Effective, Long-term & Crop-safe

Weed Management in Citrus

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Citrus Weed Management

Effective

- Adding adjuvants to enhance POST-emergent herbicide efficacy

Long-term

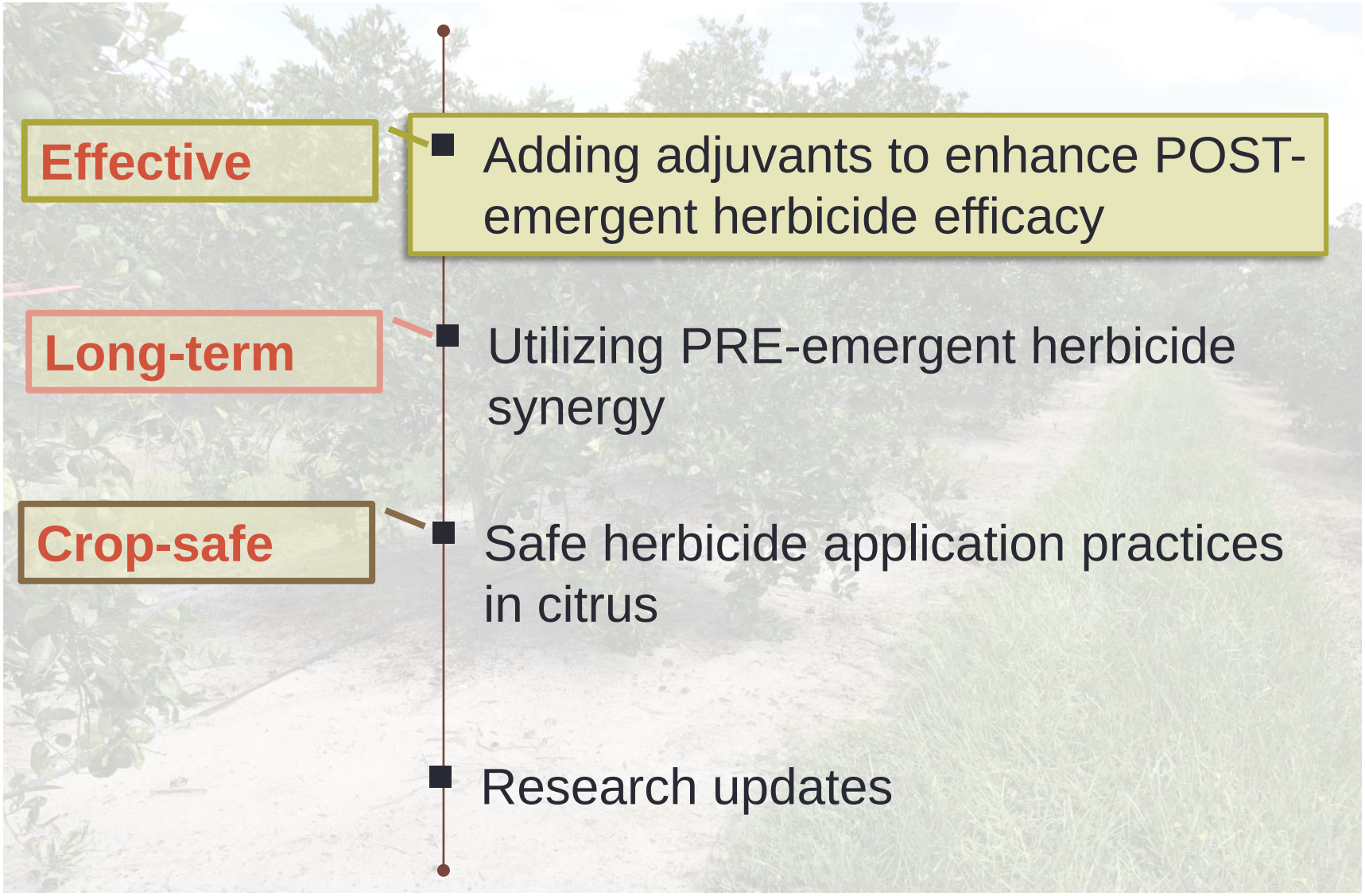
- Utilizing PRE-emergent herbicide synergy

Crop-safe

- Safe herbicide application practices in citrus

- Research updates

Citrus Weed Management



Important strategy to prevent weed outbreak in your grove

Heavy infestation of **tropical whiteweed** in citrus tree rows

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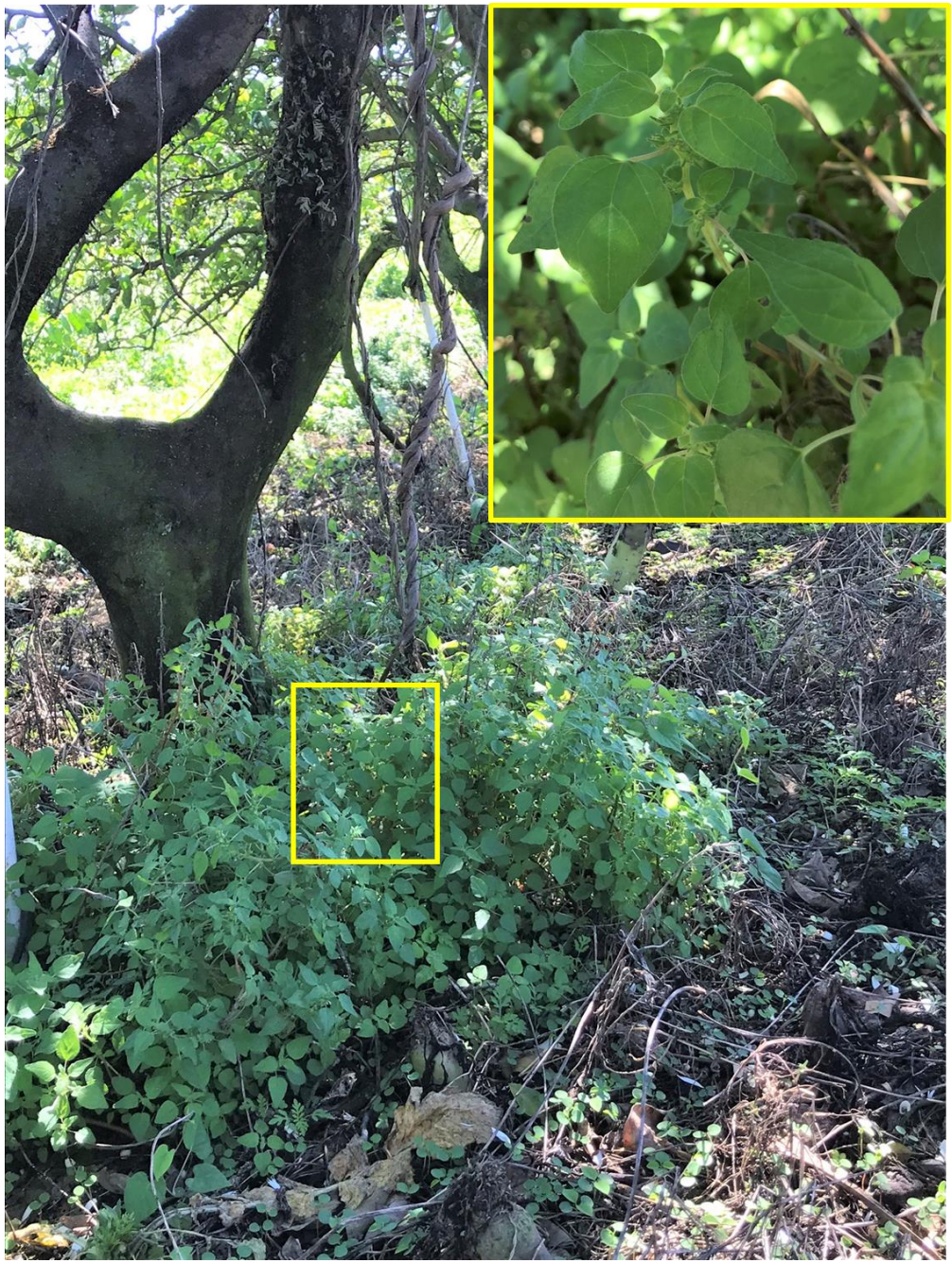
Heavy infestation of **“tropical whiteweed”** in citrus tree rows

Clustered pellitory
infestation

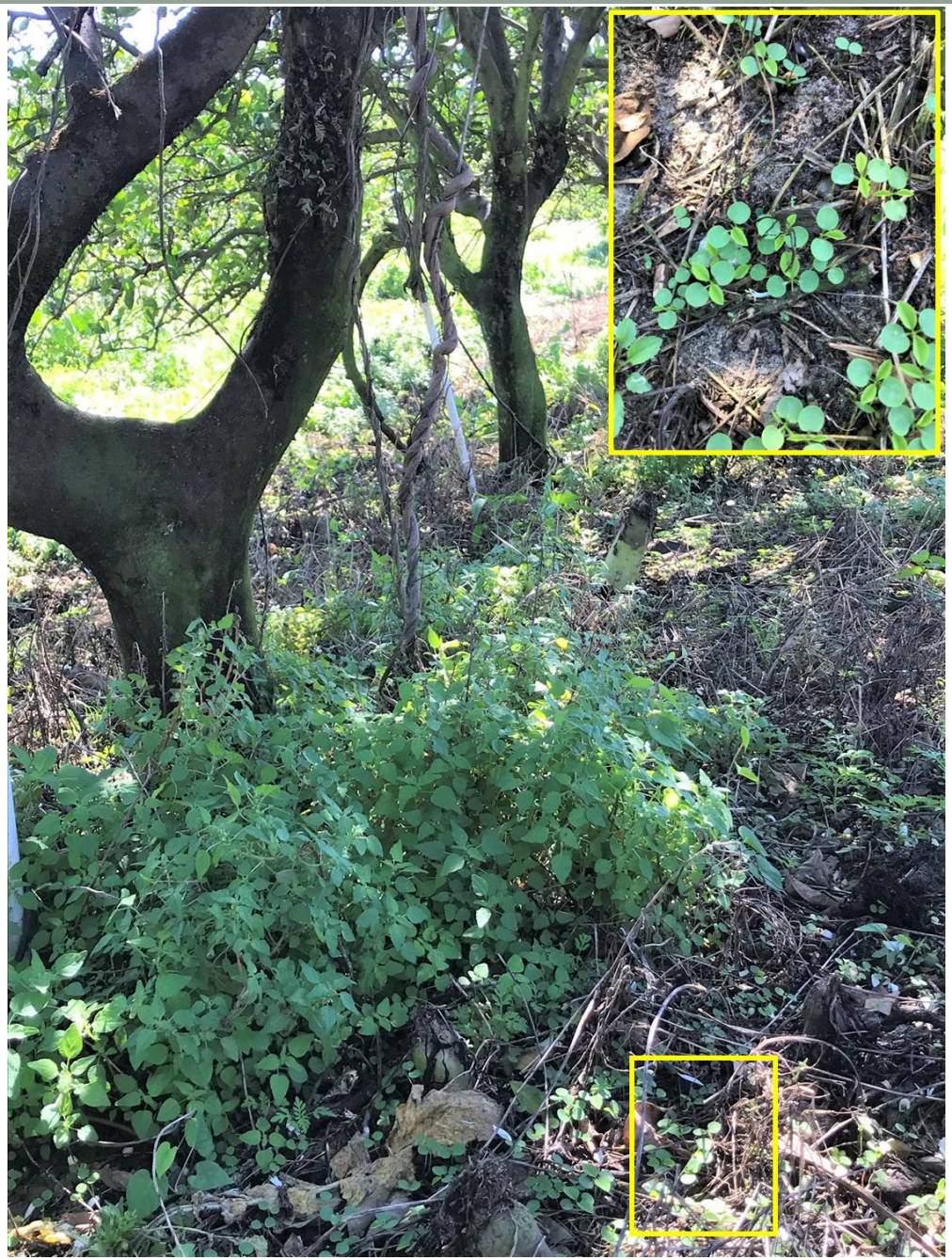


<u>Clustered pellitory</u>
infestation

Seed bank formed in the soil

Managed by broad-spectrum POST-emergent sprays

- **glyphosate**
- **paraquat**



Goat weed

- Slow response to glyphosate & paraquat application

Goat weed

- Slow response to glyphosate & paraquat application

- Tiny seeds released from the ‘seed pods’
- Each plant can potentially add <u>hundreds of thousands of seeds to soil</u>

- Monoculture of goatweed

- Each plant can potentially add **hundreds of thousands of seeds to soil**

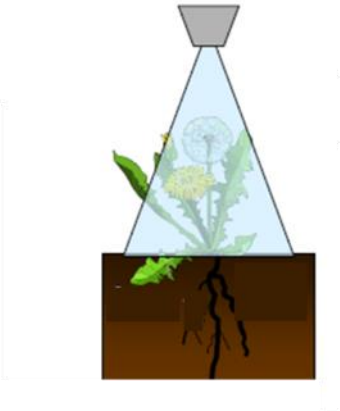
Heavy seed setters

Amaranth / Pigweed

Parthenium

Black Nightshade

Selective herbicides



POST
Foliar applied

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

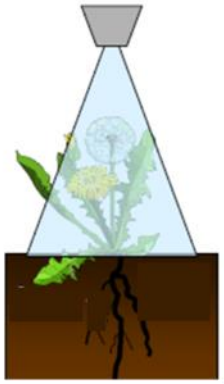
Saflufenacil – Treevix
- Broad-leaf control

Fluazifop-butyl – Fusilade
- Grass control

Consult **Florida Citrus Production Guide 2018-19** for a complete list

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

Non-selective herbicides



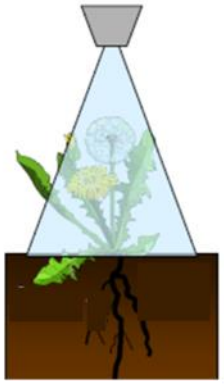
POST
Foliar applied

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

Consult **Florida Citrus Production Guide 2018-19** for a complete list

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

Non-selective herbicides



POST
Foliar applied

- **Carfentrazone –** Aim EC
- **Paraquat -** Gramoxone
- **Glyphosate + 2,4-D -** Landmaster
- **Glufosinate ammonium -** Rely 280

