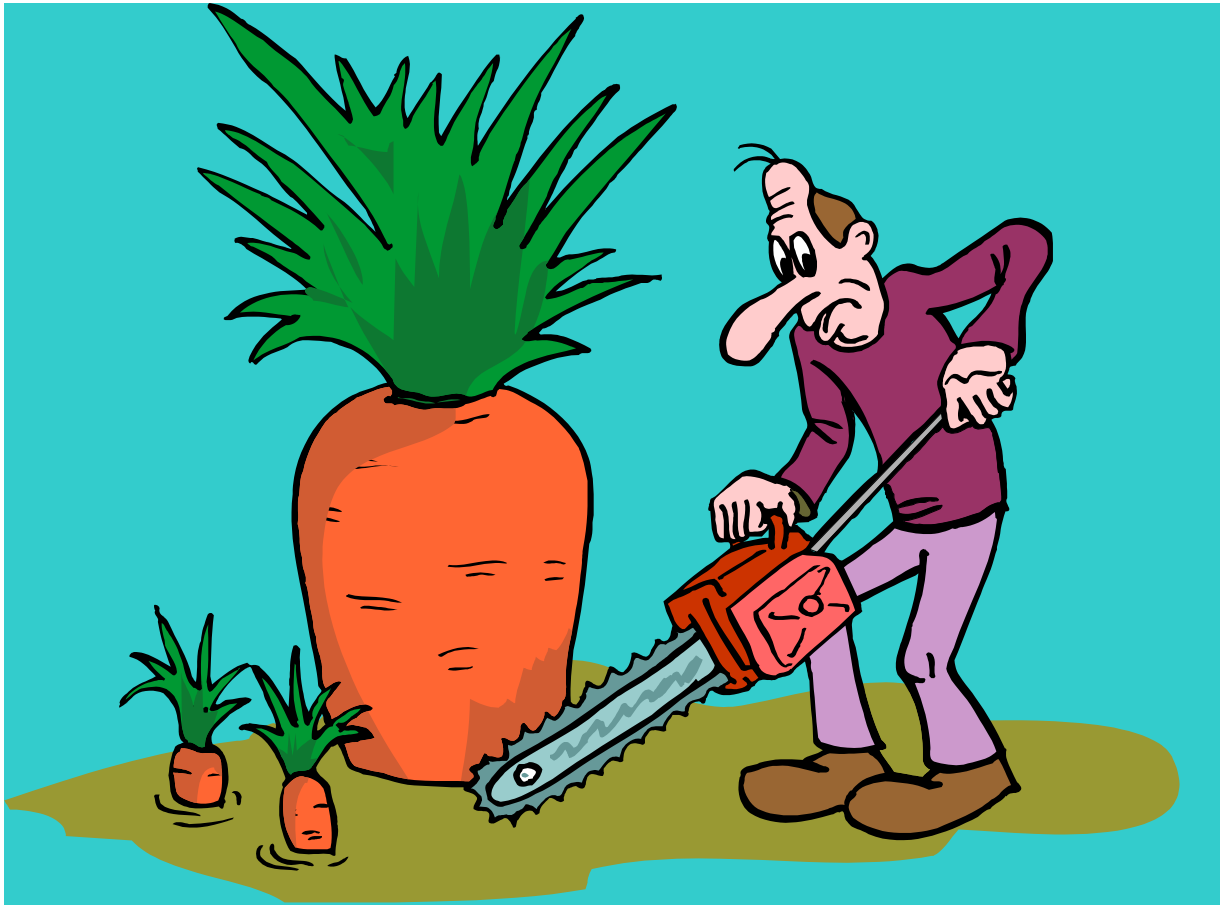
Carrot Production and Pest Management in the Central Valley



Dr. Jaspreet Sidhu
UC Cooperative Extension Farm Advisor (Vegetable Crops),
Kern County

