Temperature Treatments for Postharvest Dried Fruits and Nuts

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Control of postharvest insects is critical to the large and diverse dried fruit and nut industry.

Processors rely heavily on chemical fumigants for postharvest insect control.

Temperature treatments are potential alternatives.

Several dried fruit and nut crops are produced in the Central Valley of California, storage methods vary widely, from outdoor storage…

On-farm fig storage

Covered almond piles

Yard stacks of raisins

… to warehouse storage and large silos.

Dried fruit warehouse

Walnut silos

Almond silos

Drying methods range from sun-drying to mechanical, forced hot air dehydrators…


Sun-drying natural raisins


Walnut dehydrator

…and cold storage is often used to preserve product quality.

Insects of concern are of two broad types…

Direct field pests

Stored product pests

…regardless, tolerance for live insects at the consumer level is zero.

The two major insect pests for these products…

Indianmeal moth

Navel orangeworm

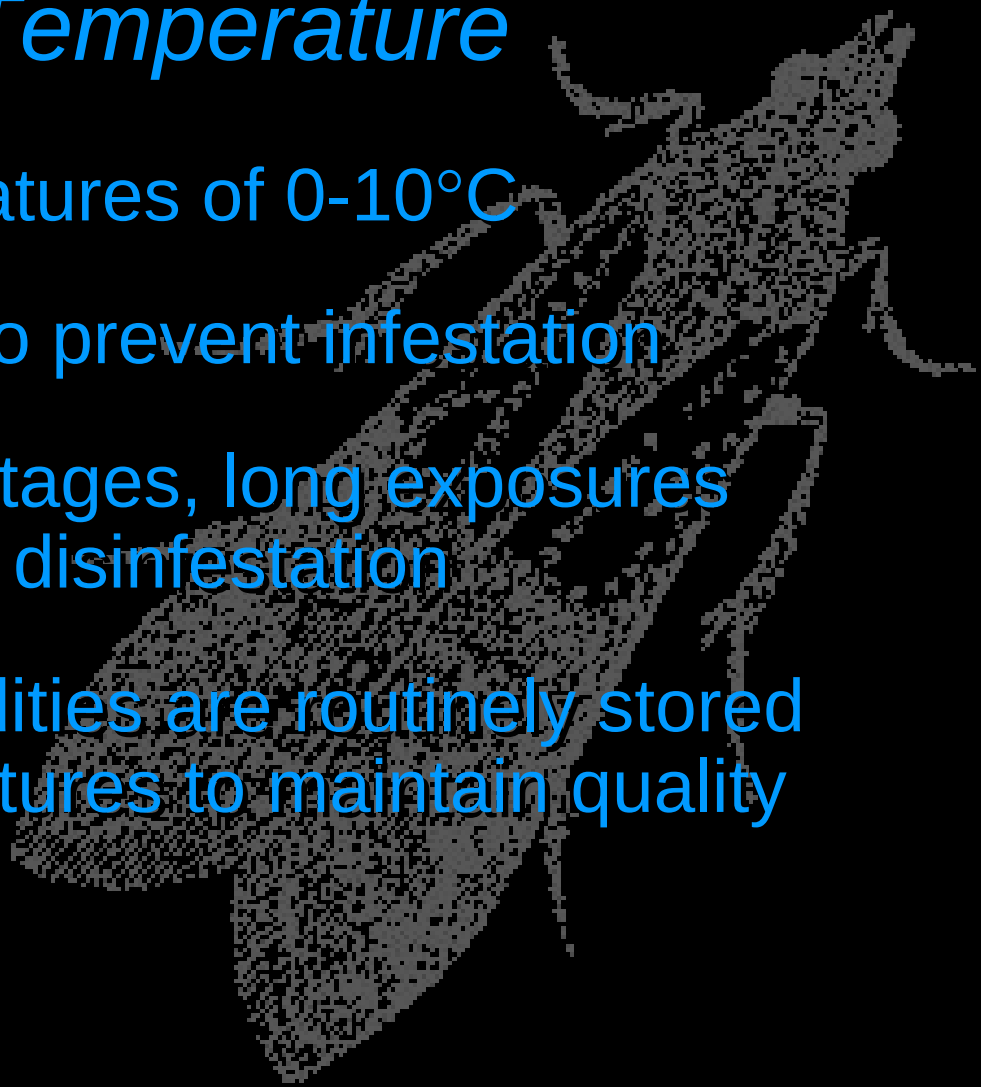
Most of our research is directed at these two pests.

