



## Rodenticides: Uses, Issues, and Nontarget Exposure

**R**odenticides are essential tools in the IPM toolbox for rodent management. Exclusion and cultural practices, such as landscape management and sanitation, are also very important tools that should be considered when managing rodent populations. However, persistent and chronic infestations often require the use of rodenticides.

Rats (Fig. 1) and mice are vectors of disease such as plague, leptospirosis, and salmonellosis. Commensal rodents are also associated with the onset of asthma and other allergies. Rats and mice can also cause structur-

al damage through burrowing (mostly Norway rats) and by gnawing on wires, gas lines, and similar materials.

In residential environments, there are huge amounts of food available for rodents, making it difficult to attract rodents to traps using food. This practical challenge, coupled with the fact that rats can be extremely neophobic (afraid of new things), sometimes makes rodents difficult to manage using traps alone.

Rodenticides are generally used for quick “knockdown” of rodent populations in order to reduce exposure to disease and allergens, and to mitigate damage to crops and structures. One problem, however, is that rodenticides may negatively impact the environment. For instance, anticoagulant rodenticides (Table 1) are sometimes

found within the tissues of nontarget wildlife.

Toxicants, particularly second-generation anticoagulant rodenticides (SGARs), can persist in rodent livers. Then, when the rodents are consumed by predators, the SGARs can be detected as residues in the livers of these predators. Predators may experience sub-lethal effects of rodenticide poisoning (the animal’s health may be affected but they do not die) in this way, but the effects on many animal species to this type of exposure is not well understood.

Assembly Bill 1687, California Natural Predator Protection Act, has been proposed to protect predators from rodenticide poisoning. It seeks to ban the application of the active ingredients in Table 1 in many situations in

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Figure 1. Roof rat.

**Table 1. Active ingredients in rodenticides used in California.**

Active Ingredient	Rodenticide class
Chlorphacinone Diphacinone Warfarin	1st-generation anticoagulant
Brodifacoum Bromadiolone Difenacoum Difethialone	2nd generation anticoagulant*
Bromethalin Cholecalciferol	Non-anticoagulant rodenticide

\*All 2nd generation anticoagulants are considered restricted use pesticides and therefore can only be purchased and applied by a licensed applicator.

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residential areas. The products listed in Table 1 contain both anticoagulant rodenticides and other rodenticides. In order to use rodenticides carefully and effectively, it is critical that pest management professionals (PMPs) and residents alike apply all rodenticides in tamper-resistant bait stations (Fig. 2) and according to label guidelines. It is important for PMPs to consider the mode of action of a rodenticide bait, its toxicity, and when and where its use may be necessary. PMPs must especially consider the en-

vironmental implications of rodenticide use. Remember that rodenticides are only one part of an effective rodent management program.

For information about identifying and managing commensal rodents, see the UC IPM Pest Notes titled [Rats](#) and [House Mouse](#).

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Figure 2. Rodenticide bait station placed along exterior wall. These stations can also house snap traps instead of a rodenticide.

## Upcoming Events



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**Vertebrate Pest Conference**  
Rohnert Park, CA  
February 26-March 1, 2018  
[www.vpconference.org](http://www.vpconference.org)

**West Coast Rodent Academy**  
Irvine, CA  
March 13-15, 2018  
For more information, email [rodentacademy@ucanr.edu](mailto:rodentacademy@ucanr.edu)

**2018 UCR Urban Pest Management Conference**  
Riverside, CA  
March 21, 2018  
[ucanr.edu/sites/ucurbanpest/Conferences/UCR\\_UPMC\\_2018](http://ucanr.edu/sites/ucurbanpest/Conferences/UCR_UPMC_2018)

## Ask the Expert!

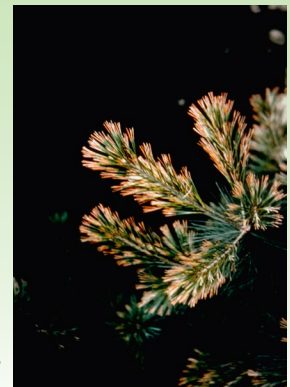
**Q: Can residents in California still legally apply all rodenticides?**

