Irrigated Alfalfa Management
for Mediterranean and Desert Zones

Integrated Management of Vertebrate Pests in Alfalfa

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Chapter 12

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Alfalfa is an attractive habitat and food source to a wide variety of vertebrates. Significant reductions in yield can result from vertebrates feeding on the leaves, stems, and roots of alfalfa plants. In addition, the burrows and soil mounds created by some of these pests may cause problems with irrigation (primarily in flood-irrigated fields) and result in damage to harvest equipment and disruptions to harvest. Pocket gophers (*Thomomys* sp.), meadow voles (*Microtus californicus* Peale), and ground squirrels (*Spermophilus beecheyi* Richardson) are the most serious of the pest species in California alfalfa fields. However, black-tailed jackrabbits (*Lepus californicus* Gray), cottontail rabbits (*Sylvilagus audubonii* [Baird]), deer (*Odocoileus hemionus* Rafinesque), and occasionally migrating waterfowl can also cause serious damage in certain areas.

The potential for damage due to vertebrate pests varies between fields and can be dependent on such factors as cultural practices (e.g., irrigation, field rotation), soil type, field location, and the surrounding habitats. Fields near rangeland, forested areas, and other uncultivated weedy areas are generally at higher

risk and are more quickly invaded than fields bordered by frequently cultivated land.

Vertebrate Management Strategies

The most successful management strategy requires knowledge of the biology and behavior of vertebrate pests and regular monitoring for them in and around fields. Historical records of pest population levels and control measures implemented, and analysis of the economics of control procedures and their potential effectiveness, can help determine the best management approach. Consideration also must be given to the presence of nonpest species. In many areas, the presence of endangered species may limit your choice of control measures.

Control options vary with the pest, and for that reason it is very important to correctly identify the species that is causing the damage before implementing a management program. This can be achieved by observing the location and type of damage within the field, the pest species present, and their signs, such as feces, tracks, burrows, and mounds. For most vertebrate pests, more than one method is available to manage their populations. Table 12.1 lists control options that may be used for vertebrate pests in alfalfa. Each of these options is discussed in more detail for each species.

Biological Control

Vertebrate populations are affected most by availability of food and cover; diseases and predators play a relatively minor role. A number of predators, including hawks, owls, foxes, coyotes, and snakes, feed on some of the rodent species that are pests in alfalfa. Installing owl boxes and predator perches may help attract predators and be part of an integrated pest management program. However, predators seldom keep rodent pests from reaching damaging levels. The high reproductive rate of small rodents allows their populations to compensate for losses due to predation. Additionally, predators often modify their diets according to the relative abundance of prey species.

Development of New Control Tools

Research into development of new control methods and studies to satisfy EPA's data requirements to maintain current pesticide registrations for vertebrate pests in alfalfa are supported by the rodenticide bait surcharge program of the California Department of Food and Agriculture. Research undertaken since 1995 has investigated the efficacy and nontarget hazards of zinc phosphide for the control of meadow voles, the use of chlorophacinone for the control of pocket gophers, baiting strategies

TABLE 12.1

Control options for vertebrate pests in alfalfa

Pest	Control Method						
	Habitat modification	Trap	Fence	Frighten	Shoot	Bait	Burrow fumigation
Pocket gopher (*Thomomys* sp.)	■	■				■	■
Meadow vole (*Microtus californicus*)	■					■	
California ground squirrel (*Spermophilus beecheyi*)	■	■			■	■	■
Black-tailed jackrabbit (*Lepus californicus*)	■	■	■		■	■	
Cottontail rabbit (*Sylvilagus audubonii*)	■	■	■		■	■	
Deer (*Odocoileus hemionus*)			■	■	■		

for California ground squirrels, and management strategies for black-tailed jackrabbits.

