periods to apply bait. The

application must be carefully timed to assure that the entire squirrel population has emerged from hibernation. Time and duration of emergence varies from year to year because of weather and ground temperature. It requires that the applicator monitor the squirrel population carefully to prevent bait application while a portion of the population is still hibernating. Weather conditions are unpredictable at this time and sudden rain, snow and cold temperatures are common. The window of time when squirrel populations are fully active before vegetation green-up is quite short. Selecting a 4 or 5 day period of good weather for bait application during this period is sometimes not possible.

Pregreen-up baiting is usually not possible for the Columbian ground squirrel. The Columbian commonly emerges from hibernation when green vegetation is already present and their acceptance of grain baits at this time is generally poor. This has restricted effective baiting operations for Columbians to summer periods between juvenile emergence and estivation.

Efficacy of the test baits on both species increased in the summer trials compared to the mid-spring baitings. The increase availability of seeds and grain likely increases the prevalence of these items in the diet of both species. This likely increases the acceptance of grain baits, in general, resulting in greater efficacy.

In summary, zinc phosphide baiting before vegetation green-up provide acceptable control of ground squirrels. Zinc phosphide grain and pellet formulations tested in mid-spring and summer, with the exception of that used on the multiple prebaited plot, produced control levels below that generally obtained with rodenticides such as strychnine and Compound 1080. The test baits with a single prebaiting applied mid-spring or summer did not provide adequate reduction in squirrel numbers for long term, economical relief of crop and equipment damage.

RECOMMENDATIONS

Zinc phosphide baits are the only presently registered alternative rodenticide for Richardson and Columbian ground squirrels that can be economically used for large acreage applications. For applicators to obtain the best possible results the following recommendation should be considered:

1. Use zinc phosphide baits formulated on oats. Use of pelleted baits or other carriers is likely to give poor efficacy.
2. Test for bait acceptance prior to application. Delay baiting if acceptance of test bait is poor.
3. Prebait treatment area once, more often if feasible, with nontoxic oats two days before application of the zinc phosphide bait.

4. Apply bait during periods of best bait acceptance. In Montana this is usually occurs prior to green-up of vegetation in spring and from mid-June through July. When possible, avoid bait application when abundant green vegetation is present.
5. Even under the best conditions, efficacy with zinc phosphide baits may be less than formerly obtained with other rodenticides.

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