"Pesticide Environmental Assessment System" (PEAS)

A Tool for Tracking and Managing Pesticide Risks

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Why Measure Pesticide Risks?

To better understand the risks stemming from agricultural pesticide use in order to prioritize IPM research and implementation, and judge the adequacy of pesticide regulatory and agricultural policies.

Assessing the impact of new technology – from *Bt* crops to pheromones

Tracking the impacts of resistance

Why Measure?

Public and private sector investments in IPM are motivated in part by a desire to **incrementally reduce reliance on higher-risk pesticides.** But what crops are most "at risk"?

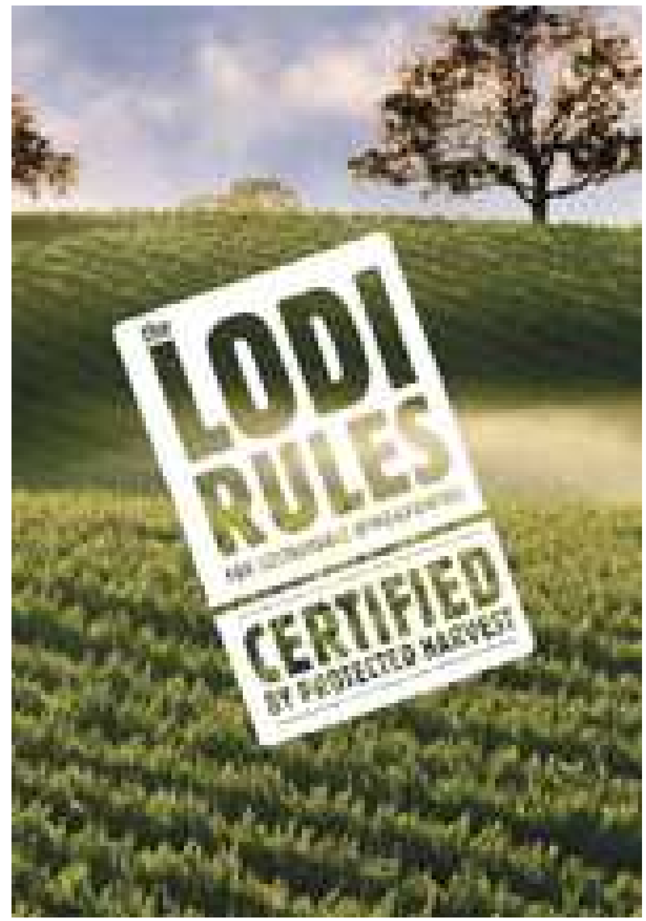
And what about **risk-risk** tradeoffs?

Why Measure?

Ecolabel programs need better methods to **evaluate and document** pesticide use and risk levels.

Baselines must be established and **goals for change.**

Measurement systems need to **strike a balance** between complexity, accuracy, and practicality.



Measurement Systems

Scale matters – field-level systems can be more complex, data-intensive than regional/state level models

All models depend on accurate pesticide use data

Also key to identify the most critical environmental or public health impacts to measure and manage

