

Eradication of Pocket Gophers

comparative field tests demonstrate best poisons, baits, and dosages for practical gopher control

Milton A. Miller

The most effective and economical method for eradicating pocket gophers—responsible for a major share of the multimillion dollar damage inflicted annually on California agriculture by field rodents—is by poisoning.

Late fall, shortly after the first heavy rains, is a particularly favorable season for control since it precedes the early winter and spring peaks in breeding.

Poisoning, gassing, and trapping were the principal control methods investigated in studies on biology and control of these burrowing pests. Nine poisons and many different bait materials were tested to find the best combinations and dosages. The effects of season of year, bait size, storage, lures and other factors that might influence the performance of poison baits also were investigated.

All trials were made in the field, mostly alfalfa fields in Yolo County infested with the Sacramento Valley pocket gopher, *Thomomys bottae navus*, but findings may also have general application.

The mortality estimates include both acceptance and toxicity—which are important in the success of a bait—since kill percentages were calculated on the basis of the number of burrows successfully baited regardless of the amount of bait taken. These kill percentages thus represent the over-all efficiency of the baits.

Comparison of Poisons

Of the poisons tested, only three—Compound 1080, strychnine alkaloid, and strychnine sulfate—gave high enough kills to be of practical value. On carrot bait or other root vegetables, these three consistently killed more than 70% of the gophers baited.

Compound 1080 is about 15 times more toxic to gophers than strychnine alkaloid and over 50 times more effective than strychnine sulfate on carrot bait.

Because of its extremely high toxicity to animals, including man, and the present lack of an antidote for this potent fast-acting killer, the use of Compound 1080 is restricted by law to licensed pest control operators and governmental officials.

This leaves strychnine as the only effective gopher poison available to the general public. Nevertheless, effective control may be obtained with practical dosages of strychnine.

Of the two forms of strychnine, the alkaloid seems to be more potent than the sulfate, particularly at low dosage. It may be true that the two forms of strychnine are of equal strength if they are injected or force-fed, but in practical field tests, strychnine alkaloid gives better results than the sulfate and is therefore preferred.

Bait Materials

No significant or consistent differences in acceptance or kill could be found between different kinds of root vegetables when these were treated with equivalent dosages of the same poison.

Among the three classes of bait materials tested—root vegetables, fruits and grains—however, there may or may not be marked differences depending on the kind of poison used. With Compound 1080, all kinds and classes of baits gave excellent kills, generally better than 80% on the average. With strychnine, root vegetables gave good results, fruits were slightly less effective, but grains were poor.

All baits, regardless of kind or poison used, were well accepted—removed from the bait sites—but the field tests give no information on their subsequent fate. Without knowing what happened to baits

after they are removed by the gopher from the bait sites, it is difficult to explain the observed differences in effectiveness between different classes of strychnine-coated baits, or why grain baits should give excellent kills with Compound 1080 but poor results with strychnine.

There is some experimental evidence that soaking dried fruit baits in water for several hours before use may improve their effectiveness and this procedure is recommended when dry fruits are used for bait. Soaking has the disadvantage, however, of making the bait soft or mushy and more difficult to insert through probe holes into the burrows.

Sweetening carrot baits poisoned with strychnine or arsenic, or scenting strychnine-coated grain bait with oil of anise—supposedly a lure for rodents—did not improve the acceptance or kill as compared to baits not so treated.

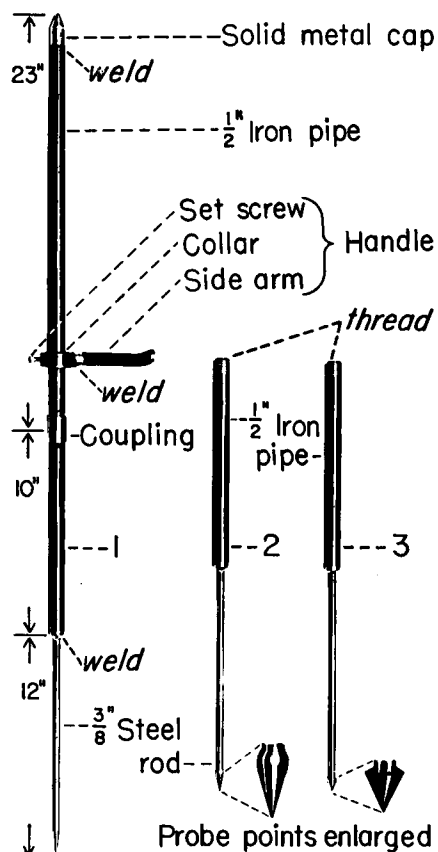
Practical Field Dosages

Dosage-mortality curves, computed from field tests using graded dosages of the better poisons, clearly indicate that for each formulation there is a limit of dosage beyond which it is impractical to add more poison.