Our major research effort…

Use of low temperatures

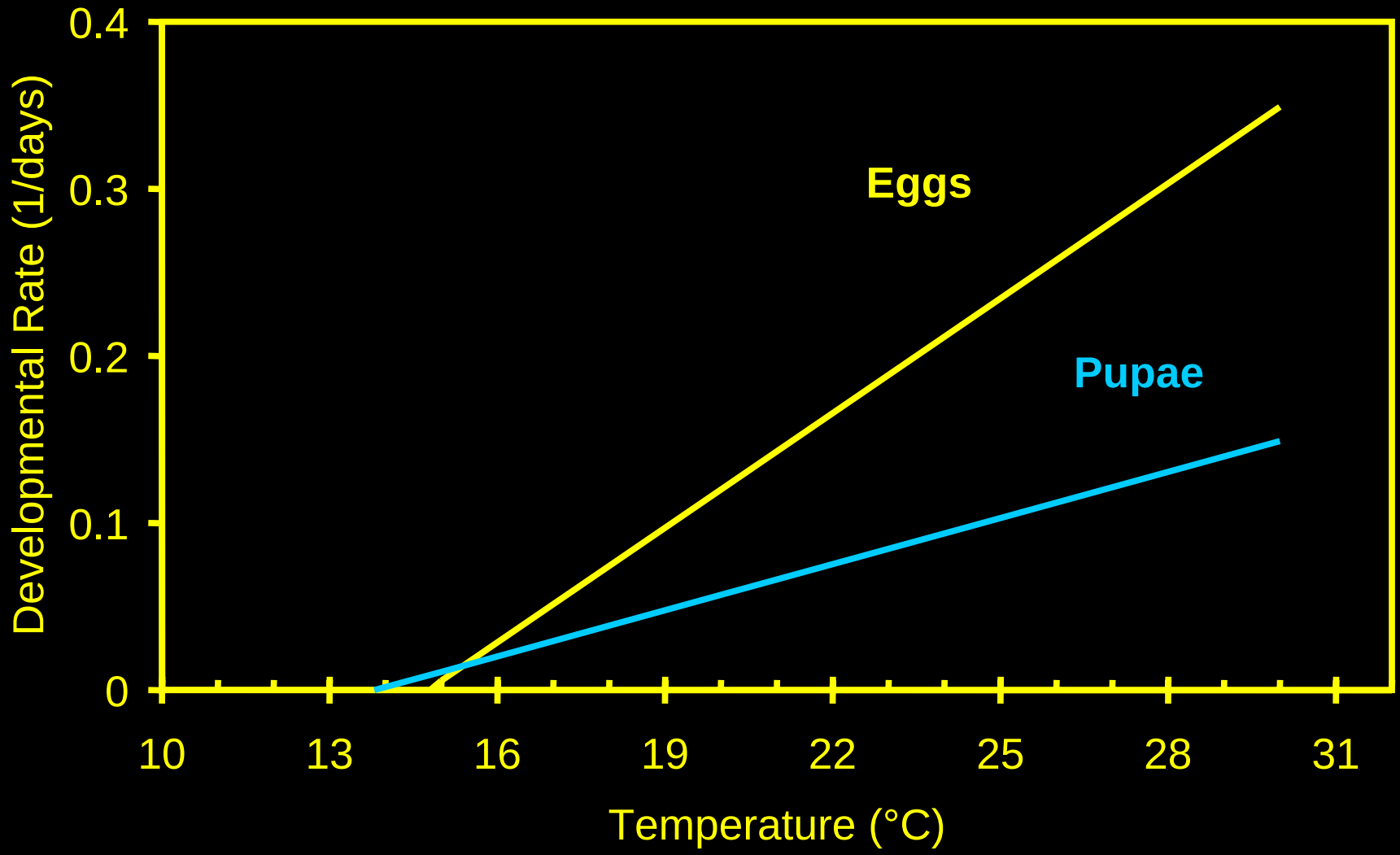
High temperature radio frequency treatments

