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Fresh Cabbage Bait for Ground Squirrel Control

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Abstract: The Nevada Department of Agriculture acquired the authority to control vertebrate pests of agriculture and public health in 1975. Prior to the Department becoming involved in vertebrate pest control, agricultural producers did not have ground squirrel baits which were very effective. The Department examined products used in surrounding states and due to the effectiveness of sodium monofluoroacetate fresh cabbage baits used in Modoc County, California, began using strychnine cabbage baits. Strychnine was chosen as a toxicant rather than sodium monofluoroacetate because it was thought to be less "toxic" politically. Fresh chopped cabbage baits were initially broadcast above ground in swaths or near active ground squirrel burrow openings. Due to the prohibition of above-ground uses of strychnine which resulted from a 1988 U. S. District Court ruling, the Department changed the labeling of its strychnine paste concentrate. Ground Squirrel (and yellow-bellied marmot) baiting directions now require bait to be placed 6 inches or more into burrow openings. The change in application procedure reduced the effectiveness of chopped cabbage bait, however it still surpasses the effectiveness of grain based baits due to the attractiveness of the cabbage to ground squirrels in Nevada. Baits are usually prepared on site by the producers who apply it immediately after formulation. One application in early spring prior to the emergence of juveniles is the optimum time for baiting. Follow-up applications may be made on surviving ground squirrels or when ground squirrels migrate in from other areas later in the season.

Key Words: ground squirrels, cabbage bait, strychnine, baiting, efficacy, bait acceptance, *Spermophilus* spp., non-target species, rodenticides, Nevada, Great Basin

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INTRODUCTION

The Nevada Legislature gave the Nevada Department of Agriculture the authority to investigate the prevalence of and take necessary action to control vertebrate pests in 1975. One of the major reasons this authority was added was because of complaints by Nevada producers that there were no effective poison baits available for ground squirrels (*Spermophilus* spp.). Ground squirrels are major pests of crops (primarily alfalfa) in northern Nevada. The Belding's ground squirrel (*S. beldingi*), Richardson's ground squirrel (*S. richardsonii*), and Townsend's ground squirrel (*S. townsendii*) cause the most damage. The California ground squirrel (*S. beecheyi*) causes damage to a lesser degree.

Commercial grain based baits with strychnine, zinc phosphide, or an anticoagulant as the toxicant were available to Nevada agricultural producers; however, as previously mentioned, they were not readily eaten by ground squirrels.

The attractiveness of green vegetation to the 3 species causing most of the damage was known (Alcorn 1940, Alsager 1972, White 1972). The Department used the Modoc County, California, cabbage bait control program as a model and selected 0.29% strychnine chopped cabbage as the bait for its ground squirrel control program. Chopped cabbage was first used as a ground squirrel bait in Modoc County around 1965 (White 1972). Modoc County used sodium monofluoroacetate (1080) as the toxicant. Nevada chose strychnine, probably because strychnine was thought to be less controversial than 1080.

PROGRAM ORGANIZATION

A bait distribution schedule was mailed in late fall to agricultural producers. Schedules were also sent to local Nevada Cooperative Extension Offices. Bait orders were taken by the Department and bait was mixed at local sites on scheduled days. Purchasers picked up the freshly mixed bait on the day it was made. They generally applied bait in the morning that day. Bait picked up late in the day was applied the following morning. Bait can be held for a few days but needs to be remixed in the bag prior to application.

A custom-made cabbage chopper was used to cut up the cabbage. One head of cabbage was chopped in about 5 seconds. One hundred pounds of chopped cabbage was mixed with a strychnine concentrate in a 1-cubic-yard cement mixer. Fifty pounds of bait was placed in labeled 6-mil plastic bags for distribution and sale. The final bait concentration was 0.29% strychnine. Bait concentration was reduced to 0.19% strychnine in 1988. Field efficacy tests, required by the EPA in their Strychnine Position Document 4 (PD4), showed the lower concentration to be efficacious. These tests are included in Table 1. Alkali fast green dye was used to differentiate treated cabbage from untreated cabbage. The dye also enabled uniformity of mixing to be determined.