Overview

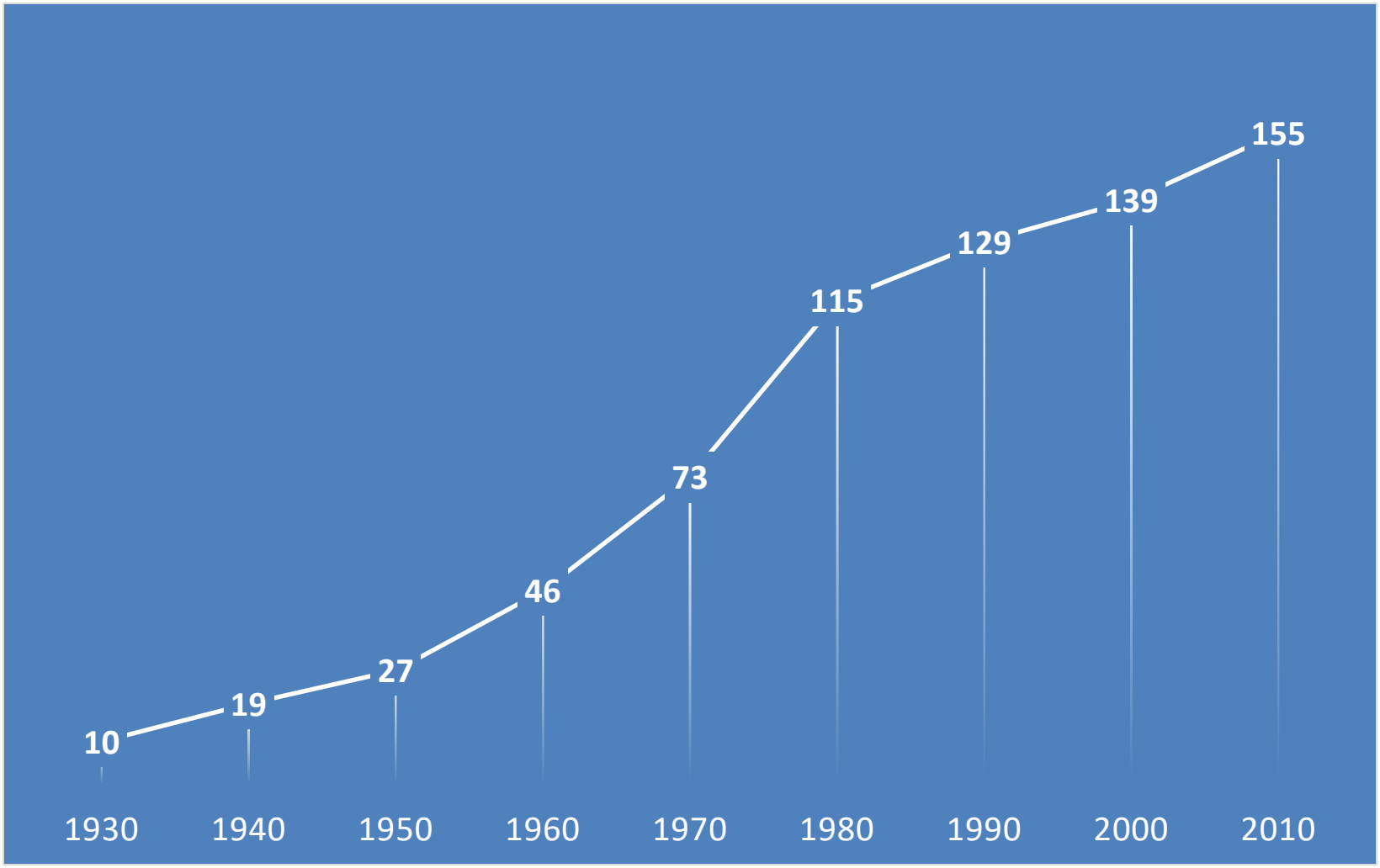
Fun facts and production stats

Carrot production

Pests and diseases

Poll questions

Number of people fed annually by one US farmer

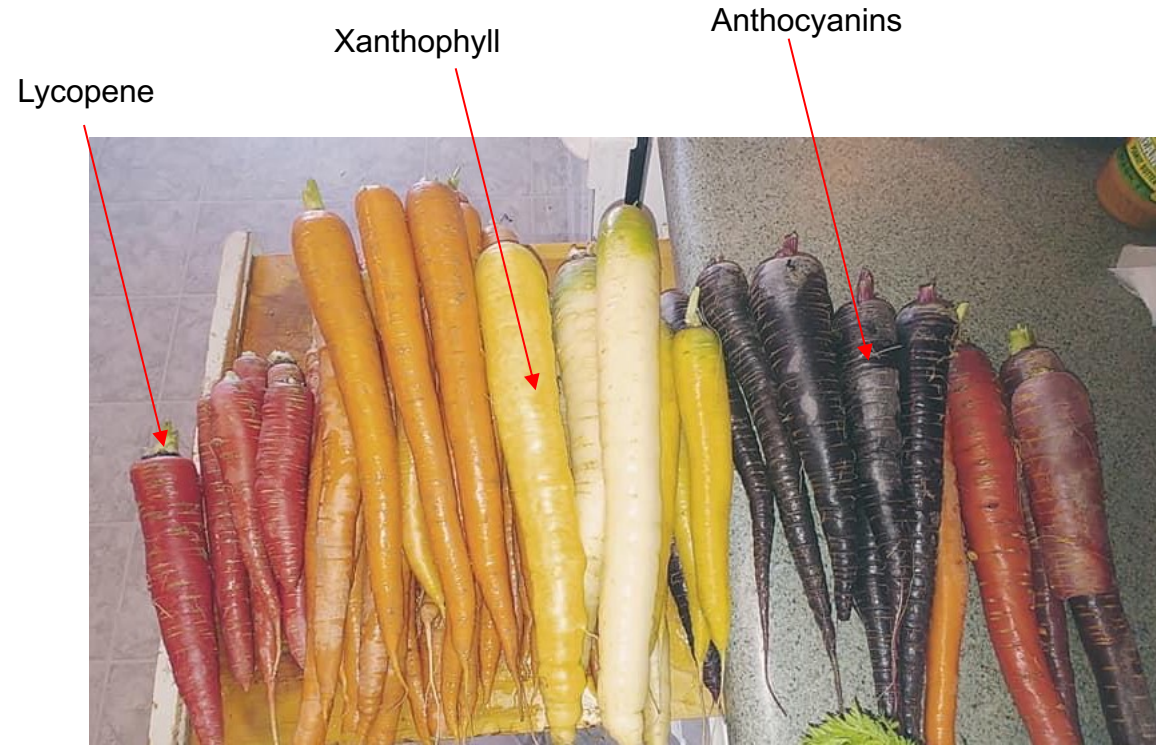


Carrots

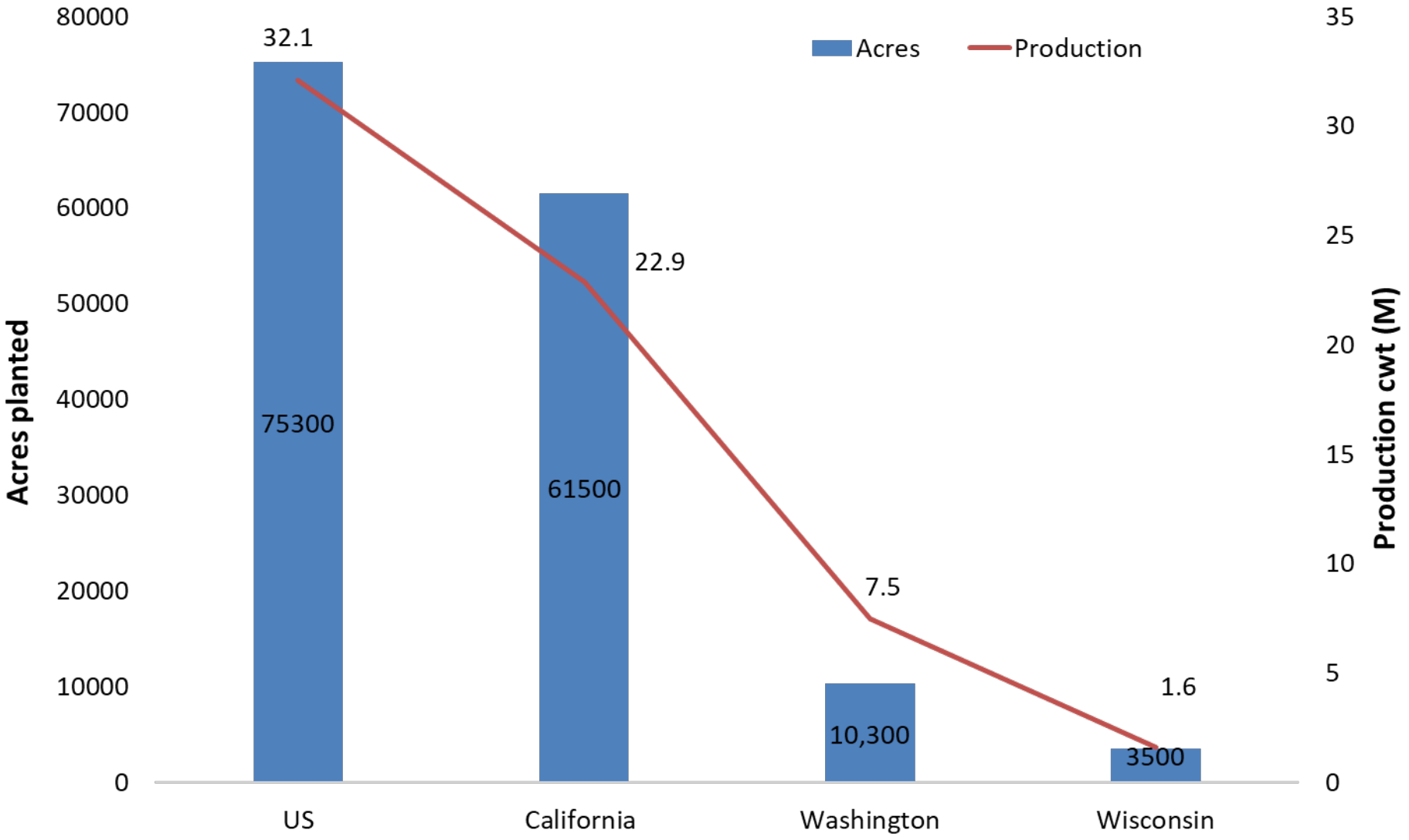
6th most consumed fresh vegetable in the U.S.
8.4 pounds per person in 2022

(Vegetable and Pulses Outlook, 2020)
(USDA ERS, 2022)

