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EFFICACY OF A CARBON MONOXIDE GAS CARTRIDGE AGAINST FIELD RODENTS

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ABSTRACT: Efficacy data of a gas cartridge are reported. The gas cartridge contains 50 g of potassium nitrate (27.5 g, 55%) mixed with sawdust (22.5 g, 45%). When ignited, it generates large amounts of carbon monoxide (avg. 23.46%) and carbon dioxide (avg. 26.26%). A mimic field trial was carried out on a winter day. The air temperature averaged 1.2°C, ranging from -3.3°C to +5°C. Sixteen adult albino rats were killed within 3 minutes exposure in a man-made burrow system, 200 cm long, with an inside diameter of 8 cm.

Field trials were conducted in different parts of China, and there were no survivors in the 108 burrows treated. Upon excavation 144 dead rodents were recovered. The first test was carried out in Zhengding, Hebei Province. (The site was along-a sunning ground where cereals are dried.) Each of 53 burrows was treated with a 50-g gas cartridge. When the burrow systems were excavated, 81 dead rodents were found: Cricetulus barabensis, 38 (46.9%); C. triton, 28 (34.6%); Mus musculus, 14 (17.3%); and Apodemus agrarius, 1(1.2%). The second trial was carried out in a sugar cane field near a ditch in Zhangjiang, Guangdong Province. Fifty-five dead rodents were dug out of the 50 burrows treated: Rattus flavipectus, 26 (47.3%); Bandicota indica, 18 (32.7%); R. losea, 7 (12.7%); and Suncus murinus (Insectivore), 4 (7.3%). The third trial was conducted in a high mountain grassland pasture above 3500 m in Qinghae Province. Five marmot burrows were each treated with a dose of 600 g of gas cartridges per burrow. Eight dead Marmota hymalayana were found near the burrow entrance.

INTRODUCTION

Fumigants can be very effective for killing rodents and their ectoparasites living in burrows in the field. Adequate fumigation of field burrows is a quick way of controlling wild rodents. It is a useful technique for preventing zoonosis outbreaks.

Fumigants commonly used include calcium cyanide, methyl bromide, chloropicrin and aluminum phosphide. Unfortunately, these chemicals can be extremely dangerous to the persons using them and they are also expensive; hence gas cartridges can be considered as a good alternative. Because the formulation of the gas cartridges in common use contains five or more active ingredients, it is difficult to identify and quantify the combustion products from each of these ingredients. From 1960 to 1964 we developed a new gas cartridge containing only two active ingredients. We present the results of our studies to evaluate the efficacy of this gas cartridge for controlling wild rodents.

FORMULATION AND ANALYSIS

The gas cartridge formulation contains 45% sawdust and 55% potassium nitrate (W/W). When ignited, it generates large amounts of carbon monoxide and carbon dioxide. The average contents of these two gases are 23.46% and 26.26%, respectively. Data of the analysis of the gases are shown in Table 1.

Table 1. Analysis of the cartridge gases.

Samples	Temperature (°C)	CO (%)	CO_2 (%)
1	20°.0'	23.0	25.8
		23.0	25.8
		23.0	25.6
2	20°.5'	21.9	28.2
		22.0	28.2
		22.0	28.2
3	20°.0'	24.6	25.2
		24.6	25.2
		24.7	25.1
4	19°.0'	24.3	26.0
		24.2	26.0
		24.2	25.8
$\bar{X}$		23.46	26.26
SD		1.10	1.21

Each gas cartridge contained 50 g of sawdust and potassium nitrate wrapped in a paper cylinder, 11 cm long, 4 cm in diameter and 0.1 cm in thickness. A firework fuse was inserted through one end into the mixture.

MAN-MADE BURROW SYSTEM TESTS

In December 1960 a man-made burrow system, 200 cm long and 8 cm in diameter, was constructed on a dam. Adult albino rats, 150 to 200-g body weight, were used as test animals. After one rat at a time was put in the nest chamber of the burrow system, one 50-g gas cartridge was ignited and inserted into the burrow entrance, which was quickly sealed tightly with sod or soil to prevent fumes escaping. Three minutes later, death was confirmed by excavating the burrow system. All 16 animals tested were killed within 3 minutes. The air temperature averaged 1°.2'C, ranging from -3°.3'C to +5°C.

FIELD TRIAL I

In October 1961, we conducted the first field trial at a village near Zhengding, Hebei Province. The study site was a narrow wasteland alongside a sunning ground used for drying wheat and maize. Soil type was sandy loam.