Many innovative control methods have been proposed as being more environmentally friendly than some of the traditional approaches. When considering alternative approaches, you should remember that testimonials aren't necessarily proof of effectiveness. Check with your local farm advisor's office to determine if the technique has proven to be successful in controlled scientific tests. As an example, burrow exploding devices (e.g., Rodentorch, Rodex 4000) have gained popularity in California. These devices deliver and ignite a mixture of propane and oxygen into a burrow system. Burrowing rodents supposedly die as a result of concussion. Research has shown that these devices, at best, reduce burrowing rodent populations by about 50 percent. Because of the rapid rate at which pests can repopulate an area, 50 percent control is not sufficient to provide an economic benefit. Additionally, these devices are labor intensive to use and should not be used where there is a potential for fire.

Legal Aspects of Vertebrate Pest Management

Under the California Fish and Game Code, pocket gophers, meadow voles, California ground squirrels, black-tailed jackrabbits, and cottontails may be lethally removed at any time by the owner or tenant of a property, if they are causing, or about to cause, a crop depredation. Deer may only be lethally removed by legal hunting or under a depredation permit obtained from the California Department of Fish and Game.

Only pesticides that are registered with California's Department of Pesticide Regulation (DPR) can be used for vertebrate pest control. Registered materials are listed in DPR's database that is available online at http://www.cdpr.ca.gov/. You may also contact your County Agricultural Commissioner for information on registered materials.

In some areas, the presence of federally and state protected endangered species in and around alfalfa fields may restrict management options. Species most likely to be of concern include the San Joaquin kit fox (*Vulpes macrotus* Merriam), kangaroo rats (*Dipodomys* sp.), and the blunt-nosed leopard lizard (*Gambelia silus* Stejneger). Where these species occur, special guidelines apply to the use of toxic baits and fumigants for vertebrate control. Detailed maps that show the ranges of endangered species and that give information on restrictions on pest control activities are available from the local County Agricultural Commissioner or the University of California Cooperative Extension. Additional information may also be obtained from the DPR Web site (http://www.cdpr.ca.gov/docs/es/intro.htm).

Live traps are sometimes used for managing vertebrate pests. Under the California Fish and Game Code, it is illegal to trap and relocate an animal. Live-trapped pest animals should be humanely euthanized. Methods currently approved by the American Veterinary Medical Association (AVMA) include shooting or gassing with carbon dioxide. Drowning is not a humane method of euthanasia.

A range of strategies for managing specific vertebrate pests are discussed below in relationship to specific species.

Pocket Gophers

Pocket gophers (*Thomomys* spp.) are the most common and most destructive vertebrate pests of alfalfa in Mediterranean and desert zones of California. Because breeding is regulated by the availability of green forage, in alfalfa fields pocket gophers may breed year-round, resulting in high population densities. Pocket gophers feed primarily on the taproot of alfalfa plants, thereby weakening or killing plants, resulting in significant yield reduction. Their burrowing can cause serious problems with irrigation as well as harvesting equipment. In addition, soil mounds may kill the alfalfa plants they cover and create weed seed beds. The damage incurred by gophers to an alfalfa field causes general stand decline and is permanent. Even after gophers have been controlled, the effect of previous gopher feeding continues to reduce yields.

Pocket gophers are burrowing rodents whose name is derived from the pair of large, external, fur-lined cheek pouches in which they

can carry food and nesting material. Pocket gophers are 6–8 inches (15–20 cm) long and have bodies well adapted to an underground existence (Fig. 12.1). They are powerfully built in the forequarters, are equipped with large claws for digging, and have a short neck and a fairly small and flattened head. Gophers have small external ears, small eyes, and lips that close behind their large incisors, thereby enabling them to keep soil out of the mouth while burrowing. Gophers use their short whiskers and tails to help navigate tunnels. They seldom travel aboveground; however, they may sometimes be seen feeding or pushing dirt out of their burrow system. They are generally more active excavating soil in the spring and fall than during the heat of summer. In uncultivated and nonirrigated areas the female normally produces one litter per year during the rainy season, when green forage is plentiful. In irrigated alfalfa fields at low elevations, pocket gophers may breed year-round. Average litter size is five or six. Pocket gophers have a maximum life span of about 5 years.

