DEVELOPING AN IPM PROGRAM FOR CONTROLLING POCKET GOPHERS AND VOLES IN ALFALFA

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ABSTRACT

Pocket gophers (*Thomomys* spp.) and voles (also known as meadow mice; *Microtus* spp.) are often the most damaging vertebrate pests 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 control options are available, although the most frequently used methods include toxic baits, fumigation with aluminum phosphide, and trapping. An Integrated Pest Management (IPM) program that incorporates several of these approaches, and potentially other techniques, can have many positive attributes for controlling pocket gophers and voles, not the least of which is greater control than is typically observed by focusing on any single method. The best IPM plan for alfalfa growers will vary depending on numerous aspects including the time of year when control is needed or implemented; the cost of control measures; the presence of non-target, threatened, or endangered species; and existent laws and regulations for potential control methods. Nonetheless, an effective IPM program can be developed by adhering to the following four-step process: 1) identify the species that is causing the damage, 2) assess your control options, 3) develop and implement the management plan, and 4) monitor to determine the effectiveness of the management plan. Adhering to these four steps should allow alfalfa growers to effectively control pocket gophers and voles, while reducing control costs.

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

INTRODUCTION

Although many vertebrate pests cause problems in alfalfa, the most frequent offenders are pocket gophers (*Thomomys* spp.) and meadow voles (also known as meadow mice; *Microtus* 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. Meadow voles are small, blunt nosed stocky rodents with small eyes and short ears and legs. They are typically dark grayish brown in color with size intermediate to that of a house mouse and a rat.

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. Female voles may produce from 5 to 10 litters per year. Therefore, continuous monitoring and control of gopher and vole populations is needed to keep their numbers low. Although gophers and voles can breed at

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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 gophers and voles to control at that time. Additionally, because voles mature rapidly and can bear many litters annually, vole populations can increase rapidly. Typically, their numbers peak every 6 to 8 years when population numbers can be as high as hundreds of voles per acre.

If left unchecked, pocket gophers and voles will cause extensive damage to alfalfa. This damage includes consumption of tap roots and above-ground vegetation that can result in reduced vigor and/or mortality of alfalfa plants, loss of irrigation water down burrow systems, and chewing on underground drip lines. 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 gopher control centers on toxic baits, fumigants, and trapping. Other control options are available as well, although their efficacy is less clear. For voles, control in seed alfalfa centers on toxic baits and cultural practices. I will briefly detail each of these approaches in the following section.

CONTROL METHODS

Toxic baits

Pocket gophers. There are three primary 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 typically been promoted as the most effective of the two. Strychnine comes in two concentrations in California: 0.5% and 1.8%. The 0.5% concentration is typically used for hand baiting, while the 1.8% concentration is used in a burrow builder. We will cover these delivery options in the following paragraphs. Zinc phosphide is also available for pocket gopher control; it comes in a 2.0% concentration. Bait acceptance can be an issue with zinc phosphide, as it has a distinctive odor and taste that gophers are often averse to. Anticoagulants such as chlorophacinone and diphacinone are multiple feeding toxicants. With these rodenticides, gophers must consume the bait multiple times over the course of 3 to 5 days to receive a toxic dose. This means larger 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 gopher. As such, some of the newer products may be more effective; I am planning a study to look at the efficacy of these new products and should have results in a year or two.

There are two primary methods for baiting in alfalfa fields: 1) hand baiting with an all-in-one probe and bait dispenser, and 2) a burrow builder. Hand baiting can be effective if you have relatively few gophers in a field. For this approach, an all-in-one probe and bait dispenser is used to locate a gopher burrow. Once the burrow is located, the bait is directly deposited into the tunnel. The opening left by the probe is then covered up with a dirt clod or rock to prevent light from entering the burrow. When using this method, be sure not to bury the bait with loose dirt as

this will limit access to the bait. Typically, it is recommended that burrow systems be treated twice to maximize efficacy.

Although hand baiting can be effective for smaller gopher populations, the burrow builder can be a more practical method for treating larger areas. The burrow builder is a device that is pulled behind a tractor on a 3-point hitch and creates an artificial burrow at a set depth. Bait is then deposited at set intervals along the artificial burrow. While engaging in normal burrowing activity, gophers will come across these artificial burrows and consume the bait within. This device must be used when soil moisture is just right. If the soil is too dry, the artificial burrow will cave in, but if it is too wet, the burrow will not seal properly and will allow light to filter in; gophers will not travel down burrows if they are not sealed. Although convenient to treat large areas, the efficacy of this method has varied quite extensively from grower to grower. Experimentation is key to determining the applicability of this approach for each grower.

