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Acceptance of Various Rodenticide Baits under Field conditions by Columbian and Richardson Ground Squirrels

By

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Abstract

Six rodenticide baits were presented under field conditions to Columbian and Richardson ground squirrels to assess each species acceptance of each bait formulation. The bait formulations tested were four grain based pelleted baits; two containing zinc phosphide and one each containing bromadiolone and chlorophacinone, and two whole grain baits; one each treated with bromadiolone and chlorophacinone. Nearly 100 percent of the whole grain baits were consumed within two days after presentation of the bait. Acceptance of the bromadiolone and chlorophacinone pellets range from 20-100 percent after four days. Little or no acceptance of the zinc phosphide pellets was observed.

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Introduction

Before large scale field testing to determine the efficacy of new field rodenticide baits it is prudent to evaluate the acceptance of the bait formulations by the target rodent. This evaluation is best done under actual field conditions where the test baits must compete with existing forage as they must under an operational control program. This type of evaluation can be done quickly, within a small physical area and by one or two persons. It allows a comparison of several bait formulations applied at the same time to a relatively homogeneous rodent population. With this technique differences in acceptance among the various bait formulations should indicate the rodents' preference and not differences in weather, stage of life cycle or subtle, unknown difference among rodent populations. Although laboratory feeding trials can give an indication of bait palatability they cannot simulate field situations. Since the target rodents must actively select the rodenticide bait, which is a new and unknown item suddenly placed in their environment, it must be palatable and compete well with the rodents' existing dietary items. This can only be evaluated under field conditions.

Study Objective

The objective of this study was to evaluate the acceptance of 6 rodenticide bait formulations by the Columbian and Richardson ground squirrel in Montana.

Methods

Study sites for the Columbian and Richardson ground squirrels were located on dryland pastures in Lewis and Clark County and Fergus County, respectively. Although the areas had been grazed no livestock were present on the sites at the time of the study. Each study site was occupied by ground squirrels in moderate to high numbers and was approximately 2 acres in size. Vegetation on the sites, primarily grasses, was sparce and varied in height from 1 to 6 inches. Below normal moisture conditions in Montana during 1985 inhibited vegetation growth in nonirrigated areas and most plants matured 2 to 3 weeks ahead of normal.

Six rodenticide bait formulations were presented to each squirrel species. A seventh, nontoxic bait, known to be highly acceptable to both species, was also presented to the squirrels. The test baits are listed in Table 1.

Each test bait was placed on the ground in a 6 to 8 inch diameter bare area near an active ground squirrel burrow. Each test bait was applied to 50 spots on separate but closely adjacent plots on the study site. The bait spots were marked using wire surveyor's flags with a notation on each flag indicating the bait formulation applied and the number of each bait spot.

TABLE 1. Bait Formulations Presented to Columbian and Richardson Ground Squirrels.

Active Ingredient	Bait Carrier	Percent Active Ingredient
Bromadiolone	Whole wheat	0.01
Bromadiolone	3/16" dia grain based pellet	0.01
Chlorophacinone	Whole wheat	0.01
Chlorophacinone	3/16" dia grain based pellet	0.01
Zinc phosphide	3/16" dia grain based pellet-A	2.0
Zinc phosphide	3/16" dia grain based pellet-B	2.0
None	Whole oat	0.0

Bait was applied by hand using a measured bait dipper. The dipper was made from a standard 3/4 inch copper pipe cap attached to the end of a 12 inch rod. The inside measurements of the pipe cap are 2.24 cm in diameter by 1.84 cm in depth (level full volume = 7.25 cm^3).

The average preapplication weight was determined for each formulation using 10 samples from the measured dipper. Preapplication counts of grain kernels or pellets of each formulation were also taken from 10 samples to give an average number of kernels or pellets initially applied.

Following application each bait spot was monitored once a day for 4 consecutive days. Each day the number of grain kernels or pellets remaining at each bait spot was counted and recorded individually by bait formulation and bait spot number.

