Citrus Institute 2018

Photos: SWFREC Citrus grove, Plot O

WEED MANAGEMENT IN CITRUS – CHALLENGES AND OPPORTUNITIES

Presenter: **Ramdas Kanissery – Weed Scientist, Southwest Florida REC**

Contribution from: **Steve Futch – Extension Agent IV, Multicounty, Citrus REC Lake Alfred**

UF | IFAS Extension
UNIVERSITY of FLORIDA

Weed management in FL citrus – Big picture

- **Impacts of weeds**
  - *Yield loss – from competition*
  - *Serves as alternate host for pest and diseases*
- **Weed control**
  - *Preventive*
  - *Mechanical*
  - *Chemical – popular method*
- **Weed management programs**
  - *Row middle – Mechanical mowing*
  - *Chemical mowing*
  - *Under tree – Utilizing herbicides*

Info credits: Steve Futch, 2017

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Impacts of weeds

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Weed control

Preventive

Mechanical

Chemical – popular method

Weed management programs

Row middle – Mechanical mowing

Chemical mowing, wiping

Under tree – Utilizing herbicides

Info credits: Steve Futch, 2017

Challenges

- Managing problematic weeds
- Minimizing crop injury

Challenges

- **Managing problematic weeds**
- Minimizing crop injury

Problem weeds in citrus

Examples of problem weeds in citrus

Goat weed

Dayflower

Spanish needle

Pig weed

Parthenium

Guinea grass

Herbicide resistance and/tolerance is the major reason

Herbicide Resistance

- Inherited ability of a weed to survive & reproduce following exposure to a dose of herbicide normally lethal to the weed
- Naturally occurring OR Induced

Herbicide Tolerance

- Inherent ability of weeds to withstand a certain dose of herbicide
- Repeated use of same product or mode of action
- Age or growth stage of weed

Eg., Glyphosate

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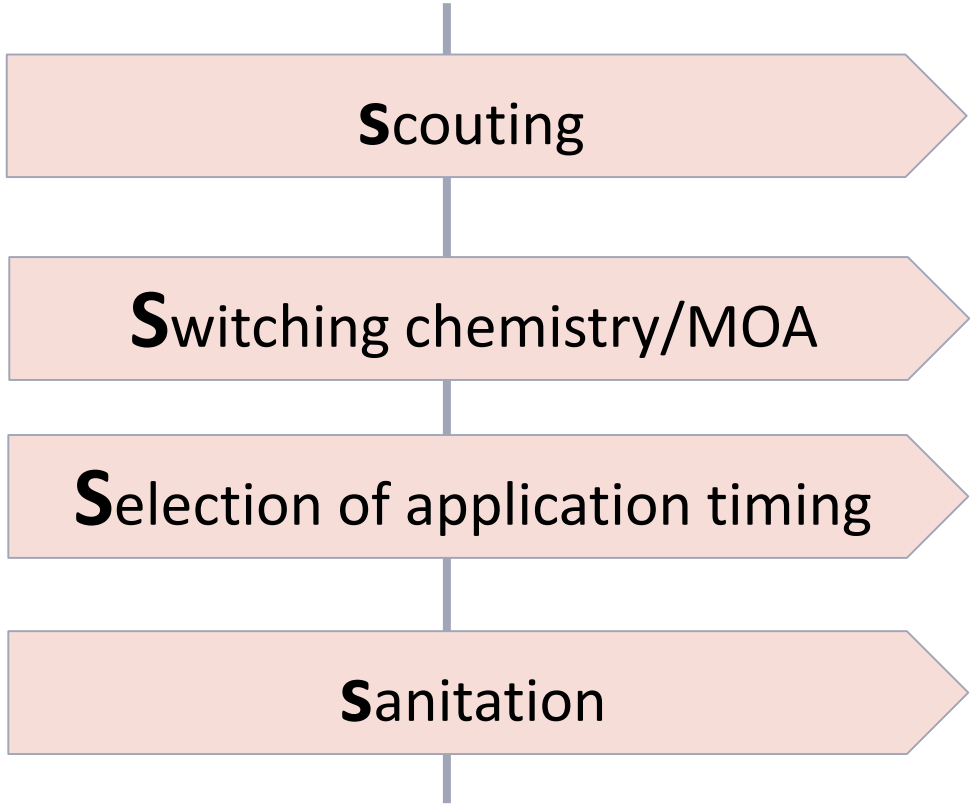
"Four **S** of resistance/tolerance management"



Problem weeds in citrus

- **Spanish Needle**
  - Herbicide tolerance

Problem weeds in citrus

- **Ragweed Parthenium**

- Herbicide resistance

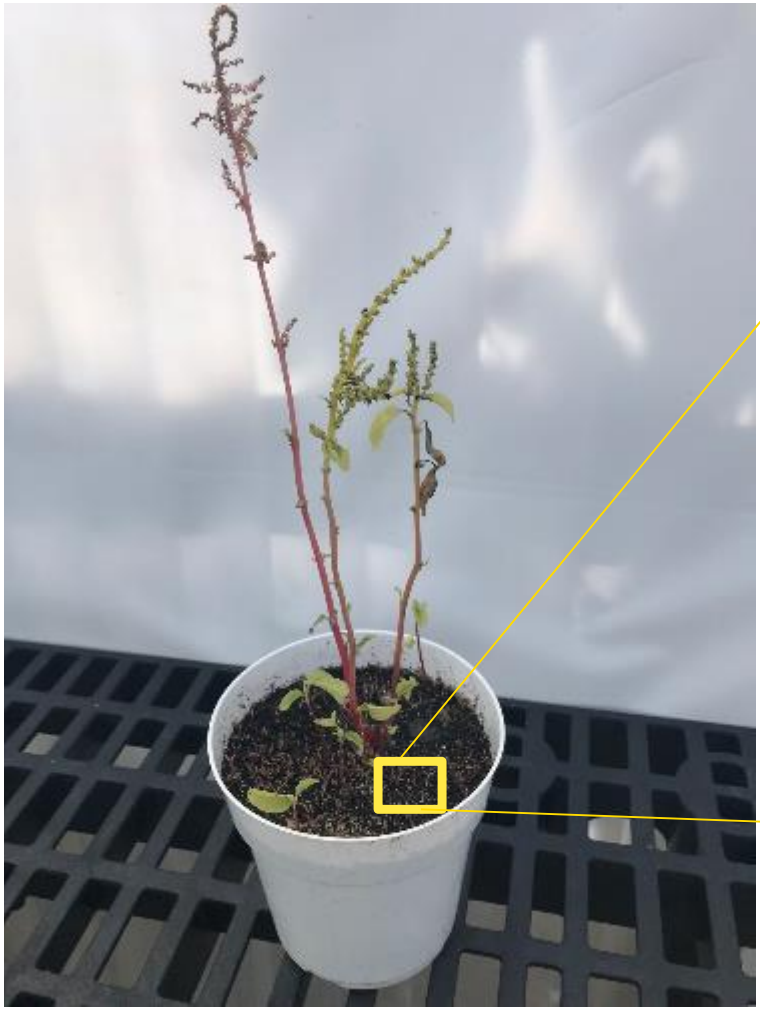
- Herbicide tolerance

Problem weeds in citrus

- **Pigweed - Amaranth**
  - Herbicide resistance/tolerance
  - Seed bank formation in soil

