

# **Appendix B: Pest Factsheets**

# **Pest Factsheets for Landscapes**

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# ANNUAL BLUEGRASS

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*Integrated Pest Management for Home Gardeners and Landscape Professionals*

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Annual bluegrass, *Poa annua*, (Figure 1) is one of the most common weeds of residential and commercial turfgrass, ornamental plantings, and gardens in the United States. It is native to Europe but is distributed worldwide. Commonly referred to as “Poa,” it is a particular problem in golf course greens and fairways, but it can also be a troublesome weed in vegetable and agronomic crops grown in cool climates. Though present in tree and vine crops in California, it usually isn’t a significant problem. The genus *Poa* consists of about 200 species worldwide. Their typical boat-shaped leaf tips (Figure 2), which curve up like the bow of a boat, are a distinguishing characteristic of the genus.

Three members of the genus *Poa* are commonly found in turfgrass sites in California. Kentucky bluegrass, *P. pratensis*, is a common cool-season turf species that is well adapted to cool, well-watered sites such as coastal and intermountain areas. Rough bluegrass, *P. trivialis*, is a less desirable turf species that does well in moist, shaded areas but lacks heat and drought tolerance, so it is short-lived and is generally considered a weed. Annual bluegrass is a weed species that, unlike Kentucky and rough bluegrass, is able to survive low mowing heights of less than 1 inch and still reseed. A fourth species, bulbous bluegrass, *P. bulbosus*, is sometimes found as a weed in Northern California turfgrass.

## IDENTIFICATION AND LIFE CYCLE

Annual bluegrass is a misnomer because there are two plant types of annual bluegrass—a true annual, *P. annua* var. *annua*, and a perennial type, *P. annua* var. *reptans*. While the two types aren’t easy to distinguish from



Figure 1. Annual bluegrass.



Figure 2. Annual bluegrass leaf tip.

each other, the annual type is more upright in its growth habit and produces more seed than the lower-growing perennial type. The annual type also tends to produce a higher percentage of dormant seed. The perennial type produces seed that germinates readily under optimum conditions. Depending on the site, there might be a predominance of one type or a mixture of both. The perennial type is common in such sites as golf course greens, while the annual type tends to be more common in lawns and parkways, although both types can be found in either of these situations.

Annual bluegrass is a cool-season grass weed that starts germinating in late summer or fall as soil temperatures fall below 70°F (Figure 3). It continues to germinate throughout winter, allowing several flushes of germination at any one site throughout the season. An-



Figure 3. Annual bluegrass seedling.



Figure 4. Leaf blades that are crinkled part way down are a key characteristic of annual bluegrass.

nual bluegrass grows 6 to 8 inches high when left unmowed. It has light green flattened stems that are bent at the base and often rooted at the lower stem joint. Leaf blades are often crinkled part way down (Figure 4) and vary from 1 to 3 inches long with typical *Poa* boat-shaped leaf tips. The inflorescence (flowering structure) has branched seed clusters (panicles) that are 1 to 4 inches long (Figure 5). Seed clusters, also called seed heads, (Figure 6) can form as soon as plants are six weeks old; although this can occur from early fall through early summer, most seed heads are formed in spring.

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## PEST NOTES

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The annual form of annual bluegrass is a rapid and prolific seeder. Each small plant can produce about 100 seeds in as few as eight weeks. Viable seed can be produced just a few days after pollination, which allows the plant to reseed even in frequently mowed turf. The small seed is amber colored and about 1/16 inch long.

Annual bluegrass has a fairly weak and shallow root system and needs frequent rainfall or irrigation to survive. It grows well in moist areas in partial shade to full sun and tolerates compacted soil conditions. In coastal regions or in moderate temperature areas where turf is frequently irrigated, annual bluegrass can persist all year. In warmer areas, it usually dies in summer.

### IMPACT

Annual bluegrass can be a major weed problem in home lawns and is a continual nuisance for turf and landscape managers. Because it is a grass weed growing in turfgrass, selectively removing it is very challenging. In turf it forms a weak sod that provides poor footing for athletic fields and golf courses. In addition, unsightly seed heads of annual bluegrass reduce the aesthetic quality of the turf and disrupt the smooth rolling surface of putting greens.

Because of its winter growth habit, it is more competitive than warm-season turf cultivars (e.g., common and hybrid bermudagrass, buffalograss, St. Augustinegrass, and zoysiagrass) during the cool season. This accounts for the severity of annual bluegrass invasions during winter. Although annual bluegrass can be a problem in all turf species, it visually blends into many cool-season turf species (e.g., Kentucky bluegrass, tall fescue, and perennial ryegrass) and is most obvious in closely mowed species, such as bentgrass and bermudagrass, especially the dwarf hybrids. In cool seasons, annual bluegrass grows faster than warm-season turf cultivars, which gives infested turf an undulating or irregular surface in as little as two days after mowing.

When annual bluegrass infests ornamental plantings, it forms a dense mat that lowers the vigor of desirable landscape plants by reducing available nutrients in the soil surface. In established woody shrubs and trees, annual bluegrass probably has little detrimental effect but can be aesthetically distracting.

Once a few annual bluegrass plants become established in turf or ornamental areas, spread can be rapid because of its prolific and rapid seed production. Mowing, foot traffic, birds, and cultivation all spread seed.

### MANAGEMENT

A primary method of control is preventing new infestations. Maintenance gardeners frequently spread weeds from site to site when weed seeds contaminate mowers, string trimmers, and aerifiers. Cleaning landscape equipment after use in infested sites can help prevent annual bluegrass from spreading to uninfested areas.

If solitary plants of annual bluegrass are found, they should be removed before seed production starts. Isolate small areas of infestation until control can be accomplished. Hand pulling or hoeing to remove annual bluegrass can be effective as long as it is done frequently. Because dense seedling infestations are common, open areas where old plants have been removed will often have new flushes of seedling plants, hence the need for frequent attention. Controlling annual bluegrass infestations manually is very expensive in commercially maintained landscapes and usually not practical or successful. However, it can be very appropriate for home gardeners.

Maintaining turf and ornamental areas properly assures their maximum vigor, which helps these plantings become as competitive as possible and slows invasion of the weed. A dense sward of turf and closely spaced ornamentals shade the soil surface and make the establishment of annual bluegrass seedlings more difficult.



Figure 5. The annual bluegrass inflorescence is branched with three to eight flattened florets in each spikelet.



Figure 6. Annual bluegrass inflorescence emerging from the leaf sheath.

### Turfgrass

No single control procedure has been successful in controlling annual bluegrass in turfgrass. Early removal of solitary infestations has been successful when practiced diligently. Open spots should be overseeded to establish a vigorous turfgrass. Removal of grass clippings might help reduce the number of seeds that reach the soil.

Overwatering, especially in shady areas, will predispose turfgrass to an



nual bluegrass invasion. Use deep and infrequent irrigation to discourage the development of shallow-rooted annual bluegrass. Try withholding water until the desirable turf is beginning to show drought stress, rather than keeping the surface moist. Avoid fertilization and don't aerate turf during the peak of annual bluegrass germination. Also, avoid cultural practices as well as use patterns that tend to promote soil compaction.

Preemergent herbicides such as benefin, bensulide, dithiopyr, oryzalin, oxadiazon, pendimethalin, and prodiamine and their combinations such as benefin/oryzalin have been very successful in limiting germination of annual bluegrass. They should be applied a few weeks before weed seeds germinate to be most effective, as they have no effect on emerged plants (Table 1). Ethofumesate and pronamide are also available for preemergent use and have some post-emergent activity on both varieties of *Poa annua*, but these herbicides can't be used in all turf species. Although most of these products may be used on residential lawns, some of the products aren't available for homeowner purchase and can be applied only by commercial applicators. To limit bluegrass germination during winter, apply preemergent herbicides in late summer or early fall when soil temperatures drop below 70°F. Where the perennial type is a large component of the bluegrass population, pre-emergent herbicides will be of little or no benefit.

There are a few relatively new post-emergent herbicides that control annual bluegrass, and none of them can be used in all turf species. They are usually applied to warm-season turfgrass species. These herbicides can be used on residential lawns by licensed or certified applicators, but they have been of little benefit when used as the sole method of control. Foramsulfuron, sulfosulfuron, and trifloxysulfuron can be used only on warm-season turfgrass species. Ethofumesate can be used in dormant bermudagrass, creeping bentgrass, Kentucky bluegrass, tall fescue,

Table 1. Summary of Herbicides for Annual Bluegrass Control.

Herbicide	Trade name	Applied to lawns?	Applied on ornamentals?	Available to home gardeners?
<b>Preemergents—apply before weed seeds germinate</b>				
benefin	Balan 2.5 G	yes	yes	no
benefin/oryzalin	Amaze Grass & Weed Preventer, XL 2G, Primera One OB-2G	yes	yes	yes
benefin/trifluralin	Team	no	yes	no
bensulide	Bensumec, Pre-San	yes	no	yes
dithiopyr	Dimension, Preen Southern Weed Preventer	yes	yes	yes
ethofumesate	Poa Constrictor	yes	no	no
oryzalin	Surflan, Weed Impede	yes	yes	yes
oxadiazon	Ronstar	yes	yes	no
pendimethalin	Pendulum, Pre M, Scotts Halts	yes	yes	turf only
pendimethalin/dimethenamid	Freehand	no	yes	no
prodiamine	Barricade	yes	yes	yes
pronamide	Kerb	yes	no	no
trifluralin	Vegetable & Ornamental Weeder, Preen Garden Weed Preventer, Treflan	no	yes	yes
<b>Postemergents—apply to young weeds</b>				
clethodim	Envoy	no	yes	no
ethofumesate	Poa Constrictor	yes	no	no
foramsulfuron	Revolver	yes	no	no
pronamide	Kerb	yes	no	no
sulfosulfuron	Certainty	yes	no	no
trifloxysulfuron	Monument	yes	no	no
<b>Nonselective postemergents—apply to weeds (will kill turf and ornamentals)</b>				
diquat	Diquat, Reward	n/a	n/a	yes
glufosinate	Finale	n/a	n/a	no
glyphosate	Roundup, Kleenup, Remuda, etc.	n/a	n/a	yes
nonanoic acid	Scythe	n/a	n/a	yes

perennial ryegrass, and St. Augustine to reduce annual bluegrass infestations. Pronamide can be used in warm-season turfgrass for established annual bluegrass, but it is slow acting (15 to 21 days).

Annual bluegrass infestations often become so severe in commercial turfgrass that complete renovation is necessary. This can be done by spraying the entire area with a nonselective herbicide such as glyphosate followed

by replanting with a desirable turf species. Planting and establishment of the new turfgrass should take place during late spring and summer so that a solid cover of new turf can be obtained before the annual bluegrass germination period. Choose a species and variety that will compete well with bluegrass. Then preemergent herbicides can be used in late summer or fall to further limit annual bluegrass from establishing.



## Ornamentals

Annual bluegrass can be controlled by various methods in ornamental plantings. Preventing germination and seeding is very important. Hand removal or spot spraying of solitary plants will save time and money in the long run. Cultivation or hand hoeing, although possible under some circumstances, generally isn't useful unless continued throughout the germination period because seed that is buried in the soil is brought to the surface where it germinates.

Mulching with landscape fabrics can be effective if the fabric is overlapped so no light is allowed to reach the soil. Use a polypropylene or polyester fabric or use a black polyethylene (plastic tarp) to block all plant growth. Plant-derived products (i.e., organic mulches) or rock can be used over the top of the synthetic fabrics.

When used alone, plant-derived products should be 2 to 3 inches thick, depending on the coarseness of the mulch. Finer materials can be less thick than coarser ones. If seeds of annual bluegrass get into the mulch, they can germinate and establish, just as if they were in soil. In these cases annual bluegrass plants can be easily removed by hand or with a hoe. Mulch thickness will need to be replenished periodically to maintain cover and eliminate light penetration to the soil.

Preemergent herbicides such as dithiopyr, oryzalin, oxadiazon, pendimethalin, prodiamine, and trifluralin or a combination such as benefin/oryzalin, benefin/trifluralin, or pendimethalin/dimethenamid can be used to limit seedling germination in sites where use of these materials is permitted (Table 1). Some of these products may be available only to commercial applicators. Make the application before seeds germinate in fall when soil temperatures go below 70°F. Preemergent herbicides will be of little benefit if established annual bluegrass plants or the perennial type of bluegrass is already present. However, if the existing bluegrass is removed, a preemergent herbicide can be applied to control seedlings that germinate later.

Few postemergent herbicides are registered for use in established ornamental

plantings. Clethodim, fluazifop, and sethoxydim are selective for grass weeds and safe on broadleaf ornamentals, but only clethodim has any effect on annual bluegrass. Spot treatment with diquat, glufosinate, glyphosate, nonanoic acid, or other nonselective herbicides can reduce annual bluegrass populations in ornamental beds, but extreme care is needed to prevent herbicide spray or drift onto desirable plants, or the herbicides will injure the plants. Clethodim and glufosinate are available only to licensed applicators at this time.

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Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original, labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Pesticides applied in your home and landscape can move and contaminate creeks, rivers, and oceans. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash or pour pesticides down the sink or toilet. Either use the pesticide according to the label, or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Household Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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*Arundo donax* L.

## Giant reed

**Family:** Poaceae

**Range:** Southern region of the U.S. In the west it can be found in California, Nevada, Utah, Arizona, New Mexico, and Texas.

**Habitat:** Riparian areas, floodplains, ditches, typically on sites with a low slope. Occurs in a wide range of soil types, but grows best in well-drained moist soils. Tolerates some salinity and extended periods of drought. Does not survive in areas with prolonged or regular periods of freezing temperatures.

**Origin:** Native to the Mediterranean region and tropical Asia. In California from the late 1700s to early 1800s, giant reed was often planted for erosion control in flood channels and as wind breaks. Since then it has been cultivated as an ornamental and to produce reeds for woodwind instruments. It is now a leading candidate for cellulosic biofuel production.

**Impacts:** Giant reed is primarily a problem in riparian corridors. It develops dense stands which often displace native vegetation, diminish wildlife habitat, and increase flooding and siltation in natural areas. Giant reed is also adapted to a periodic fire regime. The canes are readily flammable throughout much of the year, and the presence of giant reed increases the susceptibility of riparian corridors to fire. Large stands of giant reed can increase water loss from underground aquifers in semi-arid regions due to a high evapotranspiration rate. The rate of water loss is estimated at roughly three times more than that of the native riparian vegetation. It is also an alternate host for beet western yellows virus, sugarcane mosaic virus, and maize dwarf mosaic virus.

**Western states listed as Noxious Weed:** California

**California Invasive Plant Council (Cal-IPC) Inventory:** High Invasiveness



Giant reed is a bamboo-like perennial to 25 ft tall, with thick, well-developed rhizomes. Although plants are typically terrestrial, they can tolerate periodic flooding. The canes are erect, semi-woody, and about 1 to 2 inches thick. First year green canes have unbranched stems the same diameter as older canes, but more pliable. Older canes are often branched, sometimes with leaves only on the branches. The blades are less than 3 ft long and 1 to 3 inches wide. The ligules consist of a short, even, minutely fringed membrane about 1 to 2 mm long. The auricles and collar region are distinctly pale yellowish-green. The rhizomes are creeping, thick, scaly, often forming a dense network, firm and knotty at the stem bases. Rhizome and stem fragments with a node can develop into a new plant under suitable conditions.

Inflorescences consist of large terminal plume-like panicles, 1 to 2 ft long, and silvery cream-colored to purplish or brown. Giant reed does not appear to produce viable seed in North America, although some Asian populations produce viable seed. Plants reproduce only vegetatively from rhizomes and rhizome and stem fragments; and stem and rhizome fragments generally disperse with water, mud, and human activities.

### NON-CHEMICAL CONTROL

**Mechanical**  
(pulling, cutting,  
disking)

Minor infestations can be eradicated by manual methods, especially where sensitive native plants and wildlife might be damaged by other methods. Plants less than 6 ft in height and arising from a new stem or rhizome fragment can be hand pulled. This may be most effective in loose soils and after rains have loosened the substrate. Giant reed can also be dug using hand tools, particularly when used in combination with cutting near the base of the plant.

Chopping, cutting or mowing (rotary brush cutter, chainsaw, or tractor-mounted mower) can also be used to reduce giant reed infestations, although the fibrous nature of giant reed makes using these techniques difficult. Such methods usually require tractor-mounted equipment, but on rough or rocky soils scythes can be used for smaller patches. These methods generally cause less soil disturbance compared to heavy equipment. However, they are nonselective and may damage other desirable species or open up new niches for weedy invasions. These methods usually require several cuttings before the underground parts exhaust their reserve food supply, and larger giant reed patches will have enough reserves to resprout even after years of treatment. The best timing for cutting is when the plants begin to flower, as this is when the reserve energy supply in the rhizomes is lowest.

Mechanical methods using mechanized equipment (e.g., backhoe) to remove above-ground vegetation is a



common non-chemical control method for giant reed. However, such equipment is also nonselective and can only be used on accessible terrain. Most mechanical equipment is not safe to operate on slopes over 30%. It is also of limited use where soils are highly susceptible to compaction or erosion or where excessive soil moisture is present. Site obstacles such as rocks, stumps or logs also reduce efficiency. Mechanical eradication of giant reed is extremely difficult, even with the use of a backhoe, as rhizomes buried under 3 to 10 ft of alluvium readily resprout.

Regardless of the mechanical removal method employed, it is critical to remove the entire rhizome root mass. If any of the rhizome mass is left in the ground it will resprout. In addition, stems and roots should be removed, chipped or burned on site to prevent resprouting.

#### Cultural

Giant reed is not very palatable to cattle, but they will feed on it during the drier months. Sheep also have potential for the management of giant reed and have been shown to survive for extended periods on a strict diet of the perennial grass. However, sheep must be properly managed to prevent soil compaction problems particularly in wet areas. The most successful grazers are goats, particularly Angora and Spanish goats. Goats can have several advantages over mechanical and chemical control methods; they are less costly and can negotiate slopes too steep to manage with machines. Angoras are preferred over Spanish goats because of their smaller size and ease of transport. Since goats will trample or browse virtually any vegetation within a fenced area, any desirable trees or shrubs must be protected.

A flame thrower or weed burner device can be used as a spot treatment to heat-girdle the stems at the base of giant reed plants. This technique is less costly than basal and stem herbicide treatments and is suitable for use during wet weather when the wildfire hazard is low. Its effectiveness is comparable to manual cutting.

Large infestations may be burned to remove standing mature plants. This may be accomplished with or without a pre-spray of herbicides to kill and desiccate plants. When burning is used alone it will not prevent resprouting from the rhizomes. Burning is best followed by herbicide treatment of resprouting plants.

#### Biological

Little is known about the effects of various pathogens and insects on the growth and reproduction of *Arundo donax*. However, numerous insects are known to feed on this species. In recent work, the eurytomid wasp, *Tetramesa romana*, was evaluated as a potential biological control agent in North America. The wasp was found to be specific to *Arundo* and thus unlikely to harm native or cultivated plants in the Americas. Undoubtedly, many more years will be required before this species or any other potential biological control agents are identified and released.

### CHEMICAL CONTROL

The following specific use information is based on reports by researchers and land managers. Other trade names may be available, and other compounds also are labeled for this weed. Directions for use may vary between brands; see label before use. Herbicides are listed by mode of action and then alphabetically. The order of herbicide listing is not reflective of the order of efficacy or preference.

#### AROMATIC AMINO ACID INHIBITORS

Glyphosate  
*Roundup, Accord XRT II, Rodeo, Aquamaster*, and others

**Rate:** Broadcast foliar treatment: 2 to 4 qt product (*Roundup ProMax*)/acre (2.25 to 4.5 lb a.e./acre) or 2 to 4 qt product (*Rodeo* or *Aquamaster*)/acre (2 to 4 lb a.e./acre) around aquatic sites. Spot treatment: 2% v/v solution. However, the *Rodeo* product label allows up to an 8% v/v solution, depending on the equipment being used.

**Timing:** Postemergence. Mid-summer to fall application after flowering and before dormancy is the best timing to kill plants and protect injury on many natives. Follow-up application in subsequent spring to control germinating seedlings may be necessary.

**Remarks:** Glyphosate is considered the best option for control in pure stands. Two to three years of treatment are necessary. Herbicide treatment can be used after repeated mowing to reduce necessity for spring treatment to kill seedlings. Dense stands of giant reed (> 80% canopy cover) are most efficiently treated by aerial application, usually by helicopter. Helicopter application can treat at least 124 acres per day.

Undiluted glyphosate can be applied as a cut stump treatment with a paint brush within 1 to 2 minutes after stem cutting. Results have shown that glyphosate used in a cut stem treatments, regardless of time of application (May, July, or September), provided excellent control with no resprouting.

Another method of treatment includes cutting or burning plants followed by foliar treatment of glyphosate to cane regrowth to about 6 to 8 ft in height.

**BRANCHED-CHAIN AMINO ACID INHIBITORS**

Imazapyr	<b>Rate:</b> 1 to 2 qt product/acre (0.5 to 1 lb a.e./acre)
<i>Habitat</i>	<b>Timing:</b> Postemergence fall application timing is most effective, similar to glyphosate. <b>Remarks:</b> Imazapyr has soil residual activity and may impact restoration efforts.
Imazapyr + glyphosate	<b>Rate:</b> 1 pt imazapyr ( <i>Habitat</i> ) + 1 qt glyphosate product/ acre (0.25 + 1 lb a.e./acre, respectively) <b>Timing:</b> Postemergence fall application timing is most effective. <b>Remarks:</b> The combination of the two herbicides prevents the synthesis of six amino acids, as each herbicide inhibits three amino acids. This combination is thought to provide better control at lower rates of each herbicide, thus it is more affordable compared to imazapyr alone.



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# WILD BLACKBERRIES

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*Integrated Pest Management for Home Gardeners and Landscape Professionals*

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Of the 11 species of *Rubus* in California, four were introduced primarily from Eurasia. Most species of wild blackberry, also called brambles, provide important sources of food and cover for many birds and mammals.

Four species, however, are considered weeds. Two of these are non-natives, cutleaf blackberry (*R. laciniatus*) (Fig. 1) and Himalaya blackberry (*R. discolor* [formerly known as *R. procerus*]) (Fig. 2). In addition, two native species also can be weeds under certain conditions. For example, thimbleberry (*R. parviflorus*) (Fig. 3) competes with conifers during establishment in reforested areas, and California blackberry (*R. ursinus* [formerly known as *R. vitifolius*]) (Fig. 4) can infest areas adjacent to streams and ditches. Of these weedy species, the most common, vigorous, and troublesome is Himalaya blackberry.

## IDENTIFICATION

Of the four weedy wild blackberries, thimbleberry is the only nonvining species. It also lacks prickly stems and has a simple leaf with no leaflets. Both Himalaya and cutleaf blackberry have five-angled stems whereas thimbleberry is rounded in cross section, but Himalaya blackberry is easily distinguishable from the other wild blackberries by its five distinct leaflets, each one toothed and usually oval. By comparison, cutleaf blackberry has five very deeply lobed leaflets, and California blackberry has only three leaflets. Not all wild blackberry leaves are deciduous; many remain evergreen. This is an important feature for chemical control in late fall and winter.

