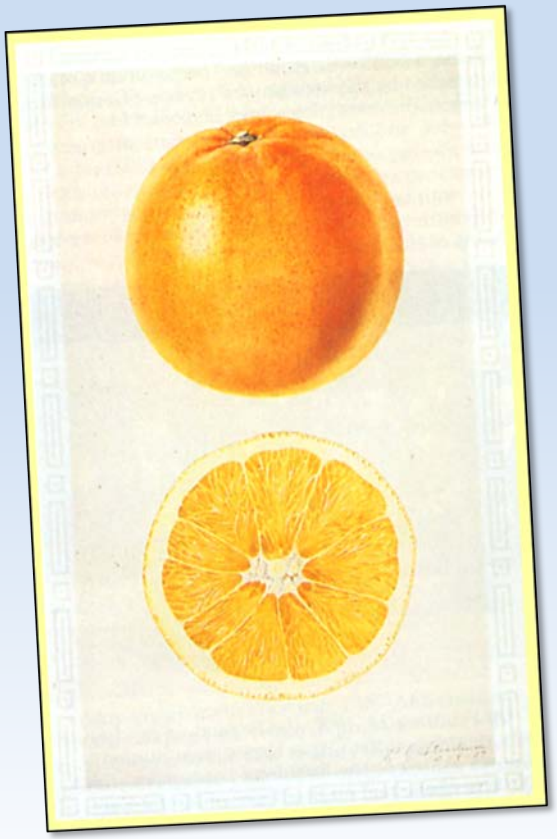

Weed Management in Citrus Orchards

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UC IPM | University of California
Agriculture and Natural Resources | Statewide Integrated Pest Management Program

My program at UC Riverside

- 90% Cooperative Extension, 10% Ag Experiment Station
  - Ecology and management of weedy and invasive plants in agriculture and wildlands
- Statewide appointment
  - Integration of herbicides with non-chemical methods (IWM)
  - Crop injury and non-target effects
  - Phenology/timing of management

Why weed management is important

- Compete with young trees
- Host insects, pathogens, rodents
- Interfere with irrigation, harvest
- Reduce soil warming (frost)
- Restrict visibility (roads, ditches, signs)
- Fuel for fires

What to expect

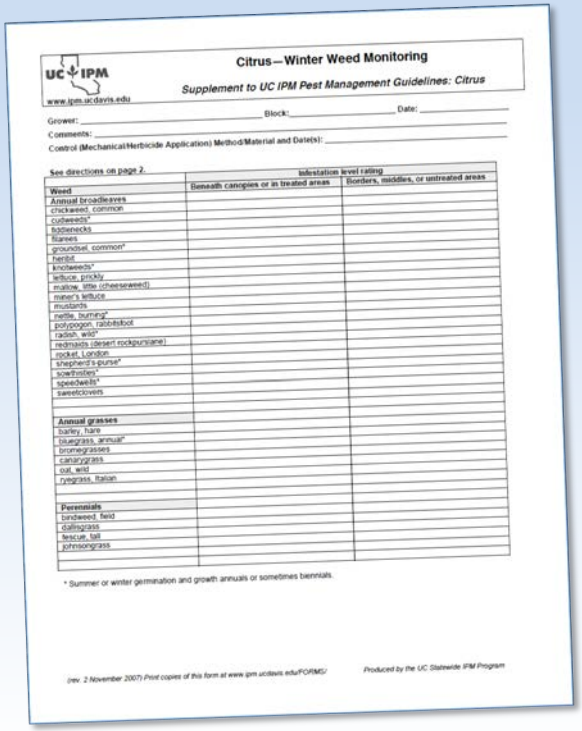
I. Basics of weed management in citrus orchards
II. Herbicides registered for citrus in CA
III. Management of problematic species
IV. UC IPM resources

Time for a question

Mention/omission of a product/active ingredient is not a recommendation/condemnation for use

I. Basics of effective weed management

- Monitoring
- Off-site (ongoing)
- On-site
  - Before Planting
  - New Orchards
  - Established Orchards



UC IPM
www.ipm.ucdavis.edu

Citrus—Winter Weed Monitoring

Supplement to UC IPM Pest Management Guidelines: Citrus

Grower: _____ Block: _____ Date: _____

Comments: _____

Control (Mechanical/Herbicide Application) Method/Material and Date(s): _____

See directions on page 2.