For strychnine baits—alkaloid and sul-

Rating of Poison Baits for Pocket Gophers
(Based on comparative field tests)

Kill	Bait	Poison
Good (Greater than 70%)	Root vegetables (mainly carrots)	Compound 1080, strychnine alkaloid, strychnine sulfate
	Grain (wheat, barley, oat groats)	Compound 1080
	Fruits (mainly dried)	Compound 1080, occasionally strychnine alkaloid
Fair (40%–70%)	Root vegetables	Castrix, thallium sulfate
	Grain (oat groats)	Castrix
	Fruits	Strychnine alkaloid
Poor (Less than 40%)	Root vegetables	ANTU, arsenic trioxide, barium carbonate, zinc phosphide.
	Grain	Strychnine alkaloid, zinc phosphide thallium sulfate (?)



Probe for locating gopher tunnels. To the upper section of the shaft may be coupled any one of the three lower sections, the points of which are designed for probing in different kinds of soil: (1) sharp tapering point for heavy, hard or dry soil; (2) carrot-shaped point for average moist soil; (3) blunt broad tip for loose, sandy or wet soil.

fate—practical field dosages are more difficult to determine than for Compound 1080 since their dosage-mortality curves rise less abruptly and flatten out considerably before really practical levels of kill are reached.

Using either form of strychnine, a 50 mg—milligram—per burrow dosage is recommended with carrots—or any other root vegetable. This gives an estimated 76% kill with strychnine alkaloid, or 67% kill with the sulfate. Repeated treatments at reasonable dosages to eliminate survivors is much more practical than overloading the baits with poison.

In most tests, 1/2 ounce of bait per burrow was standard, but double or half that amount carrying equivalent dosages of poison gave the same results. The number of pieces of bait or their size apparently makes no significant difference in kill, provided the dosage is kept constant.

Mixing Baits

For convenience bait mixes are based on an average of 360 pieces—roughly 1 1/2 x 1/2 x 1/2 inches and weighing about 1/4 ounce—of cut root vegetables per gallon of bait for 180 burrows.

The 1/3 ounce per gallon dosage of

strychnine is a little higher than the 1/4 ounce per gallon commonly recommended. Two pieces of root vegetable bait dropped into a burrow will carry the minimal lethal dosage required for practical kills.

The cut bait should be dusted in a relatively large cylindrical jar or mixing drum by adding the weighed poison a little at a time, over the baits, rolling and shaking them between dustings until the pieces are evenly coated.

A similar method may be used in preparation of grain baits, except that corn oil, mineral oil or glycerin at about one fluid ounce per eight pounds of bait should be thoroughly mixed with the bait before dusting with poison.

Time to Poison

On dry lands, gopher breeding is restricted to spring, but in irrigated alfalfa fields in the Sacramento Valley and probably elsewhere, studies show that gophers breed throughout the year, with peak periods in early winter, spring and summer.

Control may be applied effectively at any time as no significant or consistent differences in acceptance or kill were detected in testing the same formulas during different seasons of the year.

Late fall, shortly after the first heavy rains, and preceding the early winter and spring peaks in breeding, is an especially favorable season for control.

At this time, too, the gophers renew burrowing activity producing abundant fresh mounds and the vegetation is low so that active gopher systems can easily be located.

In irrigated alfalfa fields, another favorable time for gopher control is in June, preceding the summer breeding peak.

