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Evaluating the Efficacy of the RodenatorTM (Propane-Oxygen Device) for Control of Black-tailed Prairie Dogs in Montana

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ABSTRACT: Black-tailed prairie dogs' feeding and burrowing behavior is a significant economic nuisance to agricultural producers. We tested the Rodenator™ on two portions of an isolated prairie dog town in Lewis and Clark County, Montana to determine how effective it was in reducing prairie dog numbers. Though other studies have been done using propane-oxygen devices, our study employed updated application techniques and an aggressive hole closing procedure to reduce the likelihood of false failures. In the southern area, we treated 53 burrows for 30 seconds with oxygen set at 40 psi and propane at 45 psi. In the northern area, we treated 120 burrows with an injection time of 45 seconds using the same oxygen and propane psi rates. Using the open burrow method for determining efficacy, our results were 58.7% for the southern area and 65% for the northern. Our study revealed that future studies should incorporate population surveys and appropriate control plots to determine the true efficacy of the Rodenator™, and we provide suggestions to improve overall method efficiency.

KEY WORDS: black-tailed prairie dog, *Cynomys ludovicianus*, prairie dog control, propane-oxygen devices, Rodenator, rodent control

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INTRODUCTION

The Rodenator™ (E. B. Meyer, Inc., Emmett, ID; EPA Establishment #079470-ID-001) is a propane-oxygen delivery device marketed to control burrowing animals such as pocket gophers, prairie dogs, and other ground squirrels (Meyers Industries 2013b). Applicators inject a mixture of propane-oxygen gas into a burrow for a set period of time (e.g., 60 seconds), which is followed by igniting the gas, which then rapidly combusts. The event is best classified as a deflagration (i.e., burning) or combustion because the burning occurs at sub-sonic speeds (i.e., less than 100 meters/second). [Note that the on pages 15 and 17 of the Meyers Industries document the speed of the concussive force is stated as 10,000 feet per second; according to personal communication with Ed Meyer, that document should read 1,000 feet per second.] In contrast, burning that occurs at super-sonic (i.e., up to 2,000 meters/second) speeds and is accompanied by substantial overpressures up to 290psi is called a detonation (Geiger 1983). Nevertheless, the shock wave of the conflagration is powerful enough to kill burrow occupants (Shadel 2008, Meyer Industries 2013b), especially if the rodent has inhaled the mixture before ignition. If soil conditions are appropriate, the ignition event can cause some collapse of the tunnel (Shadel 2008). The mixture used in the Rodenator is proprietary, but a competing product used a propane-to-oxygen mixture rate of 5% to 95% (Shadel 2008).

Research on an earlier type of this device, called the Rodentorch, found that use could reduce active black-tailed prairie dog (*Cynomys ludovicianus*) burrows by 13% and 63.3% using 30-second and 60-second injection times respectively (Sullins and Sullivan 1992). Anecdotal reports from users of later models have similarly been skeptical about the technique's effectiveness as a method to control prairie dogs. But given that users vary in their attentiveness to both the use of the device and the extent of their monitoring of treated prairie dog towns, the author decided to evaluate the device's effectiveness under more rigorous conditions.

METHODS

Study Area

The study site consisted of two corners lying outside a pivot-irrigated alfalfa field with long-standing problems with black-tailed prairie dogs. The author named the two corners Northern and Southern, respectively. Each of these corners encompassed an area of less than four acres. Soil was sandy with small rocks (up to three inches in size) distributed on the surface. The Natural Resources Conservation Service identifies the soil as "Musselshell" and "Crago" with a sand percentage ranging from 35% to 67% to a depth of 60 inches (NRCS 2003).

To reduce the number of inactive holes and to increase the likelihood of treating active burrows (Stromberg 1978), the producer disked the northern area on March 15, 2017 and the southern area on March 21, 2017. On the evening of the March 21, prairie dogs were observed in both study fields, in the adjacent alfalfa field, and in a non-crop area to the west and north, respectively.

Active prairie dog holes in both study areas were marked with surveyor flags before treatment. Holes were considered active if prairie dogs were observed using the burrow and/or the hole size was sufficiently large enough to allow prairie dog use by visual inspection. About seven traps capable of capturing prairie dogs or Columbian ground squirrels (*Urocitellus columbianus*) were placed along the perimeter of the study area to reduce potential for reinvasion. A total of three prairie dogs and four Columbian ground squirrels were taken during the study period. We cannot be sure if these animals were from the plots or from adjacent areas.

Table 1. Weather conditions at treatment sites.

Date	Helena Valley North East Low-Hi Temp* (°C)	Helena Valley North East Precipitation*	On-site wind Meters/sec	On-site Temp
3/21/2017		Trace, but nothing the previous 4 days		
3/22/2017 Southern Plot	0.0 - 16.1	0	2.0 10:10 AM 1.8 10:56 AM 3.8 11:48 AM 6.3 12:20 AM	Not taken
3/23/2017 Northern Plot	0.61 - 12.8	0	0.0^ 6:48 AM 0.0^ 7:24 AM 0.0^ 8:07 AM 0.9 8:12 AM 1.2 8:55 AM 2.0 10:03 AM 4.0 10:25 AM	Not taken 2.1°C Not taken 2.4°C Not taken 15.0°C 11.1°C
3/24/2017	-3.2 - 17.8	0		
3/25/2017	3.3 - 17.8	0.03 inches		

^ breeze too slight to record

*Your Weather Service. 2017. Daily normals Helena-March. http://www.usclimatedata.com/climate/helena/montana/united-states/usmt0163/2017/3. Accessed April 21, 2017.

