CHAPTER TEN

VERTEBRATE PESTS

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Vertebrate pests are often a serious problem in the Intermountain Region of California. Rodents (gophers, ground squirrels, and meadow mice) are the most injurious of the vertebrate pests. In annual cropping systems, frequent field cultivation usually discourages large rodent colonies. In the intermountain area, however, the effects of cultivation are offset by the predominance of perennial crops adjacent to uncultivated land. For rodents, alfalfa fields are highly desirable habitat.

Vertebrate feeding and nesting behavior cause a range of problems to above- and belowground portions of alfalfa plants. In addition, burrowing activity —particularly by pocket gophers and the Belding ground squirrel—can disrupt harvest operations and damage harvest equipment. Mounds caused by burrowing can cover plants, resulting in further production losses. Burrowing also adversely affects the efficiency of irrigation systems, primarily in flood-irrigated fields.

Many pests are managed using the concept of threshold levels. In other words, when the pest population density reaches the level where control is economically justified, control measures are undertaken. This approach is less useful for vertebrate pests than for others, because treatment threshold levels have not been developed. Very low vertebrate pest populations can be tolerated. Their great reproductive capacity mandates that populations be maintained at low levels to prevent an unmanageable population outbreak. Table 10.1 summarizes the control methods this chapter will discuss.

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POCKET GOPHERS

Pocket gophers (*Thomomys* spp.) are the most common and often the most destructive vertebrate pest of alfalfa. Unfortunately, alfalfa is a preferred food of gophers, and it provides ideal conditions for gopher population buildup. Pocket gophers feed primarily on the taproot and often kill plants. Their feeding can lead to significant yield reduction, and their burrows cause damage to harvest machinery. The damage done by gophers to an alfalfa stand is permanent; even after gophers have been controlled, the effect of previous gopher feeding continues to affect yields.

Pocket gophers are (6- to 8-inch-long) stout-bodied, short-legged rodents well adapted for burrowing (color photo 10.1). The name *pocket gopher* refers to the fur-lined external cheek pouches, or pockets, used to carry food and nesting materials. The pocket gopher can close its lips behind its four large incisor

Table 10.1. Vertebrate pest control measures for alfalfa.[1]

CONTROL MEASURE	RODENTICIDE	TIMING	COMMENTS
POCKET GOPHERS			
Hand-baiting	Strychnine-treated grain and anticoagulant baits	Late winter and throughout growing season	Useful for small isolated infestations. Strychnine-treated grain is more effective than anticoagulant baits.
Mechanical baiting	Strychnine-treated grain	Late winter to early spring, before alfalfa breaks dormancy. May be done throughout the growing season after a cutting.	Effective for widespread infestations. Proper soil moisture content is critical. Use mechanical burrow builder only in areas where gophers are present, not as a preventive measure.
Trapping		Late winter and throughout growing season	Effective but very time-consuming. Set traps in pairs, facing opposite directions.
GROUND SQUIRRELS			
Deep tillage		Fall or spring (fall preferred)	Deep tillage destroys burrow system and is believed to reduce populations.
Shooting		Whenever observed above ground	Time-consuming, expensive, and marginally effective for large infestations. Most effective when squirrels first emerge after hibernation.
Fumigation	Acrolein (Magnacide)	When squirrels emerge after hibernation (Feb.) through June	Effective but time-consuming. Retreatment of survivors improves control considerably. Concentrate efforts on low infestations or young fields.
	Gas cartridges	March through June in the spring.	Usually only 30 to 40 percent effective, possibly due to cold, dry soils. Follow-up treatments improve control.
	Aluminum phosphide (Phostoxin, Fumitoxin)	Same as gas cartridges	Same as gas cartridges
Baiting	Chlorophacinone or diphacinone	May through June	Must be used in bait stations placed around perimeter of fields or in a grid within fields. Requires multiple feedings.
MEADOW MICE			
Vegetative cover control		Late fall (Oct. to early Dec.)	Keep vegetative cover low through dormant period by mowing or grazing.
Baiting	Zinc phosphide	Late fall to early spring, before alfalfa breaks dormancy	Apply before spring breeding, by hand or with a mechanical broadcaster. Do not treat more often than once every 6 months. Can be used outside field at any time of year.
	Chlorophacinone or diphacinone	Any time of year	Not to be used in alfalfa fields, only along fence rows and surrounding noncrop areas. Requires multiple feeding. Hand-baiting every other day for 5 days is recommended.
DEER AND ANTELOPE			
Deer fences			Must be 8 ft high and made of woven 4-by-4-in. mesh. Almost never worth the expense and effort.