Himalaya blackberry has showy flowers that form in large clusters at the end of shoots. Each flower is about 1

inch across with five white or pink petals. The fruits are black and tasty when ripe. New canes are produced each year from the crown (the base of the plant), replacing those that die naturally. New plants start from crown regrowth, rhizomes (horizontal, underground shoots), and seeds that germinate in fall and spring. Reproduction is similar for the other three species.

## IMPACT

The scrambling habit of Himalaya and the other vining wild blackberries smothers existing plant growth. In addition, the tangled mass of thorny stems blocks access of humans, livestock, equipment, and vehicles to pastures and waterways. In addition, it can host Pierce's disease and serve as a vector to movement of the pathogen to other agricultural and nonagricultural areas, including riparian sites.

In forest areas, timber-logging operations create large open areas that wild blackberries often invade. When grazed, the thorny stems can injure the nasal passages of livestock. Another undesirable aspect of vining blackberry plants is they are a good source of food and shelter for rats.

## BIOLOGY

Many animal species feed on wild blackberries; consequently, seeds spread easily from one area to another in animal droppings. Wild blackberry seeds have a hard seed coat and can remain dormant for an extended period. Once seeds germinate and grow and the plants become established, expansion of the thicket is almost entirely a result of vegetative growth from rhizomes. Over time a single plant can cover a very large area.



Figure 1. Cutleaf blackberry.



Figure 2. Himalaya blackberry.



Figure 3. Thimbleberry.



Figure 4. California blackberry.

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# PEST NOTES

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Wild blackberry plants can live for 25 years or longer. They produce vines that arise from a central crown or from buds that form along rhizomes (Fig. 5). First-year canes don't produce flowers. In the second year, the canes fruit and die. Tips of first-year canes that contact the ground form roots at the nodes, contributing to the lateral expansion of the plant.

Bumblebees and honey bees are the primary pollinators of wild blackberry flowers. The flowers can be self-pollinated, but cross pollination increases fruit set.

## MANAGEMENT

Wild blackberries are able to regenerate from the crown or rhizomes following mowing, burning, or herbicide treatment. This makes them difficult to control, and control measures often require follow-up treatment. Land managers often rely on a combination of mechanical and chemical control methods followed by a prescribed burn to dispose of vegetative material.

Because of the extensive underground root system, digging out the plants in a home landscape is a difficult undertaking. Home gardeners generally must rely on foliage-applied herbicide treatments to control an infestation of wild blackberries. One nonchemical option in the home landscape is the use of a rototiller to till the ground several times after the canes have been removed.

### Mechanical Control

Because repeated tillage easily controls wild blackberries, they aren't a problem in cultivated agricultural systems. A single cultivation, however, can fragment the rhizomes and spread the weed. **Bulldozing** also can cause resprouting and can spread the weed by fragmenting roots and stems.

**Mowing** isn't an effective method for controlling wild blackberries. In many cases it stimulates the formation of suckers from lateral roots and induces branching. Despite the lack of long-

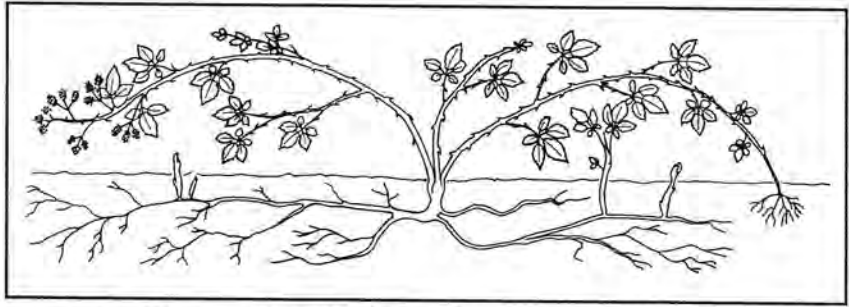


Figure 5. Vegetative growth of a blackberry plant from a central crown.

term control, mowing or chopping can provide short-term canopy reduction that will encourage the growth of grasses and broadleaf plants.

**Burning**, like mowing, isn't an effective long-term strategy, because wild blackberry plants vigorously resprout from rhizomes. However, like mowing, it also provides short-term canopy reduction.

### Biological Control

Because many *Rubus* species are native or of economic importance, biocontrol isn't a practical control method in California. In Australia, however, blackberry leaf rust (*Phragmidium violaceum*) has been released for control of the weed. Thus far this program has not been successful, because the rust hasn't caused significant damage to its host. The rust was discovered in Oregon in the early 2000s and appeared to cause some damage to Himalaya blackberry populations. However, it has not maintained that level of injury and hasn't become widespread in California.

### Chemical Control

Blackberry plants usually regrow following herbicide application; thus, repeated treatments might be necessary for effective long-term control.

**Herbicides applied to the soil.** In noncrop areas, tebuthiuron (Spike) is registered for use by licensed applicators for brush control. Tebuthiuron is a nonselective urea herbicide that is used for total control (i.e., it eliminates other vegetation in the treatment area) of shrubs, trees, and other weeds. It can

be applied in a pelleted formulation at the base of the plant to provide long-term control of wild blackberries.

**Herbicides applied to the plant.** Herbicides can be used in rangeland, pastures, noncrop areas, along roadsides, and in right-of-ways to control actively growing wild blackberry plants.

To effectively control blackberries during the growing season, an herbicide must be transported within the plant to the rhizomes and new growing points. For this to occur, the herbicide must move in the phloem with the plant sugars produced through photosynthesis. In early summer during the rapid extension of canes and expansion of foliar tissue, sugars are transported within the plant from the underground storage tissues to the shoots. After midsummer, new growth is reduced in wild blackberry first-year canes (non-flowering shoots), because these shoots are actively transporting sugars to the rhizomes. These sugars are stored for the following year's growth. In the flowering shoots (second-year canes), movement of sugars from the shoots to the rhizomes occurs later in the season than it does for first-year canes and is most active after completion of fruiting.

Time a foliar herbicide application so that it coincides with the maximum rate of sugar movement to the root system. This will depend upon whether the plants are primarily first-year canes or a combination of both first- and second-year canes. In a situation where only first-year canes are present (for example when plants have been burned or mowed), the most effective time for

optimal herbicide transport to the root system is in late summer. Herbicide application at this time reduces the likelihood of regrowth in subsequent years. Where the bramble infestation consists primarily of second-year canes or a combination of first- and second-year canes, apply an herbicide in early fall, before plants become dormant. Herbicides applied too early generally result in good kill of the top growth but very little movement of the chemical to the root system. Consequently, the plant regrows.

Plants stressed from drought or grazing don't translocate sugars as rapidly as do actively growing plants. Thus, chemical control of wild blackberry plants under stress is difficult and not recommended.

*Foliar-applied herbicides.* Herbicides used to control wild blackberry during the growing season include glyphosate, dicamba, dicamba/2,4-D combinations, and triclopyr. Of these, glyphosate (Roundup and other products containing glyphosate) and triclopyr (Brush-B-Gon, Blackberry and Brush Killer) are registered for use by home gardeners.

- Glyphosate formulated into a product with 41% active ingredient (a.i.) can provide good to excellent control of wild blackberries when applied in a 0.5 to 1.5% solution (i.e., about 0.6 to 2 ounces of product per gallon of water). One product available for use in the home landscape with this concentration of active ingredient is Roundup Super Concentrate. In natural areas, Roundup Pro is commonly used, and in riparian sites near water, the formulations Aquamaster and Rodeo are registered. Glyphosate products that have a lower concentration of active ingredient, such as Roundup Concentrate (18% a.i.), will require a 1.5 to 3.5% solution (i.e., about 2 to 4.5 ounces per gallon of water) for effective control. Late summer or early fall treatments give better control than treatments before or during flowering. To obtain good control, however, complete foliage coverage (spray-to-wet) is essential; spray the plant

until it is thoroughly wet but not to the point of runoff. Burning or mowing 40 to 60 days after spraying with glyphosate increases the level of control and also contributes to good pasture establishment by removing stem debris. Shoots recovering from sublethal glyphosate treatment tend to die more quickly when subjected to heavy grazing. Be sure to wait at least two weeks before grazing after treatment if less than 10% of the area was treated. If more than 10% of the area was treated, animals can't be grazed on the land until eight weeks following treatment.

- Dicamba alone (Banvel, Vanquish) or plus 2,4-D applied in late summer gives good control of wild blackberries. However, 2,4-D alone provides only fair control and will result in resprouting.
- Triclopyr is available to licensed applicators for commercial use in either amine (Garlon 3A) or ester (Garlon 4) formulations. Triclopyr ester (0.75 to 1% solution) is the most effective formulation of triclopyr on thimbleberry and the other three species of wild blackberries. Absorption of the herbicide into the foliage isn't as good with the amine form. Nevertheless, it also provides good control when applied at a 1% solution. The best time to apply either form of the herbicide is midsummer. When air temperatures are higher than 80°F, it is best to use the amine formulation, because the ester form is subject to vaporization. The timing for control of wild blackberries with triclopyr is somewhat earlier than that recommended for glyphosate. Like glyphosate, apply triclopyr spray-to-wet on the foliage. Sometimes glyphosate and triclopyr (1% solution each) are used in combination to achieve better control. Triclopyr is available in retail stores for use in the home landscape in products formulated at a lower concentration than those available to licensed applicators. Carefully read and follow the label of these products (Brush-B-Gon Concentrate, Blackberry and Brush Killer) to apply the correct amount to plants.

*Basal bark treatment.* Concentrated forms of triclopyr (often mixed with commercially available seed oils for better penetration) can be applied to basal regions of wild blackberries with a backpack sprayer using a solid cone, flat fan, or a straight-stream spray nozzle. Thoroughly cover a 6- to 12-inch basal section of the stem with spray but not to the point of runoff. Basal bark applications can be made almost any time of the year, even after leaves have senesced (aged, dried, and fallen from plant). In areas where people frequently harvest the fruit of wild blackberries, a midfall basal bark treatment might be desirable to avoid human contact with the chemical.

*Dormant stem and leaf treatment.* As an alternative to basal bark treatments, a 1% solution of triclopyr ester can be applied to dormant leaves and stems in late fall and winter in a 3% crop oil concentrate mixture; see product labels for the rate to use to obtain the desired concentration. As with other herbicide applications, spray the plant until it is thoroughly wet but not to the point of runoff. Like basal bark treatments, the timing of this technique prevents human contact with the herbicide during berry-picking season.

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To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

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*Picris echioides* L.

(= *Helminthotheca echioides* (L.) Holub [Jepson Manual 2012])

## Bristly oxtongue

**Family:** Asteraceae

**Range:** Primarily in California, but also found in Nevada, Oregon, Washington, Montana, and North Dakota.

**Habitat:** Roadsides, waste places, fields, pastures, crop fields, orchards, vineyards, landscaped areas, gardens, and other disturbed open places. Most common in seasonally wet places.

**Origin:** Native to the Mediterranean regions of Europe.

**Impacts:** Can form dense stands in rangelands and other areas near coastal grasslands.

**California Invasive Plant Council (Cal-IPC) Inventory:** Limited Invasiveness

Bristly oxtongue is an erect winter, or sometimes summer, annual or biennial to nearly 3 ft tall. It has milky sap, stiff-bristly foliage, and yellow dandelion-like flowerheads. Young plants overwinter as rosettes before bolting in late spring. The leaves are alternate and covered with stiff, coarse, papilla-based hairs that are minutely branched at the tips.

The flowerheads are both terminal and axillary, mostly 1 to 2 inches wide, and consist only of yellow ligulate flowers. The achenes have a white bristly to plumose pappus on a stalk. Plants reproduce only by seed. Seeds probably disperse short distances with wind. Some seeds disperse greater distances by clinging to tools, vehicle tires, and landscaping and agricultural machinery. No studies have determined the seed longevity in the soil, but seeds would be expected to persist for a couple of years.



### NON-CHEMICAL CONTROL

**Mechanical** (pulling, cutting, diking) Control can be achieved by hand pulling, string trimming, or hoeing when soil is moist. Roots should be removed to 2 inches below the soil surface. Mowing repeatedly will suppress plants, but basal leaves may result in some recovery.

**Cultural** It is not known whether plants are palatable to livestock. Burning may be an effective control option, but there are no studies to support this. However, bristly oxtongue often occurs in areas with annual grasses, and it is a late season plant. As such, there is likely a window of opportunity for burning after grasses have dried to provide fuel, but before bristly oxtongue has produced viable seed.

**Biological** There are no biological control agents available for the control of bristly oxtongue.

### CHEMICAL CONTROL

There is very little information available for the control of bristly oxtongue, but control measures for other members of the Asteraceae are expected to be effective. In particular, the chemical control options for yellow starthistle are likely to also be effective on bristly oxtongue.

The following specific use information is based on reports by researchers and land managers. Other trade names may be available, and other compounds also are labeled for this weed. Directions for use may vary between brands; see label before use. Herbicides are listed by mode of action and then alphabetically. The order of herbicide listing is not reflective of the order of efficacy or preference.



**GROWTH REGULATORS**

2,4-D

**Rate:** 1 to 4 pt product/acre (0.48 to 1.9 lb a.e./acre)

Several names

**Timing:** Postemergence to seedlings or plants no later than the bolting stage.**Remarks:** 2-4-D is a broadleaf herbicide with no soil activity. Older plants are expected to require a higher rate compared to seedlings or plants in the early rosette stage.Aminocyclopyrachlor +  
chlorsulfuron**Rate:** 3 to 4.5 oz product/acre*Perspective***Timing:** Postemergence in spring and early summer to rosettes or bolting plants, or in fall to seedlings and rosettes before the ground freezes.**Remarks:** Higher rates are necessary after plants bolt. Aminocyclopyrachlor has similar activity as aminopyralid and is expected to provide similar control of bristly oxtongue. *Perspective* provides broad-spectrum control of many broadleaf species. Although generally safe to grasses, it may suppress or injure certain annual and perennial grass species. Do not treat in the root zone of desirable trees and shrubs. Do not apply more than 11 oz product/acre per year. At this high rate, cool-season grasses will be damaged, including bluebunch wheatgrass. Not yet labeled for grazing lands. Add an adjuvant to the spray solution. This product is not approved for use in California and some counties of Colorado (San Luis Valley).

Aminopyralid

**Rate:** 5 to 7 oz product/acre (1.25 to 1.75 oz a.e./acre)*Milestone***Timing:** Postemergence in spring and early summer to rosettes or bolting plants, or in fall to seedlings and rosettes before the ground freezes.**Remarks:** Higher rates are necessary after plants bolt.

Clopyralid

**Rate:** 6 to 10 oz product/acre (2.25 to 3.75 oz a.e./acre)*Transline***Timing:** Postemergence in spring and early summer to rosettes or bolting plants, or in fall to seedlings and rosettes before the ground freezes.**Remarks:** Higher rates are necessary after plants bolt. See recommendations for yellow starthistle; control is expected to be similar for bristly oxtongue.

Picloram

**Rate:** 1 pt product/acre (4 oz a.e./acre)*Tordon 22K***Timing:** Preemergence in winter, or early postemergence in late fall or spring.**Remarks:** Picloram has a very long soil residual activity and should provide 2 years of control. It is selective on broadleaf species and does not generally injure grasses. *Tordon 22K* is a federally restricted use pesticide. Picloram is not registered for use in California.**AROMATIC AMINO ACID INHIBITORS**

Glyphosate

**Rate:** Broadcast foliar treatment: 2 to 4 pt product (*Roundup ProMax*)/acre (1.1 to 2.25 lb a.e./acre).*Roundup, Accord XRT II,*  
and others

Spot treatment: 1% v/v solution

**Timing:** Postemergence to seedlings or plants no later than the bolting stage.**Remarks:** Glyphosate is a nonselective herbicide. Studies with yellow starthistle show good control with glyphosate, and it is expected that similar results would occur with bristly oxtongue.



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# BROOMS

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*Integrated Pest Management for Home Gardeners and Landscape Professionals*

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Brooms are a group of shrubs introduced into North America from Europe in the mid-1800s. The four most common species are Scotch broom (*Cytisus scoparius*), French broom (*Genista monspessulana*), Spanish broom (*Spartium junceum*), and Portuguese broom (*Cytisus striatus*). Brooms initially were introduced as ornamentals, but the United States Department of Agriculture's Natural Resources Conservation Service used them extensively for erosion control along roadsides and in mined areas.

These highly competitive shrubs grow rapidly and form dense stands that most wildlife find impenetrable and unpalatable. Their dense stems make regeneration of most other plant species difficult or impossible, and they create a dangerous fire hazard. In addition, brooms are able to fix atmospheric nitrogen, which increases soil fertility and gives a competitive advantage to other non-native weeds that, unlike the

local natives, thrive on high nitrogen levels. Although some retail nurseries still sell a variety of broom species, homeowners should avoid planting it in their personal landscapes. Depending on your climate, a number of alternate plant species have similar attributes but are not invasive. Contact your county UC Master Gardener for a list of recommendations.

## IDENTIFICATION

Brooms are upright shrubs that grow 3 to 10 feet tall (Figs. 1 and 2). They generally produce bright yellow, pea-shaped flowers on green stems from April to June.

Scotch and Portuguese brooms produce their flowers in the leaf axils, while French and Spanish brooms have flowers at the branch tips. In some areas Scotch broom flowers can be multicolored, typically with red or purple petals along with yellow ones.

Another distinguishing characteristic between the species is stem shape. Scotch broom has a five-angled stem (star shaped when viewed from a cross section), French and Portuguese have an eight- to ten-angled stem, and Spanish broom has a finely ribbed stem making it nearly round.

Leaf characteristics also identify the species. Spanish broom produces simple leaves while the other three species have mostly trifoliolate leaves. For most species, new leaves produced in spring often are lost during hot, dry summer months or periods of stress, giving the plants their characteristic whisk broom appearance. Scotch, Portuguese, and Spanish brooms are deciduous while French broom is an evergreen.

All four brooms produce brownish-black pea pods in mid- to late summer that contain shiny, dark greenish-brown seeds. Table 1 shows identifying features of these four broom species.

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Figure 1. Brooms are upright shrubs that produce yellow flowers in spring. Most species also generate new leaves in the spring but often lose them during hot, dry summer months, creating a whisk broom appearance. Shown here is Scotch broom, *Cytisus scoparius*.



Figure 2. Spanish broom, *Spartium junceum*.

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## PEST NOTES

Publication 74147









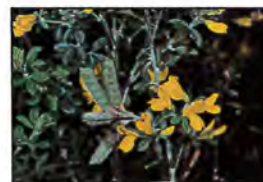


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Table 1.

Distinguishing Features of Four Common Broom Species in California.

<p><b>Scotch broom</b> (<i>Cytisus scoparius</i>)</p>	<p><b>French broom</b> (<i>Genista monspessulana</i>)</p>	<p><b>Spanish broom</b> (<i>Spartium junceum</i>)</p>	<p><b>Portuguese broom</b> (<i>Cytisus striatus</i>)</p>
 <p><b>Stems:</b> 5-sided; star-shaped cross section <b>Leaves:</b> compound, 3 leaflets, deciduous, sometimes single on new twigs</p>	 <p><b>Stems:</b> 8 to 10 ridges; round cross section <b>Leaves:</b> compound, 3 leaflets, evergreen, usually dense</p>	 <p><b>Stems:</b> smooth or finely ribbed; round cross section <b>Leaves:</b> simple, deciduous, sparse</p>	<p>No photo available.</p> <p><b>Stems:</b> 8 to 10 ridges; round cross section <b>Leaves:</b> compound, 3 leaflets, deciduous, sometimes single on new twigs</p>
 <p><b>Flowers:</b> single or paired in leaf axils <b>Petals:</b> yellow or partially red</p>	 <p><b>Flowers:</b> 4 to 10 in clusters at end of short branches <b>Petals:</b> yellow</p>	 <p><b>Flowers:</b> several in open racemes at stem ends <b>Petals:</b> yellow</p>	 <p><b>Flowers:</b> single or paired in leaf axils <b>Petals:</b> yellow</p>
 <p><b>Seed pods:</b> flattened, only margins hairy</p>	 <p><b>Seed pods:</b> slightly flattened, entirely covered with long hairs</p>	 <p><b>Seed pods:</b> slightly flattened with few, if any, long hairs</p>	 <p><b>Seed pods:</b> slightly inflated, entirely covered with long hairs</p>

**BIOLOGY**

You'll often find brooms in disturbed places such as riverbanks, road cuts, and forest clear cuts, but they also can colonize undisturbed grassland, shrubland, and open canopy forests. Invasion and spread typically are by seed dispersal. The pods ripen during the dry summer months then explosively eject their seeds a few feet away, mak-

ing a popping noise you can hear for some distance. All of the brooms are prolific seed producers with a single shrub producing as many as 2,000 to 3,500 pods containing up to 20,000 seeds. About 40% of the newly produced seeds germinate immediately after dispersal, and another 25% germinate the second year. The seeds have an impervious seed coat, enabling some seeds to remain dormant in the soil for

up to 50 years and making long-term management difficult.

After germination, stem growth is rapid—as much as 3 to 4 feet the first year. After continuing to grow quickly for another 3 to 4 years, the plant experiences 6 to 8 years of relatively slow growth. Next is a period of senescence with more dead, woody tissue than green. Plants typically live 12 to 17

years but can survive for as long as a quarter century.

Although brooms usually don't reach flowering maturity until the second or third year of growth, under the right conditions—including prevalent moisture—broom species can produce flowers and seeds their first year, making early removal important.

## MANAGEMENT

The two primary methods for managing brooms are mechanical removal and treatment with herbicides. Broom establishment is mainly through seed dispersal, so maintaining a healthy cover of desirable vegetation and reducing soil disturbance will minimize the potential of broom invasion.

### Mechanical Control

You can use hand pulling or mechanical grubbing—using a shovel, pick, or Weed Wrench—to physically remove smaller infestations in wildlands or urban areas. Remove plants in early spring or late fall when the soil is moist and it is easy to dislodge roots. Some tools, however, are difficult to use in soils that are too moist, and hand pulling can create soil disturbance that can lead to rapid reinvasion. Grubbing when the soil is dry and hard usually will break off the stems, leaving rootstalks that will vigorously resprout.

Other forms of mechanical control have not proven successful. Brush rakes and bulldozers often leave pieces of rootstalks that readily can resprout. In some cases, brush removal in late summer, when plants experience moisture stress, can slow their ability to recover. However, using large equipment to clear land creates a perfect environment for new seedling establishment, making follow-up control essential.

Mowing broom plants gives poor control, unless you perform it repeatedly throughout the growing season. Within a couple months of germination, young plants usually have produced underground rootstalks large enough to recover from a single mowing. Use extreme caution when mowing during spring and summer because of the

potential for wildfires. Mowing later in the season also can spread seeds.

