The Facts about Rodenticides

UNDERSTANDING A VALUABLE TOOL IN INTEGRATED PEST MANAGEMENT

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Courtesy of Roger A. Baldwin

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New labeling requirements for rodenticides, scheduled to go into effect this year, may have significant implications for pest-control management and the health of non-target species and the environment. Because rodenticides are so fundamentally important to controlling rodent pests—and because there is much misinformation out there about these materials—it's vital that pest-control managers and other wildlife professionals understand the facts.

In many cases, some form of lethal control is necessary to limit the extensive and costly damage that rodents and other pest species can cause, particularly to agricultural croplands. For example, in 2009 in California—a state that produces more than 400 different agricultural commodities—rodent and bird damage to 22 crops across 10 counties resulted in revenue losses ranging from $168 million to $504 million (Shwiff *et al.* 2009). These figures do not account for additional damage to structures (such as loss of structural integrity of irrigation canals caused by ground squirrels), ecological damage (such as nesting failures for song birds), and rodent transmission of diseases (such as bubonic plague, hanta virus, and leptospirosis). Nationwide, rats alone can cause an estimated $19 billion in damage each year (Pimentel *et al.* 2005).

Credit: Roger A. Baldwin

The unsightly scrapings of ground squirrel teeth mar an avacado in California, where ground squirrels and other pests destroy fruit, nut, and other agricultural crops worth hundreds of millions of dollars each year. Integrated pest management involving rodenticides can significantly reduce pest populations—and save substantial harvests.

The best way to limit such widespread damage is through an integrated pest management (IPM) approach. An IPM strategy incorporates multiple methods—including habitat modification, trapping, fumigants, and rodenticides—to provide an ecologically sound basis for controlling rodent pests. This multi-pronged approach is considered more effective than relying on any single tactic (Engeman and Witmer 2000, Sterner 2008). However, because any form of lethal control can be controversial or potentially have unintended consequences, it's important for pest-control managers to have accurate information, particularly about rodenticides.

California's Case in Point

The California ground squirrel (*Spermophilus beecheyi*) is one of the most destructive rodent pests in California. One study found that this species was blamed for financial damages estimated at $20 million to $28 million in one year (Marsh 1998). Ground squirrels can cause a wide variety of problems including direct consumption of agricultural fruits, nuts, and forage; girdling of trees and vines resulting in lower production and/or death; loss of nuts down burrows during harvest; damage to irrigation sprinkler systems; loss of irrigation water resulting in higher water usage, lower production, and increased erosion; and injury or damage to farm laborers and equipment from extensive burrow systems.

"Ground squirrels can be a major problem in our vineyards," says Jeff Lyon, senior viticulturist with Gallo Family Vineyards. "In mid-spring, I have seen them climb vines and completely consume developing shoots. The other major damage they cause is with mounding and associated danger to equipment and field workers. If left uncontrolled, the populations build over the years until they are at very high levels."

Clearly some form of control is needed in such situations. When formulating an IPM program to control ground squirrels, the first step is to determine whether habitat modifications can be made to reduce the attractiveness of the area to these pests. For example, removal of brush and pruning piles from fields will reduce preferred burrow locations for ground squirrels, thereby reducing the habitat potential of a particular field. This eliminates or cuts the cost of more direct control measures such as rodenticides and fumigants.

Unfortunately, only in rare cases is habitat modification enough to control ground squirrel populations to an acceptable level. Effective long-term control of rodent species typically requires a minimum reduction in population size of 70 percent and preferably closer to 90 to 95 percent to counteract repopulation from reproduction and immigration (Salmon *et al.* 1982). Therefore, more direct forms of control—such as trapping, fumigation, and rodenticides—will likely be needed to further reduce populations. The efficacy and appropriateness of each of these methods is influenced by a number of factors including cost, time to implement, presence of endangered species at control sites, and seasonal activity patterns and preferred foods of ground squirrels (see chart on page 53).

Burrow fumigation is one control method for which timing of the application is critical. This approach involves deploying gas cartridges (which emit carbon dioxide and carbon monoxide) or tablets of aluminum phosphide (which emit phosphine gas). Fumigation works best in spring when soil moisture is high because moist soils hold the emitted toxic gases in the burrow system. Likewise, soil moisture is required to evolve phosphine from the tablets. Later in the year, when soil moisture content is low, fumigation is less effective.

Alternatively, rodenticide baits—which are typically seed based—are less effective in spring, when ground squirrels are foraging on green vegetation, and more effective in early summer and autumn, when squirrels are feeding on seeds. Trapping may control small populations, but it is often too labor intensive and costly to implement on a large scale. No methods are effective when ground squirrels are hibernating (winter) or estivating (summer).

Acute Toxicants vs. Anticoagulants

Rodenticides are one of the most efficacious and cost-effective methods for controlling many rodent pests, and as such are clearly a necessary tool in developing an IPM program. These chemicals typically fall into one of two main categories: acute toxicants and anticoagulants.