The first distribution of bait in a particular area was in March with a second distribution about one month later. In years when ground squirrel populations were high, as many as 4 distributions occurred at monthly intervals. The March distribution and often the April distribution occurred prior to the emergence of juvenile ground squirrels from their natal burrows.

Table 1. Published and unpublished efficacy trials of toxic cabbage baits for controlling ground squirrels.

Authors	Species	Active Ingredient	Control %	Remarks
Albert and Record 1981	Columbian	strychnine	14, 61	For strychnine and zinc phosphide baits, respectively. Eight to 10 pieces were applied near burrow entrances. Test in July.
Balliette and O'Brien 1991	Richardson, Townsend	strychnine	64	In-burrow application of 0.2% baits. Five pieces per burrow. In 4 of 30 burrows some pieces were found above ground.
Marsh 1986	Richardson	strychnine	30, 75, 95, 60, 90, 95	Laboratory studies with 20 animals each. Five grams of 0.05, 0.1, 0.1, 0.1, 0.15, and 0.3% strychnine baits, respectively.
O'Brien 1978	Belding, Townsend	strychnine, 1080 zinc phosphide	86, 74, 94 39	For 0.2 and 0.3% strychnine and 0.00625% 1080 baits, respectively. Zinc phosphide 0.8% baits. Baits broadcast at 10 lbs/acre.
O'Brien 1985a	Richardson	strychnine	71,71, 88	For 0.1, 0.2, and 0.3% strychnine baits, respectively. One teaspoon 0.15% strychnine bait applied near active burrow opening.
O'Brien 1985b	Richardson	strychnine	84	One teaspoon 0.15% strychnine bait applied near active burrow opening.
O'Brien 1986a	Richardson	strychnine	92, 91, 99	For 0.2, 0.3, and 0.4% strychnine baits, respectively. About 1 teaspoon bait applied near active burrow opening.
O'Brien 1986b	Belding, Townsend	strychnine	89, 95	For 0.2 and 0.3% strychnine baits, respectively. About 1 teaspoon bait applied near active burrow opening.
O'Brien 1987a	Richardson	strychnine	95, 94, 95	For 0.2, 0.3, and 0.4% strychnine baits, respectively.
Sauer 1976	Belding	1080 chlorophacinone, fumarin	100 variable	Both 0.00625 and 0.0125% 1080 baits very effective. One application of 0.01 and 0.005% chlorophacinone, 0.05 and 0.025% fumarin at 10 lbs/acre ineffective; two applications 2 days apart near active burrows effective. Control percentages could not be determined from data in tables.

Table 2. Strychnine cabbage bait distribution in Nevada from 1976 through 1987.

Year	Pounds of Bait	Year	Pounds of Bait
1976	56,335	1982	57,100
1977	55,495	1983	29,475
1978	34,650	1984	17,455
1979	37,195	1985	19,755
1980	43,900	1986	13,800
1981	35,530	1987	12,490

Table 2 summarizes bait distribution from 1976 through 1988. In the late 1980s the demand for bait declined. The Department dropped the organized program in the early 1990s. Currently bait is formulated by the applicators themselves rather than the Department. Applicators must be certified to apply strychnine cabbage bait. Strychnine became a restricted use pesticide in 1978 and certification has been required since then. They purchase the concentrate "Strychnine Alkaloid Paste" from the Department and mix it with chopped cabbage, or sometimes with alfalfa. In some areas several producers hold "mix days" to cooperatively mix bait. The Department's mixer and chopper are available for use, and Department personnel may assist the group.

APPLICATION METHODS

From the program's inception in 1975 through 1983, two methods were used to apply bait. Large areas were treated by broadcasting bait in 45-foot-wide swaths. Treated swaths were alternated with untreated swaths. The maximum overall rate was 10 pounds per acre. Aerial application, though permitted, was never used. Aerial application was the major application method for 1080 cabbage in Modoc County starting in 1974 (Sauer 1976). The second method used was to scatter approximately 1 teaspoon of bait near ground squirrel burrow entrances. In September 1983, the U.S. Environmental Protection Agency (EPA) issued Strychnine Position Document 4 (PD4). This document was the result of their analysis of all outdoor above-ground uses of strychnine. From 1984 through 1988, bait was applied using the 1-teaspoon-per-burrow method mandated in PD4. In 1988, as a result of a lawsuit, the Eighth United States District Court prohibited all above-ground uses of strychnine. In 1989, application directions on the Department's Strychnine Alkaloid Paste label were revised to require that bait be applied below ground to control ground squirrels and yellow-bellied marmots (*Marmota flaviventris*). Above-ground uses were removed from the label. Underground use for pocket gophers remained. Current label directions require that a quantity of 10 grams of bait be placed at least 6 inches into ground squirrel burrows.

