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SMALL GRAIN PRODUCTION MANUAL PART 9

Pest Management of Small Grains—Weeds

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This publication, *Pest Management of Small Grains—Weeds*, is the ninth in a fourteen-part series of University of California Cooperative Extension online publications that comprise the *Small Grain Production Manual*. The other parts cover specific aspects of small grain production practices in California:

- *Part 1: Importance of Small Grain Crops in California Agriculture*, Publication 8164
- *Part 2: Growth and Development*, Publication 8165
- *Part 3: Seedbed Preparation, Sowing, and Residue Management*, Publication 8166
- *Part 4: Fertilization*, Publication 8167
- *Part 5: Irrigation and Water Relations*, Publication 8168
- *Part 6: Pest Management—Diseases*, Publication 8169
- *Part 7: Pest Management—Insects*, Publication 8170
- *Part 8: Pest Management—Vertebrates*, Publication 8171
- *Part 10: Small Grain Forages*, Publication 8173
- *Part 11: Small Grain Cover Crops*, Publication 8174
- *Part 12: Small Grains in Crop Rotations*, Publication 8175
- *Part 13: Harvesting and Storage*, Publication 8176
- *Part 14: Troubleshooting Small Grain Production*, Publication 8177

Weed control is important in small grains because weeds compete with developing plants, reducing grain or forage yield; green weeds that emerge late in the season can impede harvest operations and reduce grain quality; and weed seeds can contaminate the grain, making extra cleaning necessary. Effective weed control in small grains also helps reduce weed infestations in subsequent crops. Many weeds are more economical to control in small grains than in other crops. The distinction between winter and spring small grains and among different classes of cereal crops is important because some herbicide labels give different application rates or crop injury potentials for different small grains or cereal crops. Labels should be checked before an application is made and all label instructions must be followed. Table 1 gives the major weeds of importance in various regions of California (see also *UC IPM Pest Management Guidelines: Small Grains*, http://www.ipm.ucdavis.edu/PMG/selectnewpest.small-grains.html).

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Table 1. Problem weeds by region in California

Scientific name	Common name	Inter-mountain	Sacramento Valley	San Joaquin Valley	Coast	Southern California
Broadleaf weeds						
Amaranthus spp.	pigweed	•				
Amsinckia intermedia	coast fiddleneck	•	•	•	•	•
Anthemis cotula	mayweed chamomile		•	•		
Bassia hyssopifolia	fivehook basia			•		
Brassica spp.	mustard	•	•	•	•	•
Calandrinia ciliata	redmaids		•	•	•	
Capsella bursa-pastoris	shepherd's purse	•	•	•	•	•
Cardaria draba	hoary cress	•			•	
Centaurea solstitialis	yellow starthistle	•	•	•	•	
Chenopodium album	common lambsquarters	•		•	•	•
Chenopodium murale	nettleleaf goosefoot	•				•
Cirsium arvense	Canada thistle	•				
Cirsium vulgare	bull thistle	•		•	•	
Claytonia perfoliata	miner's lettuce		•	•	•	
Conium maculatum	poison hemlock	•			•	
Convolvulus arvensis	field bindweed		•	•		
Cyperus spp.	nutsedge			•		
Descurainia sophia	tansy mustard	•				•
Erodium spp.	filaree	•	•	•	•	
Hypericum perforatum	St. Johnswort				•	
Kochia scoparia	kochia	•				
Latuca serriola	prickly lettuce	•	•	•		•
Lepidium latifolium	perennial pepperweed	•				
Malva parviflora	little mallow	•	•	•		•
Matricaria matricariodes	pineappleweed		•	•		
Polygonum argyrocoleon	silversheath knotweed	•		•		•
Polygonum coccineum	swamp smartweed		•	•		
Raphanus raphanistrum	wild radish		•	•	•	
Salsola iberica	Russian thistle	•		•	•	
Senecio vulgaris	common groundsel		•	•	•	•
Silybum marianum	blessed milkthistle		•	•		
Sisymbrium irio	London rocket		•	•	•	•
Solanum spp.	nightshade	•				
Sonchus oleraceus	annual sowthistle		•	•	•	•
Stellaria media	common chickweed		•	•	•	
Taraxacum officinale	dandelion		•			
Urtica urens	burning nettle	•	•	•	•	
Grasses						
Avena fatua	wild oat	•	•	•	•	•
Bromus spp.	bromes	•	•	•	•	•
Cynodon dactylon	bermudagrass					
Elytrigia repens	quackgrass	•		•		•
Hordeum jubatum	fo•tail barley	•				
Hordeum leporinum	hare barley	•	•	•	•	
Lolium multiflorum	Italian ryegrass, annual ryegrass		•	•	•	
Phalaris minor	littleseed canarygrass			•		•
Phalaris paradoxa	hood canarygrass		•	•	•	
Poa annua	annual bluegrass			•		
Poa bulbosa	bulbous bluegrass	•				
Polypogon monspeliensis	rabbitsfoot grass		•	•		•
Secale cereale	cereal rye	•				
Setaria pumila	yellow foxtail		•	•	•	
Setaria viridis	green foxtail		•	•	•	
Sorghum halepense	johnsongrass		•	•	•	
Taeniatherum caput-medusae	Medusahead	•			•	