Acute toxicants—such as zinc phosphide, strychnine, bromethalin, and cholecalciferol—are compounds that kill the target animal after a single feeding, often within a few hours. Due to their highly toxic nature, acute toxicants are usually restricted-use materials, and therefore require a state-issued applicator's certificate or license to purchase and/or apply. Because of such restrictions, acute toxicants are not used as frequently as anticoagulant rodenticides. In fact, zinc phosphide is currently the only acute toxicant registered for aboveground use for controlling rodents in agricultural fields in California.

As pointed out in a recent article in *The Wildlife Professional* (Abhat 2010), zinc phosphide poses less risk for secondary exposure of nontarget species—exposure from consuming carcasses containing residual rodenticides—than anticoagulants. This is because phosphine gas, the killing agent in zinc phosphide, does not accumulate in body tissues following consumption, but rapidly dissipates from the body after death (Erickson and Urban 2004). This is certainly a positive attribute of zinc phosphide.

Unfortunately, there are also some significant pitfalls of zinc phosphide that were not noted in the Abhat article. For example, bait acceptance is often


Credit: Jack Kelly Clark


Credit: Roger A. Baldwin

The California ground squirrel (*Spermophilus beecheyi*) is a burrowing rodent whose extensive tunnel systems plague California's farmers. Damage in a pistachio grove (above) shows how the squirrels' burrows can weaken tree roots, cause erosion, and leave hazardous holes that pose a threat to farm workers and equipment.

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RESTRICTED USE PESTICIDE
Due to Hazards to Nontarget Organisms
For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.

Credit: California Dept. of Food & Agriculture

Credit: University of California Dept. of Agriculture and Natural Resources

Grain treated with first-generation anticoagulants is poured into a standard inverted-T bait station, which allows easy access to California ground squirrels while reducing the exposure risk for many non-target wildlife species. New labeling restrictions will restrict the use of these materials for field applications, a move the authors fear could jeopardize effective rodent control.

low with zinc phosphide because of its distinctively strong garlic-like odor and taste, although pre-baiting with nontoxic oats can improve bait acceptance in some cases. Bait shyness is also a real problem with this product, as rodents that consume a sub-lethal dose will become sick and will then associate sickness with the zinc phosphide bait. Because of this bait-shyness issue, applications of zinc phosphide are typically only recommended for one or two treatments per year, meaning that some alternative form of control will be needed if the zinc phosphide application does not result in the desired reduction in population size.

Additionally, even though zinc phosphide poses little risk of secondary exposure, one study showed that it had the highest risk of primary exposure through direct ingestion among non-target species of any of nine rodenticides studied (Erickson and Urban 2004). Likewise, if non-target animals consume zinc phosphide, there is no known antidote, whereas vitamin K is a known antidote for anticoagulants. For these reasons, anticoagulants are more commonly used and often more suitable for rodent control in both agricultural and urban/suburban settings.

Two Generations of Anticoagulants

Anticoagulants are rodenticides that limit the blood's ability to clot and thereby kill through internal hemorrhaging. A wide variety of anticoagulants are currently registered for use in the U.S., although they all fall into two categories: first generation or second generation. The first-generation materials, developed in the late 1940s to early 1970s, include warfarin, chlorophacinone, and diphacinone. These rodenticides generally require multiple feedings over the course of three to five days to be effective. Because of this multiple feeding requirement, first-generation anticoagulants are considered to have the least impact on non-target vertebrates. As such, they are the only anticoagulants registered for use in field settings.

In contrast, second-generation anticoagulants—such as brodifacoum, bromadiolone, and difethialone—were developed more recently (beginning in late 1970s) and require only a single feeding to kill target rodents. However, the time to death is four to five days, which is essentially the same as with first-generation, multiple-feeding anticoagulants (Erickson and Urban 2004). Because of this, rodent pests can continue to consume bait over several days, potentially resulting in high anticoagulant build-up in muscle tissue given the higher toxicity and longer half-lives associated with the second-generation materials. It is this potential for bioaccumulation that prohibits second-generation use in agricultural fields and rangelands, and limits use primarily to non-field settings such as residential areas and agricultural buildings.

This is important to note, as it refutes what was implied in *The Wildlife Professional* article last year, which stressed the potential secondary risks of first-generation anticoagulants. In fact, second-generation anticoagulants have a much higher risk of harmful secondary exposure because of their greater potential for bioaccumulation (Erickson and Urban 2004). For example, one study found that 82 of 96 dead raptors collected in California exhibited probable secondary exposure from second-generation anticoagulants versus only one raptor with exposure from a first-generation compound (Lima and Salmon 2010).