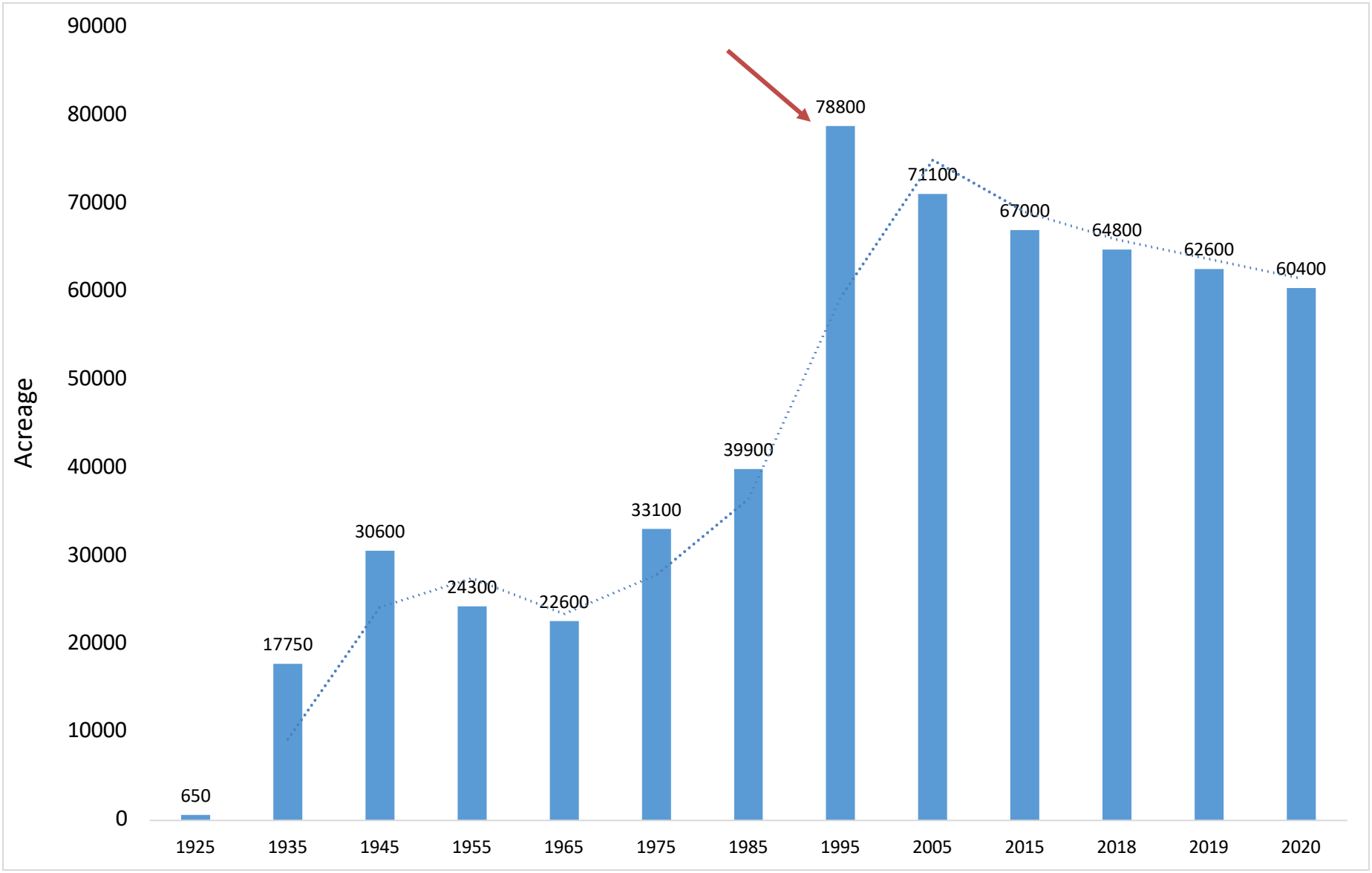
Carotenoids: Alpha and Beta



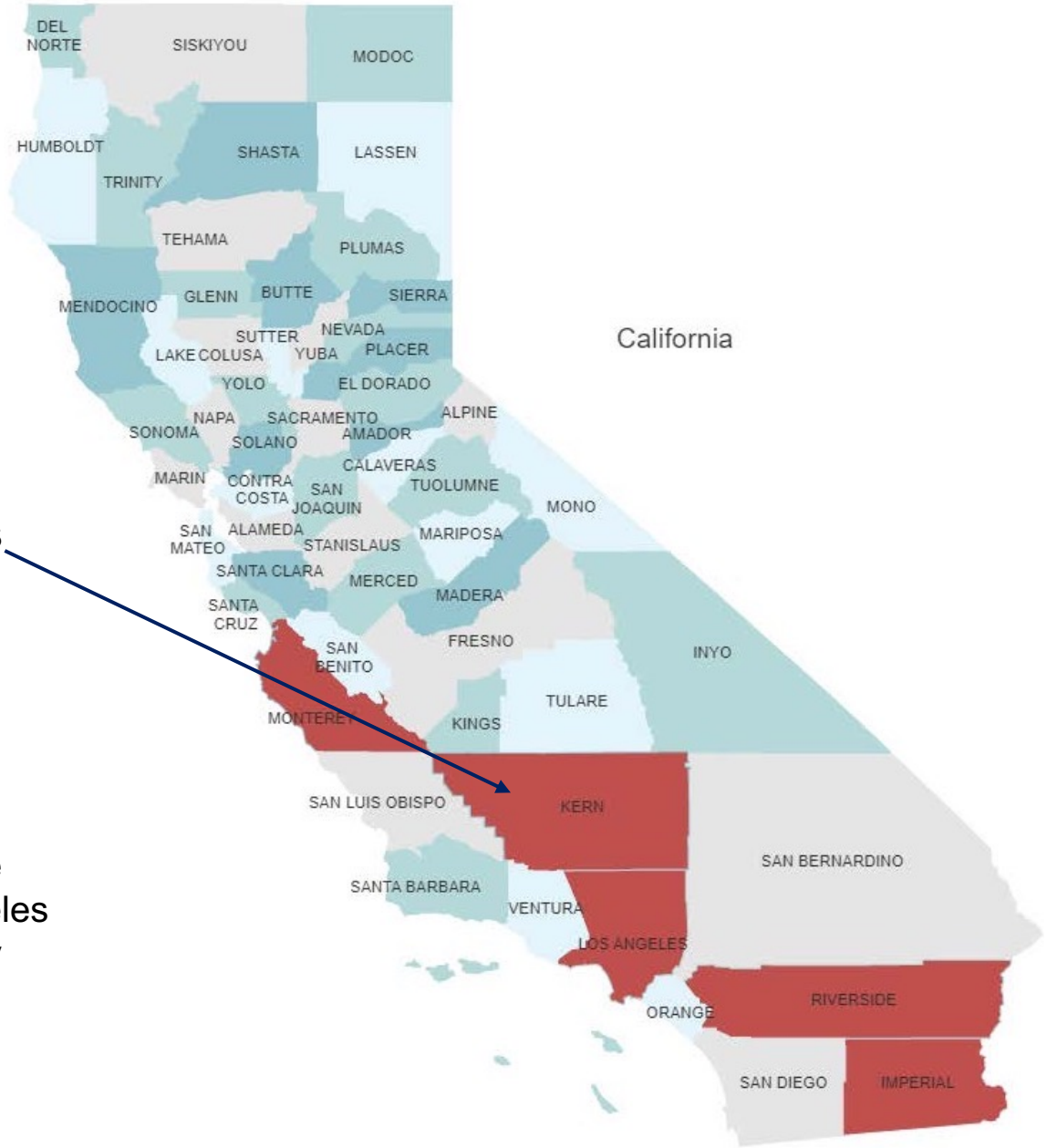
US fresh market carrot production in 2022



California carrot production 1925- current



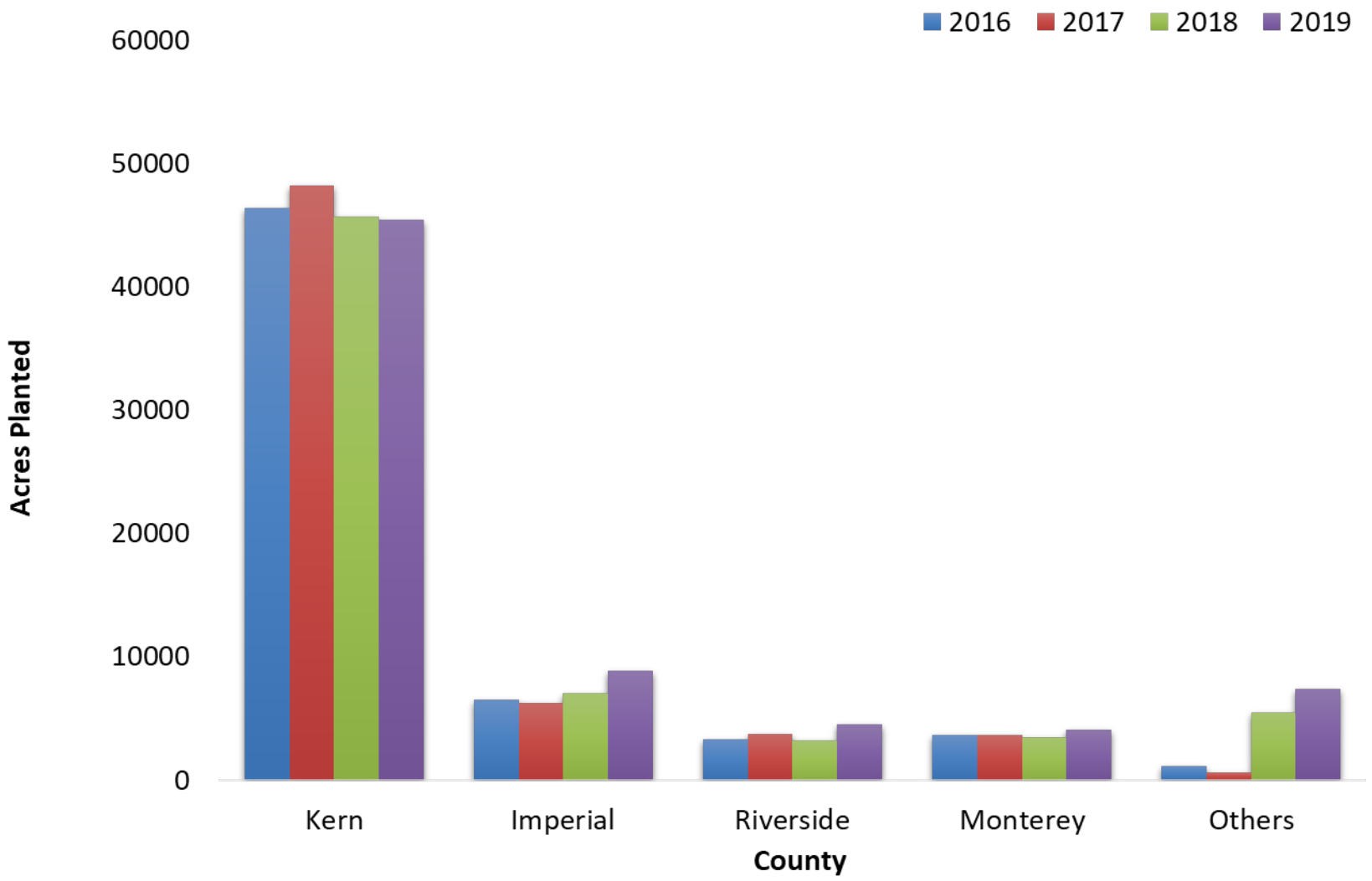
Major Carrot Growing Regions in California



Bolthouse Farms
Grimmway Farms

Kern
Imperial
Riverside
Los Angeles
Monterey

Carrot Production in different counties in California



Carrot Production

Soil sampled for nematode counts and nutrient analysis
Fields treated depending on nematode counts & weed concerns
Compost and soil nutrient added to the soil

Planting

- Beds pulled with a bed lister
- 40” beds
- Direct seeded

Baby carrots:1.3-1.5 million seed/acre

Cello pack carrots: 650,000-750,000 seeds/acre

- Four or six row planter

Carrot planting

5-6 lines per shoulder of the bed

1-1.5” apart

Linuron applied as pre-plant weed control
Mefenoxam applied pre-plant or at emergence for cavity spot

Carrots irrigated daily with solid set sprinklers for germination and growth
Solid set sprinklers also used to apply fertilizers, herbicides etc. (chemigation)

At early/ young stage:

- Fields dried down and cultivated
- Post plant Linuron applied at 2 lb rate
- Fungicides may be applied as a preventive for Alternaria leaf blight and other diseases

Period of Rapid Growth

- Canopy fills in
- Roots bulk in size
- Color develops

General practice

Fields are Scouted routinely on weekly schedules:

-Fungicides applied if needed.

-Additional fungicides may be needed late in season

-Weeds should not be an issue at this stage

Carrot Harvest

Harvested by machine into semi trailers.