Those bait formulations (zinc phosphide) that showed little if any acceptance by the squirrels were retrieved at the end of 4 days. Bait spots were collected individually and placed over an 1/8 inch screen. All bait material not passing through the screen was weighed to the nearest 0.1 gram. These weights were compared with 4 day postapplication weights of the same bait formulations where ground squirrels were excluded from the bait. Ten preweighed bait dippers of each zinc phosphide formulation were placed individually in petri dishes filled with soil from the study site. The petri dishes were placed within one inch wire mesh cages and left on the study site for 4 days. At the end of 4 days the control baits were individually collected, screened and weighed to the nearest 0.1 gram.

Because of the small plot size reliable determination of efficacy for the various formulations was not expected. An effort was made to detect any gross decline in squirrel activity. This was done by applying a standard dipper of whole oats to each of the 50 bait spots on each of the 6 bait plots and the control plot, 7 and 14 days post treatment. It was felt that any gross differences in oat consumption between the bait plots and the control plot could be attributed to decreased squirrel activity caused by squirrel mortality resulting from bait consumption.

This study was conducted between mid-June and mid-July 1985. Natural seed production was occurring on the sites and observations indicated the ground squirrels were readily consuming these seeds. The weather was unseasonably hot and dry. Daytime temperatures exceeded 90 degrees F and no rain fell during the 4 day exposure periods of the 6 test baits.

Results

Consumption of the test baits presented to Columbian and Richardson ground squirrels was generally consistent between the two species. The whole grain baits were the most readily accepted. Near 100 percent consumption of all bait spots for the

wheat baits and the whole oat control bait occurred within two days postapplication (Table 2 and 3).

The rate of consumption for the bromadiolone and chlorophacinone pelleted bait was more variable and occurred more slowly (Table 2 and 3). The Columbian ground squirrels showed a pattern of minor consumption the first 2 to 3 days with a sudden increase in consumption on day 3 and 4. Richardson ground squirrels showed a similar pattern in their consumption of the bromadiolone pellets but with a slower period of initial acceptance. With the exception of 9 bait spots little acceptance of the chlorophacinone pellets was shown by the Richardson.

Little reduction in the number of zinc phosphide pellets could be observed during the post application pellet counts. When the 4 day post application weights were compared to the control weights an average decrease in weight of 7.9 and 9.7 percent for the Zinc A bait and 0.2 and 28.2 percent for the Zinc B bait was observed for the Columbian and Richardson ground squirrel plots, respectively (Table 4). Because of the degree of pellet compaction and/or pellet composition the Zinc B pellets fractured and crumbled noticeably more than the Zinc A formulation. This may have affected the amount of recovery of the Zinc B formulation on the Richardson plot.

Applications of whole oats at 7 and 14 days post treatment indicated no reduction in squirrel activity on the test plots. All of the oats at each of the 50 bait spots on all the test bait and control bait plots were consumed within 2 days after application with the majority of the oats consumed the first day.

Discussion

Timing rodenticide applications when the target rodents will readily accept the rodenticide bait is one of the basic management criteria for obtaining good rodent control. For grain bait rodenticides one of the times of good acceptance by ground squirrels usually coincides with the general drying of the environment and the natural production of seed from maturing plants. In Montana these conditions begin mid-June through mid-July and were occurring on the study sites during this study. Application of a rodenticide on a whole grain carrier during a time when seeds are a normal part of the squirrels' diet greatly enhances the acceptance of the bait because it has the appearance of an already familiar dietary item. For this reason, it was not unexpected that the whole grain baits used in this study were well accepted. The somewhat better acceptance of the oats over the wheat may be in part caused by the oats more closely resembling the natural seeds present on the site. Wheat kernels, although similar, were likely unfamiliar enough to cause some initial avoidance.

The slower acceptance of the pelleted anticoagulant baits may have resulted from their lack of resemblance to any other food

Table 2. Acceptance of Bromadiolone and Chlorophacinone treated baits by Columbian ground squirrels under field conditions.