Problem weeds in citrus

- **Pigweed** - 200,000 seeds per plant*



***Data collected by researchers across the globe** *WSSA*

Problem weeds in citrus

- **Pigweed**

  - Seed bank formation in soil

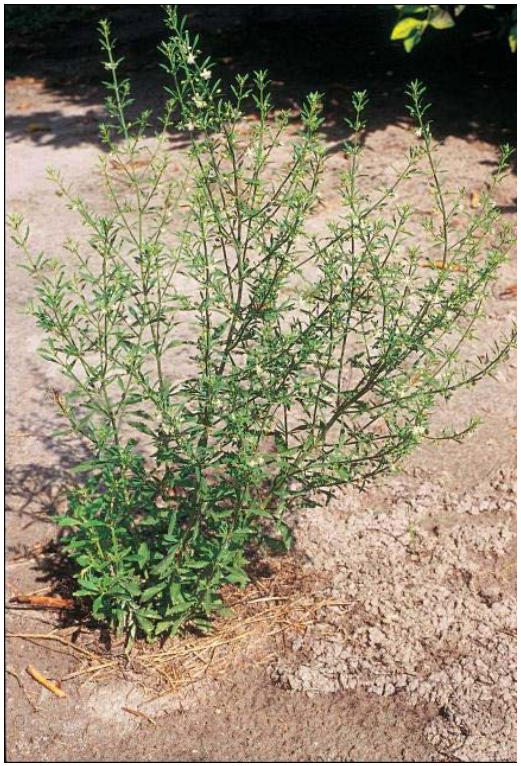
  - Compete for nutrients and moisture

Giant Amaranth/Pig weed

Immokalee, FL

Problem weeds in citrus

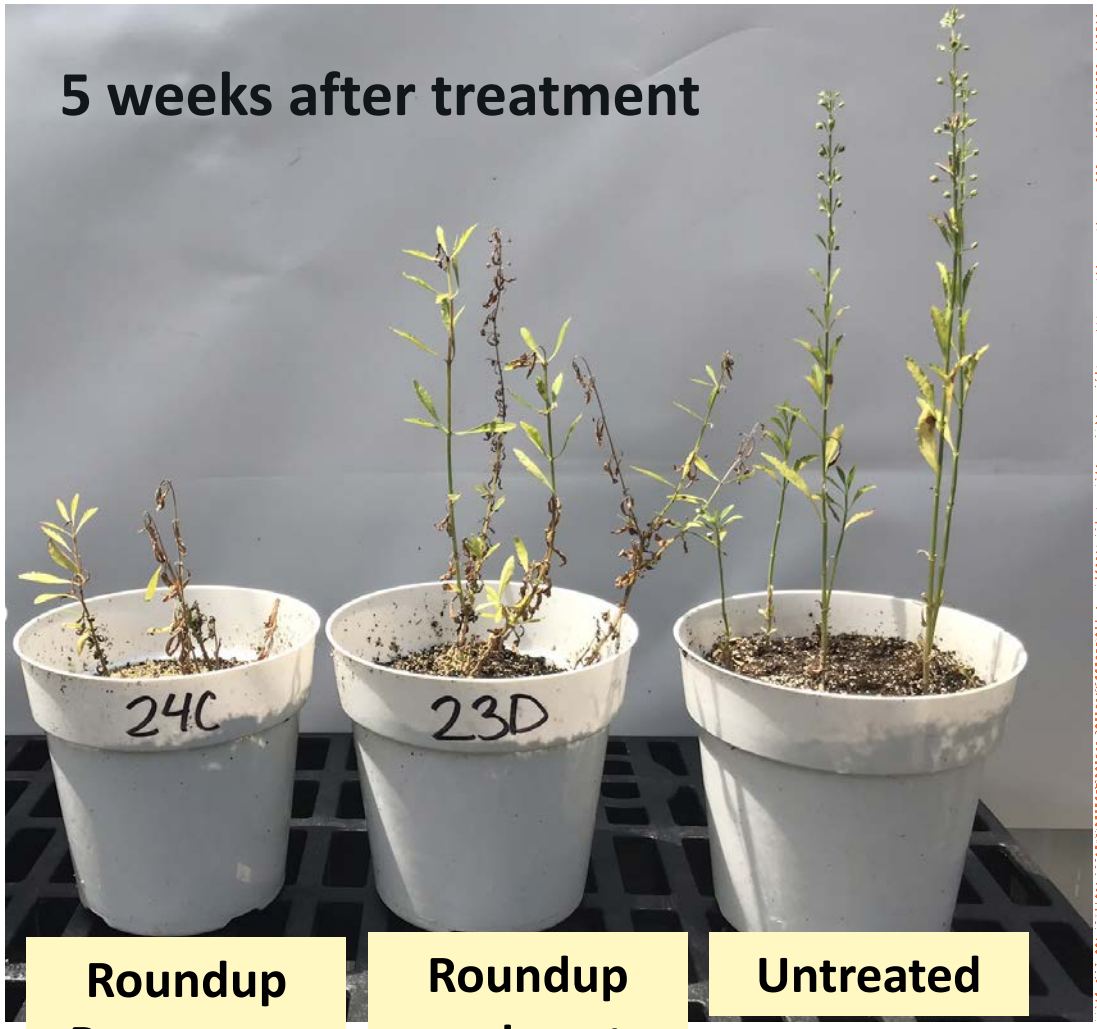
- **Goat weed**



- Herbicide tolerance
- Seed bank formation

- **Goat weed tolerance**

- Slow response to glyphosate products



Rate: 2 lbs. A.E per acre

Dayflower

- Monocot
- Slow response to glyphosate

Dayflower growing in the drip line under the citrus tree

Potential new weed watch in citrus

- **Tropical whiteweed**
  - *Ageratum conyzoides*
  - Also known as Billygoat weed

Tropical whiteweed Flowers: Note blue or purplish hue of flowers

Potential new weed watch in citrus

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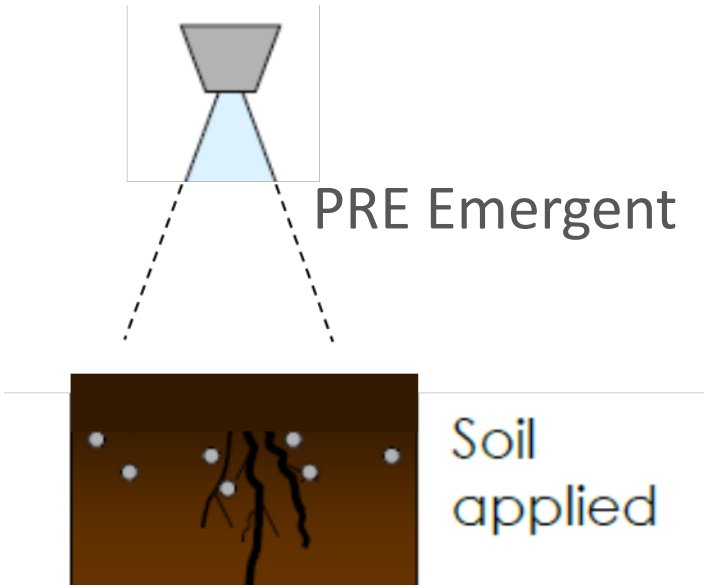
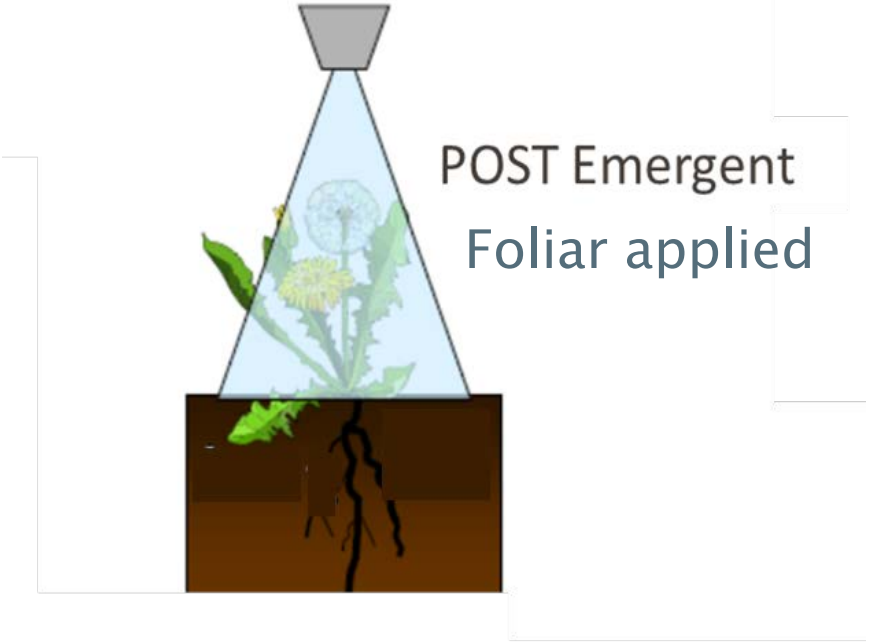
Tropical whiteweed leaves – ovate and serrated

- Managing problematic weeds
  - Selecting the right herbicide program
  - Synergy b/w herbicides
  - Selecting proper adjuvants

- Managing problematic weeds
- **Selecting the right herbicide program**
- Synergy b/w herbicides
- Selecting proper adjuvants

Herbicide classification - application timing





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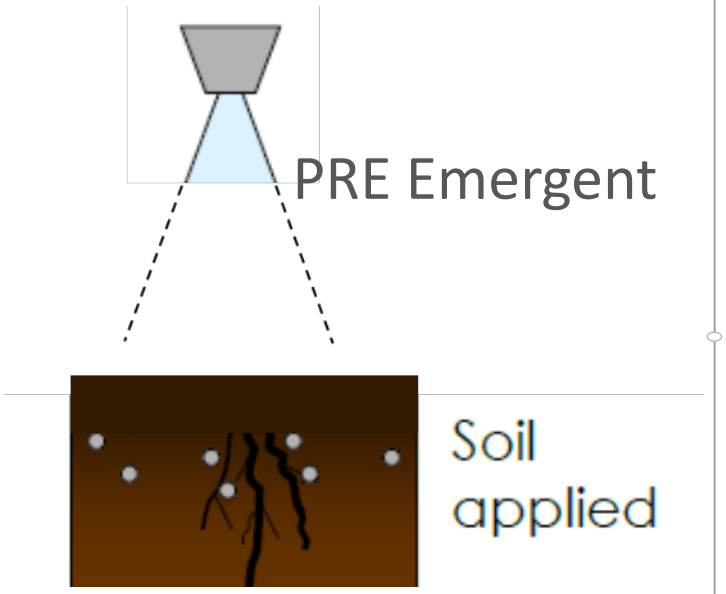
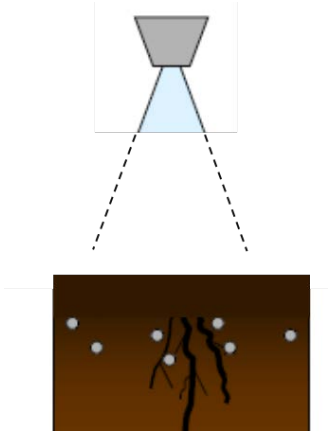


***Residual or PRE-emergent*:** applied to soil - persist in soil and kill the emerging weed seeds and seedlings.

Minimum 'existent weed coverage' to ensure max soil incorporation

Rain or irrigation to activate

Major PRE-emergent herbicides used in FL citrus



PRE
Soil residual

- **Active ingredient** – Brand name(s)
  - **Bromacil –** Hyvar X
  - **Simazine –** Princep, Caliber 90, etc.
  - **Diuron –** Direx, Karmex, etc.
  - **Norflurazon -** Solicam
  - **Indaziflam -** Alion
  - **Pendimethalin -** Prowl

* Please refer to **Florida Citrus Production Guide 2017-18** for a complete list

Major PRE-emergent herbicides used in FL citrus

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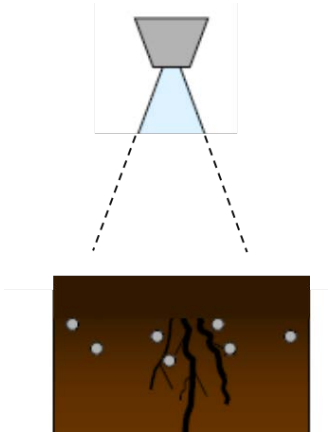