Weed	Infestation level rating: Beneath canopies or in treated areas	Borders, middles, or untreated areas
Annual broadleaves		
chickweed, common		
cudweeds*		
fiddlenecks		
flaxes		
groundsel, common*		
henbit		
knotweeds*		
lettuce, prickly		
mallow, little (cheeseweed)		
miner's lettuce		
mustards		
nettle, burning*		
polygonum, rabbitsfoot		
radish, wild*		
redmaids (desert rockpurslane)		
rocket, London		
shepherd's-purse*		
sowthistles*		
speedwells*		
sweetclovers		
Annual grasses		
barley, hare		
bluegrass, annual*		
bromegrasses		
canarygrass		
oat, wild		
ryegrass, Italian		
Perennials		
bindweed, field		
dallisgrass		
fescue, tall		
johnsongrass		

* Summer or winter germination and growth annuals or sometimes biennials.

(rev. 2 November 2007) Print copies of this form at www.ipm.ucdavis.edu/FORMS/

Produced by the UC Statewide IPM Program

Monitoring for adaptive management

- Know the species/abundance/location
- Identify longer term trends in weed population
  - Trouble spots
  - Seasonal issues
  - Consequences of management practices
  - What needs to change/adapt

Monitoring basics

- Late winter and summer
- Map it: species, abundance, location in orchard
- Pay special attention to
  - Perennials and resistant species
  - Orchard perimeter, roadsides, adjacent properties
  - Irrigation conveyance, moist areas

- Example forms available at UC IPM Online:
  - –http://ipm.ucanr.edu/PMG/C107/citrus-summerweeds.pdf
  - –http://ipm.ucanr.edu/PMG/C107/citrus-winterweeds.pdf

Time for a question

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Before planting

Eliminate future seedbank contributions

- Focus on existing perennial weeds (johnsongrass, bermudagrass, nutsedge, bindweed, etc.)

Before planting

Best opportunity for Integrated Weed Management

- Repeated discing in summer (dehydrate rhizomes)
- Herbicide
  - Systemic postemergent in early fall (carbohydrate translocation)
  - Repeat in spring for regrowth
  - Disc 2-3 wks later to expose/dehydrate rhizomes

Before planting

Deplete existing seedbank

1. Irrigate followed by postemergence herbicide
2. Preemergence herbicide
    1. Spring application to control warm-season germinators
    2. Fall application to control cool-season germinators
3. Rogue or spot-treat escapes

New orchards

- Minimize soil disturbance
- Protect trunks and foliage
  - Spray shield and/or wrapper
- Timing is critical
  - Window of susceptibility
  - Prevent seed set

New orchards

- Contact herbicides for annuals
  - Young/small plants only
- Grass-specific products
  - Annual grasses and *some* perennial grass *seedlings*
  - Actively growing, smaller plants only
- Glyphosate for larger plants and perennials

Time for a question

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Established orchards

Avoid cultivation

- Destroys feeder roots (nutrients, water, oxygen)
- Creates wound for disease entry
- Contributes to soil erosion and compaction

Established orchards

Avoid cultivation

- Creates dust which interferes with bio control of mites/insects
- Buries organic matter that insects feed on
- Increases weed population
  - Brings buried seeds to surface
  - Spreads rhizomes/tubers/stolons

Table 1. Visual estimation of general weed control in mechanical and chemical control treatments in a Yuma, AZ Limoneira 8A Lisbon lemon orchard. Means followed by the same letter within a column are not significantly different at P = 0.05 according to analysis of variance and the Student-Newman-Keuls mean separation test.