Low Temperature



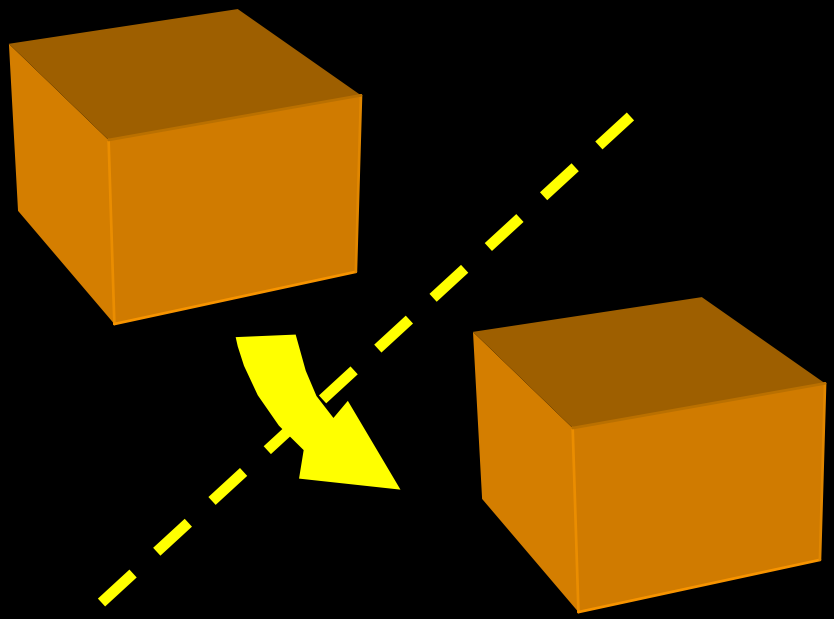
- Using temperatures of 0-10°C
- First object is to prevent infestation
- For some life stages, long exposures are needed for disinfestation
- Some commodities are routinely stored at low temperatures to maintain quality

Developmental thresholds for Indianmeal moth



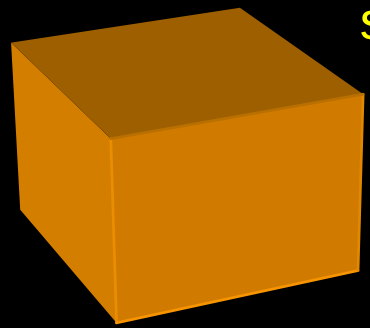
Use of Cold Storage in Combination Treatments

Raw, infested product



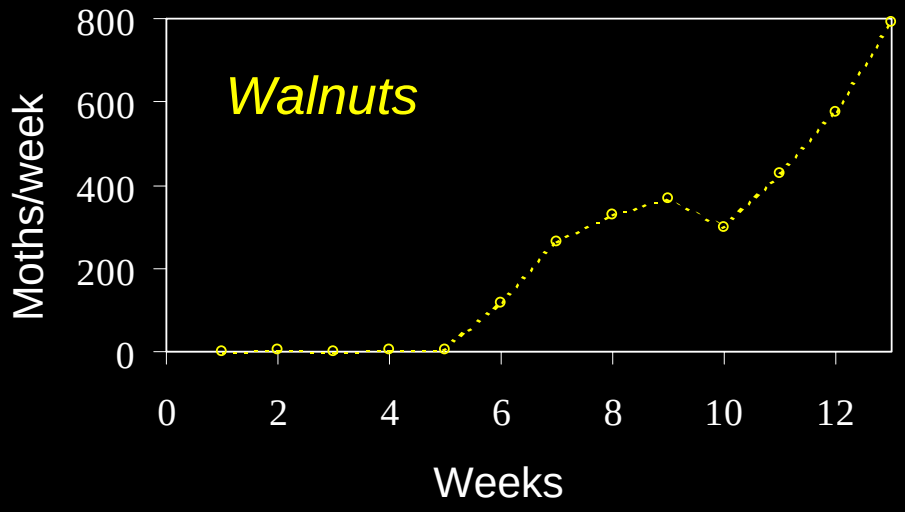
Disinfestation
(Processing Step
or Treatment)

