



# Broomrape research update

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# Broomrape

- A genus of >200 parasitic herbaceous plants
  - *Orobanche* spp (aka *Phelipanche* spp).
- Broomrapes are root parasites (attach below ground)
- Holoparasites = derives all carbon from a host plant
- Plants lack chlorophyll
  - Usually yellow- or straw-colored
- Some broomrapes have narrow host range, but others have a much wider host range
- At high density, can greatly reduce yield or even result in crop failure

# Broomrape in California

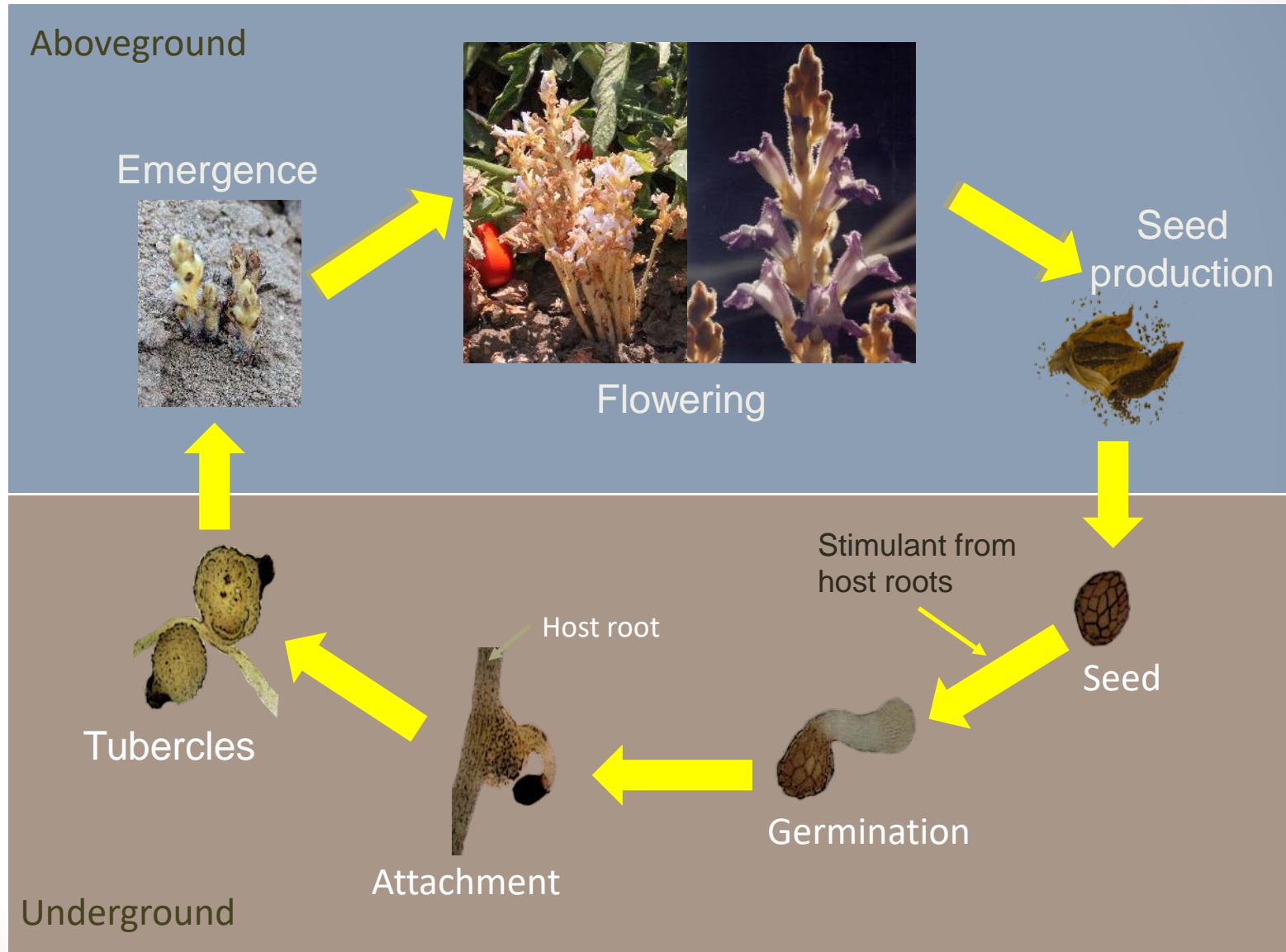
- At least two species have been detected in CA tomato fields
  - Branched broomrape (*Orobanche ramosa*) - “A-listed”
  - Egyptian broomrape (*Orobanche aegyptiaca*) – “Q-listed”
    - First report in North America – Solano Co. in 2014
- Branched broomrape has been reported on-and-off for several decades in CA
- Egyptian broomrape has a wider host range (~23 crops grown in CA!) and may be an even more serious risk
  - Potential for non-crop risks too