Pocket gophers are very territorial and antisocial. As soon as the young are weaned, they leave their mother's burrow and establish their own territory. The burrow system can cover an area from a few hundred square feet (10–20 m^2) up to more than 1,000 square feet (93 m^2). Territories are generally smaller for younger individuals or in areas with abundant food, such as alfalfa fields. Tunnels are 2–3 inches (5–8 cm) in diameter, and most are from 8–12 inches (20–30 cm) below the ground. The nests and food storage chambers are somewhat deeper.

Tunnels are usually deeper in sandy soils than in clay soils. One gopher may create several mounds in a day (Fig. 12.2). Crescent shaped mounds of fresh soil indicate their presence. These are formed as the animals push soil out of their burrows through lateral tunnels up to the surface. They plug the burrow soon after digging it to preserve fairly constant temperatures and humidity within the burrow system. Gophers may dig secondary tunnels off the main burrow for occasional aboveground grazing. In these cases, no distinctive mounds are formed. Fresh mounds of loose, finely textured soil indicate an active pocket gopher system. Because gophers also backfill old tunnels, the number of fresh mounds is not an indication of the number of gophers in an area.

Pocket gophers generally feed inside the burrow, several inches (centimeters) to a foot (30 cm) below the soil surface. Their feeding most often damages the roots, although they also eat the crowns and stems of alfalfa plants. The animals often pull the whole plants underground into their burrows. Aboveground feeding is restricted to a small area around burrow entrances.

FIGURE 12.1

Pocket gophers seldom travel aboveground; however, they may sometimes be seen feeding or pushing dirt out of their burrow system.

FIGURE 12.2

One gopher may create several mounds in a day. Crescent-shaped mounds of fresh soil indicate their presence.

Management Guidelines

Although a healthy stand of alfalfa can tolerate some gopher feeding, large populations of pocket gophers cause serious economic damage. Where forage is available year-round in irrigated fields, gopher populations may grow significantly throughout the year. A successful pocket gopher control program depends on early detection and control measures appropriate to the location and situation. Since individual burrow systems must be treated to control gophers, the cost of control increases in proportion to the number of gophers present. Additionally, the presence of burrow systems makes it easier for other gophers to invade a field. Limiting the number of burrow systems by controlling gophers as they appear may reduce treatment costs in the long term. Because mounds are difficult to detect when alfalfa is tall, the best way to monitor a pocket gopher population in alfalfa is to check for new mounds in a field shortly after harvesting.

Most alfalfa growers rely on poison baits for gopher control. Where populations are low or in alfalfa being produced organically, traps can be used. Control efforts should be concentrated in late winter to early spring when the alfalfa is breaking dormancy and before the gophers have given birth. Pocket gophers should be controlled around the perimeters as well as within the fields to reduce the potential for population increase by invasion. 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, or rye, will greatly reduce gopher population levels.

Baits

A number of rodenticides are currently registered for pocket gopher control. Of these, the best and most widely used is strychnine, an acute poison presented on grain. Anticoagulant baits are also available but are generally less cost effective because the gopher must ingest multiple doses over time. The bait is placed in the pocket gophers' main burrow runways. Depending on the level of infestation and the area to be treated, baits may be applied either by hand or mechanically using a burrow builder.

Hand-baiting is time-consuming and is generally only undertaken when the level of infestation is low or only a small area needs to be treated. Bait is placed by using either a special hand-operated bait dispenser probe or by making an opening to the burrow system with a probe and then placing the bait. The key to the success of these methods is accurately locating the gopher's main burrow. The main burrow is generally found 8–12 inches (20–30 cm) away from the plug on fresh, fan-shaped mounds. Once this is located, a rounded tablespoon (≈15 ml) of the bait is placed in the burrow and the hole closed with a rock, clod, or some other material to exclude light and prevent soil from falling on the bait. Two or three different places in the burrow system should be treated. If gopher activity continues for more than 2 days after treatment, the burrow should be treated again. Read and follow label instructions for recommended amounts and application rates.