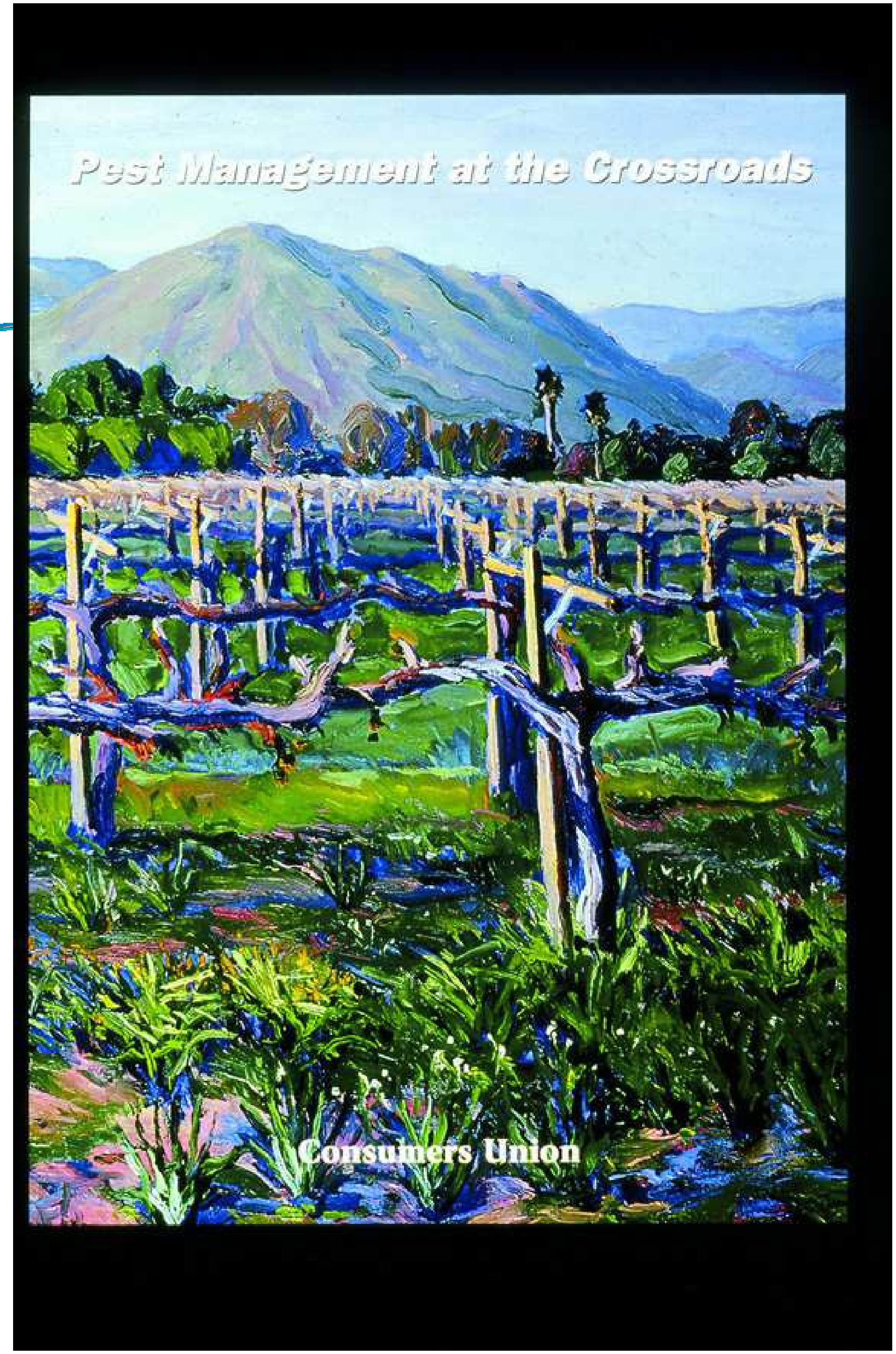
Evolution of Pesticide Risk Ranking Models

- EIQ – Joe Kovach, Cornell University, circa 1991
- IPM System Ratio, Weed Management – Benbrook, WWF 1994
- IPM Measurement System, *PMAC*, Benbrook/CU, 1996
- **Wisconsin potato collaboration**, multiattribute tox method, 1996-**ONGOING**

The Roots of PEAS

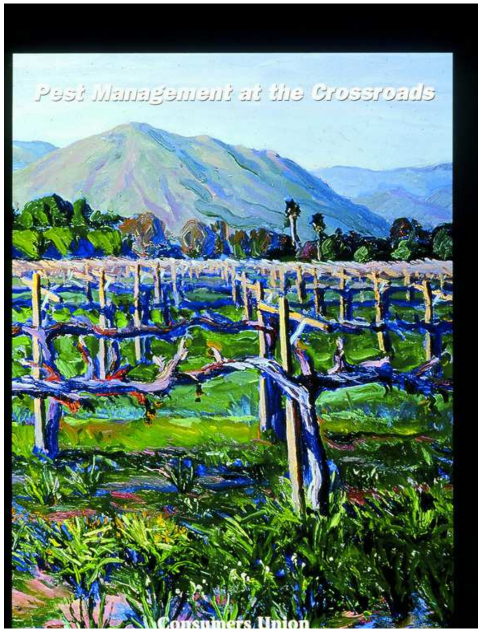
Consumers Union work on PMAC, 1992 – 1996