Voles. The use of toxic baits is the primary method for controlling voles in alfalfa. Within alfalfa fields, only zinc phosphide can be applied. Zinc phosphide is a restricted-use rodenticide; it can only be used by or under the direct supervision of a Certified Applicator. Zinc phosphide is applied directly to vole burrows and runways through spot treatments or broadcast applications. Spot treatments are used when only a few burrows are to be treated. Otherwise, broadcast applications are more efficient. If overused, problems with bait shyness can occur. As such, zinc phosphide should not be applied more than once over a 6-month period. Additionally, zinc phosphide must be applied when new growth is less than 2-inches tall. Carefully read the label for more information on restrictions for zinc phosphide application in alfalfa.

Both zinc phosphide and anticoagulant baits (e.g., chlorophacinone and diphacinone) can be applied in non-crop areas adjacent to alfalfa fields. If adjacent fields or non-crop areas harbor large vole populations, these areas should be treated as well to reduce immigration into alfalfa fields after bait application.

Fumigation

Pocket gophers. Primary fumigants used for burrowing rodent control are gas cartridges and aluminum phosphide. Studies have shown that gas cartridges are not effective for pocket gophers. Aluminum phosphide, however, is quite effective. Aluminum phosphide is a restricted-use material; it can only be used by or under the direct supervision of a Certified Applicator. That being said, it is quite effective and has a very low material cost. The primary method for applying fumigants is similar to that of hand baiting. You use a probe to find a gopher tunnel, then wiggle the probe to enlarge the opening (if the probe hole is not already large enough to allow passage of the aluminum phosphide tablets into the tunnel), and drop the label specified number of tablets or pellets into the tunnel. You then seal up the opening with a rock or dirt clod to eliminate light from entering and the toxic gases from exiting the tunnel. Once again, be careful not to bury the tablets with loose soil as this will render them ineffective. Typically, you treat each burrow system twice to maximize efficacy. The key with aluminum phosphide treatments is to only apply when soil moisture is relatively high. If you can ball up a clump of soil at the burrow depth and it maintains that ball in your hand, then soil moisture is high enough to fumigate; if the clump falls apart in your hand, it is too dry. Because of this,

fumigation is typically most effective in late winter and early spring. However, fumigation after irrigation can also be a good strategy.

Voles. Fumigants are not typically used for vole control given the large amount of labor required to treat every burrow opening. That being said, if there are only a small number of burrows to treat, aluminum phosphide can be effective. Keep in mind that aluminum phosphide is a restricted-use material that can only be used by or under the direct supervision of a Certified Applicator. For application, apply the label designated number of tablets or pellets into a burrow opening and cover the opening with soil to hold toxic gases within the burrow system. Aluminum phosphide should only be applied when soil moisture is sufficiently high. If you can ball up a clump of soil at the burrow depth and it maintains that ball in your hand, then soil moisture is high enough to fumigate; if the clump falls apart in your hand, it is too dry. Therefore, such treatments are typically most effective in late winter and early spring.

Trapping

Pocket gophers. Trapping is safe and one of the most effective although labor intensive methods for controlling pocket gophers. Nonetheless, the cost and time for application may be offset by effectiveness. Several types and brands of gopher traps are available. The most common type is a two-pronged, pincher trap such as the Macabee, Cinch, or Gophinator, which the gopher triggers when it pushes against a flat, vertical pan. Another popular type is the choker-style box trap, although these traps require extra excavation to place and may be a bit bulky to be practical in a large field setting.

To place traps, probe near a fresh mound to find the main tunnel, which usually is on the side closest to the plug of the mound. The main tunnel usually is 6 to 12 inches deep; the probe will drop quickly about 2 inches when you find it. Place traps in as many tunnels as are present as you will not know which side the gopher currently is using. After placing the traps, you can cover the hole to keep light out of the tunnel. However, recent research has shown that this step does not increase capture success in most cases. Therefore, if setting a large number of traps, it would save a substantial amount of time in setting and checking traps to leave these trap-holes uncovered. If there is no evidence that a gopher has visited the trap within 24 to 48 hours (24 hours is usually of sufficient duration, although they can be left for 48 hours if needed), move it to a new location.

Pincer-type traps can also be placed in lateral tunnels, which are tunnels that lead directly to the surface. To trap in laterals, remove the plug from a fresh mound and place the trap into the lateral tunnel so that the entire trap is inside the tunnel. Gophers will come to the surface to investigate the tunnel opening and will be caught. This approach is quicker and easier to implement than trapping in the main tunnel. However, trapping in lateral tunnels may be less effective at certain times of the year (e.g., summer) and for more experienced gophers (e.g., adult males).