The screenshot shows the California Pest Rating website for Egyptian Broomrape (*Orobanche aegyptiaca*). The page is titled "EGYPTIAN BROOMRAPE | OROBANCHE AEGYPTIACA PERS." and includes a search bar, navigation links, and a detailed pest rating profile. The profile section includes the following information:

- California Pest Rating for:** Egyptian broomrape | *Orobanche aegyptiaca* Pers.
- Lamiales; Orobanchaceae**
- Pest Rating: A | Proposed Seed Rating: P**
- PEST RATING PROFILE**
- Initiating Event:** Egyptian broomrape was found for the first time in North America in Solano County, California in July, 2014.
- History & Status:** Egyptian broomrapes are annual plants that grow from seed and require a host to survive. They are a parasitic plants that grow on the roots of Broad-leaf hosts and obtain all of their nutrients and water from these plants. As such, they can seriously reduce the yield of infested crops. Seeds germinate in response to chemicals released by host plant roots. The broomrape seedling root then attaches itself to the host plant root and remains underground until flowering. The plant has no chlorophyll and no photosynthetic leaves. Flowering stems emerge about 6 weeks after germination, then flower and begin to set seed within 7-8 weeks. Seed plants die and rot within 1-2 weeks.

The right sidebar contains links to various resources, including "Insects, Mites & Earthworms", "Nematodes", "Plant Pathogens", "Snails and Slugs", "Vertebrate Pests", "Weeds", "Image Credits", "DOCUMENTS", and "RESOURCES".