1. Rotation to annual crops is also effective for reducing the population of rodent pests.

teeth, keeping soil out of its mouth while burrowing. Pocket gophers use their short whiskers and tails to help navigate tunnels. They seldom travel above ground; however, they are sometimes seen feeding, pushing dirt out of their burrow system, or moving to a new area. They have a keen sense of smell, which they use to locate food. Pocket gophers do not hibernate and can be active in the snow. They are more active in the spring and fall than they are during the heat of summer. The female usually produces one or two litters per year but may produce up to three litters in irrigated alfalfa. Average litter size is 5 or 6 young. Births generally occur from March through June. Pocket gophers have a maximum life span of about 5 years.

Pocket gophers are extremely territorial and antisocial, living by themselves in an extensive underground burrow system that can cover an area from a few hundred square feet up to more than 1,000 square feet. Territories are smaller in habitat with abundant food, such as alfalfa fields. Mounds of fresh soil indicate their presence. The burrow system may be linear or highly branched (figure 10.1). A single burrow system may be up to 200 yards long. Tunnels are 2 to 3 inches in diameter and usually from 6 to 12 inches below the ground, but they may be more than 6 feet deep. Tunnels are usually deeper in sandy soils than in clay soils. One gopher may create several mounds in a day or as many as 200 mounds per year. Mounds are usually crescent-shaped (figure 10.2) and appear at the end of short lateral tunnels.

Control Methods

A successful pocket gopher control program depends on early detection and control measures appropriate to the location and situation. Most alfalfa growers have relied on poison baits for gopher control. Where populations are low or poison baits have been ineffective, try traps. In a field with a heavy infestation, drag the field before imposing control measures. Dragging will enable you to identify active burrow systems. Concentrate gopher control efforts in late winter to early spring, when the alfalfa is breaking dormancy and before the gophers have given birth. Flood irrigation may reduce gopher populations, but it does not eliminate the problem. Rotation to row crops or other field crops—such as barley, wheat, oats, rye, or sudangrass—may help reduce gopher population levels.