**A:** No. As of July 1, 2014, all second-generation anticoagulant rodenticides (SGAR) were restricted and can now only be applied by those who hold a current pesticide applicator license in California. These rodenticides are only registered for use in and around man-made structures. For more information, see [wildlife.ca.gov/living-with-wildlife/rodenticides](http://wildlife.ca.gov/living-with-wildlife/rodenticides).

**Q: Can air pollution cause problems in landscape trees?**

**A:** Although air pollution has declined in urban areas of California over the past two decades due largely to enhanced vehicle emission standards, ozone and sulfur dioxide sensitive trees continue to be impacted. Ozone damage appears in the form of mottling, chlorosis, spots, and bleaching of young leaves. Sensitive tree species include *Cercis canadensis* (redbud) and *Liquidambar styraciflua* (sweet gum). Symptoms of sulfur dioxide damage include bleached or tan necrotic areas between veins on young broadleaf leaves and brown tips on conifers (particularly pines).

Read more about this environmental disorder on the UC IPM Air Pollution on plants page: [ipm.ucanr.edu/PMG/GARDEN/ENVIRON/airpol.html](http://ipm.ucanr.edu/PMG/GARDEN/ENVIRON/airpol.html).



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# Common Abiotic Disorders Impacting Landscape Trees

In many cases, damage due to abiotic disorders in the landscape are under-diagnosed or overlooked. The reality is that most problems observed in landscape trees are the result of abiotic (non-living) disorders rather than biotic (living) factors such as plant pathogens, insects, nematodes, or animal pests. Some misdiagnosis occurs because damage caused by abiotic disorders and biotic agents can mimic one another. Discolored foliage, for instance, may be due to drought stress, a fungal pathogen, a nutrient toxicity or deficiency, or any of a number of other common conditions.

## Diagnosing Problems

When diagnosing plant problems, carefully consider all possible factors and consider the landscape as a whole. Are the symptoms exhibited by a single species or by a wide array of multiple species? Usually, uniform damage to multiple species, especially when limited to a single area of the landscape, points to one or more abiotic factors.

Damage from many pest insects and diseases is often restricted to a single plant species (at least initially), whereas chemical toxicities from poor water quality or overfertilization tend to cause general decline across several species.

Note any change in the plant maintenance regimen such as irrigation, fertilizer, pruning, climate, and grade changes or construction activities impacting the site. Be aware that trees previously weakened by abiotic or biotic disorders may have increased susceptibility to further damage and decline than unstressed, healthy plants. In some cases, a wide array of abiotic and biotic symptoms may coexist, making identification difficult.

In some cases, biotic injury may be obvious and abiotic disorders can be

ruled out. An example is the tell-tale white spots resembling powder on leaves and stems caused by powdery mildew.

## Alkaline Soils

California soils tend to be alkaline (average pH ranges from 7.1–7.6), which often results in nutrients such as iron, zinc, and manganese being tied up in the soil and unavailable for uptake by the plant, even though no true deficiency exists (Fig. 1). This reveals the importance of requesting a soil pH test when ordering standard nutrient analyses. Once the pH has been reduced, these important micronutrients can be taken up by the tree. Applying sulfur to soils directly or within a fertilizer that contains ammonium sulfate can reduce alkalinity over time, remedying the associated symptoms. Adding gypsum, which contains sulfur, can also reduce alkalinity. Unfortunately, there is no remedy for calcareous soils and soils irrigated with water containing calcium carbonate. When opportunities arise to plant new trees, consider selecting species more tolerant of high pH soils.