TYPES OF WEEDS

Broadleaf Weeds

A wide range of broadleaf weeds infest small grains (see table 1). The more common weeds are mustards (*Brassica* spp., especially black mustard, *B. nigra)*, wild radish *(Raphanus raphanistrum)*, London rocket *(Sisymbrium irio)*, shepherd's purse *(Capsella bursa-pastoris)*, coast fiddleneck *(Amsinckia intermedia)*, annual sowthistle *(Sonchus oleraceus)*, prickly lettuce *(Latuca serriola)*, burning nettle *(Urtica urens)*, pineapple-weed *(Matricaria matricariodes)*, miner's lettuce *(Claytonia perfoliata)*, common chick-weed *(Stellaria media)*, field bindweed *(Convolvulus arvensis)*, swamp smartweed *(Polygonum coccineum)*, common lambsquarters *(Chenopodium album)*, and yellow starthistle *(Centaurea solstitialis)*. Broadleaf weeds vary in their ability to compete with small grains. For example, an average of 1 wild radish plant per square foot (10 per sq m), when established at the same time a wheat crop emerges, can reduce yield by as much as 66 percent by completely overtopping the wheat canopy and competing for light. Low-growing weeds such as common chickweed, henbit *(Lamium amplexicaule)*, and miner's lettuce are generally less competitive, but even high populations of common chickweed can smother small plants, reduce yield, and remove soil nutrients and moisture. Poor weed management also causes weed problems in succeeding crops.

Grasses

Grass weeds are difficult to control in small grains because they mimic the growing cycle and growth habit of the crop. Many grass weeds germinate at the same time as small grains and mature slightly before or at the same time as the crop, assuring an ample supply of seed for next year's weed crop. These weeds compete for light and space and also remove soil moisture and nutrients needed for crop growth. Winter annual grassy weeds in California's small grains include wild oat *(Avena fatua)*, Italian, or annual, ryegrass *(Lolium multiflorum)*, ripgut brome *(Bromus diandrus)* and downy brome *(B. tectorum)*, hare barley *(Hordeum leporinum)*, rabbitsfoot grass *(Polypogon monspeliensis)*, and hood canarygrass *(Phalaris paradoxa)* and littleseed canarygrass *(P. minor)*.

Wild oat emerges throughout the cool season from autumn through spring. In small grains it causes lodging, slows harvest, clogs harvester screens, and lowers yields. An average of 7 wild oat plants per square foot (70 per sq m) can reduce wheat yields by 3,000 pounds per acre (3,360 kg/ha) in a crop with a yield potential of 6,000 pounds per acre (6,720 kg/ha). Barley, because of its more competitive early growth, is less affected by wild oat than is wheat. In one study a wild oat density averaging 14 plants per square foot (140 per sq m) reduced barley yield by 27 percent and wheat yield by 39 percent (Cudney et al. 2001). Ripgut brome is a particular problem in rainfed production areas. The weed reduces yield by competing with the crop, and its seed can contaminate the grain and reduce its marketability. Italian ryegrass is a major weed in the central and northern valleys of California. Infestations of hood and littleseed canarygrass can reduce yields by more than 50 percent. Hood canarygrass occurs in the central region and coast rainfed production areas, while littleseed canarygrass is most prevalent in the Imperial Valley and Southern California. Canarygrass is a prolific seed producer, and populations of canarygrass in fields continuously cropped to small grains often exceed 100 plants per square foot (1,000 per sq m). Hare barley and rabbitsfoot grass are common in the southern part of the state, although hare barley is sporadically found elsewhere in California.

