Poison Gas Tests on Gophers

gases and gas bombs much less effective and more costly than poison bait, contrary to common claims

Milton A. Miller

Controlled experiments to determine the effectiveness of several commercial poison gases and gas-generating bombs and dusts—as compared to standard poison baits—were conducted in gopher-infested alfalfa fields at Davis.

A modified open-hole test was used in evaluating the various treatments.

The data obtained clearly show that gases in general are much less effective than poison baits in controlling gophers. Best kills with gases ranged roughly between 50% and 60%, while strychnine-coated carrots gave 80% kills—a highly significant difference both statistically and practically.

Tests with Gas

Of the gas products tested, methyl bromide, chloropicrin, and a nitrocellulose film bomb gave the highest percentages of kills—approximately a little more than half the gophers succumbed.

Least effective in these tests were hydrocyanic acid gas—HCN—whether generated from moistened calcium cyanide powder or from an ignited bomb, and carbon bisulfide. When the soil was wet, consistently better kills were obtained with calcium cyanide powder than when the soil was dry—5% moisture content—although the differences were not statistically significant. Higher soil moisture probably increases kills by more quickly wetting the calcium cyanide powder, thereby accelerating generation of gas, and by sealing cracks in the soil, thus preventing escape of the gas.

The poor or mediocre performances of gases may be attributed, in part, to the ability of gophers to quickly barricade their tunnels with earth plugs, blocking passage of the gas. Hence, success in gassing would depend to a great extent on the proximity of the gopher at the time of treatment to the site chosen for injection of gas—presumably a matter of chance. Considering that the tunnel labyrinths of gophers in alfalfa fields average more than 100′ in total length — and may exceed 250′ — the chances are not very great of gassing the burrow occupant before it can take protective action.

The open-hole test. Excavation in foreground, dug two days after treatment of burrow with poison gas or poison bait, has exposed a tunnel which will remain open—as shown—if a kill was made; but if the gopher survived the treatment, he will soon plug the tunnel opening—and perhaps the excavated site—with soil. Since gophers are remarkably solitary and will quickly plug any openings made in their normally closed burrow systems, the percentage of burrows that show open sites at the end of a test is a reliable measure of the effectiveness of treatments. Gassed burrows are usually plugged; those treated with strychnine-carrot bait generally remain open.

To overcome the gopher before the animal can blockade its tunnels, various means of forcing the gas through the burrow have been devised, including pumps. All pressure methods, however, encounter the difficulty that the gopher burrow is essentially a closed system of narrow tunnels—typically 2½″ to 3″ in diameter—that are plugged at their ends, or end blindly underground. Consequently, back pressure tends to force escape of gas around the injection nozzle unless precautions are taken to seal around it. Strong pressure, too, may open cracks in the soil, allowing escape of fumes.

In tests with methyl bromide and chloropicrin, the volatile pressure of the liquefied gas was utilized. Methyl bromide was supplied in liquid form sealed in one-pound cans with a special applicator—a device for simultaneously puncturing the can and clamping the applicator to it, a valve for regulating the flow of gas, a flexible rubber hose, and a metal injector tube with side openings near the tip to deliver the gas as a fine spray. Chloropicrin was supplied in a sealed metal cylinder with valve outlet to which the applicator hose could be attached. A hand pump was used for injecting carbon bisulfide fumes into the burrow.

A special hand pump was used for blowing calcium cyanide powder into the burrow. More effective distribution of calcium cyanide dust has been reported using air delivered from a compressor mounted on a jeep. An air-dust mixing chamber with control valve is inserted in the line near the injector nozzle.

The nitrocellulose film bomb used in the tests burns with explosive violence, which the manufacturer claims drives the nitrogenous fumes along the burrow. The roll of film is jacketed in a less flammable cylinder to help produce the torching effect.

Greater kills usually resulted, as anticipated, with increased dosages of gas,

Concluded on page 14

OLIVES

Continued from preceding page

at a concentration of two pounds per 100 gallons.

Treatment *3*—Painted on fresh pruning cuts, using a solution containing one-fourth pound per gallon.

Control—No treatment.

Fruits were harvested from each tree on October 19, 1953, when they were at the straw-colored stage. They were processed immediately by the green-ripe method and canned orchard run with semicommercial equipment.

On July 8, 1954, canned samples of olives representative of each treatment were opened for examination. Tasting was done by a panel of individuals known to be sensitive to the off-flavor and under conditions where the identity of each sample was unknown to the panel.

The results, shown in the table on page 13, demonstrate that either lindane or B.H.C. applied to the trees before harvest of the olives results in a moldy, musty off-flavor in the canned olives. The results are in agreement with observations made with other crops.

