APPENDIX:

Table A: Partial List of Citations for "Non-Acute" Bee-Toxic Pesticides

CHEMICAL NAME	TRADE NAME	FUNCTION	EFFECT ON COLONY	SOURCE
Captan	Captan	Fungicide	Toxic to honey bee larvae	(Mussen, Lopez, and Peng 2004)
Chlorantraniliprole	Altacor	Insecticide	Synergistically toxic to honey bee larvae when mixed with certain fungicides	(Wade et al. 2019)
Chlorothalonil	Equus, Initiate, Bravo	Fungicide	Effects honey bee larvae, and synergistically toxic with other agrochemicals	(Zhu et al. 2014)
Difenoconazole	Quadris Top	Fungicide	Affects thermoregulation Short-term synergistic toxicity to honey bees when tank-mixed with tau-fluvalinate	(Vandame and Belzunces 1998; Lefebvre, B. & Bassand 2001)
Diflubenzuron	Dimilin	Insect growth regulator (insecticide)	Effects honey bee learning; increased larval mortality	(Abramson et al. 2004; Chandel and Gupta 1992; Wade et al. 2019)
Flubendiamide	Belt, Synapse	Insecticide	Possible effects on honey bee larvae development	(Hall 2007)
Iprodione	Nevado, Rovral	Fungicide	Increased honey bee larval mortality when mixed with insecticides (e.g. chlorantraniliprole). Increased adult bee mortality alone and in combination with other fungicides	(Wade et al. 2019; Fisher II et al. 2017)

Methoxyfenozide	Intrepid	Insect growth regulator (insecticide)	Spray applications caused increased adult honey bee mortality	(Fisher II et al. 2018)
N/A	Dyne-Amic	Organosilicone surfactant adjuvant	Significantly reduces honeybee learning ability	(Ciarlo et al. 2012)
N/A	Syl-Tac	Organosilicone surfactant adjuvant	Significantly reduces honeybee learning ability	(Ciarlo et al. 2012)
N/A	Sylgard 309	Organosilicone surfactant adjuvant	Significantly reduces honeybee learning ability; combination of viral exposure and surfactant increased mortality	(Ciarlo et al. 2012; Fine, Cox-Foster, and Mullin 2016)
N/A	Silwet L-77	Organosilicone surfactant adjuvant	Significantly reduces honeybee learning ability	(Ciarlo et al. 2012)
Paraquat Dichloride	Gramoxone	Herbicide	Disrupts larval development	(Cousin et al. 2013)
Propiconazole	Banner Maxx, Bumper, Dorado, Kestrel, Propicure, Protocol, Quilt, Tilt	Fungicide	Synergistically toxic when mixed with some insecticides	(Wade et al. 2019; Sanchez-Bayo and Goka 2014)
Pyriproxyfen	Seize	Insect growth regulator (insecticide)	Increased mortality in foraging honey bees	(Fisher II et al. 2018)
Ziram	Ziram	Fungicide	Toxic to honey bee larvae	(Mussen, Lopez, and Peng 2004)

Table B: Pesticides and Herbicides Included in Analysis. US EPA Toxicity Ratings were derived from the PNW 591 (Hooven et al. 2016), and "Possible Synergy" and "UC IPM Tier" columns derived from UC IPM website on Bee Precaution Ratings (UC IPM n.d.).

