REDUCING RODENTICIDE HAZARDS: AGRICULTURAL SETTINGS

TERRELL P. SALMON, University of California Cooperative Extension San Diego County, CA, USA

Abstract: Rodenticides including anticoagulants, zinc phosphide and strychnine are frequently used for rodent control in agricultural areas in California. While considered safe and effective, non-target secondary poisonings related to anticoagulants and other materials have been reported. There are many ways to influence the hazards associated with rodenticide use. The most important thing in controlling rodents in agricultural areas is to do the best job possible combining knowledge of the target species, bait materials and possible non-target impacts. When a control program fails or is not very effective, growers are often forced to use additional control efforts to try to correct the problem. When this happens, more rodenticide use might be necessary and, with more use comes greater primary and secondary exposure. The best way to minimize hazards associated with rodenticide use is to understand the pest, its damage potential, and the methods and materials available to mitigate the problem. When this information is used, a good and effective control program can be developed that has minimal negative impact on other non-target species or the environment.

Key words: agricultural damage, primary hazards, rodenticides, rodents, secondary hazards

Proceedings of the 12th Wildlife Damage Management Conference (D.L. Nolte, W.M. Arjo, D.H. Stalman, Eds). 2007

INTRODUCTION

Rodenticides including anti-coagulants, zinc phosphide and strychnine are frequently used for rodent control in agricultural and rangeland areas in California. While considered safe and effective for many years, recent incidences of secondary hazards related to anticoagulants and other materials have been reported. As a result, the U.S. Environmental Protection Agency (EPA) is proposing changes in the registration and use of anticoagulants and other rodent control materials in an effort to reduce primary and secondary hazards.

The EPA's proposed actions highlight concerns about rodenticides. Reducing primary and secondary hazards has been, and will continue to be an important part of developing and using rodenticides in agriculture. In California's agricultural and rural areas, the major rodent pests are the California ground squirrel (*Spermophilus beecheyi*), the Valley pocket gopher (*Thomomys bottae*), and the California vole (*Microtus californicus*). Recent publicity in California and elsewhere has focused on secondary hazards associated with anticoagulant use to control these pests. Little attention or recognition has been paid to current use practices in agricultural areas that already improve effectiveness for rodenticides and reduce their exposure to non-target wildlife.

Rodenticides, primarily the anticoagulants chlorophacinone and diphacinone, zinc phosphide, and until the late 1980s, strychnine and Compound 1080, have been used to control rodents in and around California's agricultural crops (Clark

1975). While the amount of bait used varies from year to year, approximately 1,000,000 pounds are used annually for rodent control related to agricultural operations (Timm et al. 2004).

Ground squirrels have been the subject of control efforts since agriculture began in California. The Department of Food and Agriculture (CDFA) published instructions for ground squirrel control that clearly state the importance of using bait properly to minimize primary and secondary hazards (Clark 1975). During World War I, a statewide ground squirrel control campaign was conducted in an effort to save grain for shipment to the troops and allies in Europe. Even at that time, there was concern for the hazards of using ground squirrel poisons. The 1917 squirrel campaign poster stated *"KILL THE SQUIRRELS – WILL YOU HELP?"* but included the statement *"Children we must kill the squirrels but use the poisons carefully"*. Clearly, considerations of the hazards associated with rodenticides have been integral with ground squirrel control in California for a long time.

CONCEPTS AND METHODS TO REDUCE HAZARDS

There are many ways to influence the hazards associated with rodenticide use. The most important thing in controlling rodents in agricultural areas is to do the best job possible combining knowledge of the target species, bait materials and possible non-target impacts. When a control program fails or is not very effective, growers are often forced to use additional control efforts to correct the problem. When this happens, more rodenticide use might be necessary and, with more use comes greater primary and secondary exposure.