How to Poison

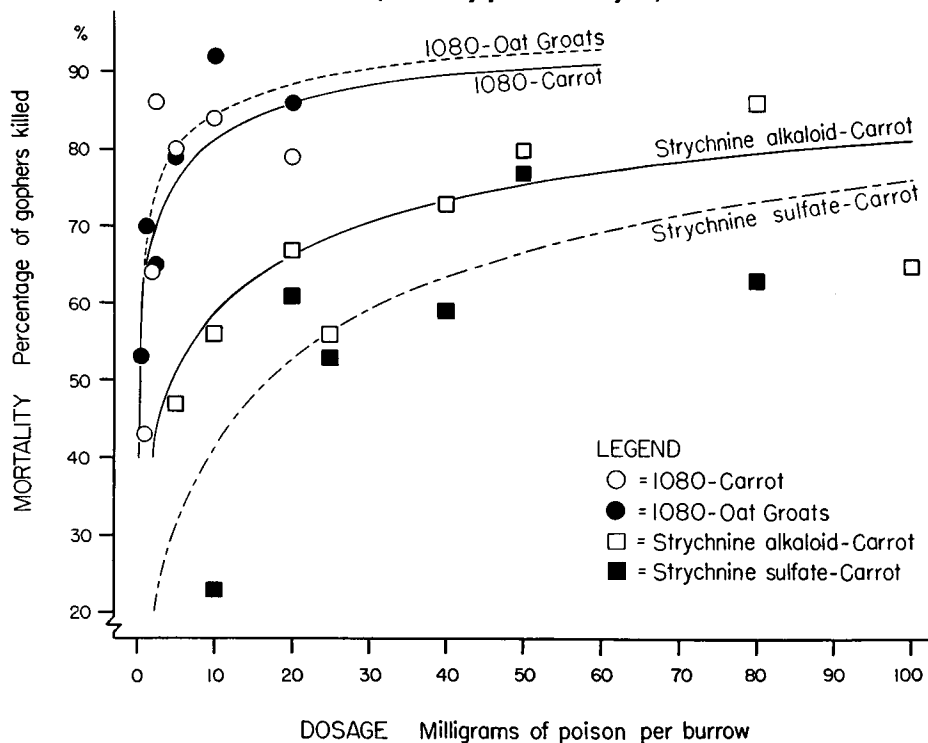
A probe is indispensable for locating gopher runways and for placing baits, especially in large-scale operations. For an occasional gopher, a broom handle or similar tool will serve fairly well.

Continued on next page

Comparison of Dosage

	Dosage per burrow		Mix poison: bait	Expected kill
	Amount of poison	Amount of bait		
Strychnine (alkaloid or sulfate)—root vegetables	50 mg	2 pcs. = 1/2 oz.	1/3 oz. per gal.	76% (alkaloid) 67% (sulfate)
Compound 1080—root vegetables	20 mg	2 pcs. = 1/2 oz.	1/3 oz. per gal.	86%
Compound 1080—grain	20 mg	14 grams = 1 tbsp.	1/4 oz. per 10 lbs.	88%

Dosage-mortality curves for four poison baits for pocket gophers (Fitted by probit analysis)



GOPHERS

Continued from preceding page

To locate runways, the probe is thrust repeatedly into the ground near fresh gopher mounds until it hits a tunnel. The operator can easily tell when this happens because then the probe drops suddenly due to changed resistance as its point passes from the soil into the open tunnel.

After locating an open runway, the small probe hole is enlarged for placing the bait by inserting the handle end of the probe. The bait is then dropped into the runway, and the probe hole closed with a clod or pressed shut with the heel.

It is more effective to place baits at two or three sites in each burrow system rather than to drop them all down a single hole.

In heavily infested fields it is often difficult to tell where one burrow system ends and another begins. In that event, baits may be placed arbitrarily every 20 feet or so.

An intensive, persistent campaign against gophers is strongly recommended. Treatment should be repeated until survivors have been eradicated or reduced to a negligible minimum.

A rough check on the effectiveness of the treatment may be had by kicking off the tops of mounds during the operation and revisiting the area several days later to look for new work. Another method is to return to the field after irrigation to check on new mounds.

For the final elimination of survivors, traps or a different poison bait formula should be used since the last survivors may be wise to the original treatment.

Once cleared of gophers, fields should be surveyed periodically for reinvaders. These are apt to migrate overland from nearby untreated lands and to dig in around the edges of the field.

Cost of Poisoning

Cost of poisoning will vary greatly with density of the gopher population, degree of control desired, price of material, labor cost, and operating conditions.

A rough idea of the expense may be had by considering how much it would cost to eradicate or reduce to a negligible minimum 100 gophers in a five-acre alfalfa field—heavy infestation of 20 per acre.