CHEMICAL NAME	CLASS	LABEL STATUS	TOXICITY RATING (US EPA)	POSSIBLE SYNERGY	UC IPM Tier
ABAMECTIN	INSECTICIDE/ MITICIDE	PS	HIGHLY TOXIC		I
CARBARYL	CARBAMATE INSECTICIDE	PS	HIGHLY TOXIC		I
CHLORPYRIFOS	ORGANOPHOSPHATE	PS	HIGHLY TOXIC	Y	I
ESFENVALERATE	PYRETHROID INSECTICIDE	PS	HIGHLY TOXIC	Y	I
LAMBDA-CYHALOTHRIN	PYRETHROID INSECTICIDE	PS	HIGHLY TOXIC	Y	I
THIAMETHOXAM	NEONICOTINOID INSECTICIDE	PS	HIGHLY TOXIC	Y	I
BIFENTHRIN	PYRETHROID INSECTICIDE	PS	HIGHLY TOXIC	Y	I
PERMETHRIN	PYRETHROID INSECTICIDE	PS	HIGHLY TOXIC	Y	I
ACETAMIPRID	NEONICOTINOID INSECTICIDE	PS	HIGHLY TOXIC	Y	II
COPPER HYDROXIDE	FUNGICIDE	PS	TOXIC		II
SPINETORAM	SPINOSYN INSECTICIDE	PS	TOXIC	Y	II
SPINOSAD	SPINOSYN INSECTICIDE	PS	TOXIC	Y	II
AZOXYSTROBIN	FUNGICIDE	NO PS	N/A	Y	III
BOSCALID	FUNGICIDE	NO PS	N/A	Y	II
BUPROFEZIN	IGR	NO PS	N/A		II
CAPTAN	FUNGICIDE	NO PS	N/A		II

CHLORANTRANILIPROLE	DIAMIDE INSECTICIDE	NO PS	N/A	Y	III
CHLOROTHALONIL	FUNGICIDE	NO PS	N/A	Y	II
CLOFENTEZINE	INSECTICIDE/ MITICIDE	NO PS	N/A		III
CYPRODINIL	FUNGICIDE	NO PS	N/A	Y	III
DIFENOCONAZOLE	FUNGICIDE	NO PS	N/A	Y	II
DIFLUBENZERON	IGR	NO PS	N/A	Y	II
ETOXAZOLE	INSECTICIDE/ MITICIDE	NO PS	N/A		II
FENBUCONAZOLE	FUNGICIDE	NO PS	N/A	Y	III
FLUBENDIAMIDE	DIAMIDE INSECTICIDE	NO PS	N/A		II
GLYPHOSATE	HERBICIDE	NO PS	N/A		II
IPRODIONE	FUNGICIDE	NO PS	N/A	Y	II
METCONAZOLE	FUNGICIDE	NO PS	N/A	Y	III
METHOXYFENOZIDE	IGR	NO PS	N/A	Y	II
MYCLOBUTANIL	FUNGICIDE	NO PS	N/A	Y	II
PARAQUAT DICHLORIDE	HERBICIDE	NO PS	N/A		II
PROPICONAZOLE	FUNGICIDE	NO PS	N/A	Y	II
PYRACLOSTROBIN	FUNGICIDE	NO PS	N/A	Y	III
PYRIPROXYFEN	IGR	NO PS	N/A		II
TEBUFENOZIDE	IGR	NO PS	N/A	Y	II

ZIRAM	FUNGICIDE	NO PS	N/A		II

Table C: Organosilicone Surfactants (Adjuvants) Included in Analysis. Organosilicone surfactants are not considered pesticides and thus have no precautionary statements or EPA toxicity ratings.

TRADE NAME
BREAK-THRU
BREAK-THRU S 233
BREAK-THRU S 240
BREAK-THRU S 321
BREAK-THRU T&O
DYNE-AMIC
FIRST CHOICE BREAK-THRU
FIRST CHOICE BREAK-THRU SUPER PENETRANT
KINETIC
SILWET ECO SPREADER WATER REDUCING ADJUVANT
SILWET L-77
SILWET L-77 SURFACTANT
SYL-TAC
SYL-TAC-EA
SYLGARD 309
SYLGARD 309 SILICONE SURFACTANT
AG RX MULTI-SPRED
FREEWAY
LEAF LIFE ORGANICS WIDESPREAD ORGANIC
LEAF LIFE WIDESPREAD ORGANIC
MULTI-SPRED
PRO MULTI-SPRED
RNA SI 100
RNA SI 1000
WIDESPREAD
WIDESPREAD MAX