Voles. Trapping is not typically used to control vole populations. Voles can easily be captured with standard mouse snap-traps, but the amount of labor, time, and resources required to remove voles from an alfalfa field is counter-productive.

Other control approaches.

A variety of other control options are sometimes used to control pocket gophers and voles in alfalfa. They are briefly discussed in the following paragraphs.

Biocontrol. This approach relies on natural predation to control gopher and vole populations. From a management perspective, this typically involves the use of owl boxes to encourage owl predation of gophers and voles over alfalfa fields. Unfortunately, no replicated scientific study has ever been able to show that owls substantially reduce gopher or vole populations in a field. Owls do eat a large number of rodents per year, but do so over a wide enough area that they are not able to reduce gopher or vole populations to low enough levels to constitute effective control.

Cultural practices. Habitat modification is an example of a cultural practice. This approach involves altering rodent habitat to reduce its desirability for that site. This can be a good approach for reducing gopher populations in many other commodities, but unfortunately is not as practical in alfalfa given the gopher's strong affinity for this crop. Likewise, cover removal can be very effective at controlling vole populations but is not practical in alfalfa.

Cultivation is a more practical example of a cultural practice in alfalfa. If you have an alfalfa field that you are going to replant, deep ripping will eliminate many of the gopher and vole burrow systems and will kill some gophers and voles in the process. Destroying the burrow systems helps slow down potential reinvasion into fields, and when combined with an aggressive gopher and vole control program post-cultivation, can provide a "clean slate" for a newly planted alfalfa field.

Flood irrigation. Where still feasible, flood irrigation can help control pocket gopher and vole populations. When a field is flooded, the gophers and voles must come to the surface or drown. When at the surface, they can be picked off by a number of predators; growers and their dogs can also actively seek out gophers and voles at this time to further reduce populations of these damaging pests.

Gas explosive device. This is an instrument that injects a mixture of propane and oxygen into the burrow system and then ignites this mixture thereby potentially killing the burrowing rodent through a concussive force. This approach has the added benefit of destroying the burrow systems which could theoretically slow down reinvasion rates by burrowing rodents. However, initial studies have not shown it to be overly effective for many burrowing rodent species. Additionally, there are potential hazards associated with this device including damage to buried pipes and cables, injury to the user, and the potential to catch things on fire. Additionally, these devices are quite loud; as such, they are not practical for use in or around residential areas. That being said, this device does kill some gophers and voles and may be useful in some specialized settings, particularly where destruction of burrow systems for gophers is required.

Repellents. No scientific data has been reported to show that chemical repellents effectively keep gophers or voles from inhabiting fields. Frightening gophers and voles with sound or vibrations also does not appear effective.

DEVELOPING AN EFFECTIVE MANAGEMENT PLAN

Often, growers will rely on a single method to control many vertebrate pest species including pocket gophers and voles. However, relying on a single control method has a number of potential problems including: 1) lower efficacy than when incorporating multiple control strategies, 2) greater potential hazard to non-target organisms and the environment if relying solely on pesticides, 3) limits the time of year when control actions can be implemented, and 4) increases the probability of behavioral or biological resistance or adaptation to a control mechanism. Therefore, I recommend incorporating an Integrated Pest Management (IPM) approach for controlling pocket gophers. The following paragraphs outline a four-step process to help you develop an effective IPM program for controlling pocket gophers and voles in alfalfa.

Step 1: Identify the species that is causing the damage. This is an intuitive step and one that often is easy to discern. However, in some cases it is difficult to identify if damage, mounds, or burrows are caused by pocket gophers, moles, voles, or some other species. For pocket gophers, look for horseshoe-shaped mounds with a plug located on the open side of the horseshoe. The plug is circular in appearance and is around 2 to 3 inches in diameter. Mole mounds are occasionally mistaken for pocket gopher mounds. However, mole mounds are typically more volcano-shaped in appearance with the plug either found in the middle of the mound or is not visible. Pocket gophers will also create feeder holes. Feeder holes are shallow burrows that open at the surface. They do not have a mound associated with them, but are usually plugged. Feeder holes can further be identified by a circle of vegetation removed for an inch or two around the circumference of the hole. When plugged, feeder holes are easy to identify, as voles never plug burrow systems. However, these plugs are quite shallow and will often cave-in. When this occurs, they can resemble vole burrows. The easiest way to differentiate between gopher feeder holes and vole burrows is to look for runways (1–2 inch wide linear runways that have been cleared of vegetation that voles use for travel) that extend back and forth between other burrow openings. If these runways are present, the open holes belong to voles. If not, they are likely gopher feeder holes whose plug has collapsed. It is important that you correctly identify the source of these burrows and mounds, as the control methods that you can effectively use vary depending on the species. For example, bait application for gophers occurs below ground, while bait is typically applied above ground for voles. Additionally, while gophers and voles are major pests of alfalfa, moles are not. Therefore, if you only have moles, control may not be needed. Without proper pest identification, a control program is likely to be ineffective at best, and may potentially be illegal.