Lopping mature plants near the base will provide some control; you'll want to do this when plants are moisture stressed in late summer or in late spring following a winter with little rainfall. Lopping at other times can lead to vigorous resprouting.

### Cultural Control

Burning alone is not an effective method for controlling brooms. Although burning can remove large amounts of debris, in many cases it can increase the population as it removes competitive vegetation, releases nutrients into the soil, and stimulates the germination of broom seeds left in the soil.

Cutting the above-ground vegetation of French or Scotch broom and allowing it to dry on site, followed by burning, can effectively control resprouting. Burning is more effective if you follow it with an herbicide application, subsequent burnings, and/or revegetation using desirable species. It is important to employ a control strategy following a burn, otherwise the broom population in subsequent years may become worse than before.

Grazing can provide control in small areas if the grazing pressure is high enough to continually suppress growth. Goats have been shown to vigorously feed on resprouting vegetation and shrubs, including brooms. You can train goats to selectively feed on brooms or other undesirable species, but overgrazing can lead to nonselective damage to desirable vegetation.

### Biological Control

In the 1960s, three insects were introduced as biological control agents on brooms—the Scotch broom seed beetle (*Bruchidius villosus*), the Scotch broom seed weevil (*Apion fuscirostre*), and the Scotch broom twig miner moth (*Leucopetera spartifoliella*). The latter two species are specific to Scotch broom, while the seed beetle also attacks Portuguese broom, Spanish broom, and French broom. Because brooms are serious problems in many countries, the Inter-

national Broom Initiative is evaluating other insects and pathogens in their native countries to determine their control potential.

### Chemical Control

California homeowners can purchase the post-emergent herbicides triclopyr and glyphosate, the most effective chemicals for controlling brooms. You can use these herbicides either alone or as a combination of glyphosate with triclopyr or imazapyr. In areas near rivers or streams, it is important to use the proper formulation of these herbicides. Ester formulations of triclopyr or imazapyr, for example, are not registered for use near water, and some glyphosate formulations cannot be used near water either.

Depending on the compound, you can apply these herbicides as foliar sprays, a cut-stump treatment, or a basal bark application. When using herbicides, be sure to prevent them from getting on desirable plants. Because glyphosate is a nonselective compound, it will damage or kill other vegetation. Triclopyr is a broadleaf herbicide that will not injure grasses but will damage or kill other broadleaf plants. Homeowners and professional applicators should wear appropriate protective equipment as stated on the herbicide label.

**Foliar Sprays.** The effectiveness of herbicides depends on three factors—timing, achieving good coverage, and using a proper concentration.

**Timing.** Foliar application of herbicides to brooms is most effective after leaves are fully developed and when the plant is actively growing. This period normally is from April into June or July, when soil moisture remains adequate. The flowering stage is the optimum time to treat. Don't apply herbicides before plants begin their spring growth or in mid-summer when plants are stressed. Although not typically a problem, dust can cover plants growing near roadsides. Herbicides, particularly glyphosate, can readily attach to dust or soil particles, thus reducing their effectiveness.



**Coverage and Concentration.** You can apply herbicides as a foliar spray using one of two methods. The first is spray-to-wet, where all leaves and stems should glisten following an application. Coverage, however, should not be to the point of runoff.

The other method is a low-volume foliar application called drizzle. This technique uses a higher concentration of herbicide, but you spray it at a lower volume. This method is advantageous in dense shrubbery or where access is limited. To achieve proper coverage, spray the herbicide uniformly over the entire canopy in a "drizzle" pattern, using a spray gun.

For spray-to-wet applications, products containing 41% glyphosate as the active ingredient can provide good to excellent control of brooms when applied at 2.5 ounces of product per gallon of water (2% of the total solution). Some products available for use in the home landscape with this concentration of active ingredient are Clearout 41 Plus, Honcho Herbicide, and Honcho Plus Herbicide. Glyphosate products that have a lower concentration of active ingredient, such as Roundup Concentrate (18% active ingredient), will require about 6 ounces of product per gallon of water (4.7% of the total solution) for effective control.

Triclopyr is available in either amine or ester formulations, with triclopyr ester being more effective on brooms, since absorption of the herbicide into the foliage is not as good with the amine form. One product available for use by licensed applicators—and for homeowners that acquire an operator identification number from their county Department of Agriculture—is Garlon 4. This and other similar products formulated with a minimum of 61% active ingredient can provide good to excellent control when applied at 1 to 1.25 ounces of product per gallon of water (0.75% to 1.5% of the total solution).

Mixing triclopyr ester with commercially available seed oils can offer better penetration. One available product is Hasten Spray Adjuvant; mix this at

1.25 ounces of product per gallon of herbicide solution (1% of the total solution).

The best time to apply either form of the herbicide is late spring. When air temperatures are higher than 80°F, it is better to use the amine formulation, because the ester form is subject to vaporization. More than one ester formulation of triclopyr is available, with differing degrees of volatilization at high temperatures.

You can use glyphosate and triclopyr in combination to achieve better control. Triclopyr is also available in retail stores for use in the home landscape in products formulated at a lower concentration than those available to licensed applicators. Carefully read and follow the label of these products—such as Brush-B-Gon Poison Ivy and Poison Oak & Brush Killer—to apply the correct amount.

The drizzle application method is good in situations of dense planting or when it is difficult to cover an entire area due to topography. Glyphosate formulated into a product with 41% active ingredient can provide good to excellent control of brooms when applied at 19 ounces of product per gallon of water (15% of the total solution). You also can apply triclopyr using a drizzle application. If you are using triclopyr ester formulated into a product with 61% active ingredient, apply it using 13 ounces of product (10% of the total solution) and 25 ounces of seed oil (20% of the total solution) per gallon of water.

Remember that although the drizzle technique uses a higher concentration of herbicide, you are applying it at a lower volume. One gallon of mixed herbicide solution should adequately treat one-half acre of densely populated broom.

**Cut Stump Application.** Cut stump treatments are most effective in spring during active plant growth or in the fall. Immediately after cutting, apply the herbicide to the cut surface with a paint brush, spray bottle, or plastic squeeze bottle. Delaying application

will result in poor control, because the cut surface quickly will develop an air interface between the water in the vascular tissue and the herbicide solution, preventing movement of the chemical into the plant.

For small stumps, completely cover the cut surface. For large stumps, it is necessary to wet only the cambium, the outer ring of wood next to and including the bark. For small-stemmed shrubs, cut the stems with loppers or clippers and paint or sponge the herbicide solution onto each cut end.

For triclopyr products containing 61% active ingredient, use 1 part product and 4 parts water. The 8% material available to homeowners in nurseries and other stores will work well undiluted. You also can apply glyphosate as a cut-stump application. If using a brand that has 18% glyphosate listed in the active ingredients, make a 1:1 solution of the product and water. If the product contains 41% glyphosate, use 1 part product and 3 parts water.

**Basal Application.** You can apply concentrated forms of triclopyr ester to basal regions of brooms using a backpack sprayer with a solid cone, flat fan nozzle, straight-stream spray nozzle, or even a wick applicator. Thoroughly cover a 6- to 12-inch high basal section of the stem with spray but not to the point of runoff. You can make basal bark applications almost any time of the year, even after leaves have senesced. For triclopyr ester formulated into a product with 61% active ingredient, the application ratio is 13 ounces of product (10% of the total solution) and 25 ounces of seed oil (20% of the total solution) per gallon of water. Glyphosate and the amine formulation of triclopyr provide poor control using this technique.

One application of an herbicide does not always completely control brooms. Retreat when new, sprouting leaves are fully expanded, generally when the plants are about 2 feet tall. Watch treated areas closely for at least a year, and retreat as necessary.



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*Delairea odorata* Lem.

## Cape-ivy

Family: Asteraceae

Range: Mainly along the coast of California and Oregon.

Also invasive in Hawaii.

Habitat: Riparian corridors, seasonal wetlands, coastal habitats, coastal bluffs and scrub, moist canyons, coastal grassland, oak woodlands, and disturbed sites such as roadsides, urban waste places, or other areas. Requires some moisture year-round. Grows in deep shade or under cloudy conditions and does not tolerate full sunlight. Tolerates serpentine soils, and established plants can survive drought conditions.

Origin: Native to the moist mountain forests of South Africa and introduced to the United States in the late 1800s as a houseplant. Also considered an invasive weed problem in Australia.

Impacts: Under favorable conditions, plants spread invasively and can develop a dense cover that outcompetes other vegetation in natural areas.

Vines grow over trees and shrubs and can form dense mats that smother underlying vegetation. Such problematic infestations also reduce native species richness and seedling recruitment in the community. Cape-ivy contains pyrrolizidine alkaloids (liver toxins) and can be toxic to animals when ingested; fish can be killed when plant materials are soaking in waterways.

Western states listed as Noxious Weed: California

California Invasive Plant Council (Cal-IPC) Inventory: High Invasiveness



Cape-ivy is a fleshy perennial vine, with stems to about 30 ft long. The leaves are glossy green, glabrous, alternate, broadly deltate to "ivy-shaped", 1 to 4 inches long, 1.5 inches wide with 5 to 9 lobes. The foliage is evergreen in mild climates and the leaves and stems are deciduous elsewhere.

The flowers are yellow, grouped on terminal and axillary corymbs, with disk flowers approximately 5 mm long arranged in clusters. The fruits are achenes about 2 to 3 mm long, often with a pappus or a crown of hairs. Plants reproduce primarily vegetatively, from fragments of rhizomes, stolons, and stems. A stem fragment as small as one inch, if it has a node, can generate a new plant. Even small fragments of dying stems can resprout, although the regeneration rate is reduced by about one-third. While most seeds produced are not viable, some viable seeds develop in sites throughout California and Oregon. When viable seed are produced, they can disperse long distances by wind.

### NON-CHEMICAL CONTROL

**Mechanical**  
(pulling, cutting,  
disking)

Manual removal of plants, including roots and rhizomes, before viable seed develops can help control infestations in areas where plants are accessible. Removing all plant material from the site will help prevent rerooting of rhizomes, stolons, or stem fragments. Follow-up removal of resprouts is essential. In some large patches, all stems can be cut at ground level and Cape-ivy rolled up like a rug. Although the below-ground reproductive tissues will resprout, this strategy makes it possible to detect and spot-treat new sprouts while avoiding contact with desirable vegetation.

Because Cape-ivy can resprout and establish from stem fragments, mowing is not recommended.

Cutting off Cape-ivy before it flowers will reduce seed production and deplete the plant's energy reserves. Resprouts are common after treatment. Cutting should be combined with an herbicide treatment or with multiple cuttings over a period of years. All plant parts should be bagged and properly disposed of.

**Cultural**

Grazing and burning are not considered effective control options. The leaves and stems can be toxic to livestock.

**Biological**

To date, no biological control agents have been released. However, extensive research by USDA-ARS has been ongoing since 1998. Several species of insects are being examined as potential controls, including a gall-forming fly (*Parafreutreta regalis*), a leaf-mining moth (*Acropelia* spp.), a defoliating moth (*Diota rostrata*), and a stem-boring moth (*Digitivalva delaireae*). The two most promising, the stem-boring moth and the gall-



forming fly, are going through the final stages of testing.

#### CHEMICAL CONTROL

The following specific use information is based on published papers and reports by researchers and land managers. Other trade names may be available, and other compounds also are labeled for this weed. Directions for use may vary between brands; see label before use. Herbicides are listed by mode of action and then alphabetically. The order of herbicide listing is not reflective of the order of efficacy or preference.

#### GROWTH REGULATORS

<i>Clopyralid</i> <i>Transline</i>	<b>Rate:</b> Spot treatment: 0.5% v/v solution plus 0.25 v/v surfactant to thoroughly wet all leaves. <b>Timing:</b> Postemergence when plants are growing rapidly. <b>Remarks:</b> Clopyralid is a selective herbicide for broadleaf species. This compound has been shown to be successful in controlling Cape-ivy in Australia.
<i>Triclopyr</i> <i>Garlon 4 Ultra,</i> <i>Pathfinder II</i>	<b>Rate:</b> Spot treatment: 0.5 to 1% v/v solution of <i>Garlon 4 Ultra</i> and water plus 0.25 to 0.5% v/v surfactant to thoroughly wet all leaves. <b>Timing:</b> Postemergence when plants are growing rapidly. <b>Remarks:</b> Triclopyr is a selective herbicide for broadleaf species. In areas where desirable grasses are growing under or around Cape-ivy, triclopyr can be used without non-target damage.

#### AROMATIC AMINO ACID INHIBITORS

<i>Glyphosate</i> <i>Roundup, Accord</i> <i>XRT II, and others</i>	<b>Rate:</b> Spot treatment: 1 to 2% v/v solution of <i>Roundup ProMax</i> (or other trade name with similar concentration of glyphosate) in water, or 1% <i>Roundup</i> (or other trade name) plus 0.5% <i>Garlon 4 Ultra</i> v/v plus silicon surfactant in water to thoroughly wet all leaves. Wiper treatment: 33 to 50% of concentrated product. <b>Timing:</b> Postemergence when plants are growing rapidly. Best results when treated in late summer or early fall. <b>Remarks:</b> Glyphosate is a nonselective systemic herbicide. It gives good control with some resprouts. In many situations, it may be more appropriate to use a wiper application to achieve selectivity. Glyphosate can be combined with triclopyr for more effective control. Use a surfactant when applying this combination.
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# CLOVERS

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*Integrated Pest Management for Home Gardeners and Landscape Professionals*

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Clover is a broad term that refers to plants in three genera: *Trifolium*, *Medicago*, and *Melilotus*. Each contains clover species that are troublesome in turfgrass and ornamental areas. They are in the legume family (Fabaceae) and have distinctive "pealike" flowers that are arranged in various types of heads.

Clover plants have a symbiotic relationship with a bacterium in the *Rhizobium* genus that allows them to fix atmospheric nitrogen and provide for their own nitrogen needs, which is why clover can maintain a dark green color even under low nitrogen fertility. Turfgrass growing in soil that is low in nitrogen may receive supplemental nitrogen from old clover plants as their roots die and decay.

## IDENTIFICATION AND BIOLOGY

Depending on the species, clovers may have an annual or perennial life cycle. Both annual and perennial clovers begin to germinate in fall when soil temperatures are in the 50° to 60°F range. Germination continues throughout the winter and early spring months. Winter rainfall will sustain the annual clovers, but irrigation is required for survival of the perennial species during the dry summer months. A weed commonly confused with clovers is *Oxalis*. *Oxalis* leaves look similar to those of clovers, but lack a stipule and generally have a more pronounced indentation at the top of each leaflet. Once *Oxalis* matures it has small yellow flowers that have five regular petals that are readily distinguished from clover flowers. For more information on *Oxalis* species, see *Pest Notes: Creep-*

*ing Woodsorrel and Bermuda Buttercup* listed in References.

**Annual Clovers.** Annual clovers that typically cause problems in turfgrass include black medic (*Medicago lupulina*) and California burclover (*Medicago polymorpha*). Another of the annual clovers, little hop clover or shamrock clover (*Trifolium dubium*), is sometimes planted as part of a turfgrass mixture.

Annual clovers grow mostly in a prostrate manner, even without mowing (Fig. 1). Black medic and burclover have trailing stems that branch from the base and radiate out from a single taproot. The compound leaves have three oval-shaped leaflets that are finely toothed with prominent veins (Fig. 2). The central leaflet has a short stem whereas the other two are almost stemless. Flowers are small, bright

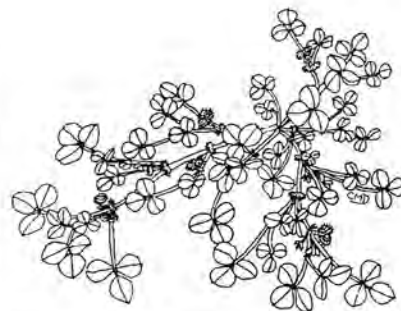


Figure 1. California burclover plant.

yellow, and borne in clusters at the end of a stem. In black medic, a single seed is produced in a smooth, small brown to black pod. The burclover seedpod is light brown and curls into a tight bur that is typically spiny. The burs contain several seeds.

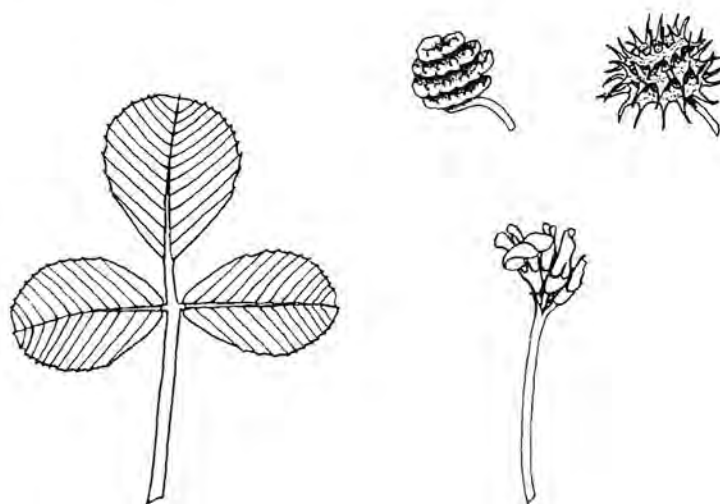


Figure 2. Leaf, seedpods, and flowers of California burclover.

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## PEST NOTES

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Figure 3. Yellow sweetclover plant.

**Sweetclovers.** Sweetclovers, including white sweetclover (*Melilotus alba*) and yellow sweetclover (*Melilotus officinalis*), are erect annuals or biennials that are more problematic in ornamental areas than in turfgrass. They grow from 2 to 5 feet tall (Fig. 3) and have a trifoliate leaf arrangement with the leaf margins toothed more than halfway back from the tip (Fig. 4a). The flowers are small, yellow or white (depending on the species), and are produced in a many-flowered terminal and in leaf axils (Fig. 4b). The small pods have one seed.

**Perennial Clovers.** The perennial white clover, *Trifolium repens*, is most often found as a turfgrass weed, but it and strawberry clover, *Trifolium fragiferum*, are sometimes planted in a mixed stand with turfgrass to reduce the need for nitrogen fertilizer application.

White and strawberry clovers have a creeping stem system that roots at the nodes (joints in the stem), forming large clumps (Fig. 5). White clover leaves are trifoliate with 1/4- to 1/2-inch-long leaflets (Fig. 6). The flowers of



Figure 4a. Leaf of yellow sweetclover.

white clover are formed in heads that are white to pale pinkish. Strawberry clover is a more robust plant than white clover and thus more aggressive. The leaves mostly form from the base of the stem with the leaflets longer and narrower than white clover. The pink flowers are borne in heads that are less showy than white clover.

**IMPACT**

Clover can be a concern in turfgrass or landscaped areas for at least three reasons. First, during the flowering period bees are attracted to the clover blooms and people playing or using the turfgrass may be stung. Second, clovers reduce the uniformity of the turfgrass because its texture, color, and growth rate are different from that of grasses. And third, the mature burs of burclover are a problem for people walking barefoot and when they become attached to clothing or pets.

**MANAGEMENT**

Clovers are relatively easy to control in the home garden by hand-pulling, cultivation, and the application of mulch. In large, landscaped areas herbicides may also be necessary. Because clover seed has a hard seed coat that is very heat tolerant, composting and solarization are not as effective in reducing clover's seed viability as they are with other weed species. The

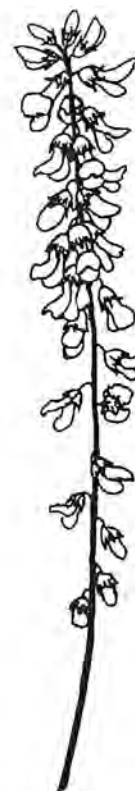


Figure 4b. Flowers of yellow sweetclover.

hard seed coat also allows the seeds to survive longer in the soil than many other weed seeds; clover seeds can germinate over many years, making the control of these plants an ongoing effort.

Once clovers are controlled, change cultural practices in the landscape and turfgrass to reduce the chance of reinfestation. Insuring a thick stand of grass can help exclude clovers in turf. Fertilization can also influence clover growth. For instance, adjust the fertilizer program to include more nitrogen and less phosphorus in turfgrass. Mulches can be effective in excluding clovers and other weeds in landscapes.

**Landscaped Areas.** Annual clovers can be easily controlled by hand-pulling, hoeing, or cultivation. Mulching, depending on the size and depth of the mulch, can prevent seedling establish-

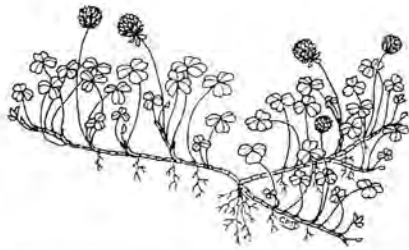


Figure 5. White clover plant.

ment. Before seeds germinate, a 4-inch thick organic mulch (e.g., compost, wood chips, etc.) can prevent establishment of clovers. Organic mulch can also be applied after the seedlings have germinated but must be applied more thicker layer (4 to 6 inches) and must cover the plants completely to block out all light. Organic mulches need to be reapplied each year to maintain the 4-inch-thick layer because they decompose and the thickness of the mulch declines over time. Woven black landscape fabric can exclude weeds over a number of years. Larger plants are more difficult to control with mulching, but they can be hand-pulled or hoed.

**Preemergent Control.** Preemergent herbicides available for landscape use are effective but generally unnecessary in the home landscape where annual clovers are easily controlled by the methods mentioned. For landscape professionals, herbicide formulations that contain isoxaben are effective for controlling annual clovers and can be used around many woody shrubs and trees. Most established annual flowers tolerate this herbicide. Herbicide formulations containing oryzalin, trifluralin, or pendimethalin will control most grass species and some broadleaf weeds but will miss many other broadleaf species (mustard, aster, legume, and cheeseweed families).

**Postemergent Control.** Postemergent control of clover is difficult. If the seedlings are small, glyphosate can be used in open areas provided desirable plants are not sprayed. Once annual clover plants reach 3 to 4 inches in

height, control with herbicides is more difficult. The top may be burned, but the plants often regrow. None of the herbicides used in turfgrass for clover control is safe to use in ornamental plantings because they can damage desirable plants.

Perennial clovers can also be controlled with glyphosate when the plants are seedlings, but once the clover is established, it cannot be controlled except by digging it out. Glyphosate at high rates will suppress some clovers.

**Turfgrass Areas.** Yellow turf and green turf clover is a good indication of low nitrogen fertility. The invasion of clover into turfgrass can be reduced by using levels of nitrogen fertilizer that will promote grass growth but not the growth of clover; this can be achieved by applying 1 pound of active nitrogen per 1,000 square feet of turfgrass during each month of active turfgrass growth (not to exceed 4 lb active nitrogen/1,000 sq ft/year). Also, high phosphorus in the soil promotes the invasion of clovers. However, nitrogen applications should be carefully calculated and applied to avoid runoff of excess fertilizer to municipal drainage systems. Clover in established turfgrass cannot be controlled by fertilization or mowing of the grass. Once clover is established, the annual clovers can be controlled by hand-pulling before seeds are formed. Hand-pulling will need to be repeated as new germination occurs and desirable turfgrass is planted in weeded areas.