## Too Little or Too Much Water

Inadequate water can negatively impact all plants, including drought resistant species, until they are established. Significant wilting and dieback often occur in newly planted container plants when roots are allowed to dry out too much between irrigation events. If not corrected, such plants will eventually die. Established plants that have moderate to high evapotranspiration rates may also suffer from a lack of water, resulting in leaf scorch and defoliation in addition to wilt. Over time, they will succumb to stunted growth, significant stem and branch die-back (particularly in upper limbs), and eventual death.



Figure 1. Iron deficiency on azalea.



Figure 2. Limb dieback and sparse canopy caused by overwatering.

Many established landscape plants suffer from too much water rather than not enough (Fig. 2). As woody plants age, they should be irrigated more deeply and less often than when they were initially planted and establishing their root systems. Low oxygen levels insufficient for plant growth and development may occur in saturated, poorly drained soils such as clay loams.

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Figure 3. Grade changes from construction can result in major root system injury.

Outbreaks of insect pests such as certain bark beetles can quickly infest stressed, water-deficient trees. Because drought-stressed trees cannot recover from wounds as quickly as healthy trees, pathogens causing several canker diseases are often common during and after drought conditions.

## Soil Compaction, Poor Aeration

Another common problem faced routinely by arborists and landscapers is compacted soils with poor structure and drainage. Soil compaction often results from heavy equipment and machinery pressing down on the soil surface; even heavy foot traffic can significantly compact soils over time. The condition worsens under soils with high moisture content. Compacted soils have low water infiltration and permeability rates, reducing pore space once filled with air. Compacted soils can severely restrict root growth of nearby trees.

Acute symptoms associated with soil compaction may include wilting and leaf drop. Over time, leaf chlorosis and necrosis, cankers, additional leaf drop, and canopy thinning occurs and entire branches may die. Under anaerobic conditions, soil may smell like rotten eggs and darken in color.

Preventive measures include limiting construction traffic around landscape sites as well as the addition of surface

barriers. Foot traffic should be kept to a minimum, using defined pathways. It is imperative that trees be protected during nearby construction. Damage from heavy equipment may be irreversible. Consider using double, overlapping sheets of plywood to protect the soil surface if the use of heavy equipment is unavoidable. Additionally, a three-inch layer of mulch can reduce soil compaction.

## Change in Soil Grade

Grade changes from construction activities should be kept at least ten feet away from trees. Even small changes in grade can result in major root system injury (Fig. 3). As little as four to six inches of soil applied on top of a root zone of a mature tree can dramatically reduce the amount of oxygen available to tree roots and result in root mortality and sometimes even tree death. Symptoms include stunting, slow or reduced tree growth, and eventually, extensive dieback. Mature, established trees are more at risk than younger or newly planted trees. Lowering the grade is also not recommended, because it can cause lower trunk and root injury, and reduces the nutrient and moisture supply to the roots.

When possible, preventing abiotic disorders is key for keeping plants healthy. Reduce the chance of damage from abiotic disorders by selecting healthy plants that are well suited to the climate and microclimate; incorporating recommended planting techniques; providing a soil environment that optimizes a healthy root system; and implementing sound cultural management practices (irrigation, fertilization, pruning, aeration, etc.).

## Heat Stress

Heat stress often occurs when a tree is planted in a climate zone with higher summer temperatures than those to which the tree is adapted. Over time, high air and soil temperatures lead

to irreversible damage. In some cases, trees well adapted to an inland or desert climate can become stressed and die under temperatures they would normally endure if a water deficit develops.

Keep in mind that heat islands created by dark surfaces such as asphalt parking lots can increase temperatures around tree plantings between 5–25°F. Even light-colored rock mulches can increase soil temperatures enough to cause damage.

## Pesticide Damage

When applied improperly, some pesticides can result in serious damage to untargeted, desirable plants (Fig. 4). Twisted, curled foliage, distorted stems, and leaf damage can occur days to weeks after an improper herbicide application. New plant growth is especially sensitive. This type of plant injury often occurs as the result of drift from herbicides containing 2,4-D applied on windy days. Damage can also occur as a result of spraying wettable sulfur or horticultural oil when temperatures exceed 90°F.