Trt. Name	Mechanical Treatment	Herbicide Treatment and Sprayer Type	General Weed Control (% weed control)	
			July 10, 2001	Oct. 31, 2001
D	Disk	None	0 ± 0 d	23.3 • •8.8 b
P1	Perfecta cultivator	None	12.5 • •19.4 cd	33.3 • •20.9 b
P2	Perfecta cultivator	PREE[a] Surflan - conventional PREE Solicam - conventional POST Roundup - conventional	23.0 • •22.8 c	84.3 • •9.5 a
P3	Perfecta cultivator in strip along tree line	PREE Surflan - conventional PREE Solicam - conventional POST Roundup - WeedSeeker	15.8 • •12.4 c	84.2 • •3.8 a
H1	None	POST Roundup - WeedSeeker	71.7 • •13.7 a	87.8 • •3.2 a
H2	None	PREE Surflan - conventional PREE Solicam - conventional POST Roundup - WeedSeeker	69.2 • •69.2 a	94.2 • •2.8 a
H3	None	POST Roundup - conventional	36.7 • •12.9 b	88.8 • •6.4 a

[a]PREE = pre-emergence herbicide, POST = post-emergence herbicide

McCloskey et al 2002

Established orchards

Preemergence herbicides

- Control and injury mediated by
  - Soil texture
  - OM
  - $CaCO_3$
- Leaching and soil texture
- Prolonged moisture
- Sequential applications

Established orchards

Postemergence herbicide

- Contact herbicides (Shark/Rely/Treevix)
  - Not translocated/only kills what is sprayed
  - Good coverage/wetting essential
  - Single spray can kill annual weeds
  - Retreatment needed for perennials; new annuals from seed

Established orchards

Postemergence herbicide

- Translocating herbicides (glyphosate/Select Max/Poast)
  - Move within plant
  - Complete coverage not as important
  - Active growth required for movement

Time for a question

Mention/omission of a product/active ingredient is not a recommendation/condemnation for use

II. Herbicides registered for CA citrus

	Top active ingredients (by acres)	2016 treated acreage
1	glyphosate	41,6495
2	indaziflam (Alion)	106,076
3	rimsulfuron (Matrix)	78,360
4	saflufenacil (Treevix)	74,110
5	glufosinate (Rely)	37,876
6	diuron (Karmex)	24,296
7	pendimethalin (Prowl)	17,042
8	mesotrione (Broadworks)	13,644
9	simazine (Princep)	13,186
10	bromacil (Hyvar)	6,501
11	oxyfluorfen (Goal)	5,834
12	sethoxydim (Poast)	4,867

Combined data for grapefruit, kumquat, lemon, lime, orange, pomelo, tangelo, & tangerine

Preemergence – 14 active ingredients

- Diuron (Karmex)
- EPTC (Eptam)
- Flazasulfuron (Mission) – also POST
- Flumioxazin (Chateau) – *Nonbearing*
- Indaziflam (Alion)
- Isoxaben (Trellis)
- Mesotrione (Broadworks)
- Norflurazon (Solicam)
- Oryzalin (Surflan)
- Oxyflurofen (Goal) – *Nonbearing*, also POST
- Pendimethalin (Prowl)
- Rimsulfuron (Matrix) – also POST
- Simazine (Princep)
- Trifluralin (Treflan)

Postemergence - 13 active ingredients

Systemic non-selective

- Glyphosate (Roundup)

Systemic grass-selective:

- Clethodim (Select Max) - *Nonbearing*
- Fluazifop-p-butyl (Fusilade)
- Sethoxydim (Poast)

Contact:

- Ammonium nanoate (Axxe)
- Caprillic/Capric Acid (Suppress)
- Carfentrazone (Shark)
- D-Limonene (Avenger AG)
- Diquat (Diquat) - *Nonbearing*
- Glufosinate (Rely)
- Paraquat (Gramoxone) – *Restricted Use*
- Pelargonic Acid (Scythe)
- Saflufenacil (Treevix)

Glyphosate alternatives

- Postemergence, non-selective, systemic herbicide alternatives?
- Postemergence options limited/unavailable
  - Non-seedling perennials
  - Broadleaf annuals/biennials above a certain size
- Very limited window of opportunity for contact herbicides
- Preemergence control critical
- Hand-roguing (expensive)
- Cover crops?