Consult **Florida Citrus Production Guide 2018-19** for a complete list

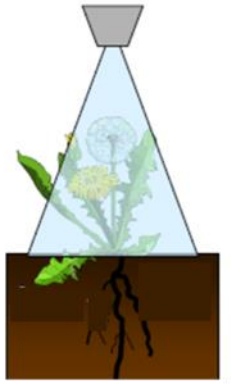
Glufosinate is an effective management option for parthenium

Heavy seed setters

Amaranth / Pigweed

Parthenium

Black Nightshade

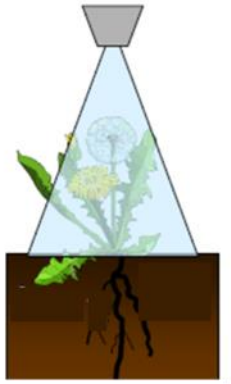


POST
Foliar applied

Spray coverage on foliage – key factor

Higher spray volumes
20 to 30 gallons per acre

- Dense weed infestations
- Large weeds / advanced growth stage



POST
Foliar applied

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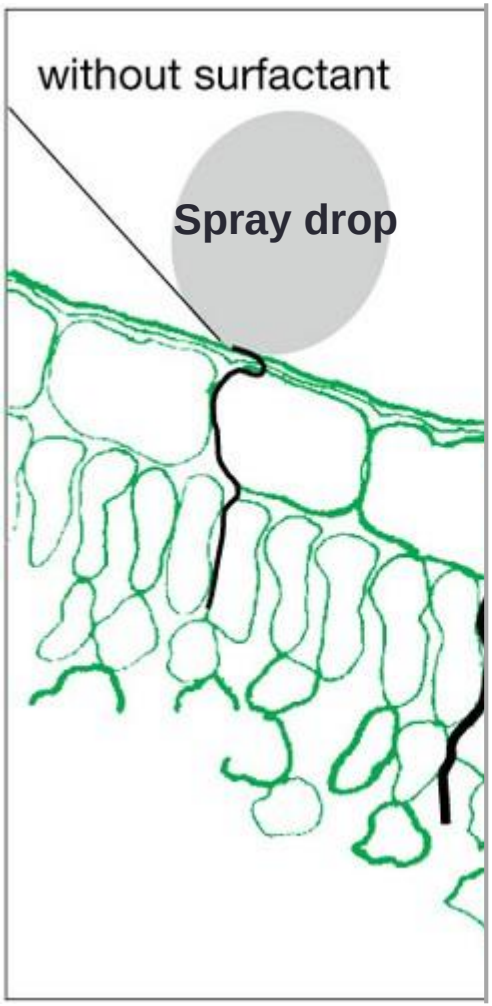
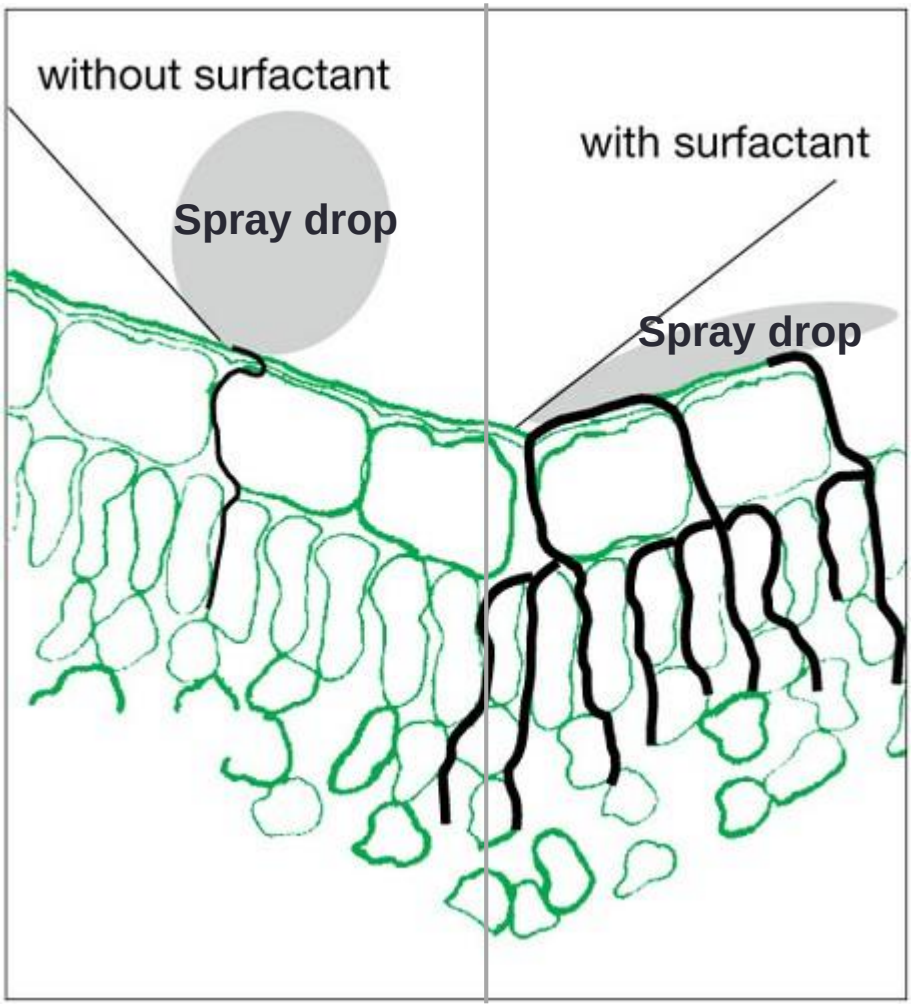
Surfactant addition

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

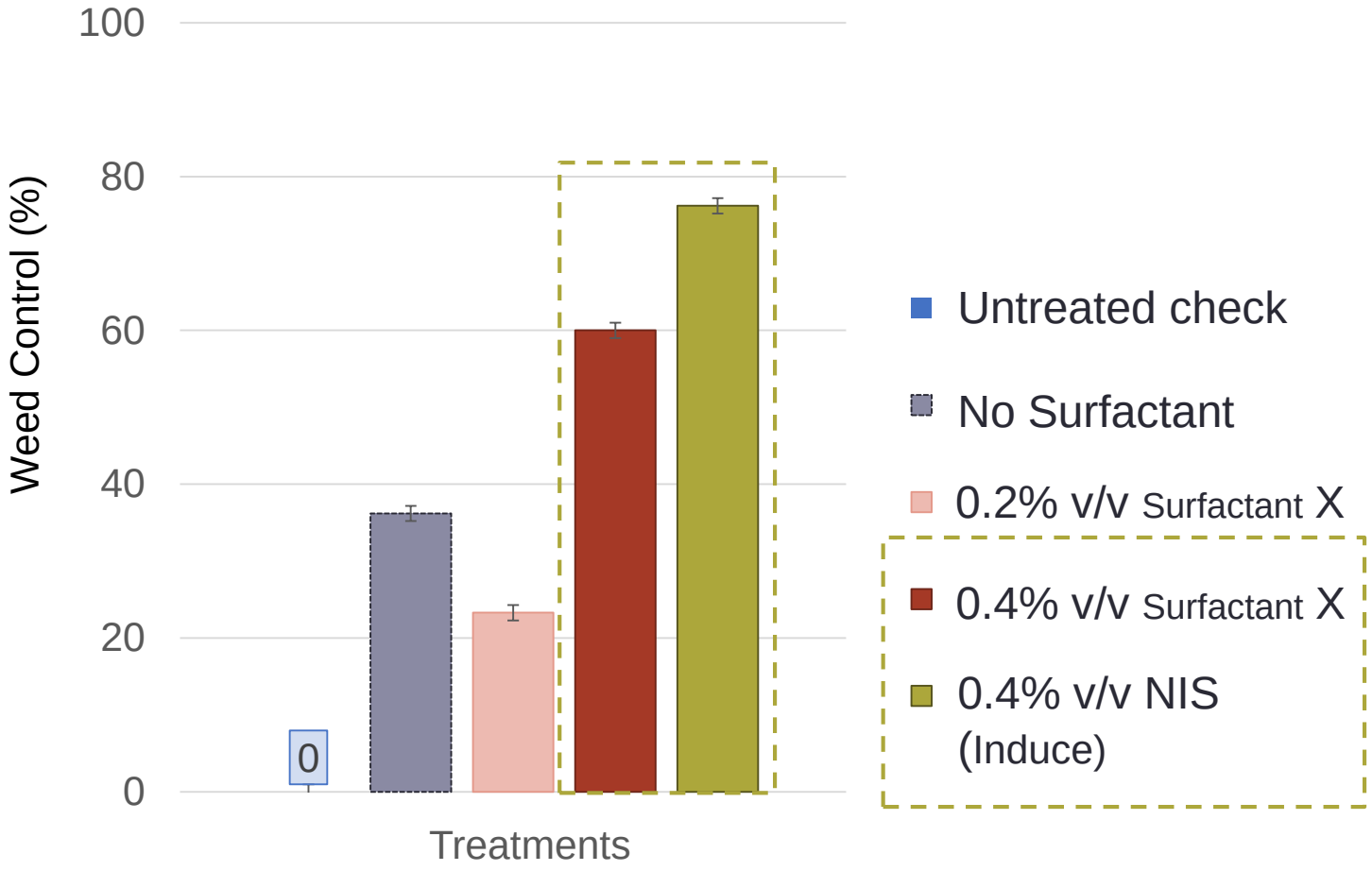
Info credit: PSU extension

Surfactant addition = better weed control for POST-emergent herbicides

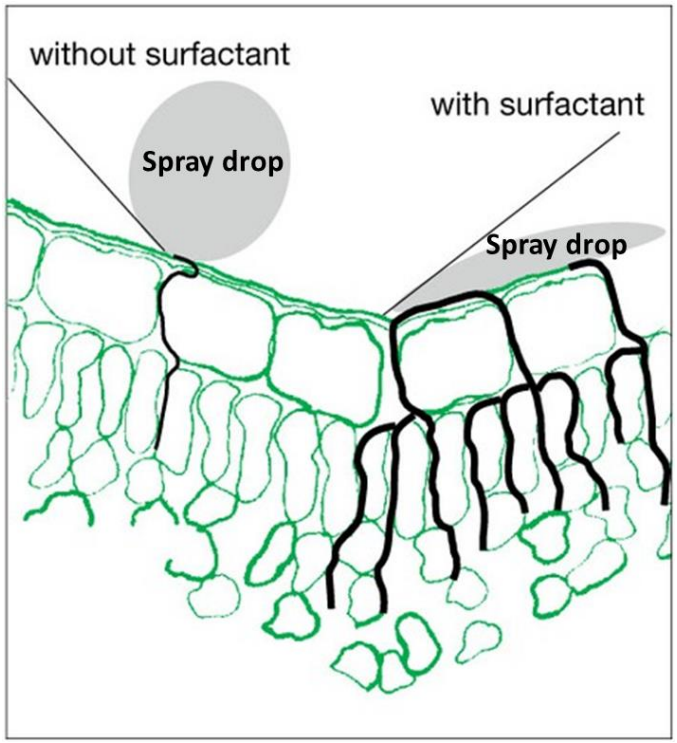
Nutsedge control using paraquat (1 qt / acre)

with & without surfactant

14 Days after treatment



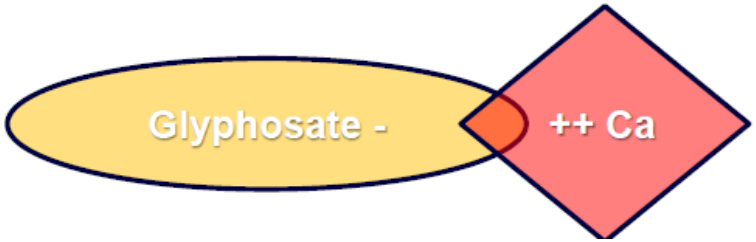
POST herbicides benefit most - from the use of appropriate surfactants



- Glyphosate + Non-ionic surfactant (NIS)
- Paraquat + Crop Oil Concentrate or NIS
- Treevix + Methylated Seed Oil

- Read the label for the right type / conc. of surfactant

Water conditioner – important component of herbicide mix



Interaction b/w cations and the herbicide reduce efficacy

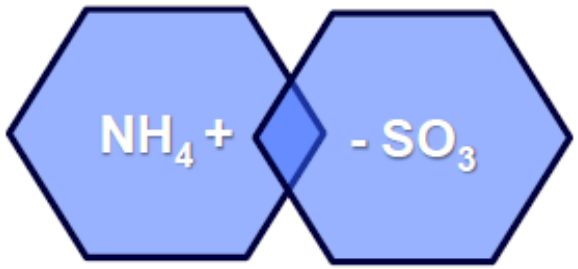
Glyphosate is NOT absorbed in this form

- 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

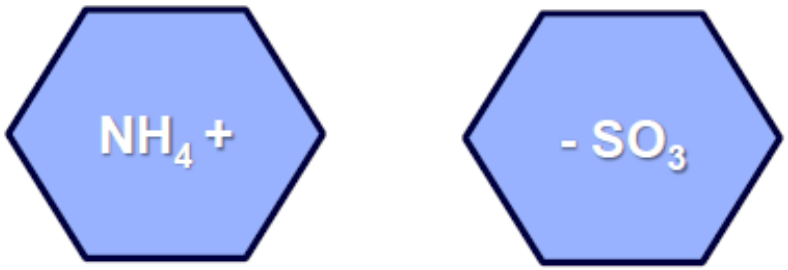
Water conditioner – important component of herbicide mix



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

Information Credits: Sarah Lancaster, UF IFAS

Water conditioner – important component of herbicide mix



AMS disassociates when added to water

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

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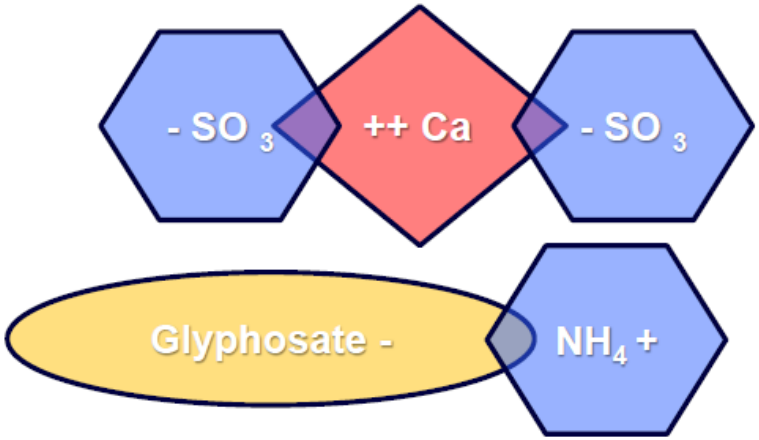
Water conditioner – important component of herbicide mix