Likewise, another study found that 27 of 30 kit foxes in California exhibited probable secondary exposure from second-generation anticoagulants versus only two affected by a first-generation material (McMillan *et al.* 2008). In reality, the potential for secondary exposure from first-generation anticoagulants appears to be quite low when used according to label requirements (e.g., amount applied per area for specific land-cover types and

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species, method of application, timing of application), and poses little risk to populations of non-target scavengers (Silberhorn *et al.* 2006).

Changes in Labeling

This year's new labeling restrictions, set forth by the Environmental Protection Agency, are designed to address concerns regarding potential risks to human health and the environment. The restrictions will apply to both first- and second-generation anticoagulants, and could be problematic for both (Hornbaker and Baldwin 2010). First-generation materials will become restricted-use rodenticides for field applications, meaning that only certified users will be able to purchase and use these materials for controlling rodents in agricultural fields. Because smaller, private growers may not be certified to apply restricted use materials, this change may result in lower usage of safer first-generation anticoagulants, which could have negative ramifications on rodent control, the ag industry, and the environment.

Second-generation anticoagulants will *not* become restricted-use rodenticides, but they will no longer be available for purchase in consumer-size packages at retail stores. Rather, they will be available for sale to non-certified users only in farm-supply stores and only in packages of eight pounds or more, a measure to discourage homeowner use. However, this does not preclude a homeowner or farmer from purchasing second-generation materials and using them in a manner inconsistent with the label. For example, they may decide to use second-generation anticoagulants for ground squirrel control around their property, even though such use is clearly not allowed.

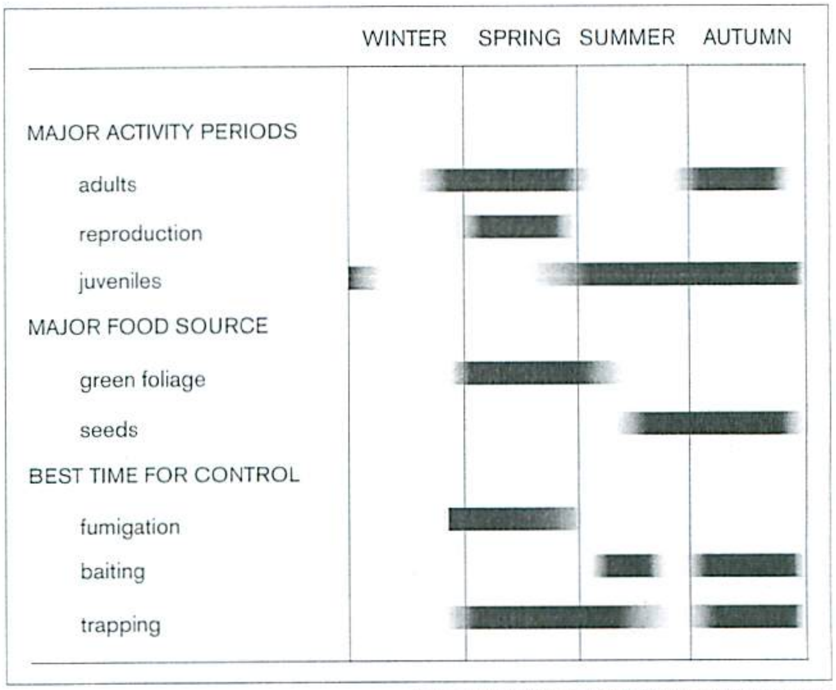
We are concerned that these anticoagulant label changes could result in one of several negative consequences. For example:

- Rodent pest populations could increase given the potential reduction in field-use of effective first-generation anticoagulants as a pest-management tool.
- There may be greater use of second-generation anticoagulants in an unlawful manner given the relative unavailability of the safer first-generation materials for non-certified users attempting pest control in agricultural fields.
- Some people may resort to using registered pesticides in a manner inconsistent with their labels, or attempting pest control with other non-registered materials such as household chemicals or antifreeze. This would likely pose a much greater threat to the environment.

In short, we feel that the new restrictions on first-generation anticoagulants may lead to greater environmental problems than would the potential decrease in availability of second-generation anticoagulants.

The Need to Get it Right

Controlling rodent pests is a difficult yet necessary action in many agricultural and urban/suburban settings throughout the world. These control actions need to be administered in a manner that is safe not only for humans but also for non-target wildlife and the environment. Today, this typically means developing



Credit: University of California Dept. of Agriculture and Natural Resources

Basic tools of Integrated Pest Management—including fumigation, baiting, and trapping—will be most effective when applied at the optimal time of year and stage in the life of the target species.

an IPM program, of which rodenticides are often an important component. Unfortunately, a lot of misinformation is out there about rodenticides, which can lead to negative feelings and reactions about this valuable tool. It is incumbent upon us as wildlife professionals to ensure that the most current and accurate information is disseminated so that our expertise can be used to help address and solve many of the problems that abound from human-wildlife interaction. ■

This article has been reviewed by a subject-matter expert.

For a complete bibliography and more information about rodenticide use, go to *www.wildlife.org*.

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