Carrot Processing

Major pests and diseases

- Root Knot Nematode
- Cavity Spot
- Alternaria Leaf Blight
- Bacterial Leaf Blight
- Cercospora Leaf Blight
- Powdery Mildew
- Southern Blight *Sclerotium rolfsii*
- White Mold *Sclerotina sclerotiorum, S. minor*
- Black rot
- Soft Rot (Bacteria)

Major pests and diseases

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Root Knot Nematode

Four species of RKN: *Meloidogyne hapla*, *M. incognita*, and *M. javanica* main species in California carrot fields

Symptoms

Carrots: Moderate host

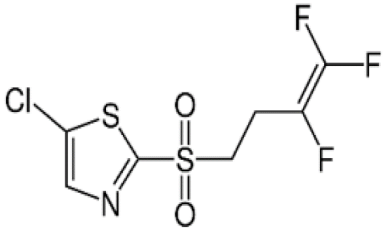
Root symptoms: galling, forking or stubbing
Reduced marketable yields
Stunted/ less vigorous plants
Predisposes to other pathogens

Challenges in management

- Crop rotation: Non-viable
- No resistant cultivars in carrots
- Management relied on pre-plant fumigation
- New fumigant regulations by Department of Pesticide Regulation (DPR)
  - limits the amount used by a grower
  - caps on the amounts allowed in a township
  - expanded buffer zones

Mi gene resistance in tomato cultivars: Breakdown instances

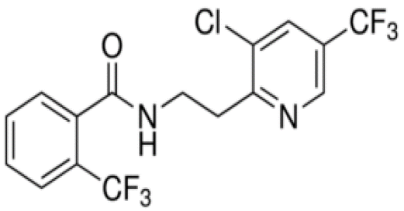
Nimitz (Adama)



Fluensulfone

Caution

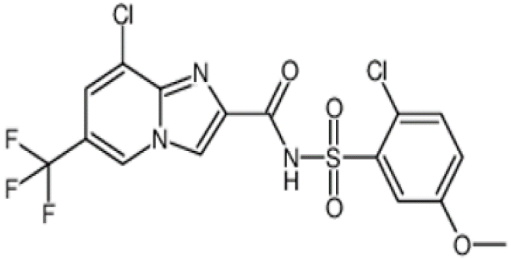
Velum(Bayer)



Fluopyram

Caution

Salibro (Corteva)



Fluazaindolizine

Caution

DP

"?"

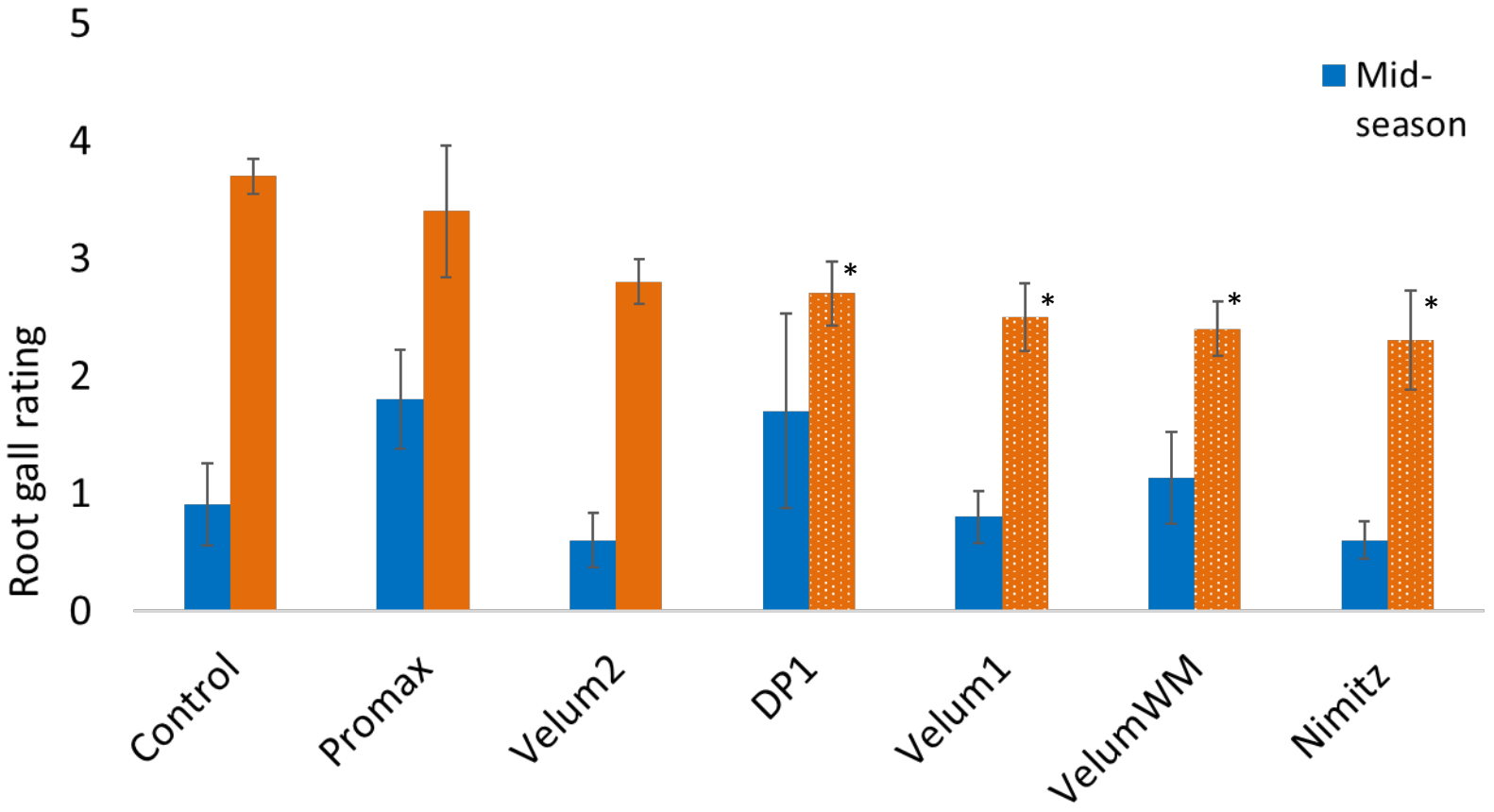
New products are less toxic, more selective, and safer to use – true nematicides

Modes of action – New or unknown

0-10 scale for carrots

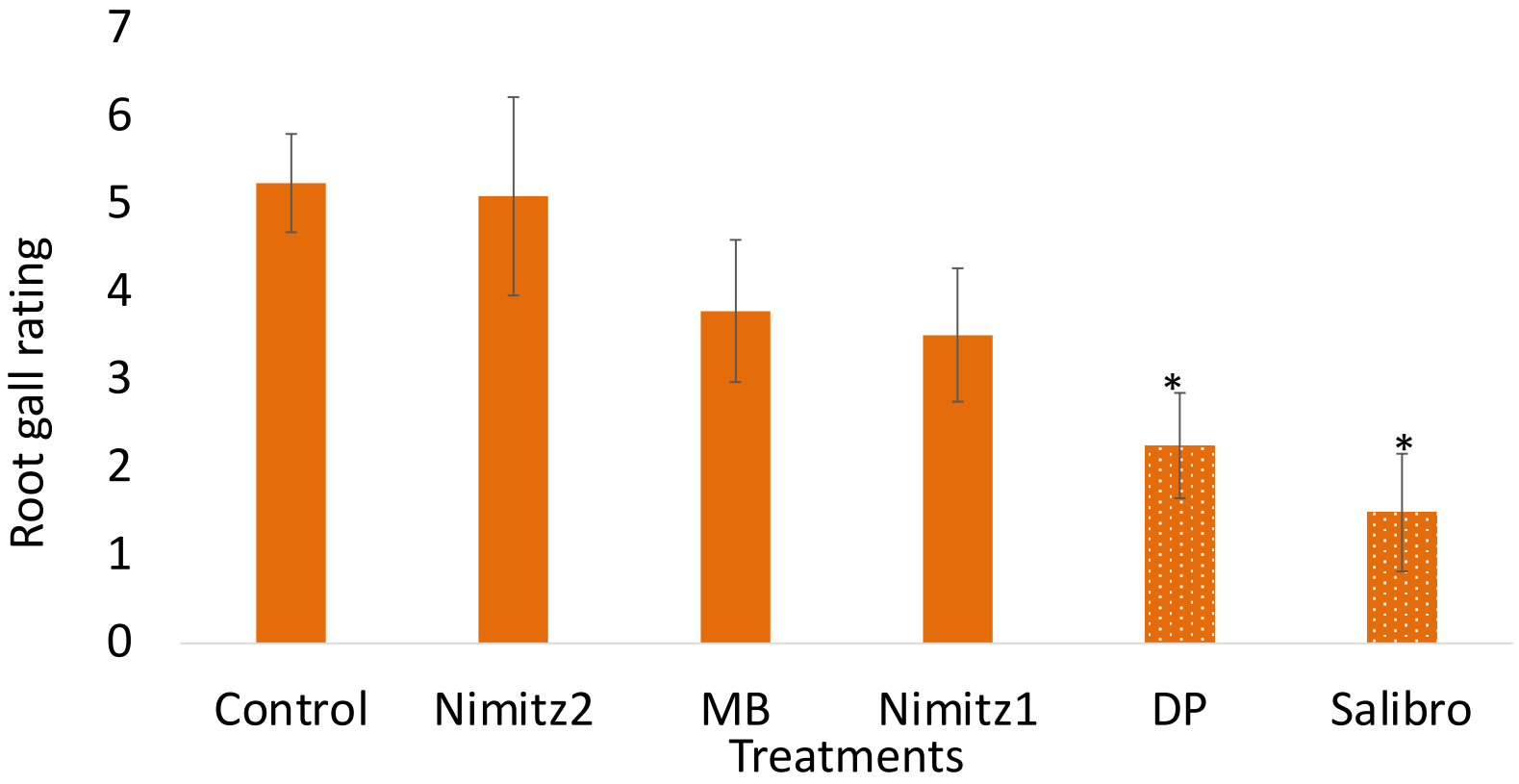
Trials: Shafter Station
Small plot field trials
Data: Root galling