Sulfate binds to cations
Ammonium binds to glyphosate

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

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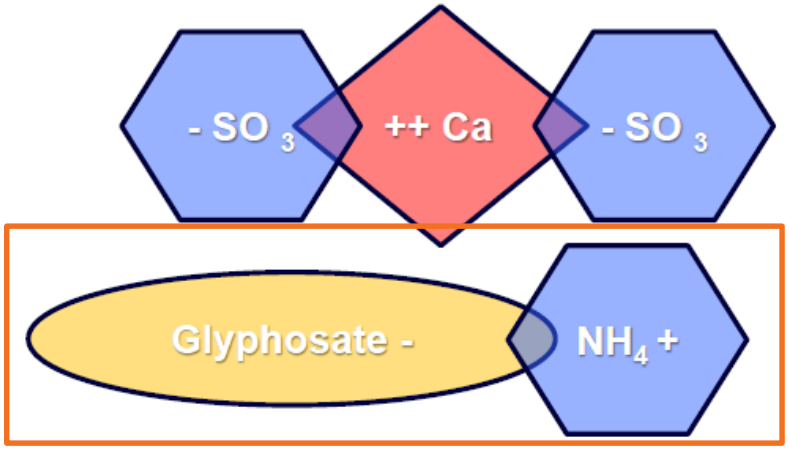
Water conditioner – important component of herbicide mix



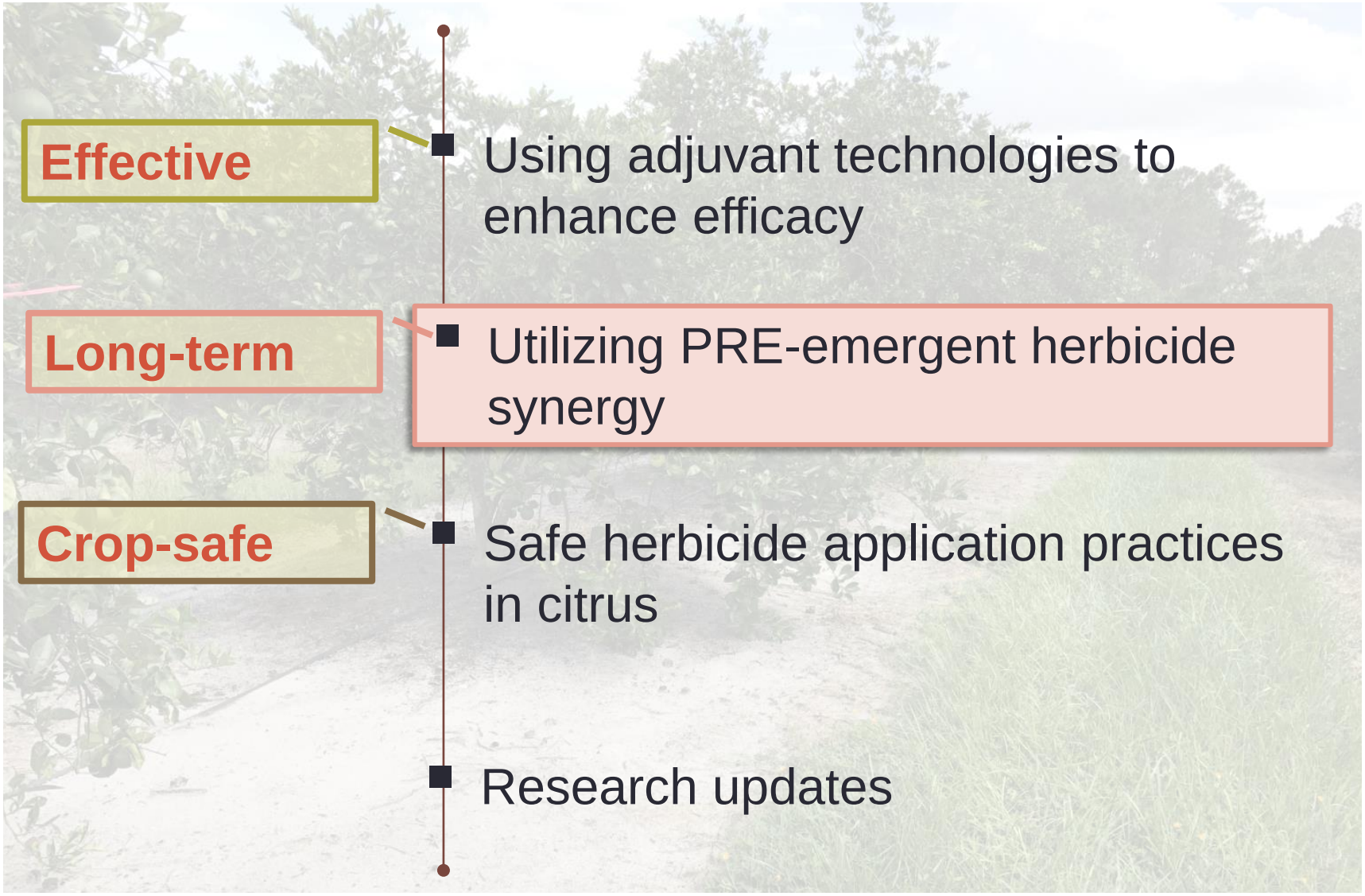
Sulfate binds to cations
Ammonium binds to glyphosate
Glyphosate is absorbed in this form

- ***Ammonium sulfate (AMS)***
  - Typically, 8 to 10 lbs./100 gal

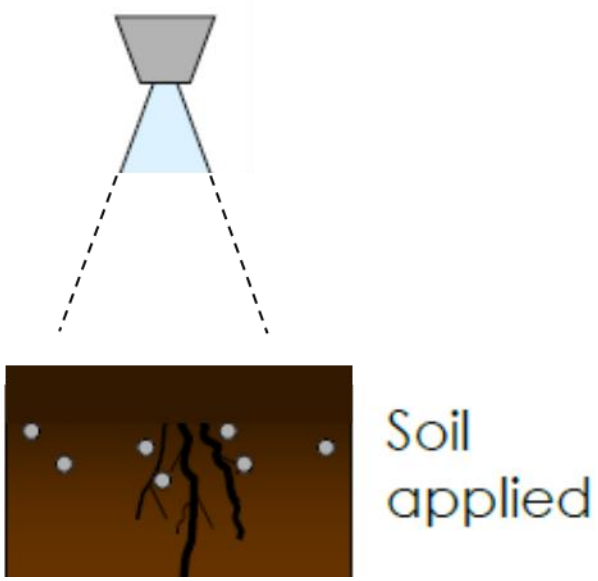
Must be added to tank before herbicide

Information Credits: Sarah Lancaster, UF IFAS

Citrus Weed Management



Pre-emergent OR Residual herbicides

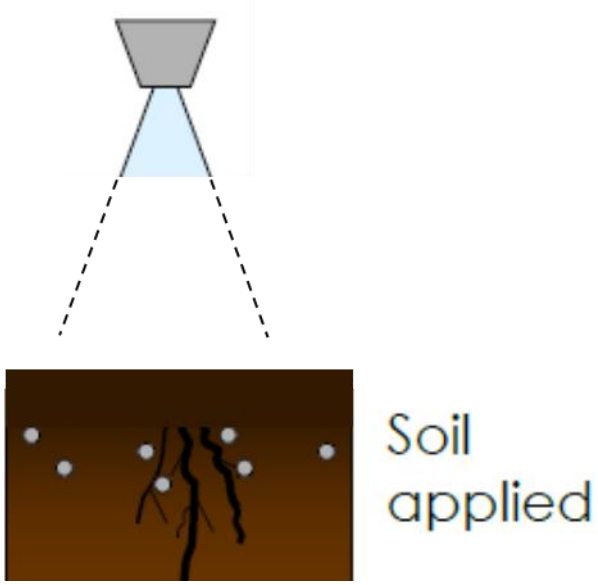


Prevent seed germination

Applied to bare soil or minimum ‘existent weed coverage’ to ensure max soil incorporation

Herbicide synergy project

Pre-emergent OR Residual herbicides



Active Ingredient(s)	*Products*
Flumioxazin	**Chateau**
Indaziflam	**Alion**
Diuron	**Karmex**

Herbicide synergy project

Active Ingredient(s)	*Products*	*Product Rate (per acre)*
Flumioxazin	Chateau	6 oz.
Flumioxazin	Chateau	8 oz.
Indaziflam	Alion	3 oz.
Indaziflam	Alion	5 oz.
Flumioxazin + Indaziflam	Chateau + Alion	6 oz. + 3 oz.
Flumioxazin + Indaziflam	Chateau + Alion	8 oz. + 5 oz.
Flumioxazin + Diuron	Chateau + Karmex	6 oz. + 4 lbs.
Flumioxazin + Diuron	Chateau + Karmex	6 oz. + 8 lbs.
Control	--	--

Herbicide synergy project

5+ Months

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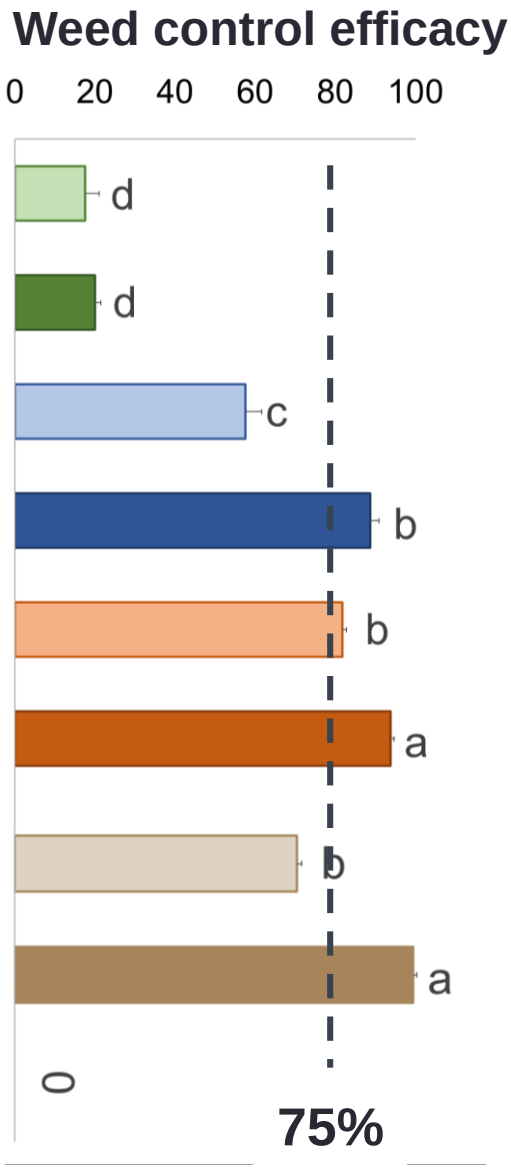


- Replication (n) = 5
- Mean comparison: Tukey's hsd ($p < 0.05$)

Control

2 Months

Indaziflam + Flumioxazin

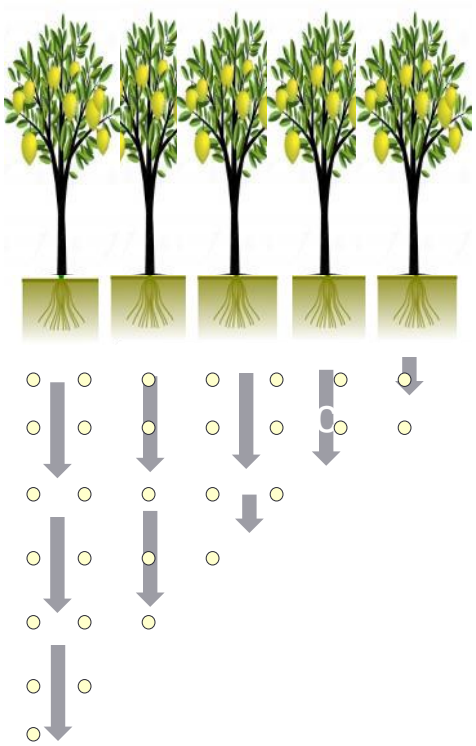
2 Months

Indaziflam + Flumioxazin

5 months after application

Study location: Immokalee

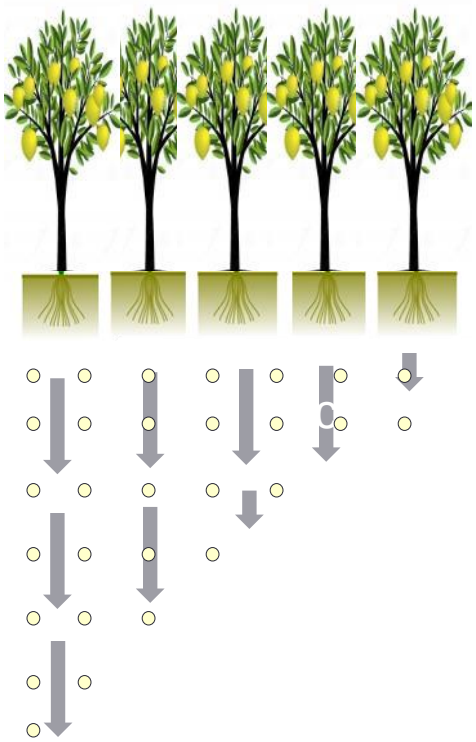
Leaching of herbicides – vertical movement



