Appendix A. Multi-Active Ingredients Product Analysis for Bifenthrin

The Agency does not routinely include, in its risk assessments, an evaluation of mixtures of active ingredients, either those mixtures of multiple active ingredients in product formulations or those in the applicator's tank. In the case of the product formulations of active ingredients (that is, a registered product containing more than one active ingredient), each active ingredient is subject to an individual risk assessment for regulatory decision regarding the active ingredient on a particular use site. If effects data are available for a formulated product containing more than one active ingredient, they may be used qualitatively or quantitatively (USEPA, 2004; USFWS/NMFS/NOAA, 2004).

Analysis of the available open literature and acute oral mammalian LD_{50} data for multiple active ingredient products relative to the single active ingredient is provided below. This data set is limited and a qualitative analysis does not support any broad conclusions about the interactive nature of bifenthrin in combination with other pesticides.

Bifenthrin has registered products that contain multiple active ingredients; there are 90 multi-active ingredient products containing bifenthrin, which were evaluated in this review. Bifenthrin can be formulated with imidacloprid, dicrotophos, *zeta*-cypermethrin, spinosad, and atrazine, among other pesticides. There is one product that is co-formulated with MGK 264, a known synergist. Further, there are no registered co-formulated products containing bifenthrin and piperonyl butoxide (PBO), another known synergist; however, EFED is aware of at least one product containing PBO that can be tank mixed with bifenthrin. Acute oral toxicity data (*i.e.*, LD_{50} values) from mammalian studies for formulated products that contain bifenthrin and one or more additional active ingredients are summarized in **Table A.1** below. The results of an open literature search for data on formulated products that contain bifenthrin using the EPA ECOTOX database starting on page 30 of this appendix.

Currently, the Agency's guidance for assessing the potential risk of chemical mixtures is limited to human health applications; however, the guidance includes principles for evaluating mixtures to assess potential interactive effects that are generally applicable. Consistent with EPA's Overview Document (USEPA, 2004), the Agency's mixture guidance discusses limitations in quantifying the risk of specified mixtures when there is differential degradation, transport and fate of chemical components following environmental release or application. The LD_{50} values are potentially useful only to the extent that a wild mammal would consume plants or animals immediately after these dietary items were directly sprayed by the product. Increasing time post application, the differential rates of degradation, transport, *etc*. for the active ingredients in the formulation only permit a qualitative discussion of potential acute risk (USEPA, 2004).

A quantitative component-based evaluation of mixture toxicity requires data of appropriate quality for each component of a mixture. In this mixture evaluation LD_{50}s, with associated 95% confidence intervals, are needed for the formulated product. The same quality of data is also required for each component of the mixture. Given that some of the formulated products do not have LD_{50} values of the required quality and since LD_{50} values are not available for all the components of these formulations, a quantitative analysis of potential interactive effects is not possible with currently accepted scientific methods. As a screening tool, a qualitative analysis can be used to indicate if formulated products exhibit interactive effects (*e.g.*, synergism or antagonism). The logic behind the analysis of the multiple active ingredient product analysis, from mammalian toxicity data is that if there are multiple studies with the technical formulation for which confidence intervals (CI) are provided for the LD_{50}, then the CI with the smallest lower CI for the LD_{50} (*i.e.*, most toxic LD_{50},) after correcting for %AI, is compared to the LD_{50} upper CI for each formulation, after correcting for %AI. If these confidence intervals do not overlap, then the formulated mixture is considered to be more toxic. When the product LD_{50}s, and associated confidence intervals, are adjusted for the percent bifenthrin (a conservative assumption that attributes all of the observed toxicity of the formulated product to bifenthrin); based on this approach, the Health Effects Division (HED) can reach one of three conclusions for the formulations:

- Formulation is no more toxic than single active ingredient
- Formulation is more toxic than single active ingredient
- There is insufficient data to establish difference toxicity

In the case of bifenthrin, a qualitative examination of the trends in LD_{50} values, with the associated confidence intervals, across the range of percent active ingredient, reveals no definitive conclusions. In all instances where there is sufficient data, it was concluded that the formulation is no more toxic than the single active ingredient. Additionally, there were several products for which the data was insufficient to establish a difference in toxicity.

There are several studies on mixture analysis in the open literature (page 30). Four of them are highlighted in this summary as examples of the broad range of responses of mixtures of bifenthrin (see p. 30 for further details). Zhang *et al.* (2008) evaluated the toxicity of 50:50 mixtures of bifenthrin and dichlorvos and phoxim done through feeding the silkworm (*Bombyx mori*) with treated mulberry leaves, *Morus albus* (L.). Based on their analysis, it was concluded that bifenthrin: dichlorvos and bifenthrin: phoxim mixtures had additive effects. In another study (Wang *et al.* 2009), the acute toxicity of the organophosphate insecticide monocrotophos (MCP) to *Daphnia magna* was determined alone and in mixtures with bifenthrin. Using a toxic unit (TU) approach, it was determined that the TU for the mixture of bifenthrin and MCP was 1.2 suggesting a limited antagonistic effect against *D. magna*, since the value was close to unity. In a study by Zhang *et al.* (2010), for a series of pesticides and their 50:50 mixtures, toxicity tests were conducted for the zebrafish (*Brachydanio rerio*). It was concluded that the bifenthrin: dichlorvos mixture shows antagonism, while the bifenthrin: phoxim mixture shows additive effects. Weston and coworkers have conducted sediment toxicity studies for synthetic pyrethroids. In one study it was found that the presence of PBO in the overlaying water could cause an increase of the toxicity of pyrethroids present in the sediment to the amphipod *Hyalella azteca* (Weston *et al.* 2006). PBO is co-applied with pyrethrins for mosquito control. PBO concentrations of 2−4 µg/L caused a two-fold increase of the toxicity to the amphipod in sediments.

Based on a qualitative evaluation of the best available data and the Agency's existing guidance, it is reasonable to conclude that these formulations may exhibit a synergistic effect in some instances. Given that the active and inert ingredients would not be expected to have similar mechanisms of action, metabolites or toxicokinetic behavior it is also reasonable to conclude that an assumption of dose-addition would be inappropriate in some instances. However, the limited size of the data set and the variation in co-formulated pesticides prohibits any definitive conclusions. Consequently, an assessment of bifenthrin potential effect when it is co-formulated with other active ingredients will be based on the toxicity of bifenthrin.

References:

USEPA. 2004. *Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs*. United States Environmental Protection Agency (USEPA). Environmental Fate and Effects Division. Office of Pesticide Programs. Available at http://www.epa.gov/espp/consultation/ecorisk-overview.pdf (Accessed 12/05/2002).

[See other references starting in page 30.]

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
LD50 Information on Technicals											
	279-EUP-101		91.40%	Bifenthrin	132519	70.1	44.5	53.8	44.2	56.7	46.5
	70506-18	BIFENTHRIN TECHNICAL INSECTICIDE/MITICIDE	99.20%	Bifenthrin	45654404	66.19	54.48	91.89	26.67	74.9	57.29
	2749-544	BIFENTHRIN TECHNICAL	96.00%	Bifenthrin	47902604	58.4	43	43	29.5		
	11678-66	BIFENTHRIN TECHNICAL	99.20%	Bifenthrin	46029701			54	26		
	5481-505	TECHNICAL BIFENTHRIN INSECTICIDE/MITICIDE	96.20%	Bifenthrin	46821105			175	42.89		
LD50 Information											
1	228-557	ATERA GC 2+1 SC INSECTICIDE	21.29	Imidacloprid							
	228-557	ATERA GC 2+1 SC INSECTICIDE	10.64	Bifenthrin	47184304	not done	not done	550	196.1	not done	not done
2	228-559	NUP06211 GC INSECTICIDE	4	Bifenthrin							
	228-559	NUP06211 GC INSECTICIDE	5	Imidacloprid	cited MRID 47184304 (228-557)						
3	228-560	NUP 06211	4	Bifenthrin	cited MRID 47184304 (228-557)						
	228-560	NUP 06211	5	Imidacloprid							
4	228-574	ATERA GC GRANULAR INSECTICIDE	0.16	Bifenthrin	47341503	not done	not done	>5000	not done	not done	not done
	228-574	ATERA GC GRANULAR INSECTICIDE	0.31	Imidacloprid							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
5	228-575	ATERA LC GRANULAR INSECTICIDE	0.31	Imidacloprid							
	228-575	ATERA LC GRANULAR INSECTICIDE	0.16	Bifenthrin	cited MRID 47341503 (228-574)						
6	228-576	ATERA 0.36 GC GRANULAR INSECTICIDE	0.16	Bifenthrin	cited MRID 47341503 (228-574)						
	228-576	ATERA 0.36 GC GRANULAR INSECTICIDE	0.2	Imidacloprid							
7	228-577	ATERA 0.36 LC GRANULAR INSECTICIDE	0.2	Imidacloprid							
	228-577	ATERA 0.36 LC GRANULAR INSECTICIDE	0.16	Bifenthrin	cited MRID 47341503 (228-574)						
8	228-578	ATERA 0.3 GC FERTILIZER INSECTICIDE	0.2	Imidacloprid							
	228-578	ATERA 0.3 GC FERTILIZER INSECTICIDE	0.1	Bifenthrin	47367403	not done	not done	>5000	not done	not done	not done
9	228-579	ATERA 0.3 LC FERTILIZER INSECTICIDE	0.1	Bifenthrin							
	228-579	ATERA 0.3 LC FERTILIZER INSECTICIDE	0.2	Imidacloprid							
10	228-580	ATERA 0.225 GC FERTILIZER INSECTICIDE	0.1	Bifenthrin	cited MRID 47367403 (228-580)						

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
	228-580	ATERA 0.225 GC FERTILIZER INSECTICIDE	0.125	Imidacloprid							
11	228-581	ATERA 0.225 LC FERTILIZER INSECTICIDE	0.1	Bifenthrin	cited MRID 47367403 (228-580)						
	228-581	ATERA 0.225 LC FERTILIZER INSECTICIDE	0.125	Imidacloprid							
12	228-582	ATERA 0.18 GC FERTILIZER INSECTICIDE	0.08	Bifenthrin	cited MRID 47367403 (228-580)						
	228-582	ATERA 0.18 GC FERTILIZER INSECTICIDE	0.1	Imidacloprid							
13	228-583	ATERA 0.18 LC FERTILIZER INSECTICIDE	0.08	Bifenthrin	cited MRID 47367403 (228-580)						
	228-583	ATERA 0.18 LC FERTILIZER INSECTICIDE	0.1	Imidacloprid							
14	228-584	ATERA 0.15 GC FERTILIZER INSECTICIDE	0.083	Imidacloprid							
	228-584	ATERA 0.15 GC FERTILIZER INSECTICIDE	0.067	Bifenthrin	cited MRID 47367403 (228-580)						
15	228-585	ATERA 0.15 LC FERTILIZER INSECTICIDE	0.083	Imidacloprid							
	228-585	ATERA 0.15 LC FERTILIZER INSECTICIDE	0.067	Bifenthrin	cited MRID 47367403 (228-580)						