Number of Kernels or Pellets Remaining Per Site n Days Post Treatment

Site No.	Control (Mean #/Site=143) Whole Oats	Bromadiolone (Mean #/Site=126) Wheat		Bromadiolone (Mean #/site=27) Pellets			Chlorophacinone (Mean #/Site=157) Wheat		Chlorophacinone (Mean #/Site=21) Pellets				
	1	1	2	1	2	3	1	2	1	2	3	4	5
1	0	0	0	23	0	0	0	0	18	15	12	0	0
2	0	47	0	24	19	0	0	0	20	17	9	0	0
3	0	5	0	26	5	0	110	0	22	22	17	12	0
4	0	67	0	26	20	0	4	0	17	13	12	12	3
5	0	56	0	23	19	0	61	0	10	4	4	4	4
6	0	93	0	25	22	0	64	0	21	17	8	0	0
7	0	110	0	24	21	0	110	0	23	20	23	15	0
8	0	4	0	23	22	0	115	0	21	19	19	5	0
9	0	90	0	21	13	0	78	0	22	22	20	18	1
10	0	90	0	24	20	0	0	0	20	14	19	19	0
11	0	110	0	21	18	0	115	0	20	20	19	17	0
12	0	100	0	26	21	0	21	0	21	19	17	6	0
13	0	100	0	26	24	0	110	0	23	19	13	0	0
14	0	85	0	21	20	0	115	0	23	23	20	0	0
15	0	92	0	24	21	0	9	1	22	17	11	1	0
16	0	69	0	25	22	0	115	0	20	20	17	7	0
17	0	29	0	27	24	0	110	0	21	16	19	0	0
18	0	95	0	24	24	0	100	0	23	23	19	19	0
19	0	79	0	25	24	0	0	0	20	14	11	0	0
20	0	0	0	24	21	0	13	0	19	16	6	0	0
21	0	0	0	26	23	0	80	0	22	20	21	1	0
22	0	70	0	25	22	0	1	0	18	11	10	0	0
23	0	0	0	26	23	0	5	0	20	12	13	1	0
24	0	41	0	24	22	0	0	0	19	19	19	0	0
25	0	0	0	26	13	0	0	0	23	20	16	0	0
26	0	0	0	22	8	0	0	0	21	18	17	0	0
27	0	0	0	23	0	0	0	0	21	21	14	3	0
28	0	0	0	0	0	0	100	0	20	12	11	0	0
29	0	1	0	22	0	0	0	0	23	20	0	0	0
30	0	0	0	23	0	0	0	0	21	18	0	0	0
31	0	82	0	27	19	0	0	0	21	19	14	0	0
32	0	77	0	23	0	0	0	0	22	15	17	1	0
33	0	87	0	20	0	0	0	0	19	13	13	0	0
34	0	54	0	23	0	0	0	0	22	18	4	0	0
35	0	0	0	26	0	0	0	0	20	20	17	0	0
36	0	0	0	24	0	0	0	0	20	17	17	0	0
37	0	0	0	27	11	0	0	0	22	14	13	5	0
38	0	0	0	23	13	0	0	0	19	13	14	0	0
39	0	115	0	24	6	0	0	0	23	16	20	0	0
40	0	101	0	0	0	0	2	0	19	13	9	0	0
41	0	80	0	23	0	0	0	0	21	16	15	2	0
42	0	12	0	22	1	0	0	0	20	10	11	0	0
43	0	25	0	15	1	0	0	0	15	8	0	0	0
44	0	0	0	22	20	0	0	0	20	14	6	0	0
45	0	18	0	22	18	0	0	0	21	15	13	14	0
46	0	18	0	20	18	0	0	0	15	0	0	0	0
47	0	40	0	25	22	0	0	0	20	13	0	0	0
48	0	115	0	22	19	0	0	0	20	20	18	19	0
49	0	115	0	24	24	0	0	0	21	14	11	0	0
50	0	85	0	24	19	0	0	0	21	19	13	0	0

Table 3. Acceptance of Bromadiolone and Chlorophacinone treated baits by Richardson ground squirrels under field conditions.