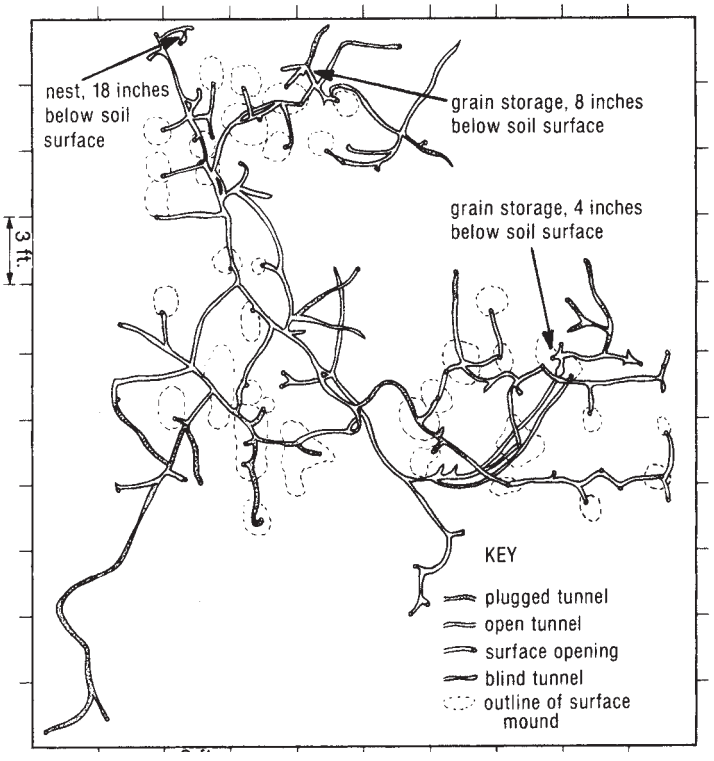
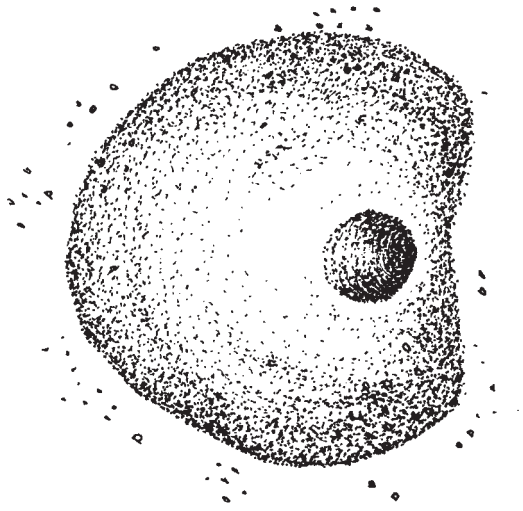


Figure 10.1. (left) The burrow system of a single pocket gopher can cover from a few hundred square feet to more than 1,000 square feet.

Figure 10.2. (below) The pocket gopher pushes soil out of a burrow, creating a crescent-shaped mound; then the gopher closes the hole with a plug.



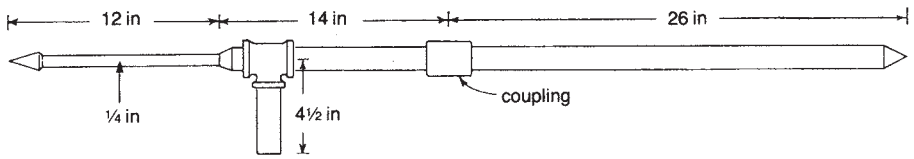


Figure 10.3. A probe for locating pocket gopher tunnels can be built in a shop. The shaft may be in one piece or divided by pipe coupling for convenient carrying when it is not in use. (Drawing not to scale.)

Toxic baits (rodenticides)

HAND-BAITING Successful hand-baiting depends on accurately locating the gopher's main burrow. To do so, use a gopher probe (figure 10.3). Look for the freshest mounds, because they indicate an area of recent gopher activity. You will usually see a small circle or depression representing a plugged lateral tunnel. This plug is generally bordered on one side by soil, giving the mound a crescent shape. Often the main burrow goes between two mounds. Begin probing 8 to 12 inches from the plug side of the mound. When the probe penetrates the gopher's burrow, it should suddenly drop about 2 inches (figure 10.4.). Enlarge the opening the probe has made in the soil by rotating the probe or inserting a larger rod or stick. Then carefully pour a tablespoon of the bait into the opening. A funnel is useful to prevent spillage. Close the probe hole with a rock, clod, or some other material. This will exclude light and prevent soil from falling on the bait. Treat two or three different places in the burrow system. If gopher activity continues for more than 2 days after treatment, treat the burrow again or use another control method.

Strychnine-treated grain is the most common pocket gopher bait. Only strychnine bait of 0.5 percent or less may be used for hand-baiting. Anticoagulant baits are also available for hand-baiting, but they are generally less effective because the gopher must ingest multiple doses over time. All gopher bait is poisonous: Use it with caution. Read and follow product label instructions carefully.

MECHANICAL BAITING One-time use of a mechanical bait applicator (also called a burrow builder or gopher machine) can control gophers over large areas. This tractor-drawn device (color photo 10.2) constructs an artificial underground burrow and deposits poison-treated grain at preset intervals and quantities. The artificial burrow will intercept most of the natural gopher burrow systems. Gophers, by nature, readily explore these artificial tunnels and consume the bait. The percentage of strychnine allowable in mechanical baiting (1.8 percent strychnine) is higher than that in hand-baiting.

