

# Control of bean thrips in navel oranges using ethyl formate fumigation for export to Australia

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# Ethyl Formate

- Natural plant volatile
  - essential oils of grasses, beer, rice, beef, and cheese (Desmarchelier et al., 1999).
  - volatile components of grapes and wine (Hiroyasu, 1972).
- Has been widely used as a fumigant for pests associated with dried fruit
- Registered for use in Australia by BOC gases as Vapormate™ in formulation with CO<sub>2</sub>
- Previously registered in US for control of insect pests in raisins, but registration expired in the 1980's

# Results from Table Grape Project

Target Pest	Life Stage	LD <sub>99</sub> <sup>1</sup>
Western Flower Thrips	egg	1.99
	2 <sup>nd</sup> instar	0.60
	prepupae	0.87
	adult	0.33
Pacific Spider Mite	deutonymph	2.39
	adult	3.73
Grape Mealybug	adult	1.79
Melon Aphid	mixed stages	0.16

1% ethyl formate, 1 hour fumigation at 23C

Simpson et al., 2007 – Journal Economic Entomology

# Preliminary Studies

## Bean Thrips

- **Mortality studies**

- Field run, unwaxed and unwashed navel oranges
- Infested with bean thrips
- Expose to ethyl formate upon arrival

- **Fruit tolerance studies**

- Field run unwaxed, unwashed navel oranges
- Expose to ethyl formate after one night at 41F and slight warming



Method Courtesy Joseph Morse and Associates

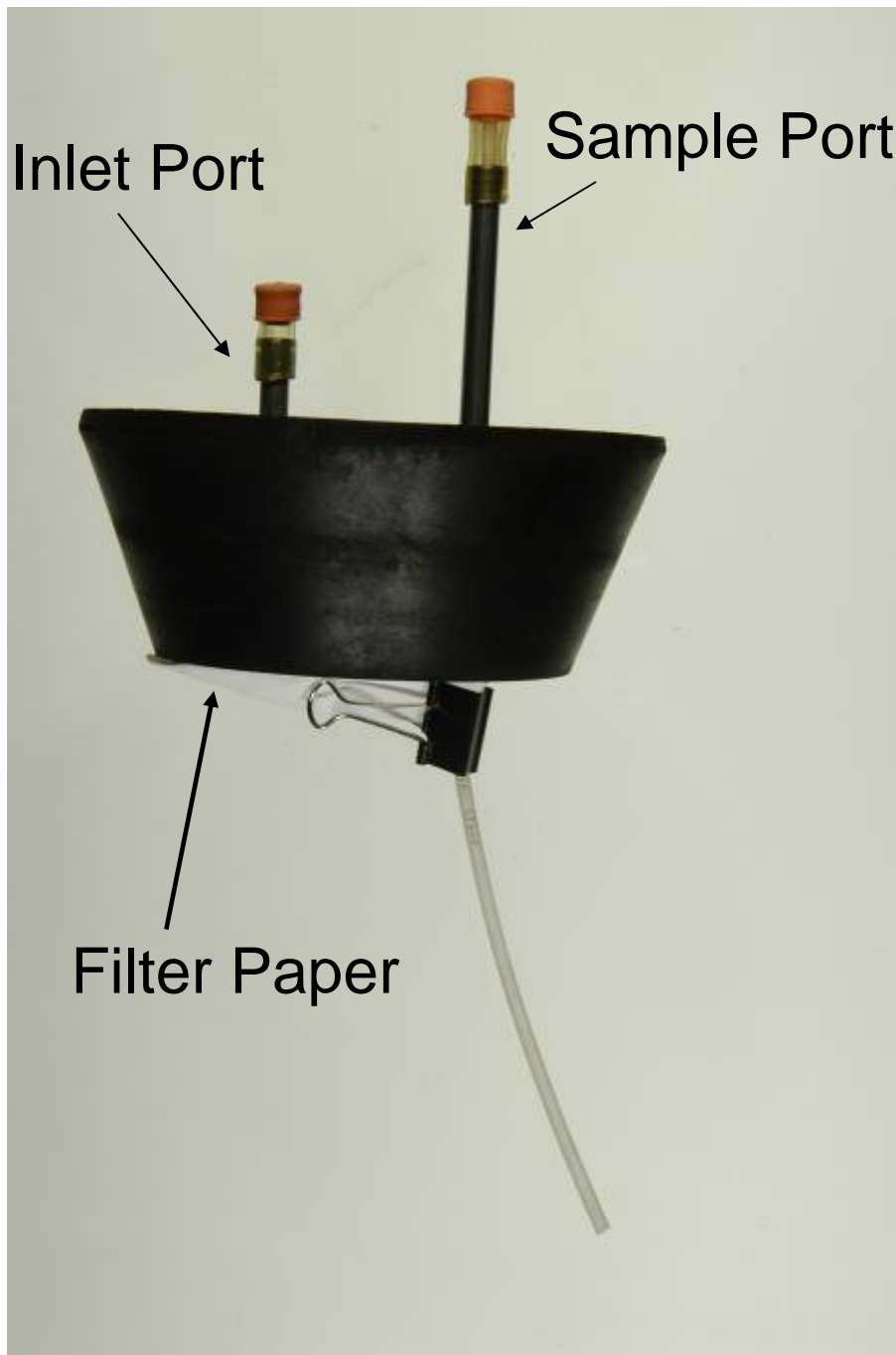
# Laboratory System for Ethyl Formate Fumigation



