

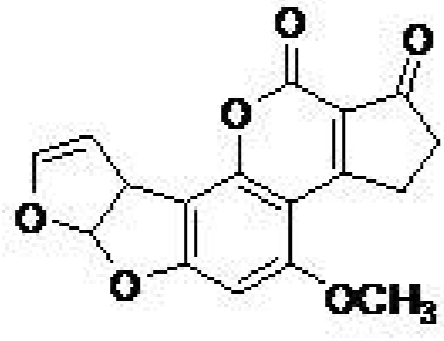
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The navel orangeworm (NOW) continues to be a major insect pest of California tree nuts. Current efforts to monitor NOW utilize virgin female NOW traps or almond meal, both of which are beneficial but have proven either unavailable commercially or inadequate, respectively. The pheromone blend, while a promising attractant, is hampered by stability problems in the field. Ambient emissions collected from 2009 almond orchards has provided a prototypical simple synthetic blend, based on relative ratios of volatiles, that has elicited promising electroantennogram responses and notable volatile trends. Data collected in 2010 include: ambient volatiles and associated SPME snapshots; pictures of kernel phenological development; and fatty acid content at collected intervals.

Problem:

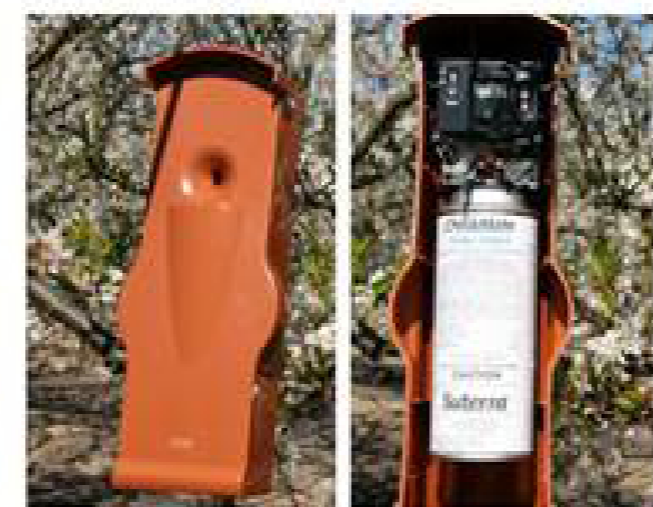
- Control of NOW continues to be a top priority of the tree nut industry...
- California Almonds
 - 80% world's needs
 - 100% U.S. needs
 - Approximately \$2 billion
- Navel Orangeworm
 - Direct feeding damage
 - Vector for toxigenic aspergilli
 - Millions of \$ annually lost
 - Ecluded effective control



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Semiochemicals For Monitoring & Control:

- Almond meal for females (egg traps)
- Baited virgin female traps (for males)
- Female sex pheromone
 - Mating disruption



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Objective:

- To develop a non-pheromonal female NOW attractant blend/lure that is environmentally friendly, safe, and stable to harsh orchard conditions



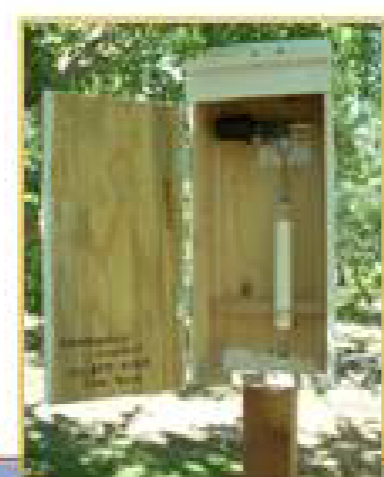
Premise:

- Female NOW use host-plant volatiles (kairomones) to locate suitable ovipositional site