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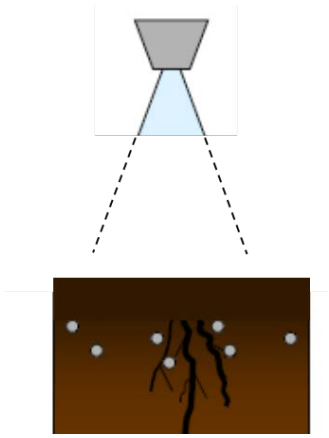

PRE
Soil residual

- **Norflurazon – Solicam 80WP**
  - Inhibit carotenoid biosynthesis
  - Chlorophyll destruction : no photosynthesis
    - Control of annual grass weeds and certain broadleaf weeds
    - May be injected through low volume drip irrigation
    - Use rate of 2.5 to 5 lbs/A
    - Maximum 10 lbs/A/yr

Major PRE-emergent herbicides used in FL citrus

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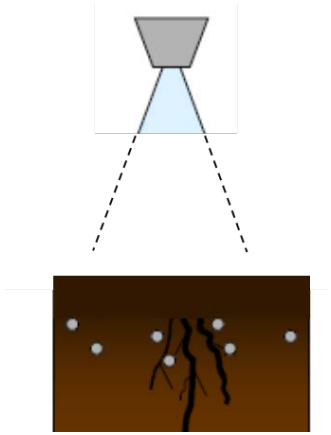

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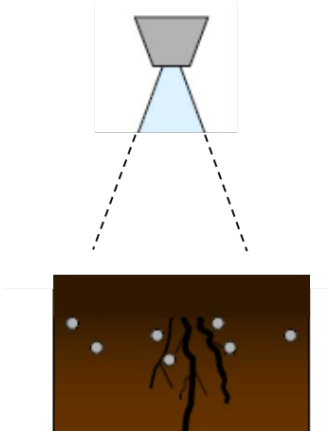
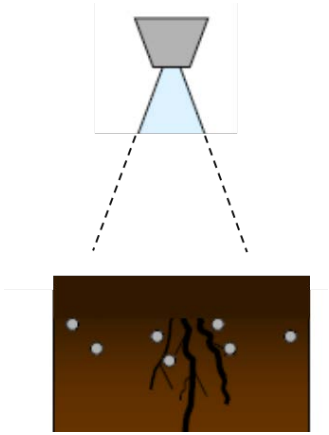


PRE
Soil residual

- **Indaziflam - Alion**
  - Inhibit cellulose biosynthesis
  - Interfere with cell wall formation and cell division
  - Control of broadleaf and grass weeds
  - Often mixed with POST product
  - Use rate of 5 to 6 oz/A
  - Maximum 10.3 oz/A/yr

New PRE-emergent herbicide on the horizon



PRE
Soil residual

- **Flumioxazin – Chateau**
  - Inhibit PPO enzyme
  - Accumulation of toxins in the plant
    - Control of grass weeds and broadleaf weeds
    - Use rate of 6 to 12 oz/A
    - Maximum 24 oz/A/yr

Supplemental Label

VALENT

CHATEAU®
HERBICIDE SW
EPA Reg. No. 59639-99
(Except California and New York)

CHATEAU® HERBICIDE SW USE IN CANEBERRY AND CITRUS FRUIT

This supplemental label expires on December 31, 2019 and must not be used or distributed after this date.

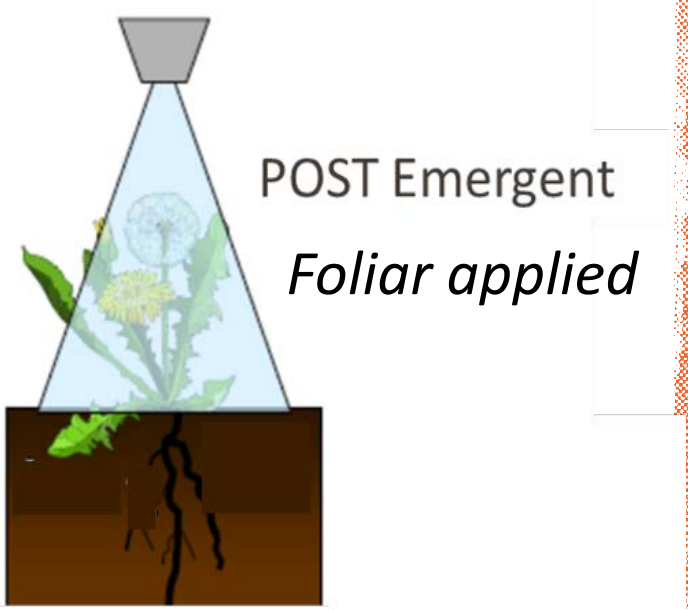
DIRECTIONS FOR USE

Herbicide classification - application timing

POST-emergent: applied to **foliage** after weed emergence

Usually no residual activity

Require surfactants



Major POST-emergent herbicides used in FL citrus

- **Active ingredient** – Brand name(s)

Non-selective herbicides

POST
Foliar applied

- **Carfentrazone –** Aim EC
- **Paraquat -** Gramoxone
- **Glyphosate –** Roundup, Touchdown
- **Glyphosate + 2,4-D -** Landmaster

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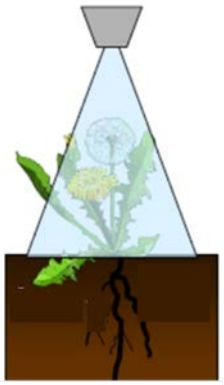
Major POST-emergent herbicides used in FL citrus

Non-selective herbicides



POST

Foliar applied

Glyphosate – Roundup, Glyfos etc.

Mode of action

Blocks the formation of essential amino acids

Inhibit protein synthesis

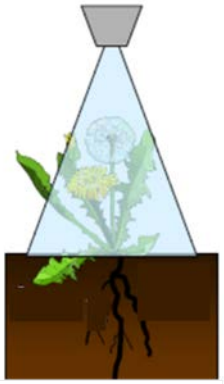
Effect

Starvation' and death of susceptible plants

- POST, non-selective, systemic
- For total or partial control of most weed species
- Rate 0.75-1.5 lb A.E. – Annual weeds
- Rate 1.75-3.75 lb A.E. – Perennial weeds

Major POST-emergent herbicides used in FL citrus

Non-selective herbicides



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- **Can be used for chemical mowing – 0.125-0.37 lb A.E**

Major POST-emergent herbicides used in FL citrus

Glyphosate - used for chemical wiping row middles

Carpet wiper

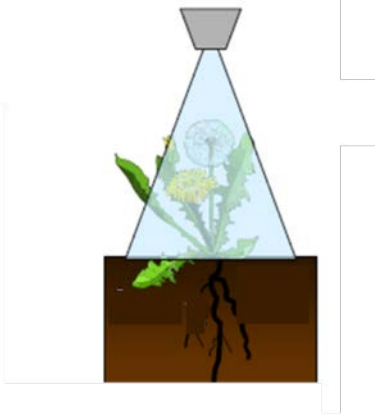
Panel wiper

Glyphosate wiping:

- 5–10% solution - **carpet** wiper
- 50–80% solution – **panel** wiper

Major POST-emergent herbicides used in FL citrus

Selective herbicides



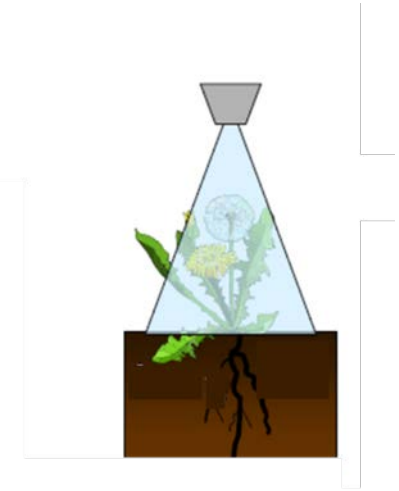
POST

Foliar applied

- **Active ingredient** – Brand name(s)
  - **Fluazifop –** Fusilade
  - **Sethoxydim –** Poast plus
  - **Saflufenacil –** Treevix

Major POST-emergent herbicides used in FL citrus

Selective herbicides



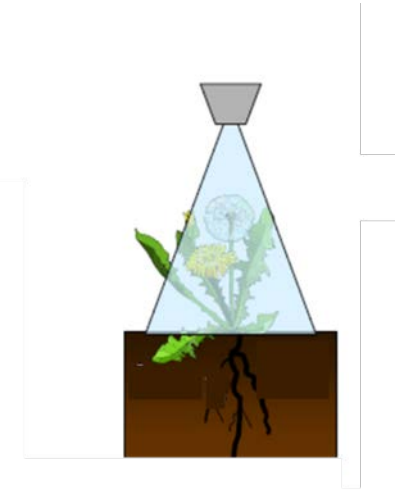
POST
Foliar applied

- **Fluazifop-p-butyl (Fusilade)**
  - For POST emergent control of annual and perennial grass
  - No effect on broadleaf weeds

- Rate 1.0-1.5 pts/acre
- Tree age: 'Non-bearing'
- Do not apply to grasses under stress conditions

Major POST-emergent herbicides used in FL citrus

Selective herbicides



POST
Foliar applied

- **Sethoxydim – Poast, Poast plus**
  - For POST emergent control of annual and perennial grass
  - No effect on broadleaf weeds

- Rate 2.25-3.75 pts/acre
- Tree age - All
- Do not apply to grasses under stress conditions