Inlet Port

Sample Port

Filter Paper



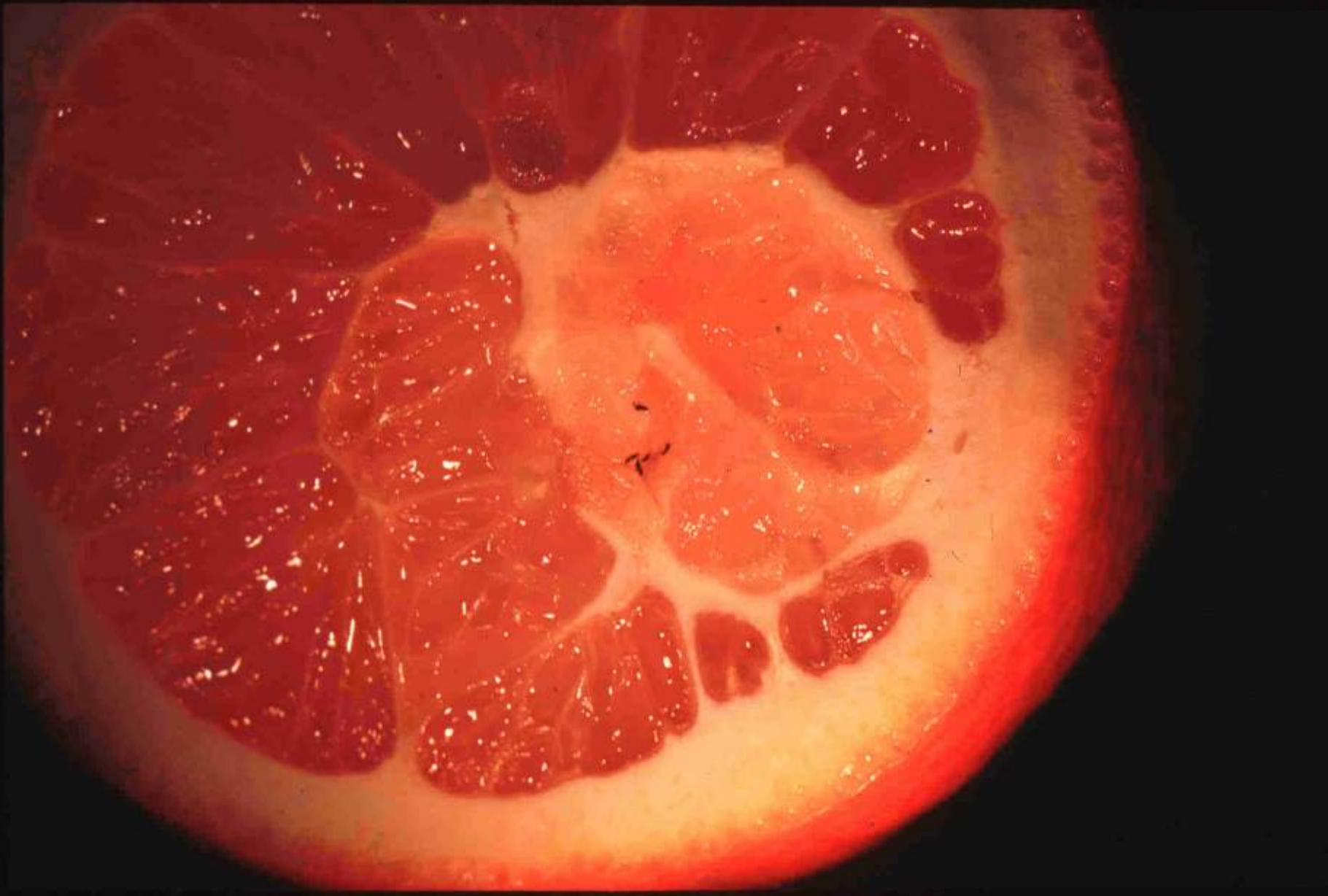


Photo courtesy Joe Morse, UCR

# Mortality of adult bean thrips in the navel of oranges following a 