

AN UPDATE ON TOOLS FOR EFFECTIVE MANAGEMENT OF POCKET GOPHERS IN ALFALFA

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ABSTRACT

The pocket gopher (*Thomomys* spp.) is often the most damaging vertebrate pest in alfalfa. The amount and form of damage they cause can be quite varied but includes a loss in vigor and/or mortality of plants, damage to underground drip lines, and loss of irrigation water down burrow systems. Many management options are available including the use of trapping, toxic baits, and burrow fumigation. We report on several research projects that have provided greater guidance on how to increase efficacy of these management options. Significant findings include efficacy comparisons between Macabee and Gophinator traps, the need for covering trap-sets, potential benefits of attractants for pocket gopher trap-sets, and the importance of proper training for rodenticide bait application. We also compared the efficacy of trapping and burrow fumigation in alfalfa fields, as well as the time requirements for implementing these management actions. Trapping was the most effective, but was also the most time-consuming management action. Conversely, burrow fumigation with carbon monoxide was the least effective, but was also least time-consuming; burrow fumigation with aluminum phosphide was intermediate. Based on our findings, all three approaches could be viable components of an Integrated Pest Management (IPM) program.

Key Words: alfalfa, baiting, Integrated Pest Management, fumigation, pocket gopher, *Thomomys* spp., trapping

INTRODUCTION

Although many vertebrate pests cause problems in alfalfa, the most frequent offender is the pocket gopher (*Thomomys* spp.). Pocket gophers are short, stout burrowing rodents, usually 6–8 inches in length. They spend most of their time below ground where they use their front legs and large incisors to create extensive burrow systems. Pocket gophers will breed anywhere from 1 to 2 times per year, although in more southern irrigated alfalfa fields, they may reproduce up to 3 times per year. Therefore, continuous monitoring and control of pocket gopher populations is needed to keep their numbers low. Although pocket gophers can breed at different times throughout the year, there is typically a pulse in reproduction toward the middle of spring. As such, control measures implemented before this reproductive pulse will often be more effective, as there will be fewer pocket gophers to control at that time.

If left unchecked, pocket gophers will cause extensive damage to alfalfa. A recent study in California estimated losses of 8.8% in alfalfa when pocket gophers are present (Baldwin et al. in press). This damage includes consumption of tap roots and above-ground vegetation that can

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result in reduced vigor and/or mortality of alfalfa plants, loss of irrigation water down burrow systems, and chewing on underground drip lines. Pocket gopher mounds can result in additional problems including serving as weed seed beds, burying of plants, and causing damage to farm equipment.

A number of options are currently available for controlling pocket gophers but most management centers on toxic baits, fumigants, and trapping. Other control options are available as well, although their efficacy is less clear. The senior author has provided details on these control methods in a previous Proceedings article (Baldwin 2011), so we will not rehash these specifics here. Rather, the intent of this article is to provide an update on new research designed to assist in the establishment of more efficacious and cost effective management programs. We will briefly detail these studies in the following section.

CONTROL METHODS

Trapping

Trap type. Several types and brands of pocket gopher traps are available. The most common type is a two-pronged, pincher trap such as the Macabee (The Macabee Gopher Trap Co., Los Gatos, CA), Easy Set (Woodstream Corporation, Lititz, PA), or Gophinator (Trapline Products, Menlo Park, CA), which the pocket gopher triggers when it pushes against a flat, vertical pan. Of these traps, the Macabee is generally considered to be the most commonly used trap in California, while the Gophinator is the newest trap currently being used for pocket gopher management in California. As such, we wanted to see which was more effective. Therefore, we trapped pocket gophers throughout the state using both traps. We found that the Gophinator trap was the most effective, primarily because it captured larger individuals at a greater rate. Capturing larger individuals is imperative for a successful management program, as these larger individuals are responsible for much of the reproduction that occurs in the pocket gopher population. Having a trap that maximizes capture success of these larger individuals should increase the efficacy of pocket gopher management programs. Therefore, the Gophinator appears to be a good trap option. Greater detail on this study can be found in Baldwin et al. (2013).

Trap cover. There has been much debate for years whether or not trap-sets should be covered to eliminate light and maintain temperature and humidity within a pocket gopher burrow system. There are two conflicting viewpoints on this topic. One belief is that by covering a trap-set opening, this will keep the pocket gopher from noticing anything abnormal within their burrow system, thereby increasing the likelihood of capture. The other viewpoint suggests that by keeping trap-sets open, this will increase visitation rates by pocket gophers to these trap sets because they do not like open burrow systems, thereby increasing capture rates. Given the uncertainty on this topic, we decided to investigate further. We found no difference in capture rates between covered and uncovered trap-sets during autumn. During warmer weather in late spring and early summer, we observed slightly greater capture rates using covered trap sets. However, this slight increase in capture success was offset by the greater amount of time required to cover and uncover trap-sets during the trapping process. As such, we do not see much reason to cover trap sets unless an individual is looking to maximize capture success rates to the greatest extent possible. This likely will not be the case in most alfalfa fields, at least when initially knocking down populations. For greater detail on this study, please see Baldwin et al. (2013).