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
16	239-2695	HOME DEFENSE MAX PERIMETER INSECT KILLER AEROSOL(1)	0.05	Bifenthrin	47311103	not done	not done	>5000	not done	not done	not done
	239-2695	HOME DEFENSE MAX PERIMETER INSECT KILLER AEROSOL(1)	0.03	Prallethrin							
17	239-2697	HOME DEFENSE MAX PERIMETER INSECT KILLER AEROSOL (2)	0.1	Imiprothrin							
	239-2697	HOME DEFENSE MAX PERIMETER INSECT KILLER AEROSOL (2)	0.05	Bifenthrin	47311303	not done	not done	>5000	not done	not done	not done
18	239-2701	ORTHO INSECTICIDE GRANULE	0.115	Bifenthrin	47838603	not done	not done	>5000	not done	not done	not done
	239-2701	ORTHO INSECTICIDE GRANULE	0.06	Chlorantranili prole							
19	239-2714	ORTHO ZB FAK	0.05	Zeta-Cypermethrin							
	239-2714	ORTHO ZB FAK	0.2	Bifenthrin	Similar to 279-3344 (MRID 47361702)						
20	239-2715	ORTHO ZB GRANULES	0.029	Zeta-Cypermethrin							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
	239-2715	ORTHO ZB GRANULES	0.115	Bifenthrin	Similar to 279-3346 (MRID 47361702)						
21	239-2717	ORTHO HOME DEFENSE INDOOR & OUTDOOR INSECT KILLER	0.0125	Zeta-Cypermethrin							
	239-2717	ORTHO HOME DEFENSE INDOOR & OUTDOOR INSECT KILLER	0.05	Bifenthrin	Similar to 279-9534 (MRID 48391302)						
22	239-2718	ORTHO BUG B GON/HOME DEFENSE-RTS/CONCENTRATE	0.075	Zeta-Cypermethrin							
	239-2718	ORTHO BUG B GON/HOME DEFENSE-RTS/CONCENTRATE	0.3	Bifenthrin	Similar to 279-9535 (MRID 48391302)						
23	239-2719	ORTHO BUG B GON/HOME DEFENSE-CONCENTRATE	0.075	Zeta-Cypermethrin							
	239-2719	ORTHO BUG B GON/HOME DEFENSE-CONCENTRATE	0.3	Bifenthrin	Similar to 279-9535 (MRID 48391302)						

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
24	239-2720	ORTHO ZBP GRANULES	0.115	Bifenthrin	No study submitted - Similar to ?						
	239-2720	ORTHO ZBP GRANULES	0.029	Zeta-Cypermethrin							
25	279-3257	DOUBLE THREAT INSECTICIDE	44.2	Spinosad	No study submitted - Similar to ?						
	279-3257	DOUBLE THREAT INSECTICIDE	25.1	Bifenthrin							
26	279-3271	DOUBLE THREAT INSECTICIDE	10.7	Spinosad							
	279-3271	DOUBLE THREAT INSECTICIDE	12.2	Bifenthrin	45730303	167	135	137	117	153	126
27	279-3314	F5997 ME INSECTICIDE/MITICIDE	0.5	Pyriproxyfen							
	279-3314	F5997 ME INSECTICIDE/MITICIDE	8	Bifenthrin	46888502	not done	not done	981.1	550	not done	not done
28	279-3315	HERO INSECTICIDE	3.75	Zeta-Cypermethrin							
	279-3315	HERO INSECTICIDE	11.25	Bifenthrin	46894602	not done	not done	550	92.34	not done	not done
29	279-3329	F6126 EW INSECTICIDE	9.72	Bifenthrin	47171002	175	29.03	not done	not done	not done	not done

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
	279-3329	F6126 EW INSECTICIDE	3.24	Zeta-Cypermethrin							
30	279-3332	BRIGADIER (R) INSECTICIDE	11.3	Bifenthrin	47222602	not done	not done	175	0	not done	not done
	279-3332	BRIGADIER (R) INSECTICIDE	11.3	Imidacloprid							
31	279-3339	LAWN INSECT CONTROL 2	0.16	Bifenthrin	No study submitted - Similar to ?						
	279-3339	LAWN INSECT CONTROL 2	0.2	Imidacloprid							
32	279-3341	ZETA-CYPERMETHRIN (F2700)BIFENTHRIN 1:4 SFR MUP INSECTICIDE/	3.25	Zeta-Cypermethrin							
	279-3341	ZETA-CYPERMETHRIN (F2700)BIFENTHRIN 1:4 SFR MUP INSECTICIDE/	13	Bifenthrin	47361702	727.3	0	not done	not done	not done	not done
33	279-3342	F6131 G INSECTICIDE	0.05	Zeta-Cypermethrin							
	279-3342	F6131 G INSECTICIDE	0.2	Bifenthrin	cited MRID 47361702 (279-3341)						
34	279-3343	F6132 G INSECTICIDE	0.05	Zeta-Cypermethrin							

Table A1. Summary Report Active Mixtures of Bifenthrin												
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
	279-3343	F6132 G INSECTICIDE	0.2	Bifenthrin	cited MRID 47361702 (279-3341)						
35	279-3344	F6133 G INSECTICIDE	0.2	Bifenthrin	cited MRID 47361702 (279-3341)						
	279-3344	F6133 G INSECTICIDE	0.05	Zeta-Cypermethrin							
36	279-3346	F6130 G INSECTICIDE	0.029	Zeta-Cypermethrin							
	279-3346	F6130 G INSECTICIDE	0.115	Bifenthrin	cited MRID 47361702 (279-3341)						
37	279-3356	ATHENA INSECTICIDE	8.84	Bifenthrin	47606702	not done	not done	774	0	not done	not done
	279-3356	ATHENA INSECTICIDE	1.33	Abamectin							
38	279-3358	F7954 ORNAMENTAL INSECTICIDE/MITICIDE	8.84	Bifenthrin	Similar to 279-3356 (MRID 47606702)						
	279-3358	F7954 ORNAMENTAL INSECTICIDE/MITICIDE	1.33	Abamectin							
39	279-3362	F6138-1 ZW INSECTICIDE	8	Bifenthrin	47619602	not done	not done	1750	1236	not done	not done
	279-3362	F6138-1 ZW INSECTICIDE	0.75	Zeta-Cypermethrin							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
40	279-3363	F6138-1 ZW FHE INSECTICIDE	0.75	Zeta-Cypermethrin							
	279-3363	F6138-1 ZW FHE INSECTICIDE	8	Bifenthrin	cited MRID 47619602 (279-3362)						
41	279-3365	F8028-2 AEROSOL	0.05	Bifenthrin	similar to 239-2695 (MRID 47311103)						
	279-3365	F8028-2 AEROSOL	0.03	Prallethrin							
42	279-3367	F6288 SC LIQUID INSECTICIDE	5	Imidacloprid							
	279-3367	F6288 SC LIQUID INSECTICIDE	2	Bifenthrin	Similar to 432-1415 (MRID 46339502)						
43	279-3380	F9043 EC INSECTICIDE	9.8	Bifenthrin	47788502	not done	not done	310.2	175	not done	not done
	279-3380	F9043 EC INSECTICIDE	8.2	Zeta-Cypermethrin							
44	279-3440	F9210-1 INSECTICIDE	7.87	Bifenthrin	48482202	not done	not done	175	29.03	not done	not done
	279-3440	F9210-1 INSECTICIDE	2.7	Zeta-Cypermethrin							
	279-3440	F9210-1 INSECTICIDE	13.83	Imidacloprid							

Table A1. Summary Report Active Mixtures of Bifenthrin												
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
45	279-3446	ZETA-CYPERMETHRIN/BIFENTHRIN SFR MUP	13	Bifenthrin	Similar to 279-3341 (MRID 47361702)						
	279-3446	ZETA-CYPERMETHRIN/BIFENTHRIN SFR MUP	3.25	Zeta-Cypermethrin							
46	279-9534	F6129 EW INSECTICIDE	0.0125	Zeta-Cypermethrin							
	279-9534	F6129 EW INSECTICIDE	0.05	Bifenthrin							
47	279-9535	F6141 EW INSECTICIDE	0.075	Zeta-Cypermethrin							
	279-9535	F6141 EW INSECTICIDE	0.3	Bifenthrin	48391302	not done	not done	<5000	2736	nor done	not done
48	279-9547	F6132 GC GRANULAR INSECTICIDE	0.05	Zeta-Cypermethrin							
	279-9547	F6132 GC GRANULAR INSECTICIDE	0.2	Bifenthrin	Similar to 279-3343 (MRID 47361702)						
49	279-9552	F6139-2 INSECTICIDE	0.05	Zeta-Cypermethrin							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
	279-9552	F6139-2 INSECTICIDE	0.2	Bifenthrin	48261002 conducted on Zeta-Cypermethrin 1.1% & Bifenthrin 4.4%	not done	not done	550	385.2	not done	not done
50	432-1407	ALLECTUS G INSECTICIDE	0.2	Imidacloprid							
	432-1407	ALLECTUS G INSECTICIDE	0.16	Bifenthrin	46255002	not done	not done	>5000	not done	not done	not done
51	432-1415	ALLECTUS SC INSECTICIDE	4	Bifenthrin	46339502	not done	not done	1030	550	not done	not done
	432-1415	ALLECTUS SC INSECTICIDE	5	Imidacloprid							
52	432-1416	ALLECTUS GC GRANULAR INSECTICIDE	0.16	Bifenthrin	Similar to 432-1407 (MRID 46255002)						
	432-1416	ALLECTUS GC GRANULAR INSECTICIDE	0.2	Imidacloprid							
53	432-1417	ALLECTUS 0.225 G PLUS TURF FERTILIZER INSECTICIDE	0.1	Bifenthrin	Bridged from MRIDs 43240703 & 43782102						

Table A1. Summary Report Active Mixtures of Bifenthrin												
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
	432-1417	ALLECTUS 0.225 G PLUS TURF FERTILIZER INSECTICIDE	0.125	Imidacloprid							
54	432-1418	ALLECTUS 0.18 G PLUS TURF FERTILIZER INSECTICIDE	0.1	Imidacloprid							
	432-1418	ALLECTUS 0.18 G PLUS TURF FERTILIZER INSECTICIDE	0.08	Bifenthrin	Bridged from MRIDs 43240703 & 43782102						
55	432-1419	ALLECTUS 0.15 G PLUS TURF FERTILIZER INSECTICIDE	0.083	Imidacloprid							
	432-1419	ALLECTUS 0.15 G PLUS TURF FERTILIZER INSECTICIDE	0.067	Bifenthrin	Bridged from MRIDs 43240703 & 43782102						
56	432-1421	ALLECTUS GC SC INSECTICIDE	5	Imidacloprid							
	432-1421	ALLECTUS GC SC INSECTICIDE	2	Bifenthrin	Similar to 432-1415 (MRID 46339502)						