1-hour exposure to ethyl formate

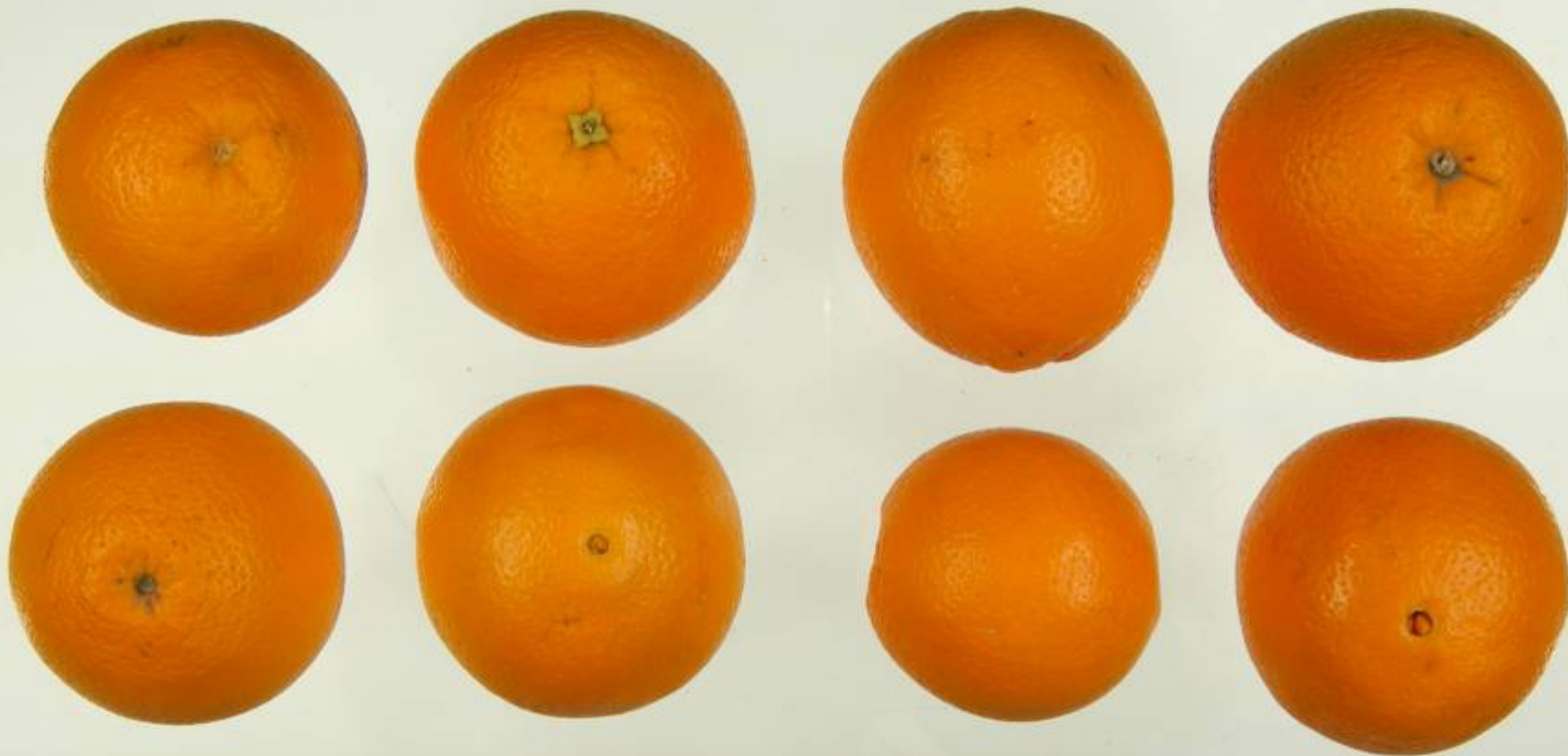
Treatment (% ethyl formate)	% Mortality	N
0.0	4.9a	162
0.5	100.0b	103
0.75	100.0b	121
1.0	100.0b	147
1.5	100.0b	87