Key

Herbicide

Leaching of herbicides – vertical movement



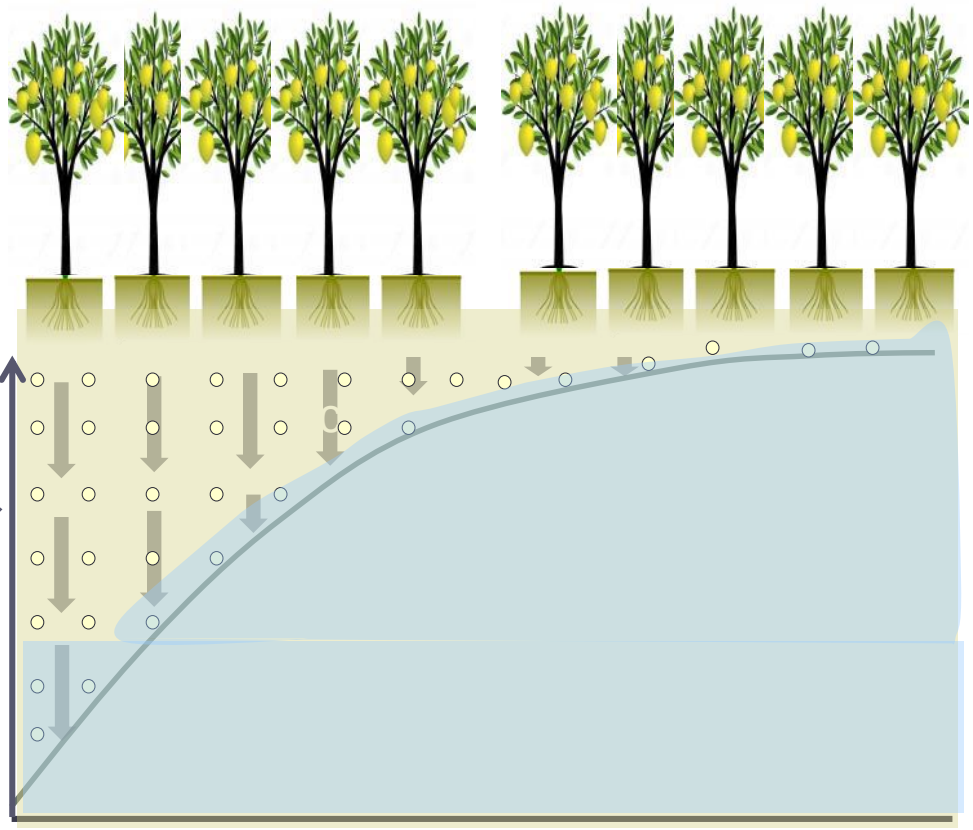
Leaching is likely when:

- Herbicide does not bind tightly to soil
- Soils with high sand – low clay

Key

Herbicide

Leaching of herbicides – vertical movement



Water holding capacity

Key

Herbicide

Common FL Soil types

Entisols

Well drained

Flatwood Spodosols

Coastal Alfisols

Poorly drained

Obreza and Collins 2002

Study location: Zolfo springs

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~5 Months

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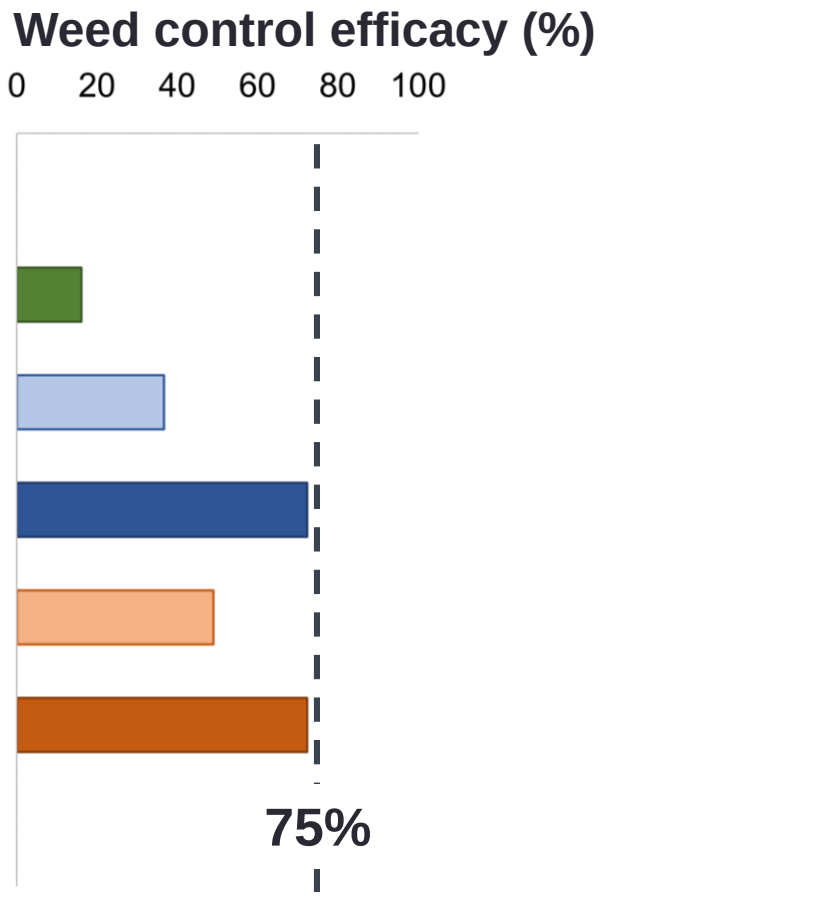
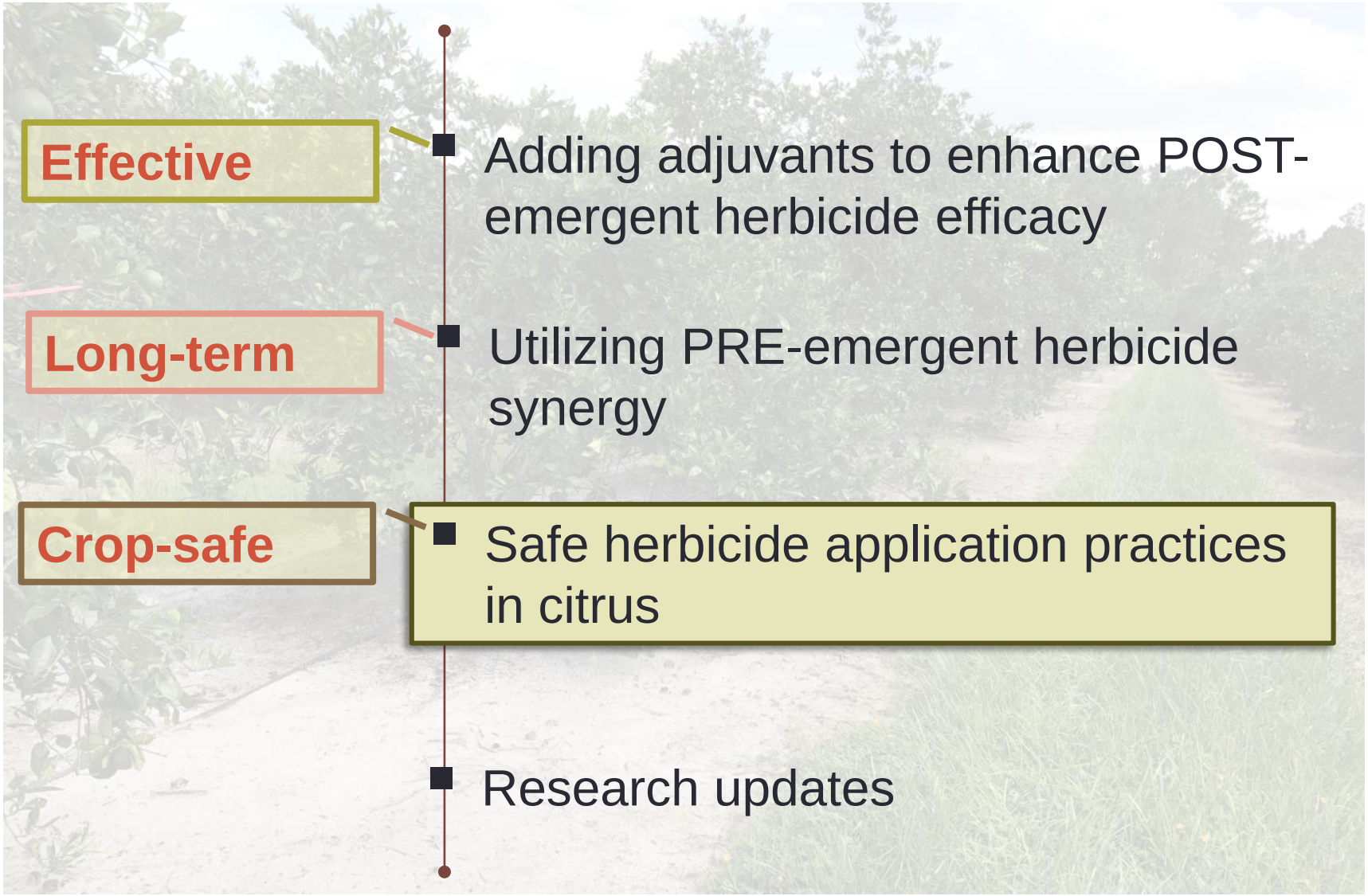
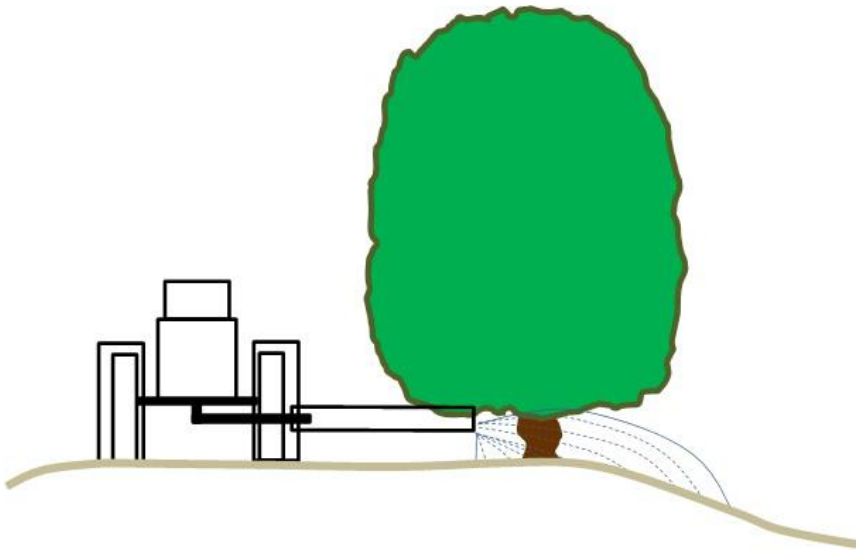