Time for a question

Mention/omission of a product/active ingredient is not a recommendation/condemnation for use

III. Problematic weed species

Herbicide resistance

- Horseweed and fleabane
- Palmer amaranth

III. Problematic weed species

Tubers/rhizomes and/or persistent seedbank

- Nutsedge
- Johnsongrass

Nutsedge

- Yellow:
  - Throughout CA to 3300 ft
  - Tubers are round and smooth
  - Tubers only at the end of rhizomes

Nutsedge

- Purple
  - Central Valley, South Coast and Desert to 820 ft
  - Tubers are oblong, rough, and scaly
  - Tubers linked by rhizomes

Nutsedge

- Susceptible to systemic herbicide **before** 5-6 leaves
  - No tubers yet
  - Building energy reserves
- Beyond 5-6 leaves
  - Poor translocation to tubers
  - Only top-killed with herbicides
  - Suppression only

Johnsongrass

- Seeds viable in soil ≥ 5 years
- Repeated tillage in summer **if soil is dry**
- Resprouts from rhizomes as ≥ 1 inch long
- Systemic herbicide after flowering- phloem transport to rhizomes

Time for a question

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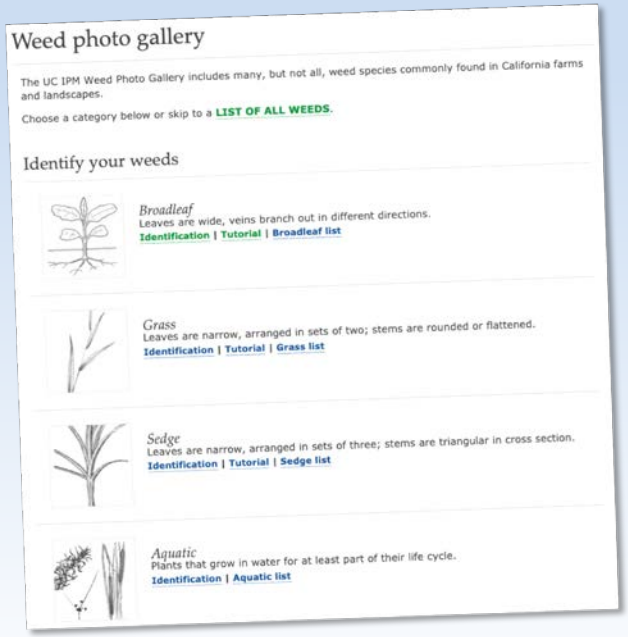
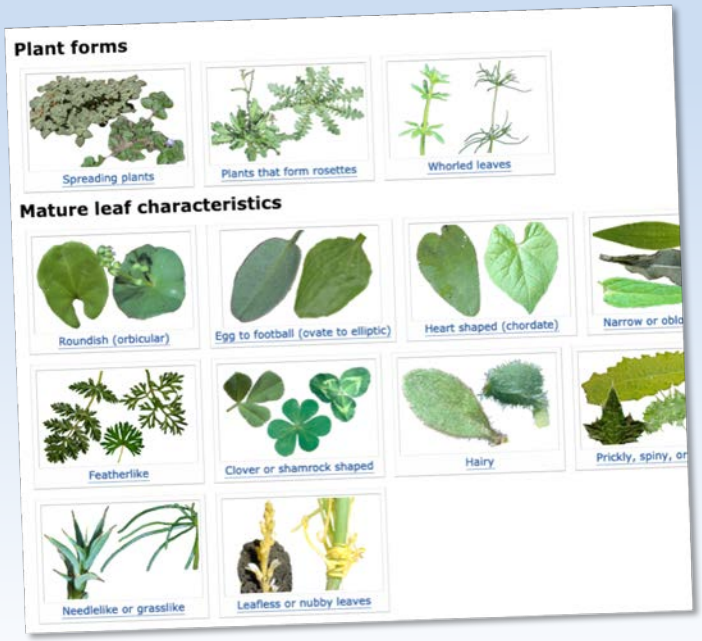
IIV. Resources – UC IPM Citrus Weeds

