Evaluation of Zinc Phosphide for Control of Pocket Gophers on Christmas Tree Plantations

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Zinc phosphide-carrot bait was comparable to strychnine-grain bait for controlling pocket gophers. We recommend development of a 0.75-percent zinc phosphide-carrot bait for special local need registration to insure safety to wildlife or domestic animals.

Pocket gophers *(Thomomys spp.* and *Geomys spp.)* can cause serious damage to conifers grown for Christmas trees. In Minnesota, Miles (*12*) reported that pocket gophers caused 13-percent mortality to Scotch pine *(Pinus sylvestris)* and 15-percent mortality to Norway pine *(P. resinosa).* In the Pacific Northwest, a 1975 survey revealed that 2,101 hectares (5,192 acres) of Christmas tree lands were sustaining damage by gophers and that landowners expected the problem to increase (*13*). Major damage areas in the Pacific Northwest are east of the Cascade Mountain range (*14*). Other regions in the United States also experienced pocket gopher damage problems.

Kill trapping with Macabee gopher traps and poisoning with 1080, Gophacide, and strychnine alkaloid grain baits are used to reduce pocket gopher populations and damage (*3, 8, 13, 14, 16*). Currently, baiting with strychnine accounts for over 90 percent of the control efforts (*2, 13*).

Of these methods, trapping can be uneconomical and ineffective (*1, 8*); 1080 has severe State and Federal pesticide use constraints (*10, 16*); Cophacide, which was developed for pocket gopher control (*15, 16*), has limited distribution; and strychnine poses serious concerns regarding inadvertent poisoning to other animals (*2*).

A toxic bait with little nontarget hazard potential, therefore, appeared desirable for controlling gophers on Christmas tree plantations, particularly those plantations that are readily accessible for use by household pets and locally sensitive wildlife species.

Zinc phosphide, an established rodenticide from the World War II era (*6*), seemed a likely candidate for testing. It has a large data base documenting its toxicology, biological activity, and effects on wildlife (*11*). The LD_{50} of zinc phosphide to pocket gophers *(Thomomys mazama) is* 14.7 milligrams per kilogram (*2*) and to *T. talpoides,* 6.8 milligrams per kilogram (*11*). Hazards to dogs, cats, and most other animals are considered minimal (*9, 11*).

Methods

Laboratory tests. Bait acceptance tests (*2, 15*) were conducted on pocket gophers to establish baseline data on bait and toxicant intake and efficacy of zinc phosphide and strychnine baits. Individually caged gophers were each offered 20 grams of treated oats or one piece of treated carrot each day for 3 consecutive days or until death. Control animals were offered untreated oats. Supplemental food was available during the test.

Baits tested included a 1-percent zinc phosphide-oat groat bait registered for gopher control in eastern Oregon, a 0.75-percent zinc phosphide-carrot bait registered for control of nutria *(Myocastor coypus)* in the United States, and three 0.5-percent strychnine-rolled oat baits used for gopher control in the United States.

Field study. Based on the results of our bait acceptance tests and a field study with radio telemetry (2), we field tested the 0.75-percent zinc phosphide-carrot bait (EPA Reg. No. 6704-52) and the 0.5-percent strychnine-oat bait (EPA Reg. No. 6704-58) for comparative efficacy against *Thomomys mazama.* The field study was conducted during November 1981 in a 4-year-old Douglas-fir *(Pseudotsuga menziesii)* and white pine *(Pimis monticola)* Christmas tree plantation on). Hofert Co. lands near Olympia, Wash. Baiting was conducted under an experimental use permit issued by the Washington State Department of Agriculture.

We modified the open-hole procedure (3, 15) initially to identify active gopher systems and later to test treatment effects. This procedure is based on the pocket gopher's behavior of plugging any opening in its burrow system within a relatively

short time. Individual 40-square-meter plots, spaced at least 20 meters apart so they represented individual pocket gophers, were sampled for gopher activity by opening two burrows per plot. *A* plot was considered active if at least one burrow was plugged with dirt within 48 hours.