Pulp temperature 60°F, air temperature 75°F

# Peel Damage Severity following Ethyl Formate Fumigation

% Ethyl Formate	0 days	21days @ 5°C	21d 5°C + 7d 20°C
0.0	1.0	1.0	1.0
0.5	1.0	1.0	1.0
0.75	1.0	1.0	1.0
1.0	1.0	1.0	2.0 (2/9)
1.5	1.0	1.0	2.7 (6/9)
2.0	1.0	1.0	4.0 (6/9)
3.0	1.0	1.0	4.6 (8/9)

Damage Scale: 1 = none, 2 = very slight; 3 = slight, 4 = moderate, 5 = severe

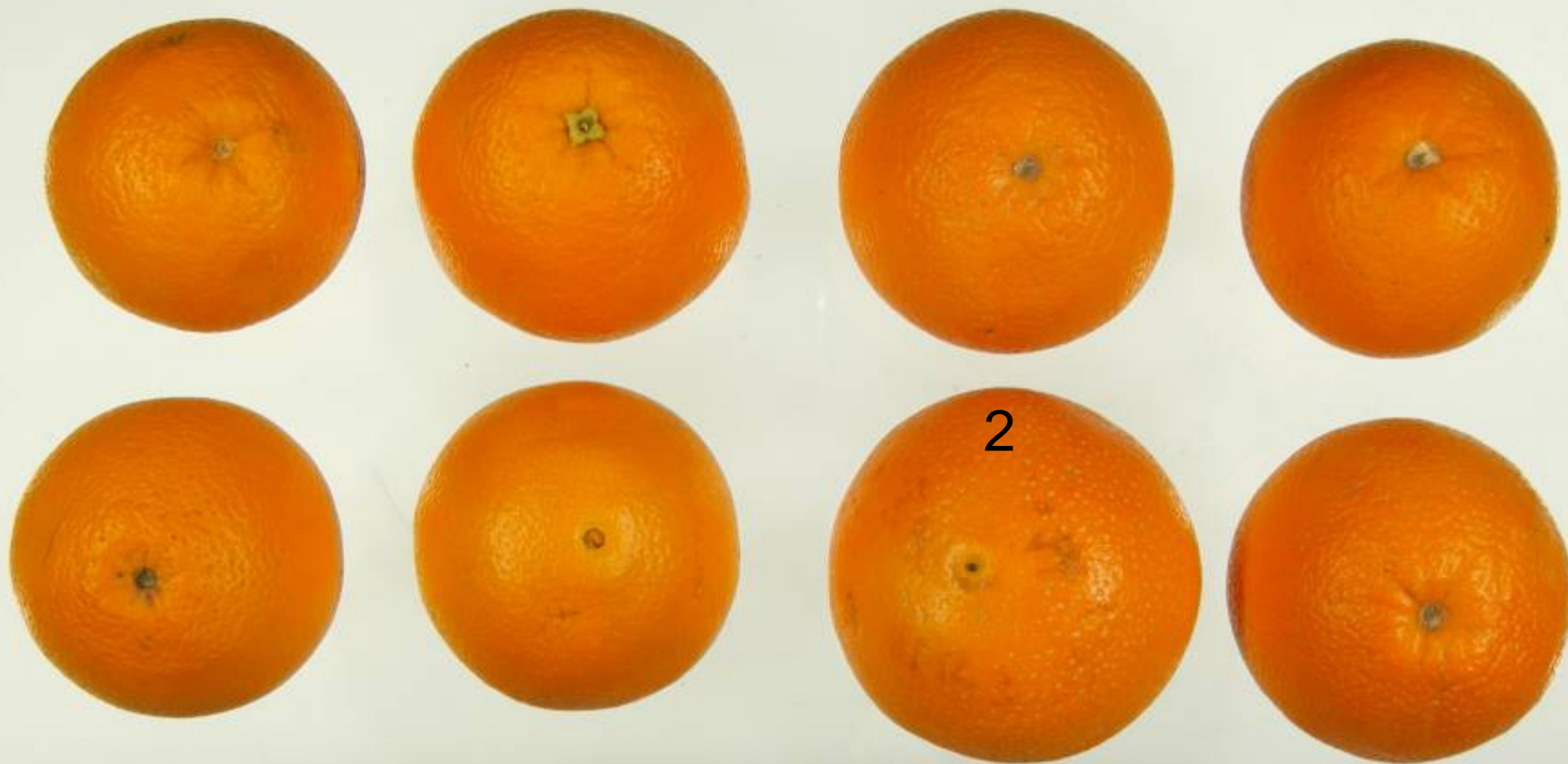


## **Control**

21 days @ 5°C + 5days @ 20°C

## **0.75% EF 1h**

21 days @ 5°C + 5days @ 20°C



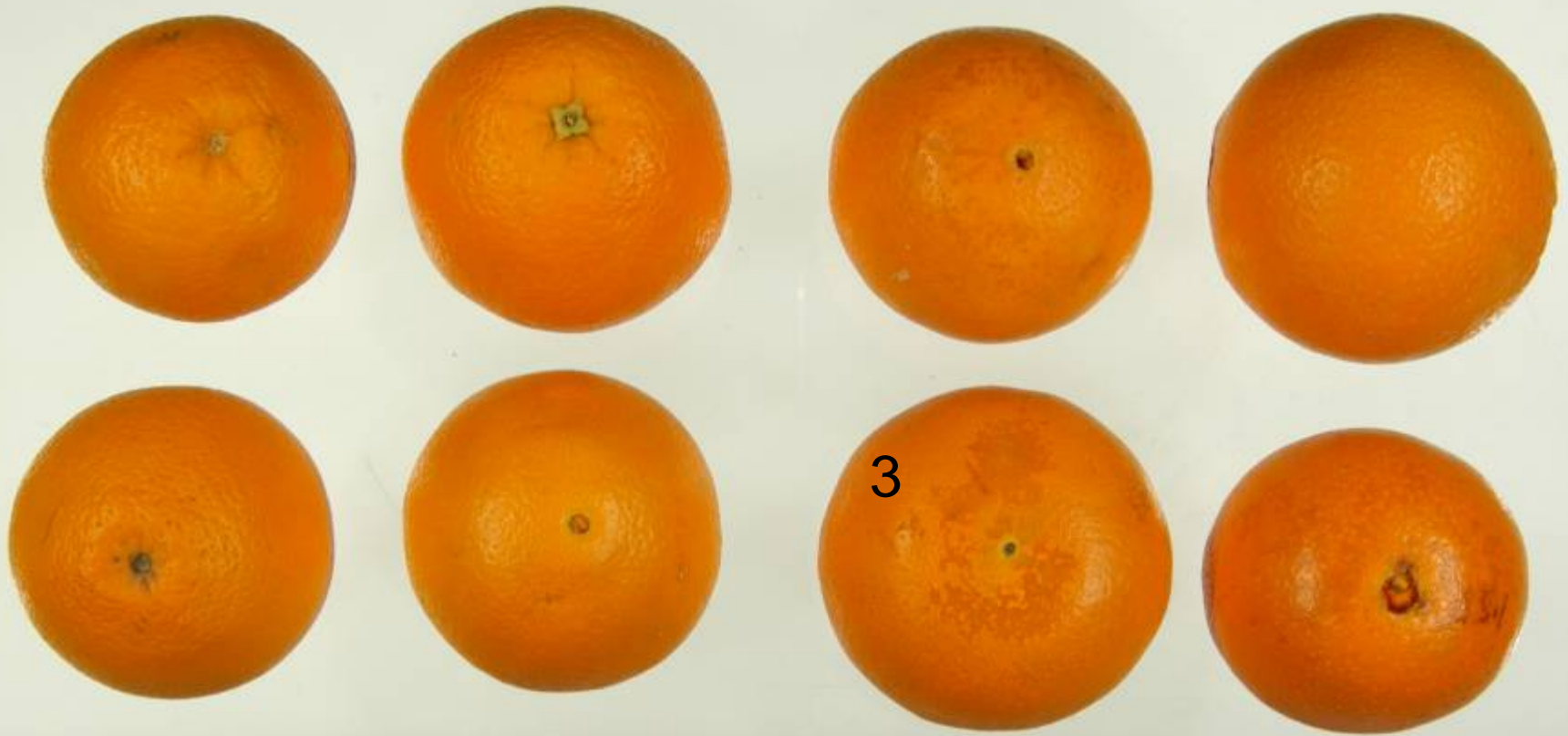
## Control

21 days @ 5°C + 5days @ 20°C

## 1%EF 1h

21 days @ 5°C + 5days @ 20°C

Damage Scale: 1 = none, 2 = very slight; 3 = slight, 4 = moderate, 5 = severe



## Control

21 days @ 5°C + 5days @ 20°C

## 1.5% EF 1h

21 days @ 5°C + 5days @ 20°C

Damage Scale: 1 = none, 2 = very slight; 3 = slight, 4 = moderate, 5 = severe

# Incidence and Severity of *Penicillium* Infection following Ethyl Formate Fumigation

% Ethyl Formate	<i>Penicillium</i> Incidence (%)	<i>Penicillium</i> Severity
0.0	0	1.0
0.5	0	1.0
0.75	0	1.0
1.0	0	1.0
1.5	0	1.0
2.0	33	2.7
3.0	22	3.5