When the level of pocket gopher infestation is high, mechanical burrow builders (Fig. 12.3) provide the most economical method of control. The burrow builder is a tractor-drawn device that constructs an artificial burrow and deposits poison bait at preset intervals and quantities. These artificial burrows are made at depths similar to burrows created by pocket gophers and in parallel rows

FIGURE 12.3

Mechanical burrow builder for large-scale application of strychnine bait for control of pocket gophers.

spaced at 20–25-foot (6–7-m) intervals so that they may intercept many natural pocket gopher runways. The pocket gophers readily explore these artificial tunnels and consume the poisoned bait. In some situations, 0.5-percent strychnine bait will give effective pocket gopher control when applied using a burrow builder. However, where it is not giving good control, a 1.8-percent strychnine bait may give superior results. The 1.8-percent bait is not registered for hand-baiting applications.

Successful control using burrow builders depends largely on soil moisture. If the soil is too wet, the tunnel may not close and may allow sunlight to penetrate the burrow. If the soil is too dry, the burrow may collapse. Burrow builders should only be used in areas where gophers are present, not as a preventive measure. As gophers seek areas with low resistance to digging, building a burrow where gophers are not present may actually facilitate the spread of those not poisoned by the treatment.

Traps

Trapping can provide economical and satisfactory control over small areas, or remove those animals remaining after a chemical control program. It is generally more effective in spring and fall when pocket gophers are most active. Several types and brands of gopher traps are available, the more common being the two-pronged pincer trap (Macabee) and the box-type trap (Fig. 12.4). Two traps facing opposite directions are placed in the main tunnel. This placement will intercept a pocket gopher coming from either direction. The traps are wired to a stake to prevent loss of the trap. The hole made to set the traps is then covered to exclude light from the burrow system. Traps should be inspected at least twice a day and moved to a different location if 3 days elapse without catching a gopher.

Other methods

Pocket gophers can easily withstand normal irrigation, but flooding sometimes forces them out of their burrows where they become vulnerable to predation. Fumigation with smoke or gas cartridges is not effective because gophers quickly seal off their burrows when they detect smoke or gas. However, aluminum phosphide fumigation (a restricted-use material) can be effective if applied when there is ample soil moisture to retain toxic gas. Follow label instructions and all of the safety precautions. To use aluminum phosphide, first probe to find the main burrow as with hand application of bait, then insert the number of tablets prescribed by the label into the burrow and seal the probe hole. As with other control methods, you need to keep monitoring for signs of renewed gopher activity. Retreat the area if you find new mounds after 24 to 48 hours. As pocket gophers feed on the taproot of alfalfa, varieties with several large roots rather than a single taproot usually suffer less when pocket gophers feed on them. Crop rotation can also help minimize problems with pocket gophers. Grain crops provide habitat that is less

FIGURE 12.4

Box (A) and Macabee (B) traps used for trapping pocket gophers.

suitable for pocket gophers because they do not establish root systems with large underground storage structures and therefore do not provide a good source of food for pocket gophers year-round. Deep tillage when an alfalfa field is taken out of production may reduce the potential for pocket gopher problems by disrupting burrow systems.

Ground Squirrels

Ground squirrels (*Spermophilus beecheyi*) inhabit most of the Mediterranean and desert regions of California where alfalfa is grown. The California ground squirrel is a large ground squirrel with gray-brown fur mottled by light flecks, and a semi-bushy tail (Fig. 12.5). In native habitats, a squirrel consumes green foliage in spring and seeds later in the season when green foliage is no longer available. In alfalfa, however, squirrels will continue to feed on the crop throughout the year. Ground squirrels damage alfalfa by injuring stem buds and crowns as they feed on the plants, resulting in reduced growth and vigor. Because the California ground squirrel prefers to live on field edges or along fence rows or roadsides, damage due to this species is most common on field perimeters.