CULTURAL PRACTICES THAT REDUCE WEED PRESSURE

An integrated weed management system combines crop rotation, fertilization, irrigation, tillage, herbicide applications, and high plant populations to help control weeds. Field sanitation is a prerequisite for weed control. Planting and tillage implements should be free of weed seeds and other plant propagules to avoid spreading weeds from field to field. Field perimeters should be kept free of weeds because they serve as a reservoir for seed to infest the field.

A properly prepared seedbed can increase yield and reduce weed pressure (see part 3, *Seedbed Preparation, Sowing, and Residue Management*). Plant high-quality, vigorous, weed-free certified seed. Using noncertified seed risks the introduction of new weed infestations. The sowing date can influence weed competition. Late sowing produces shorter small grain plants that have fewer tillers and are less competitive with weeds. Lower seeding rates also can intensify weed pressure. Studies in the Sacramento–San Joaquin Delta have shown that higher seeding rates are very effective at reducing competition by swamp smartweed, johnsongrass, mustard, wild oat, canarygrass, and common chickweed. Row spacing should be as narrow as feasible to promote early development of a solid, competitive crop canopy.

Mulch planting can give a small grain crop a head start over weeds. In mulch planting, a shallow cultivation is done following rainfall or irrigation, when weed seeds germinate before planting. The crop seed is then sown into moist soil below the mulch layer of dry soil that resulted from the cultivation. Because the crop seed is placed into moist soil, it germinates quickly, ahead of weeds.

Fertilization is essential to maximize small grain vigor and health and is an excellent weed suppression practice (see part 4, *Fertilization*). Starter fertilizer (low nitrogen and high phosphorus content) may be required in some areas. Place starter fertilizer near the seed to provide early availability to the crop, not to weeds. Broadcast-applied starter fertilizer enhances weed growth, especially for wild oat and canarygrass; broadcast applications are less efficient and should be avoided.

Irrigation and proper drainage keep small grains in a vigorous growing condition for maximum competition with weeds (see part 5, *Irrigation and Water Relations*). In areas where flooding and high water tables occur, small grains should be sown on 30- to 60-inch (0.75- to 1.5-m) raised beds. For rainfed production systems, fields can be fallowed every other year to prevent weed seed buildup and to conserve moisture for maximum small grain growth. Weeds should not be permitted to produce seed during the fallow period. Tillage operations before planting should be delayed until the first fall rains germinate the weed seeds so that tillage can kill the first flush of weeds before sowing. Weeds may also be treated with an herbicide during the fallow period (chemical fallow).

Rotating small grain crops with other crops reduces infestations of johnsongrass, wild oat, Italian ryegrass, and other weeds that are important in small grains (see part 12, *Small Grains in Crop Rotations*). Crop rotation allows weed populations to be reduced chemically, mechanically, and physically in the alternate crop. Growing different crops at different times of the year helps break the reproduction cycle of some problem weeds. Small grains are often grown so that weeds important in higher-value crops can be controlled. For example, small grains grown in rotation with vegetable crops allow postemergent broadleaf herbicides to be used to control nightshades and sowthistle, major problems in vegetable crops.

CHEMICAL CONTROL

Good cultural practices help reduce weed competition, but an integrated approach involving these measures as well as herbicide applications is often needed for complete weed control. An integrated approach reduces weed seed production and aids weed control in succeeding crops. The effectiveness of a chemical weed control program depends on the weed species present, application timing, thoroughness of spray application, environmental conditions at the time of application, herbicide use rate and spray volume, and crop management after the application is made. For example, weeds may again cause problems if late-winter rains stimulate additional weed seed germination after a herbicide application is made. Also, drought-stressed weeds are very difficult to control with postemergent herbicides, especially if they are beyond the seedling stage. Susceptibility of problem weeds to available herbicides is given in the susceptibility table in *UC IPM Pest Management Guidelines, Small Grains* (http://www.ipm.ucdavis.edu/PMG/selectnewpest.small-grains.html). This table is kept up to date with the latest available herbicides.