- Replication (n) = 5

Citrus Weed Management



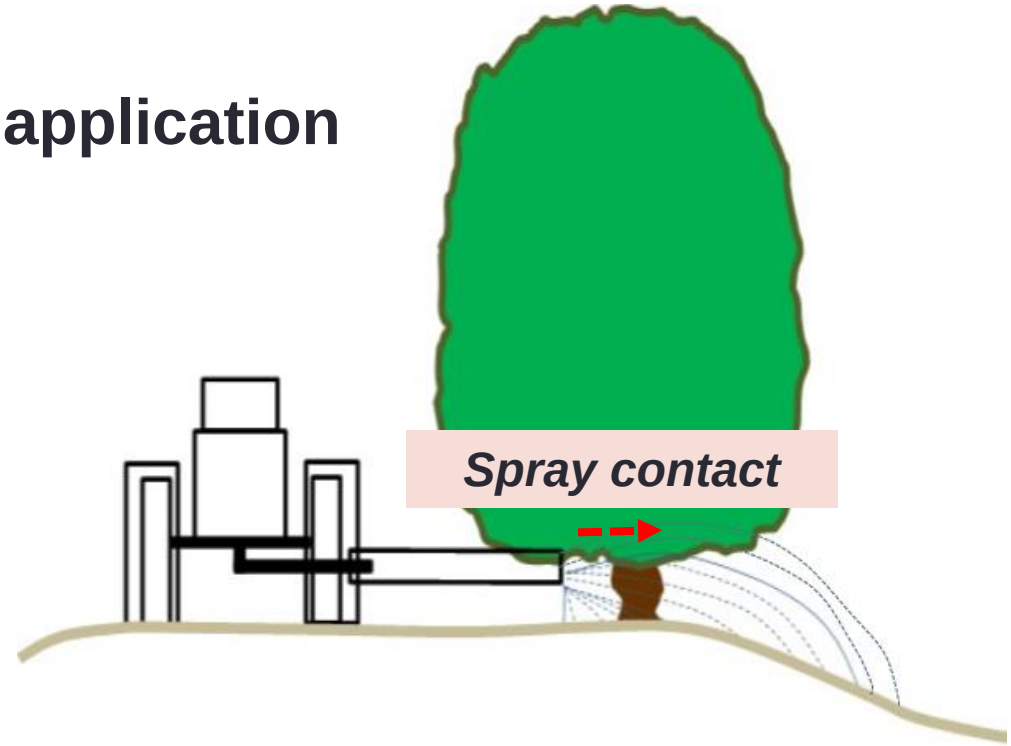
Improper herbicide application



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

Impacts of herbicides on citrus health and yield

- **Herbicide application**



Herbicide phytotoxicity to citrus

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

Citrus drop from glyphosate spray contact with fruit

Credits: Steve Futch

Herbicide phytotoxicity to citrus

Paraquat

- ‘Contact’ injury on foliage & fruits

Photo Credits: Steve Futch

Herbicide phytotoxicity to citrus

- **Diuron**
  - **Trade name: Karmex**

Contact phytotoxicity

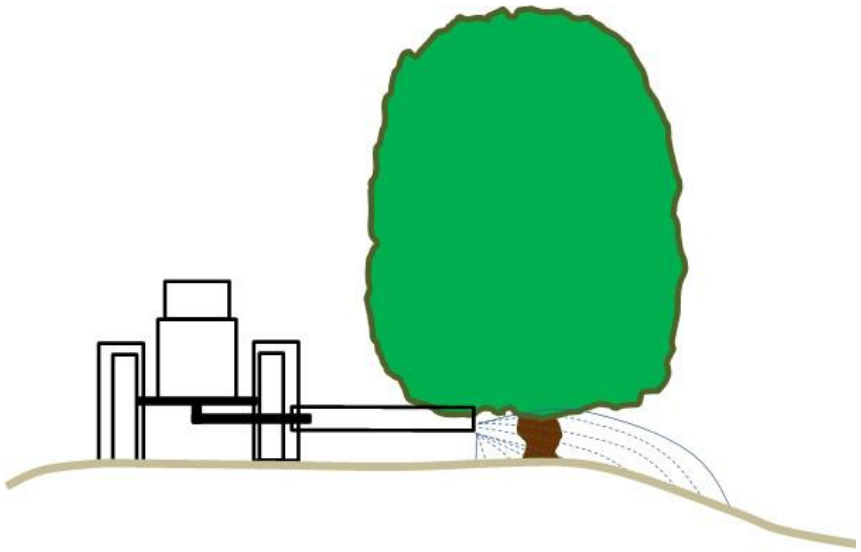
Photo Credits: Steve Futch

Herbicide phytotoxicity to citrus

- **Indaziflam**
  - **Trade name: Alion**

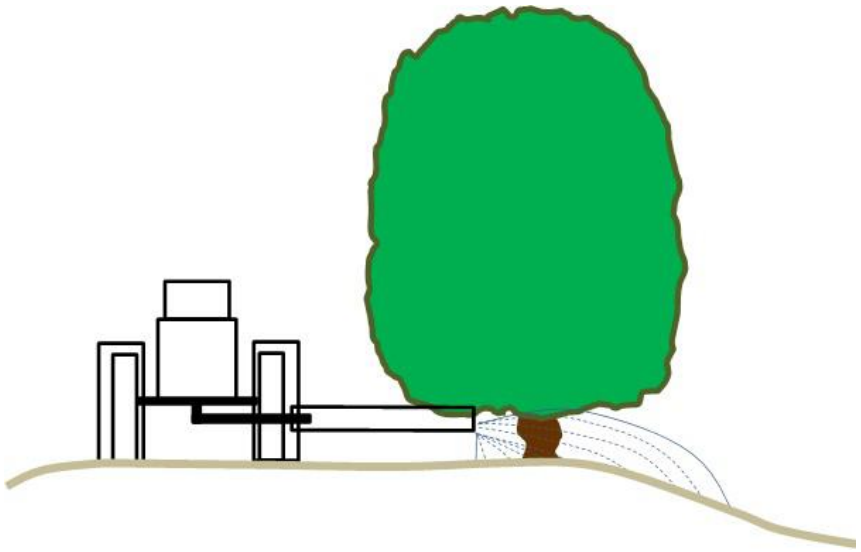
Contact phytotoxicity

Herbicide spray injury to citrus



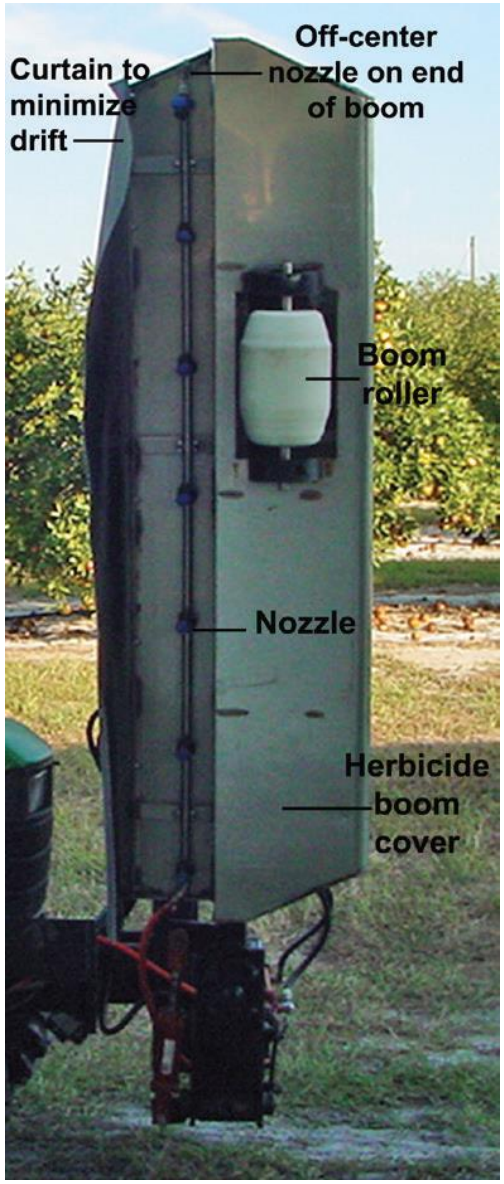
- Herbicide product
- Ground conditions
- Boom height
- Angle of the OC nozzle

Herbicide phytotoxicity to citrus



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

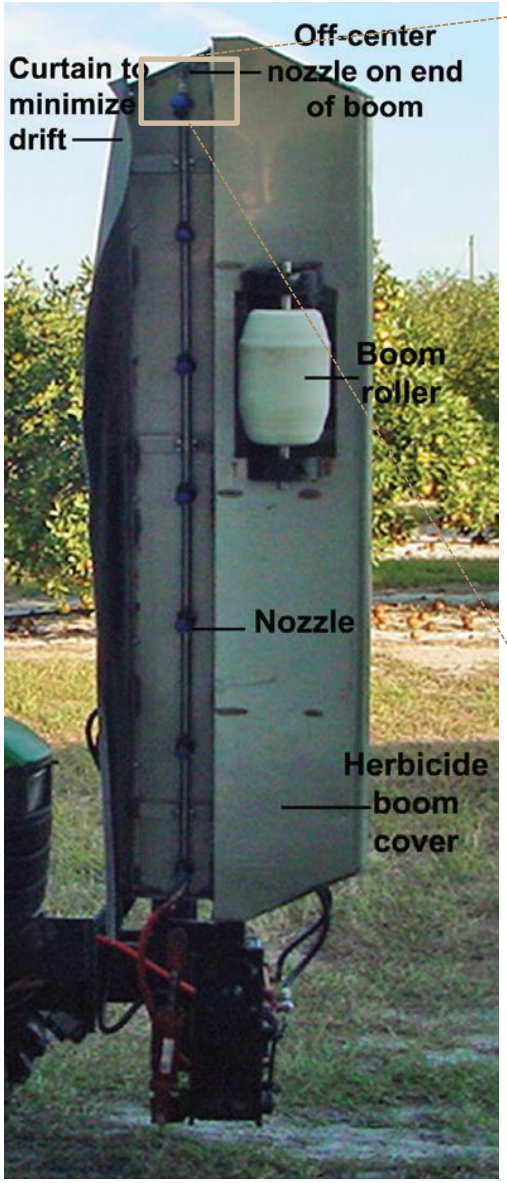
Herbicide boom spraying - OC nozzle angle



- Off Center (OC) Nozzle angle

Information Credits: Steve Futch

Herbicide boom spraying - OC nozzle angle



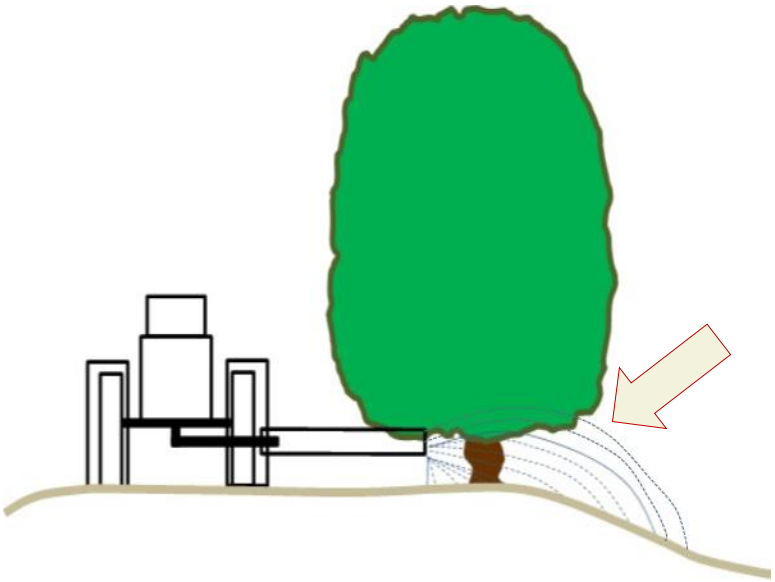
Off center nozzle on the end of the boom

0 ^{0}

40 ^{0}

Information Credits: Steve Futch

Reach of the spray is impacted by the OC nozzle angle

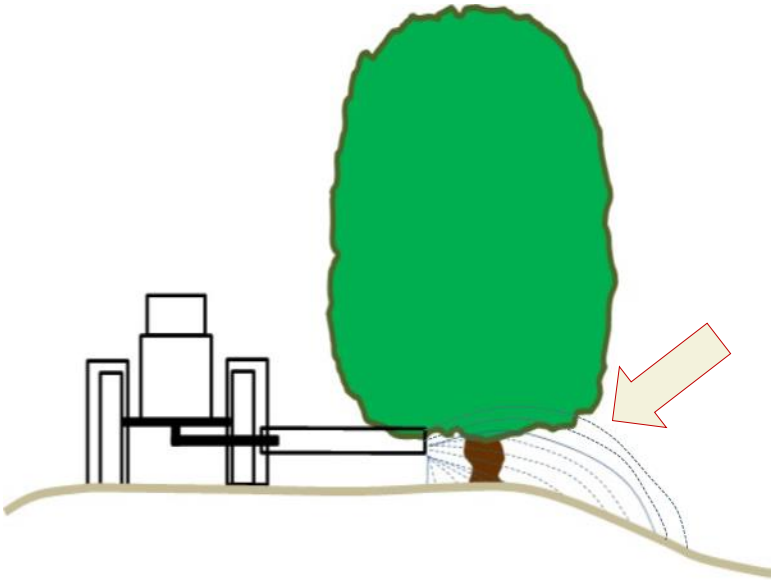


Increased OC nozzle angle

– spray droplets may drift into citrus foliage and fruits

Ref: Steve Futch et al.

Reach of the spray is impacted by the OC nozzle angle



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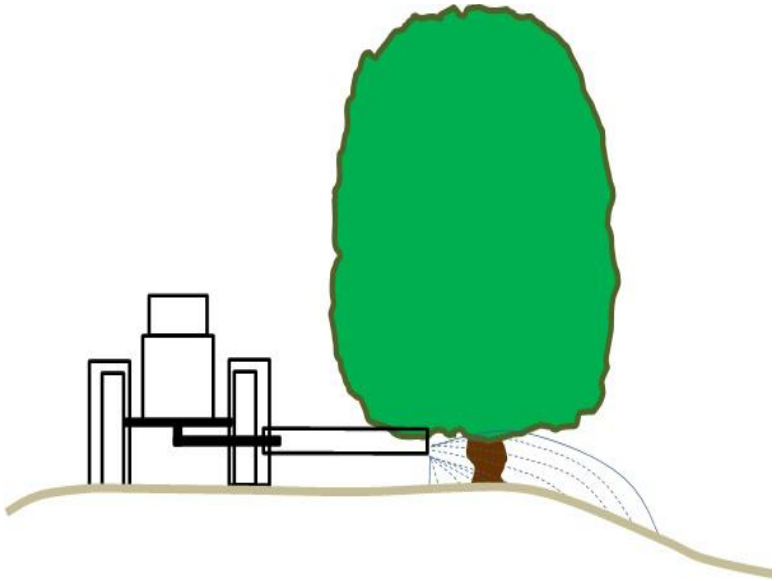
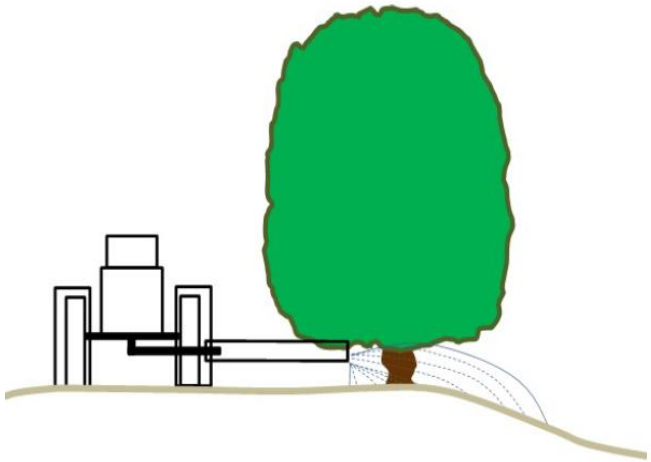


Optimum OC nozzle angle

– adequate coverage under tree

– no herbicide injury

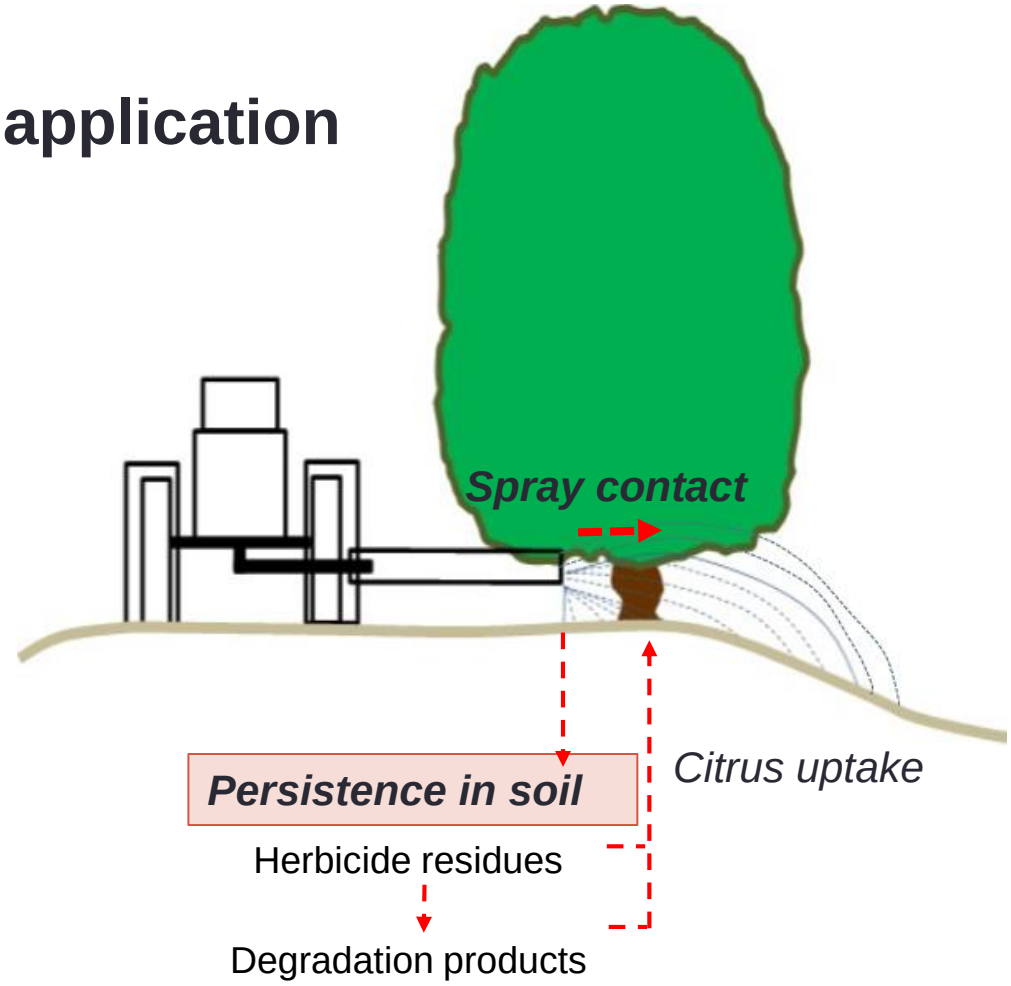
Apply accurately..



