Weed management recommendations for Florida citrus

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Outline of presentation

I. Impact of weeds on citrus production
II. Weed management tactics
III. Weed management programs
   a. Young citrus
   b. Older citrus
IV. Current herbicide use in citrus
   a. Preemergence herbicides
   b. Postemergence herbicides
V. Factors affecting herbicide choice
V. Factors affecting efficacy of herbicides
Impact of weeds on citrus

- Yield loss of up to 23-33%
- Weed control is 10 to 15% of production cost in citrus
Impact of weeds on citrus

- Interfere with grove operations such as harvesting
- Serve as alternate host of other pests such as insects and disease
- Reduce soil temperatures during freezing events
Weed management goal: reduce weed population at a level that would lessen impact of competition.
Weed control tactics

- Preventive
  - Spot treatment
  - Sanitation

- Mechanical
  - Tillage
  - Mowing

- Biological

- Chemical
  - Herbicides
  - PRE vs. POST Combinations
Weed management programs for young citrus

- Critical during the first 3 yrs after planting
Weed management programs for young citrus

- Citrus trees less competitive

- Important resources are provided
  - Irrigation
  - Fertilizer

- More weed growth due to
  - Smaller canopy
  - FL weather conducive for weed growth
↑ in tree age = less space for weeds
Weed management programs for young citrus

• Important to give citrus a head start over weeds

• Common weed control tactics employed
  ◦ PRE herbicides with good residual activity
  ◦ POST herbicides as follow-up treatment
  ◦ Restrictions on some herbicides
Weed management programs for older citrus

- Presence of weeds not too critical for productivity
  - Older trees have well developed canopy

- Maybe critical for other operations such as harvesting
  - Presence of vine weeds

Fellsmere, FL - 2011
Weed management programs for older citrus

- **Mowing**

- **Herbicides**
  - Use of a PRE with long residual activity may be more beneficial
  - POST applied as need basis
  - Reduced application (frequency) due to minimal weed pressure
Factors that determine the herbicide choice

• Tree variety and age
  ◦ Bearing vs. non-bearing
  ◦ low vs. high rates

• Location
  ◦ Flatwoods vs. Ridge
  ◦ Restrictions

Effect of various rates of experimental herbicide on newly established grapefruit at Fellsmere, FL (2010 trial)
Weeds in the area

Grasses

Sedges

Broadleaf

Annuals

Perennials
Not all weeds can be controlled by glyphosate!

Control  Glyphosate 0.28, 0.42 & 0.56 kg ae/ha, 5 WAT
## Soil applied herbicides registered for Florida citrus

<table>
<thead>
<tr>
<th>Common name</th>
<th>Brand name</th>
<th>Rates product/ac</th>
<th>Weeds controlled</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Broadleaf</td>
<td>Grasses</td>
<td></td>
</tr>
<tr>
<td><strong>Diuron</strong></td>
<td>Direx, Karmex</td>
<td>2-4 lb</td>
<td>C(A)</td>
<td>C(A)</td>
<td></td>
</tr>
<tr>
<td><strong>Bromacil</strong></td>
<td>Hyvar X</td>
<td>2-6 lb</td>
<td>C(A)</td>
<td>C(A&amp;P)</td>
<td></td>
</tr>
<tr>
<td><strong>Indaziflam</strong></td>
<td>Alion</td>
<td>5-6.5 fl oz</td>
<td>C(A)</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td><strong>Pendimethalin</strong></td>
<td>Prowl H20, Pendimax(nb)</td>
<td>6.3-7.0pt, 2-4.8 qt</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Norflurazon</strong></td>
<td>Solicam</td>
<td>2.5-5 lb</td>
<td>PC</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td><strong>Simazine</strong></td>
<td>Princep 4L, Caliber-90</td>
<td>1-2.0 gal</td>
<td>C</td>
<td>C (A)</td>
<td></td>
</tr>
<tr>
<td><strong>Oryzalin</strong></td>
<td>Oryzalin 4AS, Surflan</td>
<td>0.5-1.5 gal</td>
<td>sC</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td><strong>Oxyflourfen (nb)</strong></td>
<td>Goal</td>
<td>6 pt</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bromacil+Diuron</strong></td>
<td>Krovar I</td>
<td>2-4 lb</td>
<td>C(A)</td>
<td>C(A&amp;P)</td>
<td></td>
</tr>
<tr>
<td><strong>Trifluralin</strong></td>
<td>Treflan</td>
<td>1- 2 pts</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td><strong>Rimsulfuron (r)</strong></td>
<td>Matrix</td>
<td></td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