Postemergence Broadleaf Weed Control

Only postemergent herbicides, which are applied after the crop has emerged, are used for weed control in small grains. Fall-sown small grains are usually treated between December and mid-March, depending on the sowing date and growing conditions. Spring-sown small grains in the intermountain area of northern California are treated between April and June. Several postemergent herbicides are registered for use in small grains.

Phenoxy herbicides, including 2,4-D and MCPA, are commonly used in small grains alone or in combinations. Dicamba, another hormonal-type herbicide, is often included in the phenoxy herbicide group because of its similar mode of action. These herbicides are most effective when applied to small, succulent weeds. Small grains vary in their sensitivity to these herbicides; for example, oat is more tolerant to MCPA than to 2,4-D. Ester and amine formulations of 2,4-D and MCPA amine formulations control most broadleaf weed species encountered in small grains. The ester form is usually more effective than the amine form. However, ester use is not permitted in most counties, or applications are limited to certain times of the year. Figure 1 illustrates the proper application timing of these herbicides. Phenoxy herbicides should be applied after the small grains are well tillered but before they reach the boot stage in order to avoid yield reductions caused by phytotoxicity (see part 2, *Growth and Development*). Best control is obtained when weeds are small and before the crop has reached the jointing stage. Late applications are sometimes ineffective because the crop canopy shields the weeds, preventing herbicide contact. Dense weed populations require a more thorough application with a greater spray volume to ensure contact between the herbicide and weeds. The use of aircraft often facilitates timely herbicide application, but care must be taken to make applications at the appropriate

LEGEND
BRO = bromoxynil (Buctril)
CAR = carfentrazone (Shark)
CHS = chlorsulfuron (Glean)
CLO = clopyralid (Stinger)
DIA = dicamba (Banvel, Clarity)
DIC = diclofop (Hoelone)
FEN = fenoxaprop (Puma)
GLY = glyphosate (Roundup)
MCA= MCPA Amine
MES = mesosulfuron (Osprey)
PAR = paraquat (Gramoxone)
24D = 2,4-D Amine