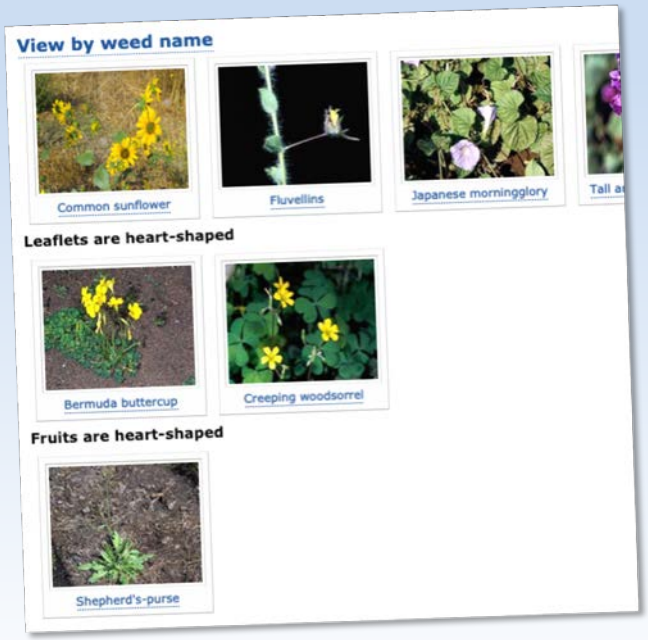
http://ipm.ucanr.edu/PMG/selectnewpest.citrus.html

- Photo gallery of common citrus weeds
- Tutorial on identification characteristics of weeds
- Herbicide susceptibility by weed species
- Herbicide symptomology

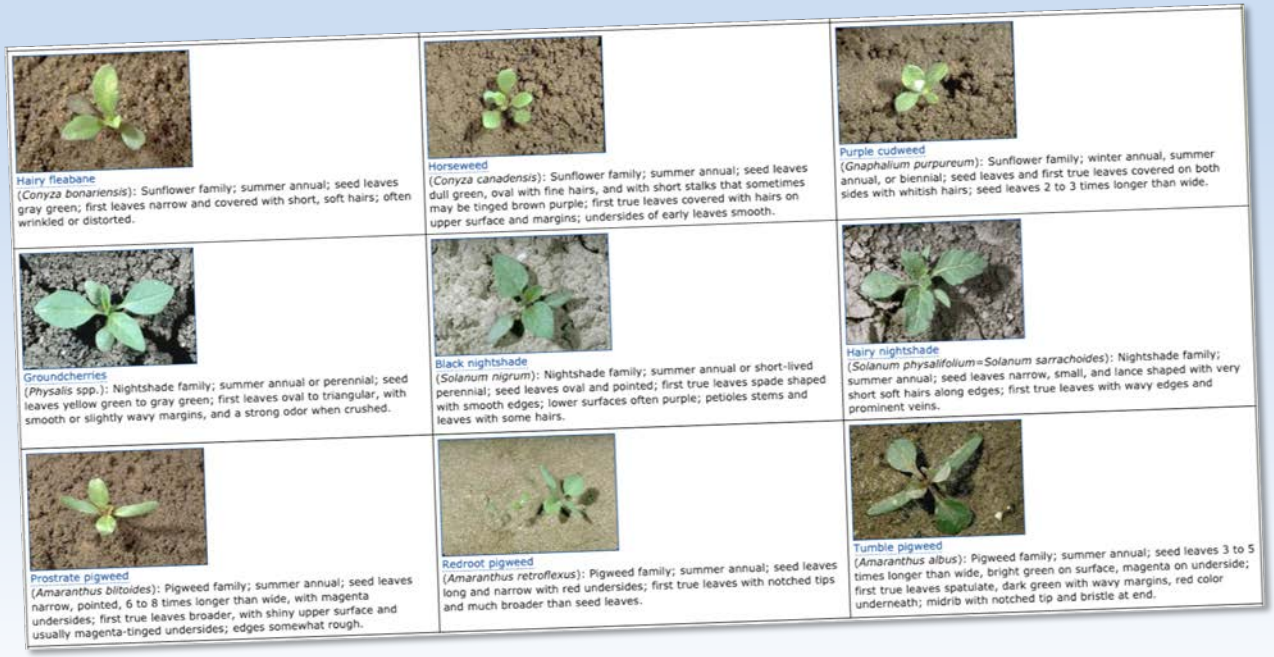
Resource: UC IPM Weed ID and photo Gallery http://ipm.ucanr.edu/PMG/weeds_intro.html