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Figure 4. Glyphosate herbicide damage to a landscape rose.

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## Planting Considerations

Circled tree roots can lead to stressed trees that can topple under wind speeds that would not lead to failure otherwise. Circled roots can occur when trees are left too long in containers; trees are planted in too small of planting hole; or, trees planted in an otherwise large enough hole and filled just with compost. In this last case, roots will often prefer the higher quality compost to the surrounding native soil and may never expand horizontally. Do not add soil amendments; gently notch the outside edge of the planting hole and return removed soil back into the hole. Don't accept nursery stock with circled roots. Plant container stock at the same depth but in holes at least 2-½ times the width of the pot. Planting a tree too deeply can lead to perpetually dry deeper roots while subjecting surface roots to crown rot.

## Mechanical Injury

Mechanical injury to trees can result in major injury, sometimes leading to death. Often, damage from tight, unremoved staking ties extends into the vascular system of the trunk, cutting off the flow of water and nutrients (Fig. 5). Early symptoms include wilting, stunting, and general tree decline. Bark can also be damaged from mowers and string trimmers, potentially providing an entryway for fungal diseases. Avoid trunk injury since damaged bark cannot be repaired.

## Salt Build-up from Overfertilization and/or use of Recycled Water

Damage due to excessive fertilizer application or irrigation with water high in certain ions appears as marginal

leaf browning or leaf scorch. With increasing numbers of landscapes being irrigated with recycled water comes the need for routine leaching.

Salt damage can result in injury and even death of sensitive plants. Soils usually contain water-soluble salts, many of which are necessary for plant growth and development. However, high concentrations of chlorides, sulfates, and nitrates of calcium, magnesium, sodium and potassium can harm a wide variety of landscape plants. Because trees store food reserves in roots, they do not require nutrients immediately after transplanting. In general, woody plants benefit from a fertilizer ratio (nitrogen, phosphorus and potassium [N-P-K]) ratio of 3-1-2 or 4-1-2. Unless symptoms of nitrogen deficiency occur, mature landscape trees should not be fertilized with more than 0.25 lb/actual N per inch of trunk circumference per fertilization event.

Soils containing excessive levels of exchangeable sodium are referred to as sodic or alkali soils. They contain a high concentration of sodium as compared to calcium and magnesium, causing fine and medium textured soils to lose aggregated structure and become impervious to air and water. Sodic soils can also be toxic to sensitive plants. It is important to note that salts can be absorbed by foliage from ocean spray and sprinkler irrigation in addition to root uptake. Symptoms of root-absorbed toxicities initially include stunting and chlorosis. These symptoms may be followed by foliar necrosis and defoliation. Older leaf edges and tips are generally the most symptomatic. Another visual diagnostic sign is the presence of a white or black crust on the soil surface.

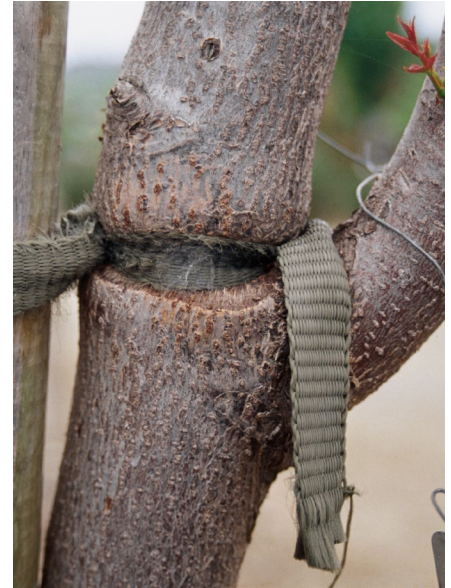


Figure 5. Girdling damage from staking ties left in place for too long.

Saline soils can be remedied by leaching salts below the root zone. When the irrigation water is more saline than most plants will tolerate, less sensitive species should be selected. No amount of leaching using the original source of saline water will correct a salt problem.