Table D: Regressions of Active Ingredient Applied per Bearing Acre of Almonds for Agrochemicals in Table B on Annual Trend

	Dependent Variable: Active Ingredient/Bearing Acre of Almonds			
	(1)	(2)	(3)	(4)
1990-2016 Trend Coefficients				
All Pesticides	-0.092*** (0.007)			
No Precautionary Statement		-0.087*** (0.005)		
Precautionary Statement		-0.007 (0.006)		
Highly Toxic			0.0004 (0.006)	
Non-Acutely Toxic			-0.087*** (0.005)	
Moderately Toxic			-0.007* (0.005)	
Fungicides				-0.093*** (0.004)
Herbicides				-0.001 (0.004)
IGR				-0.001 (0.010)
All Other Insecticides				0.001 (0.004)
Categorical Control Variables				
Label Status: Precautionary Statement		-162.441*** (15.454)		
Rating: Non-Acutely Toxic			176.452*** (14.644)	
Rating: Moderately Toxic			14.745 (15.293)	
Type of Pesticide: Herbicide				-186.370*** (11.608)
Type of Pesticide: IGR				-188.996*** (20.821)
Type of Pesticide: Other Insecticide				-189.073*** (12.068)
County: Kern	-0.722*** (0.221)	-0.369*** (0.117)	-0.266*** (0.088)	-0.206*** (0.066)
County: Kings	-0.434** (0.219)	-0.200* (0.117)	-0.130 (0.090)	-0.118* (0.070)
County: Madera	-0.417* (0.247)	-0.203 (0.128)	-0.134 (0.094)	-0.118 (0.072)
County: Merced	-0.345 (0.219)	-0.172 (0.113)	-0.114 (0.081)	-0.097 (0.065)
County: San Joaquin	-0.451** (0.219)	-0.226** (0.113)	-0.151* (0.081)	-0.127* (0.065)
County: Stanislaus	-0.377* (0.219)	-0.189* (0.113)	-0.126 (0.080)	-0.107* (0.064)
County: Tulare	-0.817*** (0.219)	-0.423*** (0.116)	-0.323*** (0.090)	-0.241*** (0.066)
Constant	186.796*** (14.798)	175.855*** (10.705)	-0.589 (11.386)	187.792*** (8.129)
Observations	206	393	526	692
R2	0.48	0.6	0.64	0.69
Adjusted R2	0.46	0.59	0.63	0.68
Residual Std. Error	0.80 (df = 197)	0.59 (df = 382)	0.508 (df = 513)	0.45 (df = 677)
F Statistic	22.35*** (df = 8; 197)	57.90*** (df = 10; 382)	75.80*** (df = 12; 513)	105.38*** (df = 14; 677)

Note: Coefficient Estimate *p<0.1; **p<0.05; ***p<0.01; (Standard Error)

Table E: Regressions of Applications per Bearing Acre of Almonds for agrochemicals in Table B on Annual Trend