Each of 53 outdoor burrows was treated with a 50-g gas cartridge. Three minutes later each burrow system was excavated to evaluate the efficacy. A total of 81 dead rodents was found: Cricetulus barabensis, 38 (46.9%); C. triton, 28 (34.6%); Mus musculus, 14 (17.3%); and Apodemus agrarius, 1 (1.2%). There were no survivors.

FIELD TRIAL II

This study was conducted at a village about 20 km southwest of Zhanjiang, Guangdong Province, in April 1963. The study site was along a ditch in a sugar cane field. Soil type was red earth.

Each of 50 burrows was treated with a 50-g gas cartridge. A total of 55 dead rodents was dug out: Rattus flavipectus, 26(47.3%); Bandicota indica, 18 (32.7%); R. losea, 7 (12.7%); and Suncus murinus (an insectivore which lives in close association with man), 4 (7.3%). No survivors were found in the burrow system.

FIELD TRIAL III

The third field trial was carried out approximately 250 km northwest of Xining, Qinghai Province, in July 1964. The study area was a high mountain grassland pasture above 3500 m. The soil type was sandy humus soil.

Each of five marmot burrow entrances was treated with 600 g of gas cartridges. Eight dead Marmota hymalayana were recovered near the burrow openings. There were no survivors. Marmots are quite social and a family may inhabit a burrow system. Two rodents were dug out of the three burrow systems.

RESULTS AND DISCUSSION

The study areas in this paper included rain-fed wheat and maize fields of North China Plain, irrigated rice fields of South China coastal area and rangeland on Northwest Plateau. They represent the major habitats of wild rodents in China. It is necessary, however, to recommend further testing of this gas cartridge in different regions.

Table 2 summarizes the results of these three field trials. The 144 dead rodents dug out of treated systems involved nine species of two orders, Rodentia and Insectivora: Cricetulus barabensis, C. triton, Rattus flavipectus, R. losea, Mus musculus, Bandicota indica, Apodemus agrarius, Marmota hymalayana, and Suncus murinus. These animals are considered pests to agriculture and/or are reservoirs of rodent-borne diseases. Of the excavated rodents, 24 (14.2%) died in burrows at depths of about 25 cm, 48 (28.4%) at 75 cm, 50 (29.6%) at 100 cm, and 47 (27.8%) died in or near nest at depths ranging from 125 cm to 369 cm. The body weight of animals was significantly correlated with depths in burrows where the dead bodies were located (r = -0.88). The details are summarized in Table 3.

The advantages of this type of gas cartridge include:

(1) When this gas cartridge is ignited the fumes contain a high concentration of carbon monoxide (avg. 23.46%), which can knock down animals in the burrows within three minutes.

(2) When the gas cartridge is ignited and inserted into a burrow, the toxic gases quickly expand to the bottom without any equipment needed to disperse the gases.

(3) The cartridges are easy and safe to use.

(4) They are cheaper than other fumigants and easier to prepare.

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Table 2. Data from the field trials.

Study area	Dose per burrows (g)	No. of burrows treated	Avg. length and range of burrow system (cm)	Species	Number dug out
Sunning ground, Zhengding, Hebei Prov.	50	53	278(98-458)	Cricetulus barabensis	38
			369(96-642)	C. triton	28
			125(39-211)	Mus musculus	14
			340	Apodemus agrarius	1
Sugar cane field, Zhanjiang, Guangdong Prov.	50	50	158(83-233)	Rattus flavipectus	26
			166(103-229)	Bandicota indica	18
			223(173-273)	R. losea	7
			127(55-199)	Suncus murinus	4
Rangeland, Northwest Plateau, Qinghai Prov.	600	5	350-2020	Marmota hymalayana	8

Table 3. The depths at which the dead rodents were found in the burrow systems following treatment with gas cartridges.

Species	Body wt.(g)	Depths (cm) 25	75	100	200
Cricetulus triton	184	5	9	6	8*
C. barabensis	44	2	15	11	10*
Mus musculus	18	4	4	6*	
Apodemus agrarius	40		1		
Rattus flavipectus	120	3	6	17*	
R. losea	90		3	4	
Bandicota indica	1800	6	8	4*	
Marmota hymalayana	5200	8			
Suncus murinus	56		2	2*	
Total		28	48	50	18

* in or near nests

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