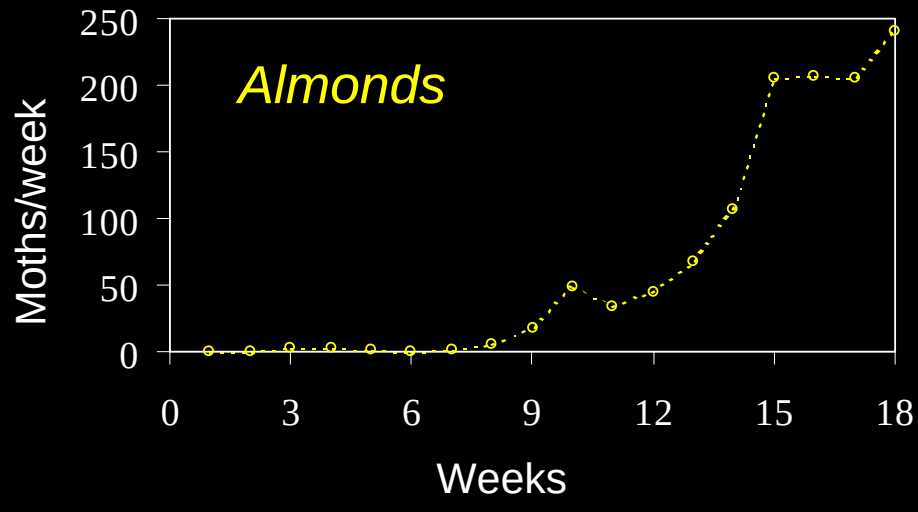
Clean product protected from reinfestation by cold storage

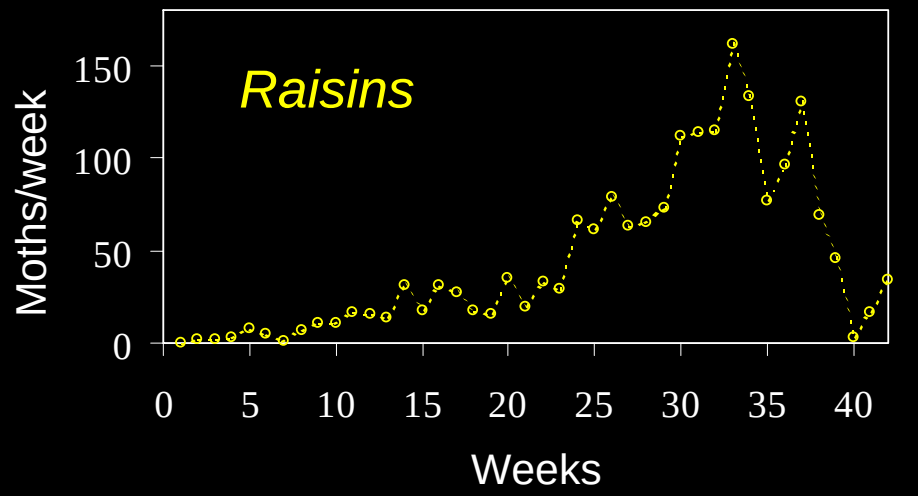


Cold storage protection against Indianmeal moth infestation in walnuts, almonds and raisins was tested.

