Beyond Glyphosate

- Alternatives to consider adding to a citrus weed management program

Ramdas Kanissery, Ph.D.
Asst. Professor / Weed Scientist
Dept. of Horticultural Sciences
Southwest Florida Res. & Education Center
University of Florida
Talk Contents…

- **Brief overview**

- **POST-emergent, non-selective alternatives**

- **PRE-emergence control**

- **Cover crops**

- **Glyphosate in FL citrus**

- **Glyphosate alternatives**
Glyphosate – most widely used herbicide in the U.S

- Glyphosate use steadily increased over years

POST emergent weed management in
- Agricultural
- Landscape
- Natural areas

Source: https://www.beyondtoxics.org/
Glyphosate use in Florida Citrus

Glyphosate: a significant herbicide in FL citrus production

- Applied 3-4 times per year

**USDA-NASS, 2017**

- 540 tons of glyphosate applied to groves in FL in a year
- >50% of area under citrus production had received glyphosate application
- Most used citrus herbicide in other producing states like CA

Source: [https://quickstats.nass.usda.gov/](https://quickstats.nass.usda.gov/)
Glyphosate – Roundup, Glyfos, Glystar etc.

**Systemic herbicide** - translocated in the weed plant

- Blocks the formation of essential amino acids
- Inhibit protein synthesis
- Results in starvation and death of susceptible plants
- Work slowly in the weed – approx. 7-14 days after application

Non-selective herbicide

POST-Emergent
Foliar applied
Emerged weeds
Glyphosate – Roundup, Glyfos, Glystar etc.

Tree row/under-tree weed control
For total or partial control of most weed species
- 0.75 - 1.5 lbs. Acid Equivalent (A.E) / acre – Annual weeds
- 1.75 - 3.75 lbs. A.E / acre – Perennial weeds

Row-middle weed management
Chemical mowing
- 0.125 - 0.37 lbs. A.E / acre

Consult the most recent Florida Citrus Production Guide for a complete listing of herbicides and their rate suggestions.
In many respects, it is a great weed management tool

- Non-selective
- Non-volatile
- No odor
- Non-staining

- Broad control spectrum
- Relatively inexpensive
- Great tank-mix partner
Concerns related to glyphosate use in citrus

Potential impacts on citrus health and yield

- Non-target herbicide effects
- Persistence in soil
Concerns related to glyphosate use in citrus

Potential impacts on citrus health and yield

- Persistence in soil

Graduate student study
Biwek Gairhe, M.S.
Vertical movement of glyphosate in citrus soils

- Values above glyphosate bars: accumulation of glyphosate as % of initially applied
- Error bars indicate standard error (n=3)

Study conducted in Flatwood soils
Glyphosate detected up to 30-40 cm (12-16”) in soil columns (40 days after application)
Degradation product of glyphosate (AMPA) in soil was also detected

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Concerns related to glyphosate use in citrus

Certain citrus weeds do not respond well to glyphosate application

- Spanish Needle
- Pusley
- Dayflower
- Ragweed Parthenium
- Goatweed
- Nightshade

Source: Herbicide resistance in Florida citrus, Citrus Industry Magazine, June 2013
The need…

“Alternate modes of actions and other weed control strategies are needed in glyphosate-reliant weed management programs”
Beyond glyphosate: Alternatives to consider in citrus

- POST-emergent, non-selective alternatives
- PRE-emergence control
- Cover crops for row middle vegetation management
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Beyond glyphosate: POST-emergent, non-selective alternatives

**Contact herbicides** – limited translocation in weed

Good spray coverage necessary

**Active ingredient** – Brand name(s)

- **Carfentrazone** – Aim EC
  - Narrow spectrum of weed control

- **Paraquat** – Gramoxone
  - Top kill only
  - Potential weed regrowth

- **Glufosinate ammonium** – Scout, Rely 280 etc.

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Beyond glyphosate: POST-emergent, non-selective alternatives

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**Beyond glyphosate.. POST-emergent, non-selective alternatives**

- **Glufosinate ammonium** — Scout, Rely 280 etc.

  *Contact herbicide* – with limited systemic activity

  **Mode of action Classification** — Group 10

  - Inhibition of the activity of glutamine synthetase (*an enzyme essential for plant metabolism*)
  - Inhibition of plants ability to utilize nitrogen
  - Results in ammonia accumulation in plants and phytotoxicity

  Tends to work very quickly in the weed – within 24-72 hrs. after application
Beyond glyphosate: POST-emergent, non-selective alternatives

**Non-selective herbicides**

- **Glufosinate ammonium** — Scout, Rely 280 etc.
  - *Contact herbicide* — with limited systemic activity

**Tree row/under-tree weed management**
- Rate 48 – 82 oz product/acre
- Pre-harvest interval of 14 days in citrus

**Works best**
- when weeds are in early growth stage and active
- warm temperatures and bright sunlight could improve the performance

