EFFICACY OF A TWO-INGREDIENT FUMIGANT ON RICHARDSON'S GROUND SQUIRRELS

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ABSTRACT: In July 1981, efficacy data were obtained on a new two-ingredient gas cartridge by field testing against Richardson's ground squirrels (Spermophilus richardsonii) in a sagebrush-rangeland pasture. The gas cartridge contained 97 g of a sodium nitrate (65%) and charcoal (35%) mixture and upon ignition generated mainly carbon monoxide with a small quantity of carbon dioxide. We live-trapped 53 (24 male and 29 female) ground squirrels, equipped each with a 164 MHz radio transmitter, and then released each at the point of capture. Later we located each ground squirrel and treated its main burrow and all burrows within 3 m by inserting ignited gas cartridges. After treatment the location of each radio-equipped ground squirrel was plotted. Ground squirrels showing no movement were presumed dead; death was confirmed by burrow excavation. Success rate was 84% as 41 of 50 (18 males and 23 females) died (82%) and 8 survived (16%). The radio transmitter on 1 (2%) failed immediately after treatment. Efficacy was estimated at 83.7%, which exceeds the 70% minimum standard established by the EPA. Thirty-eight ground squirrels died in burrows at depths ranging from 7.6 to 132.1 cm ($\bar{x}$ = 74.7 ± SE 5.2 cm), and 3 died in nests at depths ranging from 94.0 to 182.9 cm ($\bar{x}$ = 133.0 ± SE 26.2 cm). Seven of the eight survivors were retrapped. Factors contributing to survival are discussed, including soil porosity and moisture content, as well as squirrel body weight. Recommendations for further testing are presented.

INTRODUCTION

The amended Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1975 requires that the U.S. Fish and Wildlife Service's gas cartridge for controlling rangeland rodents be reregistered by the Environmental Protection Agency (EPA). Because this gas cartridge contains six active ingredients, we anticipated difficulty in reregistration, especially in identifying and quantifying the combustion products from those ingredients. Anticipating these difficulties, Savarie et al. (1980) devised a gas cartridge with two active ingredients, sodium nitrate (65%) and charcoal (35%); upon ignition it generates carbon monoxide with a small quantity of carbon dioxide. Field tests have shown this new two-ingredient gas cartridge effective for controlling denning coyotes (Canis latrans) and Norway rats (Rattus norvegicus) (Savarie et al. 1980). However, in a 1980 field test on Richardson's ground squirrels, mortality was only 68% using a cartridge containing 65 g of sodium nitrate (65%) and charcoal (35%); this was below the 70% minimum level recommended by EPA for registering a rodenticide (Fagerstone et al. 1981). Fagerstone et al. proposed increasing the combination of ingredients from 65 g to 97 g as a potential means of increasing mortality. This study reports the efficacy of a 97 g gas cartridge on Richardson's ground squirrels.

METHODS

Study Area

We conducted this study approximately 3.2 km southeast of White Sulphur Springs, Meager County, Montana, on 13-18 July 1981. The study site was sagebrush-rangeland pasture on the valley floor adjacent to the headwaters of Potter Creek. Soil type was Higler loam and stony loam (Gieseker 1953), a soil characterized by loam or stony loam on the surface and a moderately stony clay loam at the subsoil level. At depths of 38 to 51 cm, it becomes a light gray-brown stony clay loam that continues vertically beyond 91 cm.

Radio-telemetry and Treatment

On 13-14 July, we live-trapped 53 (24 male and 29 female) ground squirrels. Each ground squirrel was equipped with a 164 MHz radio transmitter, ear-tagged, sexed, weighed, and released at the point of capture. Within an hour after release, each radio-equipped ground squirrel was located, using a three-element, hand-held yagi antenna and a LA-12 receiver built by AVM Instrument Company[1], and each ground squirrel's underground position was marked with a flag. All flagged burrows, as well as burrows within about 3 m, were treated by inserting an ignited gas cartridge with the fuse end down. The burrow entrance was immediately closed with dirt to prevent gases from escaping. Treatment of burrows was accomplished in late afternoon on 14 July, and during the morning on 15 July.

Gas Cartridge Formulation

Each gas cartridge contained 64 g (65%) sodium nitrate and 33 g (35%) charcoal in a cardboard cylinder 13.3-cm long, with a 3.8-cm inside diameter, and 0.2-cm wall thickness. Ends of the cylinder were closed with 0.1-cm thick cardboard caps. A 10.8-cm firework fuse was inserted through one of the end caps into the sodium nitrate and charcoal mixture.

[1]Use of trade names does not imply Government endorsement.

Evaluation of Treatment

On 15-17 July, live traps were reset to recapture surviving radio-equipped ground squirrels. Posttreatment locations of all ground squirrels were plotted daily and ground squirrels showing no movement were presumed dead. Death was confirmed by excavating the burrow systems and recovering the radio-equipped ground squirrels. After all radio-equipped ground squirrels were recovered, we estimated the percent population reduction by the following formula:

$$\% \text{ Population Reduction} = \frac{\text{No. animals with functional radios on treatment day} - \text{No. of radio-equipped animals alive posttreatment}}{\text{No. animals with functional radios on treatment day}} \times 100$$

Differences in body weights between those ground squirrels surviving and those dying were analyzed by student's t-test.