For more detailed information, see the UC ANR publication, [Abiotic Disorders of Landscape Plants: A Diagnostic Guide](#).

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**WHAT IS IPM?** Integrated Pest Management (IPM) programs focus on long-term prevention of pests or their damage through a combination of techniques including resistant plant varieties, biological control, physical or mechanical control, and modification of gardening and home maintenance practices to reduce conditions favorable for pests. Pesticides are part of IPM programs but are used only when needed. Products are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.

# New Invasive Plants Resources

Invasive plants—plants that can disperse, establish, and spread without human assistance or disturbance—pose a serious problem in California's waterways, wildlands, and rangelands. These plants thrive outside of cultivation, unlike common garden weeds.

Characteristics that make a plant successful as a landscape ornamental, such as ease of propagation and rapid growth, can also lead to invasiveness. Many invasive plants that are established in California wildlands were intentionally introduced as ornamentals from the nursery industry. Invasive plants that were originally introduced as desirable ornamentals include pampasgrass, big periwinkle, and water hyacinth. Dyer's woad, once a valuable dye plant, now threatens rangeland in Northern California and other parts of the western United States.

Impacts from invasive plants include economic costs as well as ecological damage. Economic impacts from invasive plants include blocked streams, canals, and other waterways, as seen from *Arundo donax* (Giant reed) and other aquatic weeds, decline in livestock forage quality and quantity, and lowered land value. From an ecological aspect, invasive plants can lead to increased wildfire and flood danger, change in soil fertility or salinity, reduction in biodiversity, and threats to endangered species habitat.

Find out more about invasive plants, including management strategies and how to limit the introduction of invasive plants, in two recently revised UC IPM *Pest Notes: Invasive Plants* by Joe DiTomaso and Cheryl Wilen, and *Pest Notes: Woody Weed Invaders* by Joe DiTomaso and Guy Kyser. The



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*Dyer's woad plant in bloom.*

emerging invasive weed dyer's woad is detailed in the new *Pest Notes: Dyer's Woad* by James Stapleton and the late Steve Orloff, published in August 2017.

## New and Revised Pest Notes



Pest Notes have a new look! Visit UC IPM's Pest Notes web page, [ipm.ucanr.edu/PMG/PESTNOTES](http://ipm.ucanr.edu/PMG/PESTNOTES). New and revised titles include:

**Invasive Plants** was updated in June 2017 and contains information about new and emerging invasive species. [ipm.ucanr.edu/PMG/PESTNOTES/pn74139.html](http://ipm.ucanr.edu/PMG/PESTNOTES/pn74139.html).

**Woody Weed Invaders**, updated in July 2017, covers difficult-to-control weeds like poison oak. [ipm.ucanr.edu/PMG/PESTNOTES/pn74142.html](http://ipm.ucanr.edu/PMG/PESTNOTES/pn74142.html).

**Dyer's Woad**. This brand new Pest Notes, published in August 2017, features an emerging invasive weed and is available online at [ipm.ucanr.edu/PMG/PESTNOTES/pn74175.html](http://ipm.ucanr.edu/PMG/PESTNOTES/pn74175.html).

**Redhumped Caterpillar** was updated in December 2017 with new management recommendations. [ipm.ucanr.edu/PMG/PESTNOTES/pn7474.html](http://ipm.ucanr.edu/PMG/PESTNOTES/pn7474.html).

## Pests in the Urban Landscape

[ucanr.edu/blogs/ucipmurbanpests](http://ucanr.edu/blogs/ucipmurbanpests)

### University of California Statewide Integrated Pest Management Program



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**Always read and carefully follow all precautions and safety instructions provided on the pesticide container label, as well as any other regulations regarding the use of pesticides. Not following label directions, even if they conflict with information provided herein, is a violation of state and federal law. No endorsements of named products are intended, nor is criticism implied of products not mentioned.**