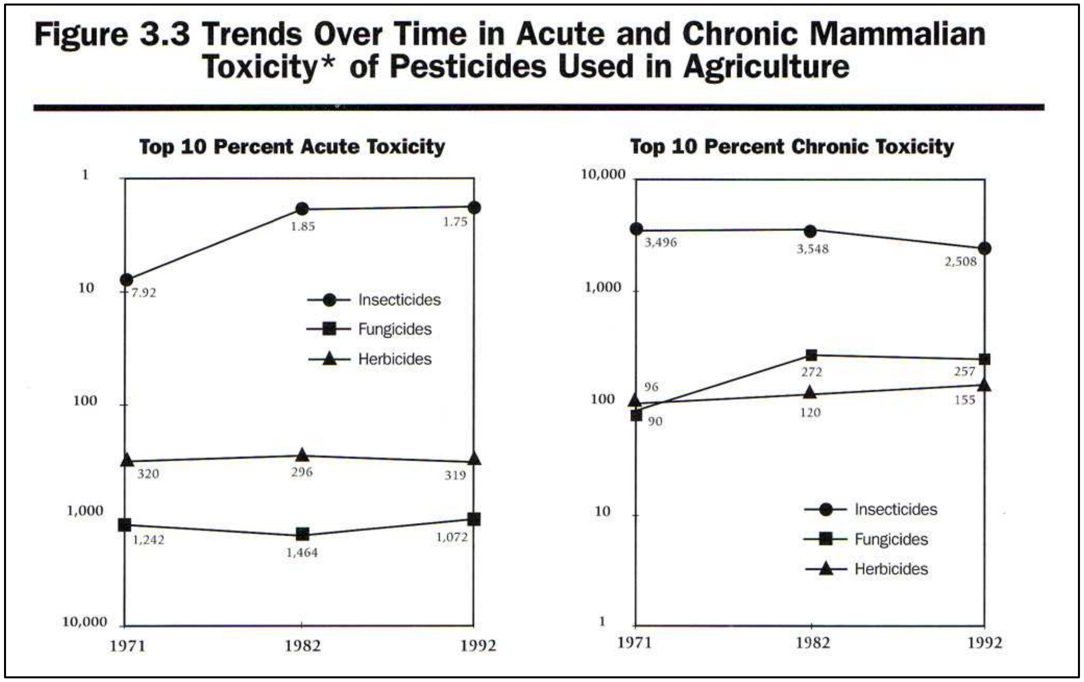
Quantitative assessment of long-term acute and chronic pesticide risk trends 1970s to 1990s based on nationwide pesticide use in the U.S.



The Roots of PEAS

Most toxic 10% pounds applied



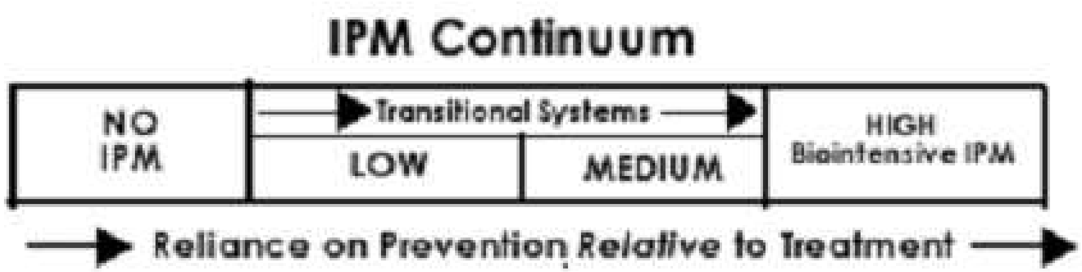


(PMAC, Benbrook et al., 1996)

The Roots of PEAS

Major focus in PMAC –

- Development of tools to measure pesticide risk over time
- Progress along the IPM continuum; **AND**
- Empirically capturing the linkages between IPM adoption and pesticide use/risk