Before using the mechanical bait applicator, determine the depth of existing gopher tunnels by using a shovel. The depth of the burrow builder should be set to that of the existing gopher tunnels. As you create the artificial tunnel, examine it periodically to make sure that it's forming properly and that the bait is properly dispensed (sometimes the applicator tube gets clogged with soil). Proper soil moisture is essential. If the soil is too wet, the tractor will bog down and the tunnel may have an open slot at the top, allowing sunlight to penetrate. If the soil is too dry, the artificial tunnel will cave in, resulting in poor control. Space burrows at 20- to 25-foot intervals. Treat the perimeter of the field to delay re-invasion from outside areas. Use the gopher machine only in areas where gophers are present, not as a preventive measure. Gophers seek areas with low resistance to digging; if you build a tunnel where gophers are not present, you can actually facilitate their spread. Raise

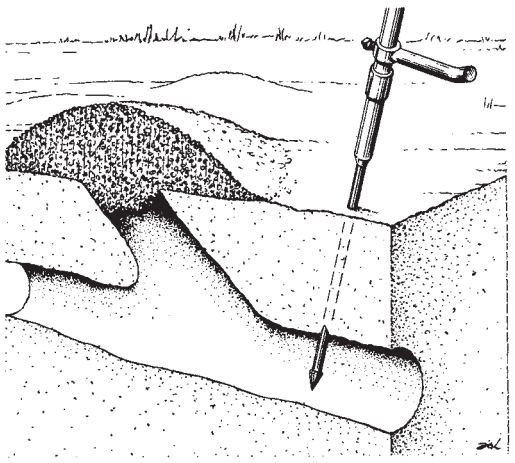


Figure 10.4. The probe has entered a main tunnel when the probe suddenly drops about 2 inches. Enlarge the probe hole to insert poisoned bait.

Use the gopher machine only in areas where gophers are present and not as a preventative measure.

the shank of the gopher machine out of the ground when crossing uninfested areas of the field.

Trapping

Trapping can be a safe and effective method to control pocket gophers when populations are low. It is most effective in spring and fall. Several types and brands of gopher traps are available. A two-pronged pincher trap (such as the Macabee) is the most common. The gopher triggers it by pushing a flat vertical pan. Another popular trap is the squeeze-type box trap.

As with hand-baiting, trapping requires that you locate the main tunnel by using a probe. Use a shovel to open the main tunnel, and insert traps in pairs facing opposite directions. This placement will intercept a gopher coming from either direction. A box trap is somewhat easier to set than a pincher trap, but placing it requires more excavation because of its large size. Wire all traps to stakes or flags so you will not lose track of them or have the trap, with gopher, stolen by a predator. Remember that you will get best results when light is excluded from the burrow. If light enters the tunnel, the gopher may plug the burrow with soil, filling the traps and making them ineffective. Cover the opening with soil, sod, cardboard, or some other material. Sift fine soil around the cover to ensure a light-tight seal. Check traps and reset them when necessary. Move the traps to a different location if 3 days elapse without catching a gopher.

Gas cartridges

Gas cartridges (smoke bombs) are not recommended for pocket gopher control. They are costly and time-consuming and provide variable control. Their ineffectiveness may be due to the extensive nature of gopher tunnel systems and diffusion of the gas in soil. Because soil moisture reduces the amount of gas diffusion, treating very moist soils results in better control than treating dry soil.