**Herbicide.** Both established annual and perennial clovers can be controlled with postemergent herbicides. The best herbicide to use depends upon the species of turfgrass. Warm-season turfgrasses such as bermudagrass, zoysiagrass, and kikuyugrass will tolerate products containing mecoprop and dicamba but not triclopyr. Cool-season turfgrasses will tolerate all of the herbicides that control clover. The herbicide 2,4-D is not effective for clover control; it will injure the plant but does not control it.

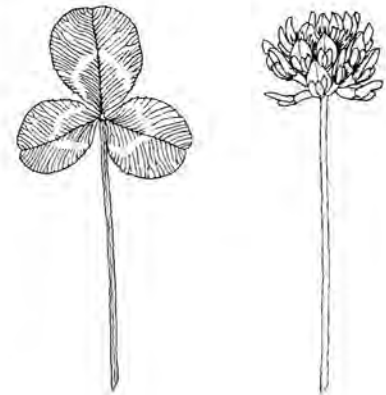


Figure 6. White clover leaf and flower.

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# CRABGRASS

*Integrated Pest Management for Home Gardeners and Landscape Professionals*

Crabgrass is a weed almost everyone is familiar with. Two species are common in California—smooth crabgrass, *Digitaria ischaemum*, (Fig. 1) and large or hairy crabgrass, *D. sanguinalis*, (Fig. 2). Both were introduced from Eurasia and are widespread throughout the United States. As annuals, they germinate, set seed, and die within one year.

You'll find crabgrass in lawns, ornamental landscapes, and vegetable gardens. Large crabgrass also grows in orchards, vineyards, and other agricultural areas. Crabgrass has many other names including crowfoot grass, watergrass, and summer grass. It grows in most parts of California, except at high elevations and areas that receive no summer water. It is often confused with goosegrass and the perennials dallisgrass and bermudagrass.

## IDENTIFICATION AND LIFE CYCLE

### Smooth Crabgrass

Smooth crabgrass is a low-growing, summer annual that spreads by seed and from rootings of the joints (culm nodes) that lie on the soil. It dies with the first frost in the fall. Unmowed, it will grow upright to about 6 inches, but even if you mow it as short as  $\frac{1}{4}$  inch, it still can produce seed.

Seedling leaves are light green and smooth (Fig. 3). They are very conspicuous in the lawn with their lighter green color. True leaves are dark green but still smooth, and the leaf blade is from  $\frac{1}{4}$  to  $\frac{1}{3}$  inch across, up to 5 inches long, and pointed. Crabgrass often forms patches in lawns, and plants can grow together to form large clumps. The projection at the base of the leaf blade, known as the ligule (Fig. 4), is small



Figure 1. Smooth crabgrass.

and inconspicuous, and the collar region lacks the clasping, prominent outgrowths or auricles present on some grasses. The leaf sheath and upper leaf surface are smooth, but a few hairs can be present on the lower leaf surface. Sometimes a reddish tint is visible at the base of the leaf.

The inflorescence, or flower stalk, (Fig. 5) has branches that originate from the main stem at  $\frac{1}{8}$ - to  $\frac{1}{4}$ -inch intervals. The branches are  $\frac{1}{2}$  to  $2\frac{1}{2}$  inches long at the end of the stalk.

### Large Crabgrass

When found in turf, large crabgrass is a low-growing, summer annual that spreads by seed and from rootings of nodes that lie on the soil. Unmowed, it can grow 2 feet tall. It won't tolerate close mowing as well as smooth crabgrass. As a result, smooth crabgrass is a more common weed in lawns.

Seedling leaves are light green and hairy. True leaves are generally 3 inches long and hairy on the upper surface of the leaf and leaf sheath. The collar region and flower stalk are similar to that of smooth crabgrass, but the branches are longer—about 2 to 5 inches—at the end of the stalk. One source reports seed production from a single, large crabgrass plant can be as high as 150,000.



Figure 2. Large crabgrass in a lawn.



Figure 3. Smooth crabgrass seedling.



Figure 4. Smooth crabgrass collar region and sheath. The ligule at the base of the leaf blade is a short projection, and there are no auricles.



Figure 5. Flowering stem of smooth crabgrass.

## PEST NOTES

University of California  
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**Lifecycle**

The flowering stems of both species of crabgrass are similar to those of bermudagrass and goosegrass, but the panicle-like branches (whorls) on the flowering stems of these other grasses originate at the same point while those on crabgrass originate about 1/8 to 1/4 inch apart at the end of the stem.

Dallisgrass, another common grass in lawns, has panicle branches that are widely separated on the flowering stem (Fig. 6). Dallisgrass and bermudagrass can be readily distinguished from crabgrass by their characteristic vegetative reproductive structures that allow rapid spread in the garden. Dallisgrass has short, thick, underground rhizomes, and bermudagrass spreads with slender, belowground rhizomes and aboveground rooting stems called stolons. As an annual weed, crabgrass spreads primarily by seed and doesn't have rhizomes or stolons.

In Southern California, the major germination period for both crabgrass species is from mid-January to early April, depending on the temperature; however, seeds can germinate throughout spring and summer. Although germination is early in areas with mild winters, growth is slow during spring months until mid-May. In June and July the plants produce primarily leaves and stems and typically flower in late July and August. In the absence of a frost, crabgrass can overwinter in warm areas or during warm winters and produce new growth and a second crop of seed in spring or early summer.

In central and northern parts of the state, crabgrass begins to sprout early to mid-March when soil temperatures reach 50° to 55°F for at least 3 consecutive days. Growth and germination will continue throughout summer and into fall.

**MANAGEMENT**

Crabgrass is easy to manage using a variety of cultural and chemical controls. Controlling crabgrass before it sets seed is important, because the seeds can remain viable for at least 3 years in soil.

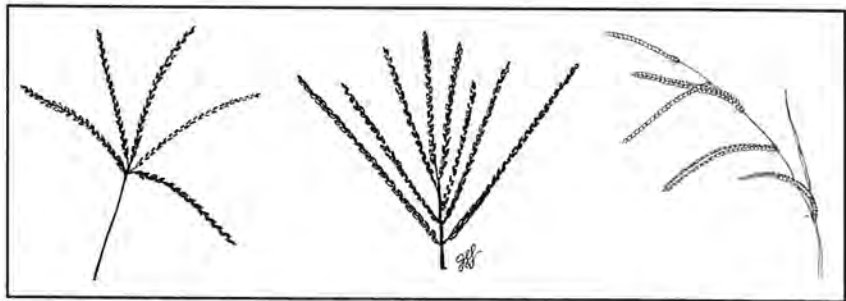


Figure 6. Flowering stems of bermudagrass (left), crabgrass (center), and dallisgrass (right).

**Cultural Control in Turfgrass**

Because crabgrass spreads and reproduces primarily by seed, any cultural efforts that reduce seed production will decrease occurrences of this weed. Cultural activities that increase the vigor of turfgrass also decrease the potential of crabgrass invasion. These include using the proper mowing height for your specific turf, selecting the best turf species for your area, overseeding to keep turfgrass thick, applying fertilizer at the correct time of year, and proper irrigation. For more information on maintaining vigorous lawns that out compete weeds, see The UC Guide to Healthy Lawns at [www.ipm.ucdavis.edu/TOOLS/TURF/TURFSPECIES/](http://www.ipm.ucdavis.edu/TOOLS/TURF/TURFSPECIES/).

**Mowing** at the optimum height for turf increases turfgrass vigor and reduces the germination and establishment of crabgrass. Select the proper mowing height from Table 1 for the dominant turfgrass species in your lawn. After mowing crabgrass-infested turf, thoroughly rinse the mower to remove seeds and avoid transferring them to uninfested sites.

**Selecting a turfgrass** that is adapted to your local conditions also will help produce vigorous turf. Cool-season species (bentgrass, Kentucky bluegrass, tall fescues, and perennial ryegrass) are most competitive in coastal and northern regions of California. Some of the newer cultivars of Kentucky bluegrass, tall fescue, and perennial ryegrass are even more competitive and grow better than the older cultivars. For example, tall fescue cultivars used

Table 1.

**Proper Mowing Height for Turfgrass Species.**

Turf species	Mowing height (in inches)
bentgrass, colonial	0.5–1
bentgrass, creeping	0.5 or less
bermudagrass, common	1–1.5
bermudagrass, hybrid	
Santa Ana	0.5–0.75
tifgreen	0.25–0.5
tifway II	0.5–0.75
bluegrass, Kentucky	1.5–2.5
dichondra	0.5–0.75
fescue, fine	1.5–2.5
fescue, tall	2–3
kikuyugrass	1–1.5
ryegrass, annual	1.5–2
ryegrass, perennial	1.5–2.5
St. Augustinegrass	1–2
zoysiagrass	.5–1

for turf vary in their ability to compete with both smooth and large crabgrass. Crabgrass tends to invade the older fescue varieties (Fawn and Kentucky 31), which grow in an open, upright manner. The slower-growing, dwarf-type tall fescue varieties, especially Bonsai, also are susceptible to crabgrass invasion. A newer Bonsai variety (2000) claims a more vigorous growth habit.

Warm-season species (bermudagrass, dichondra, St. Augustine grass, and zoysiagrass) are most competitive with weeds in interior valleys and desert regions. Kikuyugrass is more competitive in south coastal regions.



In the turf selection process it is important to consider the amount of foot traffic, pest problems, and/or shade, as these factors can significantly impact the vigor of the lawn. For example, hybrid bermuda can be very competitive, but only if it receives adequate sunlight. If it receives fewer than 6 hours of sun during the day, it will grow poorly and weeds can easily invade. Tar Heel tall fescue withstands more foot traffic on the lawn than does the variety Justice. Other newer tall fescue varieties include Barlexas, Coyote, Greenkeeper, and Innovator.

**Fertilizers** can increase turfgrass vigor and reduce the possibility of a crabgrass invasion. The best time to fertilize is when the turf is actively growing, which depends upon your turf species (Table 2). Because seedling crabgrass isn't very competitive, a vigorously growing turf will crowd out new seedlings.

**Irrigation** timing and amount also can affect crabgrass germination and growth. Overwatered turf or turf that receives daily, light irrigation becomes weak and vulnerable to invasion by this weed. Irrigating once a week will improve turf vigor. Often, crabgrass first appears in open areas with no turf, along sidewalks where the soil can be warmer, or around sprinkler heads where turf is mowed more closely.

**Cultural Control in the Landscape and Garden**

In the landscape, you easily can control crabgrass by mulching, hoeing, and hand pulling when the plants are young and before they set seed. You also can control this weed with solarization. Several chemical herbicides are available but often aren't necessary.

**Mulching** with wood products (e.g. wood chips or nuggets), composted yard waste, or synthetic landscape fabrics covered with mulch will reduce crabgrass in shrub beds and bedding plants and around trees by blocking sunlight needed for its germination, establishment, and growth. Mulch depth depends on the size of the particles; coarse mulch might need to be 3 to 6 inches deep to control all weeds, while

a finer mulch might need to be only 2 to 3 inches deep. Plan to replenish landscape mulches periodically because of decomposition, movement, or settling.

Organic mulches that have been on the soil for a while decomposing can provide an adequate growth medium for weeds to germinate and grow in. If crabgrass is germinating in the mulch, move it about with a rake to reduce seedling establishment. Hand pull escaped crabgrass plants before they set seed. Flaming with a hand-held burner will control crabgrass seedlings, but be careful not to set fire to the mulch if it is wood chips, compost, or another flammable material.

**Soil solarization** with clear plastic prior to planting is effective for eradicating crabgrass plants and seed if you apply it during periods of high solar radiation. For more information about this process, see *Pest Notes: Soil Solarization for Gardens & Landscapes* in References.

**Chemical Control**

Crabgrass is easy to control in both turfgrass and ornamental beds if you apply preemergent herbicides before it germinates or postemergent herbicides after it germinates. Avoid using chemical herbicides in vegetable gardens because of the variety of crops grown and planted there.

Read the label to make sure the product is safe to use on your turf type and around the ornamentals in your landscape. The active ingredients listed below can be found under different brand names; for a partial list, see Table 3.

**Table 2.**  
Periods of Active Growth for Cool- and Warm-season Turf Species.

Turfgrass species	Period of active growth
<b>Cool-season turf</b>	
bentgrass	March–June, September–November
bluegrass, Kentucky	late February–late May, October–December
fescue, fine	March–June, October–December
fescue, tall	March–June, October–December
ryegrass, annual (for overseeding)	October–May
ryegrass, perennial	February–June, October–December
<b>Warm-season turf</b>	
bermudagrass	April–late September
dichondra	April–October
kikuyugrass	February–November
St. Augustinegrass	March–October
zoysiagrass	April–October

**Table 3.**  
Examples of Preemergent and Postemergent Herbicides with Brand Names.

Herbicide	Brand name	Homeowner or professional use?	For use on turf?
<b>Preemergents</b>			
bensulide	Bensumec, Pre-San	homeowner	yes
dithiopyr	Dimension, Preen	professional	yes
oryzalin	Surflan, Weed Impede	homeowner	yes
oxadiazon	Ronstar	professional	yes
pendimethalin	Pendulum, Pre-M, Scotts	homeowner	yes
prodiamine	Barricade	professional	yes
trifluralin	Vegetable and Ornamental Weeder	homeowner	no <sup>1</sup>
<b>Postemergents</b>			
dithiopyr	Dimension, Preen	professional	yes
fluazifop	Poast, Grass Getter, Ornamec	homeowner	no
quinclorac	Drive, Momentum, Trimec Crabgrass	homeowner	yes
sethoxydim plus oil	Fusilade	homeowner	no

<sup>1</sup> Warm-season turf (bermudagrass and St. Augustine only). Will injure cool-season species.



**Preemergent herbicides** available for home gardeners for crabgrass control in warm-season grasses (bermudagrass and zoysiagrass) and cool-season grasses (Kentucky bluegrass, fine fescue, tall fescue, and perennial ryegrass) include benefin, bensulide, pendimethalin, and trifluralin.

Professional pesticide applicators also can use dithiopyr, oxadiazon, and prodiamine. Oryzalin also is available for home gardeners, but it is for use in warm-season turf (bermudagrass and zoysiagrass) only.

Apply preemergent herbicides before crabgrass germinates, usually around the first of March. Many fertilizers contain a preemergent herbicide (weed and feed) so that the spring fertilization and preemergent treatments can be done at the same time. However, timing is critical, and weed and feed products often are applied at the wrong time.

Crabgrass has germinated as early as Jan. 30 in Bakersfield and Fresno on warm days. If a preemergent were applied at that time it could start to break-down in 4 to 5 months, and a second application could be required. Follow label directions during application and make sure there is adequate overlap, as the herbicide is applied in the lawn to prevent strips of weeds from coming up.

There are few **postemergent herbicides** available for crabgrass control in lawns. Dithiopyr currently can be applied to home lawns but only by professional applicators. Dithiopyr provides good preemergent control of seeds and con-

trols emerged crabgrass plants up to the third leaf stage.

Quinclorac often is sold in a ready-to-use spray bottle for the homeowner; however, crabgrass control is only partial, and some species have shown resistance to this product. Companies have stopped making products containing the active ingredients MSMA and DSMA, which have been used since the 1950s, and some companies are substituting quinclorac.

Use postemergent herbicides when crabgrass is small (in the 1- to 3-leaf stage). If the crabgrass is larger, it takes more herbicide to control it, and there is a greater chance of injury to the turfgrass.

In **ornamental beds**, home gardeners can use the preemergent herbicides benefin, oryzalin, and trifluralin to control crabgrass. Landscape professionals also can use oxadiazon, pendimethalin, and prodiamine. You can use these chemicals either before crabgrass has germinated or after you've removed the weed by hoeing or hand pulling but before another flush of germination.

Use a postemergent selective herbicide (fluazifop, quinclorac, or sethoxydim plus oil) to control crabgrass over or around most broadleaved ornamentals. You also can use nonselective herbicides such as glufosinate-ammonium, glyphosate, or pelargonic acid. Use nonselective herbicides with care to prevent them from harming desirable shrubs. All of these herbicides are available for use for home gardeners.

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Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original, labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Pesticides applied in your home and landscape can move and contaminate creeks, rivers, and oceans. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash or pour pesticides down the sink or toilet. Either use the pesticide according to the label, or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Household Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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# DALLISGRASS

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*Integrated Pest Management for Home Gardeners and Landscape Professionals*

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Dallisgrass, *Paspalum dilatatum*, is a tufted perennial grass that was introduced into the United States from Uruguay and Argentina. It is now naturalized in much of the southern United States. In California dallisgrass is found throughout the state except at high elevations, such as the Great Basin and Sonoran Deserts. It has been used as a pasture grass in wet areas or irrigated sites, but it is less commonly used as forage in California because of its weedy character. The seed heads are susceptible to an ergot fungus that is toxic to livestock when ingested. Dallisgrass is primarily a weed in turfgrass, wet roadside areas, irrigation ditchbanks, and in some orchards and vineyards. It is closely related and similar in appearance to knotgrass, *Paspalum distichum*, which is a mat-forming perennial grass with good forage qualities and more desirable attributes for natural areas. Bahiagrass, *Paspalum notatum*, is also a warm-season tufted perennial with short rhizomes that could be confused with dallisgrass.

## IDENTIFICATION AND LIFE CYCLE

Dallisgrass is a coarse-textured grass that grows in a clump and slowly increases in diameter as its shallow, underground stems (short rhizomes) grow outward. The rhizomes have short internodes (the length of stem between the joints) that look like concentric rings on its surface (Fig. 1). The presence of these distinctive rhizomes is a good way to distinguish dallisgrass from other common clumping grasses in lawns, such as crabgrass. As the clump matures, the center may die and a different grass or weed may be growing in its center. Where large



**Figure 1.** Dallisgrass grows in a clump and increases in diameter as its shallow, underground stems (rhizomes) grow outward.

numbers of dallisgrass plants grow together they can form almost a solid planting with uneven texture and poor turfgrass qualities.

The leaf blades of dallisgrass are fairly wide ( $\frac{1}{4}$ – $\frac{1}{2}$  inch) compared to desirable thinner turf grasses. If left unmowed, blades will grow 4 to 10 inches long. At the base of each leaf blade is a collar with a membranous ligule about  $\frac{1}{4}$  inch long and no auricles or projections. At the base of the collar is the leaf sheath, which is slightly flattened. Frequently there is purplish coloration at the base of the grass stems (technically called culms). The flowering stalk (raceme) grows 14 to 65 inches tall and the flower head (inflorescence) consists of 2 to 10, often drooping, spikelets (delicate branches) that arise from different points at the top of the flower stalk. Each spikelet has two rows of flat, egg-shaped seeds along its entire length and is pale green to purplish in color. (Fig. 2).

For information on other troublesome species of grasses or grasslike weeds, see *Pest Notes on Annual Bluegrass, Bermudagrass, Crabgrass, Kikuyugrass, Nutsedge, and Green Kyllinga* listed in Suggested Reading.

Dallisgrass produces abundant amounts of seed, which are its primary means of dispersal. Water, lawn mowers, and humans or pets spread the seed to new places. Seeds usually germinate in spring and summer when soil temperatures are in the 60° to 65°F range and grow to form new clumps. The optimum air temperature range for growth is 80° to 90°F and when temperatures are in this range, plants grow very rapidly. This weed is often found growing in wet areas such as drain ditches, low places, and in heavily irrigated turfgrass. It tolerates both sandy and heavy clay soils and, once established, is drought-resistant and frost-tolerant. Dallisgrass does not become off-color in winter like many



warm-season grasses. It responds to nitrogen fertilizer and competes well against turfgrasses in fertilized sites.

### IMPACT

Dallisgrass creates an unsightly clump in turfgrass that can be a problem in golf courses, sports playing fields, and home landscapes. The stiff clumps are much coarser in texture than other grasses common in developed recreational areas such as lawns, golf courses, or parks and can present a hazard in sports fields and play areas, causing people to fall. It has a faster growth rate than turfgrasses. The flower stalks (racemes) often escape mowing and spring back up above the rest of the turfgrass, causing problems in golf courses and sports fields as well as lending a rough, uneven appearance to lawns (Fig. 3).

### MANAGEMENT

A major component of dallisgrass management is preventing establishment of new plants. In home landscapes, removing young plants by digging them out before they form rhizomes or set seed is the best strategy for control. Mature plants can also be dug out, but they sometimes grow back if rhizomes are left behind. In professionally managed turfgrass areas, prevention is an important component in managing this weed. When dallisgrass is abundant or the plants are located over a large area, it may be necessary to supplement cultural practices with herbicides.

#### Prevention

Dallisgrass can be introduced into lawn areas with new turfgrass seed or sod, but often the seed is introduced on mowers that have been used in contaminated sites and then moved to weed-free sites. Cleaning a mower after mowing a contaminated site should reduce the chance of invasion into new areas. Inspect sod before taking delivery to make sure dallisgrass is not present. Don't use soil from dallisgrass-contaminated areas to repair low or bare spots in lawns. In dallisgrass infested areas delay or minimize the amount of aeration performed on the turfgrass in spring when new

seedlings germinate to avoid small open areas where dallisgrass plants might become established.

#### Cultural Control

Because dallisgrass is a perennial plant, persistence is required to kill it with cultural practices. In lawn areas the clumps can be removed by digging. Mowing the turfgrass will not remove dallisgrass, but when turfgrass is mowed at its optimum height, it is better able to resist an invasion of this weed.

When dallisgrass has been established for some time in the turfgrass, seed will be abundantly present in the soil. In well-established turfgrass, seedlings may not be able to establish, but if there are open areas in the turf, seed will germinate in these areas. If bare areas are present, overseed them with desirable turfgrass species to reestablish the turf.

Dallisgrass is not normally a problem in ornamental beds, but if it does occur, the plants can be dug out and a thick layer of mulch laid over the area to control the seedlings. Along roadsides and fences or in orchards and vineyards, the plants can be dug out during summer and left in place for the clumps of rhizomes to dry. As long as all the rhizomes are dug up and dried, the plant will not regrow. New seed will continue to germinate and establish unless the seedlings are removed.

Mulching with organic materials is not very effective for the control of mature dallisgrass. However, if the tops of the plants are removed down to the soil line, laying black plastic or landscape fabric over the area will control the remainder of the plant as well as any new seedlings. Summer solarization with clear plastic significantly helps control dallisgrass seed and reduces rhizome regrowth. For information on solarization, see the publication *Soil Solarization: A Nonpesticidal Method for Controlling Diseases, Nematodes, and Weeds* listed in References.



Figure 2. Dallisgrass flower head.

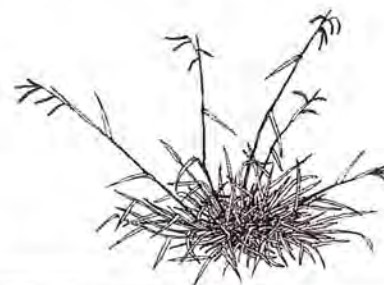


Figure 3. Dallisgrass creates unsightly clumps in turfgrass and the flower stalks often escape mowing causing hazards in recreational areas.