Examples of problem weeds in citrus

Goat weed

Dayflower

Spanish needle

Pig weed

Parthenium

Guinea grass

Fusilade
Poast, Poast plus

Goat weed

Dayflower

Effective on

Spanish needle

Pig weed

Parthenium

Guinea grass

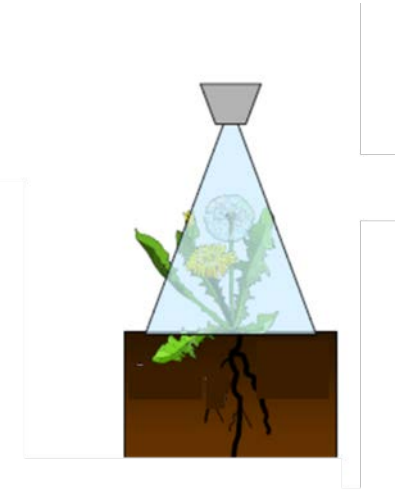
- **Sethoxydim - Poast, Poast plus**

<u>Spot treatment</u>

- 1.5 – 2.25% v/v solution
- Surfactant 1% COC
- Read label for directions

Guinea grass growing close to citrus

Selective herbicides



POST
Foliar applied

Saflufenacil (Treevix)

- For POST emergent control of broadleaf weeds
- No effect on grasses

- Rate 1 oz/acre
- Not more than 3 oz/A/yr
- Must be applied with a surfactant

Examples of problem weeds in citrus

Goat weed

Dayflower

Spanish needle

Pig weed

Parthenium

Guinea grass

Saflufenacil - Treevix

Goat weed

Dayflower

Effective on

Spanish needle

Pig weed

Parthenium

Guinea grass

Saflufenacil – Treevix is effective on 'Parthenium' weed

Trial conducted at Wauchula, FL

Pest Type			W Weed	W Weed	W Weed
Pest Name			Ragweed Parthe>	Ragweed parthe>	Ragweed parthe>
Rating Date			6/26/2013	7/3/2013	7/16/2013
Rating Type			% kill	% kill	% kill
Rating Unit			%	%	%
Number of Subsamples			1	1	1
Days After First/Last Applic.			6 6	13 13	26 26
Trt-Eval Interval			6 DA-A	13 DA-A	26 DA-A
Trt No.	Treatment Name	Rate	Rate Unit	1	2	3
1	Roundup PowerMax	64	fl oz/a	3.8 d	1.5 c	10.0 c
	LI700	0.5	% v/v			
	Choice	4	pt/100 gal			
2	Roundup PowerMax	64	fl oz/a	11.3 d	6.3 c	16.3 c
	AIM	2	fl oz/a			
	Dynamic	0.5	% v/v			
	Choice	4	pt/100 gal			
3	Rounup PowerMax	64	fl oz/a	93.8 a	95.0 a	92.5 a
	Treevix	1	oz wt/a			
	LI700	0.5	% v/v			
	Choice	4	pt/100 gal			
4	Roundup PowerMax	64	fl oz/a	57.5 b	20.0 b	77.5 ab
	Matrix	2.0	oz wt/a			
	LI700	0.5	% v/v			
	Choice	4	pt/100 gal			
5	Gramoxone Inteon	2	qt/a	35.0 c	13.8 b	63.8 ab
	LI700	0.5	% v/v			
	Choice	4	pt/100 gal			
6	Gramoxone Inteon	2	qt/a	35.0 c	15.0 b	42.5 bc
	Aim	2	fl oz/a			
	Dynamic	1	% v/v			
	Choice	4	pt/100 gal			
7	Rely 280	3	qt/a	92.5 a	88.8 a	70.0 ab
	LI700	0.5	% v/v			
	Choice	4	pt/100 gal			
8	Rely 280	3	qt/a	91.3 a	88.8 a	81.3 a
	Karmex 80WP	3	lb/a			
	LI700	0.5	% v/v			
	Choice	4	pt/100 gal			

Information credit: Steve Futch

Considerations for selecting herbicide programs

Choosing the right herbicide program:

- **Weed profile in the grove**
  - *Type of weed: grass, broadleaf, sedges*
  - *Growth stage : seedling, mature, seed production*
- **Citrus tree age**
  - *Young groves require greater attention*
  - *Higher sensitivity of young tree trunks*
- **Soil and Weather**

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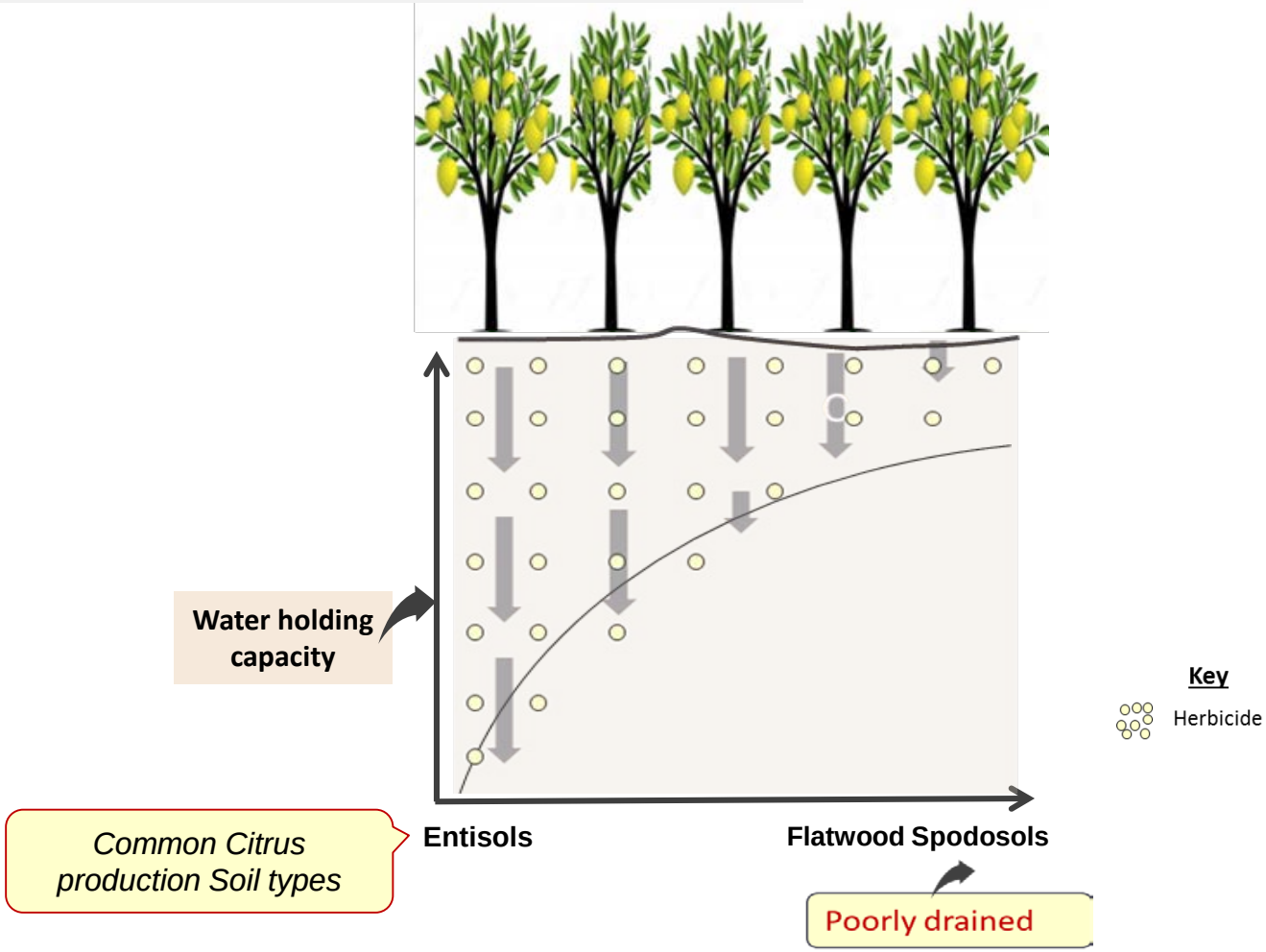
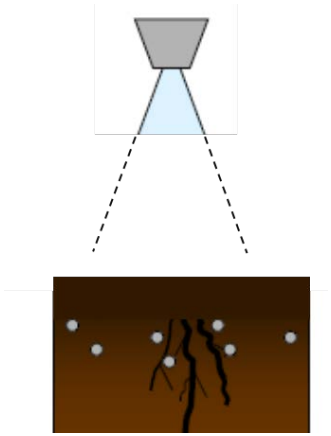
Herbicide movement in Florida citrus production



Some regions within the state are prone to leaching due to high amount of rainfall and inherent soil type

Adsorption coefficients of PRE-emergent herbicides used in FL citrus



PRE
Soil residual

Active ingredient	K_{OC} mL/g
Bromacil	**32**
Simazine	**130**
Diuron	**480**
Norflurazon	**700**
Indaziflam	**<1000**
Pendimethalin	**17,200**

Source 9th edition of the Herbicide Handbook (Senseman, 2007)
The data of Indaziflam were taken from USEPA (2011)

- Managing problematic weeds
- Selecting the right herbicide program
- **Synergy of herbicides**
- Selecting proper adjuvants

Herbicide synergy – Mixing herbicides

Synergy effect:

The total effect of mixing herbicides is greater or more prolonged than the sum of the effects of the two taken independently.

synergy

** 1 + 1 = 3*

Herbicide synergy – Mixing herbicides in one application

Synergy effect:

The total effect of mixing herbicide is greater or more prolonged than the sum of the effects of the two taken independently.

additive

**** 1 + 1 = 2***

synergy

** 1 + 1 = 3*

antagonistic

**** 1 + 1 = 1 or less***

Herbicide synergy – Mixing herbicides in one application

Advantages

- Reduce application number & cost
- Broad-spectrum & prolonged weed control

However,

Need to ensure

- Mixing compatibility
- Proper adjuvant selection
- Absence of any antagonistic effects

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Advantages

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However,

Need to ensure

- Mixing compatibility – Label, Jar test
- Proper adjuvant selection
- Absence of any antagonistic effects

Herbicide synergy – in citrus weed management

Trial conducted in Immokalee, FL

Active ingredients	Herbicide products in the test mixture	Rate oz product/A	Weed control (%) 150 DAT
Indaziflam	Alion	3	58[*c]
Indaziflam	Alion	5	89[b]
Flumioxazin	Chateau	6	18[d]
Flumioxazin	Chateau	8	20[d]
Indaziflam Flumioxazin	Alion Chateau	3 6	82[b] (65) **+17**
Indaziflam Flumioxazin	Alion Chateau	5 8	94[a] (91) **+3**
Control	n/a	n/a	5[e]

DAT: Days After Treatment
*Means with the same letter superscripts within a column do not significantly differ (Tukey's HSD, P< 0.05)
All treatments including control received glyphosate (Roundup Power Max) at 88 oz product per acre.