RKN damage on carrot roots 2021



Velum 1: At planting
Velum 2: a week after planting
VelumWM= Velum+ WaterMaxx

RKN damage on carrot roots 2022

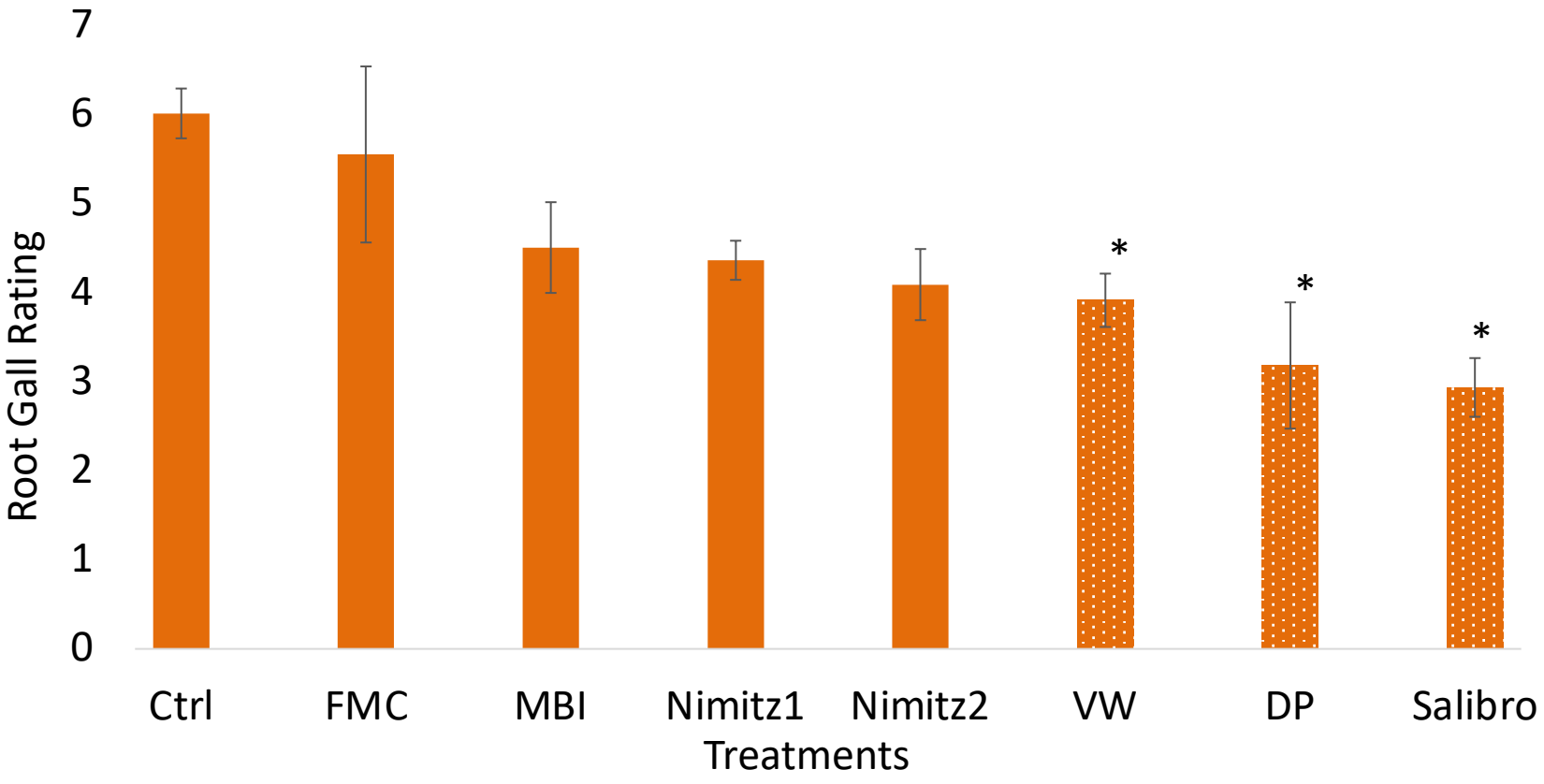


P= 0.05

Nimitz registered for use on carrots

Nimitz1: 5 pts
Nimitz2: 7 pts

RKN damage on carrot roots 2023



Nimitz1: 5 pts
Nimitz2: 3.5 pts


#7 DP1


#1 CONTROL


#6 SALIBRO

Nimitz: Side benefit

Phytotoxicity

Nimitz 5 pts

Nimitz 7 pts

Summary

- Nimitz Registered on carrots in California. Only CAUTION label, no reentry interval. **Needs further research to improve the application and thereby the performance in carrots

- Velum appeared to provide good protection against RKN in these trials but further optimization is needed for velum applications.

- Salibro and DP showed good potential in these trials; registration status???

Cavity Spot (*Pythium violae & P. sulcatum*)

Cavity spot lesions on carrots from the trial

Most economical soil borne diseases
Small sunken lesions on the surface
Lesions increase in size as carrots mature

Management

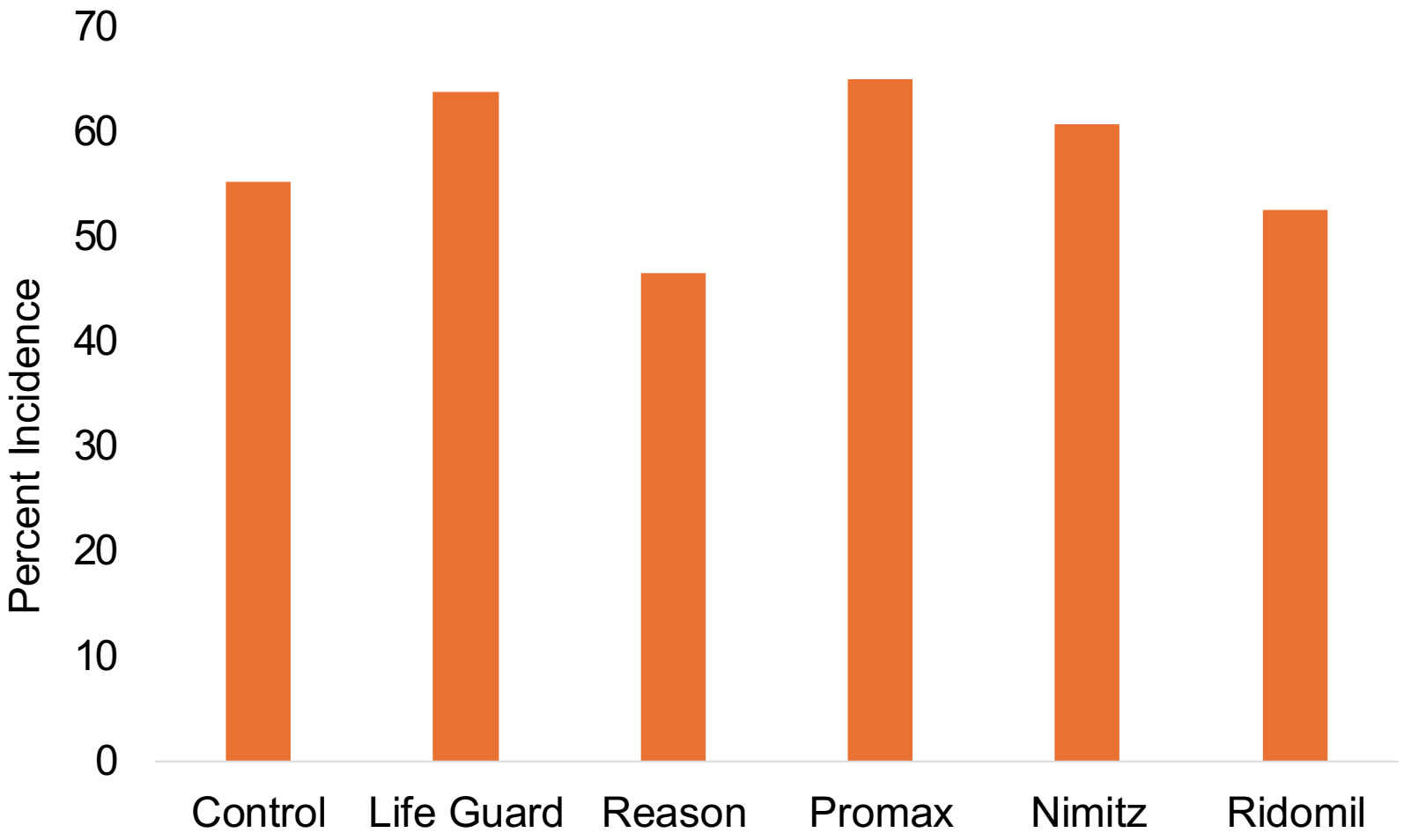
Mefenoxam –Ridomil
Fenamidone- Reason
Cyazofamid-Ranman
Fluopicolide-Presidio