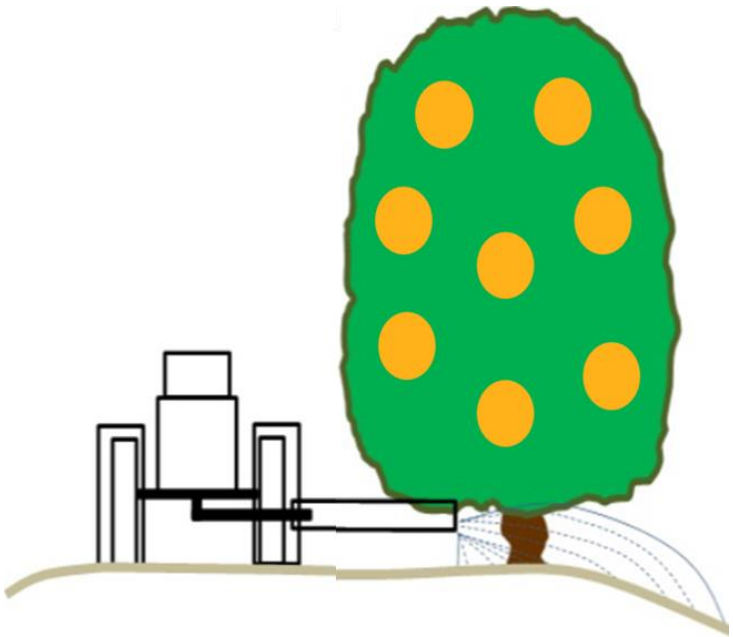
- **Maintain proper boom height**
- **Deliver the herbicide to the target**
- **Avoid tree foliage, and fruit contact**
- **Application volume**
  - ***20-50 GPA for under tree***
  - ***10-25 GPA for chemical mowing***
- **Operate equipment safely**

Impacts of herbicides on citrus health and yield

- **Herbicide application**



Impacts of herbicide persistence on citrus health and yield



- To investigate glyphosate linked fruit drop in citrus

- Application was made during Nov – Feb

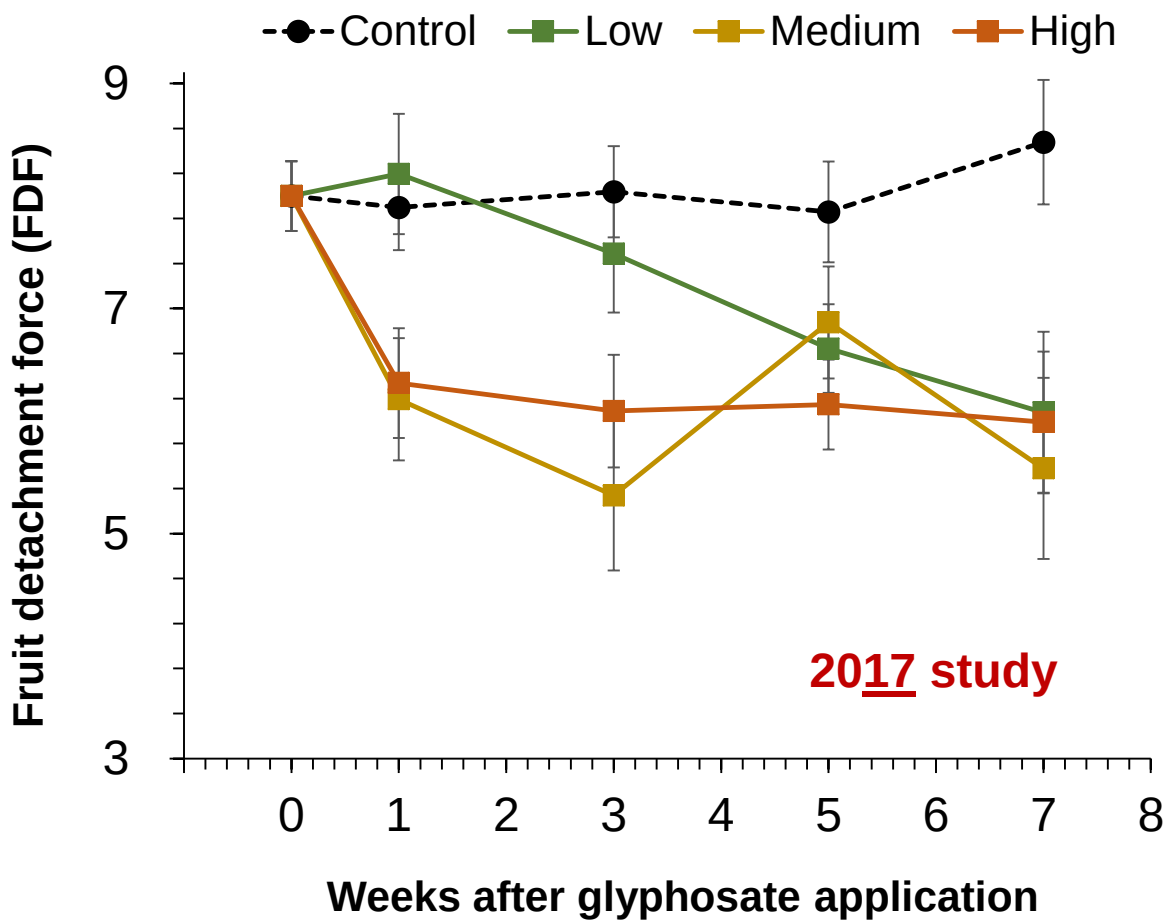
- Valencia

Fruit Detachment Force (FDF)
– indicator of fruit holding capacity

↓ FDF = ↑ higher possibility of fruit drop

FDF response to glyphosate rates

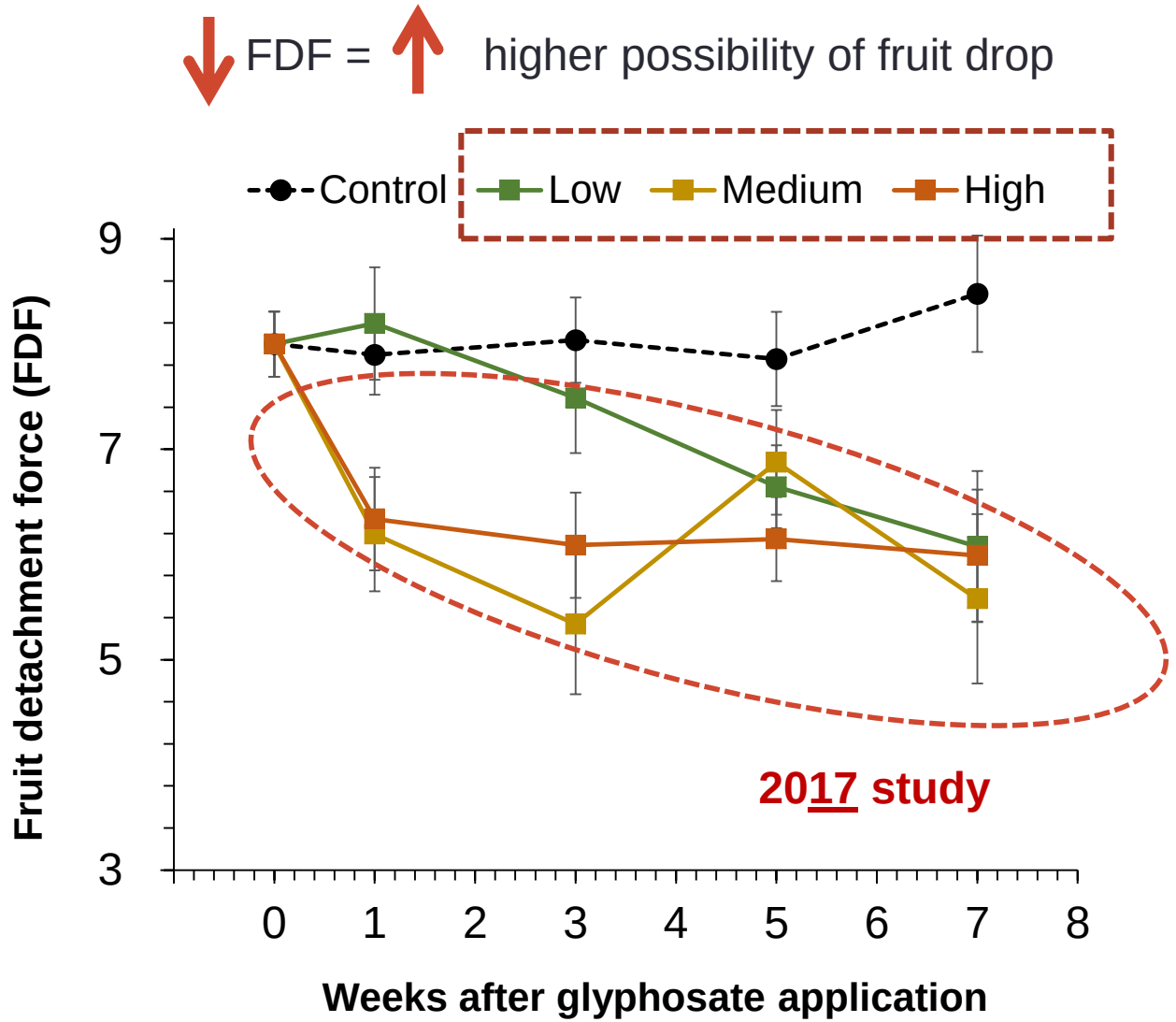
FDF = ↓ higher possibility of fruit drop



- Replication (n) = 100

Kanissery, Batuman & Alferez (2018)

- FDF response to glyphosate rates

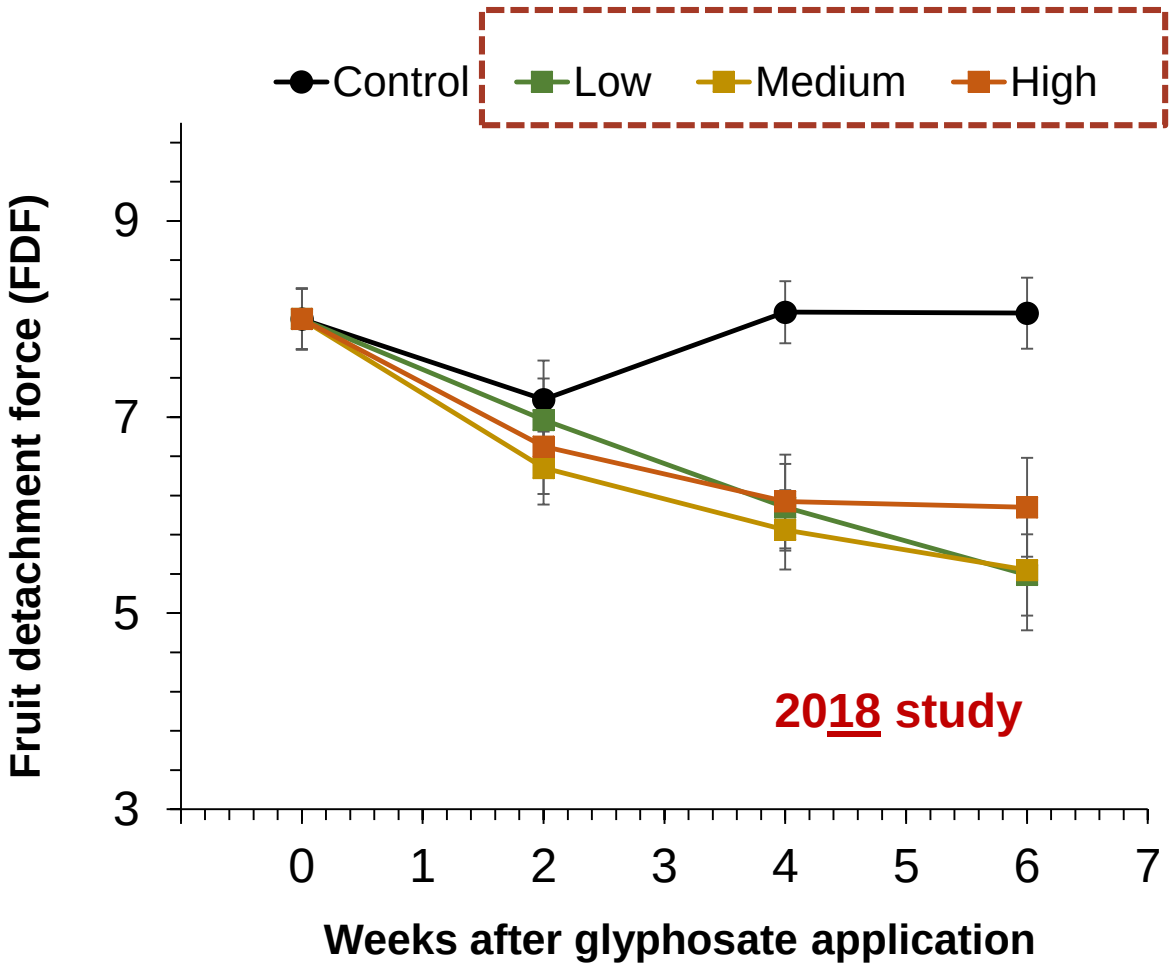


- Replication (n) = 100

Kanissery, Batuman & Alferez (2018)