Expected responses for the mixtures are shown in the parenthesis following the observed response. The difference between observed and expected values are shown by a + sign to indicate synergism

Herbicide synergy – in citrus weed management

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Flumioxazin	Chateau	8	20d
Indaziflam Flumioxazin	Alion Chateau	3 6	82b (65) **+17**
Indaziflam Flumioxazin	Alion Chateau	5 8	94a (91) **+3**
Control	n/a	n/a	5e

DAT: Days After Treatment
*Means with the same letter superscripts within a column do not significantly differ (Tukey's HSD, P< 0.05)
All treatments including control received glyphosate (Roundup Power Max) at 88 oz product per acre.

Expected responses for the mixtures are shown in the parenthesis following the observed response. The difference between observed and expected values are shown by a + sign to indicate synergism

- Johnson grass
- Spurge
- Nutsedge: yellow and purple
- Pusley
- Goatweed

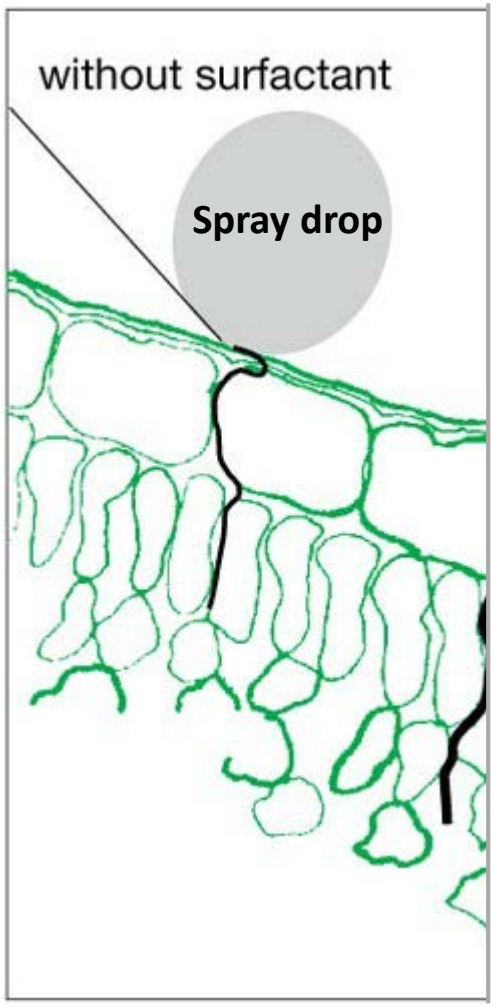
Herbicide synergy – in citrus weed management

Control
100 DAT

Indaziflam + Flumioxazin
100 DAT

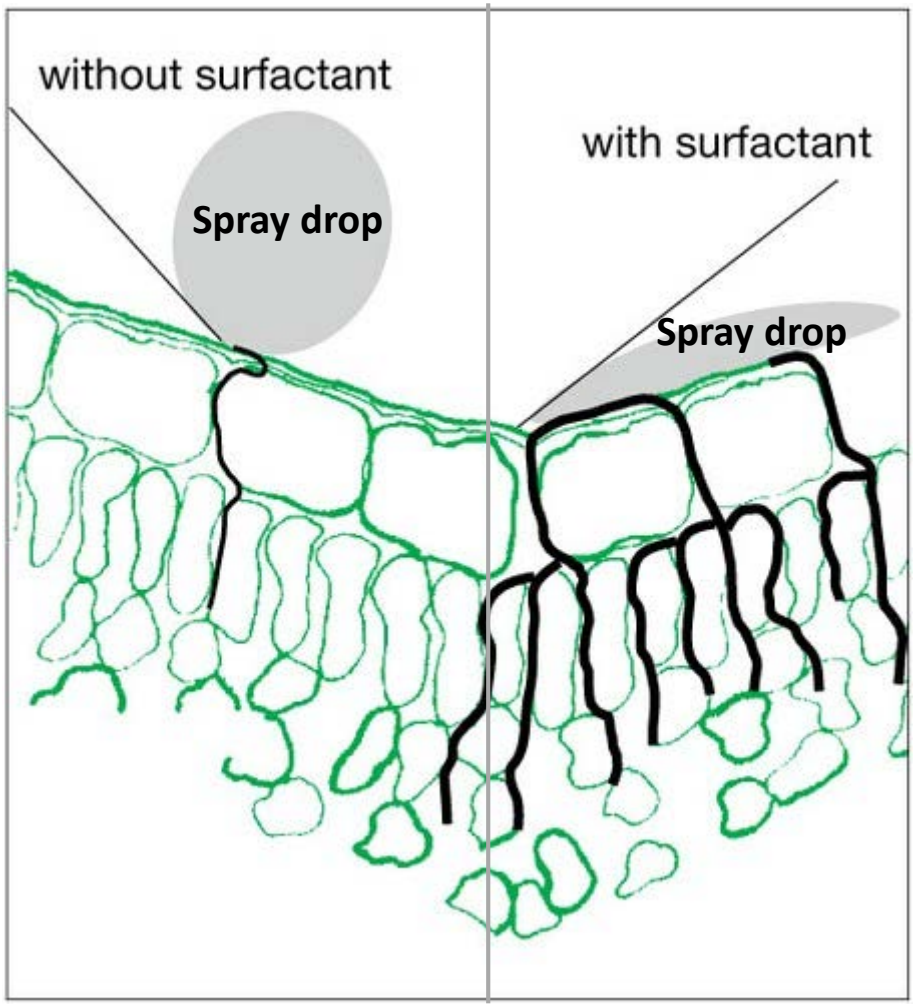
- Managing problematic weeds
- Selecting the right herbicide program
- Synergy of herbicides
- **Selecting proper adjuvants**

Surfactants – indispensable ‘adjuvant/ingredient’ for POST emergent herbicides



Surfactants reduce the ‘surface tension’ of spray droplets

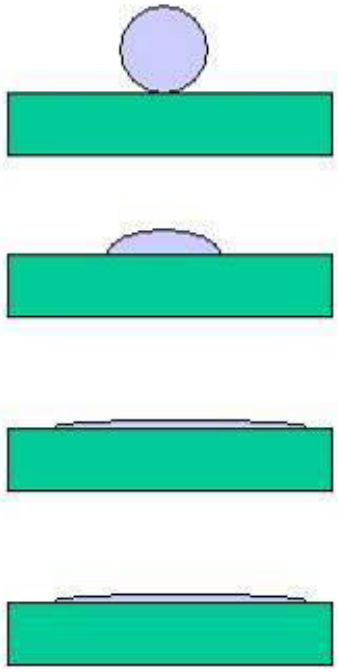
Surfactants – indispensable 'adjuvant/ingredient' for POST emergent herbicides



Spray Droplets with **low surface tension** are more likely to be retained and penetrated onto plant surfaces

Info credit: PSU extension

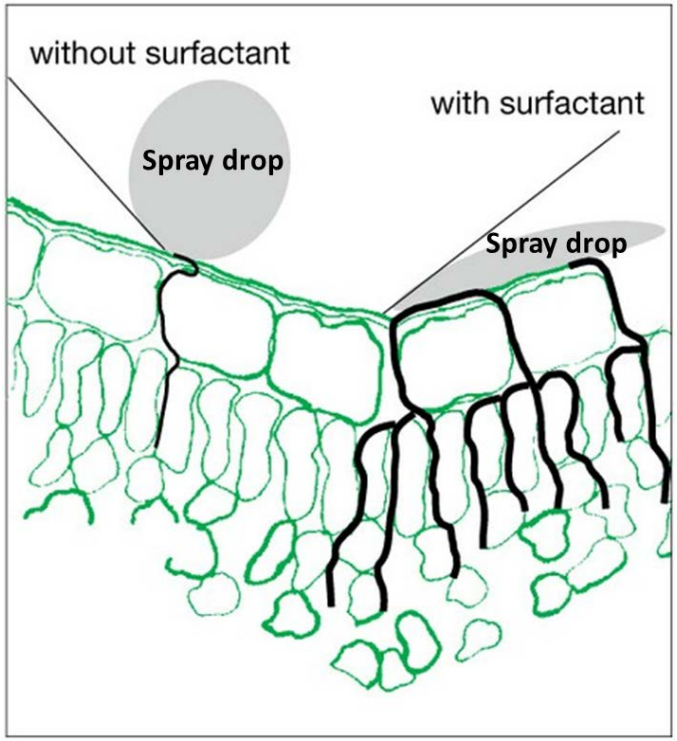
Surfactant addition = better weed control for POST-emergent herbicides



Surfactant concentration	Weed Control
0%	45%
0.12%	60%
0.25%	85%
0.50%	98%

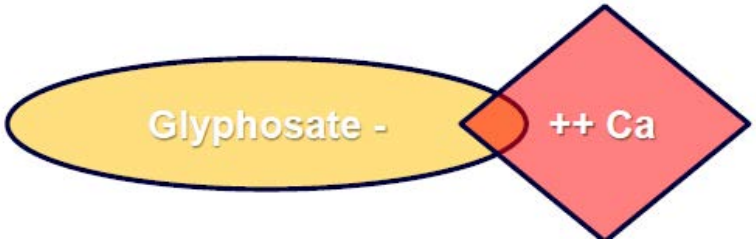
Source: Bob Hartzler, ISU Weed Science

POST herbicides benefit most - from the use of appropriate surfactants



- Glyphosate + Non-ionic surfactant
- Paraquat + Crop Oil Concentrate
- Treevix + Methylated Seed Oil

