

Vertebrate Pest Control in Alfalfa Hay

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ABSTRACT

Pocket gophers, ground squirrels, meadow voles, rabbits, hares and deer cause significant economic damage to alfalfa. Losses result from animals feeding on the plants, and burrows causing problems with irrigation and harvest. This paper reviews the biology and management options for these pests.

Key Words: alfalfa, vertebrate pests, ground squirrels, pocket gophers, meadow mice, voles, rabbits, deer

INTRODUCTION

Alfalfa is an attractive habitat and food source to a variety of vertebrate pests. Significant reductions in yield can result from their feeding on the leaves, stems and roots of alfalfa plants. In addition, the burrows 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, meadow mice and ground squirrels are the most serious of the pest species in California alfalfa fields. However, rabbits, hares, deer 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 irrigation methods as well as the location of the field 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.

Management

The most successful approach is one that aims to manage vertebrate pest populations at levels at which significant damage never occurs. Regular monitoring of vertebrate pests in and around fields should form the basis of a management program. Historical records of pest population levels, control measures implemented, economics of control procedures and the success of the method, can be used to help determine the best management approach.

Control options vary with the pest and for that reason, it is extremely 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 animals, and animal signs such as feces, tracks, burrows and mounds.

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For most vertebrate pests, more than one method is available to manage damaging populations. Table 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.

Table 1. Control options for vertebrate pests in alfalfa.

PEST	CONTROL METHOD						
	Habitat modification	Trapping	Fencing	Frightening	Shooting	Baiting	Burow fumigation
Pocket gopher	X	X				X	X
Meadow mouse	X					X	
California ground squirrel	X	X			X	X	X
Belding's ground squirrel	X		X		X	X	X
Rabbit / Hare	X	X	X		X	X	
Deer			X	X			

Biological Control. Vertebrate populations are affected most by availability of food and cover, while diseases and predators play a relatively minor role. A number of predators including hawks, owls, foxes, coyotes and snakes feed on some of the vertebrate species that are pests in alfalfa. However, natural enemies seldom keep vertebrate pests from reaching damaging levels as a result of the high reproductive rate of small rodents that allows their populations to compensate for loss to predation, and a predator's tendency to modify its diet according to the relative abundance of prey species. So, although enhancing habitat to attract predators may be considered as a part of integrated pest management program, predators should not be relied on to provide effective control.

Development of new control tools

Research into development of new control methods, and studies to satisfy EPA's data requirements to maintain current chemical registrations for vertebrate pests in alfalfa is supported by the 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 control of meadow mice, baiting strategies using chlorophacinone for control of Belding's ground squirrels, and the use of chlorophacinone for control of pocket gophers.

POCKET GOPHERS (*Thomomys* spp.)

Pocket gophers are the most common and most destructive vertebrate pest of alfalfa. 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 seed beds for weeds. The damage incurred by gophers to an alfalfa field is permanent; even after gophers have been controlled, the effect of previous gopher feeding continues to affect 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 nest material. They are six to eight inches (15 to 20 cm) long and have bodies well adapted to an underground existence. They are powerfully built in the forequarters, are equipped with large claws for digging, 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 above ground; however they may sometimes be seen feeding or pushing dirt out of their burrow system. They use their keen sense of smell to locate food. They are generally more active excavating soil in the spring and fall than they are during the heat of summer. In uncultivated and non-irrigated 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 5 or 6. Pocket gophers have a maximum life span of about five years.

Pocket gophers are extremely territorial and antisocial. As soon as 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 feet up to more than 1000 square feet. Territories are generally smaller for younger individuals or in areas with abundant food such as alfalfa fields. Tunnels are two to three inches in diameter and most are from 8 to 12 inches below the ground, but nests and food storage chambers may be more than six 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 20 mounds per year. 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.

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

Management guidelines

While a healthy stand of alfalfa can tolerate some gopher feeding, large populations 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 of increasing populations 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. As 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 immediately or shortly after mowing.

Most alfalfa growers rely on poison baits for gopher control. Where populations are low or poisoning has been ineffective, traps may 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, rye or sudangrass 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 as 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 the burrow builder.

Hand-baiting is extremely time-consuming and is generally only undertaken when the level of infestation is low and 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 success of these methods depends on accurately locating the gopher's main burrow. The main burrow is generally found 8 to 12 inches (20 to 30.5 cm) away from the plug on fresh, fan-shaped mounds. Once this is located, 15 ml (a rounded tablespoon) of the bait is placed into 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 two 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 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 spaced at 20 to 25 foot (6 to 7.5 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% strychnine bait will give effective pocket gopher control when applied using the burrow builder. However, where it is not giving good control there is a

registered 1.8% strychnine bait that may give superior results. The 1.8% bait should not be used for hand baiting.