#### Chemical Control

Where digging out clumps of dallisgrass in turfgrass is not practical, herbicides may be used. Herbicides to control established plants are referred to as *postemergent* herbicides. These herbicides are either selective and kill only specific weeds, or they are nonselective and kill any plant they come in contact with. To control germinating seed, *preemergent* herbicides are used. In order to obtain complete control of this perennial grass weed, it is necessary to control both the established dallisgrass plant and the germinating seed.

**Established Plants in Turfgrass.** The postemergent herbicides MSMA or CMA (such as Weed-Hoc or Weed-B-



Gon Crabgrass Killer for Lawns) can be used by home gardeners to control clumps of dallisgrass growing in lawns. These herbicides are relatively selective and must be applied two to three times at 3-week intervals in the summer. The turfgrass and dallisgrass should be in good growing condition before application. Also, it is best if the turf is left unmowed for 2 weeks before the first application to create the maximum amount of leaf area for coverage by the herbicide spray. Withhold irrigation for 24 hours after application. Don't apply these herbicides during extremely hot weather and check the label for rate adjustments during warm weather to minimize the risk of injuring the turfgrass. There are some restrictions on turfgrass types where these products can be used, such as on St. Augustinegrass.

Foramsulfuron (Revolver) is a new postemergent herbicide for control of cool-season grass weeds and turf species in warm season lawns. It can only be used in bermudagrass and zoysiagrass lawns and has good weed control activity on dallisgrass, but be aware that it is harmful to most cool season turfgrasses. This product is only available to professional applicators at this time, but may be used on residential lawns.

Some turf managers and home gardeners use the nonselective herbicide glyphosate (Roundup) to control dallisgrass in turf. Glyphosate kills both the dallisgrass and the turfgrass, leaving an area of dead turf. To keep the turf vigorous and growing well enough to out compete germinating dallisgrass seed, the spot needs to be overseeded or a preemergent herbicide needs to be applied. Sometimes dallisgrass is not entirely killed after an herbicide treatment, even though the turf is severely damaged or killed, and retreatment may be required. Other nonselective postemergent herbicides are not as effective as glyphosate.

**Seed in Turfgrass.** Preemergent herbicides can be used in established turfgrass to control germinating dallisgrass seed. Apply preemergent her-

bicides in late winter or early spring before dallisgrass seed germinates. Herbicides that control crabgrass such as benefin + oryzalin, bensulide, DCPA, dithiopyr, oryzalin, oxadiazon pendimethalin or prodiamine, are also effective on dallisgrass. (Bensulide, DCPA, and oxadiazon are for professional use only and may have some restrictions for use on residential lawns.) Preemergent herbicides used on lawns need to be irrigated into the soil with about ½ inch of water relatively soon after application in order to become effective. Consult the label for application details.

**Ornamental and Noncrop Areas.** In ornamental or noncrop areas, glyphosate can be used as a nonselective treatment to control established plants. Apply glyphosate when dallisgrass is flowering but before seed has been produced.

The preemergent herbicides napropamide, oryzalin, pendimethalin, or combinations of benefin plus oryzalin are effective to prevent dallisgrass seed from germinating. Benefin plus trifluralin is also available, but only for use by commercial pest controllers. Once seedlings appear, then postemergent herbicides may be necessary to control them chemically.

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## SUGGESTED READING

For information on other troublesome species of grasses or grasslike weeds, see these additional *Pest Notes* on Annual Bluegrass, Bermudagrass, Kikuyugrass, Nutsedge, and Green Kyllinga. Available online, <http://www.ipm.ucdavis.edu/PMG/PESTNOTES>.

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Pesticides applied in your home and landscape can move and contaminate creeks, rivers, and oceans. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

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# DANDELIONS

Integrated Pest Management for Home Gardeners and Landscape Professionals



Figure 1. Dandelion.

Dandelion (*Taraxacum officinale*), also known as lion's tooth, puffball, blowball, and monk's head, is a major problem in turf, ornamental plantings, meadows, pastures, and alfalfa. The genus *Taraxacum* consists of about 40 species worldwide, but only two are found in California. *Taraxacum californicum* is found in mountain meadows and *T. officinale* is found as a weed throughout California.

Dandelion was introduced from Europe and has been used as a pot-herb and medicinal plant since Roman times. It has a high vitamin and mineral content. Mature leaves are often dried and used to make a mild tea. Roots are often used to make stronger tea or dried and used for various medicinal purposes including a mild diuretic. Salads, beer, and wine are also made from the leaves and flowers.

## IDENTIFICATION AND LIFE CYCLE

Dandelion is a perennial that grows best in moist areas in full sun; however, it can survive some shade and dry conditions once established (Fig. 1). Dandelion grows year round in California except in the coldest intermountain areas where it is dormant during the winter. It produces a strong taproot that is capable of penetrating the soil to a depth of 10 to 15 feet, but it is most commonly 6 to 18 inches deep. Buds grow from the uppermost area of the root, producing a crown that can regenerate "new" plants even though the plant is cut off at or below the soil surface. Sections of the root as short as 1 inch in length are also capable of producing new plants. There are no true stems, rather the leaves are clustered in a rosette at the base of the plant. Leaves vary in length from 2 to 14 inches and from 1/2 to 3 inches wide. Margins of the leaves are deeply serrated forming the typical "lion's tooth" outline from which the name is derived (dent-de-lion = tooth of the lion) (Fig. 2).

Flowering stalks are 6 to 24 inches in length and terminate in a compound inflorescence or head that contains 100 to 300 ray flowers and looks like a characteristic puffball. Each ray flower has a strap-shaped yellow petal with five notches at the tip. Dandelion flowers are not normally pollinated but develop asexually. Flowering occurs nearly year round in the temperate climatic regions of California. The seeds are achenes and are about 1/8 inch in length with five to eight ribs. At the apex of the achene there is a slender stalk (about two to four times the length of the achene) that

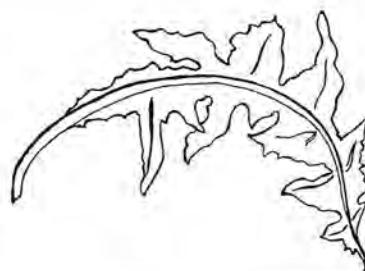


Figure 2. Deeply serrated dandelion leaf margin.

terminates in a parachute-like structure (pappus), allowing the seed to be transported via wind currents for miles (Fig. 3).

Seed germination occurs at or very near the soil surface. Light increases germination. The seed germinates when soil is moist and soil temperature is at least 50°F; however, germination is more rapid when the soil temperatures are closer to 77°F. Germination occurs throughout the growing season. The seedling stage can last 8 to 15 weeks, depending on temperature and growing conditions.

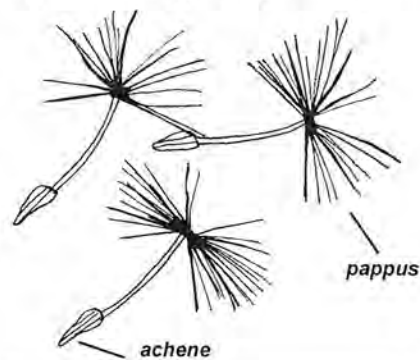


Figure 3. Dandelion seed.

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Division of Agriculture and Natural Resources

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Seedling growth is slower in cold weather.

Flowering begins soon after the seedling stage and continues throughout the life of the plant. Dandelion plants can survive for many years, developing massive, thickened crowns 6 to 10 inches across. These perennial plants are well adapted to irrigated areas such as in turfgrass, pastures, or alfalfa where frequent mowing or grazing is practiced.

**IMPACT**

Dandelion can be a major weed problem for turf and ornamental managers. In turf, it forms clumps that cause poor footing for athletic fields and golf courses. Dandelion's texture and color vary from that of normal turfgrass and the yellow flowers reduce the aesthetic quality of the turfgrass.

When dandelion infests turfgrass and ornamental plantings, it forms dense circular mats of leaves (6 to 14 inches in diameter) that crowd out desirable species and reduce the vigor of those plants that survive. Because of the extensive root system of established plants, hand-pulling or hoeing to remove dandelion is usually futile unless done repeatedly over a long period of time. Thus, control by this means is most successful in areas such as home lawns and gardens. Once a few plants become established in turfgrass or ornamental areas, their seed can be spread by wind or equipment.

Dandelion is also found in nontilled orchards where mowing is used for weed control. It can be a problem in spring when trees are in bloom because it is very attractive to bees. The pappus on the seed frequently clogs up tractor radiators, and roots of dandelion are attractive to gophers. As a weed in irrigated pastures and alfalfa, dandelion is usually most serious in the intermountain regions of

California where these sites remain in production for long periods of time (more than 5 years). Although it is slow to establish, once established it is difficult to control because of its extensive root system.

**MANAGEMENT**

Because dandelion seed can be windborne for several miles, prevention of new infestations is difficult. Solitary new dandelion plants along fence rows, roadsides, flower beds, and in turfgrass should be grubbed out (digging out the entire plant, taproot and all) before they produce seed. Monitor the area for several months to make sure that removal was complete. Areas with infestations should be isolated and seed heads removed until control can be accomplished. Turfgrass and ornamental areas should be well maintained to assure maximum vigor. Making these plantings as competitive as possible will slow invasion of the weed. Dense stands of turfgrass and ornamentals shade the soil surface, making the establishment of new dandelion seedlings more difficult.

**Home Landscapes**

In the home landscape, dandelion plants can easily be grubbed out, especially when they are young. Dandelion knives and similar specialized tools are available for removing in-

dividual weeds and their roots while minimizing soil disturbance. Control dandelion plants before they set seed to reduce the potential for further invasion by this weed. Also, landscape fabrics (see "Ornamentals" below) can be used to control this weed.

**Turfgrass**

No single control procedure has been successful in controlling dandelion in turfgrass. Early grubbing of new seedlings has been successful when practiced diligently. These plants must be dug up regularly for several years to be successfully eliminated. Spot spraying isolated plants with glyphosate can be helpful, but the turfgrass is killed, leaving open areas. Overseed the open spots to establish a vigorous turf sod.

The preemergent herbicides commonly used to control crabgrass in turfgrass have not been successful in limiting germination of dandelion. However, a relatively new broadleaf preemergent herbicide, isoxaben, has been effective but, like all preemergent herbicides, must be applied to the soil before the dandelion seed germinates (Table 1).

Postemergent herbicides that control broadleaf weeds (2,4-D, triclopyr, MCPA, and mecoprop) can control dandelion seedlings. Control of es-

**TABLE 1. Summary of Herbicides for Dandelion Control.**

Site	Material	Applied to soil before germination	Applied to young plants	Readily available to home gardeners
Turfgrass	glyphosate	—	x	yes
	isoxaben	x	—	yes
	2,4-D	—	x	yes
	triclopyr	—	x	yes
	MCPA	—	x	yes
Ornamentals	mecoprop	—	x	yes
	isoxaben	x	—	no
Orchards	oxyfluorfen	x	—	no
	glyphosate	—	x	yes

x = yes  
— = no



established plants with a postemergent treatment is much more difficult; 2,4-D works best for established dandelion control while triclopyr, MCPA, and mecoprop reduce dandelion vigor but do not kill it.

### Ornamentals

There are few options for the control of dandelion in ornamental plantings. Prevention is very important. Hand removal or spot treatment of solitary plants with glyphosate will save time and money in the long run. Pulling or hand-hoeing is helpful if done periodically during the year; however, regrowth from the extensive perennial root system limits the effectiveness of this method.

Mulching with landscape fabrics can be particularly effective for controlling seedlings if the fabric is overlapped and no light is allowed

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to penetrate to the soil. Use a polypropylene or polyester fabric or black polyethylene (plastic tarp) to block all plant growth. Fabric mulches should be covered with an organic mulch to improve aesthetics and to reduce photodegradation. Organic mulches such as wood chips or bark may also be effective in controlling dandelion seedlings if they are at least 3 inches deep and are managed in such a way as to not provide a growth medium for new dandelion seedlings.

Isoxaben and oxyfluorfen have been useful in limiting dandelion infestations when they are applied to the soil before the seed germinates. These materials can only be applied by a licensed pesticide applicator, and control may be difficult because of dandelion's extended germination period. If isoxaben is used, lightly hoe any dandelion seedlings that escape the treatment; if oxyfluorfen is used, do not disturb the soil after application.

Few postemergent herbicides are registered for use in established ornamental plantings. Spot treatment with glyphosate can control existing dandelion plants, but do not allow the spray or drift to contact desirable plants or injury will result.

### Orchards

Dandelion can be managed in commercial orchards through summer cultivations or by maintaining a competitive cover crop. Glyphosate is often used to spot treat individual plants.

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# Invasive Plants of California's Wildland

*Foeniculum vulgare*

Scientific name *Foeniculum vulgare*

Additional name Miller

information:

Common name fennel, anise, sweet fennel, aniseed, sweet anise, sweet fennel

Synonymous scientific names *Anethum foeniculum*, *Foeniculum officinale*

Closely related 0

California natives 0

Closely related 0

California non-

natives:

Listed

CalEPPC List A-1, CDFA nl

*Distribution*



HOW DO I  
RECOGNIZE IT?

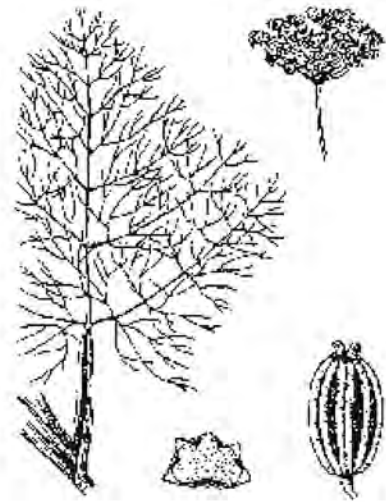
*Distinctive  
features:*

Fennel (*Foeniculum vulgare*) is an erect perennial herb, four to ten feet tall, with finely dissected, almost feathery leaves and characterized by a strong anise scent originating from stems and leaves. The flowers are yellow and small (one-quarter inch across), and are clustered in large, rounded, umbrella-like groups (compound umbels), roughly four inches across, that are conspicuous from April through July. During the growing season plants usually include a mixture of living and dead hollow stems (canes). Branches arise from the stems at conspicuously jointed nodes, and leaves arise both from the root crown and from the stems. Leaves sheath the stems where they meet. Seeds of wild fennel look like the fennel seed commonly used as a flavoring in foods: they are oblong, dorsally compressed, and ribbed.



*Description:*

Apiaceae. Perennial herb, 3.3-12 ft (1-3.5 m) high with a characteristic anise or licorice scent. Roots: mature plants have a thick, deep taproot from which erect, solid glaucous-green stems arise. Stems: 10-20 stems originate from a basal cluster in late winter, then die back the following September-November. Leaves: petioles 2.8-5.6 in (7-14 cm) long sheaths hug the stem; leaf blades triangular-ovate in outline and 0.3-2 ft (10-60 cm) long, 1-1.3 ft (30-40 cm) wide, finely dissected into nearly thread-like segments. Inflorescence: compound umbel with 15-40 spreading-ascending rays, each 0.4-1.6 in (1-4 cm) long.



Flowers: no sepals, yellow petals with narrowing tips, 5 small stamens, inferior ovary topped by two short styles. Fruits: 0.1-0.2 in (2.5-4.5 mm), oblong-ovate, dorsally compressed, with thick, prominent ridges.

**WHERE WOULD I FIND IT?**

In California fennel is found in mesic locations with a Mediterranean climate from sea level to 2,000 feet. It usually colonizes disturbed areas, especially weedy sites adjacent to fresh or brackish water, and pastures, abandoned lots, and roadsides. Common in open habitats such as grasslands, coastal scrub, savannas, and the banks of creeks, estuaries, and bays. Dense local populations have been reported from Santa Cruz Island, in fields around the San Francisco Bay region, Palos Verdes Peninsula (Los Angeles County), and Camp Pendleton (San Diego County). It is widely scattered in fields and ditches throughout the Sacramento, Salinas, and San Joaquin valleys and foothills, and in hillside pastures of most coastal counties from Mendocino south to San Diego. Fennel is particularly aggressive in areas subjected to plowing or medium-heavy grazing and recently abandoned (Beatty 1991).

Fennel occurs in soils with pH ranging from 4.8 to 8.3, but appears to prefer more acidic than alkaline conditions. The preferred soil type appears to be well drained, sandy soils, but it has been observed to thrive in sites with a high clay content (pers. observation). Fennel forms dense stands in localized areas (Beatty 1991, Beatty and Licari 1992, R. Klinger, unpubl. data).

**WHERE DID IT COME FROM AND HOW IS IT SPREAD?**

Fennel is native to southern Europe and the Mediterranean region, where it has been used for centuries as a spice and for medicinal purposes (Garland 1979). Although details about its introduction are unknown, it has occurred in California for at least 120 years and is presumed to have escaped from cultivation repeatedly (Robbins et al. 1941).

Fennel will reproduce from both root crown and seed. Seeds are dispersed by water and on vehicles and clothing. Birds and rodents eat the seeds and may disperse them as well.

**WHAT PROBLEMS DOES IT CAUSE?**

Fennel will invade areas where the soil has been disturbed and can exclude or prevent reestablishment of native plant species. It can drastically alter the composition and structure of many plant communities, including grasslands, coastal scrub, riparian, and wetland communities. It appears to do this by outcompeting native species for light, nutrients, and water and perhaps by exuding allelopathic substances that inhibit growth of other plants (Granath 1992, Colvin 1996, Dash and Gliessman 1994). It develops dense, uniform stands. On Santa Cruz Island fennel can

achieve 50 to 90 percent absolute cover and reach heights of ten feet (Brenton and Klinger 1994). Once established, fennel is tenacious and difficult to control. Because of its prolific seed production and seed viability, a long-lived seedbank can build up rapidly.

Most impact assessment for fennel has focused on native plants, but fennel's value to animals is unknown. Grazers will feed on early-season regrowth, and feral pigs will seek out and eat the roots, but mature stems are generally not used as food. Birds and rodents eat the seeds.

Fennel stand development and successional patterns are poorly understood, especially with regard to persistence. It is unclear whether fennel stands are an edaphic climax, or whether another plant community will replace them after several decades. In parks and preserves where fennel removal is part of a restoration program, transitional communities will occur after fennel is removed, but these may be dominated by other non-native species (Brenton and Klinger 1994). Klinger and Brenton (in prep. and in review) found there was a significant increase in native herbaceous species shortly after removal of fennel, but the areas quickly became dominated by non-native grasses.

## HOW DOES IT GROW AND REPRODUCE?

Fennel reproduces from both root crowns and seeds. Flower production generally begins when individuals are eighteen to twenty-four months old. Flowering stems begin to be produced in late winter to early spring, and flowers appear by early May. Seed production is prolific and can begin as early as May and continue through early November. Generally, seed production peaks in August and September. Seeds are dispersed by water, by animals, and by humans by clinging to clothing or mud on vehicles.

Seeds may persist in soil for several years without germinating. Germination can occur almost any time of the year. Vegetative growth begins in mid-winter and peaks in July to August. Initial growth during winter and spring is slow, then becomes rapid in early summer. Flowering stems die during late fall and early winter, although some remain alive and begin to produce new leaves with the onset of rains. Plants have a thick taproot.



There is little quantitative data on the population biology of fennel. Data on germination rates, seed production, survival, and longevity, density, and viability of the seedbank would be useful for developing management programs.

(click on photos to view larger image)





## HOW CAN I GET RID OF IT?

Little published information is available on controlling fennel (Brenton and Klinger 1994, Dash and Gliessman 1994). Management plans should include a survey of where fennel occurs, the current land use, land use in adjacent areas, anticipated changes in land use, and primary dispersal mechanisms.

In areas where fennel stands are already well established, management will require a long-term commitment of time and resources. Management efforts should focus on preventing or reducing disturbance favorable to further spread (soil disturbance, moderate to heavy grazing) and reducing fennel density within dense stands. Dash and Gliessman (1994) reported that non-native species dominated all areas following fennel control regardless of the technique used. For these reasons, fennel removal should be considered only a first step in a larger restoration process that will require other actions to favor recolonization by native species (Dash and Gliessman 1994). It is probably impossible to completely eradicate fennel from wildlands, but reducing stand density and disturbance will minimize its impacts.

### *Physical control:*

**Manual/mechanical methods:** Manual methods are most effective when infestations are light and locally restricted (Dash and Gliessman 1994). Digging out individual plants by hand is preferred to plowing or bulldozing because it minimizes soil disturbance, but it is labor-intensive.

Cutting, mowing, and chopping temporarily reduce the height of fennel plants within a stand, but they are ineffective as methods of removal and minimally impact the spread of fennel stands (Dash and Gliessman 1994, Colvin 1996). These techniques leave the roots intact, alive, and ready to support regrowth of shoots. Repeated cuts may have more impact by helping to exhaust the resources of the taproot over time. However, intervals between cuts must be short, because fennel recovers rapidly from cutting and begins to replenish its root energy supplies (Brenton and Klinger in review, Dash and Gliessman 1994). Cutting while plants are producing seed will promote dispersal.

**Prescribed burning:** Experiments on Santa Cruz Island indicate that burning is not an effective control method by itself (Klinger and Brenton in prep.). However, fall burns (November-December) followed by herbicide sprays the following two springs can reduce fennel cover 95 to 100 percent (Klinger and Brenton in prep.). For reducing fennel in large areas with dense stands, this method is effective but costly.

*Biological control:* Insects and fungi: No biological controls agents for fennel are known.

Grazing: Use of livestock to control fennel will probably be ineffective except where stands are small, not very dense, and young. In older and/or dense stands grazing will spread fennel further (Brenton and Klinger 1994). Since fennel can reproduce by roots as well as seed, removal of above-ground shoots will slow, but not prevent, vegetative spreading. If livestock are in pastures when fennel is producing seed, they will spread the seed to new areas. Most heavily infested areas of Santa Cruz Island were formerly used as cattle pastures (Beatty 1991).

*Chemical control:* Brenton and Klinger (1994 and in review) found that 95 to 100 percent kill was achieved when amine and ester formulations of triclopyr (Garlon 3A® and Garlon4®, respectively) were applied to fennel in early spring at rates of 6 lbs/100 gallons water (1 lb active ingredient/acre) on Santa Cruz Island. Lower concentrations (3.0 and 4.5 lbs/100 gallons) of both the amine and ester formulations were less effective, and all treatments were less effective when administered in late summer rather than early spring. Cutting fennel and treating the cut stems did not increase the effectiveness of the herbicide.

Dash and Gliessman (1994) reported that glyphosate (as Roundup®) sprayed in spring at the manufacturer's recommended rate reduced fennel cover 75 to 80 percent. Cutting prior to spraying did not increase the effectiveness of the treatments.