Decay Severity: 1 = none, 2 = very slight; 3 = slight, 4 = moderate, 5 = severe

# Mortality of the California Red Scale (*Aonidiella aurantii*) 3 weeks after a 3-hour Fumigation with Ethyl Formate

Instar	EF concentration (%)		
	0.75%	1.5%	3.0%
First	99.8	100	100
Second	98.8	100	100
Third	99.9	100	100
Mature third	99.5	100	100

# Objectives

- Develop fumigation protocol with ethyl formate for control of bean thrips in navel oranges (conc., time, temp.)
- Confirm tolerance of navel oranges to ethyl formate fumigation at effective conc., times and temp.
- Confirm efficacy and tolerance under large-scale conditions

# Year 1

- Confirm thrips mortality in lab including effect of temperature during and following fumigation on treatment efficacy
- Absorption of ethyl formate by cardboard or wood materials
- Effect of fruit waxing (carnuba and shellac) and treatment temperature on fruit tolerance
- Test tolerance of various strains of navel orange to best ethyl formate fumigation treatments
  - Navel orange strains plot at Lindcove
  - One harvest
  - Objective quality
- Timing of ethyl formate treatment on fruit tolerance
  - Before packing, after packing, after cold storage

# Year 2

- Continue laboratory work to confirm thrips mortality
  - effect of temperature, concentration and exposure time on treatment efficacy
- Effect of free moisture on fruit peel during fumigation on fruit tolerance
- Confirm fruit tolerance with two strains on three harvest dates (Dec, Feb, April)
  - At harvest and after cold storage
  - All fruit run on packingline
  - Objective and sensory quality

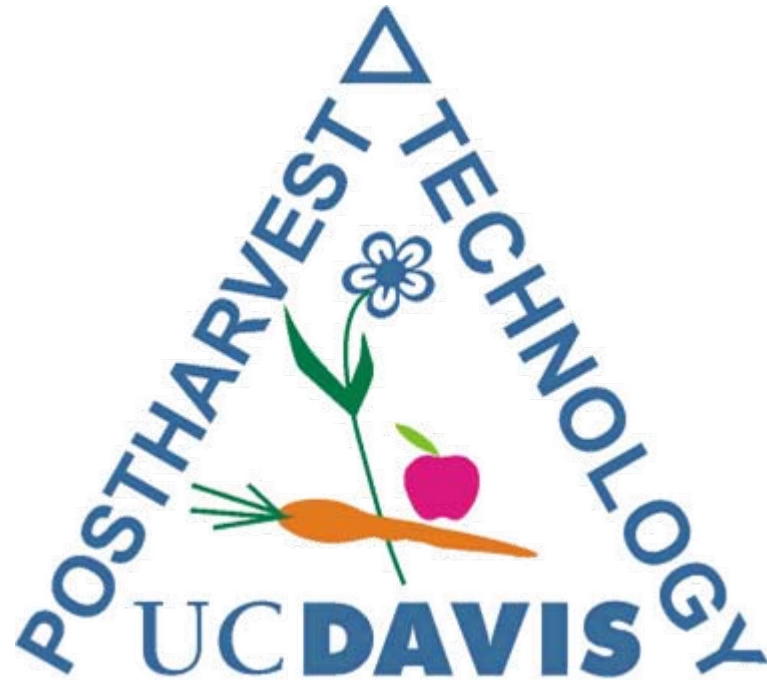
# Year 3

- Semi-commercial trials at Sunkist Growers, Inc.
  - Determine specifics of protocol, box vs. bin, forced-air vs. static
  - Confirm bean thrips mortality with large number of insects
  - Confirm fruit tolerance with many grower sources and several harvest dates
  - Prepare report for APHIS

# Budget

	Mitcham	Arpaia	Morse
2007-08	\$42,448	\$4,217	\$2135
2008-09	\$35,944	\$34,830	\$0
2009-10	\$28,258	\$5,405	\$8,736

w/TASC funding: 2007-08 budget reduced to \$5,056



**Questions??**