Ambient Orchard Volatiles as Attractants for Navel Orangeworm Monitoring

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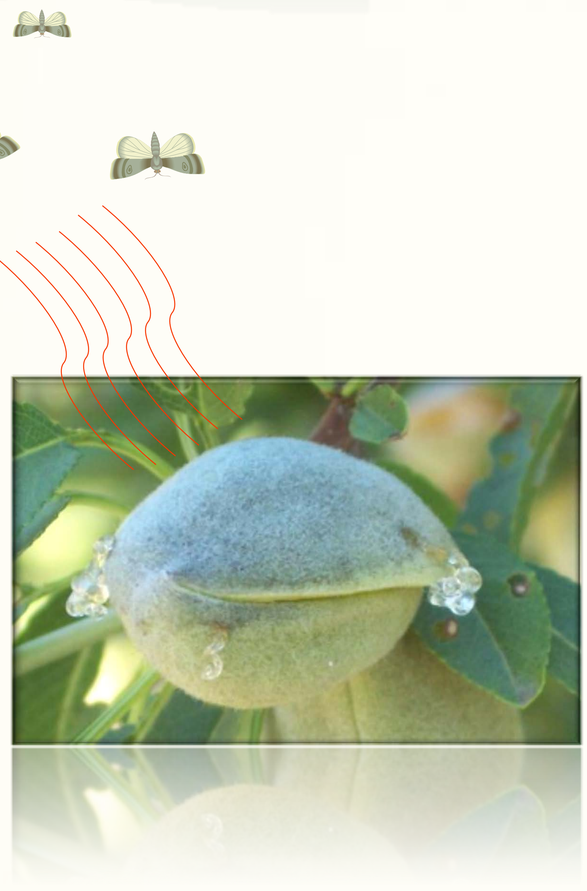

The Premise:
navel orangeworm attracted to damaged nuts (Brad Higbee)

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Hull Split and Damaged Almond Volatiles Attract Male and Female Navel Orangeworm Moths

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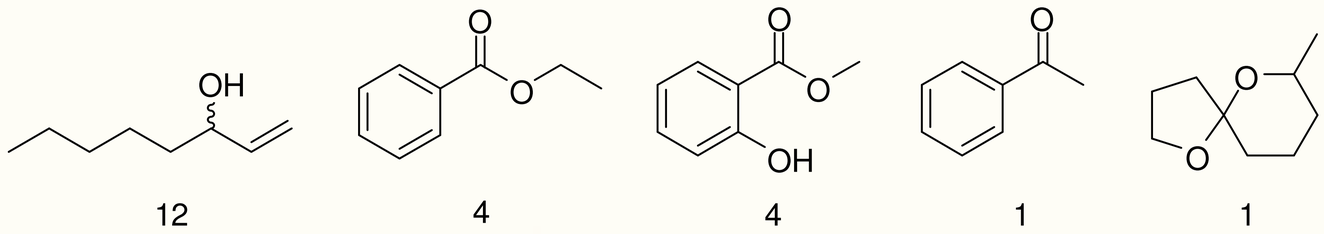
ABSTRACT: A blend of volatiles derived from the emissions of almonds at hull split and mechanically damaged almonds was compared to almond meal, the current monitoring standard for the insect pest navel orangeworm (NOW). Field trapping studies were performed to determine the blend's ability to attract adult NOW. The blend comprised racemic 1-octen-3-ol, ethyl benzoate, methyl salicylate, acetophenone, and racemic (*E*)-conophthorin. Ethyl acetate was used as a solvent with a blend component concentration of 100 mg/mL. The blend attracted both sexes of NOW when tested in five 2-week intervals spanning the first three flights of NOW in commercial almond orchards in the southern Central Valley of California. The blend demonstrated consistently higher capture rates for female NOW throughout the evaluation period, but unlike almond meal it significantly attracted males. Reported is a survey of the major and minor volatiles emitted from almonds at hull split, the key period of vulnerability to NOW infestation. Also reported is the attractancy of a formulated test blend based on the host plant volatile emissions, electroantennographic screening experiments, and field trapping studies. The results of this test blend highlight progress toward a host-plant-based attractant for NOW, a major insect pest of California tree nuts that presently lacks an adequate monitoring tool.

KEYWORDS: *almond, Amyelois transitella, field trapping, navel orangeworm, Prunus dulcis, semiochemical, volatile*

The Goal:
formulate a blend of HPVs to attract the navel orangeworm

EtOAc as solvent
200 mg/2 mL
2011 season



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2011 Results (overview)

Orchard	Treatment	Moths Captured NOW Total	Female	Male
Almond	Blend	155	59	96
	Meal	20	19	1
	Blank	2	1	1
Pistachio	Blend	32	20	12
	Meal	2	2	0
	Blank	0	0	0