Water conditioner – important component of herbicide mix



Interaction b/w cations and the herbicide reduce efficacy

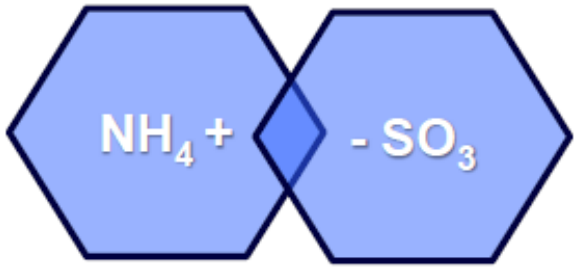
Glyphosate is NOT absorbed in this form

- Considered essential for herbicides like glyphosate
- Hard water: contains high concentrations of dissolved minerals

  Example: Ca^{2+}, Mg^{2+}, Fe^{3+}

Information Credits: Sarah Lancaster, UF IFAS

Water conditioner – important component of herbicide mix

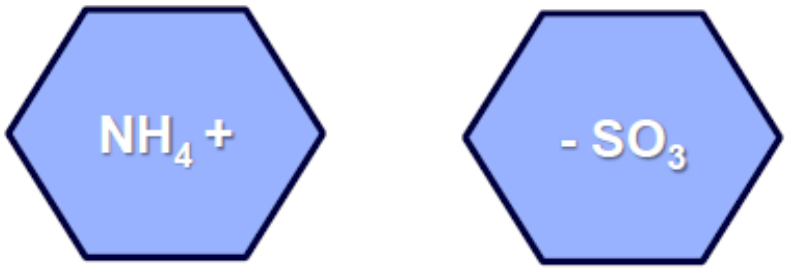


- ***Ammonium sulfate (AMS)***

Information Credits: Sarah Lancaster, UF IFAS

Water conditioner – important component of herbicide mix

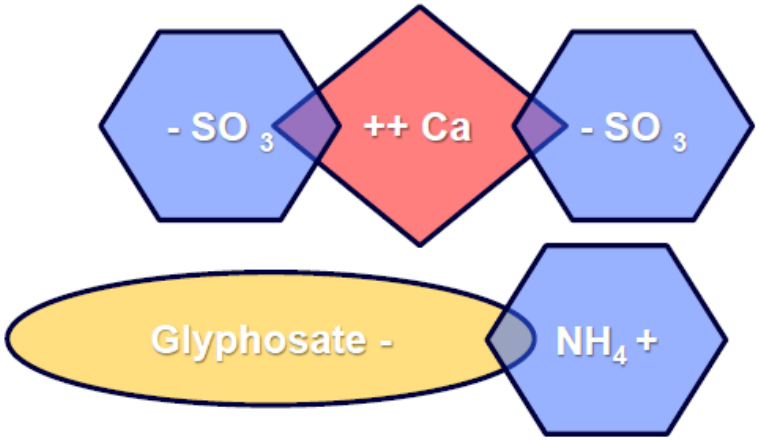
- *Ammonium sulfate (AMS)*



AMS disassociates when added to water

Information Credits: Sarah Lancaster, UF IFAS

Water conditioner – important component of herbicide mix

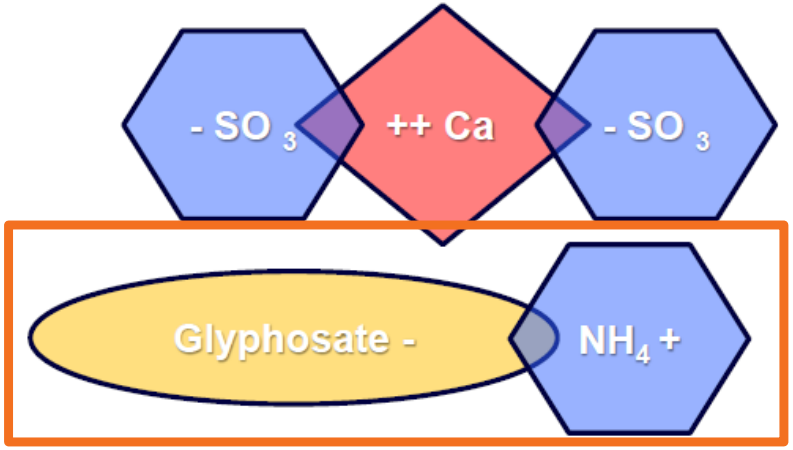


Sulfate binds to cations
Ammonium binds to glyphosate

- ***Ammonium sulfate (AMS)***

Information Credits: Sarah Lancaster, UF IFAS

Water conditioner – important component of herbicide mix



Sulfate binds to cations
Ammonium binds to glyphosate
Glyphosate is absorbed in this form

- ***Ammonium sulfate (AMS)***

Application rate is 7 to 18 lb/100 gal

8 to 10 lbs/100 gal common rate

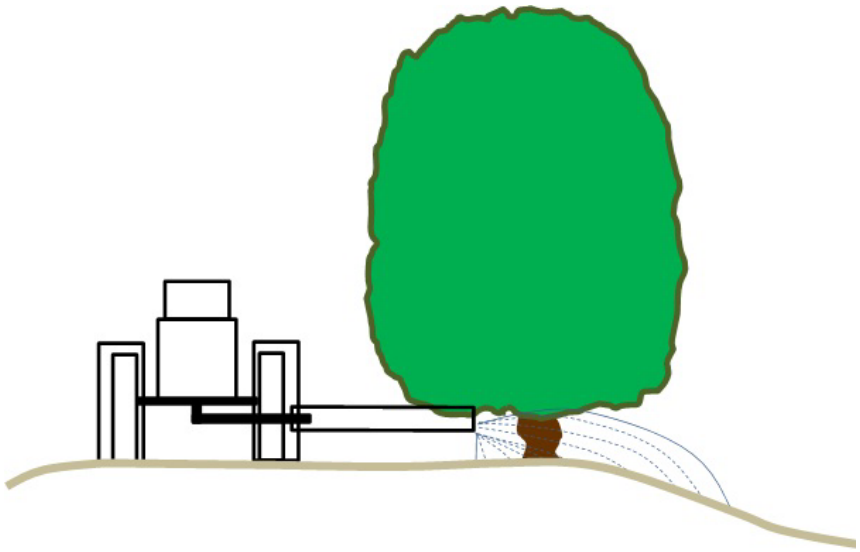
Must be added to tank before herbicide

Information Credits: Sarah Lancaster, UF IFAS

Challenges

- Managing problematic weeds
- **Minimizing crop injury**

- Improper herbicide application



- **Inadequate weed control**
- **Potential for herbicide phytotoxicity to citrus trees**