The WWF-WPVGA-UW Collaboration

Potato IPM Collaboration began in 1995 -

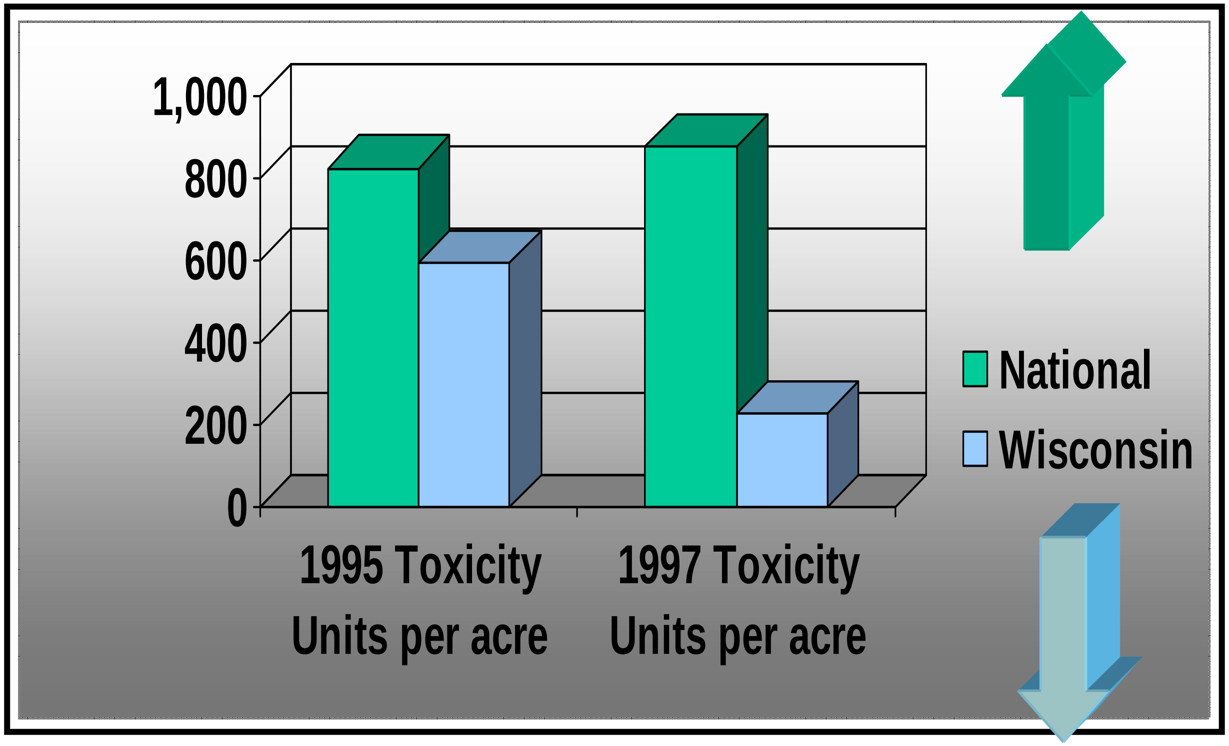
- World Wildlife Fund (WWF)
- Wisconsin Potato and Vegetable Producers Association (WPVGA)
- University of Wisconsin (UW)

WWF-WPVGA-UW Collaboration Multiattribute Measurement System

A multiattribute pesticide risk model developed and applied to estimate a 1995 baseline of Wisconsin potato pesticide use and risks (Benbrook et al., J. of Potato Research, 2002).

One, three- and five-year goals set for reductions in toxicity units and use of high-risk pesticides, with progress measured from the 1995 baseline.

The Roots of PEAS



WWF-WPVGA

1995 - 1997

Evolution of the Collaboration's Multiattribute Measurement System

- **Glades Crop Care** applications, tomato and pepper tox units, 1998-2004, with support from several SBA grants and a major USDA RAMP grant

- **Wisconsin apples**, 2002

- **Development of PEAS** for the Gerber Products Co., in partnership with Jennifer Curtis; applications to multiple crops, 2002-2005

Evolution and Applications of PEAS

- **Lodi-Woodbridge --** application of PEAS to SJV wine grapes, 2003-ongoing
- **Protected Harvest --** stone-fruits, pome fruits, processing tomatoes, summer squash, strawberries and citrus, 2004-ongoing
- **WWF Meso-American Coral Reef Project --** bananas, pineapple, oil palm, sugar, 2004-ongoing
- **University of Oregon** – application of PEAS to pesticides used for Lepidopteran control in Caneberries, 2006 USDA CAR grant (just starting)