GROUND SQUIRRELS

Ground squirrels *(Spermophilus* spp.) can be serious problems. Both California ground squirrels and Belding ground squirrels are found in and around intermountain alfalfa fields. California ground squirrels have a flecked coat and a long bushy tail. In contrast, Belding ground squirrels are slightly smaller, have a short flat tail, and are solid brown (color photo 10.3). California ground squirrels are generally more of a nuisance than a serious problem in alfalfa because they prefer to stay on field edges, along fence rows or roadsides. However, Belding ground squirrels are a very serious problem. They consume large amounts of alfalfa and inhabit the interior of alfalfa fields, constructing massive mounds that can damage hay-harvesting equipment. One study estimated that 123 squirrels per acre removed about 1,800 pounds of alfalfa per acre in 44 days. This section pertains primarily to Belding ground squirrels, not California ground squirrels.

Unlike pocket gophers, ground squirrels are frequently visible in the field. They spend much of their time out of the burrow, sunning, feeding, or socializing. The burrows provide protection and a place to rear young, store food, and rest and sleep. Their burrow system is not as extensive as that of pocket gophers, but it can be as deep as 6 feet. Ground squirrel burrow systems are much larger in diameter than are gopher systems, and their burrow entrances are always unplugged.

Belding ground squirrels come out of hibernation and are first visible from mid-January to mid-February. They breed in late February and in March. The breeding season lasts 3 to 6 weeks. Young are born in the spring. About 4 weeks after birth, the young squirrels emerge from the burrow. Females have only one litter per year. They may appear to have multiple litters because the young squirrels are visible for a long period, but this is not the case. The fact is that older females breed first and then the younger females breed, thus giving the impression of multiple litters. Litter size ranges from 3 to 12 young and averages about 7 young. Females may live 10 years or more and have a life span twice that of males.

When they first emerge after hibernation, the squirrels may eat nothing at all, surviving on stored fats, or they may subsist on alfalfa foliage. They prefer green foliage in early spring and will not eat seeds like grain until later in the season. About June 15 to July 1 some of the adult males go into hibernation for the winter. The adult females begin to hibernate later, and then, as fall approaches, the young born that year begin. Although squirrels are not active for much of the year, they are very energetic and nearly double their body weight in a few months.

Control Methods

Deep tillage

Preventing excessive populations is much easier than bringing high populations under control. Therefore, the first step in squirrel management—deep tillage—should occur when an alfalfa field is taken out of production. Deep tillage is thought to be effective for controlling squirrels because it disrupts burrow systems. It is believed to be more effective when done in fall than in spring.

Shooting

As a means of controlling large squirrel populations, shooting is seldom effective when used by itself. Shooting is time-consuming, and squirrels become gun-shy. Shooting is best used for fields with low populations or to control survivors that remain following other control operations. Do not approach shooting haphazardly. Section off the field and systematically concentrate efforts in 1-to 2-acre grids.

Fumigants

Acrolein

Registered in California for the control of burrowing rodents in the spring of 1993, Acrolein (Magnacide) is the most effective method currently available to control ground squirrels. It has achieved up to 95-percent control of both California and Belding ground squirrels in field trials and commercial applications. A dispensing rod, with nitrogen gas as the propellant, injects Magnacide into squirrel holes. A Restricted Use Permit from the Agricultural Commissioner's Office is required. Other notification requirements may exist as well; if so, they will be stated on the permit. Magnacide can be very hazardous. Those who use it must receive training from company representatives or other qualified persons.

Before using this fumigant, drag the fields to determine which holes are part of active burrow systems. Treat every hole, because distinguishing active burrows by looking at the location of the holes is impossible. Do not treat burrows until aboveground squirrel activity is apparent. The best time for treatment is early in the season, after the squirrels become active but before significant alfalfa growth has occurred. (Alfalfa growth masks burrow openings, making them difficult to locate.) Applying the fumigant before the young are born in the spring is best. Cover holes after treatment. Reopened holes indicate that squirrels were not controlled or that the burrow system was invaded by neighboring squirrels. Revisit treated areas to retreat any open burrow systems. If squirrels remain active, burrow systems can be treated after the first cutting. Do not treat holes in the summer or fall; at that time squirrels start going into hibernation and plug off their tunnels—rendering Magnacide ineffective.

Keep squirrel populations at manageable levels by concentrating efforts on young fields or fields with low infestations.