Thirty active plots were baited with 1-centimeter wedges (about 2.5 g) of 0.75-percent zinc phosphide-treated carrots; another 30 active plots were baited with 0.5-percent strychnine-treated oats. Each plot was baited with three bait sets spaced at least 1 meter apart. Each zinc phosphide-carrot bait set consisted of four carrot pieces totaling about 10 grams. Each strychnine-oat bait set contained about 4 grams of grain. Baits were delivered by spoon through probe holes into gopher burrows, and the probe holes were then covered with debris such as soil clods or vegetation.

Seven days after baiting, we opened two burrows in each plot and examined them at 24 and 48 hours for plugging activity. A dirt plug at either of the open burrows indicated a live pocket gopher.

Results

Laboratory tests. We tested five groups of 10 individually caged pocket gophers on the two zinc phosphide baits and three strychnine baits. All but the zinc phosphide-oat groat formulation yielded effective kills (90 percent or

Table 1.—*Mean bait acceptance, toxicant intake, and mortality when zinc phosphide and strychnine alkaloid baits were offered to caged pocket gophers*

Formulation	Bait concentration	Consumption		Number of lethal doses consumed	Number of deaths/ number tested	Registration remarks
		Bait	Toxicant			
	%	*G*	*Mg*			
Zinc phosphide						
Crimped oat groats, petrolatum, and mineral oil	1.0	0.26	2.6	2.2[1]	7/10	Gopher bait, eastern Oregon
Cut fresh carrots and corn oil	.75	2.20	16.5	20.1	10/10	Nutria bait, nationwide
Strychnine						
Rolled oats, molasses, salt, and soda	.5	.89	4.5	4.2	10/10	Gopher bait, nationwide
Rolled oats and molasses	.5	1.12	5.6	5.1	10/10	Experimental bait—previous standard bait formula
Rolled oats and Rhoplex AC-33	.5	1.02	5.1	4.7	9/10	Gopher bait, nationwide
Control						
Untreated rolled oats	0	1.53	_[2]	_[2]	0/10	

[1]Test results indicated that some of the test animals also ingested enough zinc phosphide to cause mortality while grooming their cheek pouches after transporting bait to their nests.

[2]_ = not applicable.

better) of test gophers (table 1). Efficacy of the strychnine-rolled oats formulation with molasses, salt, and soda did not differ from the experimental strychnine bait formulated with only molasses.

Field study. In our field test, 19 of 30 plots for each treatment remained unplugged, indicating a 63-percent reduction in pocket gopher activity for both the 0.75-percent zinc phosphide-carrot bait and the 0.5-percent strychnine-oat bait. This level of reduction is generally considered poor field efficacy (*1*). These results may have been caused, in part, by the abundant vegetative food supply for gophers that existed on the study site.

Discussion and Conclusions

Our toxicant application and evaluation was directed at individual pocket gophers. We did not attempt to recover poisoned gophers or to determine the impact of baiting on area populations. Previous work with radio telemetry (2) in this same Christmas tree plantation showed that virtually all poisoned gophers died in nests or burrows 51 to 160 centimeters (2 to 5 ft) underground. In that radio study, one poisoned gopher was recovered above ground, but we suspected that it died underground and was pushed out of its system by another animal. Another poisoned gopher, recovered in its nest, was partially consumed by an unidentified carnivore.

Based on cursory observations, our study sites contained a relatively high population of pocket gophers-one gopher about every 23 meters (75 ft). We estimate that tree mortality by gophers exceeded 10 percent. Most mortality was caused by root pruning (fig. 1) that occurred over a period of several years. In addition, a survey of a nearby 7-year-old plantation of noble fir (*Abies procera*) revealed that 8 percent of the trees were missing and 1 percent had died because of pocket