# FIELD BINDWEED

*Integrated Pest Management for Home Gardeners and Landscape Professionals*

Field bindweed, *Convolvulus arvensis*, (Fig. 1) is a native of Eurasia that first was documented in California in 1884 in San Diego. By the first quarter of the twentieth century, field bindweed was proclaimed the worst weed in California and many other Western states. It most likely arrived in the United States as a contaminant in farm and garden seeds. However, because of its flowers and climbing nature, some seeds were probably planted as ornamentals, as a ground cover, in hanging baskets, or on trellises. Field bindweed has been given many names including perennial morningglory, creeping jenny, bellbine, sheepbine, and cornbind.

## IDENTIFICATION

The first two leaves (cotyledons) of a field bindweed seedling are nearly square with a shallow notch at the tip (Fig. 2). Plants that arise from rhizomes (underground stems) lack these seed leaves. The first true leaves are arrowhead shaped and have petioles (leaf stems) that are flattened and grooved on the upper surface (Fig. 3).

Mature field bindweed plants have arrowhead-shaped leaves that can be 1/2 to 2 inches long, depending on environmental conditions. Mature leaves at the base of the stem are larger than the young leaves at the stem terminal. The flowers are trumpet shaped, white to pink, and 1 to 1 1/2 inches wide.

Field bindweed is a prostrate plant unless it climbs on an object for support. It often is found growing on upright plants, such as shrubs or grapevines, with its stems and leaves entwined throughout the plant and the flowers exposed to the light (Fig. 4). Under warm, moist conditions, leaves



Figure 1. Field bindweed.



Figure 2. The first two leaves (cotyledons) of a field bindweed seedling are notched.



Figure 3. Field bindweed seedling.

are larger and vines more robust than under drought conditions.

The root system has both deep vertical roots and shallow horizontal lateral roots (Fig. 5). The vertical roots can reach depths of 20 feet or more. However, 70% of the total mass of the root structure occupies the top 2 feet of soil. Most of the lateral roots are no deeper than 1 foot. Experiments on bindweed have shown that its root and rhizome growth can reach 2 1/2 to 5 tons per acre.



Figure 4. Field bindweed climbing up the stem of a shrub.

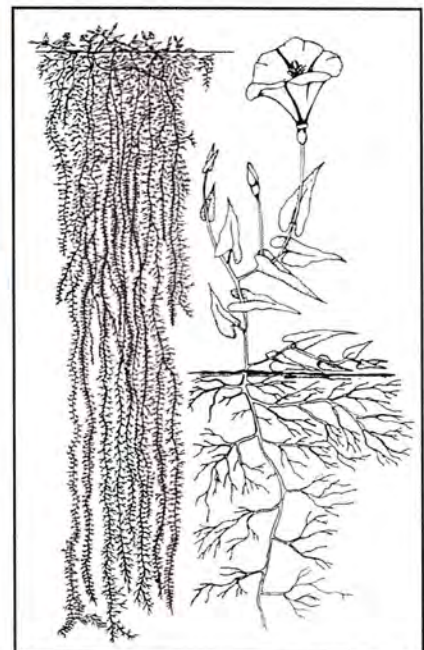


Figure 5. The root system of field bindweed can reach depths of up to 20 feet.

## PEST NOTES

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In contrast to field bindweed, the ornamental annual morningglory (in the genus *Ipomea*) has a larger (2-inch wide) and more showy flower that can be white to blue or purple (Fig. 6); it also has a thicker stem, that is sometimes hairy, and heart-shaped leaves that are 1 1/2 inches wide and 2 inches or more long. The two species are easy to distinguish from each other.

### LIFE CYCLE

Field bindweed is a hardy perennial found throughout California below the 5,000-foot elevation line. It spreads from an extensive rootstock and from seed. Most parts of the bindweed roots and rhizomes can produce buds that can create new roots and shoots. Roots capable of budding are found to depths of 14 feet. Fragments of vertical roots and rhizomes as short as 2 inches can form new plants (Fig. 7). Lateral roots serve another important function. About 15 to 30 inches from the parent plant, a lateral often turns downward, becoming a secondary vertical root, and sends out both roots and shoots from the turning point. By this means a single field bindweed plant can spread radially more than 10 feet in a growing season. This extensive underground network allows for overwintering without foliage, and it can persist for many years in the soil.

One to four dark brown seeds (Fig. 8) are produced in round, smooth, 1/4-inch capsules. An average plant produces about 550 seeds. Within one month after forming, the seed coat matures and becomes impervious to water. Seed that is 60 years old has been found to be viable. Once the seed coat is weakened, the seed will germinate at temperatures of 41° to 104°F.

Drought tolerance is a characteristic of field bindweed. In California, it seems to prefer heavy clay soils rather than sandy soils. When water is withheld, bindweed competes better than most other plants. If an area is well watered, some ornamentals might compete better than the bindweed; however, in most cases, bindweed will flourish and twine up plants. In the landscape,

field bindweed will survive with sprinkler or drip irrigation. If there is no summer water, the plant reduces its seed production first and then reduces growth and leaf size, but it still will produce some flowers and seed.

### IMPACT

Field bindweed is one of the most persistent and difficult-to-control weeds in landscapes and agricultural crops. It has a vigorous root and rhizome system that makes it almost impossible to control with cultivation between desirable plants or broad scale tillage alone; in fact, it often spreads the infestation. Its seed has a long dormancy and can last in soil for up to 60 years. It has a climbing habit that allows the plant to grow up other plants. In addition rhizomes have the ability to penetrate through fabric, plastic, and other barriers. Field bindweed also is very drought tolerant and once established is difficult to control even with herbicides.

If field bindweed is present, land is devalued and the weed precludes planting of many vegetable crops.

### MANAGEMENT

Control of field bindweed isn't easy, and it can't be accomplished with a single treatment or in a single season. Effective control requires prevention of seed production, reduction of stored carbohydrates by deep tillage of the root system, competition for light from other plants, and constant vigilance in removing top growth. Application of herbicides, which reduce bindweed growth and kill germinating seedlings, can also be part of an integrated pest management program.

#### Prevention

Three practices can reduce the possibility of introducing field bindweed—purchase and plant clean seed and ornamental stock, remove any seedlings before they become perennial plants, and prevent any plants from producing seed. If topsoil is introduced to a site, it should be free of roots, rhizomes, seeds, and other



Figure 6. Field bindweed (left) and the larger flowers of western morningglory (right).



Figure 7. Field bindweed plants developing from underground roots or rhizomes don't have seed leaves.



Figure 8. Field bindweed seeds.

bindweed propagules. It is important to control new infestations when they are small, because spot control is the least expensive and the most effective strategy.

#### Cultural Control

Experiments in some annual and perennial crops have demonstrated the effect of shade on bindweed growth. In these studies, alfalfa, cereal grains, sorghums, and corn partially reduced bindweed growth. Shade from shrubs and trees also should reduce growth, especially if there is another planting under the trees and the bindweed isn't allowed to climb above the foliage of these plants.



Seedlings of field bindweed are easy to control with cultivation, but only for about 3 to 4 weeks after germination. After that, perennial buds are formed, and successful control is much more difficult.

Cultivation or hoeing has been partially effective in reducing established stands of field bindweed. Cultivate about every 2 to 3 weeks and repeat whenever necessary. In conjunction with cultivation, withholding water to dry the site might help to reduce the perennial population in a summer season, assuming the roots have not tappered into deep moisture.

Landscape fabrics such as polypropylene and polyester and other mulches such as black plastic or cardboard have been effective for bindweed control if no light is allowed to reach the soil and the plant. The edges of the fabric must overlap so that the bindweed stems can't grow between the sheets and into the light. If holes are made in the fabric or plastic for plants, however, bindweed can also grow through these holes. A landscape fabric placed over soil then covered with bark or other plant-derived product (e.g., organic matter) or rock will likely keep field bindweed from emerging. It might take more than 3 years of light exclusion before the bindweed dies. Once landscape fabric or other mulch is removed, new bindweed plants might germinate from seed in the soil; be sure

to monitor the site and control any new seedlings. Complete death of the plant under the mulch takes 3 to 5 years.

**Chemical Control**

Herbicides have been relatively effective for suppression of bindweed but have been only partially effective for eradication (Table 1). If herbicides are used, supplementing them with appropriate preventive and cultural controls has the most success in eradication.

**Turfgrass areas.** In turfgrass areas field bindweed normally isn't a problem because frequent mowing reduces its vigor, though once established it will persist. Mowing the turfgrass won't get rid of established bindweed. Bindweed often will flower above the turf. For control, products containing 2,4-D and/or dicamba have been effective without injuring the grass turf. More than one application will have to be made during the summer growing season.

**Ornamental areas.** In ornamental landscape settings, field bindweed grows between and up through the canopy of plants. For control, products containing trifluralin, oryzalin, or pendimethalin applied before emergence will reduce new perennial shoots and control the germinating seedlings, but they won't kill

established bindweed plants. In open areas where there are no desirable plants, glyphosate (e.g., Roundup and other formulations) using a 2 percent solution is effective when bindweed plants are actively growing with no moisture stress. Glyphosate takes 2 to 3 weeks, depending upon the temperature at treatment, to kill the top growth, but it is effective, even though eradication isn't always possible. Glyphosate doesn't have residual activity, so repeated applications are necessary. It won't affect germination of field bindweed seed, so new seedlings will have to be controlled with mulch, preemergent herbicides, or persistent cultivation.

Some people have used a 2 percent solution (volume to volume) of glyphosate to paint the leaves of bindweed in shrub areas, but if you try this be sure not to allow the herbicide to touch mature leaves or green bark of ornamental shrubs or trees, or injury can result. To reduce the chance that glyphosate will contact desirable plants, place the bindweed vines on newspaper before painting the leaves. Once the glyphosate solution has dried on the bindweed leaves, the newspaper can be removed. Any regrowth of the field bindweed must be re-treated. Using a shield such as cardboard or wood is advisable while spraying herbicide treatments near ornamental plants.

**Table 1. Summary of Herbicides for Use Against Field Bindweed.**

Site	Material	Applied to soil before seeds germinate?	Applied to actively growing plants?	Available for homeowner or professional use?
turfgrass	2,4-D	no	yes	Found only in combinations for homeowner use.
	dicamba	no	yes	Found only in combinations for homeowner use.
ornamentals	glyphosate	no	yes	Readily available for homeowner use.
	oryzalin	yes	no	Some products available for homeowner use; some for professional use only.
	pendimethalin	yes	no	Readily available for homeowner use.
	prodiamine	yes	no	Readily available for homeowner use.
	trifluralin	yes	no	Readily available for homeowner use.
orchard/vineyard	glyphosate	no	yes	Readily available for homeowner use.
	trifluralin	yes	no	Readily available for homeowner use.
noncrop areas	dicamba	no	yes	Found only in combinations for homeowner use.
	2,4-D	no	yes	Found only in combinations for homeowner use.
	glyphosate	no	yes	Readily available for homeowner use.



If an area infested with bindweed is to be planted, irrigate the area to make the bindweed grow well, then treat the field bindweed with glyphosate before planting. After planting, use an appropriate preemergent herbicide or mulch and continue to control any seedlings or regrowth from the previously treated plants.

**Orchard and vineyard areas.** In orchards or vineyards where bindweed is growing beneath the branches or canes, glyphosate can be applied safely to the bindweed under the woody crop plants without injuring them, as long as tree suckers or low hanging branches aren't sprayed. For best control, apply glyphosate to the bindweed in fall when the bindweed is actively growing; however, spring treatment has the additional benefit of reducing seed production, vigor, and spread of the plant. Generally, additional applications need to be made when the bindweed regrows.

Seedlings must be controlled with mulch, tillage, or preemergent herbicides before they become established plants. Repeated cultivations are required to prevent bindweed from reestablishing. Because the seed lasts such a long time in the soil, control practices must be conducted continuously. See the UC IPM Pest Management Guidelines for grapes or specific tree crops for more information on managing weeds, <http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html>.

**Noncrop areas.** In areas outside the landscape or orchard, cultivation and herbicide treatment can be used. If herbicides are to be used, treat the bindweed plants before they are drought stressed. Use a translocated herbicide, such as glyphosate, or a combination of glyphosate and dicamba, in areas where its use is allowed, when the plant is actively growing. There is a plant-back interval to crops based on the crop to be planted. Re-treatments will be necessary to control both established plants and seedlings. If

possible, grow a competitive planting of other plants to reduce field bindweed growth and a crop that has herbicides available to use.

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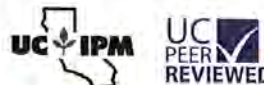
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# NUTSEDGE

*Integrated Pest Management for Home Gardeners and Landscape Professionals*

Nutsedges are common weeds in landscapes and gardens in the coastal valleys, Central Valley, and southern areas of California. They thrive in waterlogged soil, and their presence often indicates drainage is poor, irrigation is too frequent, or sprinklers are leaky. Once established, however, they will tolerate normal irrigation conditions or drought.

The two most common species of nutsedge in California are yellow nutsedge, *Cyperus esculentus*, (Fig. 1) and purple nutsedge, *C. rotundus*, (Fig. 2). Yellow nutsedge grows throughout California, while purple nutsedge grows mostly in the southern portions of the state.

## IDENTIFICATION

Although nutsedges resemble grasses and often are referred to as “nutgrass,” they aren’t grasses but are true sedges. Their leaves are thicker and stiffer than most grasses and are arranged in sets of three at their base (Fig. 3); grass leaves grow across from each other in sets of two. Nutsedge stems are solid, and in cross section they are triangular; grass stems are hollow and round, and in cross section they are almost flat or oval.

Nutsedge has three long, leaflike bracts at the base of each flower head. Yellow nutsedge has light brown flowers and seeds, while purple nutsedge flowers have a reddish tinge and the seeds are dark brown or black.

Yellow and purple nutsedges produce tubers, which are incorrectly called “nuts” or “nutlets,” thus the origin of their common name. The plants produce these tubers on rhizomes, or



Figure 1. Mature yellow nutsedge plant.



Figure 2. Mature purple nutsedge flower.

underground stems, that grow as deep as 8 to 14 inches below the soil surface. Buds on the tubers sprout and grow to form new plants and eventually form patches that can range up to 10 feet or more in diameter.

Yellow nutsedge produces round, smooth, brown or black tubers that can be up to 1/2 inch at maturity (Fig. 4). Only a single tuber forms at the end of a rhizome, and the tubers have a pleasant almond taste.

Red or red-brown scales cover purple nutsedge tubers. The tubers grow in chains with several of them on a single rhizome (Fig. 5), and they have a bitter taste. Purple nutsedge tubers can be up to 1 inch at maturity.

One weed often confused with yellow or purple nutsedge is tall umbrella

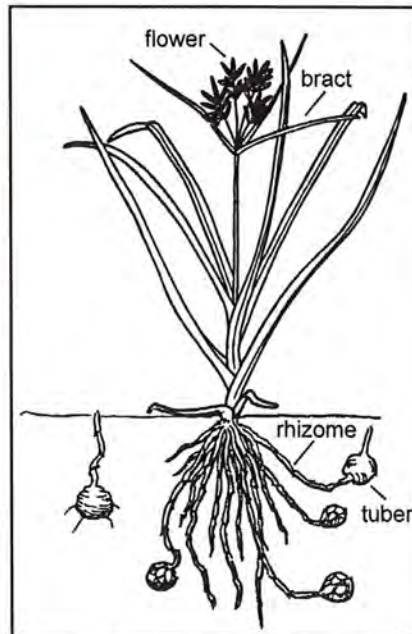


Figure 3. Yellow nutsedge leaves and bracts are arranged in sets of threes.



Figure 4. Yellow nutsedge roots, rhizomes, and tubers.



Figure 5. Purple nutsedge root system showing tubers linked in chains.

## PEST NOTES

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sedge, *C. eragrostis*, (Fig. 6), another perennial sedge that grows in wet, soggy soils. Tall umbrella sedge is a large, light green sedge that doesn't produce tubers. It spreads by seed or by new plants that form on short, thick rhizomes around the base of the mother plant. If left unmowed, it grows taller than nutsedge, but in a mowed turf you can distinguish it from nutsedges by its tendency to grow in tight clumps that are less than 1 foot in diameter, its wider leaves and stems, and its short, thick rhizomes and lack of tubers.

Another weed often confused with nutsedges is green kyllinga, *Kyllinga brevifolia*, (Fig. 7), which also is a major problem in turf and ornamental plantings. (See *Pest Notes: Green Kyllinga* in References.) Green kyllinga flowers are visibly different from those of nutsedges, and the plant produces rhizomes but not tubers.

**LIFE CYCLE**

Yellow and purple nutsedges are perennial plants. Their leaves and flowering stalks generally die back in fall as temperatures decrease, but tubers and rhizomes survive in the soil and sprout the following spring once soil temperatures remain higher than 43°F for yellow nutsedge and higher than 59°F for purple nutsedge.

The majority of tubers occur in the top 6 inches of soil where they can survive for 1 to 3 years. In field crops, research indicates most nutsedges sprout from tubers, and seeds don't contribute much to the spread of the plant; however, no work has been done to examine the role of seed in the spread of nutsedge in the landscape.

**DAMAGE**

Nutsedges are a problem in lawns because they grow faster, have a more upright growth habit, and are a lighter green color than most grass species, resulting in a nonuniform turf. In gardens and landscapes, nutsedges will emerge through bark or rock mulches (Fig. 8) in shrub plantings and vegetable and flower beds throughout the growing season.

**MANAGEMENT**

The best approach for avoiding nutsedge problems is to prevent establishment of the weed in the first place. Once established, nutsedge plants are difficult to control.

Prevent establishment by removing small plants before they develop tubers, eliminating the wet conditions that favor nutsedge growth, using certain fabric mulches in landscape beds, and making sure nutsedge tubers aren't brought in with topsoil or other materials. In addition to consistently removing small plants, you can reduce nutsedge populations by drying, shading, and using properly timed applications of herbicides.

**Cultural Control: Removing Plants and Tubers**

Tubers are key to nutsedge survival. If you can limit production of tubers, you'll eventually control the nutsedge itself.

To limit tuber production, remove small nutsedge plants before they have 5 to 6 leaves; in summer this is about every 2 to 3 weeks. Up to this stage, the plant hasn't formed new tubers yet. Removing as much of the plant as possible will force the tuber to produce a new plant, drawing its energy reserves from tuber production to the production of new leaves.

Continually removing shoots eventually depletes the energy reserves in the tuber, because the nutsedge will have to use 60% of its reserves to develop the first plant and 20% for the second. However, mature tubers can resprout more than 3 times. Even though these newer sprouts start out weaker than the previous ones, plants can develop from them and produce new tubers unless you remove them.

The best way to remove small plants is to pull them up by hand or to hand hoe. If you hoe, be sure to dig down at least 8 to 14 inches to remove the entire plant. Using a tiller to destroy mature plants only will spread the infestation,



Figure 6. Flowers of tall umbrella sedge (shown here) are dense and headlike in contrast to the looser flowers of nutsedge. Plants also lack tubers and are taller and have wider leaves than the nutsedges.



Figure 7. Green kyllinga doesn't have tubers as do nutsedges but instead spreads by rhizomes.



Figure 8. Yellow nutsedge seedling emerging through bark mulch.

because it will move the tubers around in the soil. However, repeated tillings of small areas before the plants have 6 leaves will reduce populations. If you find nutsedge in small patches in your turf, dig out the patch down to at least 8 inches deep, refill, and then seed or sod the patch.

**Drying.** During the middle of summer, you can control purple nutsedge by cultivating the infested area and then withholding all moisture to allow the sun to dry the tubers. Repeated tilling and drying are required to give good control. This method is effective only



in areas where other plants don't need irrigation. Drying isn't effective for controlling yellow nutsedge.

**Shading.** Nutsedges don't grow well in shade, so changing landscape plantings might reduce their growth. For example, a highly infested, annually planted flower bed might be better off if you replant it with a tall, dense ground cover or shrub. Low-growing ground covers won't shade out nutsedge.

**Mulching.** The commonly used black polyethylene plastic mulches don't control yellow or purple nutsedge, because the sharp points at the ends of their leaves can penetrate them. Landscape fabrics made from polypropylene polymers are available that effectively suppress nutsedge growth and have the added benefit of being water and air permeable, unlike polyethylene. If the planting permits, mulching with a thick, nonwoven landscape fabric covered with a bark or gravel mulch will suppress nutsedge growth. For complete control, however, you still will need to remove any emerging nutsedge plants.

**Chemical Control**

Few herbicides are effective at controlling nutsedge, either because of a lack of selectivity to other plants or a lack of uptake. For herbicides that are suitable, apply them when they'll be most effective (Table 1). Most herbicides aren't effective against tubers.

**Nonselective Postemergent Herbicides.** The only nonselective postemergent herbicide currently available to help control nutsedge in the home landscape is glyphosate (e.g. Roundup) or glyphosate with nonaonic acid (Roundup Plus). This herbicide requires repeated applications, and its use will result only in limited suppression of these weeds.

Many people mistakenly use glyphosate on fully grown plants to try to kill the tubers. Unfortunately, when tubers are mature the herbicide usually doesn't move from the leaves to the tubers, leaving them unaffected. Instead, apply glyphosate when the plants are

Table 1.

Controlling Nutsedges with Chemicals.<sup>1</sup>

Herbicide	Commercial Name	Apply Before Plants Emerge	Apply to Young Plants	Available to Home Gardeners
dichlobenil	Casoron	yes	no	yes
dimethenamid-P	Freehand	yes	no	no
glyphosate	Roundup	no	yes	yes
halosulfuron	Sedgehammer	no	yes	yes
metolachlor	Pennant	yes	no	no
penoxsulam	Green Light Wipe Out Tough Weed Killer for Lawns	no	yes	yes
sulfosulfuron	Certainty	no	yes	no
trifloxysulfuron-sodium	Monument	no	yes	no

<sup>1</sup> None of these products effectively controls mature plants.

young, actively growing, and haven't recently been mowed or cut.

Be sure to read the label to determine how much time after application must occur before irrigation can resume. Don't apply if rainfall is expected within 24 hours of application. Glyphosate works most quickly when the weather is warm and sunny; cool, cloudy weather following an application can delay activity. Don't spray any herbicide when it is windy to avoid injuring other plants with spray drift.

**Selective Postemergent Herbicides.** Postemergent herbicides that have some selectivity, particularly in turf, are halosulfuron (Sedgehammer) and MSMA. These herbicides move through the plant rapidly, but to be effective, you must apply them to nutsedges before the fifth-leaf stage, when the plant is still building energy reserves by drawing energy from its leaves to the newly forming tubers. After this stage, this translocation to the tubers slows down or ceases, and the herbicide will kill only the aboveground portion of the plant, leaving the tubers unaffected.

Halosulfuron is used in such minute amounts the manufacturer markets it in premeasured, water-soluble bags. Follow all label directions for optimal control of nutsedge, and be sure to add a nonionic surfactant to the spray solution. MSMA is more effective on

yellow than on purple nutsedge. Other herbicides available to professionals for use on turf include trifloxysulfuron-sodium (Monument) and sulfosulfuron (Certainty). Be sure to read the label carefully, as these products will injure some turf species.