Successful control using this method depends largely on soil moisture. If the soil is too wet, the tunnel may not close and allow sunlight to penetrate the burrow. If the soil is too dry, the burrow may collapse. The burrow builder should only be used in areas where gophers are present, not as a preventative 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 may provide economical and satisfactory control over small areas, or to remove those animals remaining after a poisoning control program. It is generally more effective in spring and fall when pocket gophers are most active. Several types and brands of gopher trap are available, the most common of these being the two-pronged pincer trap (Macabee) and the box type trap. Two traps facing opposite directions are placed in the main tunnel. This placement will intercept a pocket gopher coming from either direction. The hole made to set the traps is then covered to exclude light from the burrow system and the traps wired to a stake to prevent loss of the trap. Traps should be inspected at least twice a day and moved to a different location if three days elapse without catching a gopher.

Other methods Fumigating burrows is generally unsatisfactory because gophers can detect the gases and quickly plug up the burrow to exclude them. Porous soils may also make it difficult to maintain a toxic concentration in the burrow system. 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. When alfalfa is rotated with grain crops, the habitat is incapable of supporting pocket gophers. The annual grains do not establish large underground storage structures and therefore do not provide sufficient food for pocket gophers year round. Flood irrigation may also reduce the potential for large populations to occur.

GROUND SQUIRRELS

(*Spermophilus beecheyi*, *Spermophilus beldingi*)

Ground squirrels occur throughout most of California where alfalfa is grown. *Spermophilus beldingi*, the Belding ground squirrel, inhabits the northeastern part of the state while various subspecies of *Spermophilus beecheyi*, the California ground squirrel, occur through most of the rest of the state.

The California ground squirrel is a large ground squirrel with gray-brown colored fur mottled by light flecks, and having a semi-bushy tail. They prefer green foliage during the spring but away from alfalfa fields, they generally eat seeds later in the season. Damage to alfalfa results from squirrels feeding on the plants and slowing plant growth from injured stem buds and crowns. Because the California ground squirrel prefers to live on field edges, along fence rows or roadsides, damage due to this species mainly occurs on field perimeters.

Belding's ground squirrel is smaller than the California ground squirrel with a stocky build, short and flat tail, and a solid brownish coat. Losses due to this species are much higher than those caused by the California ground squirrel. Belding's ground squirrels rapidly invade and colonize alfalfa fields, create extensive burrow systems within fields, and consume large amounts of alfalfa. In Butte Valley, Siskiyou County, losses of between 21% and 48% of potential yield in the first cutting were estimated over the 1995 - 1997 period. The mounds created by Belding's ground squirrels can also disrupt harvest and result in damage to harvesting equipment.

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 six feet. Ground squirrel burrows are much larger in diameter than pocket gopher burrows, and their burrow entrances are always unplugged.

Ground squirrels are social animals and live in groups. Females have one litter averaging seven to eight young, per year in the spring. About six 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. Ground squirrels also 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.

Management guidelines

Poison baits, burrow fumigants and trapping represent the three major control options available for ground squirrels. The success of these practices in controlling ground squirrels varies with species and is largely dependent on timing as a result of the life cycle of the squirrel.

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. As the baits consist of treated grains, 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; they must be used in bait stations which are designed to contain enough bait for the required multiple feedings and to reduce the risks to non-target wildlife.

Fumigation Burrow fumigation can be extremely effective in controlling both the California and Belding ground squirrel. 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 effective during periods in the summer and winter when the ground squirrels are inactive. At these times the squirrels plug their burrow systems behind them and aren't exposed to the gas. There are a number of fumigants currently registered for ground squirrel control. Acrolein (Magnacide) is the most effective fumigant for use against the Belding ground squirrel. A dispensing rod, with nitrogen gas as the propellant, injects acrolein into squirrel burrows. As acrolein is hazardous, those who use it must receive training. This

fumigant is also too costly and time-consuming to be used on older fields with high squirrel population levels. It is mostly used in young fields to keep populations at manageable levels.

Gas cartridges (smoke bombs) and aluminum phosphide (Phostoxin and Fumitoxin) are easy and relatively safe fumigants to use. They are extremely effective against California ground squirrels but only have minimal effectiveness against the Belding ground squirrel. Cold, dry soils throughout the range of this species may partially explain the poor results. In addition, the burrow system of Belding's ground squirrel is so extensive that enough toxicant may not be released into one burrow system to be lethal. Cartridges are placed in burrows that show evidence of recent squirrel activity. After the cartridge fuse has been ignited, it's pushed deep into the burrow with a shovel or stick and the burrow entrance plugged quickly with soil to seal in the toxic gas. Aluminum phosphide tablets react with the atmospheric and soil moisture to produce phosphine gas. These tablets are also placed deep into the opening of each burrow and the entrance sealed.