Understanding the Pest Species and the Environment

A primary way to reduce hazards from rodenticide use is to clearly understand the target species' biology and behavior. The physiology of the animal can play a major role. Certainly, species variation in susceptibility to specific rodenticides is well known (Hygnstrom et al. 1994). Feeding or foraging behavior is another major factor in targeting specific species. For example, ground squirrels are excellent foragers for seeds. In studying their foraging behavior, Dochtermann (2005) found that squirrels would find seeds broadcast very thinly in the environment. He also determined that at the standard application rate for anticoagulants (10 lbs/acre) squirrels would find and consume grain broadcast as far as 90 feet from their burrows. He demonstrated that broadcast baiting was an effective baiting strategy that minimized non-target primary hazards because the bait was spread so sparsely in the environment.

Selection of Bait Material

The selection of the bait material can also influence primary and secondary hazards. The effects of specific toxicants vary between species (Hygnstrom et al. 1994). The difference in susceptibility between the target species and potential non-targets in the treatment area can sometimes be used to influence primary and secondary hazards. The chemistry of the toxicant in the target species also influences hazards associated with that chemical's use. A striking example is the secondary hazard associated with zinc phosphide compared to anticoagulants such as chlorophacinone and diphacinone for ground squirrel control. Of the three toxicants, zinc phosphide produces far lower secondary hazards than the anticoagulants because of the fate of the toxicant in the poisoned squirrel carcass (Clark 1984, Hygnstrom et al. 1994).

Improving Bait Material

A characteristic of rodenticides compared to most other pesticides is that the target pest (the rodent) must eat the bait material in sufficient quantities to be lethal. Like most animals, rodents have taste preferences that vary by species as well as among individuals. Most rodent control experts have experienced problems with bait acceptance where rodents either shy from eating the bait or eat an insufficient amount. In agriculture this can be especially problematic since the crop being protected is sometimes similar (e.g., corn or wheat) to the bait material. The ingredients in the bait can impact tastes or otherwise influence the consumption of the bait (Salmon and Dochtermann 2006). Since all ingredients of the bait material can influence bait acceptance, and because the acceptance can vary from site to site, special attention should be taken to ensure the bait selected will be acceptable to the target rodent.

Modifying Bait Material

Toxicants are often formulated using different carriers and structures. The same toxicant and inert ingredients can be formulated as a meal, block, small pellet or kibble. Each formulation can impact primary hazards associated with the bait since larger bait (if formulated at the same percent active ingredient), will contain more toxicant per exposure. Larger baits may also be easier to find and consume by non-target species. The size argument can work in both directions, however. Sometimes, if bait is too small, it may not be found by the target animals, but would be available for smaller non-target species. An example of this would be using meal-type bait, commonly used for mice and rats, for ground squirrels. While squirrels are excellent foragers for seeds, they are not generally attracted to meal baits. Certainly, there are situations where larger or smaller baits are appropriate, so bait size should not be the sole determinate for bait selection.

The durability of bait also impacts its potential hazard. Both zinc phosphide and the first generation anticoagulants degrade rapidly when exposed to environmental factors such as heat, moisture, and sunlight. When cereal based baits are exposed to moisture, they are prone to fungus and mold growth which definitely influences bait acceptance.

The EPA has often suggested that reducing the concentration of bait will reduce the associated hazards. It stands to reason that putting less toxicant in the environmental will reduce potential hazards. However, there are many issues that must be considered before this simple logic can prove to be fact. First, the bait concentration can definitely impact product efficacy. While laboratory tests might determine the LD_{99}, these tests generally do not factor in competing forces that influence bait consumption in the field. In agricultural areas, this can be especially important when nearby crops provide adequate and sometimes more palatable food resources than does the bait. There are cases, however, where reducing concentration of a bait material did not negatively impacting efficacy (Salmon et al. 2007). This reduction resulted in a reduced anticoagulant load in the poisoned squirrels which translates to lower secondary risks to non-targets consuming the poisoned squirrels (Ward 2003).

Modifying Baiting Strategies

Bait can be applied in various ways to control rodents in agricultural areas. Probably the most common example is the use of bait stations for anticoagulants. The specific station design can keep some non-targets away from the bait, thereby reducing primary hazards. For example, reducing the entrance diameter to 3 inches (from the

typical 4) keeps larger animals such as cats and small dogs from entering the station. Research has also shown that bait stations can be used to exclude specific non-targets such as threatened or endangered species that are in the treatment area and would likely be poisoned if they had access to the bait (Whisson 1999).