About 40% to 50% of humans are insensitive to this moldy, musty off-flavor development in food crops, including olives. To detect contaminated fruit, personal sensitivity to the off-flavor developed in olives by the benzene hexachloride type of insecticide must be established.

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GOPHERS

Continued from page 7

but the differences were generally not statistically significant because of too few tests. Increases in kill were often too small to justify the added cost of materials. Manufacturer's recommendations with respect to dosage were followed and included in experiments involving graded dosages.

In methyl bromide tests, the suggested dosage of 10 cubic centimeters per burrow gave no kills in 14 burrows. The minimal lethal field dosage for methyl bromide, as indicated by the present study, lies between 10 and 20 cubic centimeters per burrow. Seemingly, a practical limit was reached at 20 cubic centimeters per burrow with a 51% kill as increasing the dosage level to 30, and 40 cubic centimeters per burrow yielded no significant increase in kill.

With carbon bisulfide, calcium cyanide powder and the nitrocellulose film bomb, doubled dosages increased the kills but did not bring mortality even close to practical levels.

Dosages should be established in relation to the air volume inside the burrow, and that volume widely varies—depending on the size of the gopher, type of soil, cover crop, and size and age of the burrow itself. The dosage of gas that might kill a gopher in a small new burrow in the garden would likely have no toxic effect in a long-established system in a cultivated field. Even in the same field, burrows vary greatly in size; nine excavated in an alfalfa field had tunnel volumes ranging from one to eight cubic feet with an average of 3.9 cubic feet.

Operational Difference

The operational principles in gassing and poisoning gophers are diametrically opposed, which probably accounts for the difference in results. When gas is the lethal agent, it must seek out its victim wherever it happens to be or go in its extensive tunnel system; but with poison baits, the victim must find the lethal agent.

Success in poisoning with baits may be attributed to high acceptance of baits by gophers who seem to be attracted to almost any object dropped into their burrows—even clean paraffin blocks are taken. Gophers are easily lured by any poisoned bait, such as a piece of carrot or other root vegetable.

Compared to poison baits, the cost of poison gases is excessive, even more so when labor and equipment costs are added. Cost of materials is almost negligible in poisoning—about a half cent per burrow—whereas gases cost many times that amount without giving the desired results. More time is needed, too, for gassing a burrow than for poisoning; gassing takes three or four minutes per burrow as compared to two minutes on the average for poisoning. The cost differential between gassing and poisoning would become even greater if calculated on the basis of kill.

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Some tests reported in the foregoing article were conducted by James T. Rogers, Jr., a senior student in zoology, working under the direction of Professor Milton A. Miller. Dan Evans, Ray Meek, and Joseph Keeler, undergraduate students, and G. Victor Morejohn, a graduate student, assisted in the field work.

The compressed air apparatus for blowing calcium cyanide powder mentioned in the above report was developed by William Batzner, U. S. Bureau of Reclamation, Boise, Idaho.

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Kills of Gophers with Poison Gases and Poison Baits with Cost of Treatments.

Treatment	Dosage per burrow	Cost of materials per burrow	Number of burrows tested	Percentage kill ± S. E.
		cents		%
Methyl bromide (CH_3Br)	10 cc.	3.4	14	0
	20 cc.	6.7	47	51 ± 7.3
	30 cc.	10.1	30	50 ± 9.1
	40 cc.	13.4	57	58 ± 6.5
Carbon bisulfide (CS_2)	45 cc.	2	11	18 ± 11.6
	90 cc.	4	15	26 ± 11.8
Chloropicrin (CCl_3NO_2)	40 cc.	33	25	48 ± 10
	Soil dry:			
Calcium cyanide powder [$Ca(CN)_2$]; generates HCN when wet	¾ oz.	4.7	25	16 ± 7.3
	1½ oz.	9.4	10	20 ± 12.7
	Soil wet:			
	¾ oz.	4.7	10	20 ± 12.7
	1½ oz.	9.4	20	30 ± 10
Cyanide bomb; generates HCN when ignited	1 bomb	13.3	29	14 ± 6.4
Nitrocellulose film bomb; generates NO-NO_2 mixture	1 bomb	12	25	44 ± 9.9
	2 bombs	24	24	54 ± 10.2
Strychnine alkaloid on carrot. Toxic control	50 mg. on two 7-gm pcs.	0.57	114	80 ± 3.8
Unpoisoned carrot. Nontoxic control.	two 7-gm pcs.	0.25	18	6 ± 5.6*
No gas. Nontoxic control.	--	--	12	0

* *Normally, burrows treated with clean bait are plugged indicating no kill; but in these tests, one of eighteen so treated remained open indicating natural death, or capture of the occupant by a predator, or abandonment of the burrow by the gopher during the experiment.*