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

Fencing Because Belding's ground squirrels are not known to be good climbers, construction of a fence around a new alfalfa field (or along the perimeter from which invasion is likely to occur) may be a cost-effective way of reducing invasion and minimizing damage caused by this species. Research is currently being undertaken to evaluate this technique.

Other methods Deep tillage when an alfalfa field is taken out of production may aid in controlling Belding ground squirrels by disrupting burrow systems. Shooting may also be useful in some situations as where population levels are low or to control survivors of other control operations, but is seldom effective when dealing with large ground squirrel populations.

MEADOW MICE (*Microtus* spp.)

Meadow mice, also known as voles or field mice have a body length of 4 to 6 inches (10 to 15 cm) when mature, heavy bodies, short legs and tail, small eyes and small partially hidden ears. Their soft, dense fur is blackish brown to greyish brown. Meadow mice are active year round in a variety of crops. Alfalfa provides both an excellent food and habitat for this pest. Meadow mice feed on all parts of the 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.

They dig short, shallow burrows and make underground nests of grass, stems and leaves. A good indication that significant numbers of meadow mice are in the field is the presence of well-worn trails two inches (5 cm) wide leading to unplugged entrance holes, in areas of the field where foraging is evident. These trails are most evident in late winter before the alfalfa resumes growth. Meadow mice reproduce very rapidly and populations fluctuate considerably. A female can produce between two and five litters per year. An average litter contains four or five young.

Spring is the peak breeding period, a second shorter breeding period occurring in fall. A heavily infested field may support a peak population of 1000 to 3000 animals per acre.

Management Guidelines

Cultural practices that make the field and surrounding areas less favorable as meadow mouse habitat can be effective in preventing serious meadow mouse problems. These practices include controlling weeds, cultivating fence rows, roadsides and ditchbanks and reducing ground cover in adjacent orchards. These areas often provide a habitat from which the meadow mice can invade an alfalfa field.

The easiest time to detect meadow mouse populations is in the late winter or early spring when the alfalfa is still dormant. This is also the best time to apply controls because they begin their spring breeding cycle shortly before or just after the alfalfa begins to grow.

Baits Where meadow mouse problems are serious, applying bait is the only effective measure. However, no baits are currently registered for use in alfalfa during the growing season. Zinc phosphide is registered for use in alfalfa during the dormant period, and can also be used at any time of the year in non-crop areas around alfalfa fields. Bait may be applied mechanically or by hand. Anticoagulant baits may not be used at any time in alfalfa but can be applied at any time along fence rows and in surrounding non-crop areas to reduce the source of meadow mice. To be effective, bait must be available for meadow mice to consume over a period of several days.

HARES (*Lepus* spp.) and RABBITS (*Sylvilagus* spp.)

The blacktailed jackrabbit, actually a hare, is the most common rabbit-like pest in California alfalfa fields. The blacktailed jackrabbit has very long ears, short front legs and long hind legs. The cottontail, a true rabbit, is a pest in local areas. Cottontails are smaller than jackrabbits and have much shorter ears. Their populations undergo distinct cycles, reaching peak levels every five to ten years. Coyotes, bobcats and eagles are amongst the natural enemies of rabbits and hares and may have a significant impact on their populations in some areas. Rabbits and hares are classified as game mammals and can be taken by legal sport hunting methods during hunting seasons. If they follow Fish and Game Code, owners and tenants of agricultural lands may take hares or rabbits that cause agricultural damage.

Rabbits and hares are most active at night, feeding mostly at dusk and dawn. As their diet comprises green vegetation, alfalfa is therefore a favored food source and damage to plants can be significant in areas where there are large populations.

Management Guidelines

Exclusion Fences, although expensive, are often the only effective means of minimizing damage due to rabbits. Rabbit fences should be made out of one inch woven wire mesh and be at least 36 inches high and supported by posts. The bottom six inches of fence should be bent at a right angle away from the alfalfa field and buried six inches under the soil.

Baits Anticoagulant baits (Diphacinone and Chlorophacinone) are registered for use in bait stations against rabbits and hares. As they will not enter enclosed stations, the bait should be presented in a feeder in areas frequented by rabbits such as runways, 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 non-target animals from the bait.

DEER

Deer may occasionally cause significant damage to alfalfa fields in areas where nearby habitat, especially wooded or brush areas, provide cover. As 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. Shooting deer also has limited benefit. 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 should be encouraged where deer are an ongoing problem. Deer proof fences provide the only effective control in many situations but are rarely cost-effective.

ADDITIONAL READING

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