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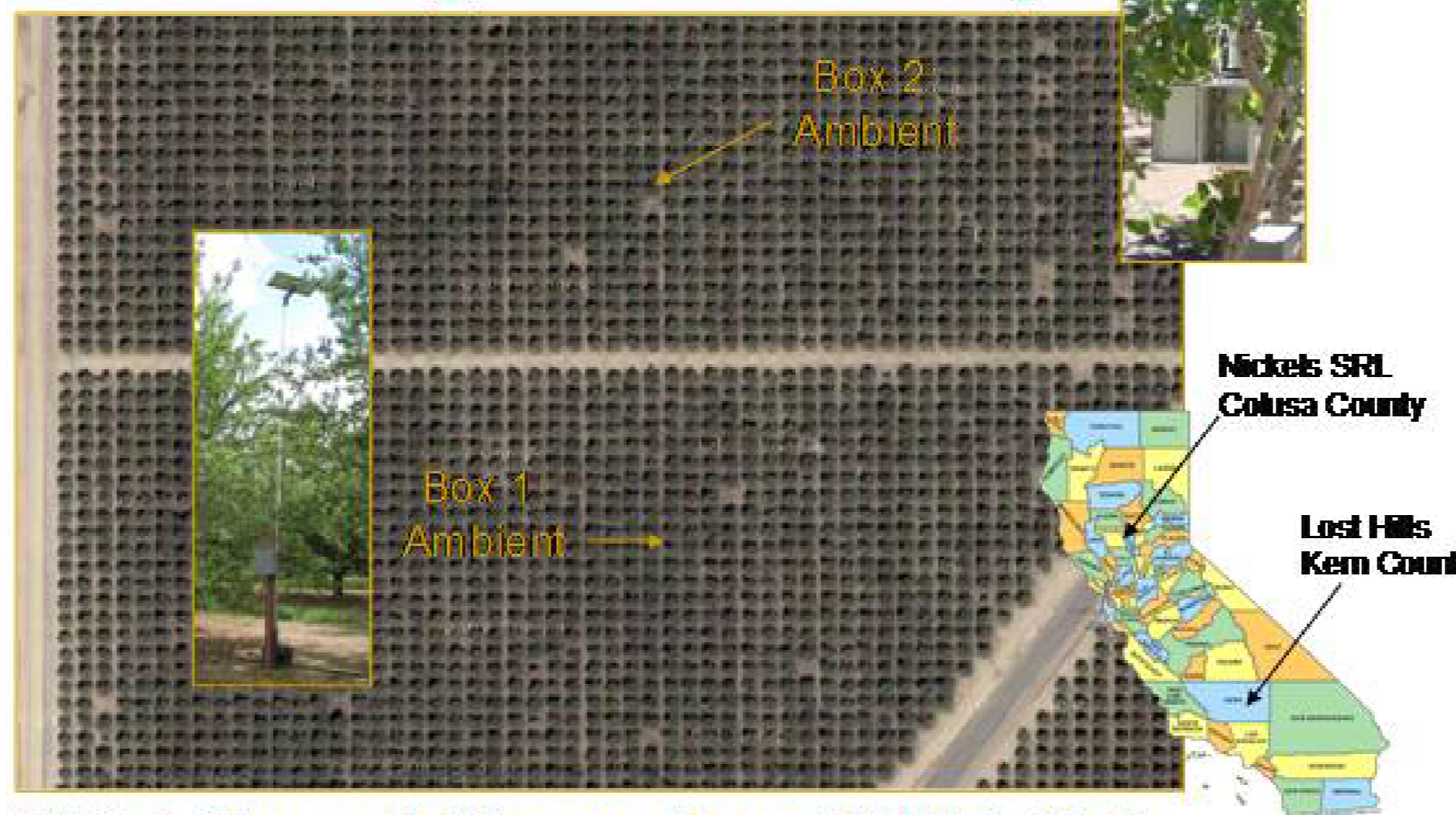
Ambient Volatiles History:

- 2008 – Developed 1st prototype
 - Proof of concept
 - Venturi & compressed air (\$\$\$\$\$)
- 2009 – 2nd Generation
 - Independent
 - Higher resolution
- 2010 – 3rd Generation
 - Sturdier cartridges
 - Diurnal capabilities



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LSAVC Experimental Setup:



Nickels: Nonpareil/Monterey/Carmel/Aldrich 4:2:1:1
Lost Hills: Nonpareil/Monterey/Carmel 2:1:1

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2009 Almond Orchard Volatile Results:

- Four Collections
 - Duplicated in orchards with two boxes
 - Lost Hills Collections (Kern County)
 - April 23rd – May 5th (12) 482-587 dd
 - June 30th – July 7th (7) 1586-1762 dd
 - July 7th – July 15th (8) 1752-1930 dd
 - August 11th – August 21st (10) 2592-2817 dd
 - Nickels Collections (Colusa County)
 - May 12th – May 18th (6) 594-719 dd
 - June 22nd – July 2nd (10) 1242-1470 dd
 - July 17th – July 23rd (6) 1768-1908 dd
 - July 27th – July 30th (3) 1993-2057 dd

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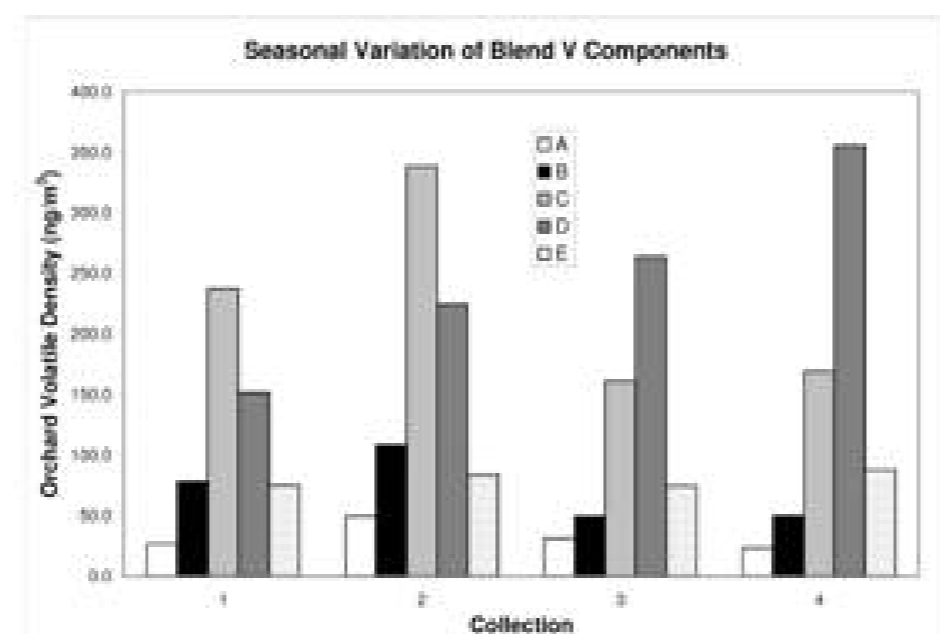
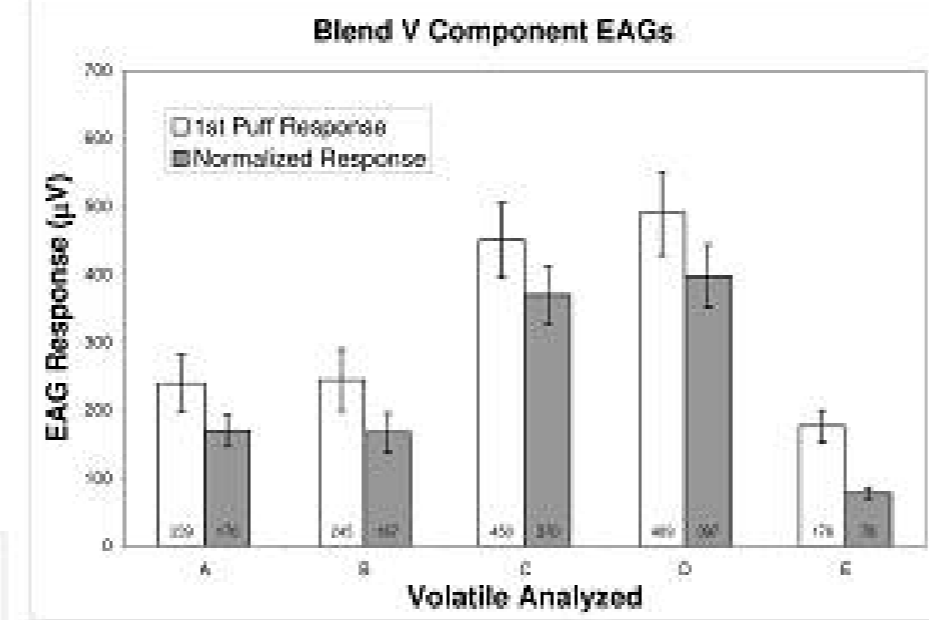
2009 Almond Orchard Volatiles:

#	Ambient Almond Volatile Amounts (ng/m ³)			
	Collection 1	Collection 2	Collection 3	Collection 4
1	26.8	49.3	31.1	23.3
2	0.0	0.0	0.0	7.0
3	3.0	5.3	0.0	3.5
4	12.2	13.1	11.4	13.1
5	3.7	0.6	0.0	0.0
6	1.6	4.8	4.5	6.9
7	78.1	108.2	49.6	50.1
8	237.4	338.4	161.2	169.4
9	11.1	3.9	13.9	11.2
10	3.8	0.0	19.1	21.7
11	306.8	165.3	306.6	1971.5
12	3.9	1.7	3.5	10.0
13	3.4	8.1	10.8	6.2
14	7.7	9.3	14.8	7.0
15	12.6	0.0	5.3	3.2
16	11.9	10.4	19.0	25.9
17	151.5	224.8	263.8	305.4
18	51.9	59.7	23.3	31.8
19	5.4	7.2	5.3	9.8
20	4.3	9.6	13.9	13.5
21	0.0	0.0	1.4	3.0
22	122.7	191.7	76.7	77.5
23	0.0	11.9	14.8	0.0
24	74.7	83.7	74.4	87.8
25	3.5	0.0	0.0	11.3
Degree Days	482-587	1586-1732	1752-1930	2592-2817
Collection Dates (days)	4/23-5/5 (12)	6/30-7/7 (7)	7/7-7/15 (8)	8/11-8/21 (10)

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Analysis of a 2009 Volatile Blend:

- Volatile components
 - Simple synthetic blend comprised of five volatiles
 - Blend V
- Electroantennogram (EAG) analysis