This fumigant is too costly and time-consuming to be used on older fields with high squirrel populations. Keep squirrel populations at manageable levels by concentrating control efforts on young fields or fields with low infestations.

Gas cartridges and aluminum phosphide
Smoke bombs and aluminum phosphide (such as Phostoxin and Fumitoxin) have been used with limited success. Although Phostoxin has been effective for control of California ground squirrels, it is only 30 to 40 percent effective for control of Belding ground squirrels. Cold dry soils, which prevent the toxicant from penetrating far, may partially explain the poor results. Also, the burrow system of the Belding ground squirrel is so extensive that perhaps not enough toxicant is released to be lethal.

If you use Phostoxin before March, cold soil will reduce its effectiveness. To determine which holes are active, drag the field before using gas cartridges or Phostoxin. Gas cartridges are often preferred over Phostoxin because they help the user determine which holes are part of the same burrow system—smoke escapes from holes in the same system. Seal the hole from which smoke escapes by stomping on it. Determining which holes belong to the same burrow system is difficult when using Phostoxin. Two holes that are next to each other are not necessarily part of the same burrow system, but two holes 25 feet apart may be. Therefore, you must place Phostoxin tablets or pellets in every hole.

Baits

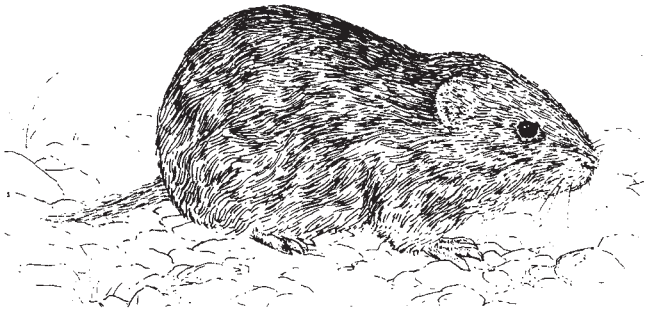
Anticoagulant baits (chlorophacinone or diphacinone) have been used in some areas of the Intermountain Region. Do not use them before May, because squirrels will not feed on grain early in the season. For baits to be effective, squirrels must feed on them for at least 5 days, with interruptions of no longer than 48 hours between feedings. Greater than 90-percent control has been achieved when anticoagulant baits have been used properly. Grain baits can no longer be broadcast on fields; they must be used in bait stations (figure 10.5). Place bait stations around the perimeter of the field and within the field at spacings no larger than 100 feet.

Squirrel management requires the integration of several control practices, each employed at the correct time. These practices include deep cultivation in the fall, fumigation with Magnacide, shooting, and anticoagulant baits.

MEADOW MICE

Meadow mice (*Microtus* spp.)—also referred to as meadow voles, or field mice—are another serious rodent pest of alfalfa in portions of the Intermountain Region. They have been especially problematic in Scott Valley and the Tulelake Basin. Meadow mice are 4 to 6 inches long when mature. They have heavy bodies, short legs and tails, and small, rounded ears. Their soft dense fur is blackish brown to grayish brown.

Meadow mice are active all year long. Alfalfa is an ideal habitat for them. They feed on all parts of the plant, foraging on stems and leaves in summer and fall and roots and crowns in winter and early spring. They dig short, shallow burrows and make underground nests of grass, stems, and leaves. Their presence is indicated by well-worn trails, approximately 2 inches wide, leading to entrance holes without mounds (color photo 10.4). Their trails are especially evident in late winter, before the alfalfa resumes growth.



Meadow mouse

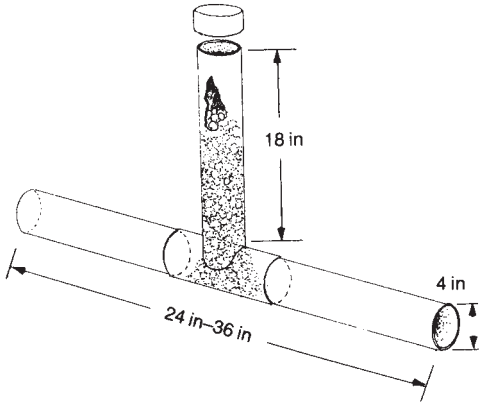


Figure 10.5. This bait station for ground squirrels is made of PVC pipe. Check bait stations on a regular basis to ensure a constant supply of bait.