Herbicide phytotoxicity to citrus

- **Glyphosate**
  - **‘Contact’ injury on foliage**

Herbicide phytotoxicity to citrus

- **Glyphosate**
  - **‘Contact’ injury on fruits**

Photo Credits: Steve Futch

Herbicide phytotoxicity to citrus

Paraquat

- ‘Contact’ injury on foliage & fruits

Photo Credits: Steve Futch

Herbicide phytotoxicity to citrus

- **Diuron**

Contact phytotoxicity

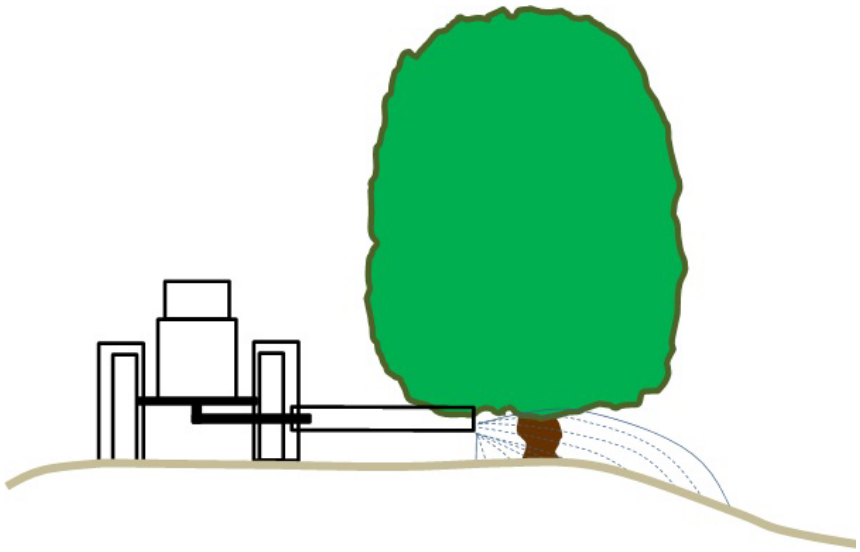
Photo Credits: Steve Futch

Herbicide phytotoxicity to citrus

- **Indaziflam - Alion**

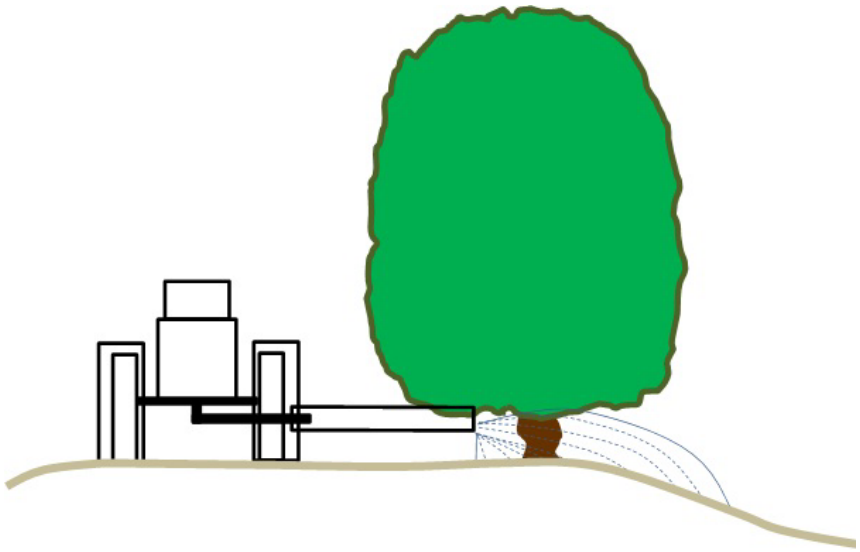
Contact phytotoxicity

Spray coverage



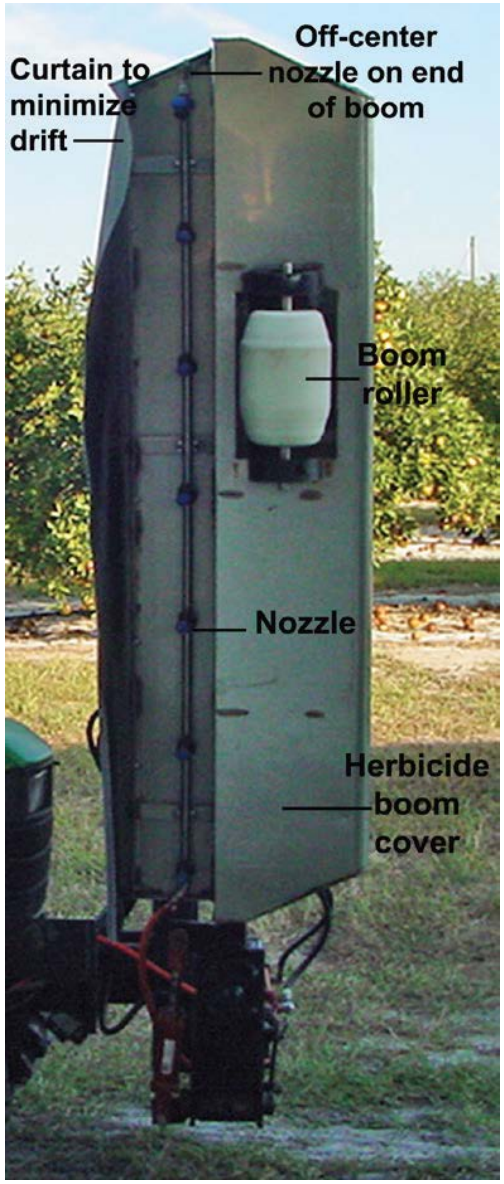
- Herbicide product
- Application speed
- Ground conditions
- Application pressure
- Boom height
- Angle of the OC nozzle

- **Spray coverage**



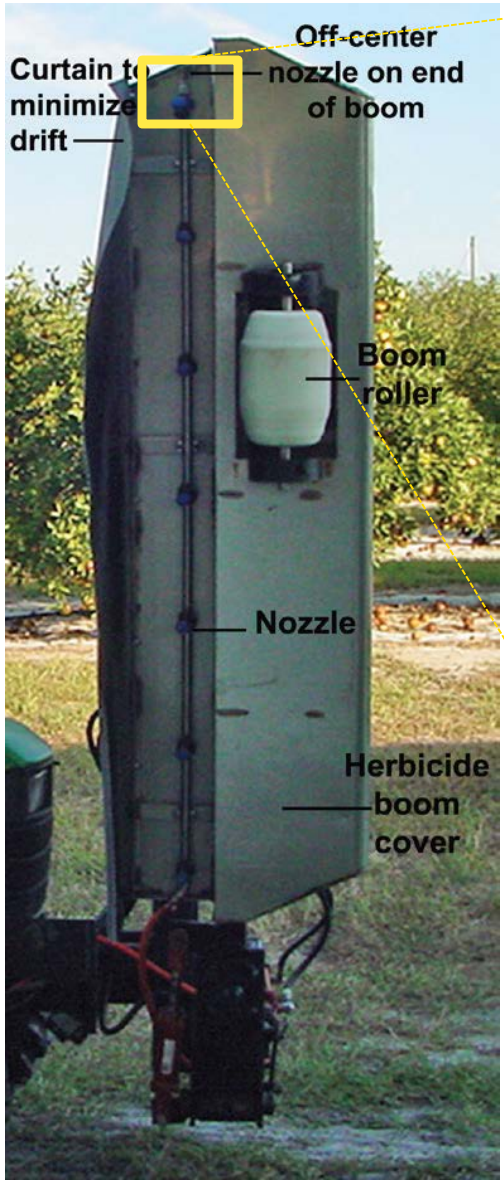
- Herbicide product
- Application speed
- Ground conditions
- Application pressure
- Boom height
- **Angle of the OC nozzle**

Herbicide boom spraying - OC nozzle angle



Information Credits: Steve Futch

Herbicide boom spraying - OC nozzle angle



Off center nozzle on the end of the boom

0 ^{0}

40 ^{0}

Information Credits: Steve Futch

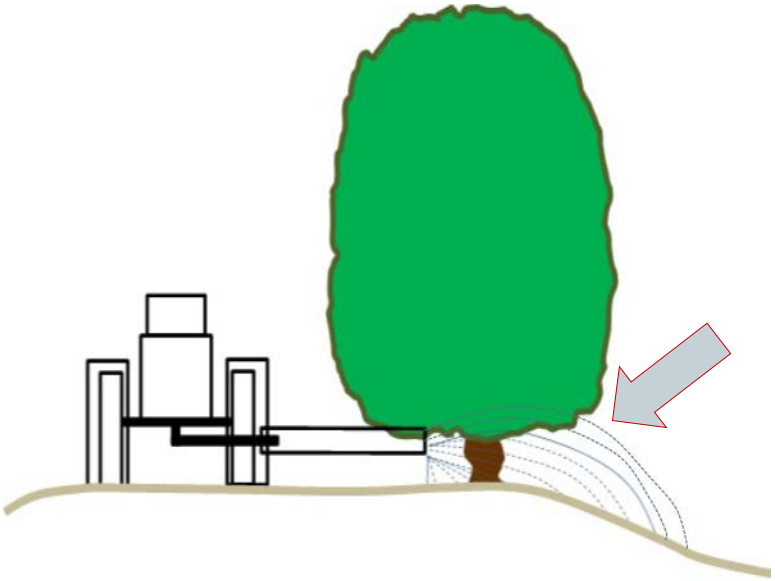
Reach of the spray is impacted by the OC nozzle angle

- Off Center (OC) Nozzle angle

- Greater OC nozzle angle
- Higher and further beyond the end of the boom spray is directed
- Increases the chances for foliage and fruit phytotoxicity in citrus

Ref: Steve Futch et al
Study conducted at the CREC, Lake Alfred

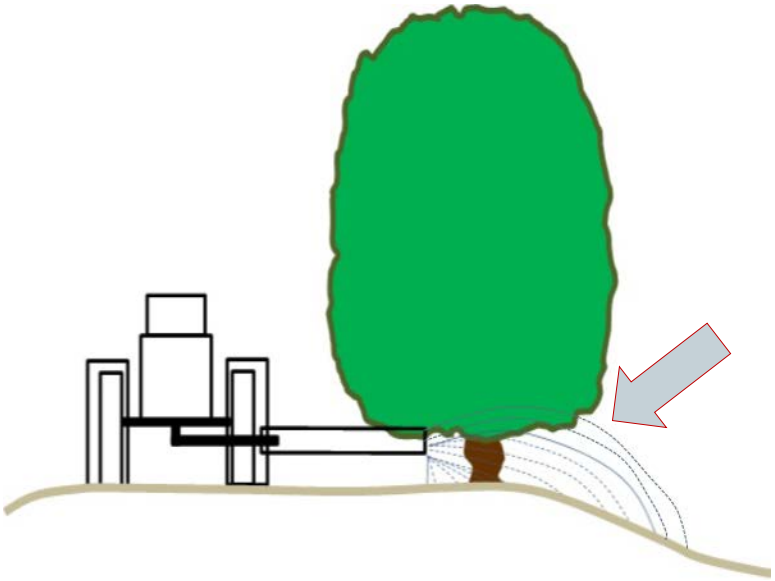
Reach of the spray is impacted by the OC nozzle angle



Increased OC nozzle angle

– spray droplets may drift into citrus foliage and fruits

Reach of the spray is impacted by the OC nozzle angle



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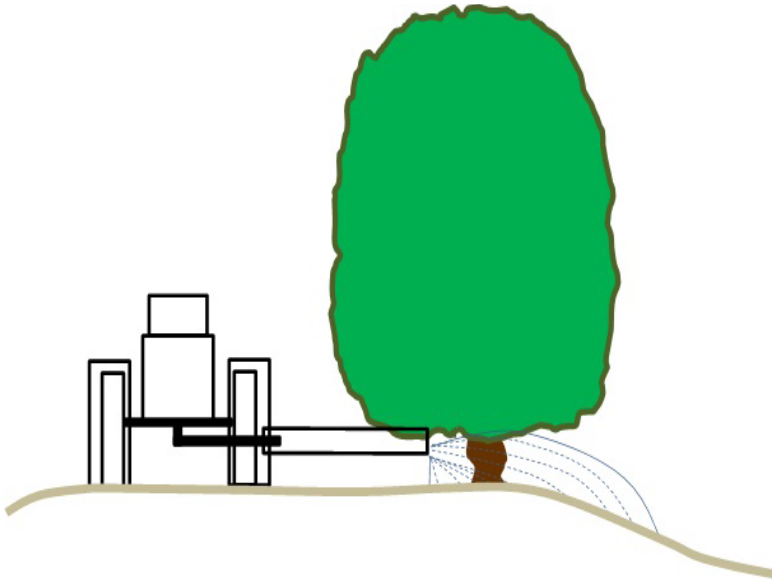
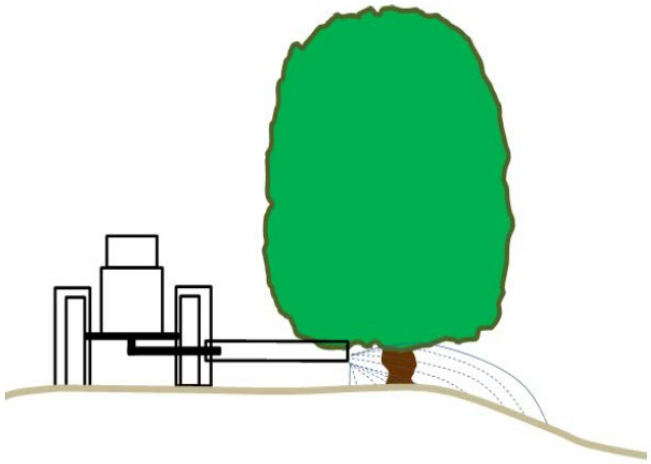


Optimum OC nozzle angle

– adequate coverage under tree

– no herbicide injury

Apply accurately..