	Dependent Variable: Applications/Bearing Acre of Almonds			
	(1)	(2)	(3)	(4)
1990-2016 Trend Coefficients				
All Pesticides	-0.0001*** (0.0001)			
No Precautionary Statement		-0.00003 (0.00005)		
Precautionary Statement		-0.0001** (0.0001)		
Highly Toxic			0.00003 (0.0001)	
Non-Acutely Toxic			-0.00003 (0.00004)	
Moderately Toxic			-0.0001*** (0.00005)	
Fungicides				-0.0002*** (0.00004)
Herbicides				-0.00004 (0.00004)
IGR				0.0001 (0.0001)
All Other Insecticides				0.0001 (0.00005)
Categorical Control Variables				
Label Status: Precautionary Statement		0.170 (0.138)		
Rating: Non-Acutely Toxic			0.148 (0.1398)	
Rating: Moderately Toxic			0.3357** (0.146)	
Type of Pesticide: Herbicide				-0.327*** (0.125)
Type of Pesticide: IGR				-0.562** (0.224)
Type of Pesticide: Other Insecticide				-0.514*** (0.130)
County: Kern	-0.010*** (0.002)	-0.005*** (0.001)	-0.005*** (0.001)	-0.003*** (0.001)
County: Kings	-0.001 (0.002)	-0.0003 (0.001)	-0.0005 (0.001)	-0.0003 (0.001)
County: Madera	0.003 (0.002)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
County: Merced	0.008*** (0.002)	0.004*** (0.001)	0.003*** (0.001)	0.002*** (0.001)
County: San Joaquin	0.011*** (0.002)	0.006*** (0.001)	0.004*** (0.001)	0.003*** (0.001)
County: Stanislaus	0.014*** (0.002)	0.007*** (0.001)	0.005*** (0.001)	0.004*** (0.001)
County: Tulare	-0.008*** (0.002)	-0.004*** (0.00005)	-0.004*** (0.001)	-0.002*** (0.001)
Constant	0.264*** (0.119)	0.274*** (0.090)	-0.066 (0.108)	0.412*** (0.088)
Observations	206	393	526	692
R2	0.62	0.81	0.83	0.8
Adjusted R2	0.6	0.81	0.82	0.8
Residual Std. Error	0.01 (df = 197)	0.005 (df = 382)	0.005 (df = 513)	0.005 (df = 677)
F Statistic	40.64*** (df = 8; 197)	165.37*** (df = 10; 382)	204.48*** (df = 12; 513)	197.31*** (df = 14; 677)

Note: Coefficient Estimate *p<0.1; **p<0.05; ***p<0.01; (Standard Error)

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Table F: Regressions of Organosilicone Surfactants (Table C) per Bearing Acre of Almonds on Annual Trend

	Dependent Variables:			
	Pounds/Bearing Acre of Almonds		Applications/Bearing Acre of Almonds	
	(1)	(2)	(3)	(4)
1990-2016 Trend Coefficients				
All Adjuvants	0.008*** (0.001)		0.0005*** (0.00005)	
Sublethal		0.007*** (0.001)		0.0003*** (0.00004)
Unknown		0.001 (0.001)		0.0001** (0.0001)
Categorical Control Variables				
Toxicity Rating: Unknown		10.562*** (2.501)		0.394*** (0.127)
County: Kern	-0.047* (0.024)	-0.025* (0.014)	-0.003** (0.001)	-0.001** (0.001)
County: Kings	0.003 (0.027)	0.004 (0.017)	-0.0004 (0.001)	-0.0002 (0.001)
County: Madera	0.033 (0.026)	0.019 (0.015)	0.002 (0.001)	0.001* (0.001)
County: Merced	0.130*** (0.024)	0.073*** (0.014)	0.007*** (0.001)	0.004*** (0.001)
County: San Joaquin	0.031 (0.024)	0.017 (0.014)	0.007*** (0.001)	0.004*** (0.001)
County: Stanislaus	0.041* (0.024)	0.023 (0.014)	0.007*** (0.001)	0.004*** (0.001)
County: Tulare	-0.064** (0.025)	-0.037** (0.015)	-0.002* (0.001)	-0.001* (0.001)
Constant	-16.156*** (1.906)	-13.352*** (1.479)	-0.927*** (0.098)	-0.657*** (0.075)
Observations	175	300	175	300
R2	0.484	0.487	0.591	0.514
Adjusted R2	0.46	0.47	0.572	0.497
Residual Std. Error	0.083 (df = 166)	0.064 (df = 289)	0.004 (df = 166)	0.003 (df = 289)
F Statistic	19.500*** (df = 8; 166)	27.489*** (df = 10; 289)	30.035*** (df = 8; 166)	30.557*** (df = 10; 289)

Note: Coefficient Estimate *p<0.1; **p<0.05; ***p<0.01; (Standard Error)

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