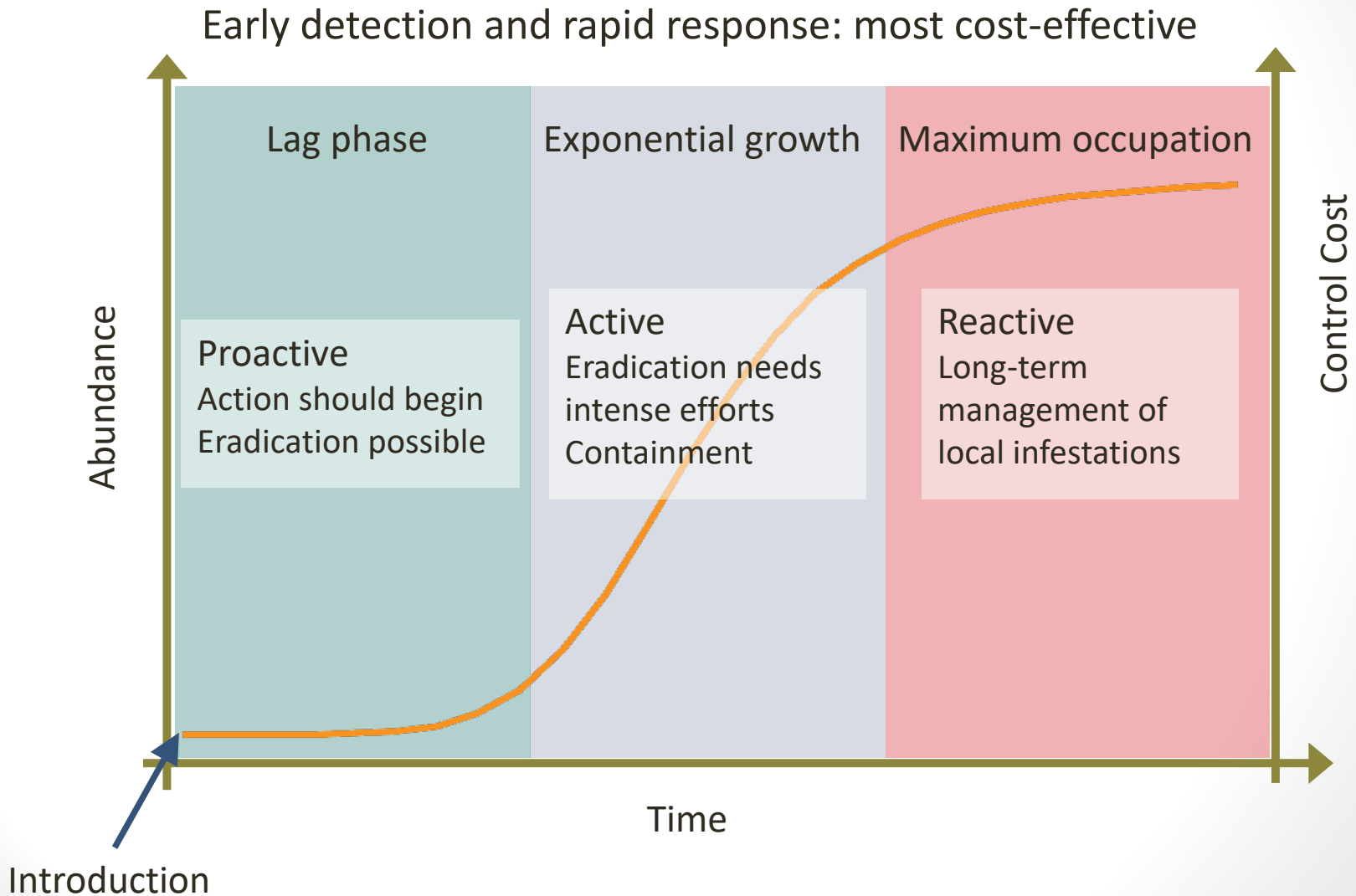
# Lifecycle







# Phases of Invasion:





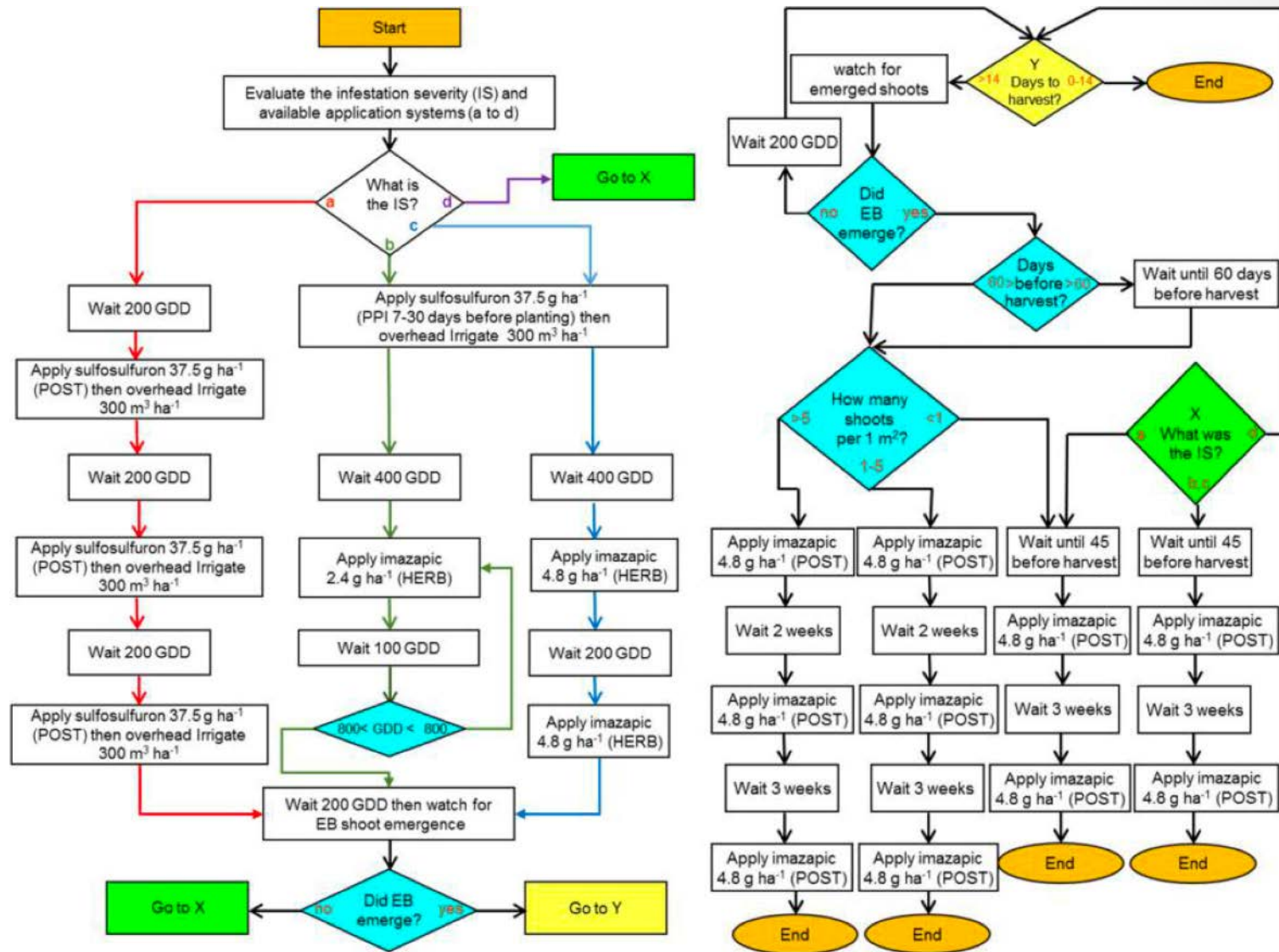
# Current management plan in CA

- Scouting, reporting, quarantine, crop destruct...
- We do not currently have data on suppression/control of branched or Egyptian broomrape with CA-registered pesticides
  - Both species have been detected in conventional processing tomato fields; suggests little (or incomplete) efficacy of registered herbicide programs
  - Quarantine treatments are based on soil fumigation
- Minimizing spread will be key in the short-term
- Will need to develop mitigation approaches for our systems

# Broomrape management elsewhere

- Israeli cooperators have been working on broomrape management for several decades
  - Eizenberg, Goldwasser, and others
- Weed is not eradicated, but is managed to an acceptable level
  - Management is based on carefully-timed and –placed herbicides to disrupt key broomrape life stages
  - Uses a Decision Support System known as PICKIT
    - Sequential herbicide treatments applied based on growing degree day modeling