Number of Kernels or Pellets Remaining Per Site n Days Post Treatment

Site No.	Control (Mean #/Site= 143 Whole Oats		Bromadiolone (Mean #/Site=126) Wheat				Bromadiolone (Mean #/Site=27) Pellets				Chlorophacinone (Mean #/Site=157) Wheat		Chlorophacinone (Mean #/Site=21) Pellets			
	1	2	1	2	3	4	1	2	3	4	1	2	1	2	3	4
1	0	0	0	0	0	0	27	27	27	20	0	0	24	19	20	20
2	0	0	0	0	0	0	24	24	24	22	0	0	22	20	21	21
3	0	0	0	0	0	0	21	21	20	10	0	0	6	0	0	0
4	0	0	0	0	0	0	23	22	24	22	0	0	22	22	22	21
5	0	0	0	0	0	0	22	22	22	22	0	0	20	0	0	0
6	0	0	1	0	0	0	28	28	28	26	127	0	0	0	0	0
7	0	0	4	3	1	0	25	24	23	23	125	0	3	0	0	0
8	0	0	0	0	0	0	23	23	20	15	115	0	24	0	0	0
9	0	0	3	0	0	0	17	13	6	1	112	3	21	0	0	0
10	12	0	0	0	0	0	26	26	25	18	122	0	17	18	18	18
11	0	0	5	0	0	0	26	26	27	27	118	0	21	21	21	22
12	124	89	1	1	0	0	28	27	24	22	105	0	23	23	23	21
13	0	0	1	0	0	0	27	23	7	5	119	1	24	24	24	23
14	9	0	121	0	0	0	34	32	32	31	122	0	2	0	0	0
15	0	0	113	0	0	0	26	24	19	11	128	0	0	0	0	0
16	0	0	3	0	0	0	6	4	5	3	94	0	23	22	22	22
17	0	0	120	0	0	0	25	23	21	18	98	0	21	20	21	20
18	3	0	1	0	0	0	27	25	17	9	103	0	25	24	23	23
19	0	0	6	0	0	0	29	23	18	15	89	0	24	24	23	20
20	0	0	111	0	0	0	35	21	10	11	52	0	23	22	22	23
21	0	0	3	0	0	0	29	26	17	19	120	3	21	21	21	2
22	120	0	122	0	0	0	29	23	5	6	8	0	21	20	21	19
23	0	0	4	0	0	0	28	23	4	3	10	7	23	23	23	22
24	0	0	1	0	0	0	28	27	26	24	85	0	23	23	23	22
25	0	0	2	0	0	0	29	24	19	20	32	0	19	13	16	4
26	123	0	3	1	0	0	27	29	20	17	2	0	21	21	21	20
27	7	0	2	0	0	0	30	30	30	30	0	0	23	23	23	23
28	0	0	3	0	0	0	28	28	22	0	0	0	23	23	23	21
29	0	0	4	0	0	0	24	20	1	1	0	0	22	22	22	21
30	0	0	8	0	0	0	34	32	0	0	0	0	19	19	19	19
31	0	0	0	0	0	0	28	2	0	0	0	0	23	23	22	22
32	0	0	4	0	0	0	31	0	0	0	0	0	19	19	19	18
33	2	0	0	0	0	0	34	32	0	0	0	0	24	24	23	24
34	104	0	0	0	0	0	34	31	0	0	0	0	20	20	20	19
35	120	0	1	0	0	0	41	27	22	0	129	0	20	20	20	18
36	125	0	2	0	0	0	38	0	0	0	40	0	22	22	22	21
37	0	0	145	45	0	0	34	0	0	0	93	0	21	21	20	19
38	0	0	100	0	0	0	35	34	0	0	11	0	19	14	15	16
39	0	0	0	0	0	0	25	19	22	13	3	0	21	20	21	21
40	0	0	0	0	0	0	32	0	0	0	0	0	19	19	18	17
41	0	0	1	0	0	0	27	16	0	0	0	0	23	23	23	23
42	0	0	123	110	4	0	38	34	1	0	0	0	23	22	22	22
43	0	0	0	0	0	0	35	29	0	0	0	0	21	21	20	20
44	65	0	144	137	122	0	28	1	0	0	3	0	21	21	21	19
45	0	0	146	143	0	0	32	0	0	0	0	0	23	22	22	22
46	0	0	124	83	54	0	30	1	0	0	86	0	24	25	24	25
47	0	0	0	0	0	0	28	2	0	5	104	0	20	21	20	21
48	0	0	138	110	113	112	28	23	5	0	128	3	24	23	23	22
49	0	0	125	113	101	95	35	32	1	24	8	0	21	21	20	21
50	0	0	137	130	146	132	33	30	27	0	13	0	19	20	20	18