PEAS Component Indices

FIVE FOCUS AREAS:

- Acute mammalian risks to workers
- Dietary risks to infants and children
- Acute avian toxicity
- Acute aquatic organism toxicity (*daphnia magna*)
- Acute toxicity to honey bees (a sentinel organism representative of pesticide impacts on beneficial insects)

PEAS Component Index Values

- Separate toxicity factor values are calculated for individual pesticides in each of five areas, based on the typical (or actual) one-time rate of application per acre.
- Toxicity data is inverted so that more toxic pesticides score higher.
- Per acre-treatment toxicity units are then scaled and ranked from highest per acre to lowest within each risk category.

PEAS vs. WWF-WPVGA-UW Model

Wisconsin model estimates **potential** pesticide toxicity and risks, without regard to whether the target organisms are actually exposed.

The basic metric is pounds of a pesticide applied multiplied by its toxicity factor value, which is driven solely by relative toxicity in animal studies.

PEAS vs. WWF-WPVGA Model

PEAS uses similar toxicity factor values, but adjusts potential risk to reflect real-world exposure potential, to the extent possible.

PEAS includes a set of risk-specific "**Use Pattern Adjustment Factors**" (UPAFs) that modify per acre toxicity units (or Environmental Impact Points).

PEAS vs. WWF-WPVGA Model

"**Use Pattern Adjustment Factor**" equals one for an in-season liquid foliar application.

UPAFs usually are less than one –

- Liquid to a granular (UPAF goes UP for birds in this case)
- In season application to pre-plant, or pre-plant and tarped

Use Pattern Adjustment Factors (UPAF)

Parameters that drive UPAFs:

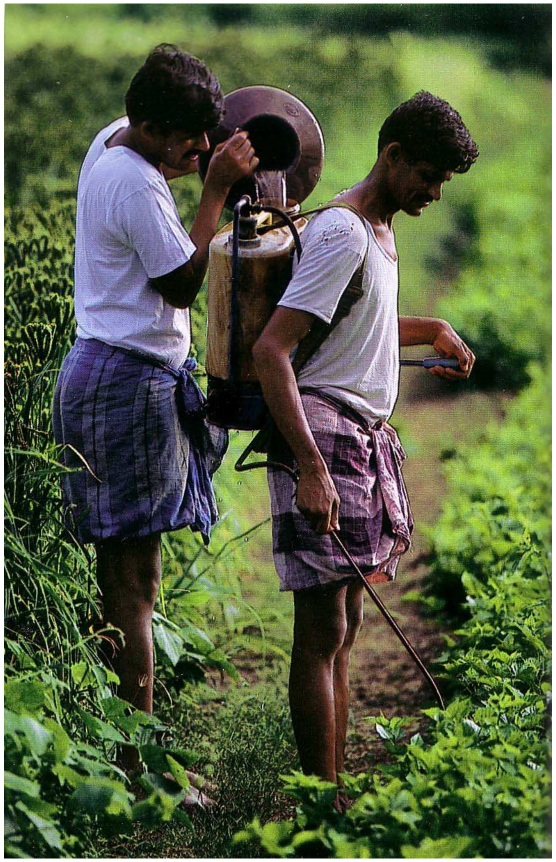
- Pesticide formulation (as applied) (e.g. liquid, dust, granular)
- System target (e.g. foliar, soil, ambient)
- Timing of application (e.g. pre-plant, post-harvest)
- Method of application (e.g. air, ground, in irrigation)

An in-season, liquid foliar application is used as the UPAF benchmark, with value equal to one.