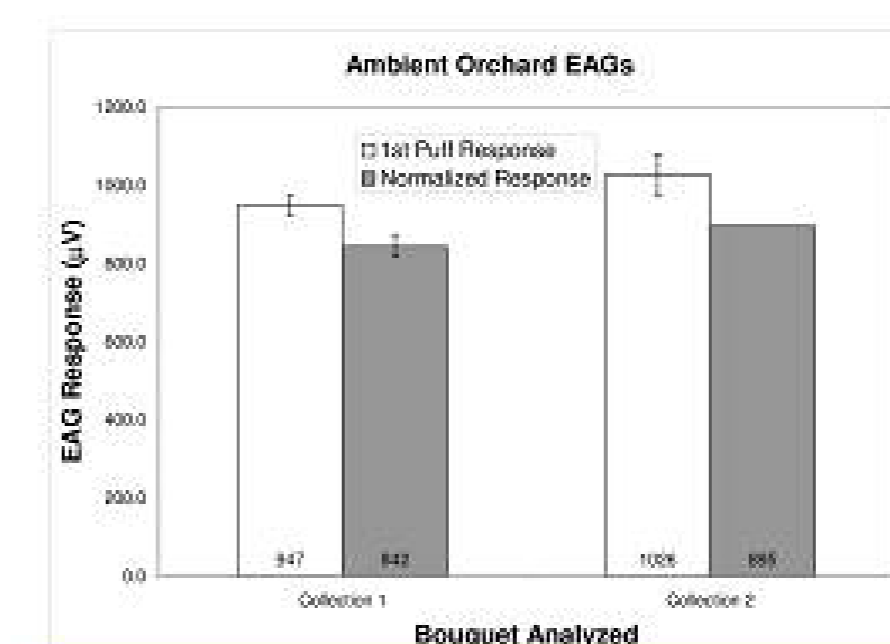
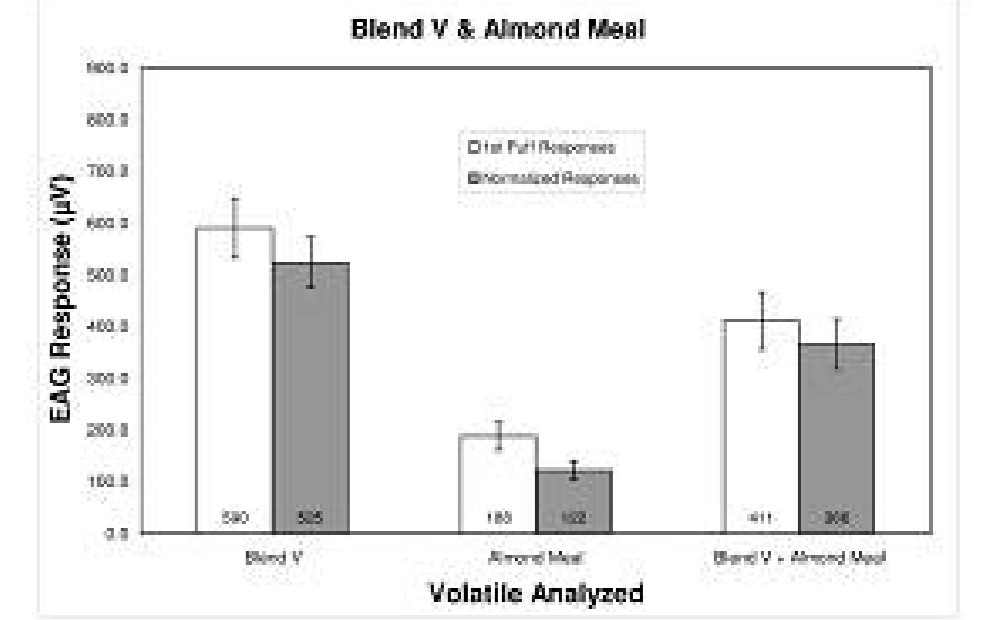


- Relative Seasonal Variation
 - Lost Hills location
 - Blend V components
- Notable Trends
 - Peak and Increase
 - Others relatively steady

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EAGs of 2009 Blend V:

- Blend V & Almond Meal
 - Blend V elicits greater EAG response than almond meal
 - Blend V + Almond meal approximately equal



- Orchard Bouquet
 - Two collections evaluated
 - Nearly equal
 - Greater than synthetic blend

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Flight Tunnel Analysis of Blend V:

Table 2 NOW moths caught and eggs deposited during overnight flight tunnel studies. Each experiment consisted of the release of 20 mated moths, male and female, each 2-6 days old.

	Treatment Pairs ^a				Statistics
	Experiment #1	Experiment #2	Experiment #3	Experiment #4	
Males Captured	1.2 ± 0.6	0.2 ± 0.2	0.1 ± 0.1	0.2 ± 0.2	F _{3,20} = 2.6
Females Captured	3.3 ± 1.4 [*]	0.8 ± 0.5 [*]	5.0 ± 0.9 ^{***}	0.9 ± 0.3 ^{***}	F _{3,20} = 17.3
Eggs Deposited	30.5 ± 10.1 ^{***}	12.8 ± 6.4 ^{***}	52.9 ± 7.1 ^{***}	1.2 ± 0.9 ^{***}	F _{3,20} = 14.6
N=20					P < 0.001

^a Experimental conditions: 60 mg almond meal, gray septa impregnated with 100 µl of pentane and allowed to evaporate for control, or gray septa impregnated with 5 mg Blend V in 100 µl of pentane, which was allowed to evaporate prior to analysis. Mean values are paired. Treatments were significantly different by paired t-Tests: * P < 0.05; ** P < 0.01; *** P < 0.001.