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
57	432-1426	ALLECTUS 0.18 GC PLUS TURF FERTILIZER INSECTICIDE	0.08	Bifenthrin	Similar to 432-1418 (bridged from MRIDs 43240703 & 43782102)						
	432-1426	ALLECTUS 0.18 GC PLUS TURF FERTILIZER INSECTICIDE	0.1	Imidacloprid							
58	432-1427	ALLECTUS 0.225 GC PLUS TURF FERTILIZER INSECTICIDE	0.1	Bifenthrin	Similar to 432-1417 (bridged from MRIDs 43240703 & 43782102)						
	432-1427	ALLECTUS 0.225 GC PLUS TURF FERTILIZER INSECTICIDE	0.125	Imidacloprid							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
59	432-1428	ALLECTUS 0.15 GC PLUS TURF FERTILIZER INSECTICIDE	0.067	Bifenthrin	Similar to 432-1419 (bridged from MRIDs 43240703 & 43782102)						
	432-1428	ALLECTUS 0.15 GC PLUS TURF FERTILIZER INSECTICIDE	0.083	Imidacloprid							
60	538-301	SCOTTS SOUTHERNMAX	1.067	Atrazine							
	538-301	SCOTTS SOUTHERNMAX	0.11	Bifenthrin	46818504	not done	not done	>5000	not done	not done	not done
61	538-302	SOUTHERNMAX PRO	1.089	Bifenthrin	Similar to 538-301 (MRID 46818504)						
	538-302	SOUTHERNMAX PRO	1.067	Atrazine							
62	538-307	SOUTHERN FERTILIZER WITH WEED AND INSECT CONTROL	1.352	Atrazine							
	538-307	SOUTHERN FERTILIZER WITH WEED AND INSECT CONTROL	0.139	Bifenthrin	47581907	not done	not done	>5000	not done	not done	not done
63	1381-243	TUNDRA SUPREME	9	Bifenthrin	47792103	not done	not done	98	55	not done	not done

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
	1381-243	TUNDRA SUPREME	28.6	Chlorpyrifos							
64	5481-552	BIDRIN XP	82	Dicrotophos							
	5481-552	BIDRIN XP	25.1	Bifenthrin	No study submitted; Label indicates Tox. Cat. I (<50 mg/kg)						
65	5481-560	SMARTCHOICE 2.5G	2.15	Chlorethoxyfos							
	5481-560	SMARTCHOICE 2.5G	0.35	Bifenthrin	Cited a study (MRID 43540203) on a 2.5% chlor-ethoxyfos formulation; assigned to Tox. Cat. II						
66	5481-561	SMARTCHOICE 5G	4.3	Chlorethoxyfos							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
	5481-561	SMARTCHOICE 5G	0.7	Bifenthrin	Cited a study (MRID 41290622 on a 5.3% chlorethoxyfos formulation; assigned to Tox. Cat. II)						
67	5481-9024	BIDRIN XP II	10.8	Bifenthrin	No study submitted; Label indicates Tox. Cat. I (<50 mg/kg)						
	5481-9024	BIDRIN XP II	43.1	Dicrotophos							
68	5905-548	EMPOWER(2) GRANULAR INSECTICIDE	1.15	Bifenthrin	No study submitted; presumably similar to a 1.15% bifenthrin formulation.						

Table A1. Summary Report Active Mixtures of Bifenthrin												
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
	5905-548	EMPOWER(2) GRANULAR INSECTICIDE	0.001	Indole-3-butyric acid							
69	8033-96	F4688 50 WSP INSECTICIDE TERMITICIDE	27.27	Bifenthrin	46432802	not done	not done	550	89	not done	not done
	8033-96	F4688 50 WSP INSECTICIDE TERMITICIDE	22.73	Acetamiprid							
70	8033-109	F5688 11% ME INSECTICIDE TERMITICIDE	5	Acetamiprid							
	8033-109	F5688 11% ME INSECTICIDE TERMITICIDE	6	Bifenthrin	47868803	not done	not done	1035	556.4	not done	not done
71	8033-116	JUSTICE OF INSECTICIDE	10	Bifenthrin	48404404	not done	not done	438.5	270	not done	not done
	8033-116	JUSTICE OF INSECTICIDE	13	Acetamiprid							
72	9198-233	THE ANDERSONS GC BICARB INSECTICIDE + FERTILIZER	2.3	Carbaryl							
	9198-233	THE ANDERSONS GC BICARB INSECTICIDE + FERTILIZER	0.058	Bifenthrin	46813603	not done	not done	>5000	not done	not done	not done
73	9198-234	THE ANDERSONS BICARB LAWN INSECT KILLER GRANULES	2.3	Carbaryl							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
	9198-234	THE ANDERSONS BICARB LAWN INSECT KILLER GRANULES	0.058	Bifenthrin	Similar to 9198-233 (MRID 46813603)						
74	9198-235	THE ANDERSONS BICARB INSECTICIDE + FERTILIZER	2.3	Carbaryl							
	9198-235	THE ANDERSONS BICARB INSECTICIDE + FERTILIZER	0.058	Bifenthrin	Similar to 9198-233 (MRID 46813603)						
75	9198-238	THE ANDERSONS 0.058% BIFENTHRIN + 0.115% IMIDACLOPRID INSECT	0.058	Bifenthrin	46937503 (containing 0.218% imidaclopri d & 0.176% bifenthrin)	not done	not done	>5000	not done	not done	not done
	9198-238	THE ANDERSONS 0.058% BIFENTHRIN + 0.115% IMIDACLOPRID INSECT	0.115	Imidacloprid							
76	9198-239	THE ANDERSONS 0.077% BIFENTHRIN + 0.155% IMIDACLOPRID GRANUL	0.077	Bifenthrin	Cited study in MRID 46813603 (see 9198-238)						

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
	9198-239	THE ANDERSONS 0.077% BIFENTHRIN + 0.155% IMIDACLOPRID GRANUL	0.155	Imidacloprid							
77	9198-240	THE ANDERSONS GC 0.077% BIFENTHRIN + 0.155% IMIDACLOPRID GRA	0.077	Bifenthrin	Cited study in MRID 46813603 (see 9198-238)						
	9198-240	THE ANDERSONS GC 0.077% BIFENTHRIN + 0.155% IMIDACLOPRID GRA	0.155	Imidacloprid							
78	9198-241	THE ANDERSONS GC 0.058% BIFENTHRIN + 0.115% IMIDACLOPRID INS	0.058	Bifenthrin	Cited study in MRID 46813603 (see 9198-238)						
	9198-241	THE ANDERSONS GC 0.058% BIFENTHRIN + 0.115% IMIDACLOPRID INS	0.115	Imidacloprid							
79	34704-1045	LPI 6332-15 INSECTICIDE	5.7	Bifenthrin	47874802	not done	not done	1098	550	not done	not done
	34704-1045	LPI 6332-15 INSECTICIDE	5.7	Imidacloprid							

Table A1. Summary Report Active Mixtures of Bifenthrin												
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
80	42750-156	IMID-BIFEN 0.15 LAWN + FERTILIZER	0.083	Imidacloprid	Similar to 432-1419 which was bridged from MRIDs 43240703 & 43782102						
	42750-156	IMID-BIFEN 0.15 LAWN + FERTILIZER	0.067	Bifenthrin							
81	42750-157	IMID-BIFEN 0.15 GC + FERTILIZER	0.083	Imidacloprid							
	42750-157	IMID-BIFEN 0.15 GC + FERTILIZER	0.067	Bifenthrin	Similar to 432-1428 which was similar to 432-1419 [bridged from MRIDs 43240703 & 43782102)						

Table A1. Summary Report Active Mixtures of Bifenthrin												
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
82	42750-158	IMID-BIFEN 0.18 LAWN + FERTILIZER	0.08	Bifenthrin	Similar to 432-1428 which was similar to 432-1419 [bridged from MRIDs 43240703 & 43782102)						
	42750-158	IMID-BIFEN 0.18 LAWN + FERTILIZER	0.1	Imidacloprid							
83	42750-159	IMID-BIFEN 0.18 GC + FERTILIZER	0.1	Imidacloprid							
	42750-159	IMID-BIFEN 0.18 GC + FERTILIZER	0.08	Bifenthrin	Similar to 432-1426 which was similar to 432-1418 [bridged from MRIDs 43240703 & 43782102]						

Table A1. Summary Report Active Mixtures of Bifenthrin												
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
84	42750-160	IMID-BIFEN 0.36 LAWN INSECTICIDE	0.16	Bifenthrin	No study; registered using cite-all.						
	42750-160	IMID-BIFEN 0.36 LAWN INSECTICIDE	0.2	Imidacloprid							
85	42750-161	IMID-BIFEN 0.36 GC INSECTICIDE	0.16	Bifenthrin	No study; registered using cite-all.						
	42750-161	IMID-BIFEN 0.36 GC INSECTICIDE	0.2	Imidacloprid							
86	42750-162	IMID-BIFEN 0.225 LAWN + FERTILIZER	0.1	Bifenthrin	Similar to 432-1417 (bridged from MRIDs 43240703 & 43782102)						
	42750-162	IMID-BIFEN 0.225 LAWN + FERTILIZER	0.125	Imidacloprid							

Table A1. Summary Report Active Mixtures of Bifenthrin												
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
87	42750-163	IMID-BIFEN 0.225 GC + FERTILIZER	0.1	Bifenthrin	Similar to 432-1427 which was similar to 432-1417 (bridged from MRIDs 43240703 & 43782102)						
	42750-163	IMID-BIFEN 0.225 GC + FERTILIZER	0.125	Imidacloprid							
88	66222-205	BIFENTHRIN/NOVALURON PREMIX INSECTICIDE	6.5	Bifenthrin	47922503	not done	not done	280	140.2	not done	not done
	66222-205	BIFENTHRIN/NOVALURON PREMIX INSECTICIDE	4	Novaluron							
89	66330-365	ALOFT GC SC INSECTICIDE	24.7	Clothianidin							
	66330-365	ALOFT GC SC INSECTICIDE	12.3	Bifenthrin	47096005	not done	not done	310.2	175	not done	not done
90	66330-366	ALOFT LC SC INSECTICIDE	24.7	Clothianidin							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	**Current Registration No.**	**Name**	**Percent A.I.**	**Active Ingredient**	**MRID(s) for Acute Oral Study**	**Male Oral LD50 (mg/kg)**	**Male Oral LD50 Lower CI (mg/kg)**	**Female Oral LD50 (mg/kg)**	**Female Oral LD50 Lower CI (mg/kg)**	**Comb. Oral LD50 (mg/kg)**	**Comb. Oral LD50 Lower CI (mg/kg)**
	66330-366	ALOFT LC SC INSECTICIDE	12.3	Bifenthrin	Cited study in MRID 47096005 (see 66330-365)						
91	66330-367	ALOFT GC G INSECTICIDE	0.125	Bifenthrin	47096011	not done	not done	>5000	not done	not done	not done
	66330-367	ALOFT GC G INSECTICIDE	0.25	Clothianidin							
92	66330-368	ALOFT LC G INSECTICIDE	0.125	Bifenthrin	Cited study in MRID 47096011 (see 66330-367)						
	66330-368	ALOFT LC G INSECTICIDE	0.25	Clothianidin							
93	68543-38	BENGAL INSECTICIDE CONCENTRATE 5	22	MGK 264	47625502	not done	not done	707.1	400	not done	not done
	68543-38	BENGAL INSECTICIDE CONCENTRATE 5	4.3	Bifenthrin							
94	75341-14	ORD-X240	0.2	Tebuconazole	47169403	not done	not done	>5000	not done	not done	not done
	75341-14	ORD-X240	0.04	Bifenthrin							
	75341-14	ORD-X240	43.7	Borax (B4Na2O7.10 H2O)							