Consult the most recent *Florida Citrus Production Guide* for a complete listing of herbicides and their rate suggestions
To get the best out of Glufosinate-ammonium

Spray coverage on foliage – key factor
40 gallons or less per acre
Higher spray volumes
- Dense weed infestations
- Large weeds / advanced growth stage

Spray additives
- Water conditioners - AMS
- Surfactants

Avoid
- contact or spray drift with green bark, stems or foliage *(Use nonporous wrap in young trees)*

- Carefully read and follow herbicide label directions!
Beyond glyphosate: Alternatives to consider in citrus

- POST-emergent, non-selective alternatives
- PRE-emergence control
- Cover crops for row middle vegetation management
Beyond glyphosate.. PRE-emergence control

PRE-emergence control very critical in citrus

- For long term weed suppression

Quick weed emergence in citrus tree rows

After 30 days
Major PRE-emergent herbicides used in FL citrus

Active ingredient – Brand name(s)

- **Simazine** – Princep, Caliber 90, etc.
- **Diuron** – Direx, Karmex, Diuron 4L etc.
- **Norflurazon** - Solicam
- **Pendimethalin** - Prowl
- **Indaziflam** - Alion
- **Flumioxazin** - Chateau

Consult the most recent Florida Citrus Production Guide for a complete listing of herbicides and their rate suggestions.
PRE-emergent herbicides

- Tank mixing PRE-emergent with POST-emergent herbicide is common
- Improve weed control efficacy
- Glyphosate is the most popular tank mix partner in PRE-emergent herbicide programs
Evaluation of *Glyphosate & Glufosinate* as tank-mixing partners with PRE-emergents

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Glufosinate ammonium – alternative to glyphosate?

- Evaluation of **Glyphosate & Glufosinate** as Tank-mixing partners with PRE-emergents
- **Fall 2019 study** - Immokalee
- Replication (n) = 4
- ± Standard Error
- 30 GPA application
- All treatments has a water conditioner (Quest @ 0.25% v/v) and Surfactant (Induce @ 0.50% v/v)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Weed Control (%)</th>
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<tbody>
<tr>
<td><strong>Active Ingredient(s)</strong></td>
<td><strong>Product(s)</strong></td>
</tr>
<tr>
<td>Flumioxazin</td>
<td>Chateau</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>RoundUp</td>
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<td>Flumioxazin Glufosinate-Ammonium</td>
<td>Chateau Scout</td>
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<tr>
<td>Glyphosate</td>
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Untreated Control ---- ---- 34 ± 11 13 ± 7
Glufosinate ammonium – alternative to glyphosate?

Examples of weeds controlled in this study

Weed pressure

Guinea grass

Geraniums

Clustered pellitory
Beyond glyphosate: Alternatives to consider in citrus

- POST-emergent, non-selective alternatives
- PRE-emergence control
- Cover crops for row middle vegetation management
Beyond glyphosate.. Cover crops

- **Row middles – b/w rows**

Some vegetation is desirable to minimize erosion

Vegetation suppression utilizing chemical mowing and wiping with glyphosate
Beyond glyphosate.. Cover crops

“Cover crops for row-middle management in citrus”

- For weed control
- Soil quality improvement

Cove crop mix planted in citrus row middles
Cover crops for row-middle management in citrus

- Cover crops significantly reduced the weed pressure in treated row-middles when compared to non treated controls

Density Survey in Citrus Row Middles
Time: Spring 2019
Location: North Grove, Immokalee, FL

- Cover crops significantly reduced the weed pressure in treated row-middles when compared to non treated controls

- Cover crops: Daikon radish, White Clover, Crimson Clover & Buckwheat

- No. of observations per treatment (n) = 18

- Error bars represent standard error

- Bars with the same letters do not significantly differ (Tukey’s HSD, P<0.01)

Cover Crops (CC) vs Weeds

Number of plants per Sq. meter

- CC Mix-1
- CC Mix-2
- CC Mix-1 + Eco Mowing
- CC Mix-2 + Eco Mowing
- No CC Control

up to 84% reduction in weed density
POST-emergent, non-selective alternatives
- Contact herbicides
- Glufosinate ammonium
- Coverage, surfactants, water conditioner

Pre-emergence control
- Long term weed suppression
- Glufosinate-ammonium is a potential tank mix alternative

Cover-crops
- For row-middle vegetation
- Weed suppression and soil quality
Just a quick reminder..

- Carefully read and follow all herbicide label directions
  - Proper PPE and worker safety
  - Deliver the herbicide to the target
  - Avoid tree foliage, and fruit contact
- Herbicide resistance/tolerance management
- Best herbicide practices
- Rotate herbicide modes of action
SWFREC weed science team

From left: Shea Teems, Biwek Gairhe, Robert Riefer, Ramdas Kanissery

Not in picture: Terea Bentley, Miurel Brewer

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and more..
Contact
Ramdas Kanissery
UF/IFAS SWFREC
2685 State Road N
Immokalee, FL
Phone: (239) 658-3455
rkanissery@ufl.edu