Step 2: Consider your control options. There are many different aspects to consider when developing an IPM program for controlling pocket gophers and voles. These include: 1) what time of year is it, and how does this influence the efficacy of various control methods, 2) how bad is the infestation, and how will this influence the cost of various control methods, 3) are there non-target, threatened, or endangered species that are likely to be affected by control actions, and 4) are there laws or regulations that will limit the ability to use any of the various control methods? Examples of items to consider for each of these are as follows:

Timing. This is a key component to consider, as it influences many different aspects of an effective control program. Examples of the influence of timing are:

- Pocket gopher and vole populations are often at their lowest levels in late winter. A control program focused on this time of year would require the least amount of effort and should provide the greatest control.
- Almost all forms of control become too difficult to justify attempting once alfalfa gets more than a few inches tall. Therefore, control actions for seed alfalfa should be focused on periods of dormancy.
- Fumigation with aluminum phosphide requires relatively high soil moisture. Therefore, you must time these control strategies for when sufficient soil moisture is present.

Cost. Some control options are more costly than others, while others are more effective than alternative options. This will vary depending on the density of rodent populations. For example, use of a burrow builder may be an effective way to treat a large field with abundant gophers. However, if this field has only a few gophers present, an alternative method such as trapping or fumigation may be less expensive and more economical.

Non-target, threatened, or endangered species. This is an important aspect to consider. If threatened or endangered species are present, certain control options may not be available for use, or at a minimum, may require some alteration in application procedure (e.g., may only be able to treat burrow systems that are "verified" as currently occupied by pocket gophers rather than all "potentially" occupied burrow systems). If you are unsure if you have any threatened or endangered species in areas that you plan to control, contact your local County Agricultural Commissioner's office. They can help you make that determination. Also, some rodenticides (anticoagulants, strychnine) pose potential secondary hazards to predators and scavengers who may consume rodents that are dead or dying. This potential non-target poisoning may limit your use of these rodenticides if you are in an area where you are concerned about such issues (e.g., close to residential area where pets may find and consume poisoned gophers or voles).

Laws and regulations. Some rodenticides are allowable for use in controlling pocket gophers but not voles. Additionally, there are often different concentrations of active ingredients in rodent baits, and what may be an allowable use at one concentration may not be allowable at a different concentration. For example, 0.5% strychnine treated grain is a non-restricted use material when used to control pocket gophers in non-agricultural settings. However, 1.8% strychnine is always a restricted-use material. As such, only certified users may purchase this material. It is imperative that rodenticide users understand the restrictions involved with using a control strategy before developing a plan to control all vertebrate pests.

Step 3: Develop and implement the proposed management plan. After considering all of your options, it is time to develop and implement your management plan. Ideally, you will incorporate multiple control methods into this plan for reasons listed at the beginning of this section. One example of an IPM plan to control a field heavily infested with gophers if you are planning on replanting the next year would be to first deep-rip the field after the last cutting. You could then proceed with trapping to eliminate all gophers that survived the ripping process. With trapping, as with most all control measures, there will always be a small segment of the population that is trap shy. For those gophers that you do not capture with traps (i.e., trap shy), you could fumigate with aluminum phosphide. This approach would minimize pesticide use, while hopefully providing efficient control. Obviously, this approach would only be useful if

you were replanting the field. If you were not planning on replanting, you might decide to use 1.8% strychnine bait applied via a burrow builder to reduce gopher populations. This approach will allow you to treat a large area relatively quickly. However, it alone may not result in sufficiently lower numbers of gophers. Therefore, after reducing gopher populations with the burrow builder, you could then target remaining active burrow systems with trapping or aluminum phosphide to further reduce these populations. Keep in mind that with large gopher populations, multiple applications of trapping, fumigation, and baiting may be needed to eliminate an acceptable percentage (at least 70%) of the population. These are only two of many potential combinations of control techniques that could be incorporated into an IPM plan. Each grower will have a unique set of circumstances that will influence what is best for them.