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
	75341-14	ORD-X240	0.3	Copper, bis(8-quinolinolato-N1,O8)-,							
95	83222-40	IMIDACLOPRID PLUS BIFENTHRIN 1 + 1 SC	11.3	Imidacloprid	Similar to 279-3332 (MRID 47222602)						
	83222-40	IMIDACLOPRID PLUS BIFENTHRIN 1 + 1 SC	11.3	Bifenthrin							
96	83923-1	BITHOR SC GC	5	Imidacloprid							
	83923-1	BITHOR SC GC	2	Bifenthrin	Similar to 432-1421 (MRID 46339502)						
97	83923-2	BITHOR SC	4	Bifenthrin	Similar to 432-1415 (MRID 46339502)						
	83923-2	BITHOR SC	5	Imidacloprid							
98	86363-11	BIFENCHLOR	28.6	Chlorpyrifos							
	86363-11	BIFENCHLOR	9	Bifenthrin	Similar to 1381-243 (MRID 47792103)						
99	89168-22	ATERA 2+1 SC INSECTICIDE	10.64	Bifenthrin	47184304	not done	not done	550	196.1	not done	not done

Table A1. Summary Report Active Mixtures of Bifenthrin											
Product	Current Registration No.	Name	Percent A.I.	Active Ingredient	MRID(s) for Acute Oral Study	Male Oral LD50 (mg/kg)	Male Oral LD50 Lower CI (mg/kg)	Female Oral LD50 (mg/kg)	Female Oral LD50 Lower CI (mg/kg)	Comb. Oral LD50 (mg/kg)	Comb. Oral LD50 Lower CI (mg/kg)
	89168-22	ATERA 2+1 SC INSECTICIDE	21.29	Imidacloprid							

ECOTOX Database literature with mixtures

***Screen of ECOTOX Records and Papers Providing Data on Multiple A.I. Involving Bifenthrin and Non-Target Organisms* (presented in alphabetical order)**

Adu-Acheampong, R. and Ackonor, J. B. The Effect of Imidacloprid and Mixed Pirimiphos-Methyl and Bifenthrin on Non-Target Arthropods of Cocoa. 2005; 45 , (4): 153-154.
Rec #: 1070
Abstract: Imidacloprid was less effective in reducing ant populations than a mixture of pirimiphos-methyl and bifenthrin, while the mixture also greatly reduced the number of spiders. Imidacloprid caused some reduction in spider numbers for a week after spraying but then numbers rose substantially. Copyright (copyright) 2005 John Wiley & Sons, Ltd.

Ahmad, M. Observed Potentiation Between Pyrethroid and Organophosphorus Insecticides for the Management of Spodoptera Litura (Lepidoptera: Noctuidae). 2009; 28 , (3): 264-268.
Rec #: 550
Abstract: Mixtures of pyrethroids plus organophosphates were assessed for their potentiation in resistant field populations of Spodoptera litura from Pakistan by using a leaf-dip bioassay method. Cypermethrin, alpha-cypermethrin, bifenthrin, deltamethrin, and cyfluthrin exhibited potentiation by ethion. Mixtures of deltamethrin + triazophos and cyfluthrin + methamidophos also showed potentiation. Cypermethrin in combination with profenofos or chlorpyrifos produced an antagonism. (copyright) 2008 Elsevier Ltd. All rights reserved.

Amweg, E. L.; Weston, D. P.; You, J., and Lydy, M. J. Pyrethroid Insecticides and Sediment Toxicity in Urban Creeks from California and Tennessee. 2006; 40, (5): 1700-1706.
Rec #: 1490
Abstract: Pyrethroid pesticides have replaced organophosphates for many urban applications, including structural pest control, landscape maintenance, and residential home and garden use. This study was intended to determine if pyrethroids are detectable and widespread in diverse urban systems and if concentrations are high enough to cause associated aquatic toxicity. Urban creeks in California and Tennessee were tested on up to four occasions for pesticide residues in sediments, and aquatic toxicity was determined by acute toxicity tests using the amphipod, *Hyalella azteca*. In California, 12 of the 15 creeks tested were toxic on at least one sampling occasion, and sediment pyrethroid concentrations were sufficient to explain the observed toxicity in most cases. The pyrethroid bifenthrin, due to its high concentrations and relative toxicity as compared to other pyrethroids, was likely responsible for the majority of the toxicity at most sites. Cypermethrin, cyfluthrin, deltamethrin, and lambda -cyhalothrin also contributed to toxicity at some locations. The source of cypermethrin and deltamethrin was probably almost entirely structural pest control by professional applicators. Bifenthrin, cyfluthrin, and lambda -cyhalothrin may have originated either from professional structural pest control or from lawn and garden care by homeowners. None of the sediments collected from the 12 Tennessee creeks were toxic, and pyrethroids were rarely

detectable. Regional differences between Tennessee and California are possibly attributable to climate, differences in types of residential development, and pesticide use practices.

Auber, A.; Roucaute, M.; Togola, A., and Caquet, T. Structural and Functional Effects of Conventional and Low Pesticide Input Crop-Protection Programs on Benthic Macroinvertebrate Communities in Outdoor Pond Mesocosms. 2011; 20, (8): 2042-2055.
Rec #: 30880
Keywords: MIXTURE

Bacheler, J. S. and Mott, D. W. Efficacy of Selected Pyrethroids Against Bollworms and European Corn Borers in Southern North Carolina, 1994. POPENV,MIXTURE; 1995; 20, 190-191 (57F).
Rec #: 31430

Bennett, E. R.; Moore, M. T.; Cooper, C. M.; Smith, S. Jr.; Shields, F. D. Jr.; Drouillard, K. G., and Schulz, R. Vegetated Agricultural Drainage Ditches for the Mitigation of Pyrethroid-Associated Runoff. 2005; 24, (9): 2121-2127.
Rec #: 30
Keywords: MIXTURE

Bonnet, Julien; Corbel, Vincent; Darriet, Frederic; Chandre, Fabrice, and Hougard, Jean-Marc. Topical applications of pyrethroid and organophosphate mixtures revealed positive interactions against pyrethroid-resistant Anopheles gambiae. 2004; 20, (4): 438-443.
Rec #: 6140
Abstract: The efficacy of a binary mixture of bifenthrin (pyrethroid) and chlorpyrifos-methyl (organophosphate) has been tested against susceptible and pyrethroid-resistant strains of Anopheles gambiae Giles, the major malaria vector in sub-Saharan Africa. Dose-mortality regression lines were determined for each insecticide alone and in mixtures by topical applications on adult female mosquitoes. A combination index (CI) was used to quantify the interactions occurring between the pyrethroid and organophosphate insecticides. The results revealed synergism at high doses against both susceptible ($0.7 > CI > 0.3$) and pyrethroid-resistant ($0.9 > CI > 0.7$) An. gambiae. These results suggest that insecticide mixtures may be an alternative strategy for vector control, especially in areas where mosquitoes are resistant to pyrethroids. [Journal Article; In English; United States]

Buschman, L. L.; Sloderbeck, P. E., and Currie, R. S. Efficacy of Post-Tassel Miticide Applications Against Spider Mites and Field Response in Corn, 2003C. POP,GROSOIL,ENV,MIXTURE; 2005; 30, F13.
Rec #: 240
Notes: EcoReference No.: 93046

Buschman, L. L.; Sloderbeck, P. E., and Currie, R. S. Efficacy of Post-Tassel Miticide

Applications Against Spider Mites and Field Response in Corn, 2003C. POPSOIL,ENV,MIXTURE; 2005; 30, 3 p. (F13).
Rec #: 31040
Notes: EcoReference No.: 93046

Buschman, L. L.; Wildman, L., and Sloderbeck, P. E. Second Generation European Corn Borer Control, 1993. POPSOIL,ENV,MIXTURE; 1994; 19, 190 (25F).
Rec #: 220
Notes: EcoReference No.: 96170

Bynum, E. D. Jr.; Archer, T. L., and Plapp, F. W. Jr. Action of Insecticides to Spider Mites (Acari: Tetranychidae) on Corn in the Texas High Plains: Toxicity, Resistance, and Synergistic Combinations. POP,MORENV; 1990; 83, (4): 1236-1242.
Rec #: 250
Notes: EcoReference No.: 112467

Cao, Z. Y.; Shafer, T. J.; Crofton, K. M.; Gennings, C., and Murray, T. F. Additivity of Pyrethroid Actions on Sodium Influx in Cerebrocortical Neurons in Primary Culture. 2011; 119, (9): 1239-1246.
Rec #: 28720
Abstract: BACKGROUND: Pyrethroid insecticides bind to voltage-gated sodium channels and modify their gating kinetics, thereby disrupting neuronal function. Although previous work has tested the additivity of pyrethroids in vivo, this has not been assessed directly at the primary molecular target using a functional measure. OBJECTIVES: We investigated the potency and efficacy of 11 structurally diverse food-use pyrethroids to evoke sodium (Na(+)) influx in neurons and tested the hypothesis of dose additivity for a mixture of these same 11 compounds. METHODS: We determined pyrethroid-induced increases in Na(+) influx in primary cultures of cerebro-cortical neurons using the Na(+)-sensitive dye sodium-binding benzo-furan isophthalate (SBFI). Concentration-dependent responses for 11 pyrethroids were determined, and the response to dilutions of a mixture of all 11 compounds at an equimolar mixing ratio was assessed. Additivity was tested assuming a dose-additive model. RESULTS: Seven pyrethroids produced concentration-dependent, tetrodotoxin-sensitive Na(+) influx. The rank order of potency was deltamethrin > S-bioallethrin > beta-cyfluthrin > lambda-cyhalothrin > esfenvalerate > tefluthrin > fenpropathrin. Cypermethrin and bifenthrin produced modest increases in Na(+) influx, whereas permethrin and resmethrin were inactive. When all 11 pyrethroids were present at an equimolar mixing ratio, their actions on Na(+) influx were consistent with a dose-additive model. CONCLUSIONS: These data provide in vitro relative potency and efficacy measurements for 7 pyrethroid compounds in intact mammalian neurons. Despite differences in individual compound potencies, we found the action of a mixture of all 11 pyrethroids to be additive when we used an appropriate statistical model. These results are consistent with a previous report of the additivity of pyrethroids in vivo.

Carson, W. G.; White, K. K., and Trumble, J. T. Chemical Trials and Impact on Insects in Celery, 1991. POP,GROSOIL,ENV,MIXTURE; 1994; 19, 82-83 (33E).

Rec #: 300
Notes: EcoReference No.: 82728

Castle, S. J.; Prabhaker, N.; Henneberry, T. J., and Toscano, N. C. Host Plant Influence on Susceptibility of Bemisia Tabaci (Hemiptera: Aleyrodidae) to Insecticides.
Rec #: 27130
ABSTRACT: A resistance monitoring program conducted for the polyphagous whitefly, Bemisia tabaci (Gennadius), in Imperial Valley, CA, USA generated a large set of LC50s for adults collected from broccoli, cantaloupe and cotton crops over a four-year period. A vial bioassay and, subsequently, a yellow-sticky card bioassay produced similar temporal profiles of relative susceptibilities to the pyrethroid insecticide bifenthrin. Both bioassays revealed that whiteflies collected from broccoli were significantly less susceptible to bifenthrin compared to the other two crops. A similar finding was observed for endosulfan and the mixture of bifenthrin+endosulfan in the yellow-sticky card bioassay. The possibility that seasonal differences contributed to the observed differences in susceptibility provided the impetus to conduct a reciprocal transfer experiment using broccoli (or kale) and cantaloupe grown simultaneously in the field and greenhouse. Whitefly adults collected from an organic farm over three consecutive weeks had significantly higher LC50s on kale than those collected the same day on cantaloupe. After culturing in the greenhouse on broccoli or cantaloupe and testing again, LC50s remained significantly higher on broccoli after one week and again at the F1 generation. In contrast, whiteflies originating on kale in the field and transferred to cantaloupes in the greenhouse had significantly reduced LC50s at the F1 generation. When tested against the bifenthrin+endosulfan mixture, significantly higher LC50s were generated for whiteflies reared on broccoli in the greenhouse at one week and the F1 compared to the field source from cantaloupes. The consistently higher LC50s for whiteflies on broccoli and other Brassica spp. crops, compared to cantaloupes or cotton, point to statistically significant host-plant influences that are expressed in both field-collected and greenhouse-reared populations of whiteflies.