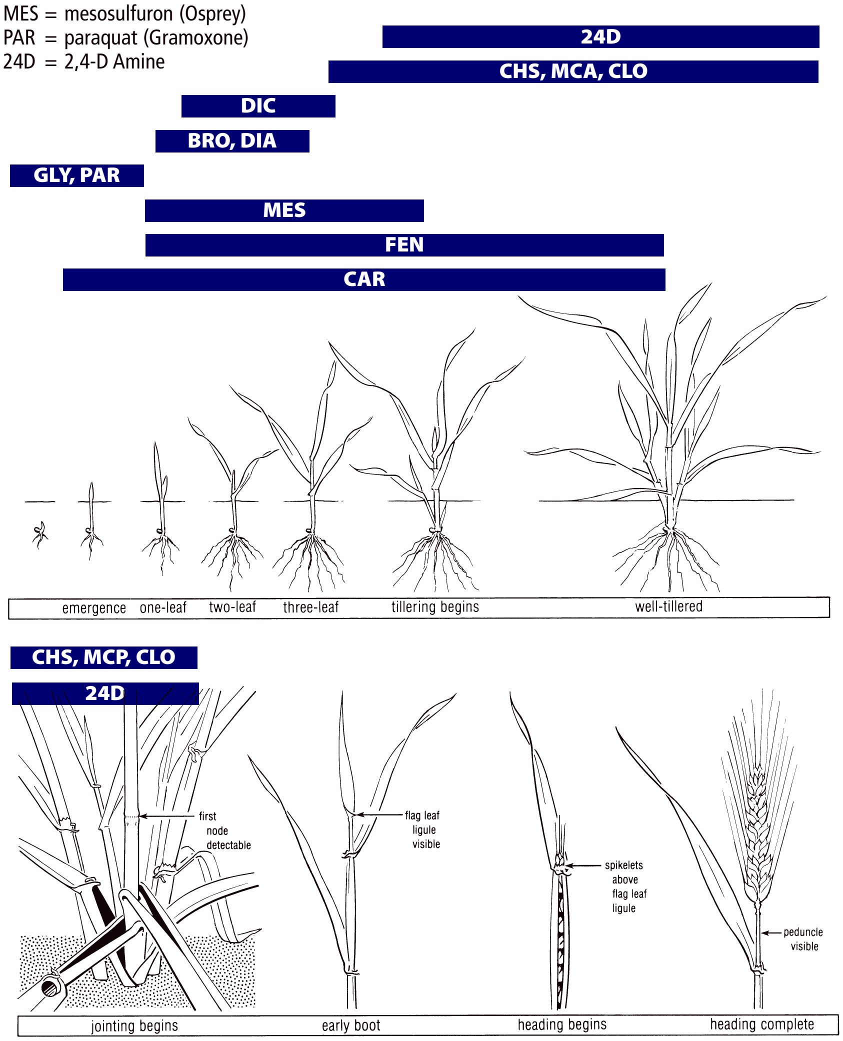

Figure 1. Timing of herbicide applications. *Source:* adapted from *UC IPM Pest Management Guidelines, Small Grains: Developmental Growth Stages*, *http://www.ipm.ucdavis.edu/PMG/r730000111.html.*

time to avoid injury to adjacent crops from drift or volatilization. MCPA does not control large weeds as well as 2,4-D amine and 2,4-D ester herbicides, but it has greater crop safety, especially when applied to small grains in early growth stages.

Dicamba (Banvel, Clarity) is effective for broadleaf weed control; however, small grains are generally more sensitive to it than they are to 2,4-D. Dicamba is safer when applied at early growth stages (2- to 5-leaf stage). It cannot be used on fall-sown barley. Dicamba controls small plants of common chickweed and coast fiddleneck, which are not controlled by 2,4-D or MCPA. It usually is combined with bromoxynil and MCPA. When applied early, this combination is very effective and increases the weed spectrum controlled compared with either of the herbicides used alone.

Bromoxynil (Buctril), a contact herbicide, is effective on young seedling weeds with no more than 2 to 4 leaves. It is less effective on older weeds and must be tank-mixed with other herbicides, for example, when larger mustards are present. Bromoxynil is not translocated (moved) from the site of absorption like the phenoxy herbicides. Therefore, higher-volume application and thorough coverage is more important with bromoxynil than with phenoxy herbicides. An advantage of bromoxynil is that it controls the toxic weed coast fiddleneck when applied at early growth stages of the weed; phenoxy herbicides often fail to control coast fiddleneck. Bromoxynil is also recommended in areas with phenoxy-sensitive crops such as grapes, cotton, and tree crops.

Chlorsulfuron (Glean) is registered for use on wheat in a wheat-fallow rotation. It is a sulfonyl urea herbicide with a very low application rate. It is not widely used in California because it has a long soil life (at least 18 months), which prevents its use in areas where many different crops are grown. This herbicide controls most broadleaf weeds, including coast fiddleneck and common chickweed. It should be applied to small weeds when the small grain crop is in the 2 to 3 leaf stage to boot stage and should not be used on soils with pH above 7.5.

Clopyralid (Stinger), a picolinic acid, is registered for use on wheat, barley, and oats. It translocates systemically through weeds, similar to phenoxy herbicides. It has a longer soil persistence than phenoxy herbicides, which limits planting of some broadleaf crops before 12 to 18 months after application. It is effective on a different spectrum of weeds than 2,4-D, MCPA, or dicamba. Chlopyralid is especially effective for control of legumes and composites such as Canada thistle *(Cirsium arvense),* and yellow starthistle. Because it does not control many common broadleaf weeds such as mustards, it must be tank-mixed for complete control of the wide range of broadleaf weeds found in small grains. On wheat, clopyralid should be applied from the 3-leaf stage to early boot stage, complimenting the timing of 2,4-D and MCPA.

Carfentrazone (Shark) is a contact herbicide that controls weeds by disrupting cell membranes. It is effective at very low application rates on coast fiddleneck, little mallow, burning nettle, and other weeds that are difficult to control with other herbicides. Adding surfactants to carfentrazone often causes temporary crop burn. Tank mixing with UN-32 (urea-ammonium nitrate) may enhance weed control. Tank-mixing carfentrazone with dicamba provides good control of common chickweed. Combining carfentrazone with phenoxy herbicides broadens the weed spectrum controlled, lowers herbicide application rates, and can reduce the risk of weeds building up herbicide resistance.