**Preemergent Herbicides.** Although no preemergents control purple nutsedge, those that reduce yellow nutsedge include dichlobenil (Casoron), metolachlor (Pennant), and dimethenamid-P (a component of Freehand). Metolachlor and dimethenamid-P are safer around many ornamentals than dichlobenil, but they are available only to professional pesticide applicators.

No preemergent herbicides that effectively control nutsedge can be used on turfgrass, but you can use them on selected ornamental plants. Read the label directions to see which ornamentals will tolerate each herbicide, and follow all label instructions regarding how to apply the product. Preemergent herbicides reduce the number of emerging nutsedge plants, but for long-term control, retreatment is necessary.

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*Oxalis pes-caprae* L.

## Buttercup oxalis (Bermuda buttercup)

**Family:** Oxalidaceae

**Range:** In the western U.S., it occurs in California and Arizona.

**Habitat:** Coastal dunes, scrub, grasslands, oak woodlands, gardens, turf, urban areas, orchards, vineyards and agricultural fields. Grows in most environments and can tolerate many soil types. Grows in full sun in cool coastal areas, but inland it grows primarily in semi-shaded sites.

**Origin:** Native to South Africa and brought to North America as a garden ornamental.

**Impacts:** Buttercup oxalis is a major problem in field-grown flowers and in the home landscape, especially in groundcovers. In the last 10 years, this plant has spread extensively throughout California invading native coastal dunes and natural areas along the coast. Due to its extensive occurrence in yards and gardens, buttercup oxalis has the potential to rapidly spread via the production of bulbs and the movement of contaminated soils into adjacent natural areas. Plants contain variable quantities of soluble oxalates and can be lethally toxic to livestock when ingested in quantity.

**California Invasive Plant Council (Cal-IPC) Inventory:** Moderate Invasiveness



Buttercup oxalis is a low-growing perennial with clover-like leaves and yellow flowers. Plants grow from bulbs and produce a loose basal rosette of leaves to 14 inches tall. Stems are mostly below ground. Leaf stalks are 5 inches long with a trifoliate leaf, green to dark purple-tinged, 6 to 10 mm long, and 5 to 24 mm wide. Leaflets are glabrous to sparsely pubescent, broadly heart-shaped, often pubescent below, and typically folding downward at midday and at night. Small, whitish-brown bulblets develop on the stem at the base of the rosette of leaves, and new bulbs form underground along the rhizome. A plant forms about a dozen small bulbs per year, each less than 1 inch long. Slender white rhizomes are about 4 inches long with true roots growing upward from the mature bulb apex. The leaves and flowers develop from the top of the rhizome. A threadlike rhizome grows downward from the mature bulb base and produces a tuberous root with many fibrous roots below. Small bulbils develop in the leaf scale axils along the length of the threadlike rhizome. Bulbs and bulblets readily detach from rhizomes.

The flowers are bright yellow, 0.75 to 1.5 inches wide, and are borne on top of a leafless stalk rising 6 to 12 inches tall. Viable seed never has been documented in the United States, and rarely has it been seen anywhere else in the world. The foliage dies and the bulbs become dormant when temperatures rise in late summer. Plants reproduce vegetatively by bulbs and spread with cultivation, soil movement, intentional planting, and disposal of garden refuse and nursery soil.

### NON-CHEMICAL CONTROL

#### Mechanical (pulling, cutting, disking)

Hand pulling can provide control but care must be taken to remove the entire plant, including underground rhizome and bulbs. Repeated pulling of the tops will deplete the bulb's carbohydrate reserves, but these efforts take years to be successful.

Cultivation can provide control on new infestations. Repeated tillage is required to effectively control the bulbs.

#### Cultural

Grazing is not considered an effective control option. Plants contain variable quantities of soluble oxalates and can be lethally toxic to livestock when ingested in quantity.

Burning is also not considered to be an effective control option.

#### Biological

There is currently no biocontrol agent available for the control of *O. pes-caprae* in North America. A potential biocontrol agent is *Klugeana philoxalis*, a larval feeder on shoots of *O. pes-caprae*, but no other information on this species is available.



## CHEMICAL CONTROL

The following specific use information is based on published papers and reports by researchers and land managers. Other trade names may be available, and other compounds also are labeled for this weed. Directions for use may vary between brands; see label before use. Herbicides are listed by mode of action and then alphabetically. The order of herbicide listing is not reflective of the order of efficacy or preference.

### GROWTH REGULATORS

Fluroxypyr <i>Vista XRT</i>	<b>Rate:</b> 15 to 22 oz product/acre (5.3 to 7.7 oz a.e./acre) to thoroughly wet all leaves <b>Timing:</b> Early postemergence when plants are growing rapidly. <b>Remarks:</b> Fluroxypyr provides selective postemergent control of many annual and perennial broadleaf weeds. It has no soil activity.
Triclopyr <i>Garlon 4 Ultra</i>	<b>Rate:</b> 2 to 4 qt product/acre (2 to 4 lb a.e./acre) plus 0.25 to 0.5% v/v surfactant to thoroughly wet all leaves <b>Timing:</b> Postemergence when plants are growing rapidly. <b>Remarks:</b> Triclopyr is a selective herbicide for broadleaf species. It has no soil activity.

### AROMATIC AMINO ACID INHIBITORS

Glyphosate <i>Roundup, Accord XRT II, and others</i>	<b>Rate:</b> Spot treatment: 2% v/v solution <i>Roundup ProMax</i> (or other trade name with similar concentration of glyphosate) and water to thoroughly wet all leaves <b>Timing:</b> Postemergence when plants are growing rapidly. Applications in early spring provide best control. <b>Remarks:</b> Glyphosate is a nonselective systemic herbicide with no soil activity. Repeated applications may be necessary for complete control.
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### BRANCHED-CHAIN AMINO ACID INHIBITORS

Imazapyr <i>Arsenal, Habitat, Stalker, Chopper, Polaris</i>	<b>Rate:</b> 3 pt product/acre (12 oz a.e./acre) plus 0.25 to 0.5% v/v surfactant to thoroughly wet all leaves <b>Timing:</b> Postemergence when plants are growing rapidly. <b>Remarks:</b> Imazapyr is a preemergent and postemergence herbicide effective for controlling broadleaf weeds and grasses. It has fairly long soil residual activity.
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### PHOTOSYNTHETIC INHIBITORS

Hexazinone <i>Velpar L</i>	<b>Rate:</b> 2.75 to 4.5 pt product/acre (0.7 to 1.1 lb a.i./acre) to thoroughly wet all leaves <b>Timing:</b> Early postemergence when plants are growing rapidly. <b>Remarks:</b> Hexazinone provides both contact and residual control of many broadleaf and grasses. It has a long soil activity, is considered mobile, and should not be used in areas where the water table is shallow. High rates of hexazinone can create bare ground, so only use high rates in spot treatments.
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# POISON OAK

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*Integrated Pest Management for Home Gardeners and Landscape Professionals*

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Poison oak, also known as Pacific poison oak or western poison oak (*Toxicodendron diversilobum*), is native to western North America with a distribution extending from British Columbia to the Baja California peninsula. In Washington and Oregon, poison oak is found mainly in the western regions of the states. In California it is widespread and grows in a wide range of habitats from sea level to the 5,000-foot elevation and in areas including open woodland, grassy hillsides, coniferous forests, and open chaparral.

## IDENTIFICATION

Poison oak is a woody shrub or vine that loses its leaves in winter. In open areas under full sunlight, it forms a dense, leafy shrub usually 1 to 6 feet high (Fig. 1). In shaded areas, such as in coastal redwoods and oak woodlands, it grows as a climbing vine, supporting itself on other vegetation or upright objects using its aerial roots (Fig. 2).

Leaves normally consist of three leaflets with the stalk of the central leaflet being longer than those of the other two (Fig. 3); however, leaves occasionally are comprised of 5, 7, or 9 leaflets. Leaves of true oaks, which are superficially similar, grow singly, not in groups. Poison oak leaves alternate on the stem. Each leaflet is 1 to 4 inches long and smooth with toothed or somewhat lobed edges. The diversity in leaf size and shape accounts for the Latin term *diversilobum* in the species name. The surface of the leaves can be glossy or dull and sometimes even somewhat hairy, especially on the lower surface.

In spring, poison oak produces small, white-green flowers (Fig. 4) at the point where leaves attach to the stem. Whitish-green, round fruit (Fig. 5) form in

late summer. In early spring the young leaves are green or sometimes light red. In late spring and summer the foliage is glossy green and later turns attractive shades of orange and red (Fig. 6).

## IMPACT

Poison oak thrives along roadsides and other areas where established vegetation is disturbed, in uncultivated fields, and on abandoned land. It also is a problem in wood lots, Christmas tree plantations, rangeland, and recreation areas. While it can reduce optimal grazing area in rangeland or pastures, the primary concern associated with poison oak is the allergic reaction it causes in many people.

All members of the genus *Toxicodendron*—which includes poison oak, poison ivy, and poison sumac—cause allergic contact dermatitis. About 2 million cases of skin poisoning are reported in the United States each year, primarily from these three species. In California, the number of working hours lost as a result of dermatitis from poison oak makes it the most hazardous plant in the state.

Contact with poison oak leaves or stems at any time of the year can cause an allergic response. When the allergen contacts the skin surface of sensitive individuals, the surrounding cells rapidly absorb it. Within 1 to 6 days, skin irritation and itching will be followed by water blisters, which can exude serum. Contrary to popular belief, the exuded serum does not contain the allergen and does not transmit the rash to other regions of the body or to other individuals. The dermatitis rarely lasts more than 10 days. Only about 15 to 20% of the population is immune to the allergenic reaction caused by poi-



Figure 1. Poison oak as a shrub.



Figure 2. Poison oak as a vine.

son oak and show no symptoms when exposed to the plant. Once a reaction occurs, repeated exposures further increase sensitivity. Conversely, long periods with no exposure will reduce an individual's susceptibility. Animals with fur usually don't suffer skin irritation, although a dog can develop symptoms on its nose or underbelly.

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Livestock can graze on the tender foliage with no adverse effects.

In addition to direct contact with the plant, transmission of the allergen can occur by touching contaminated clothing, gloves, tools, or animals, particularly pets. When poison oak is burned, the oils can disperse via the smoke particles. Breathing this smoke can cause severe respiratory irritation.

After coming in contact with the allergen, the best way to prevent skin irritation is to pour a mild solvent such as isopropyl (rubbing) alcohol over the exposed area then wash with plenty of cold water; avoid using warm water, since it enhances the penetration of the oil. If isopropyl alcohol is not available, use cold water by itself to help dilute the oil, so it no longer is as harmful.

Perform these steps within five minutes of exposure. Even if it's too late to prevent the rash, washing the skin to remove excess plant oil will keep the rash from spreading. Be sure to thoroughly wash your hands, since they serve as the major route for transferring the allergen to other parts of the body, especially the face.

Using only a small amount of water or disposable hand wipes is more likely to spread the toxin than remove it. You can use soap but only if you also use copious amounts of water.

If you wash with isopropyl alcohol or soap, be sure you are done working outside for the day, since these products also will remove your skin's protective oils, which help repel the plant toxin; your body will not regenerate these protective oils for 3 to 6 hours. If re-exposure could occur within 6 hours, you will have better results washing with lots of water.

The product Tecnu, which most drug stores sell, will remove the poison oak oil from your skin. You should wash the contacted areas within 2 to 8 hours after exposure. You also can use Tecnu to decontaminate laundry, pets, and tools.

## BIOLOGY

A variety of birds will eat poison oak fruit, and establishment of this plant in new locations generally is from seeds these birds have transported. The passage of the hard-seeded fruit through the bird's digestive tract facilitates germination by reducing the period of dormancy. Once established, the plant spreads slowly using its underground horizontal rootstalks, which actually are stem tissue. A single root system can cover a very large area, several feet in diameter.

Poison oak can survive under a wide range of temperatures, elevations, soil types, moisture conditions, and light intensities. However, it is most commonly found on hillsides with shallow soils.

## MANAGEMENT

The primary ways of managing poison oak are mechanical removal by hand pulling, which is not recommended for individuals who are sensitive to this plant, and treatment with herbicides. Maintaining a healthy cover of desirable vegetation will reduce potential invasion. This is easiest where you have available irrigation and regularly cultivated soil.

Poison oak is a native species in the western United States. As such, a number of indigenous insects and pathogens already are present. Typically, biocontrol isn't an option with a native species. Furthermore, in most areas, poison oak is not a pest, but rather a natural component of the plant community.

Don't burn poison oak, since it creates a serious health hazard and doesn't effectively reduce infestations. Grazing by sheep and goats can be effective in small areas. Deer or horses also will graze poison oak when the foliage is young, before the plant flowers.

### Mechanical

You can physically remove plants located in a yard or near houses through hand pulling or mechanical grubbing



Figure 3. Poison oak leaves and flower.



Figure 4. Poison oak flowers.



Figure 5. Poison oak fruit.



Figure 6. Poison oak fall foliage.



using a shovel or pick. It is essential to remove the entire plant including its roots. Remove plants in early spring or late fall when the soil is moist and it is easier to dislodge rootstalks. Grubbing when the soil is dry and hard usually will break off the stems, leaving the rootstalks to vigorously resprout. Detached and dried brush still can cause dermatitis, so bury or stack the plant material in an out-of-the-way location, or take it to a disposal site. Again, never burn poison oak.

Ideally, anyone engaged in hand pulling poison oak should have a high degree of immunity to the allergen. Whether you are sensitive or believe you are immune, wear appropriate protective clothing, including washable cotton gloves over plastic gloves. Wash all clothing thoroughly, including shoes, after exposure.

Other forms of mechanical control have not proven to be successful. Brushrakes and bulldozers often leave pieces of rootstalks that readily can resprout. In some cases, brush removal late in summer, when plants are experiencing moisture stress, can slow their ability to recover. Mowing has little effect in poison oak control, unless you perform it at least four times during the growing season. Within 2 months of germination, young plants usually have produced underground rootstalks large enough to recover from mowing damage. A single plowing is of no value and often serves to propagate the shrub. However, good seedbed preparation and planting cultivated crops for a year or more will control poison oak infestations.

### **Chemical Control**

Herbicides used to control poison oak in California include glyphosate (Roundup, etc.) and the auxinic herbicides triclopyr (Garlon, Ortho Brush-B-Gon, etc.), 2,4-D (Brush Buster Woody Plant Herbicide, etc.), a combination of 2,4-D and dicamba (Spectracide Brush Killer Spray Concentrate, Spectracide Poison Ivy & Poison Oak Brush Killer, and Ortho Weed B Gon Max), or a combination of glyphosate and imazapyr

(Ortho Groundclear Vegetation Killer). You can apply some of these herbicides as stump or basal applications, but all are applied as a foliar spray.

Glyphosate is one of the most effective herbicides for controlling poison oak. However, effective control depends upon proper timing of the application. Apply glyphosate late in the growth cycle, after the fruit has formed but before leaves have lost their green color. If you are using hand-held equipment, you can apply glyphosate as a 2% solution in water. Products or spray mixtures containing less than 2% glyphosate may not effectively control poison oak. It is important to note that glyphosate is a nonselective compound and will damage or kill other vegetation it contacts.

Auxinic herbicides such as triclopyr, 2,4-D, dicamba, and combinations of these herbicides also control poison oak. You can apply these herbicides earlier than glyphosate, when plants are growing rapidly from spring to midsummer.

Triclopyr is the most effective auxinic herbicide for poison oak control. It has a wider treatment window than glyphosate, and it often gives more consistent control. Two formulations of triclopyr are available. Triclopyr amine is the least effective of the formulations and requires relatively high rates. Triclopyr ester or triclopyr ester plus 2,4-D ester gives better herbicide absorption into the foliage and is more effective.

When 2,4-D is combined with dicamba, it provides much better control than if it is used alone in a 1% solution. Premixed combinations of these herbicides are available. Dicamba applied at 0.5% gives better long-term control of poison oak than 2,4-D.

A new herbicide in California, imazapyr, also is very effective for controlling poison oak, but it is available for application only by licensed pesticide applicators. In forestry, two formulations are available. The water-soluble formulation (Arsenal) is effective as a foliar treatment at 1% plus a 0.25% surfactant.

A similar treatment with an emulsifiable concentrate formulation (Chopper, Stalker) will control poison oak at a 2% solution in water or a 1% solution plus 5% of a methylated or ethylated seed oil. The best timing is in either spring after full leaf expansion or in mid-August through September.

**Stump Application.** Stump treatments are most effective during periods of active growth. Cut poison oak stems 1 to 2 inches above the soil surface, and immediately after cutting, treat the stump. A delay in treatment will result in poor control. Apply an herbicide such as glyphosate, triclopyr, or combinations of triclopyr with 2,4-D (or 2,4-D and 2,4-DP) with a paint brush that is 1 to 2 inches wide or with a plastic squeeze bottle that has a spout cap. Treatment solutions should contain either undiluted glyphosate (use a product that contains at least 20% glyphosate), triclopyr amine, or a 20 to 30% triclopyr ester solution mixed with 70 to 80% methylated or ethylated seed oil.

Be sure to completely cover all surfaces of the stumps with the herbicide until it runs down the base of the stubs. Spray any regrowth from cut stumps with a foliar spray when the leaves fully expand.

**Basal Application.** Basal bark applications can be made almost any time of the year, even after leaves have discolored or dropped. Apply triclopyr to basal regions of poison oak using a backpack sprayer with a solid cone, flat fan, or a straight-stream spray nozzle. Thoroughly cover a 6- to 12-inch basal section of the stem, but not to the point of runoff.

**Foliar Sprays.** The effectiveness of herbicides applied to poison oak foliage depends upon the plant's growth stage and whether spray-to-wet coverage and proper concentration occurred. Foliar application is most effective after leaves are fully developed and when the plant is actively growing. This period is normally from April into June or July, when soil moisture is still adequate. The flowering stage is the optimum

time to spray. Do not apply herbicides before plants begin their spring growth or after the leaves have begun to turn yellow or red in late summer or fall.

To achieve spray-to-wet coverage, all leaves and stems should be glistening following herbicide application. However, coverage should not be to the point of runoff. One application of an herbicide usually doesn't completely control poison oak. Treat again when new, sprouting leaves are fully expanded,

generally when the plants are about 2 feet tall. Watch treated areas closely for at least a year, and re-treat as necessary.

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To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

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Pesticides applied in your home and landscape can move and contaminate creeks, rivers, and oceans. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash or pour pesticides down the sink or toilet. Either use the pesticide according to the label, or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Household Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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# SPOTTED SPURGE AND OTHER SPURGES

*Integrated Pest Management for Home Gardeners and Landscape Professionals*

Spotted spurge (*Euphorbia maculata*) is an annual plant native to the eastern United States. In California, it is the most common species of the spurge family, which also includes creeping spurge (*E. serpens*) and petty spurge (*E. peplus*). These weeds invade many of the state's crops, affecting vegetables, trees, citrus, turf, ornamental beds, and container ornamentals. Management of all the spurges is similar.

## IDENTIFICATION

Spotted spurge grows close to the ground, often forming a dense mat (Fig. 1). Its dark green leaves, which grow in pairs called "opposites," are  $\frac{1}{8}$  to  $\frac{1}{2}$  inch long and about  $\frac{1}{8}$  inch wide. Frequently a red spot will mark the leaf halfway down its center vein (Fig. 2).

Flowers, fruit, stems, and leaves are hairy. The short stems have a separate stipule—or little, scalelike appendage—at their base, although you may need a 10X hand lens to see them. Broken stems and branches secrete a milky, poisonous sap. Although spotted spurge sap is being studied as a cure for various skin cancers, in general, the sap of all members of this genus is an eye and skin irritant.

Spotted spurge produces tiny, pinkish flowers (Fig. 3) that consist only of stamens and pistils grouped in small, flowerlike cups, called cyathia, in the leaf axils, the area where the leaf joins the stem. The fruit is a three-celled seed capsule that is  $\frac{1}{16}$  inch or less. Each cell contains one seed that is about  $\frac{1}{25}$  inch long. The plant's central taproot system is capable of extending more than 24 inches into the soil.

Although spotted spurge is the major spurge weed in California, six other

species of spurges appear regularly as weeds in the state—ground spurge (*E. prostrata*), creeping spurge, petty spurge, garden spurge (*E. hirta*), nodding spurge (*E. nutans*), and thyme-leaved spurge (*E. serpyllifolia*). Ground and creeping spurges are troublesome weeds throughout California, while petty spurge is a problem only in Southern and coastal California landscapes.

All spurges have milky sap, which can be toxic to some animals. Ground spurge (Fig. 4) and creeping spurge (Fig. 5) grow prostrate like spotted spurge but have no markings on their leaves. All spurges reproduce by seed, and creeping spurge also can produce roots along the stem, creating new plants vegetatively. Petty spurge (Fig. 6) is a cool season annual found in shady, moist areas, particularly in flower beds. Native to Europe, it grows upright and is much less invasive than spotted and creeping spurge species. Garden, nodding, and thyme-leaved spurges cause fewer problems.

There are 18 native species of spurge occurring in various parts of California. Some of these native species can appear at the edges of cultivated areas adjacent to wildlands, but they are poorly adapted to cultivated conditions and rarely occur as weeds.

The plant key in Table 1 provides information to help with identifying spurges commonly encountered as weeds in California. Any weedy spurge collected in California that doesn't appear to fit these characteristics can be keyed using *The Jepson Manual* listed in References, or you can take the weed to your local cooperative extension office. The Weed Identification Tool available online through UC Davis' Weed Research



Figure 1. Mature spotted spurge is a low-growing plant.



Figure 2. Spotted spurge with red leaf spots and a broken stem exuding milky sap.



Figure 3. Spotted spurge flowers and leaf spots.



Figure 4. Ground spurge plant.

## PEST NOTES

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and Information Center (<http://weedid.wisc.edu/ca/weedid.php>) is an easy-to-use program useful for homeowners and professionals.

**BIOLOGY**

Most weedy spurges are summer annuals that don't like competition and depend on their prolific seed production for survival. A single plant can produce several thousand seeds, which are small and can remain dormant in the soil until conditions are suitable for germination (sprouting). Seeds produced in summer germinate immediately while those produced in late fall mostly will lie dormant and won't germinate until spring.

Spotted spurge germinates best when temperatures are 75° to 85°F, but germination can occur at temperatures as low as 60°F and as high as 100°F. When moisture is available, germination can occur from February through September in most areas of California. Light also is a requirement for maximum germination; seeds buried deeper than 1/2 inch won't germinate well. Plants that germinate early in spring in cool conditions can remain as small seedlings until temperatures are more

desirable for growth. Once the seed germinates, a small rosette of leaves develops. As growth continues, the leaves form a dense mat that can grow up to 3 feet in diameter. Reproductive growth is rapid, and the plant can produce seeds as soon as 5 weeks after germination.