*commonly used; ^ - New; C-control, PC-partial control; A-annual; P-perennial; s-some
r - Restricted ; nb – non bearing
Recently registered PRE products for citrus

Alion (Indaziflam) – Bayer CropScience

- Mode of action: inhibition of cellulose biosynthesis
- Rates: 5-6.5 oz/ac; 10.3 oz/acre total annual
- Has excellent residual activity: 90-120 DAT
- Very effective against grasses and broadleaf
  - Limited activity on bermudagrass, annual sedge and purple nutsedge
  - Excellent on FL/BR pusley
Alion efficacy at 90 days after treatment

Indaziflam (5 fl oz/A)  Norflurazon + Diuron
## Foliar applied (POST) herbicides registered for citrus

<table>
<thead>
<tr>
<th>Common name</th>
<th>Brand name</th>
<th>Rate</th>
<th>Weeds controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>product/ac</td>
<td>Broadleaf</td>
</tr>
<tr>
<td>Glyphosate*</td>
<td>many brands</td>
<td>22-43 oz</td>
<td>C</td>
</tr>
<tr>
<td>Carfentrazone</td>
<td>Aim EC</td>
<td>2 – 7.9 fl oz</td>
<td>C</td>
</tr>
<tr>
<td>Clethodim</td>
<td>Prism</td>
<td>6 fl. oz</td>
<td>C</td>
</tr>
<tr>
<td>Glyphosate + 2,4-D</td>
<td>Landmaster</td>
<td>1-8 qt</td>
<td>C</td>
</tr>
<tr>
<td>Fluazifop</td>
<td>Fusilade DX/2E</td>
<td>1-1.5 pt</td>
<td>C</td>
</tr>
<tr>
<td>Paraquat*(r)</td>
<td>Gramoxone SL/ Inteon</td>
<td>2.5-4 pt 20 pt max/yr</td>
<td>C</td>
</tr>
<tr>
<td>Sethoxydim</td>
<td>Poast Plus</td>
<td>2.25-3.75 pt</td>
<td></td>
</tr>
<tr>
<td>Saflufenacil</td>
<td>Treevix</td>
<td>1 oz</td>
<td>C</td>
</tr>
</tbody>
</table>

*commonly used; ^new; C-control, PC-partial control; A-annual; Perennial; s-some
nb –non bearing; r - Restricted
Recently registered POST herbicides for citrus

Treevix (Saflufenacil) – BASF

- Mode of action: protoporphyrinogen oxidase (PPO) inhibitor
- Rates: 1 oz/acre
- Quick and excellent burndown activity
- Very good on broadleaf but not on grass weeds
  - can be tank mixed with grass or non-selective herbicides
Treevix efficacy on citrus weeds

Untreated control

Treevix at 1 oz/ac

Treevix + Prowl H20 + Glyphosate
- effective on FL/BR pusley and Spanishneedles
Factors affecting efficacy of herbicides
For a herbicide to work it must:

- come in contact with a plant surface (root, shoot, leaves)
- remain at site long enough to penetrate or be absorbed
- move to its site of action
Fate of Herbicides in the Environment

- Volatilization (thiocarbamates and dinitroanilines)
- Plant uptake (all)
- Adsorption by soil organic matter and clay (thiocarbamates, dinitroanilines, chloroacetamides, substituted ureas and triazines)
- Photochemical decomposition (dinitroanilines)
- Runoff and erosion (all)
- Chemical breakdown (triazines)
- Microbial decomposition (all)
- Leaching (phenoxyxs, picolinates, sulfonyleureas and imidazolinones)
Factors affecting efficacy of herbicides

- **soil**
  * organic matter, texture, CEC, pH

- **climatic**
  * temperature, moisture, humidity, light intensity

- **Proper application**
  * Age of weeds, timing, rates, spray equipment
Soil Factors: Organic Matter (OM) and Texture

- most important for soil applied herbicides
- *Indirectly influences all processes that affect herbicides!!*

↑ OM and clay content = ↑ adsorption of herbicides
Soil Factors: Texture

- Soil texture is used to determine application rates of soil-applied herbicides.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Coarse</th>
<th>Medium</th>
<th>Fine</th>
<th>Months after Planting to First Allowed Application (West/East of the Mississippi River)</th>
<th>Months after Application to Planting of Replacement Crop (West/East of the Mississippi River)</th>
<th>Special Use Directions &amp; Exceptions (see list below)</th>
<th>Pre-Harvest Interval (PHI) (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citrus</td>
<td>2.5 - 5.0</td>
<td>2.5 - 5.0</td>
<td>3.75 - 5.0</td>
<td>5.0</td>
<td>0/0</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>Irrigated Citrus (FL and TX only)</td>
<td>2.5 - 10.0</td>
<td>2.5 - 10.0</td>
<td>3.75 - 10.0</td>
<td>5.0 - 10.0</td>
<td>0/0</td>
<td>1, 2</td>
<td>30</td>
</tr>
<tr>
<td>Apples</td>
<td>2.5 - 5.0</td>
<td>2.5 - 5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>0/0</td>
<td>3</td>
<td>60</td>
</tr>
</tbody>
</table>
Soil Factors: Cation Exchange Capacity (CEC)