Preemergent Grass Weed Control

Preemergent herbicides are not commonly used in small grains in California, but they can be effective in certain situations. Trifluralin (Treflan, Trilan) is a preemergent herbicide used for wild oat and canarygrass control in wheat and barley. It is applied before or after sowing and must be incorporated no deeper than 2 inches (5 cm). A double incorporation is more effective than a single incorporation. Small grains must be planted below the 2-inch herbicide zone (for semidwarf wheat, this depth is near the limit for successful emergence). Results can be erratic if the zone of treatment does not have adequate moisture. Crop safety is marginal.

Postemergent Grass Weed Control

Diclofop (Hoelon) controls wild oat, canarygrass, and Italian ryegrass in wheat and barley. Diclofop controls wild oat and ryegrass in the 1 to 4 leaf stage and canarygrass in the 1 to 2 leaf stage. Avoid applications under saturated soil conditions or cold weather.

Fenoxaprop ethyl (Puma) controls canarygrass, wild oat, and several foxtails, including yellow foxtail *(Setaria pumila)* and green foxtail (*S. viridis)*. It also suppresses mustards. It has a wide window of application, providing effective control when applied between the 1 to 6 leaf stage of grasses. For best control of wild oat, delay application until most wild oat plants have emerged. A tank mixture with bromoxynil allows for a wide range of weed control at an early timing. Fenoxaprop cannot be tank-mixed with phenoxy herbicides since reduced grass control often results when such tank mixtures are used.

Mesosulfuron (Osprey) controls most grassy weeds and many broadleaf weeds in wheat. It is especially effective on Italian ryegrass, wild oat, littleseed and hood canarygrass, and annual bluegrass. It controls ripgut brome and other brome species, depending on weed size at application. Most California wheat cultivars have good tolerance to the herbicide. However, wheat plants will turn a lighter green color for a couple of weeks following application. If soil nitrogen levels are low, this symptom will persist longer, and supplemental nitrogen should be applied. When treated beyond the 1 tiller stage, temporary growth suppression and shortening of the wheat plant will occur. The crop will recover more quickly from these symptoms under good growing conditions. Mesosulfuron is effective on certain broadleaf weeds, including common chickweed, wild radish, and mustards. It also provides partial control of many other broadleaf weeds, including common groundsel *(Senecio vulgaris)*, little malva, coast fiddleneck, yellow starthistle, and blessed milkthistle. Mesosulfuron can be tank-mixed with bromoxynil and MCPA and may be applied from the 1 leaf to 1 tiller wheat stage and up to the 2 tiller stage of grasses. A methylated seed oil or a nonionic surfactant is required; adding ammonium sulfate or low rates of UN-32 enhances weed control on difficult-to-control weeds. Restrictions on crop rotations are greater than with fenoxaprop.

Controlling Weeds before Planting and Crop Emergence

Weeds that have germinated can be chemically removed using paraquat and glyphosate before cereal planting or emergence. These nonselective herbicides have no soil-residual effects on germinating small grain plants as long as they are applied before plants emerge through the soil. If the herbicide comes into contact with wheat or barley plants, severe injury will occur. Glyphosate can also suppress perennial weeds such as johnsongrass, nutsedge (*Cyperus* spp.), bermudagrass *(Cynodon dactylon)*, and dandelion *(Taraxacum officinale)* when they are growing before grains are planted or emerge.

Controlling Weeds before Harvest

The presence of green weeds late in the season can cause harvest and postharvest problems. Green weeds can slow the progress of combines, raise the moisture content of the harvested crop, and discolor or even cause off-flavors of the harvested grain. Weeds that often cause problems at harvest include field bindweed, Russian thistle, fivehook bassia *(Bassia hyssopifolia)*, kochia, common lambsquarters, knotweed, swamp smartweed, and johnsongrass. Problems with green weeds at harvest can be avoided by using a preharvest herbicide application (2,4-D or glyphosate where permitted) or by swathing the crop before combining. In both cases the green weeds should be allowed to dry before the crop is combined.

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