Cloyd, Raymond A. Getting Mixed-Up: Are Greenhouse Producers Adopting Appropriate Pesticide Mixtures to Manage Arthropod Pests? 2009; 19, (3): 638-646.
Rec #: 27800
Abstract: Pesticide mixtures are commonly used by greenhouse producers to deal with the array of arthropod (insect and mite) pests encountered in greenhouses. Greenhouse producers tank mix pesticides due to convenience because it is less time consuming, costly, and labor intensive to mix together two or more pesticides into a single spray solution and then perform one spray application compared with making multiple applications. Pesticide mixtures may also result in improved arthropod pest control. However, there has been no quantitative assessment to determine what pesticide mixtures (two-, three-, and four-way combinations) are being adopted by greenhouse producers and why. As such, a survey was conducted by distributing evaluation forms in conjunction with three sessions at two greenhouse producer conferences (two in 2007 and one in 2008) to obtain data on the types of pesticide mixtures used by greenhouse producers and determine if there

are any problems associated with these pesticide mixtures. The evaluation form requested that participants provide information on the four most common pesticide mixtures (insecticides and/or miticides) used and for what specific arthropod pests. The response rate of the evaluation forms was 22.5% (45/200). The two-way pesticide mixture that was cited most often (n = 8) was the abamectin (Avid) and bifenthrin (Talstar) combination. The two pesticides typically included in a majority of the two-way and three-way mixtures were spinosad (Conserve) and abamectin. Spinosad was a component of 17 two-way and 7 three-way combinations, while abamectin was cited in 15 two-way and 9 three-way combinations. Both products are labeled for control of the western flower thrips (Frankliniella occidentalis), which is one of the most important insect pests in greenhouses. One pesticide mixture that was difficult to interpret involved the fungicides, thiophanate-methyl (Cleary's 3336) and metalaxyl (Subdue). This mixture was cited twice, and the arthropod pest listed was thrips (Thysanoptera). However, both fungicides have no insecticidal activity. Two of the mixtures listed in the survey used pesticides with similar modes of action: acephate (Orthene) + methiocarb (Mesurol), and pyrethrins (Pyreth-It) + bifenthrin (Talstar). A number of the pesticide mixtures listed for spider mites (Tetranychidae) were questionable due to similar life stage activity of the a.i. as indicated on the label including fenpyroximate (Akari) + clofentezine (Ovation), abamectin + chlorfenapyr (Pylon), and bifenazate (Floramite) + etoxazole (TetraSan). In fact, 38% of pesticide mixtures cited for twospotted spider mite (Tetranychus urticae) control should have been avoided due to analogous life stage activity. The data obtained from the survey clearly demonstrates that greenhouse producers implement a wide-range of pesticide mixtures to deal with the multitude of arthropod pests in greenhouses. However, the basis by which greenhouse producers decide the types of pesticides to mix together is not known. As such, the survey data can be used to direct future multistate or multiregional extension (outreach) efforts in developing programs specifically designed to educate greenhouse producers on which pesticides should and should not be mixed together.

Corbel, V; Darriet, F; Chandre, F, and Hougard, J M. Insecticide mixtures for mosquito net impregnation against malaria vectors. 2002 Sep; 9, (3): 255-259.
Rec #: 6550
Abstract: Insecticides belonging to the pyrethroid family are the only compounds currently available for the treatment of mosquito nets. Unfortunately, some malaria vector species have developed resistance to pyrethroids and the lack of alternative chemical categories is a great concern. One strategy for resistance management would be to treat mosquito nets with a mixture associating two insecticides having different modes of action. This study presents the results obtained with insecticide mixtures containing several proportions of bifenthrin (a pyrethroid insecticide) and carbosulfan (a carbamate insecticide). The mixtures were sprayed on mosquito net samples and their efficacy were tested against a susceptible strain of Anopheles gambiae, the major malaria vector in Africa. A significant synergism was observed with a mixture containing 25 mg/m2 of bifenthrin (half the recommended dosage for treated nets) and 6.25 mg/m2 of carbosulfan (about 2% of the recommended dosage). The observed mortality was significantly more than expected in the

absence of any interaction (80% vs 41%) and the knock-down effect was maintained, providing an effective barrier against susceptible mosquitoes.

Daglish, G. J.; Wallbank, B. E., and Nayak, M. K. Synergized Bifenthrin Plus Chlorpyrifos-Methyl for Control of Beetles and Psocids in Sorghum in Australia. 2003; 96, (2): 525-532. 141268.
Rec #: 25150
Keywords: MIXTURE
Abstract: NO MIXTURE//The efficacy of bifenthrin (0.5 mg/kg) + piperonyl butoxide (7 mg/kg) + chlorpyrifosmethyl (10 mg/kg) against beetle and psocid pests of sorghum was evaluated in silo-scale trials in southeast Queensland, Australia. The pyrethroid bifenthrin was evaluated as a potential new protectant in combination with the organophosphate chlorpyrifos-methyl, which is already registered for control of several insect pests of stored cereals. Sorghum (approximately 200 metric tons) was treated after both the 1999 and 2000 harvests and sampled at intervals to assess treatment efficacy and residue decline during up to 7 mo of storage. Generally, test strains of the beetles Rhyzopertha dominica (F.), Tribolium castaneum (Herbst), Oryzaephilus surinamensis (L), and Cryptolestes ferrugineus (Stephens) were prevented from producing live progeny for up to 7 mo. The treatment failed against one strain of R. dominica known to be resistant to bioresmethrin and organophosphates. Two malathion-resistant strains of O. surinamensis were marginally controlled with 94-100% fewer adult progeny produced. For psocids, no strains of Liposcelis bostrychophila Badonnel, Liposcelis decolor (Pearman), or Liposcelis paeta Pearman produced live progeny, although the control of a field strain of Liposcelis entomophila (Enderlein) was generally poor. Results show that this treatment should protect sorghum for at least 7 mo against most prevalent strains of grain insect in eastern Australia, although control may be limited in areas in which L. entomophila or pyrethroid-resistant R. dominica are present. [Journal Article; In English; United States] Journal Of Economic Entomology//

Darriet, F; Corbel, V, and Hougard, J M. Efficacy of mosquito nets treated with a pyrethroid-organophosphorous mixture against Kdr- and Kdr+ malaria vectors (Anopheles gambiae). 2003 Dec; 10, (4): 359-362.
Rec #: 6360
Abstract: In order to prevent the resistance of Anopheles gambiae s.l. to pyrethroids from spreading too quickly and to lengthen the effectiveness of insecticide impregnated mosquito nets, it has recently been suggested to use mixtures of insecticides that have different modes of action. This study presents the results obtained with tulle mosquito nets treated with bifenthrin (a pyrethroid) and chlorpyrifos-methyl (an organophosphorous) both separately and in mixture on two strains of An. gambiae, one sensitive to all insecticides, and the other resistant to pyrethroids. The values of KDt50 and KDt95 and the mortality induced with the mixture of bifenthrin (25 mg/m2) and chlorpyrifos-methyl (4.5 mg/m2) show a significant synergistic effect on the strain of An. gambiae susceptible to insecticides. However, the tested combination does not induce any synergistic effect on the VKPR strain selected with permethrin, but only enhances the effectiveness of

the two insecticides taken separately.

Del Socorro, A. P.; Gregg, P. C., and Hawes, A. J. Development of a Synthetic Plant Volatile-Based Attracticide for Female Noctuid Moths. III. Insecticides for Adult Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae).
MOR,POPENV,MIXTURE,ORAL; 2010; 49, (1): 31-39.
Rec #: 470
EcoReference No.: 156622

Ellis, M.D., B.D. Siegfried, and B. Spawn. 1997. The Effect of Apistan® on Honey Bee (*Apis mellifera* L). Responses to Methyl Parathion, Carbaryl and Bifenthrin Exposure. *Apidologie* (1997) 28, 123-127
EcoReference No.: 63845
Research Description: The effect of mixtures of fluvalinate (Apistan® Queen Tabs) with bifenthrin, carbaryl and methyl parathion was studied. Fluvalinate is used to treat honey bees against the varroa mite (*Varroa jacobsoni*). For bifenthrin, the LD_{50} was 0.034 µg/L (0.023-0.058), while for the fluvalinate treated bees, the LD_{50} was found to be 0.018 µg/L (0.016-0.020). The synergistic ratio was found to be 1.9 and found to be significant given that the C.L.'s did not overlap unlike for the other two combinations. The authors indicated that the data support that honey bees treated with fluvalinate are more susceptible to treatments with bifenthrin, while the same was not true for carbaryl or methyl parathion.

Ensminger, Michael; Bergin, Rick; Spurlock, Frank; Goh, Kean S, and Ensminger, Michael. Pesticide Concentrations in Water and Sediment and Associated Invertebrate Toxicity in Del Puerto and Orestimba Creeks, California, 2007-2008. 2011 Apr; 175, (1-4): 573-587.
Rec #: 27540
Keywords: SURVEY, SEDIMENT, MIXTURE
Abstract: The California's San Joaquin River and its tributaries including Orestimba (ORC) and Del Puerto (DPC) Creeks are listed on the 2006 US EPA Clean Water Act 303(d) list for pesticide impairment. From December 2007 through June 2008, water and sediment samples were collected from both creeks in Stanislaus County to determine concentrations of organophosphorus (OP) and pyrethroid insecticides and to identify toxicity to *Ceriodaphnia dubia* and *Hyalella azteca*. OPs were detected in almost half (10 of 21) of the water samples, at concentrations from 0.005 to 0.912 mu gL super(-1) . Diazinon was the most frequently detected OP, followed by chlorpyrifos and dimethoate. Two water samples were toxic to C. dubia; based on median lethal concentrations (LC sub(50)), chlorpyrifos was likely the cause of this toxicity. Pyrethroids were detected more frequently in sediment samples (18 detections) than in water samples (three detections). Pyrethroid concentrations in water samples ranged from 0.005 to 0.021 mu gL super(-1) . These concentrations were well below reported C. dubia LC sub(50)s, and toxicity was not observed in laboratory bioassays. Cyfluthrin, bifenthrin, esfenvalerate, and lambda -cyhalothrin were detected in sediment samples at concentrations ranging from 1.0 to 74.4ngg super(-1), dry weight. At DPC, all but one sediment sample caused 100% toxicity to H. azteca. Based on estimated toxicity units (TUs),

bifenthrin was likely responsible for this toxicity and lambda -cyhalothrin also contributed. At ORC, survival of H. azteca was significantly reduced in four of the 11 sediment samples. However, pyrethroids were detected in only two of these samples. Based on TUs, bifenthrin and lambda -cyhalothrin likely contributed to the toxicity. Date revised - 2011-05-01. Publication date - Apr 2011. Language of summary - English. Location - USA, California, San Joaquin R.; USA, California. Pages - 573-587. ProQuest ID - 864962367. Corporate institution author - Ensminger, Michael; Bergin, Rick; Spurlock, Frank; Goh, Kean S. DOI - 8fb6ea45-c58f-4d02-8415mfgefd101; 14444808; CS1146964; 10.1007/s10661-010-1552-y; 0167-6369; 1573-2959