Over reliance on one products can lead to resistance development

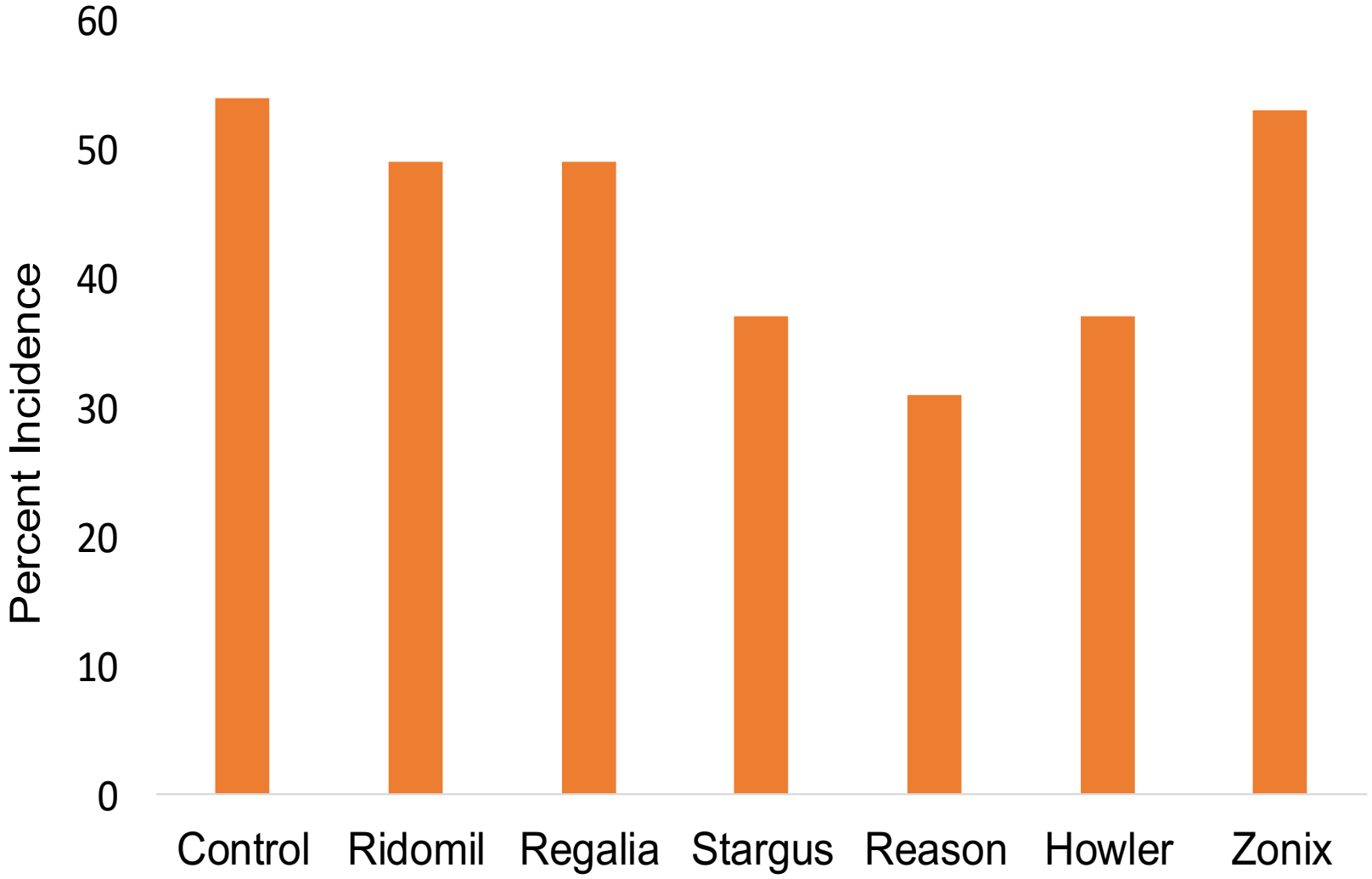
Rotation of crops and chemical chemistries is important for long term management of cavity spot.

Management in organic systems is challenging

2022 data


Percent Incidence
70
60
50
40
30
20
10
0
Control
Life Guard
Reason
Promax
Nimitz
Ridomil

2023 data


Percent Incidence
60
50
40
30
20
10
0
Control
Ridomil
Regalia
Stargus
Reason
Howler
Zonix

Cavity Spot Screening: USDA Project

- Screening for resistance is CONTINUING, as part of the carrot breeding program of Dr. Phil Simon.
- Sixty breeding lines for resistance to cavity spot will be screened in order to select resistant carrots that will be suitable for production in California

- Some purple-colored varieties are more resistant to CS
- Generally, reds are more susceptible

Foliar blights of Carrots

Fungal

- Alternaria Leaf Blight (ALB) *Alternaria dauci*
- Cercospora Leaf Blight (CLB) *Cercospora carotae*

Bacterial

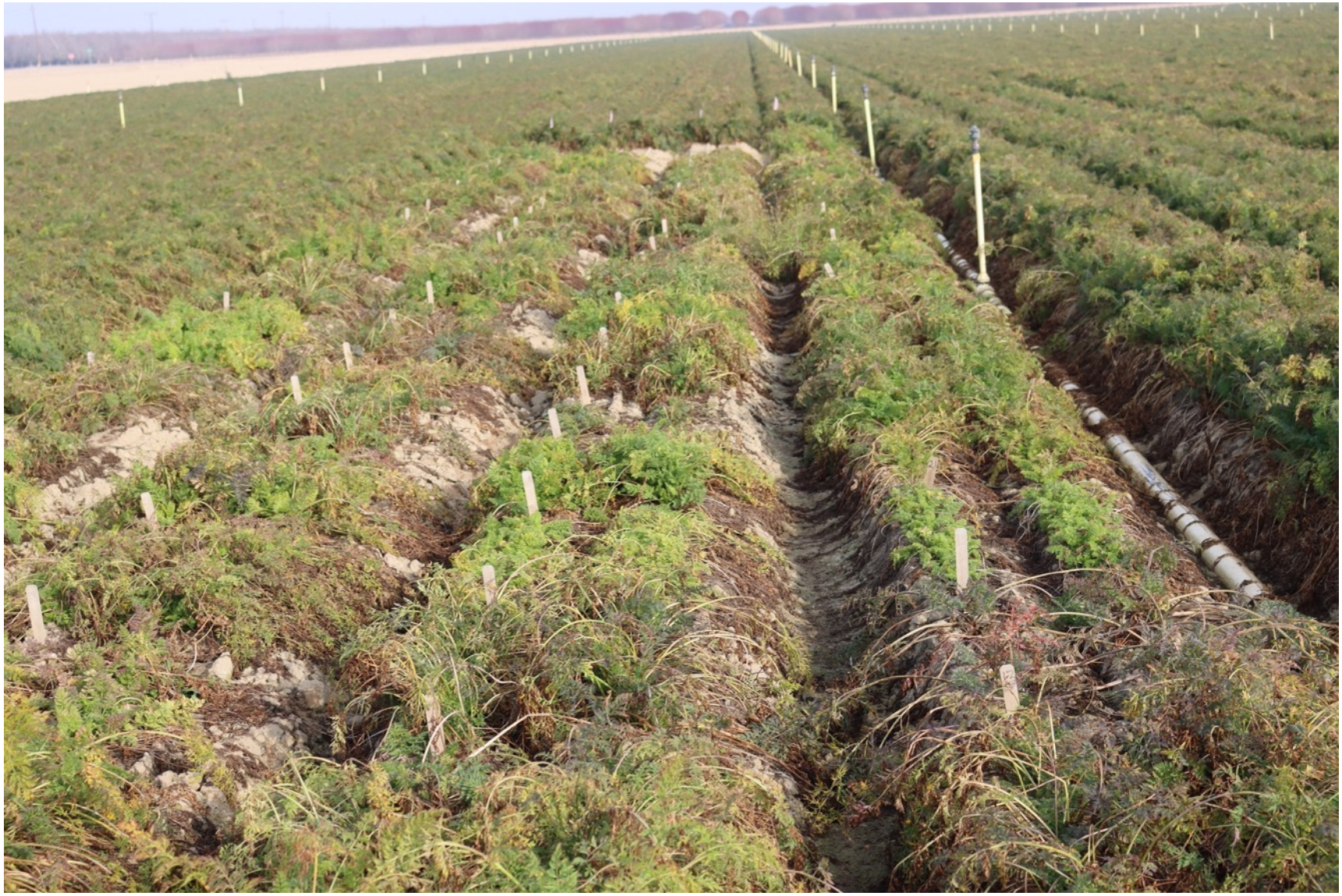
- Bacterial Leaf Blight *Xanthomonas campestris pv. carotae*

Alternaria Leaf Blight

Alternaria dauci

- Significant problem for carrot producers in California
- Infection usually begins on older leaves first
- Dark brown to black necrotic lesions (often surrounded by a yellow halo) along leaf margins and petioles
- The lesions enlarge and expand to kill the leaves
- In severe infections, tops will have scorched/ blackened appearance
- Yield losses occur as the carrots cannot lifted by the tops during mechanical harvest due to weakened tops