    - Takes into account severity of the broomrape infestation

# PICKIT: a Decision Support System for Egyptian Broomrape Management



Success with PICKIT: \$4,731/ha increase in net revenue



# Ongoing/planned research

- Herbicide approaches
  - Based on Israeli-developed PICKIT system
  - Will need efficacy and crop safety data under CA production systems to facilitate registration
- Modeling species/system
  - Confirm and fine-tune thermal time modeling for decision-support
- Evaluation of soil disinfestation approaches
  - Fumigants, biosolarization, etc.
- Detection and identification
  - Sensor technologies
- Equipment sanitation approaches





## Crop Safety Studies

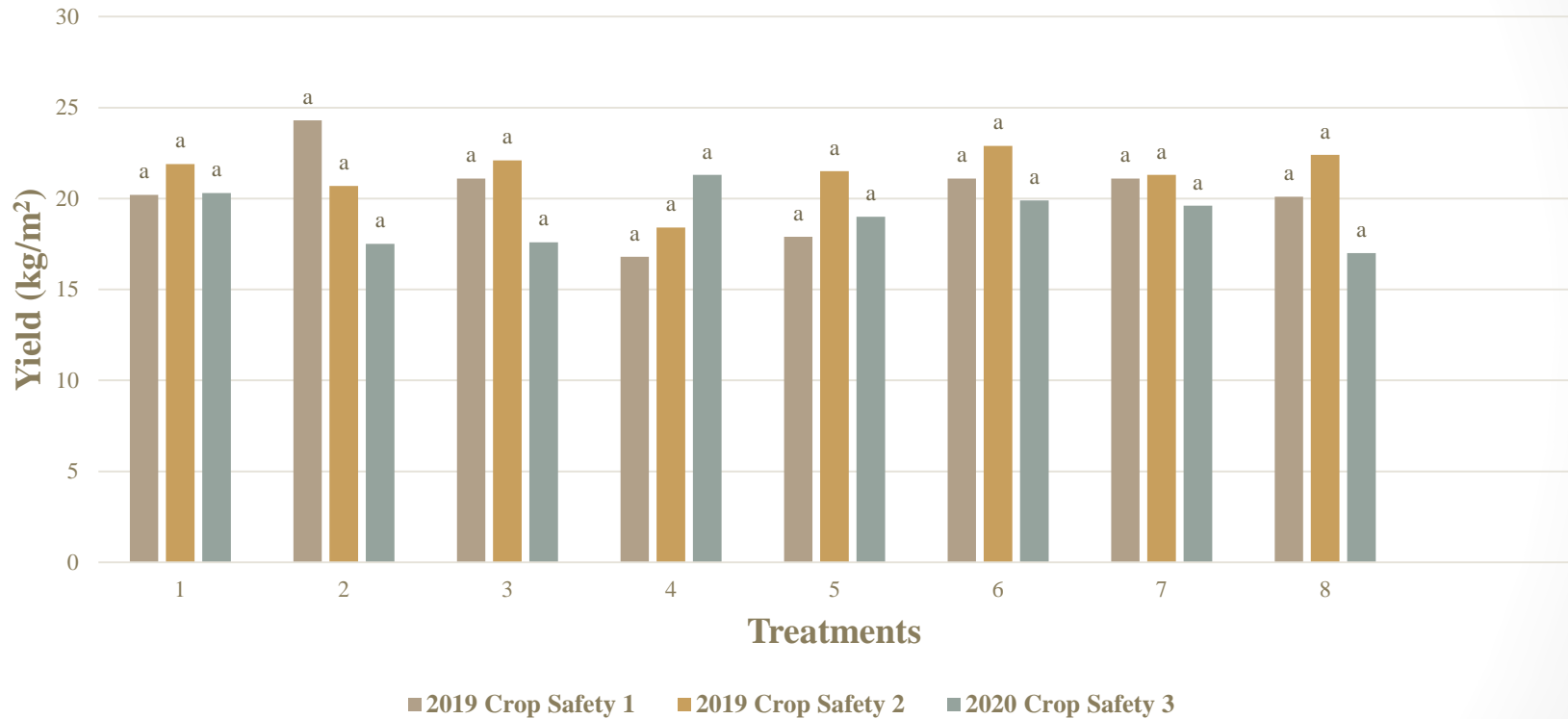
- 8 treatments
- 4 replications
- RCBD
- ‘Heinz 1662’ mechanically transplanted on 12 inch spacing
- Crop Safety 1: Planting May 2, 2019, Harvest September 4, 2019
- Crop Safety 2 Planting May 30, 2019, Harvest September 19, 2019
- Crop Safety 3 Planting April 22, 2020, Harvest September 3, 2020