Modifying baiting strategies (timing and method of application) rather than reducing bait concentration, may have more effect in reducing non-target risks (Whisson and Salmon 2002, Mahl and Salmon 2003). In a laboratory study, Whisson and Salmon (2002) showed that the timing of bait applications was more important than bait concentration in controlling ground squirrels. They recommended reducing the number of applications to 2 (label recommends 3 to 4) with 2 to 3 days between applications. The method of application is also important. Broadcast baiting for ground squirrels was just as effective as spot baiting, but reduced the secondary risks from poisoned carcasses significantly (Silberhorn et al. 2003). These examples demonstrate that emphasizing research in baiting strategies could lead to much more effective control efforts and, at the same time, reduced hazards to non-target species.

CONCLUSION

There is growing concern over the poisoning of non-target species during field applications of rodenticides to control rodent pests in agricultural settings. This has lead the EPA to propose changes in the bait material, use methods, concentrations and labels to reduce primary and secondary hazards. Much work is being done to identify hazards and find new or different ways to use rodenticides to solve agricultural problems caused by rodents. It is important to recognize that the best way to minimize hazards associated with rodenticide use is to understand the pest, its damage potential and the methods and materials available to mitigate the problem. When this information is used, a good and effective rodent control program can be developed that has minimal negative impact on other non-target species or the environment.

LITERATURE CITED

CLARK, D.O. 1975. Vertebrate pest control handbook 2nd edition. Division of Plant Industry. State Department of Food and Agriculture. Sacramento, CA. 621 pp.

CLARK, J.P. 1984. Vertebrate pest control handbook 4th edition. Division of Plant Industry. State Department of Food and Agriculture. Sacramento, CA. 803 pp.

DOCHTERMANN, E.A. 2005. The spatial and temporal foraging behavior of the California ground squirrel (*Spermophilus beecheyi*) under conditions of supplemental resources: Implications for control programs and methods. M.S. thesis, University of California, Davis, CA.

HYGNSTROM, S.E., R.M. TIMM, AND G.E. LARSON. 1994. Prevention and control of wildlife damage. University of Nebraska Cooperative Extension. Lincoln, NE. 848 pp.

MAHL, U.H.J., AND T.P. SALMON. 2003. Within-burrow and surface feeding of oat grain by California ground squirrels. Proceedings of the Wildlife Damage Management Conference 10:370-377.

SALMON, T.P., AND E.A. DOCHTERMANN. 2006. Rodenticide grain bait ingredient acceptance by Norway rats (*Rattus norvegicus*), California ground squirrels (*Spermophilus beecheyi*) and pocket gophers (*Thomomys bottae*). Pest Management Science 62(7):678-683.

_____, D.A. WHISSON, A.R. BERENTSEN, AND W.P. GORENZEL. 2007. Comparison of 0.005% and 0.01% diphacinone and chlorophacinone baits for controlling California ground squirrels (*Spermophilus beecheyi*). Wildlife Research 34:14-18.

SILBERHORN, E.M., D.L. SCHNABEL, AND T.P. SALMON. 2003. Ecological risk assessment for grain-based field use anticoagulant rodenticides registered by the California Department of Food and Agriculture for special local needs. Unpublished report to the California Department of Food and Agriculture 109 pp.

TIMM, R.M., D.L. SCHNABEL, T.P. SALMON, W.P. GORENZEL, N. DECHORETZ, AND M. MEYERS. 2004. California's rodenticide surcharge program: history and accomplishments. Proceedings of the Vertebrate Pest Conference 21:350-356.

WARD, L.A. 2003. The distribution and excretions of diphacinone in California ground squirrels (*Spermophilus beecheyi*) and the potential risk of secondary exposure to non-target species. M.S. Thesis. University of California, Davis, CA, USA.

WHISSON, D.A. 1999. Modified bait stations for California ground squirrel control in endangered kangaroo rat habitat. Wildlife Society Bulletin 27:172-177.

_____, AND T.P. SALMON. 2002. Effect of timing of applications and amount consumed of 0.01% diphacinone on mortality of California ground squirrels (*Spermophilus beecheyi*). Crop Protection 21:885-889.