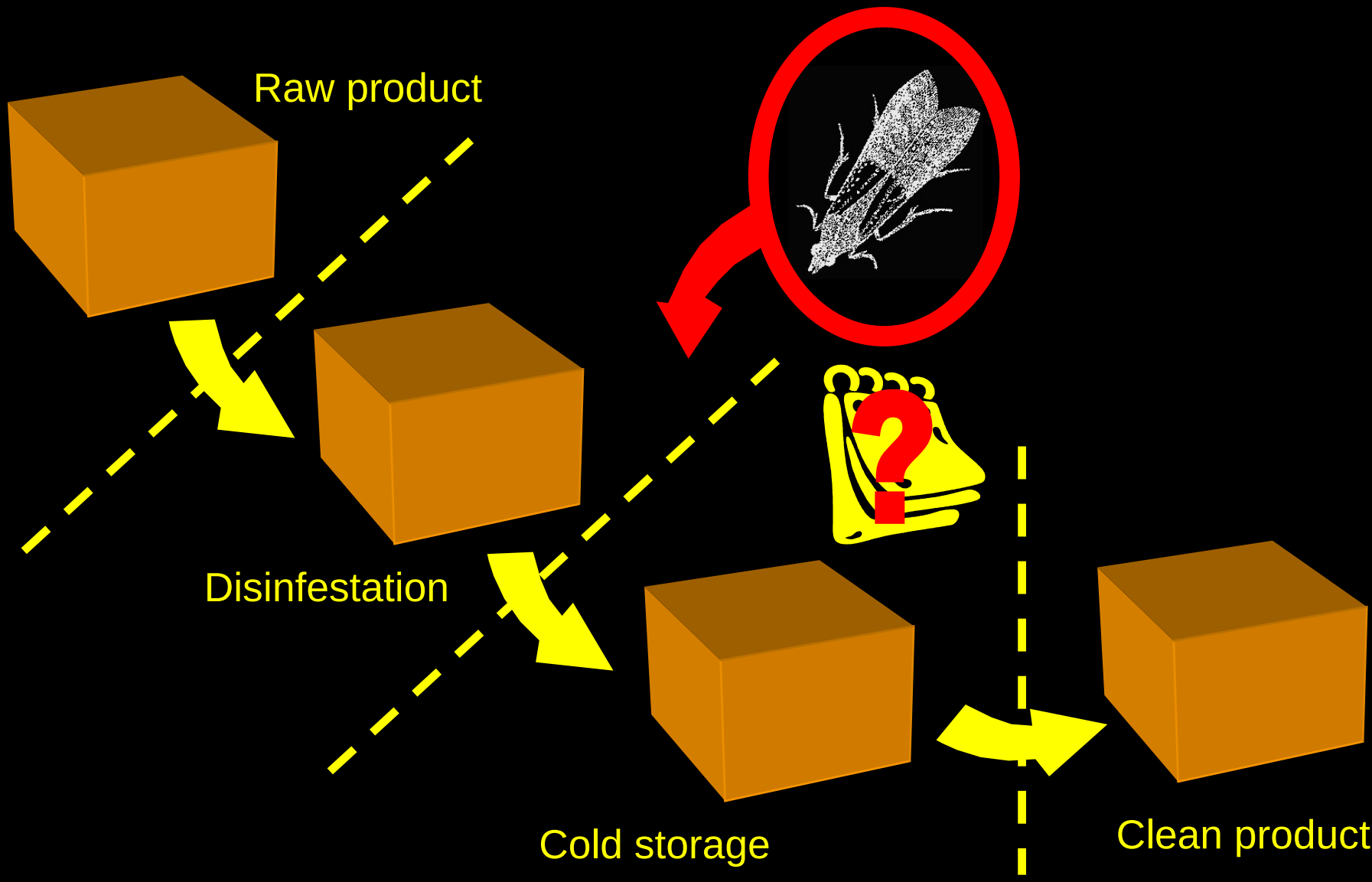
Indianmeal moth trap results for combination treatments







Potential for reinfestation…



Adult Indianmeal moth mortality at 10°C

Exposure (days)	Females	Males
7	4.9	5.9
35	15.0	23.9
70	94.9	92.6
98	100.0	99.8

Indianmeal moth fertility after 30 day exposure to 10°C

Female Condition	Eggs/female	% hatch
Untreated	369.8	85.3
Mated before exposure	152.8	0
Mated after exposure	140.4	5.3

LT95 (days) for insect eggs at low temperatures

Target Insect	10°C	5°C	0°C
Indianmeal moth	11.6	9.8	7.7
Navel orangeworm	9.1	7.1	2.8

Larval and pupal survival at 10°C

Exposure (days)	IMM		NOW	
	Larvae	Pupae	Larvae	Pupae
0	96.9	90.0	98.0	84.4
12	78.6	17.8	92.3	28.9
19	85.5	6.2	82.0	15.6
26	87.0	7.1	70.1	1.8
33	83.0	0.0	60.4	0.0
40	79.1	0.0	51.3	0.0

Larval and pupal survival at 5°C

Exposure (days)	IMM		NOW	
	Larvae	Pupae	Larvae	Pupae
0	88.7	89.6	92.0	90.6
5	72.7	61.6	28.0	79.8
10	28.0	32.0	1.3	58.7
15	16.0	17.2	0.7	26.7
20	13.3	1.4	0.0	0.0
25	1.3	0.0	0.0	0.0

Larval and pupal survival at 0°C

Exposure (days)	IMM		NOW	
	Larvae	Pupae	Larvae	Pupae
0	90.7	91.5	94.0	90.7
4	42.2	45.3	1.3	44.0
6	9.3	22.8	0.0	16.0
8	2.7	20.0	0.0	8.0
10	2.7	5.3	0.0	2.7
12	0.0	2.7	0.0	0.0

Low temperature treatments against diapausing Indianmeal moth larvae require sub-freezing treatment temperatures.