Feretti, D.; Zerbini, I.; Zani, C.; Ceretti, E.; Moretti, M., and Monarca, S. Allium cepa Chromosome Aberration and Micronucleus Tests Applied to Study Genotoxicity of Extracts from Pesticide-Treated Vegetables and Grapes. 2007; 24, (6): 561-572. 143722.
Rec #: 140
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Rec #: 20180
Rec #: 25860
Keywords: IN VITRO,MIXTURE

Fife, J. H.; Leonard, B. R.; Torrey, K. D., and Graves, J. B. Cotton Aphid Control in the Macon Ridge Region of Louisiana, 1995. POPENV,MIXTURE; 1996; 21, 248-249 (75F).
Rec #: 30600
Notes: EcoReference No.: 151643

Flood, B. R. Corn Earworm and European Corn Borer Control in Sweet Corn, 1985. GRO,POPENV,MIXTURE; 1986; 11, 128-129 (171).
Rec #: 440
Notes: EcoReference No.: 87888

Hara, A.H., T.Y. Hata, and B.K.S. Hu. 1994. Phytotoxicity of Insecticides on Dendrobium Orchids, HI, 1994. Phytotoxicity of Insecticides on Dendrobium Orchids, Hawaii, 1994. *Resource Information*. Available at http://www.extento.hawaii.edu/kbase/resource/phytotox5_trial.htm (accessed 11/15/12)
EcoReference No.: 102694
Research Description: Phytotoxicity trials were conducted in 1993 and 1994 (trials 1 and 2) in a commercial farm in Hilo, Hawaii. Test species were dendrobium mature plants (3.5 ft) (three cultivars: ‘Uniway Supreme’, ‘Uniway Pearl’ and ‘Uniway Princess’; 36 plants per cultivar per treatment). During trial 1, besides the control plot, bifenthrin (Talstar Flowable, at 0.4 lb a.i./100 gal) was applied alone, or with acephate (Orthene Turf, Tree and Ornamentals, at 0.5 lb a.i./100 gal). Additionally, the spreader-sticker Ad-Here at 5 fl oz/100 gal was co-applied to the insecticide treated samples and to the controls. Trial 2 involved pesticides other than bifenthrin.

A summary of the results for trial 1 is presented below. "Blossom drop" refers to number of days inflorescences remained intact (start of blossom wilt or senescence) or initiation of blossom drop. "Vase life" refers to end of vase life (>50% of blossoms affected), for inflorescences harvested randomly from each plot one week after the last insecticide application. Treatment mean values were compared using the t-test. Based on the results, the authors concluded that bifenthrin applied alone and bifenthrin plus acephate were not phytotoxic after six weekly applications. For the inflorescences treatments *vs.* control, the number of days to the start of blossom senescence (blossom drop), was not significantly different. It was found that the vase life of the 'Uniway Supreme' inflorescences from bifenthrin alone was significantly longer than from flowers from the control plot.

Results Trial 1	**'Uniway Supreme'**		**'Uniway Pearl'**		**'Uniway Princess'**	
Chemical	**Blossom drop**	**Vase life**	**Blossom drop**	**Vase life**	**Blossom drop**	**Vase life**
Bifenthrin + Acephate	11.0±0.0	30.0±4.8	11.0±0.0	36.4±3.6	13.8±3.8	31/2±1.8
Bifenthrin	13.8±3.8	32.8±1.8 *	15.0±3.0	36.0±5.5	10.6±4.3	29.2±6.3
Control	13.8±3.8	27.8±3.8	15.0±3.0	34.4±2.2	12.4±3.1	27.8±9.4

*Significantly different from the control by t test ($p<0.05$)

Hoagland, K. D.; Drenner, R. W., and Smith, J. D. Phytoplankton Community Responses to Mixtures of Agricultural Pesticides. 1991; 27, (suppl.3): 31-(ABS) (ABS 163). 147522.
Rec #: 16280
Rec #: 21960
Rec #: 30730
Keywords: ABSTRACT,MIXTURE (Was ECOREF# 68578)

Immaraju, J. A.; Paine, T. D.; Bethke, J. A.; Robb, K. L., and Newman, J. P. Western Flower Thrips (Thysanoptera: Thripidae) Resistance to Insecticides in Coastal California Greenhouses. MORENV,MIXTURE; 1992; 85, (1): 9-14.
Rec #: 320
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Johnson, D. R. and Studebaker, G. Control of Spider Mites in Cotton, 1990. POPSOIL,ENV,MIXTURE; 1993; 18, 236 (63F).
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Notes: EcoReference No.: 82236

KIM SS; KIM DI, and LEE SC. Joint toxic action of acaricide mixtures to the bifenthrin-and the cyhexatin resistant strain of Tetranychus urticae. 1993(1): 41-48.
Rec #: 10210
Abstract: BIOSIS COPYRIGHT: BIOL ABS. These studies were conducted to investigate the joint toxic action of mixtures of several acaricides including bifenthrin, cyhexatin, dicofol and ethion to the bifenthrin-and the cyhexatin

resistant strain of Tetranychus urticae. The toxicity of acaricidal mixtures was greatly varied with the kind of acaricide combinations and their mixture ratios. With the bifenthrin resistant strain, the combinations of bifenthrin with each of the tested acaricides were synergized at the given mixture ratios. The higher synergistic action in the each combination was observed at 6:4 ratio with ethion, 8:2 ratio with dicofol, and cyhexatin. With the cyhexatin resident strain, the maximum synergistic action was observed at 2:8 ratio of cyhexatin and dicofol. However, there was no synergistic actions in all cyhexatin mixtures with ethion and bifenthrin.
Animals/Genetics/ Biochemistry/ Poisoning/ Animals, Laboratory/ Herbicides/ Pest Control/ Pesticides/ Arachnida/ Entomology/Economics/ Insecticides/ Pest Control/ Pesticides/ Anatomy, Comparative/ Animal/ Arthropods/Physiology/ Physiology, Comparative/ Pathology/ Arthropods

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Notes: EcoReference No.: 97438

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Notes: EcoReference No.: 97503

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Notes: EcoReference No.: 97216

Leonard, B. R. Management of Tobacco Budworm, Heliothis virescens (F.) and Bollworm, Helicoverpa zea (Boddie) in Cotton: Host Plant Resistance and Ovicidal Approaches. GRO,MOR,POP,REPSOIL,ENV,MIXTURE; 1990: 194 p. (UMI# 9104149).
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Notes: EcoReference No.: 155048

Lizotte Jr., Richard E.; Douglas Shields Jr., F.; Murdock, Justin N., and Knight, Scott S. Responses of Hyalella azteca and phytoplankton to a simulated agricultural runoff event in a managed backwater wetland. 201; 87, (7): 684-691.

Rec #: 160
Keywords: MIXTURE
Abstract: We assessed the aqueous toxicity mitigation capacity of a hydrologically managed floodplain wetland following a synthetic runoff event amended with a mixture of sediments, nutrients (nitrogen and phosphorus), and pesticides (atrazine, S-metolachlor, and permethrin) using 48-h Hyalella azteca survival and phytoplankton pigment, chlorophyll a. The runoff event simulated a 1 h, 1.27 cm rainfall event from a 16 ha agricultural field. Water (1 L) was collected every 30 min within the first 4 h, every 4 h until 48 h, and on days 5, 7, 14, 21, and 28 post-amendment at distances of 0, 10, 40, 300 and 500 m from the amendment point for chlorophyll a, suspended sediment, nutrient, and pesticide analyses. H. azteca 48-h laboratory survival was assessed in water collected at each site at 0, 4, 24, 48 h, 5 d and 7 d. Greatest sediment, nutrient, and pesticide concentrations occurred within 3 h of amendment at 0 m, 10 m, 40 m, and 300 m downstream. Sediments and nutrients showed little variation at 500 m whereas pesticides peaked within 48 h but at <15% of upstream peak concentrations. After 28 d, all mixture components were near or below pre-amendment concentrations. H. azteca survival significantly decreased within 48 h of amendment up to 300 m in association with permethrin concentrations. Chlorophyll a decreased within the first 24 h of amendment up to 40 m primarily in conjunction with herbicide concentrations. Variations in chlorophyll a at 300 and 500 m were associated with nutrients. Managed floodplain wetlands can rapidly and effectively trap and process agricultural runoff during moderate rainfall events, mitigating impacts to aquatic invertebrates and algae in receiving aquatic systems. Riverine floodplain wetland/ Sediment/ Nutrients/ Pesticides/ Invertebrates/ Algae

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Notes: EcoReference No.: 88509

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Notes: EcoReference No.: 92323

McPherson, R. M.; Hynson, T. P., and Weeks, S. D. Green Cloverworm Control with Foliar Insecticides, 1985. POPENV,MIXTURE; 1986; 11, 346-347 (433).
Rec #: 890
Notes: EcoReference No.: 87876

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Rec #: 900
Notes: EcoReference No.: 87877

Micinski, S.; Fitzpatrick, B. J., and Graves, J. B. Control of the Bollworm-Tobacco Budworm Complex, 1991. POPSOIL,ENV,MIXTURE; 1992; 17, 237-238 (79F).
Rec #: 950
Notes: EcoReference No.: 82242

Miller, D. K.; Downer, R. G.; Burris, E.; Leonard, B. R., and Williams, B. J. Control of Selected Broadleaf Weeds With Glufosinate as Influenced by Insecticide Coapplication. 2005; 19 , (3): 719-723.
Rec #: 1120
Keywords: MIXTURE
Abstract: Coapplication of herbicides and insecticides affords growers an opportunity to control multiple pests with one application, given that efficacy is not compromised. Glufosinate was applied at 470 g ai/ha both alone and in combination with the insecticides acephale, acetamiprid, bifenthrin, cyfluthrin, dicrotophos, emamectin benzoate, imidacloprid, indoxacarb, lambda-cyhalothrin, methoxyfenozide, spinosad, or thiamethoxam to determine coapplication effects on control of some of the more common and/or troublesome broadleaf weeds infesting cotton. Hemp sesbania, pitted morningglory, prickly sida, redroot pigweed, and sicklepod were treated at the three- to four- or the seven- to eight-leaf growth stage. When applied at the earlier application timing, glufosinate applied alone provided complete control at 14 d after treatment, and control was unaffected by

coapplication with insecticides. When glufosinate application was delayed to the later application timing, visual weed control was unaffected by insecticide coapplication. Fresh-weight reduction from the herbicide applied to larger weeds was negatively impacted by addition of the insecticides dicrotophos and imidacloprid with respect to redroot pigweed and prickly sida, but only in one of two experiments. In most cases, delaying application of glufosinate to larger weeds resulted in reduced control compared to that from a three- to four-leaf application, with the extent of reduction varying by species. Results indicate that when applied according to the herbicide label (three- to four-leaf stage), glufosinate/insecticide coapplications offer producers the ability to integrate pest management strategies and to limit application costs without sacrificing control of the broadleaf weeds evaluated.