- FDF response to glyphosate rates

FDF = higher possibility of fruit drop



- Replication (n) = 100

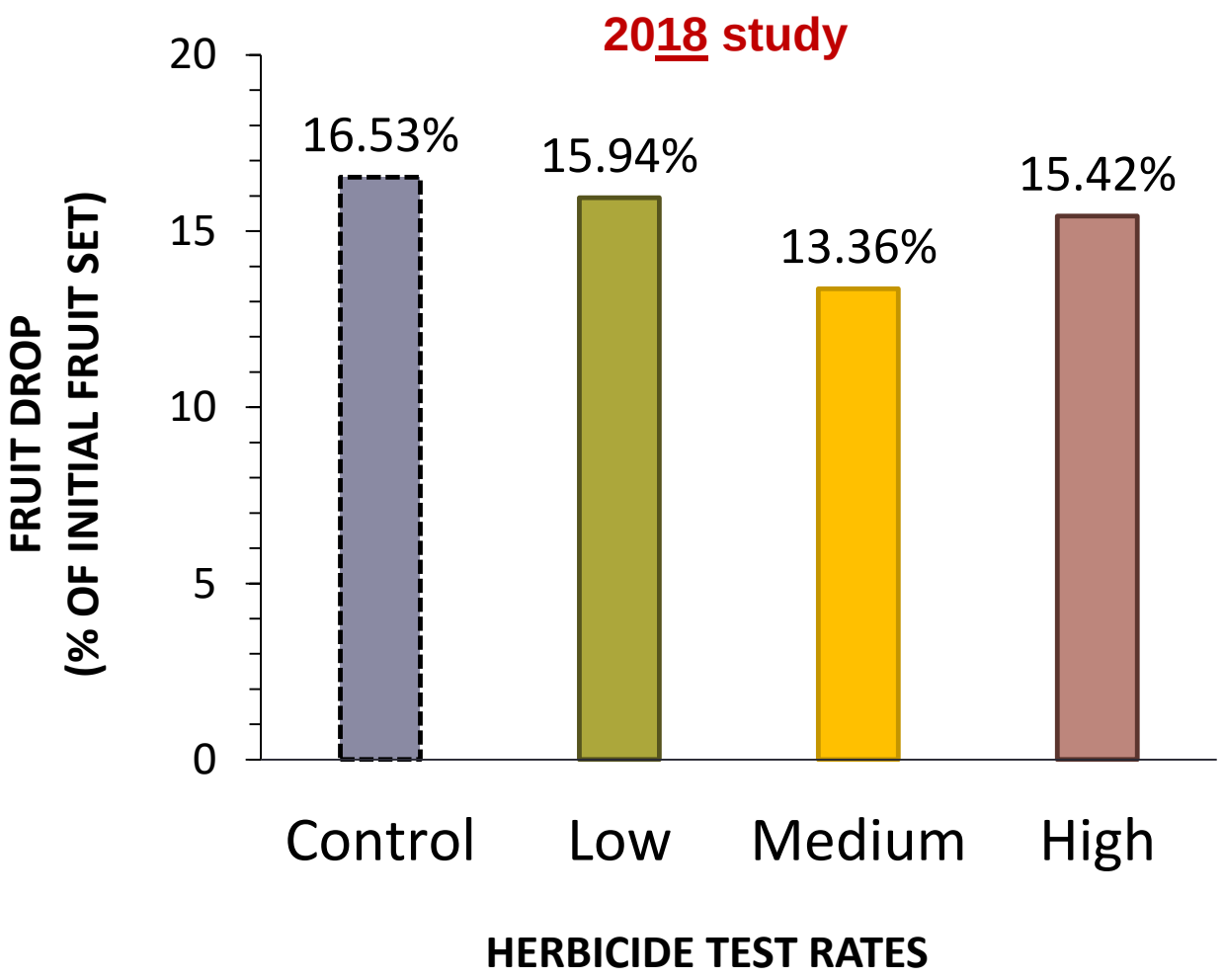
Kanissery, Batuman & Alferez (2018)

Citrus fruit drop v/s glyphosate application

% of fruit dropped - No statistical difference b/w treatments observed in this study

Yield was low in the control

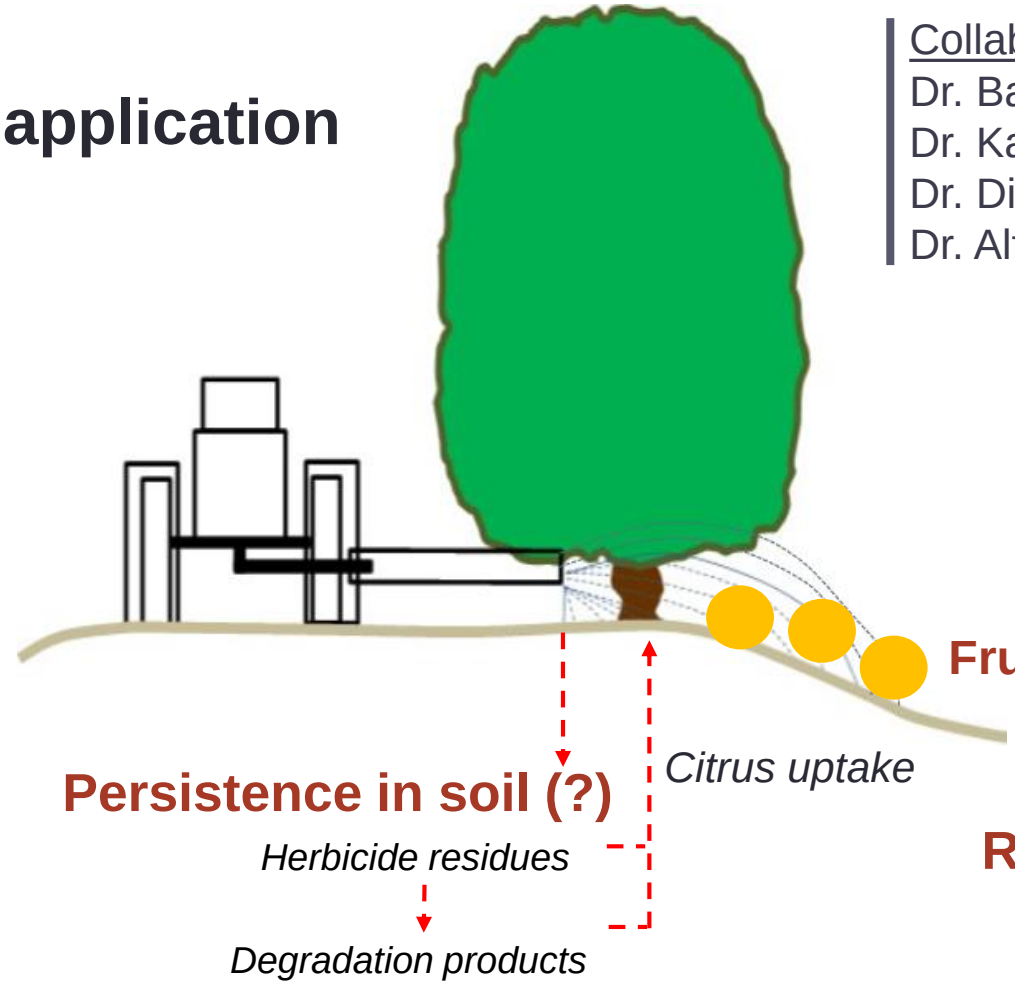
- Competition from weeds



- Replication (n) = 20

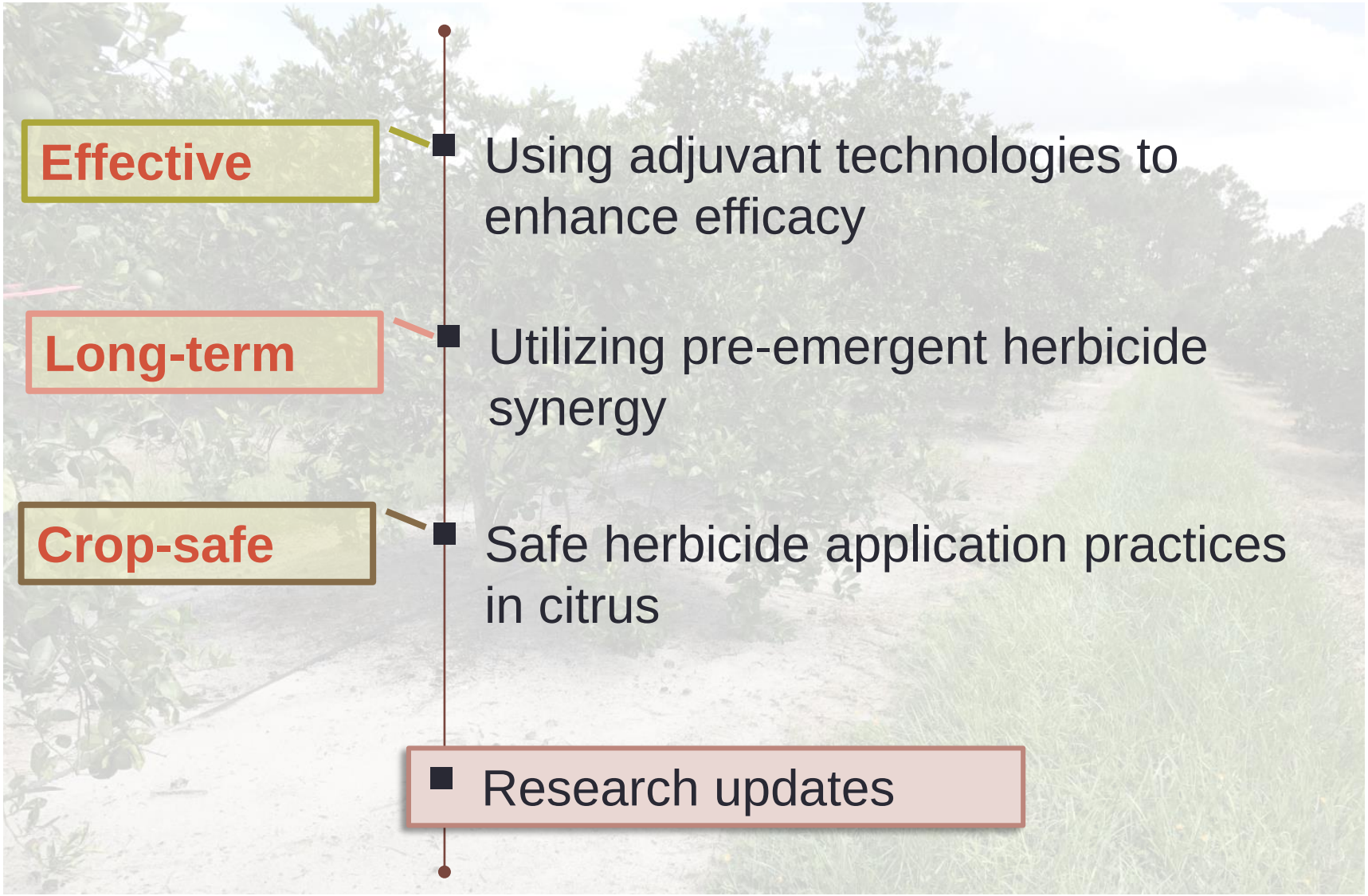
Impacts of herbicides on citrus health and yield

- **Herbicide application**



Collaborators
Dr. Batuman(PATH)
Dr. Kadyampakeni(SWS)
Dr. Dittmar(HOS)
Dr. Alferez(HOS)

Citrus Weed Management



SWFREC Weed Science Projects

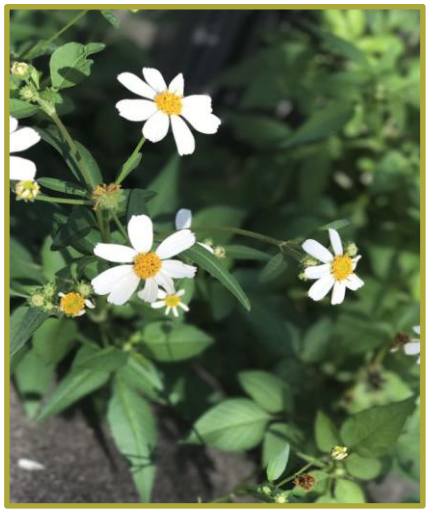
- Study the feeding behavior of psyllids on citrus weeds

Collaborator
Dr. Justin George (USDA – Fort pierce)

- Can psyllids use weeds in citrus groves as alternate feeding sources for survival ?
- Can weeds act as host plants for CLas infected psyllids ?