Alternaria Leaf Blight



Disease Development

- Infected Seed
  - *A. dauci* is seed borne. ALB infection must be minimized in seed production fields
  - Hot water treatment may be helpful

- Spore Movement

Spore movement

Old field to new field

Carrot debris

Irrigation lines

Management

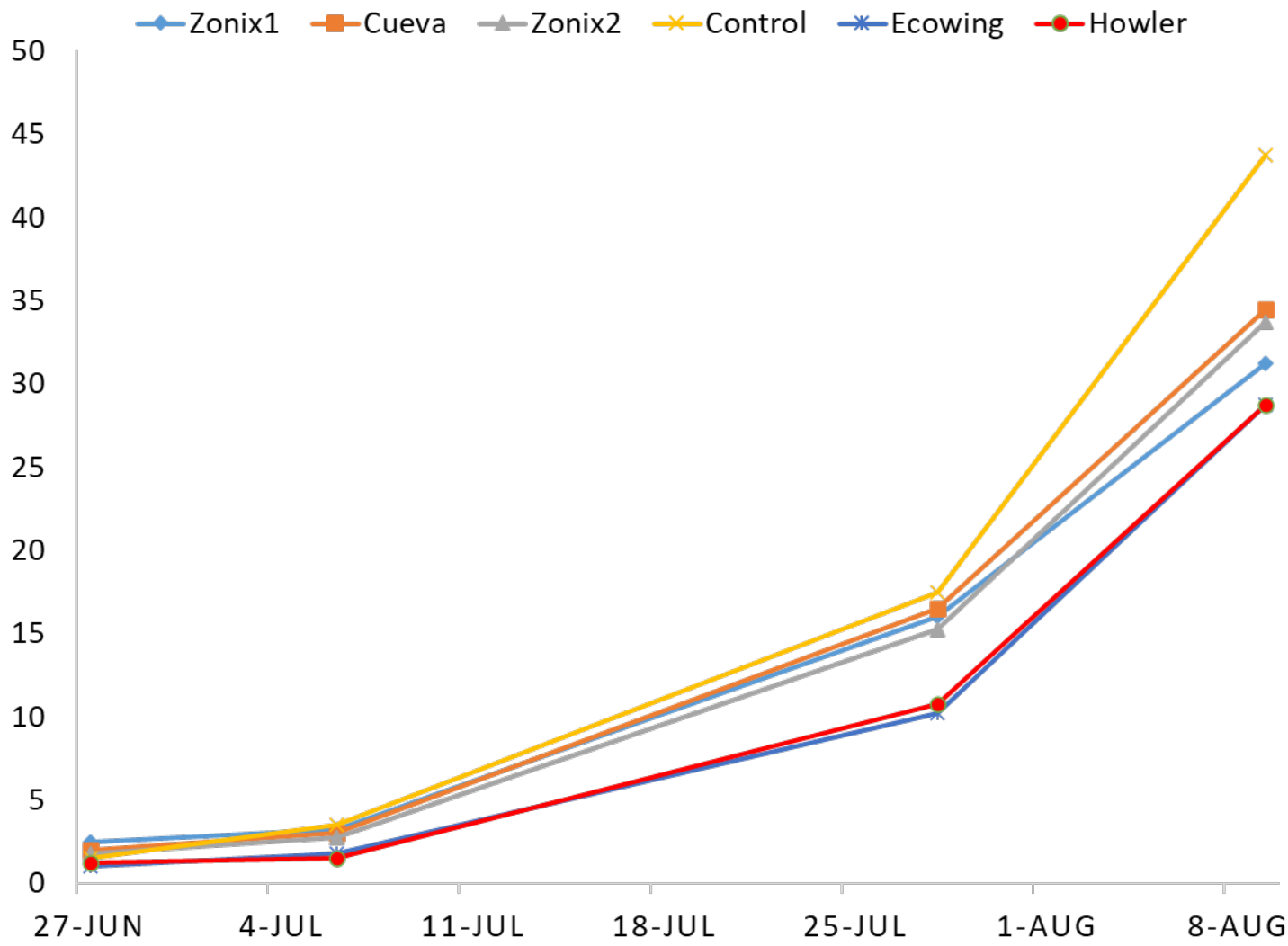
- Use clean seed, especially if you plant carrots in new area
- Remove volunteer carrot plants
- Clean equipment between fields
- Avoid planting new fields of carrots nearby older carrot fields
- Make sure old carrot debris is soil incorporated and is fully decomposed
- Crop Rotation-2-3 Years
- Fungicides at an early stage: primary strategy

Fungicide efficacy trials

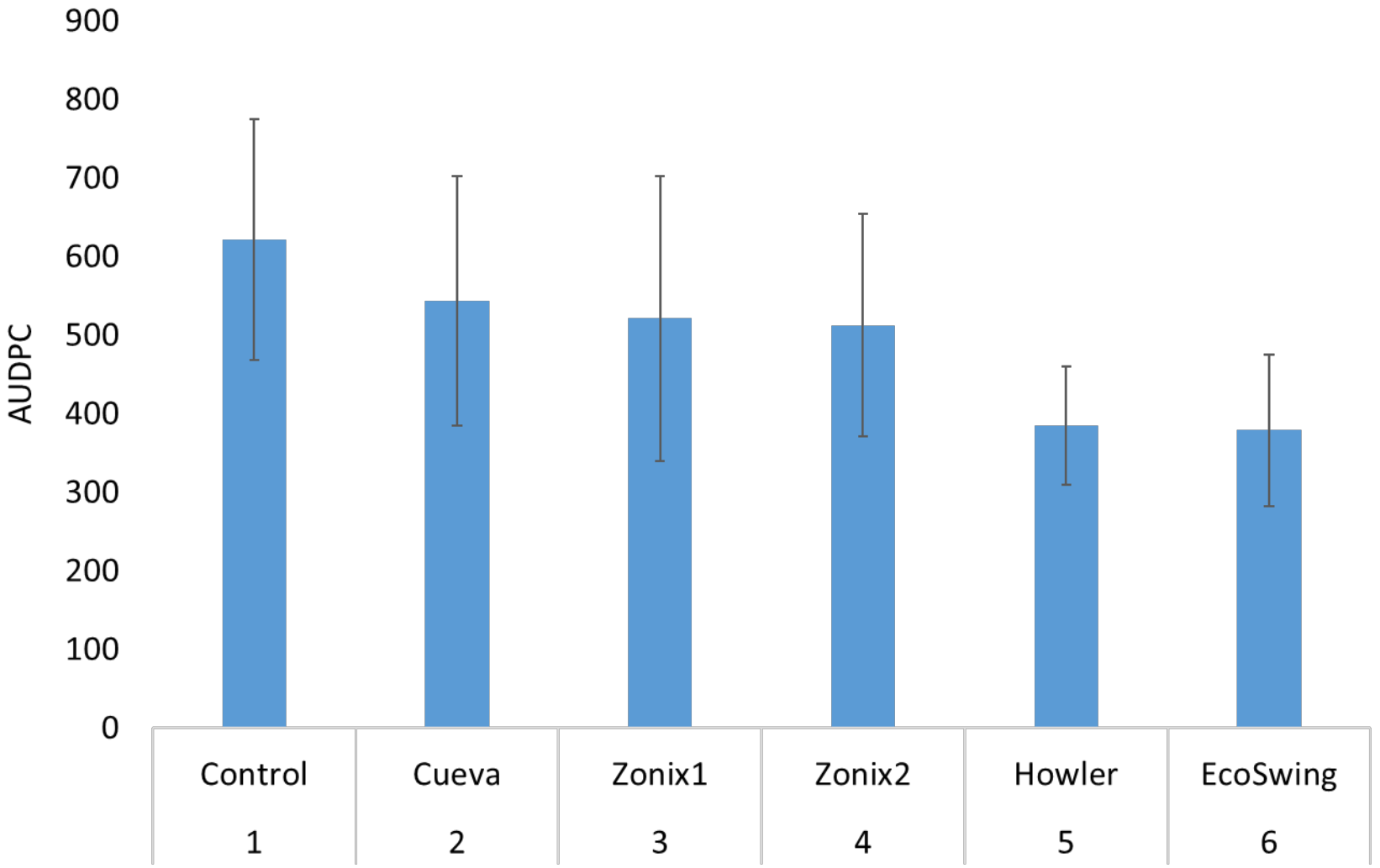
Treatments

	Treatment	Rate per acre	Applications
1	Control		
2	Howler	5 lbs	Five, 10-14 days interval
3	Zonix1	500 ppm ai	Five, 10-14 days interval
4	Zonix2+ adjuvent5459	500 ppm ai+ 0.14% v/v	Five, 10-14 days interval
5	Cueva	31.8 gal	Five, 10-14 days interval
6	EcoSwing	4 pints	Five, 10-14 days interval

Percent diseased foliage in six treatments over time during the 2022 growing season



Disease development



Cercospora Leaf Blight

- Often in Coastal regions
- Young foliage is affected
- Small, circular tan to brown spots and curled leaf margins

Management

- Use clean seed.
- Make sure the crop debris from old carrot crop is completely decomposed.
- Fungicides

  -The same materials used for Alternaria leaf blight.