NON-TARGET HAZARDS

The 1988 Eighth District Court injunction and EPA's PD4 were issued, in part, because of hazards to non-target species from strychnine baits. Non-target species may be impacted in two ways. The first is through the direct consumption of strychnine baits. The second is through the consumption of target species poisoned with strychnine baits.

There is limited information regarding the direct consumption of cabbage baits by non-target species. The Nevada Department of Agriculture, each year from 1976 through 1983, sent a questionnaire to each purchaser of cabbage bait. Non-target animals believed to have been poisoned were part of the information requested. Non-

target animals which would have consumed bait totaled: 63 cottontail rabbits, 1 pheasant, and 1 sheep. Non-target species which would have consumed poisoned ground squirrels were: 132 magpies, 108 crows or ravens, 42 cats, 31 dogs, 7 hawks, 4 badgers, and 2 coyotes. Non-target species reports were not validated by the Nevada Department of Agriculture. These unpublished reports were prior to reduction of bait concentration from 0.3% to 0.2% strychnine, the elimination of broadcast baiting in PD4, and the later elimination of all above-ground uses of strychnine by the Eighth U.S. District Court.

Levels of strychnine in strychnine cabbage bait-poisoned ground squirrels were examined by the Nevada Department of Agriculture (O'Brien 1987b). Strychnine in Richardson's ground squirrel stomachs averaged 2.4 mg and ranged from 0.1 mg to 19.1 mg. From 1 to 120 ground squirrels stomachs would have to have been consumed to provide an LD₅₀ to a 10-kg dog.

Lowering the bait strychnine concentration from 0.3% to 0.2% reduced strychnine levels, but broadcast baiting did not appear to increase strychnine levels compared to spot baiting by each burrow (O'Brien 1987b). Further studies were suggested. There is no information on strychnine levels in poisoned ground squirrels with the in-burrow baiting method currently used.

DISCUSSION

Cabbage baits and other fresh baits have not been used extensively for ground squirrel control in the United States. Cabbage bait cannot be stored like grain baits; rather, it must be used soon after being formulated. In addition, cabbage costs more than grain and may be more difficult to obtain. Cabbage bait does not last long once it has been applied. The cabbage dries up, and once the succulence of the bait is gone its attractiveness to ground squirrels and perhaps other animals declines. Marsh (1986) measured moisture loss of cabbage as part of simulated field applications. One-day weight loss averaged 67%; 3-day loss was about 90%. In dry windy conditions (e.g. Nevada), weight loss would probably occur faster. The short-lived nature of the bait reduces availability for consumption by non-target species.

The attractiveness of cabbage to ground squirrels enables it to out-perform grain baits, especially when alfalfa or another preferred crop is present. Marsh (1986) documented the attractiveness of cabbage to Richardson's ground squirrels. They ate almost two-thirds of their body weight per day when offered unlimited amounts! The benefits of cabbage bait would be maximized with a toxicant other than strychnine. The toxicant, unlike strychnine, should be able to be used above ground where it will be more readily consumed by ground squirrels. Non-target losses in Nevada occurred primarily from animals consuming poisoned ground squirrels. This toxicant would not act as quickly as strychnine, which would enable digestion and metabolism of the bait, ideally to nontoxic metabolites. Strychnine acts so fast

that, as indicated previously, large amounts can remain in the stomach of a poisoned ground squirrel. Of the currently registered rodenticides in the United States, cholecalciferol (vitamin D₃) appears to me to be the most promising. Marshall (1984) provides a good summary of its characteristics.

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