Psyllids on citrus weeds

Weeds currently tested

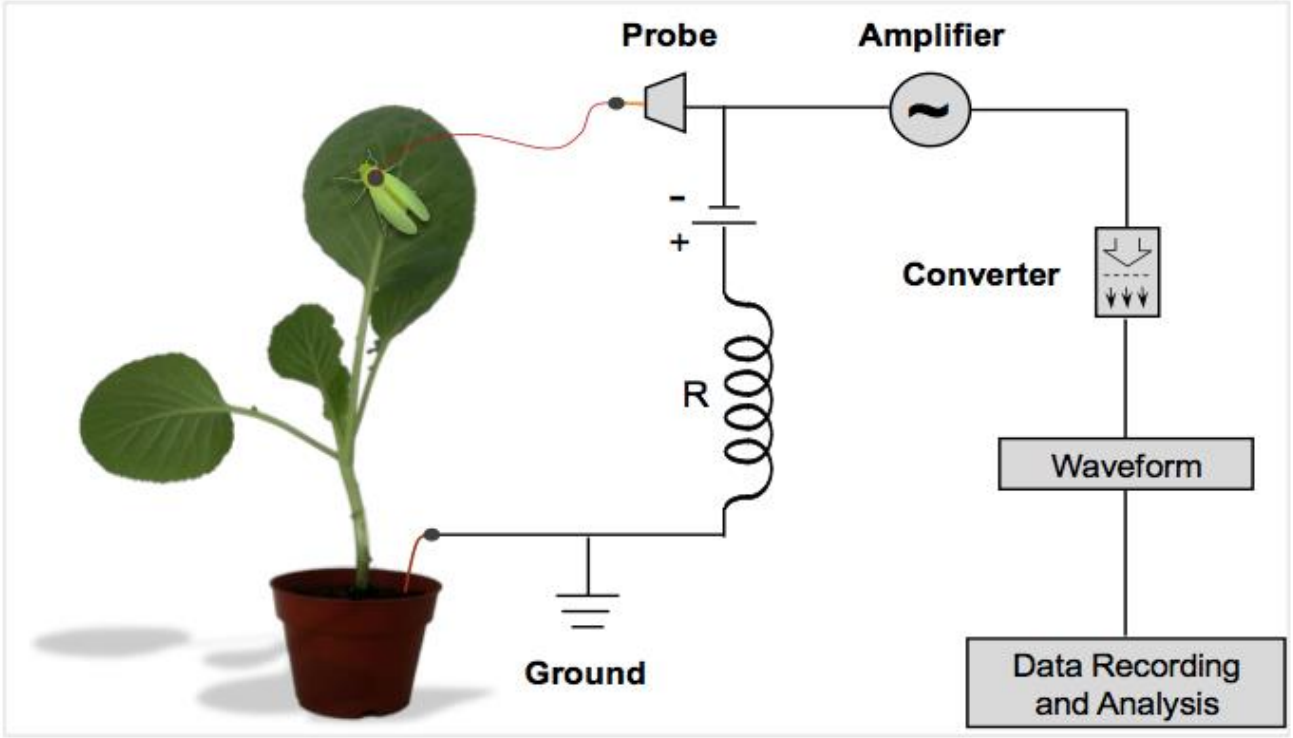


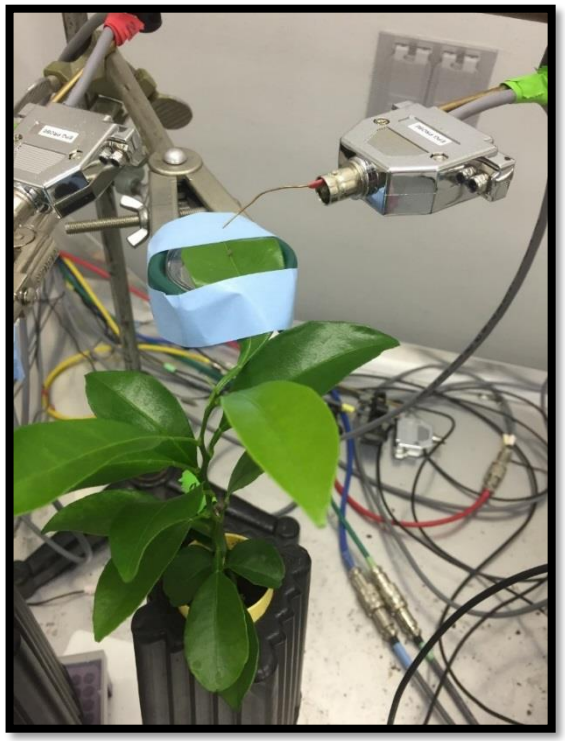
Spanish needle
Bidens alba

Dog fennel
Eupatorium capillifolium

Primrose
Ludvigia octovalvis

Psyllids on citrus weeds





- Electrical Penetration Graph (EPG) technology - *to study the feeding behavior of psyllids on weeds in citrus*
- Xylem vs phloem feeding behavior in weeds

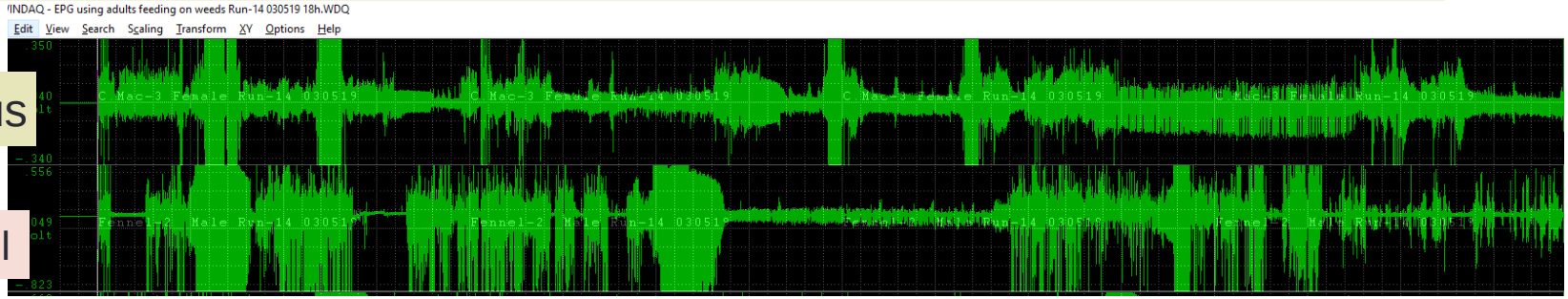
Electrical Penetration graph recording set up

Psyllid adult feeding on Primrose

EPG recordings on leaves of citrus, Dog fennel, Primrose and Spanish needle

Citrus

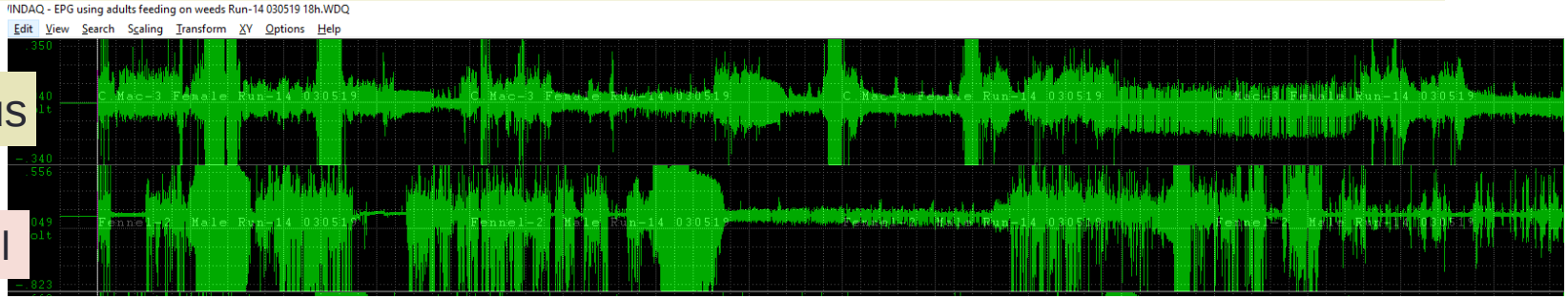
Dog fennel



EPG recordings on leaves of citrus, Dog fennel, Primrose and Spanish needle

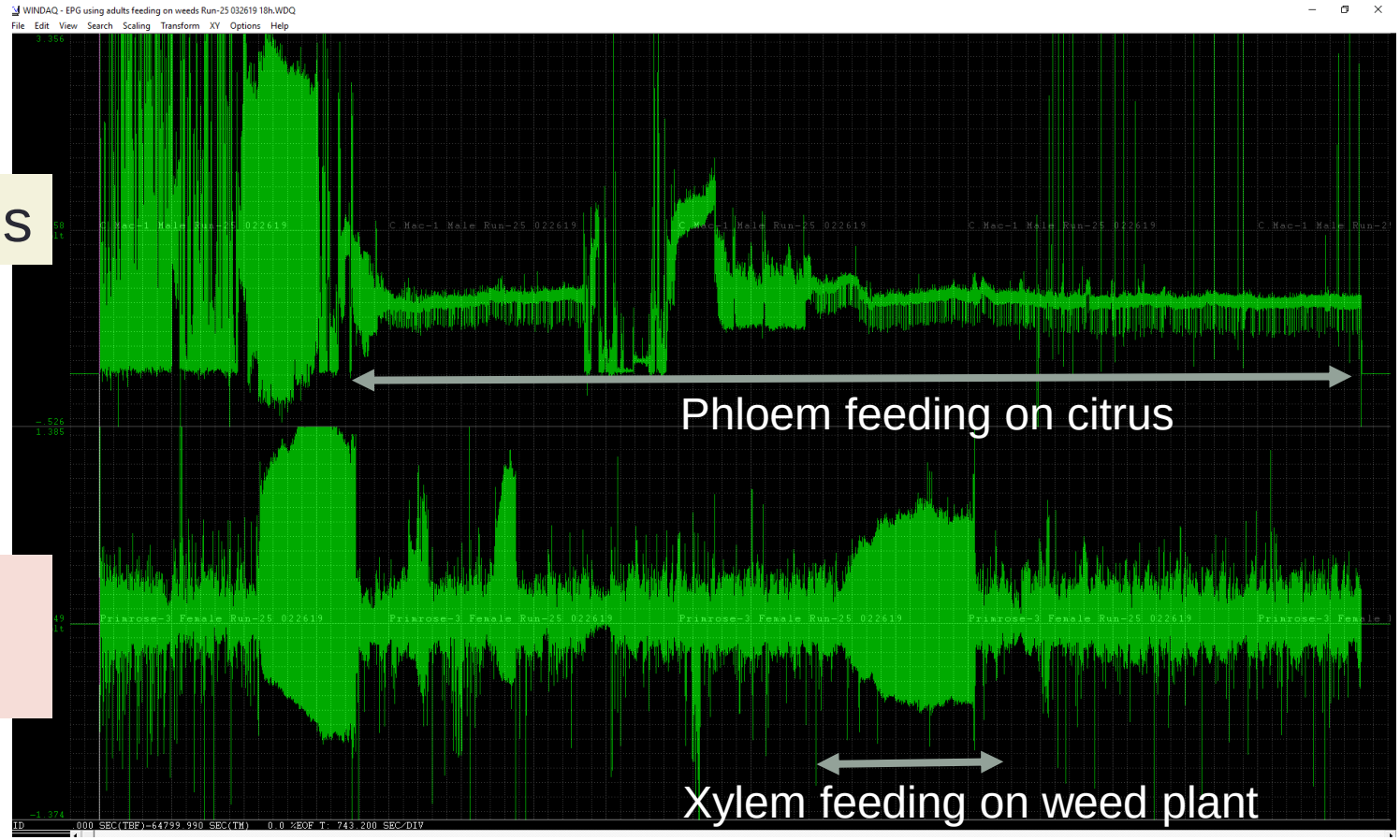
Citrus

Dog fennel



Citrus

Primrose weed



Psyllids on citrus weeds - EPG study

- Psyllids do extensive xylem feeding on weeds tested
- Xylem feeding is enough for psyllid adult survival
- NO phloem feeding observed so far on the weeds tested
- Psyllids may be potentially able to use weeds as alternate feeding sources during insecticide spray applications

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> "Weed management is important in citrus groves"

“Weed management is important in citrus groves”

Spanish needle

Dog fennel

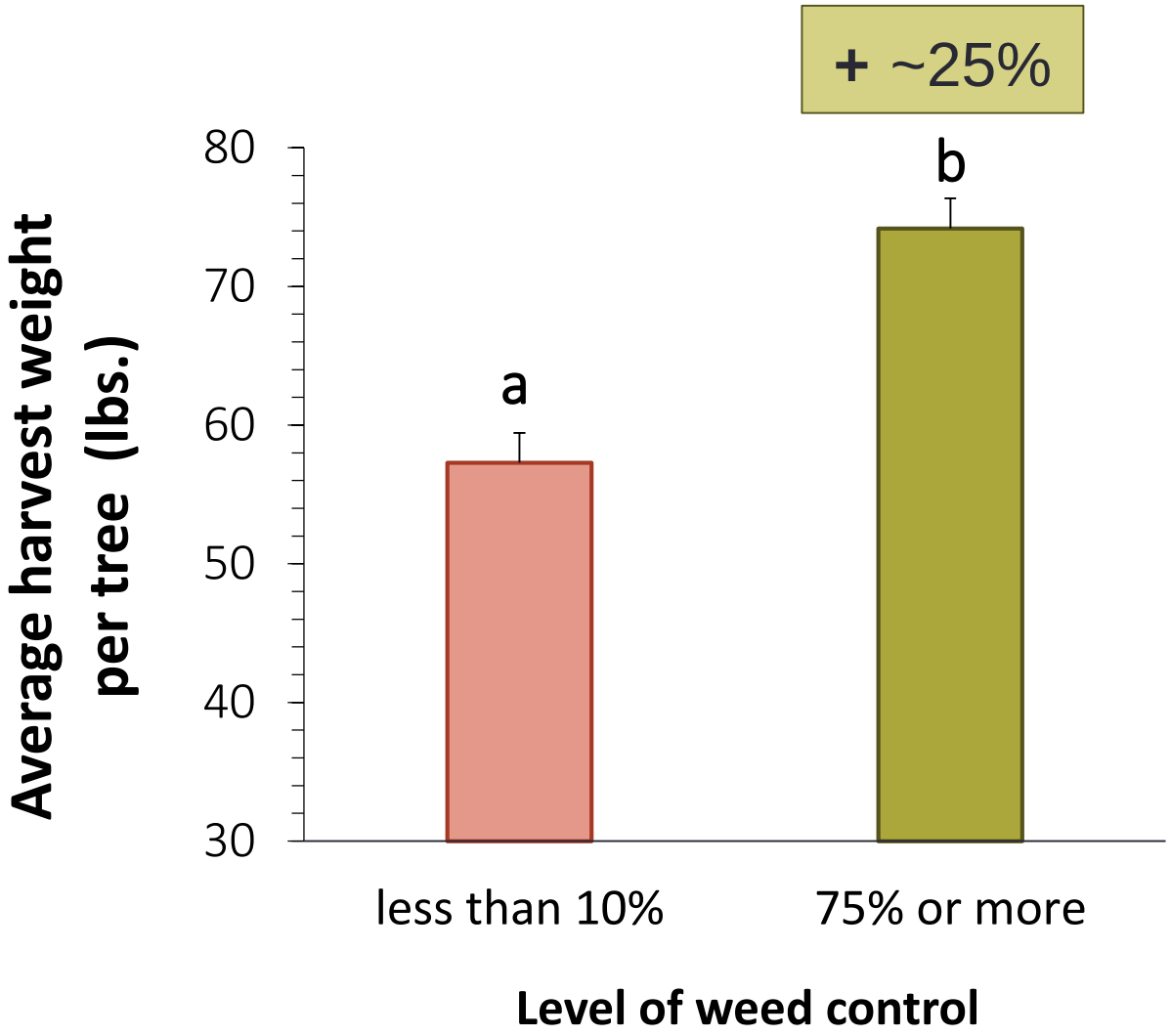
Primrose

“Weed management is important in citrus groves”

- Weeds can potentially become alternate feeding sources for psyllids

“Weed management is important in citrus groves”

- Competition from weeds can impact yield



- Replication (n) = 20
- Mean comparison: Tukey’s hsd ($p < 0.05$)

Summary

Summary: Citrus weed management

- **Enhancing spray efficacy**
  - *POST sprays before flowering/seeding*
  - *Coverage - Spray volume ; surfactants*
- **PRE-herbicide combinations**
  - *Longer term weed control*
  - *Understand the soil type and location*
- **Crop-Safe herbicide application**
  - *Avoid spray contact with foliage & fruits*
- **Research updates**
  - *Weeds – possible alternate food source for psyllids*

Thank you…

SWFREC weed science team

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

In set: ***Cami McAvoy, Maria Martinez, Budji Toussaint***

Contact

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