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Notes: EcoReference No.: 156579

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Call Number: NO MIXTURE(BFT)
Notes: EcoReference No.: 81375
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Abstract: BIOSIS COPYRIGHT: BIOL ABS. Pyrethroid and endosulfan mixtures applied at full and reduced rates with 3 application methods (air-assisted electrostatic, air-assisted hydraulic, and standard hydraulic sprayers) were evaluated in field studies in 1992 and 1993 for control of sweetpotato whitefly, Bemisia tabaci strain B (Gennadius), also known as silverleaf whitefly, Bemisia argentifolii Bellows & Perring, and spray deposition on cauliflower, Brassica oleracea L. Evaluations of sweetpotato whitefly control were based on adult suppression, immature colonization, and cauliflower harvests. Spray deposition and coverage on abaxial and adaxial leaf surfaces was measured with a leaf wash technique and water sensitive cards placed on leaves near the terminal and base of plants. Depending on how control was assessed, the air-assisted electrostatic application technique did not consistently improve sweetpotato control when compared with hydraulic application equipment.

Palumbo JC and Mullins, C. H. JR. Efficacy of Pyrethroid and Endosulfan Combinations Against Whitefly Adults on Spring Cantaloupes 1995. 1996.
Rec #: 11910

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Notes: EcoReference No.: 68414

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POP,GROSOIL,ENV,MIXTURE; 1994; 19, 68-69 (18E).
Rec #: 1220
Notes: EcoReference No.: 82736

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Rowland, S. and Cartwright, B. Harlequin Bug Control on Cabbage, Spring, 1992.
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Samson, P. R.; Staier, T. N., and Bull, J. I. Evaluation of an Application Procedure for Metarhizium Anisopliae in Sugarcane Ratoons for Control of the White Grub Dermolepida Albohirtum. 2006; 25 , (8): 741-747.
Rec #: 870
Keywords: MIXTURE
Abstract: The biological control product BioCane(trademark), containing spores of the fungal pathogen Metarhizium anisopliae isolate FI-1045, is available for soil application against the white grub Dermolepida albohirtum (Waterhouse) in sugarcane in Australia. Currently, BioCane(trademark) granules can only be applied in plant crops, where they are distributed in a horizontal band in the planting furrows and covered with soil. Options for management of D. albohirtum would be broadened if M. anisopliae could also be effectively applied in ratoon crops. We evaluated the efficacy of spores of M. anisopliae sprayed as an aqueous suspension into two vertical slots cut into the soil in the rows of sugarcane ratoons. We were able to achieve vertical bands of spores, as determined by collecting soil samples at incremental depths and counting colonies after plating on artificial media, although spores were concentrated towards the bottom of the slot. Numbers of white grubs were reduced by treatment in some trials in comparison to untreated plots, but results were inferior to those obtained using the standard chemical insecticide, imidacloprid (Confidor^(registered trademark)). When a low application rate of M. anisopliae was combined with bifenthrin (Talstar^(registered trademark)), only bifenthrin was shown to contribute to efficacy with no interaction between effects of the two products, despite promising results in a previous bioassay. Application of M. anisopliae is not likely to be an economically viable treatment for sugarcane ratoons using this technique. (copyright) 2005 Elsevier Ltd. All rights reserved.

Schuster, D. J. Insecticides for Management of the Sweetpotato Whitefly on Fresh Market Tomatoes in West-Central Florida, Spring, 1990. POPSOIL,ENV,MIXTURE; 1992: 163.
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Rec #: 30770
Keywords: MIXTURE

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Keywords: MIXTURE

Sparks, A. N. Jr. Evaluation of Insecticide Efficacy for SPWF Control on Cucurbits, 1992. POPENV,MIXTURE; 1993; 18, 129-130 (54E).
Rec #: 31080
EcoReference No.: 83300

Stansly, P. A. and Cawley, B. M. Control of Adult Sweetpotato Whitefly (SPWF) and Tomato Mottle Geminivirus (TMoV) Transmission on Staked Tomato, Spring, 1992. POPENV,MIXTURE; 1994; 19, 156-(121E).

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EcoReference No.: 54471

Tanigoshi, L. K. and Aguilar, H. Control of Twospotted Spider Mite on Azuki Bean, 1992. POPENV,MIXTURE; 1993; 18, 191-(7F).
Rec #: 30810
EcoReference No.: 121443

Tanigoshi, L. K.; Bergen, J. R., and Chamberlain, J. D. Twospotted Spider Mite Insecticide Efficacy in Strawberry, 1998. POPENV,MIXTURE; 1999; 24, 78 (C21).
Rec #: 1490
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Thalavaisundaram, S.; Herron, G. A.; Clift, A. D., and Rose, H. Pyrethroid Resistance in Frankliniella occidentalis (Pergande) (Thysanoptera: Thripidae) and Implications for Its Management in Australia. MORENV,MIXTURE; 2008; 47, (1): 64-69.
Rec #: 31230
EcoReference No.: 119727

Trimble, A. J.; Belden, J. B.; Mueting, S. A., and Lydy, M. J. Determining Modifications to Bifenthrin Toxicity and Sediment Binding Affinity from Varying Potassium Chloride Concentrations in Overlying Water. MORAQUA,MIXTURE; 2010; 80, (1): 53-59.
Rec #: 100
EcoReference No.: 156444

Trimble, A. J.; Weston, D. P.; Belden, J. B., and Lydy, M. J. Identification and Evaluation of Pyrethroid Insecticide Mixtures in Urban Sediments. 2009; 28, (8): 1687-1695. 163923.
Rec #: 20660
Keywords: MIXTURE,REFS CHECKED,REVIEW

Tsagkarakou, A.; Van Leeuwen, T.; Khajehali, J.; Ilias, A.; Grispou, M.; Williamson, M. S.; Tirry, L., and Vontas, J. Identification of Pyrethroid Resistance Associated Mutations in the Para Sodium Channel of the Two-Spotted Spider Mite Tetranychus urticae (Acari: Tetranychidae). BCM,MORENV,MIXTURE; 2009; 18, (5): 583-593.
Rec #: 240
EcoReference No.: 119762

Van Leeuwen, T.; Stillatus, V., and Tirry, L. U. C. Genetic Analysis and Cross-Resistance Spectrum of a Laboratory-Selected Chlorfenapyr Resistant Strain of Two-Spotted Spider Mite (Acari: Tetranychidae). MORSOIL,ENV,MIXTURE; 2004; 32, (4):

249-261.
Rec #: 90
EcoReference No.: 75967

Wang, L., W. Ye, S. Zhou, K. Lin, M. Zhao, and W. Liu. 2009. Acute and Chronic Toxicity of Organophosphate Monocrotophos to *Daphnia magna*. *Journal of Environmental Science and Health, Part B: Pesticides, Food Contaminants, and Agricultural Wastes*, (2009) **44**, 38-43 (EcoReference No.: 120298)
Research Description: In this study, the acute toxicity of the organophosphate insecticide monocrotophos (MCP) to *Daphnia magna* was determined alone and in mixtures with bifenthrin, and sodium dodecyl benzene sulfonate. The 24-hr EC50s, 48-hr LC50s, LOECs and NOECs were as shown in the following table. Using a toxic unit (TU) approach, it was determined that the TU for the mixture of bifenthrin and MCP was 1.2 suggesting a limited antagonistic effect against *D. magna*, since it was close to unity.

Chemical	24-hr EC_{50} (µg/L)	48-hr LC_{50} (µg/L)	LOEC (µg/L)	NOEC (µg/L)
Bifenthrin	3.24 (2.85 ~ 3.68)			
Monocrotophos (MCP)	161(157 ~ 164)	388	10	5
Bifenthrin: MCP 50:1	121 (112 ~ 132)			

ABSTRACT: The acute and chronic toxicity of monocrotophos (MCP), the **binary joint toxicity of MCP and bifenthrin** (BF), and sodium dodecyl benzene sulfonate (SDBS) to Daphnia magna (D. magna) was evaluated. The 24 h-median effective concentration (24 h-EC(50)) and 48 h-median lethal concentration (48 h-LC(50)) of MCP towards D. magna were 161 and 388 micro g/L, respectively. In addition, the lowest-observed effective concentration (LOEC) and non-observed effective concentration (NOEC) of MCP to D. magna were 10 and 5 micro g/L, respectively. Furthermore, the chronic value (ChV) of MCP against D. magna was 7 micro g/L and the acute chronic ratio (ACR) was 55. The number of offspring per female and the intrinsic rate of natural increase (r) were identified as the parameters that were most sensitive to MCP. In addition, toxic unit (TU) analysis was employed to evaluate the joint toxicities. The calculated TU(mix) values of binary equitoxic mixtures of MCP + BF and MCP + SDBS were 1.47 and 1.63, respectively, which suggests that both equitoxic mixtures exert a limited antagonistic effect. The results of this study revealed that the toxic threshold of MCP towards D. magna is higher than its reported highest residue (4 micro g/L) in the ordinary aquatic environment, and that concurrent exposure to BF or SDBS may exert a slight antagonistic effect.

Waters, T. D.; Walsh, D. B.; Wight, R. P., and Ferguson, H. J. Acaricidal Efficacy Against McDaniel Mite in Timothy Hay, 2004. POPENV,MIXTURE; 2005; 30, F84.
Rec #: 1560
EcoReference No.: 93019

Wedberg, J. and Jensen, B. Labeled and Unlabeled Insecticides for Control of European Corn Borer on Sweet Corn in Wisconsin, 1991. POPENV,MIXTURE; 1992; 17, 110-

(46E).
Rec #: 30840
EcoReference No.: 121403

Wedberg, J. and Jensen, B. Use of Labeled and Experimental Insecticides for Control of European Corn Borer and Corn Earworm on Sweet Corn, 1998B. PHY,POPSOIL,ENV,MIXTURE; 1999; 24, 134-135 (E43).
Rec #: 31340
EcoReference No.: 88209

Weston, D.P., J. You, and M.J. Lydy. 2004. Distribution and Toxicity of Sediment-Associated Pesticides in Agriculture-Dominated Water Bodies of California's Central Valley. *Environ. Sci. Technol.*, **2004**, *38* (10), pp 2752–2759
Abstract: The agricultural industry and urban pesticide users are increasingly relying upon pyrethroid insecticides and shifting to more potent members of the class, yet little information is available on residues of these substances in aquatic systems under conditions of actual use. Seventy sediment samples were collected over a 10-county area in the agriculture-dominated Central Valley of California, with most sites located in irrigation canals and small creeks dominated by agricultural effluent. The sediments were analyzed for 26 pesticides including five pyrethroids, 20 organochlorines, and one organophosphate. Ten-day sediment toxicity tests were conducted using the amphipod *Hyalella azteca* and, for some samples, the midge *Chironomus tentans*. Forty-two percent of the locations sampled caused significant mortality to one test species on at least one occasion. Fourteen percent of the sites (two creeks and four irrigation canals) showed extreme toxicity (>80% mortality) on at least one occasion. Pyrethroid pesticides were detected in 75% of the sediment samples, with permethrin detected most frequently, followed by esfenvalerate > bifenthrin >lambda-cyhalothrin. Based on a toxicity unit analysis, measured pyrethroid concentrations were sufficiently high to have contributed to the toxicity in 40% of samples toxic to *C. tentans* and nearly 70% of samples toxic to *H. azteca*. Organochlorine compounds (endrin, endosulfan) may have contributed to the toxicity at a few other sites. This study provides one of the first geographically broad assessments of pyrethroids in areas highly affected by agriculture, and it suggests there is a greater need to examine sediment-associated pesticide residues and their potential for uptake by and toxicity to benthic organisms.