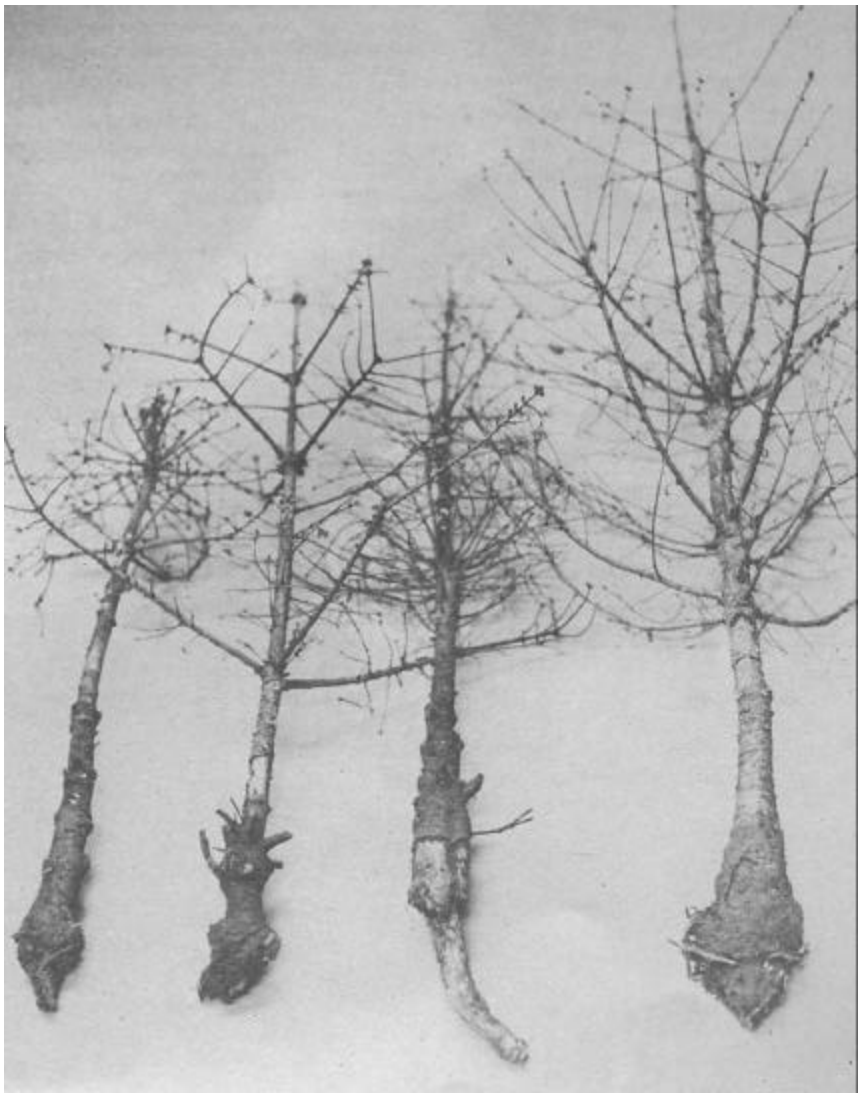

Figure 1.—*Douglas-fir Christmas trees killed by pocket gophers. The club-shaped base of these trees is characteristic of root pruning by pocket gophers.*

gophers. An additional 5 percent had gopher mounds surrounding the base of the trees indicating that root pruning by these animals was still occurring; growth of other trees was stunted. Pocket gophers were responsible for the majority of missing and stunted trees in this plantation (fig. 2).

In conclusion, our study showed that zinc phosphide was comparable to strychnine in controlling pocket gophers. Based on other studies (*4, 5, 7, 14*), vegetative control could be integrated with baiting and other pest management methods (*1*) for reducing the long-term impact of pocket gophers and competing vegetation on growth and survival of Christmas trees. Our data, therefore, supports the recommendation by Barnes and others (*2*) for further development of the 0.75-percent zinc phosphide-carrot bait for a special local need registration to control pocket gophers in Christmas tree plantations and other local areas where safety to wildlife or domestic animals must be insured.

Figure 2.—*Openings and stunted trees in this noble fir Christmas tree plantation are caused by pocket gophers.*

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