2012 Results (preliminary)

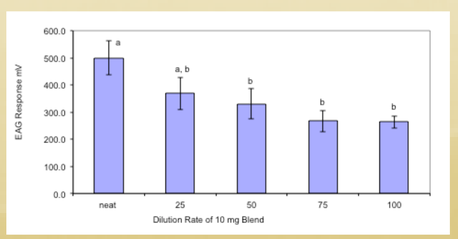
Orchard	Treatment	Moths Captured (2012) NOW Total	Female	Male
Almond	Blend	540	285	255
	Blend (membrane)	70	29	41
	Meal	40	33	7
	Blank	3	1	2
Pistachio	Blend	107	66	41
	Blend (membrane)	51	16	35
	Meal	29	25	4
	Blank	0	0	0

test interval[b]	Flt	*N*	moths	Treatment[a] host plant blend[c]	almond meal	blank	One-way ANOVA	males in virgin female-baited traps (range)
April[d]	1	10	NOW	11.30 ± 1.97 a	1.60 ± 0.34 b	0.10 ± 0.10 c	$F = 27.87$; df: 2, 27; $P < 0.001$	
			female	4.40 ± 0.97 a[f]	1.60 ± 0.34 b[f]	0 c	$F = 13.64$; df: 2, 27; $P < 0.001$	
			male	6.90 ± 1.10 a[f]	0 b[f]	0.10 ± 0.10 b	$F = 38.86$; df: 2, 27; $P < 0.001$	86.57 ± 18.74 (27–183)
May	1	5	NOW	1.60 ± 0.60 a	0.20 ± 0.20 b	0 b	$F = 6.91$; df: 2, 12; $P = 0.018$	
			female	0.60 ± 0.25	0.20 ± 0.20	0	$F = 3.50$; df: 2, 12; $P = 0.081$	
			male	1.00 ± 0.63	0	0	$F = 2.50$; df: 2, 12; $P = 0.143$	20.60 ± 13.34 (0–105)
June	2	7	NOW	1.14 ± 0.26 a	0 b	0 b	$F = 19.20$; df: 2, 18; $P < 0.001$	
			female	0.43 ± 0.20 a	0 b	0 b	$F = 4.50$; df: 2, 18; $P = 0.035$	
			male	0.76 ± 0.29 a	0 b	0 b	$F = 6.25$; df: 2, 18; $P = 0.014$	26.80 ± 10.00 (0–102)
July	2	9	NOW	2.00 ± 0.58 a	0.22 ± 0.22 b	0.11 ± 0.11 b	$F = 11.74$; df: 2, 24; $P < 0.001$	
			female	0.44 ± 0.24	0.11 ± 0.11	0.11 ± 0.11	$F = 1.14$; df: 2, 24; $P = 0.344$	
			male	1.56 ± 0.63 a	0.11 ± 0.11 b	0 b	$F = 6.34$; df: 2, 24; $P = 0.009$	17.80 ± 6.54 (0–52)
August	3	7	NOW	1.14 ± 0.40 a	0.14 ± 0.14 b	0 b	$F = 6.22$; df: 2, 18; $P = 0.014$	
			female	0.71 ± 0.42	0.14 ± 0.14	0	$F = 2.25$; df: 2, 18; $P = 0.148$	
			male	0.43 ± 0.20 a	0 b	0 b	$F = 4.50$; df: 2, 18; $P = 0.035$	30.00 ± 10.28 (2–85)
overall		38	NOW	4.08 ± 0.89 a	0.53 ± 0.15 b	0.05 ± 0.04 b	$F = 20.19$; df: 2, 111; $P < 0.001$	
			female	1.55 ± 0.39 a[f]	0.50 ± 0.15 b[f]	0.03 ± 0.03 b	$F = 12.72$; df: 2, 111; $P < 0.001$	
			male	2.53 ± 0.54 a[f]	0.03 ± 0.03 b[f]	0.03 ± 0.03 b	$F = 21.46$; df: 2, 111; $P < 0.001$	
total[e]			NOW	155	20	2		
			female	59	19	1		
			male	96	1	1		

[a]Capture values are means ± SE. Data in rows followed by different letters are significantly different ($P < 0.05$), by one-way, repeated measures ANOVA followed by all pairwise multiple comparisons by Fisher LSD method. [b]April, 4/30–5/5 May, 5/13–5/27; June, 6/17–7/1; July, 7/2–7/17; August, 8/5–8/19. [c]Females captured in May–August traps baited with the Blend were all mated and with one spermatophore. [d]Five-day period. [e]Total, combined captures over all test periods. [f]Significant difference between male and female captures, by paired *t* test, $P < 0.005$.

Results Highlights

Blend consistently outperforms almond meal in both orchards
NOW in almonds more responsive to Blend later in season compared to pistachio
In 2011 almond meal ca. 2x the capture of females
In 2011 & 2012 pistachio captured more female NOW



Student's *t* test.

Multidisciplinary Project

Portions of this Research were conducted under the following projects:
- TFCA 5325-42000-037-05 Almond Board of California
- TFCA 5325-42000-037-07 California Pistachio Research Board
- CRADA 58–3K95–7–1198 Paramount Farming Company
- RCA 5325-42000-037-13 California Department of Food and Agriculture
- SCA 5325-42000-037-10 University of California, Riverside
- USDA-ARS CRIS Project 5325–42000–037–00D