

## Incorporating Burrow Fumigants into an IPM Approach for Control

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### Common Control Options

The California ground squirrel (*Ostospermophilus beecheyi*) is one of the most damaging vertebrate pests in California with damage to agriculture conservatively estimated at 30–50 million dollars annually. Numerous techniques are available for controlling ground squirrels including use of anticoagulant baits, acute toxicant baits, burrow fumigants, and trapping. Anticoagulant baiting (e.g., diphacinone and chlorophacinone) has been perhaps the most frequently studied and used approach for controlling ground squirrels. Anticoagulant baits are grain based (e.g., oats, wheat, or milo) and are often distributed through the use of bait stations, although they can also be applied through spot and broadcast treatments. An acute toxicant, zinc phosphide, is also available for use, but is only available for spot and broadcast baiting. Zinc phosphide is a restricted use material, so proper certification is required to use this material. The use of anticoagulant bait is cheaper and often requires less effort than burrow fumigation and trapping, although they are more expensive and time consuming to apply than zinc phosphide. However, zinc phosphide can only be applied once per year and often has lower bait acceptance than anticoagulants. Baits are typically most effective during early summer and autumn months when ground squirrels are actively feeding on seeds. Treatments during extreme heat of mid-summer are often less effective because some of the squirrels are in summer hibernation.

There are a variety of traps available for controlling ground squirrels although they typically fall into two categories: body-gripping traps and live traps. Live traps have the advantage of not killing captured individuals. Therefore, if a non-target animal is captured, it can be released unharmed. However, ground squirrels must be humanely euthanized after capture, thereby limiting its appeal for many growers and PCAs. Body-gripping traps are kill traps, thereby eliminating the need for euthanizing captured ground squirrels. However, because they are kill traps, extra care must be exercised to not capture non-target animals. This makes their use in residential areas, and in areas occupied by the endangered San Joaquin kit fox (*Vulpes macrotis mutica*), less appealing. Trapping is generally the most time-consuming and costly of the above listed methods. However, it is one of the only methods effective at controlling ground squirrels anytime they are active, and it

can be used in organic crops.

Burrow fumigation with gas cartridges and aluminum phosphide is also effective for controlling ground squirrels. As opposed to baiting, there is little risk of secondary poisoning with fumigants, as fumigation relies on the use of toxic gases to euthanize ground squirrels in their burrow system. Fumigation is generally less expensive and time consuming than trapping, but more so than baiting. However, fumigation is generally only effective when soil is moist. Therefore, fumigation is restricted to late winter and spring or following irrigation. Nonetheless, fumigation can be an important part of an IPM approach for controlling ground squirrels, as it is effective at times of the year when baiting is ineffective.

Aluminum phosphide is particularly effective at controlling ground squirrels. A recent study on ground squirrels indicated 97–100% control for aluminum phosphide; gas cartridges yielded 62–86% control. Additionally, depending on user experience and products purchased, aluminum phosphide applications can be 1.6X quicker to apply and material costs 6X cheaper to apply than gas cartridges. However, aluminum phosphide is a restricted use material. Additionally, aluminum phosphide has further label restrictions that are likely responsible for its limited use for ground squirrel control in California, as the appropriate steps required to use aluminum phosphide often appear overwhelming for the average grower or PCA. Therefore, I have outlined the basic requirements that need to be considered before applying aluminum phosphide. Hopefully this will diminish some of the ambiguity associated with the application of this fumigant.

### Aluminum Phosphide Requirements

Requirements for using aluminum phosphide often vary across counties and are subject to change over time, so you should always contact your county Agricultural Commissioner to get updated requirements before using aluminum phosphide in your area. That being said, the general requirements are as follows:

- 1.) You first need to determine if you have endangered species in your area before applying fumigants. Your county Agricultural Commissioner can help you determine if aluminum phosphide applications could potentially influence any endangered species on your property and

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whether or not aluminum phosphide applications are possible. You can also get more information on endangered species regulations from the DPR web site (<http://www.cdpr.ca.gov/docs/endspec/>).

- 2.) You must complete a Fumigation Management Plan (FMP) before applying aluminum phosphide. One copy should be kept on hand at the field site and another copy stored with your personal records. The appropriate FMP form varies from county to county, so you will need to contact your local Agricultural Commissioner to obtain the appropriate form. A new form should be filed for each new field that you treat.
- 3.) You must file a Notice of Intent with the county Agricultural Commissioners office a minimum of 24 hours before applying aluminum phosphide.
- 4.) A Certified Applicator must be physically present at the site when aluminum phosphide treatments are being applied.
- 5.) Upon completion of aluminum phosphide application, you must file a Pesticide Use Report with the county Agricultural Commissioner by the 10th of the month following application (pest control businesses must file a use report within 7 days of application).
- 6.) You must follow transportation procedures listed in the Department of Transportation shipping exemption when transporting aluminum phosphide in your vehicle. The proprietor where you purchase aluminum phosphide should have this information available for you at the time of purchase.
- 3.) Do not pour the product directly into or onto gloves; rather use the cap, funnel, or other device to place aluminum phosphide tablets into burrows.
- 4.) Use smaller flasks (e.g., 100 tablets) to reduce the risk of applicator exposure.
- 5.) Always point and hold the flask downwind, out and away from the breathing area when the cap is not tightly in place.
- 6.) Vent new flasks for 1-2 minutes prior to initial use, less time if air is moist.
- 7.) Never apply during any rainfall or in areas being irrigated with sprinklers.
- 8.) Do not mix the contents of partially-used flasks.
- 9.) Use a leverage device to open new containers to avoid placing it against your waist or knee for leverage.
- 10.) Close the flask as quickly as possible using manufacturer's cap.
- 11.) Be careful not to wipe your face with your gloves.
- 12.) Always air out your gloves between applications and for at least 12 hours overnight.
- 13.) Air out any contaminated clothing.