Resource: UC IPM weed seedling id



Hairy fleabane (*Conyza bonariensis*): Sunflower family; summer annual; seed leaves gray green; first leaves narrow and covered with short, soft hairs; often wrinkled or distorted.

Horseweed (*Conyza canadensis*): Sunflower family; summer annual; seed leaves dull green, oval with fine hairs, and with short stalks that sometimes may be tinged brown purple; first true leaves covered with hairs on upper surface and margins; undersides of early leaves smooth.

Purple cudweed (*Gnaphalium purpureum*): Sunflower family; winter annual, summer annual, or biennial; seed leaves and first true leaves covered on both sides with whitish hairs; seed leaves 2 to 3 times longer than wide.

Groundcherries (*Physalis* spp.): Nightshade family; summer annual or perennial; seed leaves yellow green to gray green; first leaves oval to triangular, with smooth or slightly wavy margins, and a strong odor when crushed.

Black nightshade (*Solanum nigrum*): Nightshade family; summer annual or short-lived perennial; seed leaves oval and pointed; first true leaves spade shaped with smooth edges; lower surfaces often purple; petioles stems and leaves with some hairs.

Hairy nightshade (*Solanum physalifolium=Solanum sarrachoides*): Nightshade family; summer annual; seed leaves narrow, small, and lance shaped with very short soft hairs along edges; first true leaves with wavy edges and prominent veins.

Prostrate pigweed (*Amaranthus blitoides*): Pigweed family; summer annual; seed leaves narrow, pointed, 6 to 8 times longer than wide, with magenta undersides; first true leaves broader, with shiny upper surface and usually magenta-tinged undersides; edges somewhat rough.

Redroot pigweed (*Amaranthus retroflexus*): Pigweed family; summer annual; seed leaves long and narrow with red undersides; first true leaves with notched tips and much broader than seed leaves.

Tumble pigweed (*Amaranthus albus*): Pigweed family; summer annual; seed leaves 3 to 5 times longer than wide, bright green on surface, magenta on underside; first true leaves spatulate, dark green with wavy margins, red color underneath; midrib with notched tip and bristle at end.