2019/2020 Crop Safety Treatments					
Treatment No.	Treatment	Rate	Rate	Application	GDD Appl.
		(lbs. ai/ac)	(g ai/ha)		
1	Untreated Check				
2	Untreated Check 2**				
3	Sulfosulfuron (Outrider)	0.031	35	PPI	
	Imazapic (Cadre)	0.004	4.8	CHEM x5	400, 500, 600,700,800
4	Sulfosulfuron (Outrider)	0.031	35	PPI	
	Imazapic (Cadre)	0.004	4.8	CHEM x2	400, 600
5	Imazapic (Cadre)	0.002	2.4	POST	
6	Sulfosulfuron (Outrider)	0.062	70	PPI	
	Imazapic (Cadre)	0.008	9.6	CHEM x5	400, 500, 600,700,800
7	Sulfosulfuron (Outrider)	0.062	70	PPI	
	Imazapic (Cadre)	0.008	9.6	CHEM x2	400, 600
8	Imazapic (Cadre)	0.004	4.8	POST	

\*\* Treatment 2 was a placeholder for a commercial standard PRE tank mix that was not applied in the 2020 experiment. \*\*\* The entire field was treated with 32 fl oz/ac s-metolachlor (Dual Magnum) and 16 fl oz/ac trifluralin (Treflan).