Before applying, always read the label thoroughly to ensure you understand the restrictions and dangers associated with this product. Some important tips to consider when using aluminum phosphide are as follows (adapted from Baker and Krieger 2002):

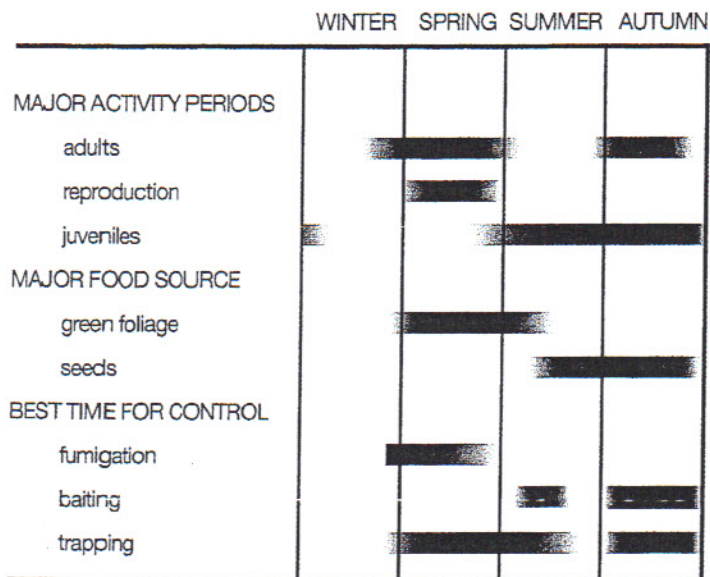
- 1.) Apply when there is constant air movement (wind) so fumes blow away from your breathing zone.
- 2.) Use smooth leather gloves for application.

Although the procedures required to use aluminum phosphide may seem daunting initially, hopefully this guide will provide much of the information needed to effectively use aluminum phosphide. Once the protocol is understood and the procedures mastered, it becomes a very effective tool for controlling ground squirrels.

### IPM for Ground Squirrels

Although fumigation can be an effective tool for controlling ground squirrels, few vertebrate pests can be optimally controlled by using a single management strategy. This holds true for ground squirrels as well, as the use of multiple control options will likely yield the greatest

**Figure 1. Activity periods and preferred food sources for the California ground squirrel. Activity periods vary somewhat from one growing area to another depending on local climate. To choose the most effective control action for ground squirrels and the proper timing, you need to know when they are active and what their preferred food sources are.**



control. The first step to consider when developing an IPM plan is to determine if habitat modifications can be made to reduce the attractiveness of the area to ground squirrels. For example, removal of brush and pruning piles from fields will reduce preferred burrow locations for ground squirrels, thereby reducing the habitat potential for a particular field. This will reduce costs of more direct control measures such as baiting and fumigation.

The next step is to consider the time of year for application as this greatly influences the effectiveness of control measures. Baiting works best in early summer and autumn when ground squirrels are consuming seeds; fumigation works best in late winter and spring when soil is moist; trapping will work anytime ground squirrels are active (Fig. 1). One potential strategy for controlling ground squirrels would be to use fumigants approximately 7–10 days after ground squirrels become active. This represents the time of year when populations are smallest. Additionally, if you fumigate in late winter and early spring, you can remove reproductive females and their young from the population before they leave the burrow system, thereby greatly reducing the amount of effort needed to treat the entire population. Then you can follow up with trapping, anticoagulant

bait, or zinc phosphide bait later in the year to remove the remaining ground squirrels in your fields.

Alternatively, if you have a large population of ground squirrels, you may decide to first treat the infested area with zinc phosphide during early summer or autumn. This should substantially reduce the population before hibernation. Then, shortly after ground squirrels become active, you could fumigate all active burrow systems. By first treating the infested areas with zinc phosphide the previous year, you should be able to dramatically decrease labor costs associated with fumigation the following year. Then, if any ground squirrels remained, you could try anticoagulant baiting or trapping to remove those individuals. These are just two of many potential options. The treatment strategy you employ will depend upon your needs and qualifications.

With any IPM program, monitoring the population is extremely important. Squirrels are fairly easy to spot. Monitor the area by driving through or observing from a distance during mid-morning when the squirrels are most active. This will help you identify where control efforts should be placed and how much material (i.e., baits, fumigants, and traps) will be needed. Additionally, monitoring after implementing control actions will help determine how effective they were and what, if any, follow-up is needed.

#### More Information

For more information on aluminum phosphide application safety, see:

Baker, R.O., and R. Krieger. 2002. Phosphine exposure to applicators and bystanders from rodent burrow treatment with aluminum phosphide. *Proceedings of the Vertebrate Pest Conference* 20:267–276.

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