Available for summer and winter annuals and perennial grass and broadleaf species

Time for a question

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Weed species herbicide susceptibility

http://ipm.ucanr.edu/PMG/r107700311.html

- Selected weed species
  - Summer and winter annuals
  - Summer perennials
- Selected pre- and post-emergence herbicides

- Needs updating for
  - PRE: Alion, Broadworks, Matrix, Mission, Zeus
  - POST: Rely, Treevix

Weed herbicide susceptibility: selected perennial species

PERENNIAL WEEDS	PREEMERGENCE										POSTEMERGENCE								PERENNIAL WEEDS
	BRO*	DIU*	EPT[1]	FLM	ISO[1]	NOR*	ORY	OXY[1]	SIM*	TRI	CAR	CLE[1]	DIQ[1]	FLU[1]	GLY	OXY[1]	PAR*	SET	
Bermudagrass (Seedling)	N	N	C	N	N	C	C	C	P	C	N	C	P	P	C	C	P	C	Bermudagrass (Seedling)
Bermudagrass (Perennial)	N	N	N	N	N	P	N	N	N	N	N	P	N	P	C	N	N	P	Bermudagrass (Perennial)
Bindweed, Field (Seedling)	P	C	N	—	C	P	P	N	C	C	—	N	—	N	C	P	P	N	Bindweed, Field (Seedling)
Bindweed, Field (Perennial)	N	N	N	—	C	N	N	N	N	P	—	N	—	N	P	P	N	N	Bindweed, Field (Perennial)
Dallisgrass (Seedling)	C	N	C	—	N	N	C	N	C	C	N	P	P	N	C	C	N	C	Dallisgrass (Seedling)
Dallisgrass (Perennial)	C	N	N	N	N	N	N	N	N	N	N	N	N	N	C	N	N	—	Dallisgrass (Perennial)
Johnsongrass (Seedling)	C	C	C	C	N	C	C	N	C	N	N	C	P	C	C	C	C	C	Johnsongrass (Seedling)
Johnsongrass (Perennial)	P	N	N	N	N	C	C	N	N	N	N	C	N	N	C	N	N	C	Johnsongrass (Perennial)
Nutsedge, Yellow	C	N	P	N	N	P	N	N	N	N	N	N	P	N	P	N	N	N	Nutsedge, Yellow
Nutsedge, Purple	C	N	P	N	N	P	N	N	N	N	N	N	P	N	P	N	N	N	Nutsedge, Purple

Ratings Legend

C = control P = partial control N = no control — = no information

* Permit required from county agricultural commissioner for purchase or use.

1 For use on nonbearing citrus only.

Also available for summer annuals (list too big to fit here)

Weed herbicide susceptibility: selected winter annuals

Susceptibility of Winter Weeds to Herbicide Control

ANNUAL WEEDS	PREEMERGENCE										POSTEMERGENCE								ANNUAL WEEDS
	BRO*	DIU*	EPT[1]	FLM	ISO[1]	NOR*	ORY	OXY[1]	SIM*	TRI	CAR	CLE[1]	DIQ[1]	FLU[1]	GLY	OXY[1]	PAR*	SET	
Barley, Hare	C	C	C	P	—	C	C	P	P	C	N	C	P	C	C	P	C	C	Barley, Hare
Bluegrass, Annual	C	C	C	C	—	C	C	P	P	C	N	C	P	N	C	P	C	N	Bluegrass, Annual
Bromegrass	C	C	C	P	—	C	C	P	N	C	N	—	—	N	C	N	C	N	Bromegrass
Canarygrass	C	C	C	P	—	C	C	P	P	C	N	C	P	C	C	N	C	N	Canarygrass
Burclover, California	P	C	N	—	P	C	N	C	C	N	—	N	—	N	C	P	P	N	Burclover, California
Cudweeds	C	C	P	—	C	C	N	N	C	N	—	N	C	N	C	P	C	N	Cudweeds
Fiddlenecks	C	C	C	—	C	C	C	C	C	C	C	N	C	N	C	C	C	N	Fiddlenecks
Filarees	C	C	C	C	C	P	C	C	C	P	—	N	C	N	P	C	P	N	Filarees
Henbit	C	C	C	C	C	C	P	C	C	P	—	N	C	N	C	C	C	N	Henbit
Miner's Lettuce	C	C	P	—	—	C	C	C	C	C	—	N	—	N	C	C	C	N	Miner's Lettuce
Mustards	C	C	N	C	C	P	N	C	C	N	P	N	C	N	C	C	C	N	Mustards
Nettle, Burning	C	C	C	C	C	C	P	C	C	P	C	N	P	N	C	P	C	N	Nettle, Burning
Oat, Wild	C	P	C	C	—	C	P	P	N	P	N	C	P	C	C	N	P	C	Oat, Wild
Polypogon, Rabbitsfoot	C	C	C	—	—	C	C	P	P	C	—	—	—	C	C	P	C	C	Polypogon, Rabbitsfoot
Radish, Wild	C	C	N	—	C	C	N	C	P	N	—	N	—	N	C	P	P	N	Radish, Wild
Redmaids (Desert Rockpurslane)	C	C	C	—	—	C	C	C	C	C	—	N	—	N	C	C	C	N	Redmaids (Desert Rockpurslane)
Rocket, London	C	C	P	C	C	C	N	P	P	N	C	N	C	N	C	C	C	N	Rocket, London
Ryegrass, Italian	C	C	C	P	—	C	C	P	P	C	N	C	P	—	C	N	C	—	Ryegrass, Italian
Shepherd's-purse	C	C	P	C	—	C	N	C	C	N	P	N	C	N	C	P	C	N	Shepherd's-purse
Sowthistles	P	C	C	P	C	P	N	C	C	N	N	N	C	N	C	P	C	N	Sowthistles
Sweetclovers	P	C	N	—	P	C	N	C	C	N	—	N	—	N	C	P	P	N	Sweetclovers