To ensure proper functioning and use of the Rodenator, the author relied on the expertise of Ed Meyer, owner of the Rodenator. He brought two R-1 Rodenators and oversaw equipment calibration and ensured that equipment worked properly. Oxygen, propane, and vehicle-trailer combination to transport the equipment was provided by the landowner, George Cawlfield. Oxygen flow was set at 40psi and propane flow at 45psi throughout the study, which was slightly below the recommendations in the manual of 50psi for oxygen and 53psi for propane (Meyers Industries 2013b). Mr. Meyer tested the mixture rate on burrows outside the test area to ensure that the setting was appropriate before starting our work on the southern test plot.

Burrows in both plots were treated in a systematic fashion. Flags were numbered during treatment. Unmarked burrows encountered during our work were also treated and flagged. If treatment revealed that proximal burrows were connected or burrows had a high likelihood of being connected (<15 ft), we flagged those holes with the same number and used letters (45a, 45b, etc.) to distinguish them, as our concern lies with burrow systems not individual holes. On a few occasions, treatment revealed the presence of proximal holes that were closed and thus hidden from our view. Those holes were also closed and marked.

Applicators had the option to cover the wand with soil to prevent gas from escaping the burrow or having it siphoned off by wind (Ed Meyer, pers. comm.). Meyer asserted that excessive wind could siphon the gas mixture from the burrows thereby reducing the efficacy of the treatment (see NASA 2015, Propane-101 2011). Wind speeds varied during our treatments but typically tended to increase as the day progressed (Table 1). Following treatment, holes were backfilled (Hygnstrom 1994). To help ensure adequate filling, the soil plug was probed with the handle-end of the shovel to cause the soil to fill the hole more fully. Additional soil was added as needed. Variance in hole closing effort could not be eliminated.

On March 22, 2017, we treated burrows of the southern plot for 30 seconds prior to ignition. On March 23, we treated the northern plot using a 45-second injection time. With the help of Larry Cawlfield, we used two R-1 Rodenators until 10:03 AM, when lack of bottled oxygen forced us to use only one Rodenator. We also lost some time as one of the oxygen regulators froze up at 8:12 AM, forcing us to wait about 15 minutes for it to thaw before continuing. Air temperature at that time was 2.4° C. Other details of our treatments are as follows:

Southern Area
- ~15,584 m^2 or 3.85 acres using Google Earth
- Image date 7/25/2014
- Time in 10:25 AM
- Time out 12:43 PM

Northern Area
- ~15,014 m^2 or 3.71 acres using Google Earth
- Image date 7/25/2014
- Time in 7:25 AM; Began with two Rodenators
- Time 9:20 AM; Changed O_2 tank, treated 65 burrows
- Time 10:03 AM; Down to one Rodenator due to empty tank (~89 burrows treated)
- Time out 10:50 AM
- Restart 11:00 AM
- End time 11:13 AM

Following treatment, each site was inspected for opened holes daily for two days. Each burrow was designated with one of three classifications: “0” for no activity; “1” for a small hole, but too small for a prairie dog; and “2” for a dig-out consistent with prairie dog presence. Holes receiving a designation of “2” had their

Table 2. Details on treatment of Southern and Northern sites.

Site	Treated Burrows	Injection Time	Treatment Time (hrs:mins)	Minimum Apparent Efficacy	Std Error	Maximum Apparent Efficacy	Std Error
Southern	53	30 sec	2:18	26.4%	0.060548	58.7	0.067635
Northern	120	45 sec	3:48	54.6%	0.045641	65.0	0.067634

flags removed. Holes receiving a “1” on the first day were back-filled and left for the second day check.

RESULTS

Since the study design identified changes over time, our results (Table 2) can be interpreted in different ways. The minimum efficacy results represent the percentage of holes that did not experience any reopening over the 48-hour period following treatment. The maximum efficacy results signify the percentage of holes that failed to be reopened sufficiently for prairie dog entry. Sometimes, a hole would be disturbed on day one but not on day two, allowing it to be designated as a successful treatment. Other times, the reverse would be true.

The author clearly saw evidence of animals trying to dig into the closed burrows, as several holes showed digging but the animal failed to break through and enter the hole. Weather for the period is indicated in Table 1.

DISCUSSION

Treatment of burrows proceeded very quickly. This was particularly true in the northern plot when we used two Rodenators. Two Rodenators not only permitted treating a swath approximately 100 feet wide but also reduced the need for a single applicator to re-cover ground, treating both sides of the vehicle and trailer. The speed of work in the northern plot was so fast that sometimes the note-taker marked flags with the same number. The author recommends that in future studies, the note-taker not be responsible for hole closing. One burrow in the northern plot reopened after it was treated. It was treated again in the abundance of caution. This occurrence was due to the soil plug collapsing into the burrow, rather than because of animal movement, because it took about a minute’s worth of shoveling to fill it sufficiently to keep the opening closed.

