Weed Management in Citrus Orchards

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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
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:
Time for a question

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

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

<table>
<thead>
<tr>
<th>Trt. Name</th>
<th>Mechanical Treatment</th>
<th>Herbicide Treatment and Sprayer Type</th>
<th>General Weed Control (% weed control)</th>
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<tr>
<td>D</td>
<td>Disk</td>
<td>None</td>
<td>0 ± 0 d</td>
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<tr>
<td>P1</td>
<td>Perfecta cultivator</td>
<td>None</td>
<td>12.5 ± 9.4 cd</td>
</tr>
<tr>
<td>P2</td>
<td>Perfecta cultivator</td>
<td>PRE* Sulfan - conventional</td>
<td>23.0 ± 22.8 e</td>
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<td>PRE* Soltan - conventional</td>
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<tr>
<td></td>
<td></td>
<td>POST Roundup - conventional</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>Perfecta cultivator</td>
<td>PRE* Sulfan - conventional</td>
<td>15.8 ± 12.4 c</td>
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<tr>
<td></td>
<td>in strip along tree</td>
<td>PRE* Soltan - conventional</td>
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</tr>
<tr>
<td></td>
<td>line</td>
<td>POST Roundup - WeedSeeker</td>
<td></td>
</tr>
<tr>
<td>H1</td>
<td>None</td>
<td>POST Roundup - WeedSeeker</td>
<td>71.7 ± 13.7 a</td>
</tr>
<tr>
<td>H2</td>
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<td>PRE* Sulfan - conventional</td>
<td>69.2 ± 49.2 a</td>
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<td>PRE* Soltan - conventional</td>
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<td></td>
<td></td>
<td>POST Roundup - WeedSeeker</td>
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<tr>
<td>H3</td>
<td>None</td>
<td>POST Roundup - conventional</td>
<td>36.7 ± 12.9 b</td>
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</table>

*PRE = 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

Question # 4
## II. Herbicides registered for CA citrus

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

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

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

Available for summer and winter annuals and perennial grass and broadleaf species.
Time for a question

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

Also available for summer annuals (list too big to fit here)
Weed herbicide susceptibility: selected winter annuals

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<th>ANNUAL WEEDS</th>
<th>BRD*</th>
<th>DIU*</th>
<th>EPT*</th>
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</table>

**Ratings Legend**

- Control (C)
- Partial control (P)
- No control (N)
- No information (—)

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

1 For use on nonbearing citrus only.
Time for a question

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