Unlike pocket gophers, ground squirrels are frequently visible, spending much of their time sunning, feeding, or socializing in and around fields. Burrows provide protection as well as a place to sleep and rest, rear young, and store food. The systems are not as extensive as those of pocket gophers but can be as deep as 6 feet. Ground squirrel burrows are much larger in diameter than pocket gopher burrows, and the burrow entrances are always unplugged (Fig. 12.6).

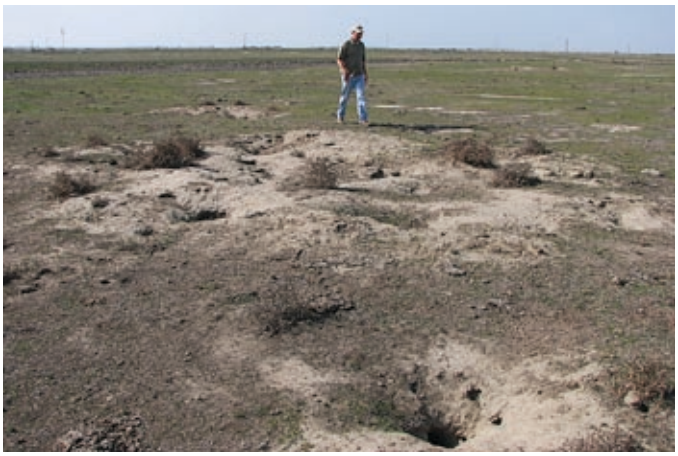
Ground squirrels are social animals and live in groups. Females have one litter per year in the spring, averaging seven to eight young. About 6 weeks after birth, the young ground squirrels emerge from the burrows and begin to graze on forage. During the hottest and driest part of the summer, many adult squirrels go into a resting state (estivation) until temperatures become more favorable in the fall. Most squirrels, especially the adults, hibernate in the winter. Because of these periods of inactivity, ground squirrel numbers may often appear to be much greater in spring and early fall than at other times of the year.

FIGURE 12.5

The California ground squirrel is a large ground squirrel with gray-brown fur mottled by light flecks, and a semi-bushy tail.

FIGURE 12.6

Ground squirrels usually burrow outside alfalfa fields but can inhabit them if the irrigation is fairly light.



Management Guidelines

Poison baits, burrow fumigants, and trapping represent the three major control options available for ground squirrels. The success of these in controlling ground squirrels varies and is largely dependent on correct timing.

Baits

Poison baits are the most commonly used control tool. The acute rodenticide zinc phosphide, and the anticoagulants diphacinone and chlorophacinone are currently registered for ground squirrel control in California. Because the baits consist of treated grains (the seeds of cereal grasses and other food plants), they are most effective in the late spring and fall when seeds are the preferred food of the ground squirrel. Grain baits are not registered for broadcast application on alfalfa fields, but may be broadcast around the field edge or provided in bait stations that are designed to contain enough bait for the required multiple feedings and to reduce the risks to nontarget wildlife.