RESULTS AND DISCUSSION

Ground squirrel mortality exceeded the 70% minimum standard established by EPA for rodenticide registration, as treatment reduced the population by an estimated 83.7%. Of the 53 ground squirrels only 50 had functional radios at the time of treatment; 41 (82%) (18 males and 23 females) died, and 8 (16%) (13 males and 5 females) survived. One (2%) of the 50 functional radio-transmitters failed immediately after insertion of the gas cartridge into the burrow entrance; this ground squirrel was never found. The latter squirrel, together with three radio-equipped individuals that we lost contact with before treatment, were omitted from percent population reduction calculations.

We recovered all 41 dead ground squirrels with functional radio transmitters. Of these, 38 (93%) died in burrows at depths ranging from 7.6 to 132.1 cm, $\bar{x}$ = 74.7 cm (SE = ± 5.2) (Fig. 1). Three (7%) ground squirrels died in nests, located at depths of 94.0, 122.0, and 182.9 cm, $\bar{x}$ = 133.0 cm (SE = ± 26.2). The eight surviving ground squirrels showed posttreatment movements within their burrow systems, and seven were subsequently retrapped.

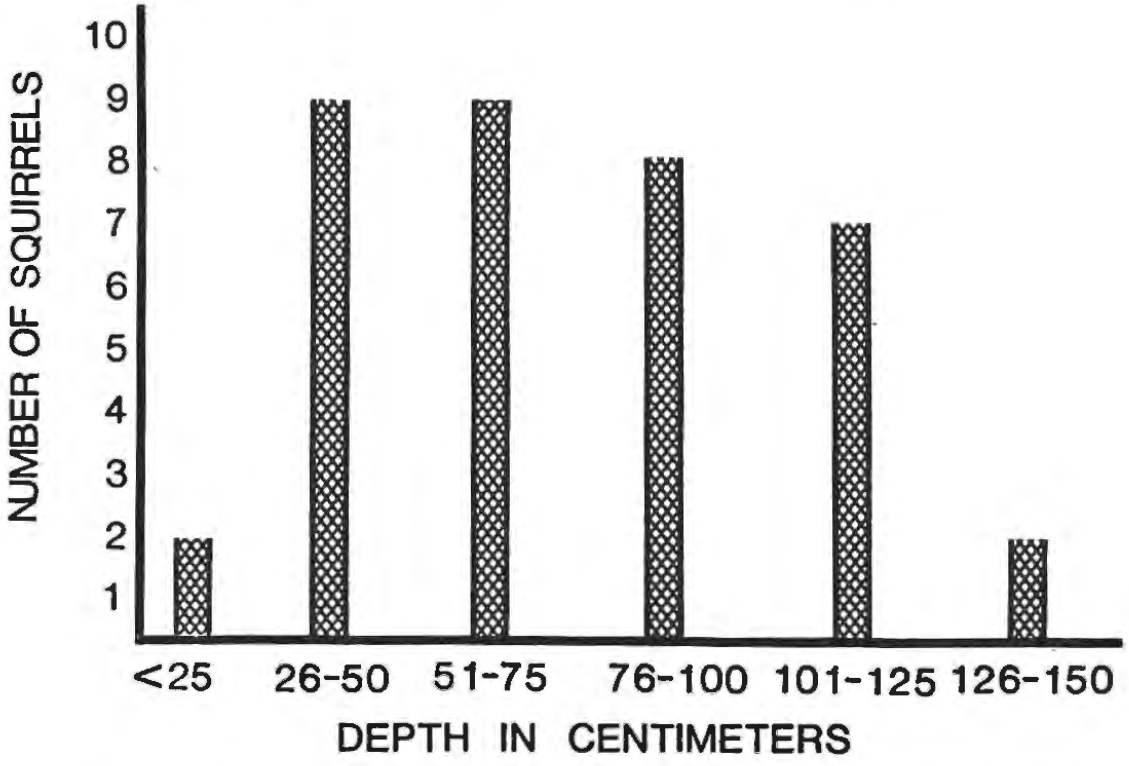

Fig. 1. Depths at which radioed Richardson's ground squirrels were recovered in the burrow system following treatment with the 97 gram charcoal-sodium nitrate gas cartridge.

Possible factors contributing to test survival include:

(1) Soil porosity and moisture content - The soil, dry and porous at treatment, may have allowed gas diffusion before the ground squirrels received a lethal dose. Dry soil increases diffusion, whereas wet soil decreases gas diffusion (McClean 1981). The study area soil was dry, receiving only 0.51 cm of rain the week before treatment. Soil porosity (the ratio of the volume of

solids) also influences the diffusion of gases. Highly porous soil such as dry, sandy soil has a high diffusion rate, whereas heavy clay has a low gas diffusion rate.

(2) Body weight - Survival was greater among heavier ground squirrels; these survivors averaged 432 g ± SE 35.0 compared to 352 g ± SE 12.6 for the ones that died. Difference in body weight between the two groups was significant ($t = 2.37$, $P = 0.22$).

RECOMMENDATIONS

We recommend further testing of this gas cartridge in different geographic regions and perhaps under wetter soil conditions. If efficacy continues to exceed the minimum standard of 70% established by the EPA, then this two-ingredient cartridge would be a prime candidate for registration. The demand for a gas cartridge to control rangeland rodents in the western United States has increased from between 600,000 and 800,000 gas cartridges sold yearly before 1975 to 2,000,000 sold in 1981. This increased demand has been brought about by the amended FIFRA which placed toxicants (1080, strychnine, and zinc phosphide) for controlling rangeland rodents on the restricted EPA list, limiting their use only to certified pest control operators. This restriction forces many small ranchers and farmers to use gas cartridges as a primary instead of a secondary device for controlling rangeland rodents.

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