- **Maintain proper boom height**
- **Deliver the herbicide to the target**
- **Avoid tree foliage, and fruit contact**
- **Application volume**
  - ***20-50 GPA for under tree***
  - ***10-25 GPA for chemical mowing***
- **Operate equipment safely**

Citrus weed management: summary

Challenges

- Managing problematic weeds
- Minimizing crop injury

Opportunities

- **Selecting the right herbicide program**
  - **POST & PRE**
  - **Selective herbicides**
- **Synergy b/w herbicides**
  - **Mix compatibility**
- **Selecting proper adjuvants**
  - **Surfactants**
  - **Water conditioners**
- **Avoid foliar and fruit contact**
  - **Proper OC nozzle angle**

Citrus weed management: summary

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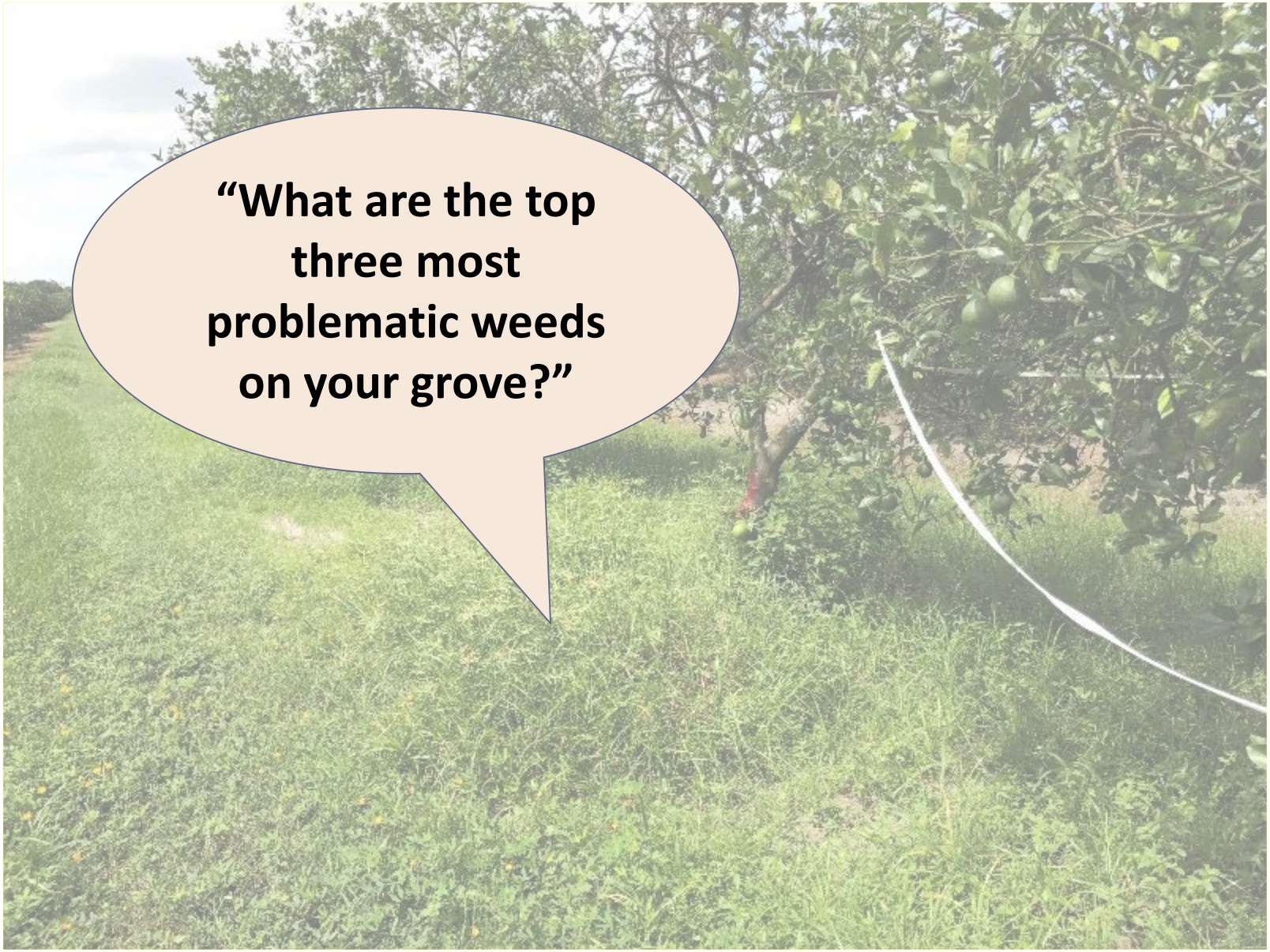
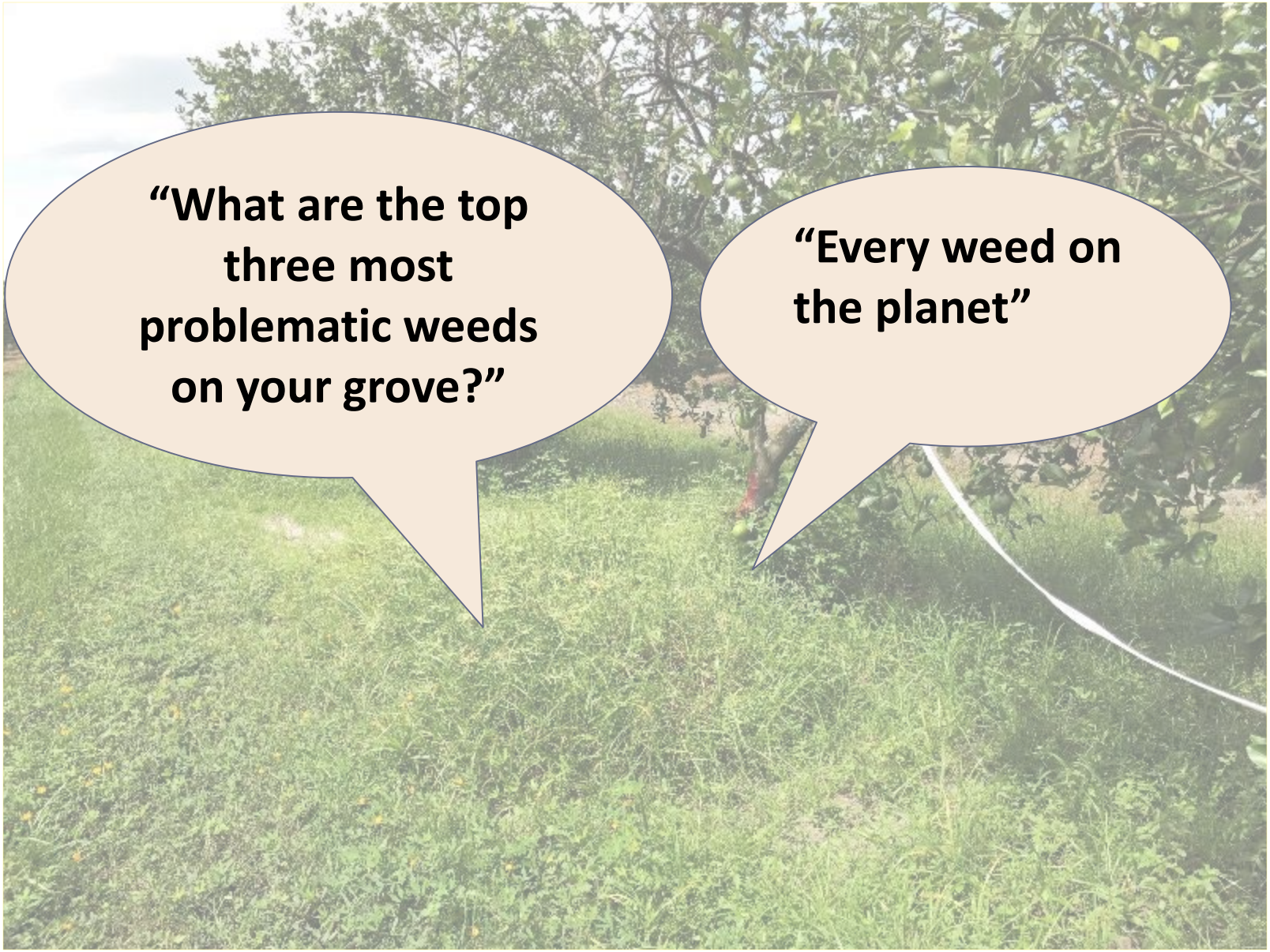

“What are the top three most problematic weeds on your grove?”


“What are the top three most problematic weeds on your grove?”
“Every weed on the planet”

Thank you…

SWFREC weed science team

Contact

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