**IMPACT**

Spotted spurge can establish itself in horticultural, agricultural, and non-crop sites. It overgrows sparse turf areas and low-growing ground covers, invades open areas in gardens and landscapes, and can grow in sidewalk cracks. In addition to reducing the growth of desirable plants, spotted spurge reduces uniformity and quality of turf, provides a habitat for undesirable insects in citrus groves, serves as an intermediate host for fungal diseases of cultivated crops, and attracts ants with its seed.

Spotted spurge is poisonous and can kill sheep grazing in pastures where it is the predominant weed. Sheep that consumed as little as 0.62% of their body weight of this plant have died within a few hours.



Figure 5. Creeping spurge infesting a field-grown, container plant.





Figure 6. Mature petty spurge.

**MANAGEMENT**

The primary method of managing spurges is prevention, since controlling these weeds is very difficult once plants have established themselves. Avoid bringing seeds into uninfested areas by using weed-free planting seed

Table 1.

A Key to the Weedy Spurges of California.

<p><b>Flowers (cyathia) in dense axillary or terminal clusters</b> (generally greater than 10 cyathia per cluster)</p>	<p><b>Stems erect</b>, to 3 feet tall, sparsely hairy <b>Nodding Spurge</b> (<i>Euphorbia nutans</i> Lagasca)</p>		
	<p><b>Stems prostrate</b> with numerous, spreading hairs <b>Garden Spurge</b> (<i>E. hirta</i> L.)</p>		
<p><b>Flowers (cyathia) solitary or paired</b> in leaf axils (Note: Since leaves are opposite, 2 to 4 cyathia will be in close proximity.)</p>	<p>Cyathia, fruit, stem, and leaves <b>hairy</b></p>	<p>Fruit very <b>sparsely hairy</b>, 1.5–2 mm long; seeds 1–1.25 mm long and wrinkled with low rounded ridges; leaves lacking reddish central spot (rare form) <b>Thyme-leaved Spurge</b> (<i>E. serpyllifolia</i> Persoon)</p>	
		<p>Fruit <b>distinctly hairy</b>; less than 1.5 mm long; seed generally less than 1 mm, cross-ridge with narrow sharp ridges, or wrinkled; if wrinkled, leaves usually with reddish central spot (very common species)</p>	<p><b>Seeds cross-wrinkled</b>; fruit with appressed hairs over entire surface; leaves generally (greater than 95% of plants) with a reddish central spot <b>Spotted Spurge</b> (<i>E. maculata</i> L.)</p> 
	<p>Cyathia, fruit, stem and leaves <b>hairless</b></p>	<p><b>Stipules</b> (appendages at leaf base) <b>united</b> into a whitish scale between the leaves; stems almost always rooting at the nodes; leaf margins smooth-edged or faintly toothed <b>Creeping Spurge</b> (<i>E. serpens</i> Kunth)</p>	<p><b>Seeds cross-ridged</b>; fruit spreading hairy, mostly on edges only; leaves never with reddish central spot <b>Ground Spurge</b> (<i>E. prostrata</i> Aiton)</p> 
		<p><b>Stipules separate</b> and hairlike; stems rarely or never rooting at the nodes; leaf margins distinctly toothed, at least near the tip <b>Thyme-leaved Spurge</b> (<i>E. serpyllifolia</i> P.)</p>	



and uncontaminated planting stock. Clean work clothing and machinery such as lawn mowers to remove any seeds that might be present, and remove spurge plants as soon as you discover them.

### Cultural Control

**Weeding or cultivating.** Constantly monitor infested areas, so you can mechanically till or hand pull new plants before they produce seed. Take care as you weed, since plants that you hand pull often break at the stem, leaving the root and several buds or a single stem from which regrowth is possible. Wear gloves when you hand pull, since the sap can be a skin irritant. Mowing is an ineffective method of control, since most species grow closely to the ground.

When planting new, container-grown ornamentals and ornamental beds, be sure to use sterilized or weed-free planting mix. When purchasing plants for ornamental beds, avoid those with spotted spurge infestations. Mulches can effectively limit spotted spurge if they prevent light from reaching the seed.

**Solarization.** Before planting an area with turf or ornamentals, you might want to follow the management method known as soil solarization. Covering the soil with sheets of clear plastic for 4 to 6 weeks during the summer can effectively reduce the number of seeds in areas where summer daytime temperatures are very hot. In areas where summer temperatures are lower than 90°F, soil solarization can partially control this weed. For more information, see *References, Soil Solarization for Gardens & Landscapes*.

**Mulch.** Probably the most common strategy for controlling weeds in ornamental plantings is to use organic or synthetic mulches, which prevent light from reaching weed seeds and seedlings, starving them before they can start making food through photosynthesis. Bark, compost, or straw laid at least 2 inches thick can effectively control many weed seeds including

many spurge species. A large, coarse bark will require a 3- to 4-inch layer to be effective; however, larger, coarser mulches last longer than finely shredded ones. Thick mulch eventually can accumulate soil, decaying organic matter, and weed seeds that can germinate. All organic mulch needs periodic replacement.

Black, synthetic polypropylene weed barriers (fabrics or geotextiles), which are available at nurseries, also block sunlight and starve weed seedlings. The fabrics are porous to allow water to drain through them. Often a synthetic barrier with bark or rock on top makes the area more aesthetically pleasing. Organic mulches such as bark and straw don't need to be as thick if you also are using the fabric. Since mulches and weed barriers reduce evaporation from the soil surface, adjust the irrigation cycle to prevent overwatering.

**Turf management.** One of the best control measures for spotted spurge in turf is to maintain a competitive stand of grass. When open areas develop in turf due to stress, disease, lack of fertility, insects, or abuse, light penetrates to the soil surface, allowing spotted spurge to germinate. Once spotted spurge establishes itself, altering cultural practices such as fertilization or irrigation won't control it. However, raising the mowing height to 2 inches or more in tall fescue or perennial ryegrass can reduce initial invasions. Check turf for excessive thatch, which should be less than 1/2 inch high.

**Food Crops.** In home vegetable gardens, you can control spurge seedlings by using soil solarization, mulches, and early cultivation.

### Chemical Control

**Preemergent herbicides** can help prevent spotted spurge outbreaks if you apply them in late winter before weed seeds germinate. Time the application, so it occurs before the soil temperature exceeds 55° to 60°F at a depth of 1 inch.

Preemergent herbicides for turf and ornamentals include benefin (Balan),

pendimethalin (Pendulum), isoxaben (Gallery), oryzalin (Surflan), trifluralin (Treflan, Preen), and dithiopyr (Dimension). Of these, only pendimethalin, trifluralin, dithiopyr, and oryzalin are available for use by home gardeners. Combination products such as oryzalin plus benefin are available to both home gardeners and landscape professionals.

Preemergent chemicals are almost never used in home vegetable gardens, because chemical residues last for months after application, and product labels routinely regulate against such use. Herbicide recommendations for commercial orchard and vegetable crops are available online; see the UC IPM Pest Management Guidelines at <http://www.ipm.ucdavis.edu/PMG/>.

**Postemergent herbicides** available to home gardeners include 2,4-D/MCPP/dicamba combination products, triclopyr (Turflon), and glyphosate (available for both commercial and home landscape use). In general, 2,4-D and its combinations don't control the larger, more mature spotted spurge plants.

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Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original, labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Pesticides applied in your home and landscape can move and contaminate creeks, rivers, and oceans. Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash or pour pesticides down the sink or toilet. Either use the pesticide according to the label, or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Household Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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# YELLOW STARHISTLE

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*Integrated Pest Management for Home Gardeners and Landscape Professionals*

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Yellow starthistle, *Centaurea solstitialis*, is native to Eurasia and was introduced to California around 1850 via South America. It is now common in open areas on roadsides, rangeland, wildlands, hay fields, pastures, and waste areas. Recent reports indicate that yellow starthistle infests between 10 and 15 million acres in California. Disturbances created by cultivation, poorly timed mowing, road building and maintenance, or overgrazing favor this rapid colonizer. It forms dense infestations and rapidly depletes soil moisture, thus preventing the establishment of other species. It is also poisonous to horses, causing a nervous disorder called "chewing disease" (nigropallidal encephalomalacia), which is fatal once symptoms develop. Horses are the only animal known to be affected in this manner and should not be allowed to graze on yellow starthistle.

## IDENTIFICATION

Yellow starthistle is a gray-green to blue-green plant with a deep, vigorous taproot. It produces bright, thistlelike yellow flowers with sharp spines surrounding the base. Yellow starthistle grows to heights varying from 6 inches to 5 feet. The stems of mature plants are rigid, spreading, and typically branching from the base in open areas (Fig. 1). Stems and leaves are covered with a loose, cottony wool that gives them a whitish appearance. Stems appear winged due to leaf bases that extend beyond the nodes. Basal leaves are 2 to 3 inches long and deeply lobed. Upper leaves are short (0.5 to 1 inch long) and narrow with few lobes.

## BIOLOGY

Yellow starthistle is a long-lived winter annual that is usually found below 7,000 feet elevation in dry, light-intensive areas where average annual

rainfall is between 10 and 60 inches. Seed output can be as high as 30,000 seeds per square meter, with about 95% of the seed being viable soon after dispersal. Most seeds germinate within a year of dispersal, but some can remain viable in the soil for more than 3 years.

Yellow starthistle seeds germinate from fall through spring, which corresponds to the normal rainy season in California. After germinating, the plant initially allocates most of its resources to root growth. By late spring, roots can extend over 3 feet into the soil profile, although the portion above ground is a relatively small basal rosette. This allows yellow starthistle to out-compete shallow-rooted annual species during the drier summer months when moisture availability is limited near the soil surface. It also helps explain why yellow starthistle survives well into the summer, long after other annual species have dried up, and why it can regrow after top removal from mowing or grazing.

The competitive ability of yellow starthistle also depends on light intensity at the soil surface during the seedling and rosette stages of development. Yellow starthistle proliferates at high light intensity and does poorly in low light. High light conditions often occur along roadsides, in disturbed sites, grasslands, and on south-facing slopes at higher elevations.

## MANAGEMENT

Control of yellow starthistle cannot be accomplished with a single treatment or in a single year. Effective management requires control of the current population and suppression of seed production, combined with establishment of competitive, desirable vegetation.



Figure 1. Yellow starthistle.

## Prevention

Yellow starthistle proliferates along roadsides. Invasion by this weed may be increased with disturbances created by road building and maintenance. Seeds are often spread by vehicles or with the transportation of livestock or contaminated soil. Survey roadsides for the presence of this weed and immediately control new infestations to prevent seed production and its subsequent spread.

Yellow starthistle also can be spread as a contaminant in grass seed. Only certified seed should be used for range or pasture seeding. Seed may also come as a contaminant in all classes of hay, particularly grass hay. Carefully check hay shipments for evidence of yellow starthistle. Hay used as mulch along

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roadsides or disturbed areas can be a source of yellow starthistle introduction. When feeding hay is suspected of containing yellow starthistle, place bales in one area and periodically check around feeding areas for signs of starthistle seedlings. Livestock that have fed in yellow starthistle-infested areas should not be pastured or shipped to uninfested areas. Control newly emerged seedlings to prevent establishment. It is important to control new infestations when they are small because spot eradication is least expensive and most effective at this time.

### Biological Control

Four natural enemies of yellow starthistle have been imported from Europe and by 2003 were well established in California. These biological control agents include two weevils (*Bangasternus orientalis* and *Eustenopus villosus*) and two flies (*Urophora sirunaseva* and *Chaetorellia succinea*). They all attack the flower/seed head and directly or indirectly reduce seed production, the only means of reproduction and spread of the weed. The insects lay their eggs in, on, or near flower/seed heads and complete their development within them. *Eustenopus villosus* adults also directly reduce seed production by feeding on immature flower heads. All of these insects are highly host-specific to yellow starthistle and do not attack commercially valuable crops or native plants.

These insects already occur in most areas of California that are infested with yellow starthistle. If additional releases of these natural enemies are made, protect the release area from practices that may damage the insects. Such practices include insecticide applications, soil cultivation, summer-prescribed burning, or mowing when the plants are in the flowering stage. After establishment, the insects are capable of building up to high numbers and spreading on their own. These insects do best in areas with warm, dry summer climates.

The most recent releases, *Eustenopus villosus* and *Chaetorellia succinea*, have

proven to be the most effective agents for yellow starthistle seed suppression. These insects are becoming more widespread throughout the state. However, they only suppress yellow starthistle seed production by about 50%, so they should not be considered as the sole method of control. It is possible that a combination of herbicides and biological control will provide more sustainable control than either technique used alone. Landowners and managers with yellow starthistle problems may contact their county agricultural commissioner's office about obtaining these biological control insects.

Most recently a rust, *Puccinia jaceae* var. *solstitialis*, was approved for release in California. Trials are under way to determine the potential effectiveness of this organism on yellow starthistle.

### Cultural Control

Yellow starthistle begins emergence with fall rains and continues to germinate throughout the rainy season. A single cultivation after the rainy season when soils are dry effectively controls yellow starthistle seedlings and rosettes. This treatment must be made after the last rains but before seeds are produced. If cultivation is carried out too early (e.g., before the last rains) seed will continue to germinate and another cultivation will be needed to control each new flush of seedlings that results from a spring rain.

*Mowing* can be used to manage yellow starthistle, provided it is well timed and used on plants with a high branching pattern. Mowing early growth stages results in increased light penetration and rapid regrowth of the weed. If plants branch from near the base, regrowth will occur from recovering branches. Repeated mowing of plants too early in their life cycles (rosette or bolting stages) or when branches are below the mowing height will not prevent seed production, as flowers will develop below the mower cutting height. Plants with a high branching pattern are easier to control, as recovery will be greatly

reduced. Even plants with this growth pattern must be mowed in the late spiny or early flowering stage to be successful. An additional mowing may be necessary in some cases.

To encourage growth of desirable vegetation, let these species set seed before mowing, but be sure to mow well before starthistle is in full flower. In general, mowing is most effective when soil moisture is low and no irrigation or rainfall follows mowing.

*Grazing* is effective in reducing yellow starthistle seed production. Sheep, goats, or cattle eat yellow starthistle before spines form on the plant. Goats will eat starthistle even in the spiny stage. The plant's crude protein concentration is variable, but ranges from 28% at the rosette stage down to 11% at the bud stage and should be sufficient to meet the general maintenance requirements for most ruminants. When it is abundant, yellow starthistle appears to have the ability to sustain animals several weeks beyond annual grass "dry down." Intensive grazing in late May and June using large numbers of animals for short duration can reduce plant height, canopy size, and seed production. Avoid overgrazing, however; do not allow more than half the grass forage to be removed. Grazing more than this will reduce the grasses' recovery rate and ability to shade out yellow starthistle.

*Burning* is best performed at the end of the rainy season when flowers first appear. Yellow starthistle should be green at this time and will require desiccated vegetation to burn. Most annual vegetation other than yellow starthistle, particularly grasses, should have dried and shed their seeds by this time. The foliage of these plants serves as a fuel source to allow a more complete burn. Burning for 2 or more consecutive years helps suppress yellow starthistle and deplete the soil seedbank. Burning can also increase the recovery and density of perennial grasses. Burning can damage biological control agents, but insects from adjacent areas will readily move back into the site the fol-



lowing year.

### Revegetation

Control practices are capable of reducing yellow starthistle populations, but in the absence of competition, starthistle will often reestablish. Effective management requires that desirable plant species be encouraged or planted and managed to prevent yellow starthistle germination or growth. Species choice for revegetation will depend on the intended use of that site. Resident vegetation such as perennial bunchgrasses or wildflowers may be desirable along roadsides, abandoned pastures, or in rangelands and wildlands. In these situations, cultural, biological, or chemical methods can be used to reduce yellow starthistle while encouraging other plant species, if possible, with practices such as fertilization. Research efforts to reestablish native perennial grasses are in progress. Perennial grasses are slow to establish and may require herbicide treatments to assist yellow starthistle or annual grass control during establishment, but once well established, alternative controls such as properly timed grazing, mowing, or burning can be used effectively.

In pastures, eliminate dense stands of yellow starthistle and reseed the area with a fast-growing, competitive forage species. Although annual legumes work well for this purpose, the lack of selective herbicides makes follow-up treatments difficult. Therefore, grasses are best because selective herbicides can then be used to control yellow starthistle plants not eliminated by grass competition. In areas with scattered yellow starthistle infestations, eliminate scattered plants and overseed with a desirable species to provide enough competition to prevent yellow starthistle from reestablishing.

In all instances, choose desirable species that are well adapted to the site and not likely to become invasive themselves. Species that grow well are the best competitors.

### Chemical Control

Both postemergent and preemergent herbicides are available to control yellow starthistle along roadsides, rights-of-way, and noncrop areas. Most herbicides registered for use in rangeland and pastures are only active postemergence. Clopyralid, however, has both preemergence and postemergence activity on yellow starthistle.

**Postemergent Herbicides.** Postemergent herbicide treatments generally work best on seedlings. The long germination period of yellow starthistle makes control with a single application almost impossible. A treatment following the first flush of seedlings opens a site up for later flushes. Waiting until later in the rainy season to apply a postemergent herbicide allows a greater number of seedlings to be treated, but larger plants will require higher herbicide rates and may not be controlled.

*Aminopyralid* and *clopyralid* are growth regulator herbicides for use in non-crop areas, including rangeland and pastures. Unlike other growth regulator herbicides, these are effective on yellow starthistle both postemergence and preemergence. The most effective timing for aminopyralid application is from December to March, when yellow starthistle is in the seedling to midrosette stage; its soil residual should last until the end of the rainy season. Clopyralid has a shorter soil residual and should be applied January to March. For both chemicals, earlier applications (i.e., in fall) may not provide full-season control, and later applications (bolting to early spiny stage) will require higher rates. A single application at the recommended time will provide season-long control. Aminopyralid is used at 0.75 to 1.75 oz acid equivalent/acre, and clopyralid is used at 2 to 3.96 oz acid equivalent/acre. Both chemicals are selective on many members of the sunflower family, particularly thistles, but can also injure legumes, including clovers. Most other broadleaf species and all grasses are not injured. There are no grazing restrictions after aminopyralid or clopyralid use in

rangelands. While not registered for use around the home, aminopyralid and clopyralid do have registration for use in pastures, rangelands, rights-of-way, roadsides, and other noncrop areas. Clippings from treated areas should not be used as compost; these herbicides degrade slowly in compost and can be a problem when used as a mulch or fertilizer source in sensitive crops or landscapes.

2,4-D can provide acceptable control of yellow starthistle if it is applied at the proper rate and time. Treatment in the rosette growth stage provides better control than later applications. Amine formulations are as effective as ester formulations at the small rosette growth stage, and amine formulations reduce the chance of off-target movement.

Application rates of 0.5 to 0.75 lb active ingredient/acre will control small rosettes. Applications made later in the season, when rosettes are larger or after bolting has been initiated, require a higher application rate (1 to 2 lb active ingredient/acre) to achieve equivalent control. 2,4-D is a growth regulator and a selective herbicide that controls many other broadleaf plants, but has minimal effect on clovers and generally does not harm grasses. It has little, if any, soil activity. Drift from 2,4-D applications is common, particularly from ester formulations. Use caution when applying near sensitive vegetation or during windy or high temperature conditions. Certain formulations of 2,4-D require a restricted materials permit; generally formulations that are sold in small quantities (i.e., liquid formulations that do not exceed 1 quart and dry formulations that do not exceed 1 pound) do not require a permit.

*Dicamba* is very effective at controlling yellow starthistle at rates as low as 0.25 lb active ingredient/acre. When yellow starthistle rosettes are small, about 1 to 1.5 inches across, the 0.25 lb active ingredient/acre rate works well, but higher rates (0.5 to 0.75 lb active ingredient/acre) are needed if plants are larger. Applications made in late

rosette to early bolting stages have provided excellent control, although earlier treatments are better.

Dicamba is also a growth regulator and selective herbicide that controls many broadleaf plants, including clovers, but does not harm grasses. Its soil activity is very short. Like 2,4-D, it is available as both an amine and as an ester formulation. Drift from dicamba applications is common, especially from the ester formulation. Some formulations have lower drift potential than others. Use caution when applying near sensitive vegetation. Certain formulations of dicamba require a restricted materials permit; generally formulations that are sold in small quantities (i.e., liquid formulations that do not exceed 1 quart and dry formulations that do not exceed 1 pound) do not require a permit.

*Triclopyr* at 0.5 lb active ingredient/acre provides complete control of yellow starthistle seedlings but is not as effective on larger plants. More mature plants require rates up to 1.5 lb active ingredient/acre. Like 2,4-D and dicamba, triclopyr is a growth regulator herbicide with little or no residual activity. It is foliar-absorbed and active on broadleaf species, including clovers, but typically does not harm grasses. Triclopyr is formulated as both an amine and ester. The ester formulation is more sensitive to drift than the amine form. Caution should be observed when using the ester formulation. This material is registered for use around the home as well as for pastures, rangelands, rights-of-way, roadsides, and other noncrop areas.

*Glyphosate* controls yellow starthistle at 1 lb active ingredient/acre. Good coverage, clean water, and actively growing yellow starthistle plants are all essential for adequate control. Unlike growth regulator herbicides, glyphosate is nonselective and controls most plants, including grasses. It has no soil activity. A 1% solution of glyphosate also provides effective control and is used at this concentration for spot treatment of small patches. An application of glyphosate

is a very effective method of controlling starthistle plants in the bolting, spiny, and early flowering stages at 1 to 2 lb active ingredient/acre. However, glyphosate will severely damage desirable perennial grasses if they are sprayed as well. Glyphosate is registered for use around the home as well as for pastures, rangelands, rights-of-way, roadsides, and other noncrop areas.

**Preemergent Herbicides.** Preemergent herbicides must be applied before seeds germinate to be effective. The long germination period of yellow starthistle requires that a preemergent material have a lengthy residual activity. Make applications before a rain, which will move the material into the soil. Because these materials adhere to soil particles, off-site movement and possible injury of susceptible plants could occur if the soil is dry and wind occurs before rain. When yellow starthistle plants have already emerged, it is possible to combine a postemergent herbicide (to control emerged plants) with a preemergent herbicide (to provide residual control of any subsequent germination) for an effective control strategy.

Chlorsulfuron and sulfometuron are preemergent herbicides registered for roadsides and other noncrop uses. Chlorsulfuron was recently registered for use in rangelands. Both are very effective at controlling yellow starthistle when applied at 1 to 2 oz active ingredient/acre. Little postemergence activity occurs on yellow starthistle with these two compounds. Best control is achieved when applications are made before weeds emerge. They may not be used around the home.

### **Integrated Approaches**

Combinations of prescribed burning and clopyralid can be very effective for yellow starthistle control. However, when using this integrated approach it is important that a prescribed burn be conducted the first year (or possibly for 2 years) and that clopyralid be applied in the last year of the program. Treating in the first year and burning in the second year

may increase the starthistle problem because burning has been shown to increase seed germination during the following rainy season. Continued control of yellow starthistle after the last year of treatment can be accomplished by either mowing, spot spraying, or hand-pulling. ❖



For more information contact the University of California Cooperative Extension or agricultural commissioner's office in your county. See your phone book for addresses and phone numbers.

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