Table 4. Weights(g) of two pelletted zinc phosphide bait formulation exposed under field conditions to Columbian and Richardson ground squirrels.

Control Field Trial (No Access by Squirrels)				Columbian Ground Squirrel Field Bait Acceptance Trial (Free Access by Squirrels)				Richardson Ground Squirrel Field Bait Acceptance Trial (Free Access by Squirrels)			
ZINC A		ZINC B		ZINC A		ZINC B		ZINC A		ZINC B	
4 Days		4 Days		4 Days		4 Days		4 Days		4 Days	
Pre Wt	Postapolic Wt	Pre Wt	Postapolic Wt	Postapolic Wt		Postapolic Wt		Postapolic Wt		Postapolic Wt	
4.70	4.20	4.30	3.70	4.50	3.90	3.20	2.90	3.40	3.90	2.60	1.80
4.40	3.80	4.20	3.70	1.90	3.70	4.00	3.50	2.80	3.30	2.70	2.90
4.80	4.10	3.90	3.50	4.00	3.50	3.40	3.90	3.30	4.30	2.70	1.90
4.30	4.00	4.20	3.50	2.80	4.00	3.40	4.30	3.80	3.90	1.90	2.60
4.00	3.60	3.50	3.10	4.10	3.80	4.10	3.40	3.50	2.90	2.90	2.80
4.60	4.20	4.40	3.90	4.00	4.20	3.00	3.30	3.10	4.10	2.30	1.20
4.80	4.30	4.30	3.70	3.80	4.20	2.90	3.60	3.20	3.50	2.40	2.60
4.30	3.80	4.30	3.80	4.20	3.80	3.40	3.60	4.00	4.00	3.70	2.10
4.80	4.10	3.90	3.40	3.50	3.40	4.20	3.70	3.60	4.10	2.10	.50
4.70	4.30	3.80	3.10	4.50	4.10	3.40	3.30	3.30	3.70	2.90	2.90
				4.00	3.50	3.70	3.80	4.10	4.20	3.50	3.40
Mean Wt 4.54	4.04	4.08	3.54	3.80	4.20	3.50	4.20	3.80	3.60	2.70	4.50
				3.50	4.20	3.20	1.80	4.30	4.10	2.10	3.90
Difference	.50		.54	3.10	3.60	2.80	3.50	2.70	3.90	2.50	1.60
				3.00	4.10	3.60	3.40	4.10	4.50	1.90	3.40
Percent Change	-11.0%		-13.2%	4.10	3.90	4.00	3.40	3.80	3.80	2.00	2.50
				3.90	4.30	4.00	3.80	3.40	3.40	2.90	1.60
				3.80	4.30	3.80	3.70	3.80	4.40	1.70	3.80
				.90	4.10	4.10	3.90	3.90	3.60	2.50	2.80
				2.30	3.10	3.40	4.30	3.30	4.00	1.10	4.00
				3.60	4.00	3.60	3.60	3.50	3.20	2.30	3.20
				1.20	4.40	4.20	4.00	3.80	4.30	2.20	3.10
				2.70	3.20	3.70	2.10	3.90	4.20	1.90	2.70
				4.20	*	3.50	2.60	4.50	3.60	2.60	*
				4.10	*	3.40	*	3.10	*	2.00	*
				Mean Wt	3.65		3.53		3.72		2.54