Spring is the peak breeding period; a second, shorter breeding period occurs in fall. Female meadow mice can produce between two and five litters per year. An average litter contains four or five young. Meadow mouse populations fluctuate dramatically from year to year, depending on habitat and weather conditions. The populations increase rapidly under favorable conditions and the damage they cause can be dramatic. Heavily infested fields can support a population of 1,000 to 3,000 meadow mice per acre.

Control Methods

An important component of meadow mouse control is making the field and surrounding areas a less favorable habitat. Controlling weeds and cultivating along fence rows, roadsides, and ditchbanks can help reduce meadow mouse populations by reducing the number of invading mice. Dense vegetative cover in the field encourages meadow mice by providing food and protection from predators and environmental stress. Hence, the amount of alfalfa cover remaining on a field as winter begins affects meadow mouse populations and damage. In areas where meadow mice are known to be a problem, graze or mow the field in late October to early December, after alfalfa has "frozen back" and is no longer actively growing. This is particularly important in years with snow cover, because snow protects meadow mice from predators. Fences can be constructed to exclude meadow mice, but they are not cost-effective for protecting alfalfa fields.

Trapping

Trapping is not a cost-effective control measure in alfalfa fields, but it is useful to monitor populations. When mouse damage is visible along the edge of a field, set two trap lines of 50 traps each. The number of mice caught in one night per 100 traps is used to assess the population level. Infestations that yield fewer than 5 meadow mice per 100 traps are considered light; 10 per 100 traps, moderate; and 20 or more per 100 traps, heavy. Begin treatment when the population is moderate.

Baits

Toxic baits are necessary where mouse problems are serious. However, at the time of publication, no baits are registered for use in alfalfa during the growing season. Zinc phosphide (a restricted-use pesticide) is registered for use in alfalfa only during the dormant period, although it can be used in areas around alfalfa fields at any time of year. Treat heavily infested alfalfa fields with zinc phosphide (a single-feeding bait) in the late fall to early spring, before alfalfa breaks dormancy and before mice begin spring breeding. Use a mechanical broadcaster to apply bait. Monitor areas around the alfalfa and treat them as needed, at any time of year. Zinc phosphide requires only one feeding to be lethal. Bait shyness, a condition that results when meadow mice consume only enough to make them sick and then discontinue feeding, is a potential problem with zinc phosphide. Follow label instructions to limit the potential for bait shyness, and do not treat more often than every 6 months.

Anticoagulant baits may not be used in alfalfa at any time of year, but they can be used at any time along fence rows and in the surrounding noncrop areas. To be effective, meadow mice must consume an anticoagulant over a period of at least 5 days. Therefore, the bait must be available to the mice until the population is controlled. The usual procedure is to hand-bait the runways near burrow openings every other day for 5 days. Read label instructions to ensure the proper rate of application.

DEER AND ANTELOPE

Deer and antelope can be problematic, consuming significant amounts of alfalfa in some fields in the Intermountain Region. Their feeding can be considerable in fields adjacent to wooded or brush areas.

After obtaining a depredation permit from the California Department of Fish and Game, you are permitted to shoot deer. Shooting is unlikely to solve the problem, however. Using traps, poisons, and toxic bait to control deer and antelope is illegal. Deer fences are the only legal, somewhat effective control measure. A fence should be 7 to 8 feet high and made of woven mesh wire (4- by 4-inch mesh). A few strands of barbed wire no more than 4 inches apart can extend the height of shorter fences. Deer fences are costly and almost never worth the expense and effort. Damage from deer and antelope is largely unavoidable—consider it one of the losses associated with growing alfalfa in the Intermountain Region.

ADDITIONAL READING

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