Attractants. Trappers have long sought to find an attractant that maximizes capture rates of target animals. This holds true for pocket gophers as well, yet little information exists on the effectiveness of potential attractants for increasing capture rates of this species. As such, we decided to test several attractants that are readily available and have been reported as potential attractants for pocket gophers. These attractants included peanut butter, anise oil infused petroleum jelly, carrot oil infused petroleum jelly, and a commercial grapefruit-scented attractant (Lee's Gopher Getter, Wildlife Control Technology, Inc., Fresno, CA). We also tested if capture rates for the varying attractants differed between covered and uncovered trap sets.

We found that the attractants did not affect either visitation rate or capture rate. However, when no attractant was used, the number of pocket gophers captured per 100 trap nights was greater when trap sets were uncovered vs. when covered indicating that the opening was serving as an effective attractant. In contrast, capture rates were generally high and consistent when using peanut butter as an attractant regardless of whether or not the trap set was covered or uncovered. Combined with data from a previous investigation (Baldwin et al. 2013), this suggests that there is no advantage to using an attractant when utilizing uncovered trap sets, but there is likely some benefit to using peanut butter in covered trap sets. Using peanut butter in covered trap-sets may be particularly useful for follow-up trapping after initial trapping efforts are complete. Pocket gophers that have sprung a trap but were not captured will likely be much more difficult to capture if following the same trapping protocol (e.g., uncovered trap-set). Therefore, growers may see increased capture success in follow-up trapping programs if they switch to using covered trap-sets that are baited with peanut butter. Greater detail on this study will be published in Baldwin et al. (2014) early next year.

Rodenticide baiting

Bait type. There are three primary rodenticide baits for pocket gopher control: 1) strychnine, 2) zinc phosphide, and 3) anticoagulants (e.g., chlorophacinone and diphacinone). Both strychnine and zinc phosphide are considered acute toxicants. This means that they kill after a single feeding. Strychnine has historically come in two concentrations in California: 0.5% and 1.8%. However, due to supply issues, strychnine importation into the U.S. is currently very low. As such, the 1.8% strychnine bait is no longer available for purchase. This is an important consideration, as the 1.8% strychnine has long been considered the most efficacious of all the pocket gopher baits. Going forward, growers will need to identify an alternative rodenticide if they wish to continue to use baiting as a pocket gopher management option.

Zinc phosphide is also available for pocket gopher control; it comes in a 2.0% concentration. Bait acceptance can be low with zinc phosphide, as it has a distinctive odor and taste that pocket gophers are often averse to. Anticoagulants such as chlorophacinone and diphacinone are multiple feeding toxicants. With these rodenticides, pocket gophers typically must consume the bait multiple times over the course of 3 to 5 days to receive a toxic dose. This means greater amounts of bait are required to maintain a ready bait supply over this time period. Because of this, acute toxicants are typically preferred over anticoagulants for pocket gopher control. However, there are several new products on the market that contain these same toxicants but utilize a different delivery mechanism for providing the toxicant to the pocket gopher. As such, some of the newer products may be more effective and should be tested. The senior author has received funding to test these materials this spring. Hopefully, we will have a better idea of which rodenticide baits will be most efficacious in the near future.

Bait application. Hand baiting via an all-in-one probe and bait dispenser is likely the most commonly used approach for applying bait into pocket gopher burrow systems. However, the efficacy of this approach, and any other baiting technique, is reliant on applying the bait into the pocket gopher burrow system. This task is more difficult than it sounds, particularly for novice bait applicators, and is likely one of the reasons why baiting has often resulted in less efficacious control when compared to other pocket gopher management options.

Effective training is the best way to ensure that bait will be applied into active pocket gopher burrow systems, yet such training is often lacking for many bait applicators. The extent to which this lack of training negatively affects baiting programs is unknown. Therefore, a study was conducted that compared the efficacy of individuals who received a limited training program to individuals who received a more extensive training program. The limited training program provided education to novel applicators on identifying pocket gopher mounds and tunnel systems, as well as information on how to use the bait applicator. This training lasted approximately 15 minutes, and is believed to be representative of the level of training received by many farm laborers. The more extensive training program included the same information, but focused extensively on teaching applicators to identify back-filled tunnels (tunnels that are filled with loose soil, and therefore, are no longer in use by a pocket gopher) from extant tunnel systems (those likely to still be used by pocket gophers). The extensive training program also stressed the importance of continually checking the functionality of bait-application equipment, as bait probes often malfunction from time-to-time; 1.8% strychnine bait was used during this study.

Results from this study indicated that individuals who received the more thorough training program were more than twice as effective (efficacy = 58%) at removing pocket gophers than those individuals who received the limited training program (efficacy = 27%). Clearly, proper training is imperative for maximizing the efficacy of baiting programs. Greater detail on this study can be found in Baldwin (2011).