## PICKIT crop safety studies yield data across eight treatments from 2019/2020 field trials





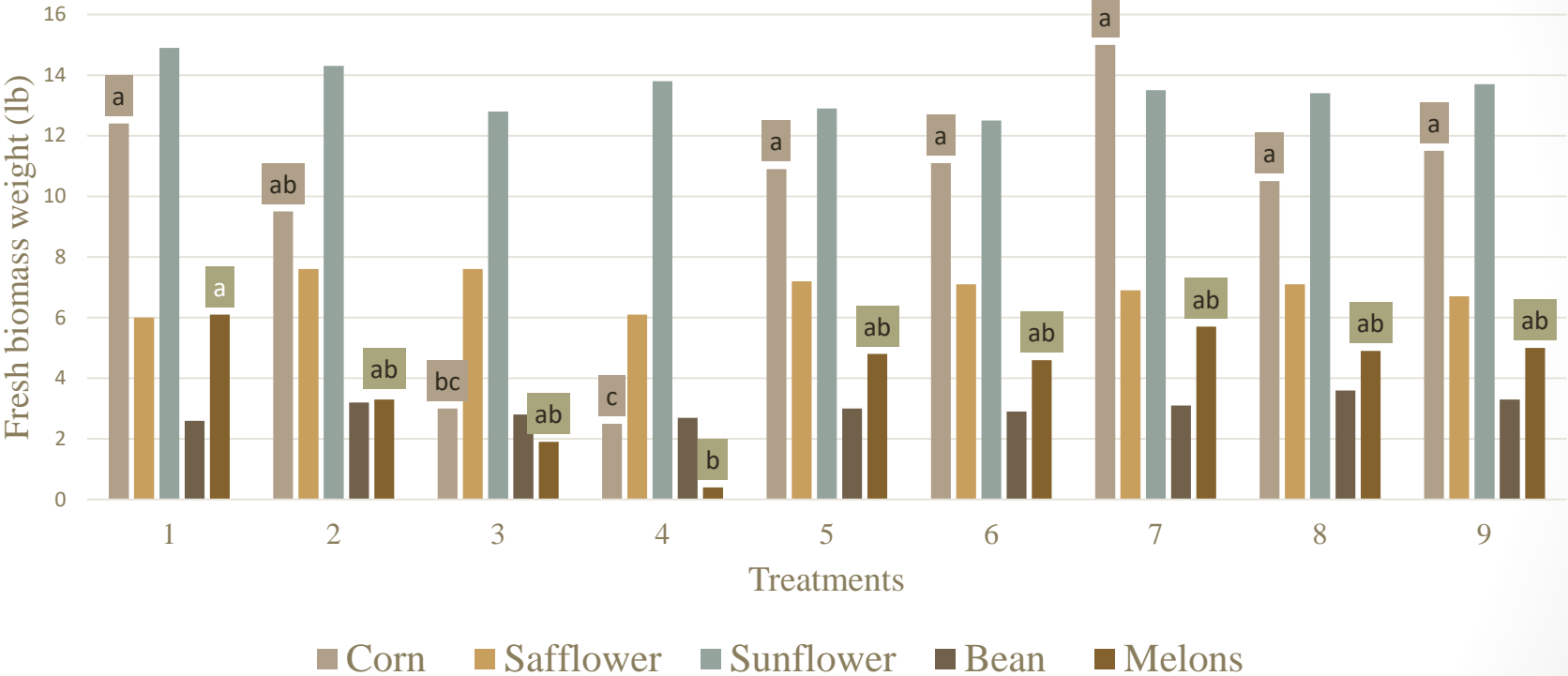
# Rotational Crop Study

- 9 treatments
- Modified split plot design
- Treatments applied summer 2019 on tomato crop
- Rotational crops planted spring 2020 (wheat fall 2019)
- Wheat\*, Melons, Beans, Corn, Safflower, Sunflower
- Fresh biomass, height, visual injury data\*

## 2019/2020 Rotational Crop Treatments and Application Timing

<b>Treatment Number</b>	<b>Treatment Name</b>	<b>Rate</b>	<b>Application</b>	<b>GDD Appl.</b>
<b>1</b>	Check	na	na	na
<b>2</b>	Sulfosulfuron 0.5X	18.75 g ai/ha	PPI	na
<b>3</b>	Sulfosulfuron 1X	37.5 g ai/ha	PPI	na
<b>4</b>	Sulfosulfuron 2X	70 g ai/ha	PPI	na
<b>5</b>	Imazapic 1X	4.8 g ai/ha	CHEMx5	400,500,600,700,800
<b>6</b>	Imazapic 2X	9.6 g ai/ha	CHEMx5	400,500,600,700,800
<b>7</b>	Imazamox 2X	9.6 g ai/ha	CHEMx5	400,500,600,700,800
<b>8</b>	Imazapyr 2X	9.6 g ai/ha	CHEMx5	400,500,600,700,800
<b>9</b>	Imazethapyr 2X	9.6 g ai/ha	CHEMx5	400,500,600,700,800

# Rotational crop study fresh biomass across nine treatments and five crops



# Results

- Treatments 3 and 4 (Sulfosulfuron 1x and 2X) presenting stunting and chlorosis on corn
- Differences in melon biomass was likely due to weed pressure and non-treatment herbicide treatment