Fumigation

Burrow fumigation can be extremely effective in controlling ground squirrels. It is most successful in the spring or after irrigating when soil moisture is high because moist soil closes up surface cracks and helps retain a high toxic level of gas in the burrow. Fumigation is not as effective during summer and winter when most ground squirrels are inactive. At these times, the squirrels plug their burrow systems behind them and aren't exposed to the gas. A number of fumigants are registered for ground squirrel control. Acrolein (Magnacide) is a restricted-use material that is injected into burrows via a dispensing rod, with nitrogen gas as the propellant. Gas cartridges (smoke bombs) and aluminum phosphide tablets (Phostoxin and Fumitoxin) are easy and relatively safe fumigants to use. Cartridges are placed in burrows that show evidence of recent squirrel activity. After the cartridge fuse has been ignited, it is pushed deep into the burrow with a shovel or stick, then the burrow entrance is plugged quickly with soil to seal in the toxic gas. Aluminum phosphide tablets, also a restricted use material, react with the atmospheric and soil moisture to produce phosphine gas. These tablets are also placed deep into the opening of each burrow, then the entrance is sealed with a wad of newspaper and tamped soil.

Traps

Trapping ground squirrels sometimes provides satisfactory control of small numbers of squirrels. A number of kill traps (e.g., Conibear trap, modified pocket gopher trap) are available.

Other methods

Shooting may also be useful in some situations, such as where population levels are low or to control survivors of other control operations. It is seldom effective when dealing with large ground squirrel populations.

Meadow Voles

Meadow voles (*Microtus* sp.), sometimes called field mice, have a mature body length of 4–6 inches (10–15 cm); heavy bodies; short legs and tail; small eyes; and small, partially hidden ears (Fig. 12.7). Their soft, dense fur is blackish to grayish brown. Meadow voles are active year-round in a variety of crops. Alfalfa provides excellent food and habitat for this pest. Meadow voles feed on all parts of the

FIGURE 12.7

Meadow voles are common but usually hide from sight.

FIGURE 12.8

Meadow vole burrows are usually open and connected by trails.

plant, foraging on stems, leaves, and seeds in the spring, summer, and fall and concentrating on a diet of roots and crowns in the winter.

Meadow voles dig short, shallow burrows and make underground nests of grass, stems, and leaves. A good indication that significant numbers of meadow voles are in the field is the presence of well-worn trails 2 inches (5 cm) wide, leading to unplugged, small entrance holes in areas of the field where foraging is evident (Fig. 12.8). These trails are most evident in late winter before the alfalfa resumes growth. Meadow voles reproduce very rapidly, and populations fluctuate considerably. A female can produce from two to five litters per year; each litter averages four or five young. Spring is the peak breeding period; a second shorter breeding period occurs in fall. A heavily infested alfalfa field may support a peak population of 1,000 to 3,000 animals per acre (405 to 1,215 per hectare).

Management Guidelines

Cultural practices that reduce vole habitat within the field as well as surrounding areas can be effective in reducing the potential for serious problems. These practices include controlling weeds; cultivating fencerows, roadsides, and ditch banks; and reducing ground cover in adjacent orchards. These areas often provide a habitat from which the meadow voles can invade an alfalfa field. The easiest time to detect populations is after harvest and raking of the field. This is also the best time to apply controls because the voles begin their spring breeding cycle shortly before or just after the alfalfa begins to grow.

Baits

Where meadow vole problems are serious, applying bait is the only effective control measure. Zinc phosphide is the only bait registered for control of meadow voles in alfalfa. It may be applied by hand to burrows and runways, or broadcast to heavily infested areas. Adjacent noncrop areas that provide habitat to meadow voles should also be treated. To minimize the potential for bait shyness and reduction in bait efficacy developing, it should not be used in the same field more than once in a 6-month period. Zinc phosphide is a restricted use material and may therefore only be applied under permit from the local County Agricultural Commissioner; local restrictions may apply.

Anticoagulant baits may not be used in alfalfa but can be applied by hand or broadcast at any time along fencerows and in surrounding noncrop areas to reduce the source of meadow voles. To be effective, anticoagulant bait must be available for meadow voles to consume over a period of several days. Bait stations are generally ineffective due to meadow vole range and behavior.