Bacterial Leaf Blight

Xanthomonas campestris pv. Carotae

(certain production areas in Antelope and Cuyama valley)

- Difficult to distinguish from ALB
- Lesions begin at margins of leaf blades
- Initially, the lesions are water-soaked, brown green, later become brown, sometimes with a yellow halo
- Petiole lesions are brown, sometimes with bacterial ooze
- Plants that have bolted (formed flowers) will often have bacterial ooze from cracks on stalks

Bacterial Leaf Blight

Management

- Use clean seed. Hot water treatment of seed can reduce incidence of BLB
- Incorporate carrot debris left over from harvest
- Crop rotations
- Use copper-based bactericides

Field Evaluations of Existing Chemistries for *Xhc* Management: 2022

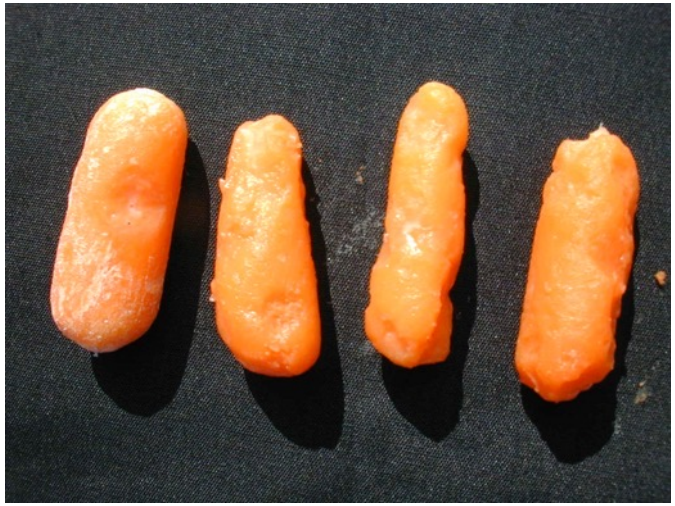
Foliage					
Treatment	Sampling#1 (March 8)	Sampling#2 (March 14)	Sampling#3 (March 30)	Sampling#4 (April 18)	AUDPC
Control	6.45	8.17	7.51	7.17	9.37
Oxidate	5.99	7.72	7.02	6.07	8.89
Kocide 3000	4.17*	7.44	5.58	4.39**	8.49*
LifeGard	5.23	7.19	6.46	5.86	8.35*
Actigard 50WG	5.87	7.48	5.84	6.22	8.56
ChampION	5.67	8.00	6.35*	4.29	9.06
Cueva	6.05	6.87	5.97	2.17**	8.00*
ManKocide	5.54	7.72	7.12	4.39	8.91
Mastercop	5.84	8.15	6.09	5.88	9.20
Nordox	5.70	6.84	3.59*	3.98*	7.89**
P-value	**0.197**	**0.2197**	**0.0762**	**0.005**	**0.0322**

Evaluate Chemical and Biocontrol Options for *Xhc* Management: Field Evaluations of Existing Chemistries 2023

Foliage						
Treatment	Sampling#1	Sampling#2	Sampling#3	Sampling#4	Sampling#5	AUDPC
Control	0.00	4.84	3.38	4.41	5.59	
Badge SC	6.44	3.79	6.68	6.01	5.68	
Kocide	4.65	7.31	6.93	6.84	6.62	
LifeGard/Agrititan	3.62	3.74	6.58	5.81	6.46	
NuCop	5.58	4.97	6.20	4.88	6.00	
ChampION	5.91	4.42	6.51	0.00	5.28	
Cueva/Nordox	7.25	5.67	5.57	4.07	6.16	
ManKocide/LifeGard	7.12	5.93	6.80	4.27	5.24	
Mastercop	6.27	7.10	6.74	6.56	6.22	
Nordox/LifeGard	7.66	7.62	3.29	3.77	3.80	
P-value						

Soft Rot (*Pectobacterium carotovora*)

- A summer-time disease
- Infection occurs in the field; however, the problem may appear in the field, in the shed, or after the carrots are processed
- Often recognized as a soft, watery, and slimy decay of the carrot root, accompanied by a foul odor
- Also, could be secondary



Soft Rot

Management

- Eliminate low spots and ensure good drainage
- Proper irrigation management
- Avoid bruising and wounds to carrot roots during harvest and processing
- Use chlorinated wash water and store under cool conditions

Southern Bight (*Athelia rolfsii*)

- Hot weather: > 85° to 99°F
- High soil moisture and frequent irrigation favor the disease
- White mycelial mat at the crown/base of plants
- Numerous tan-brown sclerotia

Management

- Rotation to nonhosts such as corn or small grains for at least 2 years may reduce numbers of sclerotia
- Deep plowing
- Burying plant debris helps destroy sclerotia
- Fungicides: Challenging

Cottony Soft Rot (*Sclerotina sclerotiorum*)

- Problematic under cool, damp conditions for extended periods of time
- Temps: 55° to 77°F.
- Can occur at any growth stage
- White cottony mycelial mass
- Large black colored sclerotia
- Sclerotinia rot is usually soft and watery compared to Rhizoctonia rot
- Not foul smelling


UC Statewide IPM Project
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Sclerotia comparison

Southern blight

White rot

Management

- Deep plowing
  - but not eliminate it completely because spores may be blown in from other fields
- 3-year rotation to cereals, corn, or cotton will help reduce sclerotial populations in the soil
- Trimming carrot foliage after the canopy closes for better air circulation may be helpful
- Avoid planting into fields with a history of cottony soft rot

Black Root Rot (Black Crown)
Alternaria radicina

- Seed-borne disease
- The pathogen can also survive on crop debris
- Spores survive in soil for several years
- Older, mature carrots are more susceptible
- High moisture and warm temperatures favor

Black Root Rot (Black Crown)

- Starts in the crown with black lesions on the base of the petioles
- Lesions extend into the root causing the characteristic “ Black crown”
- Tops weaken affecting mechanical harvest
- Yields impacted

Management

- Initially is a seed borne disease
  - Use certified clean seed
- Once introduced to a field, it becomes a soil borne pathogen
  - -Deep plowing
  - -Incorporation of crop debris into soil after harvest reduces inoculum
  - -Fungicides: Challenging

Root Dieback (Forking & Stubbing)

Damage to the growing root tip causes the carrot root to fork or stub, rendering it unmarketable

Often caused by *Pythium ultimum* or *P. irregulare*

Occurs soon after planting

Young tap root is infected at early stage (2-3 weeks after germination)

Other factors

- Poor soil structure/ Soil compaction
- Improper irrigation management
- Hard freezes
- Nematodes
- Rhizoctonia

Proper diagnosis
Good soil tilth
Proper drainage

Powdery Mildew (*Erysiphe polygoni*)

Minor disease

White, powdery fungal growth on old leaves and petioles

Some varieties more susceptible than others.

Chemical control usually not needed.

Powdery Mildew

Seedling damping-off

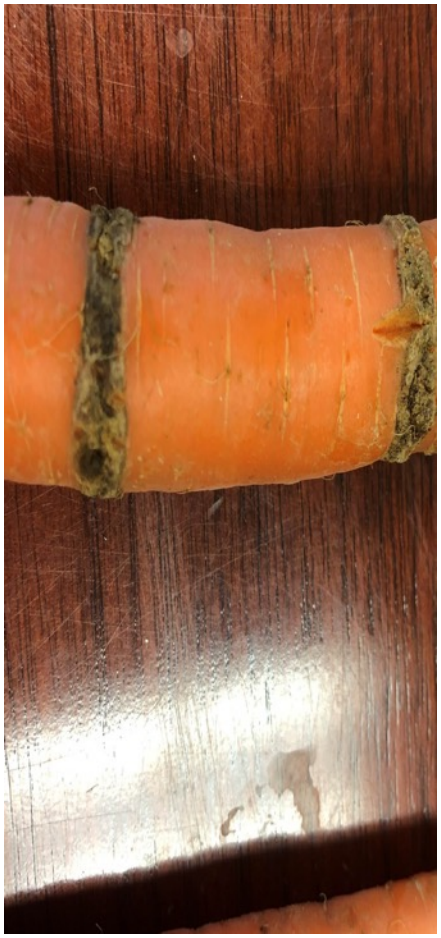
- Several *Pythium* spp., *Rhizoctonia solani,* and other soilborne fungal pathogens
- Damping-off leads to poor seed germination, root dieback, seedling death end eventually poor stand
- Stem girdling/ pinching at the soil is visible and the infected tissue is water soaked

Rhizoc in field

Area of field that got too hot and dry.
Run hands through canopy and tops will fall off.

Crater rot: Rhizoctonia

Scab: *Streptomyces scabies*



Pitted and raised corky lesions on the root portion of the plant
Lesions are typically horizontally oriented
May or may not occur in carrots following a potato crop

Virus : Carrot Motley Dwarf

Cooler growing regions

Motley dwarf is caused by 2 viruses, *Carrot Red Leaf* and *Carrot Mottle Virus*.

Only transmitted by the Carrot Willow Aphid (narrow host range)

Treatment: Avoid planting new fields near older fields

Phytoplasmas- *Aster Yellows and BLTVA*

(Beet leafhopper-transmitted virescence agent)

Severely distorted and malformed umbels

Thin woody roots with many root hairs

Resources

UC Publications

UC Pest Management Guidelines (ipm.ucanr.edu)

UC Cooperative Extension

Contact
Jaspreet Sidhu
Jaksidhu@ucanr.edu
661-304-8870

Thank You !