Mortality of diapausing IMM larvae at -10°C

Exposure (hours)	Lab	Wild-type
24	32.2	22.3
48	41.6	34.9
120	63.2	71.7
168	78.5	82.6
240	99.0	92.6
360	100.0	100.0

Mortality of diapausing IMM larvae at -15°C

Exposure (hours)	Lab	Wild-type
6	47.5	50.6
24	99.5	94.9
36	99.2	97.0
48	100.0	97.5
60	100.0	99.6
72	100.0	100.0

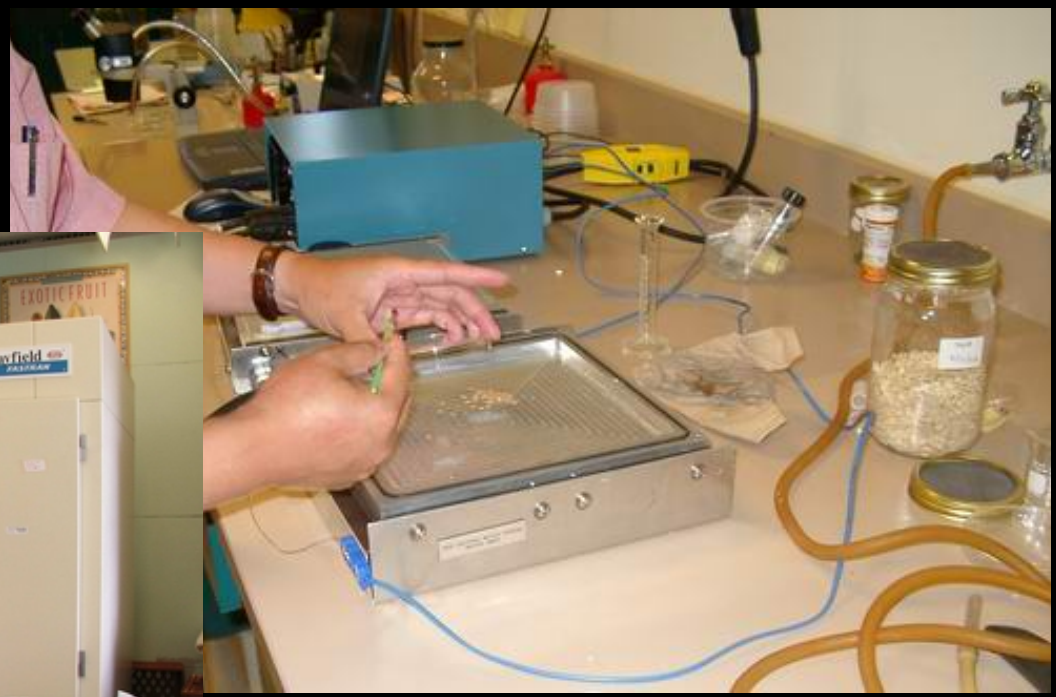
Mortality of diapausing IMM larvae at -20°C

Exposure (hours)	Lab	Wild-type
3	50.9	31.4
6	94.2	86.6
9	100.0	99.7
12	100.0	99.9
15	99.7	100.0
18	100.0	100.0

High temperature radio frequency treatments

- Radio frequency heating provides very rapid heating throughout the product
- Product quality is not effected when subjected to high temperatures for short periods
- Treatment times as short as 10 minutes are possible