* No Bait Recovered

item in the squirrels' diet. Providing there is no other inhibiting factor besides appearance, such as undesirable odor or taste, the squirrels probably require some period of time to become familiar with the pellets and accept them as a food item in their diet. This is illustrated on the Columbian ground squirrel plot for the bromadiolone and chlorophacinone pellets. Initial consumption was slight for 2 to 3 days followed by a rather sudden increase in consumption. This pattern is less clear for the Richardson indicating that a longer familiarization period may have been required. Similar avoidance of new, unfamiliar items in a ground squirrel's environment has been observed with the use of bait stations for ground squirrel control. Familiarization periods from 2 days to 2 weeks may occur before significant use of the stations begin (Sullivan 1983.)

The poor acceptance of zinc phosphide baits may also be related to the new, unfamiliar appearance of the pelleted baits compared to the usual food items in the squirrels' diet. Additional factors such as the characteristic odor and taste of zinc phosphide may also inhibit acceptance. Marginal acceptance of an acute poison such as zinc phosphide which might result in sublethal symptoms of poisoning and subsequent bait shyness may further inhibit bait consumption. Field studies of pelleted zinc phosphide rodenticides have shown very poor efficacy for Columbian ground squirrel control (Baril 1980). Other field evaluations of grain bait zinc phosphide rodenticides have shown acceptable, although variable results, in controlling ground squirrels and prairie dogs in Montana. (Sullivan and Baril 1981; Sullins 1980, 1977; Matschke, et. al. 1983).

The consumption of the pelleted anticoagulant baits over a several day period may be an important factor in obtaining adequate efficacy with the low concentrations of active ingredient used in these baits. Small multiple doses of an anticoagulant can cause death where the consumption of an equal amount in a single dose may not (R.E. Marsh pers. com.). If field rodent baits using anticoagulants are to be formulated with active ingredient concentration of 0.01 percent or less, multiple feedings of a single application or multiple applications to the same site will likely be required.

For multiple feedings of a single application, the longevity of the bait will be important. Pelleted baits will have to maintain their integrity long enough for familiarization and consumption to occur. Pelleted baits that deteriorate quickly may show poor efficacy in controlling ground squirrel populations. Both bromadiolone and chlorophacinone degrade quickly when exposed to sunlight (L. Askham pers. com.). Toxicity of baits formulated with these anticoagulants may significantly decrease after only a few days exposure to field conditions. Timing of the applications will be important not only to achieve good bait acceptance by the ground squirrels but to select a time period when little or no rain is expected to occur. To achieve adequate

acceptance of pelleted bait formulations prebaiting with nontoxic pellets may be required.

For multiple applications of an anticoagulant bait to the same site, quick acceptance of the bait is important. For Montana situations this usually requires a grain bait carrier or prebaiting when using pelleted baits. Multiple baiting also multiplies costs by the number of applications. For areas such as rangeland, pastures and haylands, where ground squirrel control most commonly occurs in Montana, this method of application may be cost prohibitive.

Recommendations for further evaluations

Continued field testing of the anticoagulant baits for efficacy on ground squirrels, both grain and pellet formulations, is recommended. Spot baiting of active burrows by hand and broadcast baiting methods should be considered. Several rates of application (i.e. volume/burrow; lbs/acre) up to some practical maximum amount should be tested. Determination of the maximum rate should be based on considerations of potential application costs and nontarget hazards.

Because of the poor acceptance shown for the zinc phosphide formulations used in this study no testing for efficacy with these formulations is recommended. Further acceptance tests of pelleted zinc phosphide formulations with different composition may be useful. Further bait acceptance tests with these formulations using prebaits may also be appropriate.

The conclusions reached in this study regarding the general phenomenon of bait acceptance are based on observations, past field experience and supposition, not actual comparative data. It would be useful to look more closely at the process of acceptance by comparing blank and toxic baits, how baits of various shapes and composition are responded to under different environmental conditions, and how much preconditioning, either from natural field conditions or prebaiting, is required to achieve adequate bait acceptance by ground squirrels.

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