Step 4: Monitor fields. This is a very important step to consider but is one that is often overlooked. First off, you must monitor gopher and vole activity to determine how effective you were at reducing these populations. If you did not achieve the desired level of control, then you will need to retreat. Additionally, if control levels were substantially lower than what you expected, you should take time to contemplate why so that you do not repeat the same results after the next round of treatments. For example, perhaps you treated a field with aluminum phosphide, but achieved only 25% control. This is much lower than would be expected. One explanation would be that soil moisture was to low. If you think this might be the case, do not retreat gopher or vole tunnels with aluminum phosphide until you have higher soil moisture. The specific level of control that you are targeting is up to you, but it is typically recommended that you shoot for a minimum of 70% control, and closer to 90% is much better. As previously stated, gophers and voles are rodents, and as such, can reproduce quite rapidly. If you only reduce rodent populations by 60% and do not treat the field again until the following year, they will have had time to repopulate the area to approximately the same level they achieved the prior year. Therefore, to obtain long-term reductions in rodent populations and subsequent lower control costs, higher levels of control are needed; given the gopher and voles known propensity for causing damage in alfalfa, a zero-tolerance policy is typically warranted. Specific monitoring protocols that can be used for gophers and voles are as follows.

Pocket gophers

To monitor gopher populations to determine treatment efficacy, I recommend one of two methods: the mound count and the open-hole methods. Both of these methods work in much the same way in that they allow you to determine the presence or absence of a gopher in a designated area. For implementation, I recommend establishing 10 to 20 30 foot by 30 foot plots throughout a field following a grid structure; keep a minimum of 45 feet between each plot to minimize the potential of gophers moving between plots during the sampling period. Be sure to establish these plots in areas where you know you have gophers.

Once the plots have been established, you can begin the monitoring process. For the mound count method, clear away all gopher sign within each plot using your boot, rake, or shovel. Be sure to clear away or cover up feeder holes as well. Two days after clearing all gopher sign, come back and check for new gopher activity. If you have activity (i.e., new mounds or feeder holes), you know that a gopher is present. If not, then you assume no gopher is present. After you have finished this monitoring activity, treat the area using whatever

strategy you have decided to use. Approximately one week after treating the area, clear all old sign away from the previously established plots, and come back two days later to check for new activity. This will give you an idea of the level of control you have experienced. For example, let us assume that you established 20 plots prior to treatment and determined that all 20 plots had gopher activity. This equates to 100% occupancy of your monitoring plots. After pre-treatment monitoring, you then treat all burrow systems with zinc phosphide bait via a hand probe. One week after application, you go back in and clear mounds from the previously monitored plots, and two days later you check for activity. This time, you find that 12 of the 20 plots no longer exhibit gopher activity. This means you have experienced a 60% (12/20) decrease in gopher populations after one treatment. In this case, one more treatment round would likely be warranted. Perhaps this time you may use trapping or aluminum phosphide.

The open-hole method is very similar except you are not clearing old activity within study plots; rather you dig a hole down to a gopher tunnel and leave it open. You do this twice for each study plot. Because gophers do not like open burrow systems, they will plug it up if they are using that tunnel. If you find a plugged hole, you know that a gopher is in the plot. After opening the holes to the burrow system, you check them two days later to verify presence. If no holes are plugged, you consider that plot "unoccupied". If any of the 2 holes in that plot are plugged, you consider the plot "occupied". You then repeat this monitoring procedure one week after the control treatment is applied and calculate the level of control in the same manner as described for the mound count method. Both of these methods work fairly well, although the open-hole method can be more precise given that gophers sometimes do not mound for several days. For example, you could sample at a time when gophers are not mounding much. If using the mound count method, you may overestimate your level of control. However, many individuals prefer to use the mound count method as it is quicker to use; the choice is yours.

Voles

Voles can be monitored in much the same way that gophers are monitored when using the mound count method except that with voles, you will be counting open burrows rather than mounds. Following this approach, create 20 or more 5 foot by 5 foot plots throughout a field. Within these plots, cover all burrow openings with soil. Two days later, return to these plots to determine if any of the burrows are open. If so, voles are present; if not, we assume there are no voles present in the plot. This process should be conducted 1 to 3 days before and 3 to 7 days after zinc phosphide or aluminum phosphide applications. If using anticoagulant baits in peripheral areas, you should not test efficacy until 7 to 10 days after application, as it typically takes 5 days for mortality to occur with these baits.

Unfortunately, even after dramatically reducing gopher and vole populations, your work is not done. Constant monitoring of fields is warranted given these rodents ability to rapidly repopulate. Once a field is under control, it takes relatively little work to keep it that way if a grower is vigilant. If you are not vigilant, odds are the gophers and voles will repopulate and you will have to start over again.