- soils ability to adsorb positively charged compounds
- fine-textured, high-organic matter soils have larger CEC’s than coarse, low-organic matter soils
- influence rate of application

[Paraquat molecule image]
Soil Factors: pH

- influences water solubility, adsorption, and persistence of herbicides

- more persistent in high pH soil
  - triazines - Simazine
  - sulfonylureas - Matrix
### Important Soil Parameters Of Two Citrus Soil Types (0-12”)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>“Ridge” Candler Sand</th>
<th>“Flatwoods” Myakka Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand (%)</td>
<td>96.5</td>
<td>93.2</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>2.0</td>
<td>4.4</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>1.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Org. matter (%)</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>pH (H₂O)</td>
<td>5.6</td>
<td>5.8</td>
</tr>
<tr>
<td>CEC (meg/100g)</td>
<td>1.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Bulk density (g/cc)</td>
<td>1.3</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Climatic Effects: Temperature

- In johnsongrass, Roundup absorption doubled as temperature was increased from $75^\circ$ to $95^\circ$ (McWhorter et al. 1980)
Climatic Effects: Moisture - PPI/PRE

- activation
  * movement to 0.5” within 7-10 d
  
  but not too much (leaching!)

- adsorption
  * availability
Some regions within the state are prone to leaching due to high amount of rainfall and inherent soil type.
Leaching of commonly used PRE herbicides in citrus under two amounts of rainfall
Climatic Effects: Moisture - POST

Dry weather causes.....

- plants to develop thicker cuticles
- reductions in absorption, retention, and translocation
- POST herbicides i.e. glyphosate: better control if applied in Fall than in Spring
Climatic Effects: Relative Humidity

• A higher relative humidity level ..... 
  * extends drying period of herbicide droplets.
  * hydrates plant cuticles.
Effect of relative humidity on uptake and translocation of $^{14}$C-glyphosate in Florida beggarweed

- **Uptake** (% of applied) = 4.4
- **Translocation** (% of applied) = 1.6
- **Translocation** (% of absorbed) = 2.9

LSD (P = 0.05)
Climatic Effects: Light Intensity

- influences photosynthesis, cuticle development, stomatal openings, and photodecomposition

- Some herbicides are incorporated to prevent photodecomposition
Time of Application

- **Pre-emergence**: Before weed emergence
- **Post-emergence** Foliage applied

![Graph showing percent kill over stages of development](image)
Effect of application time of glyphosate on mortality of Brazil pusley and Texas panicum

Singh et al. 2005

May 1: BR pusley – 0.2 m
Texas panicum – 0.3 m

Reduced control since weeds were older
Growth stage and glyphosate rate effects on herbicide efficacy
Growth stage and glyphosate rate effects on herbicide efficacy

Older weeds = higher rate of herbicides
Use of adjuvants

• POST herbicides benefit most from the use of appropriate surfactants
  o glyphosate + NIS + AMS
  o Paraquat + COC
  o Treevix + MSO

• Adjuvants increase absorption and translocation of herbicides within the plants
Enhanced uptake of herbicide by surfactants in *Bidens pilosa*
Calibration of spray equipment

Spray volume is affected by:

- Speed
- Nozzle size
- Pressure

Calibrate equipment to check for correct spray output delivery
Increase in nozzle flow after 40 hrs of use

<table>
<thead>
<tr>
<th>Material</th>
<th>Increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brass</td>
<td>11.4</td>
</tr>
<tr>
<td>Delavan</td>
<td>7.5</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>6.1</td>
</tr>
<tr>
<td>Lurmark</td>
<td>2.1</td>
</tr>
<tr>
<td>Hardened S. S.</td>
<td>1.2</td>
</tr>
<tr>
<td>Thermoplastic</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Source: Kris Firth, Farm Chem. June 1989, P. 36
To maximize herbicide efficacy:

- Know your weeds
  Scout groves periodically

- Know what is available

- Read herbicide labels
To maximize herbicide efficacy:

- Follow herbicide label recommendations
  - Rate of application
  - Time of application
  - Weed growth stage
  - Use appropriate type and rate of adjuvant
Thank you...

Citron melon at Conserve II