Weston, D.P., R.W. Holmes, J. You, M.J. Lydy. 2005. Aquatic Toxicity Due to Residential Use of Pyrethroid Insecticides. *Environ. Sci. Technol.*, **2005**, *39* (24), pp 9778–9784
Abstract: Pyrethroids are the active ingredients in most insecticides available to consumers for residential use in the United States. Yet despite their dominance in the marketplace, there has been no attempt to analyze for most of these compounds in watercourses draining residential areas. Roseville, California was selected as a typical suburban development, and several creeks that drain subdivisions of single-family homes were examined. Nearly all creek sediments collected caused toxicity in laboratory exposures to an aquatic species, the amphipod *Hyalella azteca*, and about half the samples caused nearly complete mortality. This same species was

also found as a resident in the system, but its presence was limited to areas where residential influence was least. The pyrethroid bifenthrin is implicated as the primary cause of the toxicity, with additional contributions to toxicity from the pyrethroids cyfluthrin and cypermethrin. The dominant sources of these pyrethroids are structural pest control by professional applicators and/or homeowner use of insecticides, particularly lawn care products. The suburbs of Roseville are unlikely to be unique, and similar sediment quality degradation is likely in other suburban areas, particularly in dry regions where landscape irrigation can dominate seasonal flow in some water bodies.

Weston, D. P.; Amweg, E. L.; Mekebri, A.; Ogle, R. S., and Lydy, M. J. Aquatic Effects of Aerial Spraying for Mosquito Control over an Urban Area. 2006; 40, 5817-5822.
Rec #: 30810
EcoReference No.: 119530
Abstract: In an effort to combat West Nile Virus, planes dispersed insecticide over Sacramento, CA, treating nearly 50,000 hectares with pyrethrins and the synergist piperonyl butoxide (PBO). Widespread dispersal of insecticide over a metropolitan area, coupled with extensive pretreatment data on the area's urban creeks, provided a unique opportunity to study effects of mosquito control agents on aquatic habitats within an urban setting. There was no evidence of aquatic toxicity from the two active ingredients in the product applied. However, PBO concentrations were high enough to enhance toxicity of pyrethroids already existing in creek sediments from general urban pesticide use. PBO concentrations of 2−4 μg/L were high enough to nearly double the toxicity of sediments to the amphipod *Hyalella azteca*. Though the increase in toxicity was modest, it was unexpected to find environmental synergy at all. Risk assessments for mosquito control agents have focused on the active ingredients but have failed to recognize the potential for interactions with pesticides previously existing in the environment, which in this case appeared to represent a risk to aquatic life greater than that of the active ingredients themselves.

Weston, D.P., M. Zhang, and M.J. Lydy. 2008. Identifying the cause and source of sediment toxicity in an agriculture-influenced creek. *Environmental Toxicology and Chem*istry, 27: 953–962. doi: 10.1897/07-449.1
Abstract: Del Puerto Creek, an agriculturally influenced stream in northern California, USA, with a history of sediment toxicity, was used as a case study to determine the feasibility of using sediment toxicity testing and chemical analysis to identify the causative agent for the toxicity and its sources. Testing with the amphipod *Hyalella azteca* confirmed historical toxicity and identified a point along the creek at which there was an abrupt increase in sediment toxicity that persisted for at least 6 km downstream. Three recently developed whole sediment toxicity identification evaluation manipulations, temperature reduction, piperonyl butoxide addition, and esterase addition, were applied to sediment from one site and were suggestive of a pyrethroid as the cause for toxicity. Utilizing published median lethal concentration (LC50) values in a toxic unit analysis, the pyrethroid insecticide bifenthrin was identified as the primary contributor to toxicity in nearly all sites at which toxicity was observed, with occasional additional contributions

from the pyrethroids lambda-cyhalothrin, esfenvalerate, and cyfluthrin. Most agricultural drains discharging to Del Puerto Creek contained bifenthrin in their sediments at concentrations near or above acutely toxic concentrations. However, only one drain contained sediments with bifenthrin concentrations approaching the concentrations measured in creek sediments. This fact, along with the proximity of that particular discharge to the location in the creek with the highest concentrations, suggested that one drain may be responsible for much of the toxicity and pyrethroid residues in creek sediments. The methods employed in this study are likely to be of considerable value in total maximum daily load efforts in Del Puerto Creek or other California surface water bodies known to have pyrethroid-related aquatic toxicity.

Winters, S. and Cartwright, B. Control of Lepidopterous Larvae on Cabbage, Summer, 1990.
POPENV,MIXTURE; 1991; 16, 65-66 (19E).
Rec #: 1650
EcoReference No.: 90586

Yang, E.; Yang, Y.; Wu, S., and Wu, Y. Relative Contribution of Detoxifying Enzymes to Pyrethroid Resistance in a Resistant Strain of Helicoverpa Armigera. 2005; 129 , (9-10): 521-525.
Rec #: 1080
Abstract: The relative contribution of oxidases and esterases to pyrethroid resistance was studied in a YS-FP strain of Helicoverpa armigera from China. The YS-FP strain was derived from a field-collected strain (YS) by 16 generations of selection with a mixture of fenvalerate and phoxim. Compared with the YS strain, the YS-FP strain showed 1850- to > 7140-fold resistance to four ester-bonded phenoxybenzyl alcohol pyrethroids (fenvalerate, deltamethrin, cypermethrin and cyhalothrin), > 205-fold resistance to a non-ester phenoxybenzyl alcohol pyrethroid (etofenprox) and only 19-fold resistance to an ester-bonded methylated biphenyl alcohol pyrethroid (bifenthrin). The oxidase inhibitor piperonyl butoxide eliminated most the of resistance to fenvalerate, deltamethrin, cypermethrin, cyhalothrin and etofenprox, whereas the esterase inhibitor S,S,S-tributylphosphorothioate had a small synergistic effect for fenvalerate and cyhalothrin only. This suggests that the resistance to these pyrethroids in the YS-FP strain was mainly because of enhanced oxidative detoxification. The monooxygenase activities of the midguts of sixth-instar larvae of the YS-FP strain to substrates p-nitroanisole, ethoxycoumarin and methoxycoumarin were 3.7-, 4.7- and 10-fold, respectively, compared with that of the YS strain. Glutathione S-transferase activity and esterase activity were not significantly altered in the YS-FP strain. This confirms that enhanced oxidative detoxification was a major mechanism contributing to pyrethroid resistance in the YS-FP strain. (copyright) 2005 Blackwell Verlag.

Zhang, Z.Y., D.L. Wang, Z.J. Chi, X.J. Liu, and X.Y. Hong. 2008. Acute Toxicity of Organophosphorus and Pyrethroid Insecticides to *Bombyx mori*. *Journal of Economic Entomology*, 101(2):360-364. 2008 (EcoReference No.: 114962)
<u>Research Description</u>: Acute toxicity values were determined for two organophosphate (dichlorvos and phoxim) and four pyrethroid insecticides (which included bifenthrin) towards the silkworm, *Bombyx mori* (L.). Toxicity of 50:50

mixtures was also conducted. This was done through feeding the silkworm with treated mulberry leaves, *Morus albus* (L.). Additionally, combination coefficients (Q values), for mixtures of two insecticides were defined as follows (for Q equations, see Zhang *et al.* 2010):

The predicted LC_{50} of the mixture is defined as follows:

P_a and P_b are the proportions of chemicals A and B, respectively. In this study P_a = P_b = 0.5. In this instance, if Q is greater than 1.75, it is indicated that the mixture shows synergism and if Q is less than 0.57, the mixture shows antagonism. It was concluded that bifenthrin: dichlorvos and bifenthrin: phoxim mixtures had additive effects. For toxicity results and Q values, see the following table.

Chemical	24-hr LC_{50} (mg/L)	Q	48-hr LC_{50} (mg/L)	Q
Bifenthrin	0.09 (0.06-0.11)		0.06 (0.05-0.06)	
Dichlorvos	6.63 (5.60-7.83)		4.11 (3.09-5.32)	
Phoxim	1.05 (0.80-1.42)		0.45 (0.28-0.60)	
Bifenthrin: Dichlorvos	0.12 (0.12-0.13)	1.48	0.10 (0.09-0.11)	1.18
Bifenthrin: Phoxim	0.33 (0.28-0.39)	0.50	0.13 (0.11-0.15)	0.81

Zhang, Z.Y., X.Y. Yu, D.L. Wang, H.J. Yan, and X.J. Liu. Acute Toxicity to Zebrafish of Two Organophosphates and Four Pyrethroids and Their Binary Mixtures. *Pest Manag Sci* 2010; **66**: 84–89
EcoReference No.: 151326
<u>Research Description</u>: For a series of pesticides and their 50:50 mixtures, toxicity tests were conducted for the zebrafish (*Brachydanio rerio*). LC_{50}s were measured for test periods of 24, 48, 72, and 96-hr for permethrin, tetramethrin, bifenthrin, etofenprox, dichlorvos and phoxim individually and for the 50:50 mixtures of pyrethroid: organophosphate insecticides. For bifenthrin, and bifenthrin mixtures the results are as shown in the following table:

Chemical	24-hr LC_{50} (mg/L) (95% confidence limit)	48-hr LC_{50} (mg/L) (95% confidence limit)	72-hr LC_{50} (mg/L) (95% confidence limit)	96-hr LC_{50} (mg/L) (95% confidence limit)
Bifenthrin	0.0065 (0.0051–0.0093)	0.0039 (0.0026–0.0050)	0.0034 (0.0020–0.0046)	0.0032 (0.0021–0.0041)
Dichlorvos	51.3 (47.2–55.8)	32.3 (28.7–36.0)	15.0 (12.1–18.4)	13.0 (10.4–16.1)
Phoxim	1.28 (1.22–1.34)	0.700 (0.646–0.759)	0.513 (0.458–0.581)	0.469 (0.414–0.527)
Bifenthrin: Dichlorvos	0.0251 (0.0226–0.0279)	0.0182 (0.0156–0.0210)	0.0177 (0.0152–0.0202)	0.0154 (0.0136–0.0173)
Bifenthrin: Phoxim	0.0154 (0.0135–0.0174)	0.0106 (0.0095–0.0116)	0.0095 (0.0085–0.0107)	0.0087 (0.0076–0.0097)

Q values were calculated as shown in the following table (for equations, see Zhang *et al.* 2008). Based solely on the Q values, it was concluded that the bifenthrin: dichlorvos mixture shows antagonism, while the bifenthrin: phoxim mixture shows additive effects.

Chemical	24-hr (Q)	48-hr (Q)	72-hr (Q)	96-hr (Q)
Bifenthrin: Dichlorvos	0.52	0.43	0.38	0.42
Bifenthrin: Phoxim	0.84	0.73	0.71	0.73