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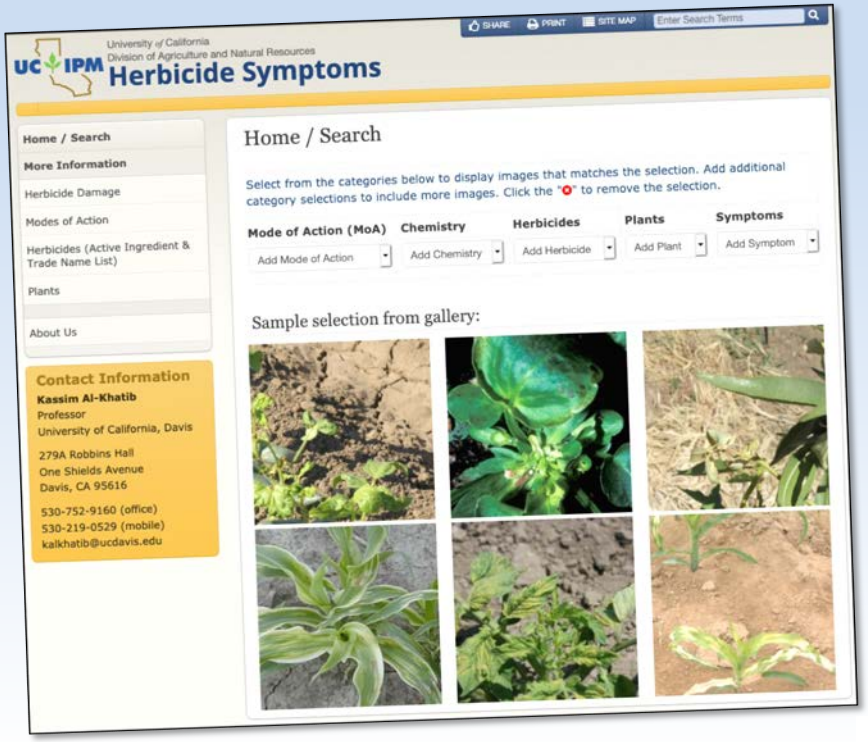
Resources – UC IPM Herbicide Symptoms

http://herbicidesymptoms.ipm.ucanr.edu/

Search for images of herbicide injury by:

- Mode of action
- Herbicide
- Crop
- Symptom
  - Chlorosis, necrosis, cupping, etc.



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