Thermal death points were first determined in heat block studies…



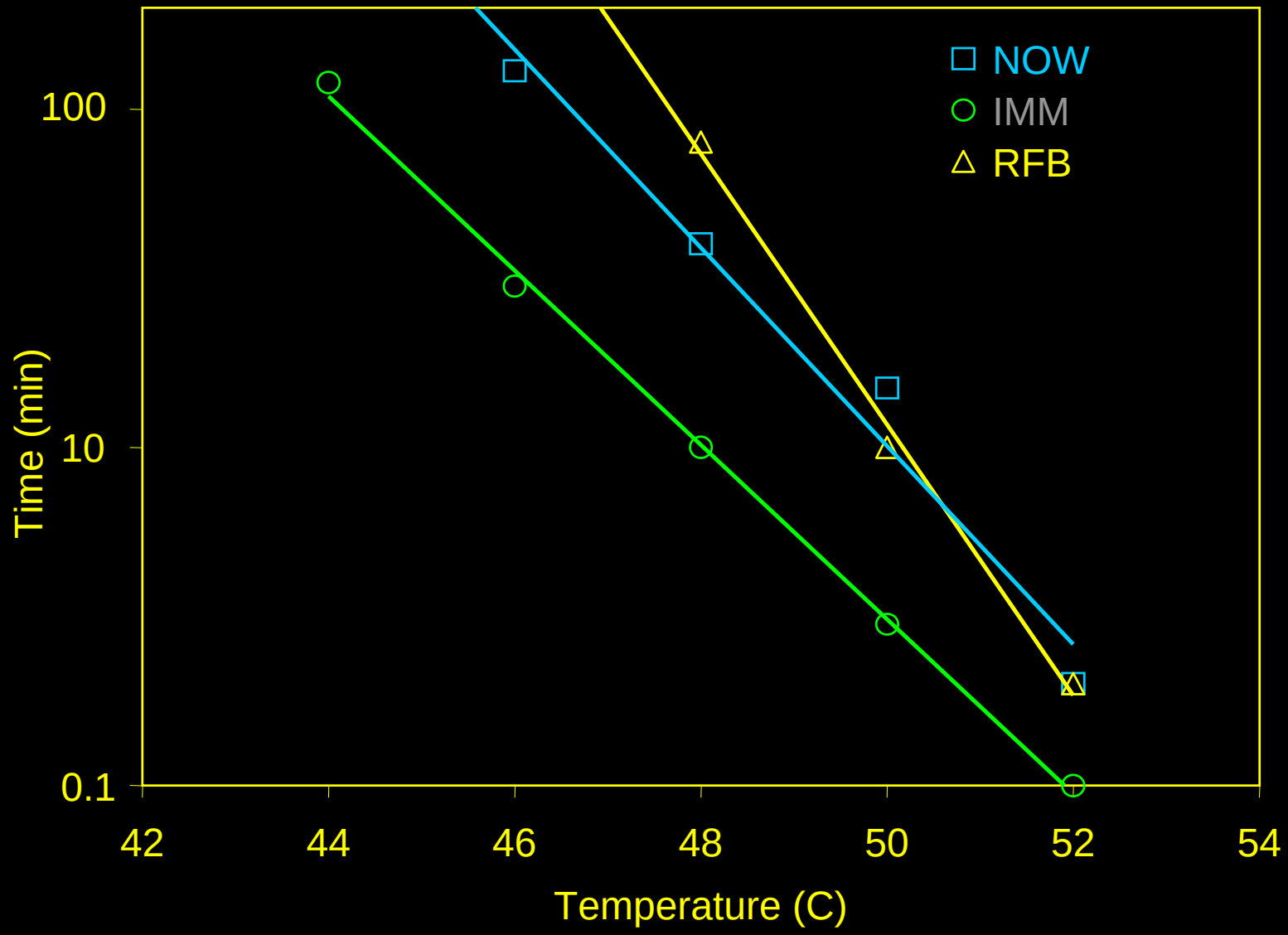
…treatments based on this work were tested in radio frequency ovens.

Relative heat tolerance of red flour beetle stages

Stage	Treatment		
	48°C / 20 min	50°C / 8 min	52°C / 0.5 min
Eggs	100.0 a	100.0 a	99.2 a
Early Larvae	96.2 ab	99.5 a	92.3 a
Late Larvae	24.7 c	74.9 b	27.5 b
Pupae	72.9 b	99.4 a	46.1 b
Adults	78.6 b	97.0 a	52.3 b

Averages within columns followed by different numbers are significantly different (LSD means separation)

Comparison of TDT curves for target species



Comparison of lethal times (minutes) for target species

Temp	Target Species		
(°C)	RFB	NOW	IMM
		LT_{95}	
48	64.5	40.9	7.6
50	7.9	13.5	2.2
52	1.5	4.3	0.9
		LT_{99}	
48	75.4	46.8	8.8
50	9.5	15.3	2.5
52	1.7	5.0	1.0

Fifth instar navel orangeworm was used for tests in radio frequency ovens.

Mortality of fifth-instar NOW in walnuts after radio frequency (27 MHz) treatment to 55°C

Treatments	# Alive	# Dead	% Mortality
Control	180	0	0
RF+5min hot air	0	180	100
RF+10min hot air	0	180	100
RF/hot air+10min hot air	0	180	100

Treatments consisted of 60 test insects replicated 3 times

Other results from radio frequency studies

- Walnut quality is not harmed
- May need higher temperatures to disinfest almonds
- Addition of hot air becomes more critical with products like almonds

Questions?