A user manual (Meyer Industries 2013a) suggested application rates for different soils with oxygen regulator set at 50psi and the propane set at 53psi (see Table 3). Our site could be classified between sandy and loam soil. Note that injection times would be lower than what is listed in the table when using the higher psi rates of 50 and 53, respectively.

Identification of the cause behind hole openings was confounded in several ways. First, Columbian ground squirrels sometimes reopened holes, possibly skewing results. Upon reflection, it appears that in the southern area we treated holes that were likely created by Columbian ground squirrels. If this opinion is correct, then removal of these applications would likely require improving the efficacy of the treatment a percentage point or two. Despite these challenges and not using Severson and Plumb’s (1998) <7 cm guideline, the author believes the visual assessment was sufficiently accurate for this study for obtaining meaningful results.

Second, it was not always possible to determine whether the hole was reopened from the outside or from within, though evidence of the former was obtained. We did notice prairie dogs moving from the untreated field area to burrows in the treated areas. The author perceived that as a general rule, burrows in proximity to prairie dogs in untreated areas were more likely to be reopened than those more remote areas. The question is “Why did prairie dogs seek to reopen closed burrows?” Possible answers include the following: 1) They were hiding in a non-home burrow and were simply wanting to return to their own burrow; 2) they wanted to occupy or obtain a different, perhaps more desirable burrow; 3) they wanted to help a fellow coterie member dig out; and 4) they wanted to feed on the dead prairie dog(s). Hoogland (1995) observed that prairie dogs did cannibalize dead prairie dogs found on the surface. He also found evidence of prairie dogs entering burrows to kill and cannibalize young. Is it possible that prairie dogs were attempting to enter closed burrows to feed on the dead prairie dogs? Unfortunately, we cannot answer that question. We do believe, however, predators such as badgers or coyotes were not responsible for the reopening of burrows during our study period, as no evidence of their activity was observed.

While highly likely that prairie dog numbers declined, these reductions were not apparent when looking at the size of the town’s footprint. Broadly viewed, the town footprint (i.e., acreage occupied by prairie dogs) did not experience the dramatic reduction landowners would expect and want. It seemed to the author and the landowner that prairie dogs from untreated areas redistributed themselves throughout the treated area. That, coupled with the likelihood that some prairie dogs survived the treatment, would make it appear that the town was as full as before. If our assessment is correct, the redistribution of remaining prairie dogs explains why producers anecdotally have not been impressed with the device, as they wanted to diminish the footprint of the prairie dog town. Upon seeing prairie dogs throughout the site, they would be disappointed even though the total population of prairie dogs likely declined. It is unclear to this author why

Table 3. Injection rates for different soils.

Soil Type	Rate
Clay Soil Composition	45-60 seconds oxy regulator at 30psi
Black or Heavy Soil	45-60 seconds oxy regulator at 30psi
Loam or Medium Soil:	30-45 seconds oxy regulator at 30psi
Sandy or Light Soil:	60-90 seconds oxy regulator at 30psi

Hygnstrom and VerCauteren's (2000) research on fumigants did not experience similar challenges with prairie dog redistribution in the treatment area. Possibly the prairie dogs in Nebraska had already completed mating, whereas Montana prairie dogs we had treated may have not (Hygnstrom and Virchow 2002, Foresman 2012).

Any accurate assessment of the Rodenator's effectiveness in controlling prairie dogs requires researchers to perform population surveys before and after treatment, or assess population or burrow activity using control plots, to ensure the changes in prairie dog or burrow activity are the result of treatment. Otherwise, we recommend that the study treat the entire town, or at least a buffer zone large enough to minimize reinvasion of the plot. If the first method is used, the town must be isolated enough to prevent reinvasion during the period required to count burrows or be done during a period when prairie dogs are less likely to redistribute themselves in the landscape. Researchers should also use a control area(s) to see if hole closing on its own affected prairie dog behavior (T. P. Salmon, pers. comm.).

Management Implications

Although the Rodenator did not meet the control standard of 70% efficacy, a definitive dismissal of the device would be premature. This study does not allow conclusions as to the overall efficacy of the Rodenator, It does point out many of the difficulties in conducting field efficacy studies of vertebrate pest control methods and materials. When compared to a 1991 study, the Rodenator did appear to achieve higher results using 15 seconds less of injection time. The manufacturer says a design change enlarged the Rodenator's orifices, thereby permitting greater gas flow when pressures are increased (E. Meyer, pers. comm.). It is possible that further technological advances coupled with improvements in technique will eventually allow the device to break the 70% control level threshold. An additional study, using population survey data, is required to ultimately answer the question of whether the Rodenator is sufficiently efficient and effective to warrant use for the control of black-tailed prairie dogs. Obviously, further study is necessary to adequately evaluate the efficacy of the Rodenator for prairie dog control.

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