Hares and Rabbits

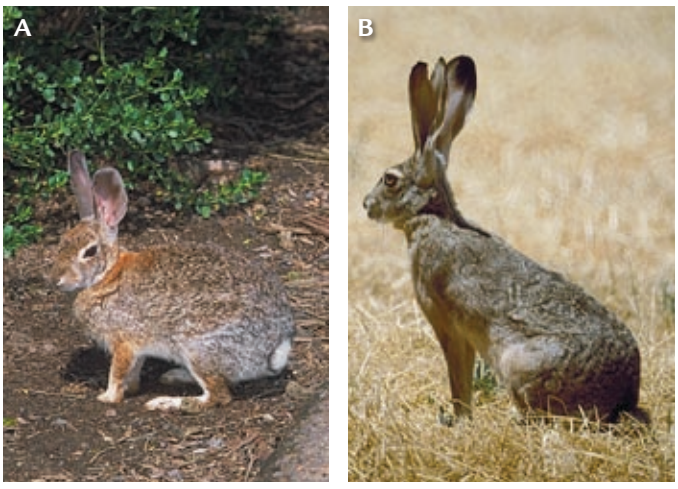
The black-tailed jackrabbit, actually a hare (*Lepus* sp.), is the most common rabbit-like pest in California alfalfa fields. The black-tailed jackrabbit has very long ears, short front legs, and long hind legs. The cottontail rabbit, a true rabbit, can be a pest in local areas. Cottontails (*Sylvilagus* sp.) are smaller than jackrabbits and have much shorter ears (Fig. 12.9). Rabbits and hares are classified as game mammals and can be taken by legal sport hunting methods during hunting seasons. Owners and tenants of agricultural lands may take hares or rabbits that cause agricultural damage at any time without a depredation permit.

Management Guidelines

Rabbits and hares are most active at night, feeding mostly at dusk and dawn. Alfalfa is

FIGURE 12.9

Cottontail rabbits (A) are smaller than jackrabbits (B) and have much shorter ears.



a favored food, and damage to plants can be significant in areas where there are large populations. A combination of methods, including exclusion and baits, may be helpful in controlling populations.

Exclusion

Fences, although expensive, are often the only effective means of minimizing damage caused by rabbits. Rabbit fences should be made out of 1-inch (2.5-cm) woven wire mesh and be at least 36 inches (90 cm) high and supported by posts. The bottom 6 inches (15 cm) of fence should be bent at a right angle away from the alfalfa field and buried 6 inches (15 cm) under the soil.

Baits

Anticoagulant baits (diphacinone and chlorophacinone) are registered for use in bait stations against rabbits and hares. Because they will not enter enclosed stations, the bait should be presented in a feeder in areas frequented by rabbits, such as runways and resting or feeding areas. Prebaiting with untreated bait may allow rabbits and hares to become accustomed to feeding from the station. Once they feed on the untreated bait (usually after 3 to 5 days) and begin to consume all untreated bait in a single night, this bait can be replaced with poison baits. Bait should be provided until all evidence of feeding has ceased. Bait stations are frequently covered during most daylight hours to exclude nontarget animals from the bait.

Shooting

Shooting may be useful in some situations for hares and rabbits, although it is quite labor intensive.

Deer

Deer may occasionally cause significant damage to alfalfa fields in areas where nearby habitats, especially wooded or brushy areas, provide cover (Fig. 12.10). Because deer are night feeders and may not be observed in fields, footprints, scat, and damage are often the first evidence of their activities.

It is illegal to use traps or poisons to control deer. Noise-making devices and lights sometimes discourage deer, but results are erratic and long-term effectiveness is unlikely. Although deer are classified as game animals, depredation permits to shoot deer out of season may be issued by local game wardens. A variety of regulations must be followed to comply with permit requirements. Deer numbers may also be reduced during the regular deer sport-hunting season, and hunting should be encouraged where deer are an ongoing problem. Deer-proof fences are costly but provide the only effective control in many situations.

Additional Reading

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FIGURE 12.10

Deer can move into an alfalfa field at night and do significant damage.

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