Comparison of management techniques

Efficacy. Burrow fumigation is a commonly used technique to manage pocket gophers. The most frequently used burrow fumigant for managing pocket gophers is aluminum phosphide. This burrow fumigant is generally considered to be one of the most efficacious options for managing pocket gophers. This approach requires the application of aluminum phosphide tablets into the burrow system. They then react with moisture in the burrow system to emit phosphine gas, which is toxic to all animals.

In addition to aluminum phosphide, carbon monoxide generating machines can now be used to control pocket gophers in California. As their name implies, these devices generate carbon monoxide and inject it into the burrow systems which then asphyxiates the inhabitants. The Pressurized Exhaust Rodent Controller (PERC, H & M Gopher Control, Tulelake, CA) is the primary carbon monoxide generating machine available for managing pocket gophers. Early trials have indicated that this approach is moderately effective (Orloff 2012), although more research is needed to substantiate these initial trials. Nonetheless, this could be a promising approach for controlling a number of burrowing pests.

As previously mentioned, trapping is also a highly effective option for managing pocket gophers, but comparisons of this approach to other control options in alfalfa are generally lacking.

Therefore, we set up a study to compare the efficacy of trapping using the Gophinator trap, burrow fumigation with aluminum phosphide, and burrow fumigation with carbon monoxide to determine which was most efficacious. We observed the highest efficacy value for trapping ($\bar{x} = 92\%$, SE = 3%), followed by aluminum phosphide ($\bar{x} = 84\%$, SE = 2%), and the PERC machine ($\bar{x} = 62\%$, SE = 2%).

Application time. We also recorded application times, as this will greatly influence the cost effectiveness of each management action. Application times for each treatment for each management action were as follows: trapping ($\bar{x} = 2$ min, 32 s; SE = 8 s), aluminum phosphide ($\bar{x} = 23$ s; SE = 1 s), and PERC machine ($\bar{x} = 3$ min, 24 s; SE = 4 s). It is important to note that these times pertain to each application. These application times did not account for search times; rather it only included the time required to apply the treatment once the burrow system was identified. For trapping and the PERC machine, there was typically only one application per burrow system. However, for aluminum phosphide, we attempted to provide two applications per burrow system whenever possible. This obviously resulted in a doubling of actual application time for aluminum phosphide.

We also recorded the number of burrow systems treated for each management technique, as well as the total amount of time spent in the fields applying these management actions. This allowed us to calculate the average application time required for each management technique. This value was important for a couple of reasons. For the PERC machine, multiple burrow systems could be treated at the same time, as multiple hoses and probes extended from the same machine. This helps offset the longer application times for each burrow system. Secondly, because aluminum phosphide needed to be applied twice per burrow system, this required additional search time to find a second tunnel to apply the tablets into. This search time could be lengthy and needed to be accounted for. These adjusted application times were as follows: trapping ($\bar{x} = 6$ min, 14 s; SE = 20 s), aluminum phosphide ($\bar{x} = 6$ min, 5 s; SE = 24 s), and PERC machine ($\bar{x} = 3$ min, 24 s; SE = 28 s).

Discussion. Trapping was the most efficacious management option we addressed. The observed 92% efficacy is well above the 70% threshold typically required to prove a control technique efficacious. That being said, trapping was much more time consuming than PERC applications, and was slightly more time consuming than aluminum phosphide applications. Still, the observed greater efficacy likely offsets the increased time requirement, thereby making trapping a valuable management option for alfalfa growers.

We were a bit surprised that aluminum phosphide did not prove more efficacious, as other studies have shown 100% efficacy when tablets were properly applied into the burrow systems (Baker 2004). As with baiting (see Bait application section), aluminum phosphide will not work if it is applied into back-filled tunnels. Therefore, the lower efficacy observed in this study could be due to misapplication. Still, application times were somewhat less than that observed for trapping, thereby striking an equitable balance between trapping and aluminum phosphide. Ultimately, aluminum phosphide should be considered highly efficacious and should continue to be included in pocket gopher management programs when possible.

The PERC machine proved to be the least time-consuming control option, but was also the least effective. For the PERC machine to reach the same level of efficacy of the other two control options, 1 or 2 additional applications would likely be needed. This would make application costs relatively equivalent between the 3 approaches, assuming the goal was around 90%

efficacy. However, this is assuming we will see similar efficacy for additional applications which may or may not be true. Additionally, fixed costs are much greater with the PERC machine given the high cost of the machine, so this needs to be considered when deciding upon the best management option.

Based on our results, trapping, aluminum phosphide, and carbon monoxide producing machines can all be effective at controlling pocket gophers in alfalfa fields. As such, a combination of these approaches, as well as other management options such as baiting and tillage practices (i.e., Integrated Pest Management [IPM]), should be used to manage pocket gophers, rather than relying on any single one approach. IPM programs have numerous advantages than relying on any single approach including: 1) greater efficacy than when incorporating multiple control strategies, 2) lower potential hazard to non-target organisms and the environment if relying solely on pesticides, 3) no limitation on the time of year when control actions can be implemented, and 4) reduces the probability of behavioral or biological resistance or adaptation to a control mechanism. Fortunately, we have numerous effective management tools to use to construct an IPM program for pocket gophers in alfalfa.

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