Labor is the principal item. Given abundant fresh mounds and low vegetation so that gopher systems can readily be seen, and moist soil for easy and efficient probing, an experienced operator can thoroughly treat at least 25 systems an hour. To this must be added an hour for preparing baits and the time required for a second treatment to reduce survivors. Assuming an 80% kill, it would take

about another hour to re-treat the 20 surviving gophers—killing presumably another 80%, or 16 of them. Thus, to obtain a 96% kill would take two treatments, requiring approximately six man-hours. With labor at \$1.00 an hour, this would amount to a little more than six cents a gopher, or about \$1.20 per acre.

Cost of materials would be nominal. With strychnine alkaloid at \$28.96 per pound it would take only 40¢ worth of this poison to kill nearly 100 gophers, about four tenths of a cent per gopher. With strychnine sulfate at \$22.24 per pound, 35¢ worth would be needed.

For bait, about four pounds of cut root vegetables would be required for 100 gophers using strychnine alkaloid—slightly more with strychnine sulfate.

The cheapest available bait material can be used—culled or unmarketable vegetables are satisfactory. At 5¢ a pound, the bait for 100 gophers would only cost about 20¢, or two tenths of a cent per gopher. The cost of poisons and baits together at most would add about six tenths of a cent per gopher to the total cost.

Poisoning is cheaper and obtains better kills than either gassing or trapping.

Trapping may be desired for final eradication or may be preferable in small areas or for small numbers of gophers, but poisoning with the proper poisons, baits and dosages is the most effective and economical method for eradicating pocket gophers.

Milton A. Miller is Associate Professor of Zoology, University of California College of Agriculture, Davis.

COTTON

Continued from page 2

Careful operation of the harvester itself is extremely important. Growers cite the necessity for keeping picker drums clean of dirt, grease and soiled cotton, using a minimum of moisture on the spindles and not picking when weather conditions are very unfavorable—high humidity.

Growers also reported successful machine-picking in very rank, high-yielding cotton.

Grades of machine-picked cotton varied widely among the gins. Some gins in each area had grades comparable with hand-picked cotton.

Economic Advantage

The economic advantage of machine-picking must be evaluated on more than just the costs of machine versus hand-picking.

In this study, machine-picked grades were lower than those for hand-picked cotton. Money returns from the crop,

therefore, were lower for machine-picked than for hand-picked cotton. The difference averaged, for the season, slightly less than one full grade.

An indication of the effect of grades on money returns is the government loan value. The loan value of hand-picked cotton at 35 gins averaged \$142.84 per bale, and of machine bales \$132.52, a difference of \$10.32 per bale. The \$10.32 difference in loan value is a market cost to be charged to mechanical harvest.

The net economic advantage of machine-picking is found by adding together harvesting costs, value of field waste, and value of grade-loss, and comparing the total with the cost of hand-picking.

These figures are summarized in terms of the average grower in 1949:

	Hand picking	Machine picking
Picking cost	\$45.00	\$14.65
Field waste		1.20
Grade-loss		10.32
Total harvesting cost	\$45.00	\$26.17
Difference in favor of machine-picking		\$18.83

A practical economic question facing the grower is at what yield of seed cotton per acre he can afford machine-picking. In 1949 a grower's total cost would have been \$6.47 per hundredweight of seed cotton worth \$7.70 above ginning costs—assuming second picking cotton with lint at 20¢ a pound and cottonseed at \$45.00 a ton.

A grower who considered only the direct costs of operating a mechanical harvester—exclusive of overhead—could operate when the yield was only 75 pounds. His direct costs would be \$6.25 per hundredweight.

Trimble R. Hedges is Associate Professor of Agricultural Economics, University of California College of Agriculture, Davis.

TOMATO

Continued from page 4

cut off. Although insects were suspected, in many cases, careful examinations revealed that the damage was out of proportion to the insect population present. Observations were made that indicated that birds were responsible for the loss. Of these, horned larks were the most important offenders.

A. E. Michelbacher is Associate Professor of Entomology, University of California College of Agriculture, Berkeley.

W. W. Middlekauff is Assistant Professor of Entomology, University of California College of Agriculture, Berkeley.

E. E. Stevenson is Farm Advisor, Stanislaus County, University of California College of Agriculture.