# 2020 efficacy study



## 2020 PICKIT Efficacy Study Treatment and Application Timing, Woodland, CA

Trt. No	Treatment	Rate oz ai/a	Rate g ai/ha	Application	GDD Appl.*
1	Untreated Check	--	--		
2	Treflan	3 pt/A		PPI	
	Matrix	1 oz wt/A		PPI	
3	Sulfosulfuron (Outrider)	0.535	37.5	PPI	
	Imazapic (Cadre)	0.0685	4.8	CHEM x5	400, 500, 600, 700, 800
4	Sulfosulfuron (Outrider)	0.535	37.5	PPI	
	Imazapic (Cadre)	0.0685	4.8	CHEM x2	400, 600
5	Imazapic (Cadre)	0.0343	2.4	POSTx2	
6	Sulfosulfuron (Outrider)	0.535	70	PPI	
	Imazapic (Cadre)	0.137	9.6	CHEM x5	400, 500, 600, 700, 800
7	Sulfosulfuron (Outrider)	1	70	PPI	
	Imazapic (Cadre)	0.137	9.6	CHEM x2	400, 600
8	Imazapic (Cadre)	0.0685	4.8	POSTx2	
9	Sulfosulfuron (Outrider)	0.535	37.5	PPI	
	Imazamox (Raptor)	0.0685	4.8	CHEM x5	400, 500, 600, 700, 800
10	Sulfosulfuron (Outrider)	0.535	37.5	PPI	
	Imazapyr (Habitat)	0.0685	4.8	CHEM x5	400, 500, 600, 700, 800
11	Sulfosulfuron (Outrider)	0.535	37.5	PPI	
	Imazethapyr (Pursuit)	0.0685	4.8	CHEM x5	400, 500, 600, 700, 800
12	Rimsulfuron (Matrix)	2 oz wt/A		POST	

\* PPI: preplant incorporated POST: post emergence CHEM: Chemigated. Cumulative Growing Degree Days (GDD) were calculated after tomato transplanting date by using the formula  $GDD = \sum(\bar{T} - T_b)$ , where  $\bar{T}$  is mean daily temperature and  $T_b$  is the base temperature set at 10 °C (50 degrees Fahrenheit).

\*\* The entire experimental area was treated with the grower's preplant incorporated herbicide program of S-metolachlor (2pt/ac), pendimethalin (1pt/ac), metribuzin (1pt/ac), and diazinon (1gal/ac) and also with a post-transplant application of 2.5 oz /ac Matrix.