^b Moths not released.

- Female NOW showed significant ovipositional preference for Blend V relative to Almond Meal

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2009 Ambient Collection Summary:

- Ambient almond orchard emissions are relatively quantifiable
- A representative, preliminary simple synthetic blend was formulated
- Laboratory analysis demonstrated
 - EAG activity by female NOW
 - NOW ovipositional activity



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2010 Ambient Collections:

- Increased number of collections for higher resolution of volatiles and possible relation to phenology
- SPME analyses performed for corroboration and comparison (snapshot of tree emissions)
- Physical nut size at time of collections recorded
- Kernel fatty acid content will be determined
- Performed in pistachio orchards for comparison of crop emissions



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2010 Data Undergoing Analyses:

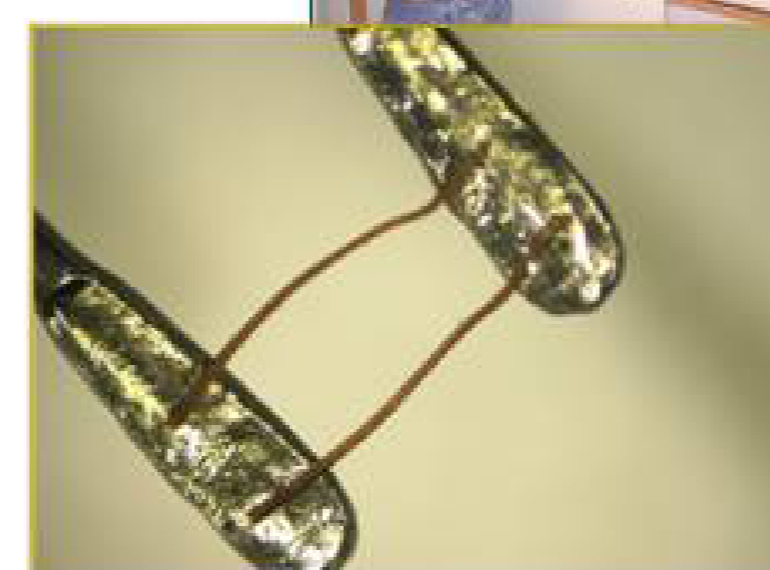
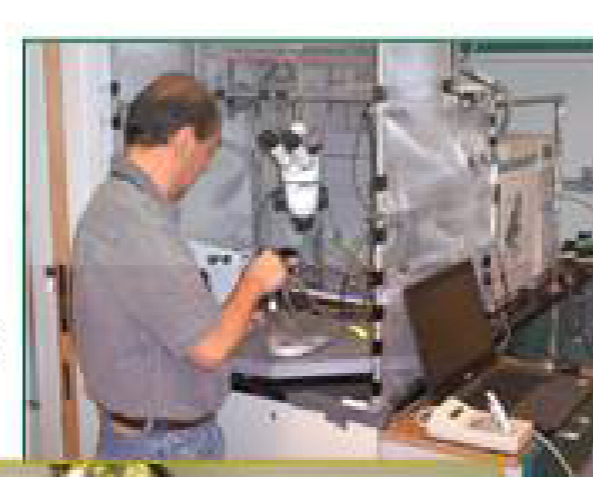
- Volatile emissions similar to 2009
 - Increased # of collections providing more accurate emission trends (11 vs. 4)
 - Trends providing "dynamic blends"
- Application of GC-FID for better quantitation of volatiles
 - Allowed for enhanced analysis of emission trends
 - Allowed for more blend formulations
 - GC-MS still used for identification



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2010 Volatiles Undergoing Bioassays:

- EAG Analysis
 - Several blends
 - Dynamic vs. static orchard emissions
 - Comparison to BLND.V and Almond Meal
- Flight Tunnel
 - To corroborate EAG results
- Field Studies
 - Top blends for field trapping studies in 2011
- Mix with other attractants



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 - Jennifer Hayashi



Orchard Air
Ambient Orchard Volatile Collection

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