# Broomrape Scouting





May 29, 2020



June 3, 2020



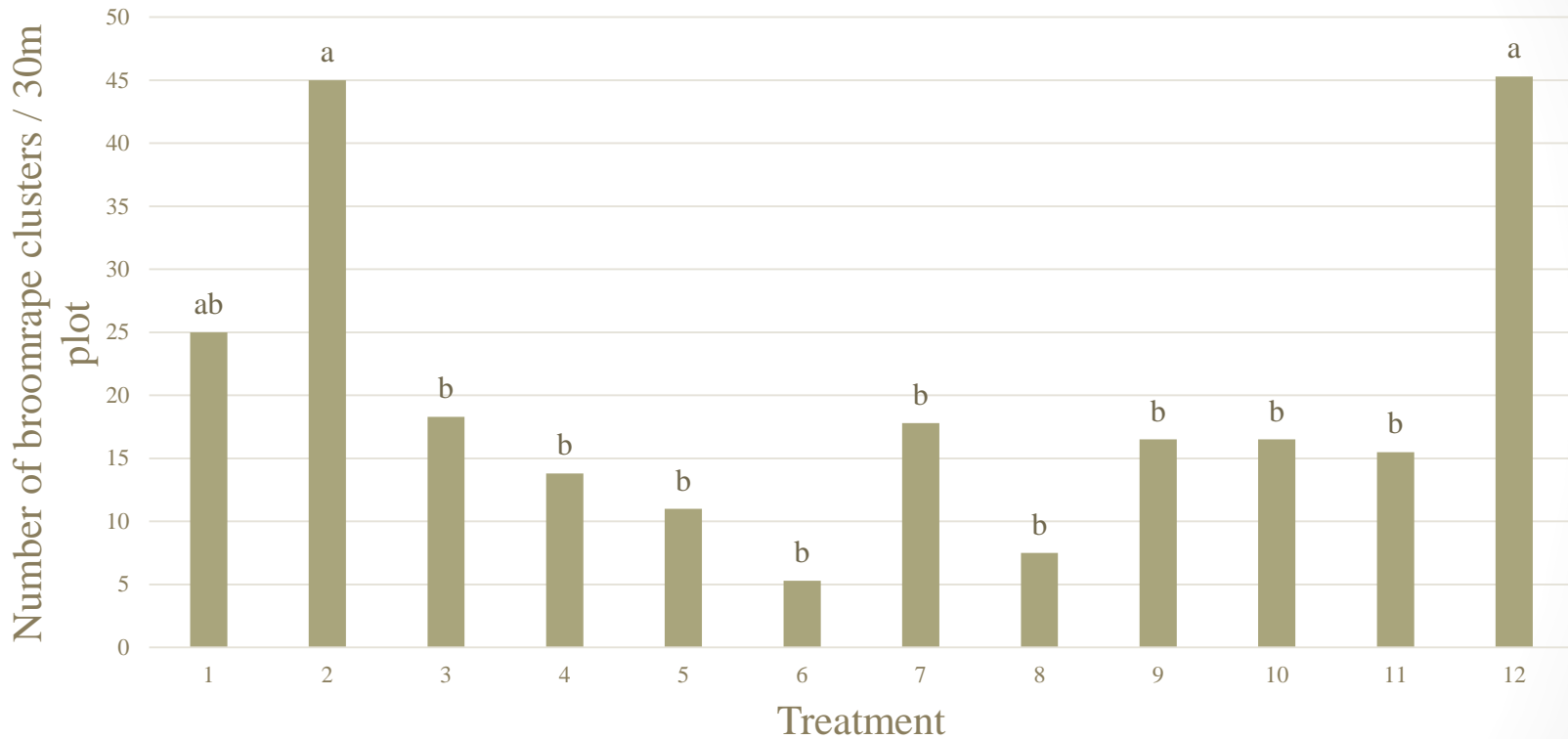
July 1, 2020



August 3, 2020



## Cumulative broomrape clusters per 100 ft plot, end of season (2020)



Non-PICKIT

Various PICKIT trts (sulfosulfuron + imazapic)

sulfosulfuron + other IMI

\*Field variability. Trts #3 and #6 were expected to be good but Trt #8 really shouldn't have been

# PICKIT program in CA

## Progress

- 2019
  - 2 crop safety trials at UCD
  - Plantback trial (tomato yr)
- 2020
  - 1 crop safety trial at UCD
  - Rotational crop safety eval
  - Efficacy trial in Yolo Co
  - IR4 sulfosulfuron “residue” trials initiated

## Results and Challenges

- Crop safety:
  - appears adequate with sulfosulfuron and imazapic
- Plantback:
  - some rotational crop limitations
- Efficacy:
  - Suppressive, but not amazing
  - Timing/rates need adjustment
- Registration outlook:
  - Sulfosulfuron – feasible
  - Imazapic - unlikely

# Discussion

- What did not work and why?
  - Soil
  - Branched vs. Egyptian phenology
  - GDD
- Imazamox
- Future Research



# PICKIT in 2021

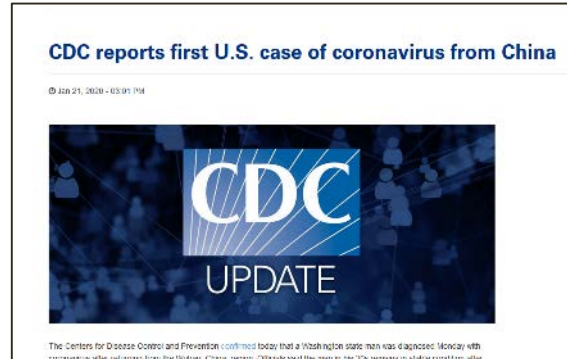
- Plan to pivot focus to imazamox (rather than imazapic)
  - Raptor is registered in CA and has a more favorable pathway to registration
  - Not expected to be as effective as imazapic (at comparable rates)
    - Generally not as soil-active but should have less plantback issues
    - With repeated chemigation, impacts of shorter half-life minimized
- The CA efficacy and crop safety projects will proceed mostly supported by IR-4 and CDFA-SCBG program
- Have initiated a CTRI trial to be conducted by cooperators in Chile
  - Southern hemisphere project allows a “first look” before treatments begin in CA in May 2021
    - Can adjust rates/timing before the CA project begins
- CA field trial (chemigation and fumigation) planned for 2021

# Summary in pictures:

Be aware of this:



Think about it like this:



Don't do this:



- Do this:
  - Be aware
  - Clean equipment (in and out of field)
  - Scout fields
  - Work with your CAC to report and limit spread
  - Protect the CA tomato industry

- Project collaborators
  - CTRI, UCCE, UC Davis, Newe Ya'ar Research Center
  - UC Davis Chile Life Sciences Innovation Center
- Funding sources
  - California Tomato Research Institute
  - USDA-IR4 and CDFA-DPR grants
  - CDFA – Specialty Crop Block Grant funding
- Material support and cooperation
  - Ag Seeds: transplants and transplanting services
  - Grower/cooperator: land, equipment, crop management!



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