Some Use Pattern Adjustment Factors are Greater Than One

UPAF is set greater than one for aerial applications for certain risks

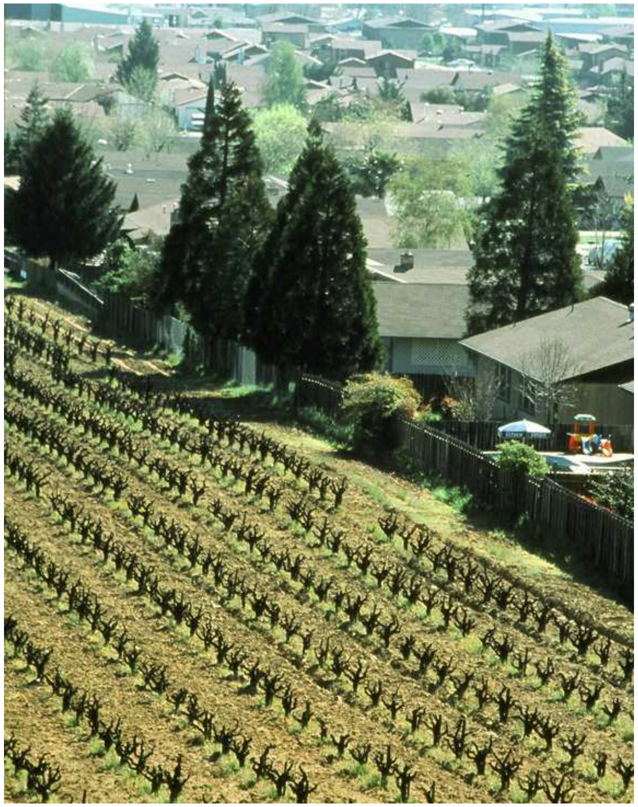
And way up for --



Why Add Use Pattern Adjustment Factors to a Pesticide Risk Model?

Toxicity alone is a misleading indicator of risk; where an application is made obviously can matter greatly.

Use patterns have a big impact on non-target organism exposure levels.



Why Add Use Pattern Adjustment Factors to a Pesticide Risk Model?

Pesticide manufacturers and farmers work to reduce risks by choosing the best formulation, right kind of application equipment, surface applied versus incorporated, tarp-no tarp, and optimal timing.

UPAFs provide a simple, transparent and verifiable method to "credit" manufactures, applicators, farmers, and IPM experts for changes in use patterns that reduce risks.

Worker Exposure/Acute Mammalian Toxicity Index (WE/AM)

<u>Basis for the WE/AM Use Pattern Adjustment Factors</u>

In-Season Applications including Bloom, Post-emergence, Year Round and Post-Transplant								
FOLIAR				SOIL				
Liquid		Dust		Liquid			Granular	
Air	Ground	Air	Ground	Air	Ground	Irrigation	Air	Ground
1.3	1.0	1.3	1.3	0.8	0.6	0.4	0.36	0.3

Pre-season Applications including Dormant, Delayed Dormant, Pre-emergence, Pre-plant and Fallow											
FOLIAR				SOIL							
Liquid		Dust		Liquid				Granular	Fumigant – Tarped or Injected		
Air	Ground	Air	Ground	Air	Ground	Irrigation	Injected	All Treatments	Liquid	Gas	Other or Unspecified
1.3	1.0	1.3	1.3	0.25	0.2	0.15	0.1	0.2	0.0005	0.00001	0.0005

Other Types of Applications including Pheromone Use, Post Harvest (Storage and Transport), Seed Treatments and Baits					
AMBIENT OR PHEROMONE		POSTHARVEST (Storage & Transport)	SEED TREATMENTS	BAIT	WAXES AND COATINGS
Impregnated Material	Puffer	Gas or Liquid	All Seed Treatments	Solid	Liquid
0.001	0.001	0.001	0.1	0.1	0.001

Need for Scaling Factors

Unadjusted toxicity factors can vary by four or more orders of magnitude.

One index with really big numbers can totally dominate multiattribute risk.

Scaling is required to assure roughly equal weights are given to different risks.

Scaling Factors

A scaling factor is a number that is multiplied by all the values within a risk index, changing the absolute values of the index, but not the relative values.

PEAS uses scaling factors to equalize the weight given to each of the five component indices.

Done by forcing the highest number in each risk index to equal 100.

Then, if a research team or grower group wants to double the weight on worker risks, or place one-half the weight on Daphnia, this can be done by adding weighting factors.

Worker Exposure/Acute Mammalian Toxicity Index (WE/AM)

Lodi-Woodbridge Wine Grapes - Pesticide Toxicity Factors

PESTICIDE: Abamectin

TRADE NAME: Agri-Mek

PESTICIDE TYPE: I/M

APPLICATOR: LW

MULTIATTRIBUTE VALUE = 0.562

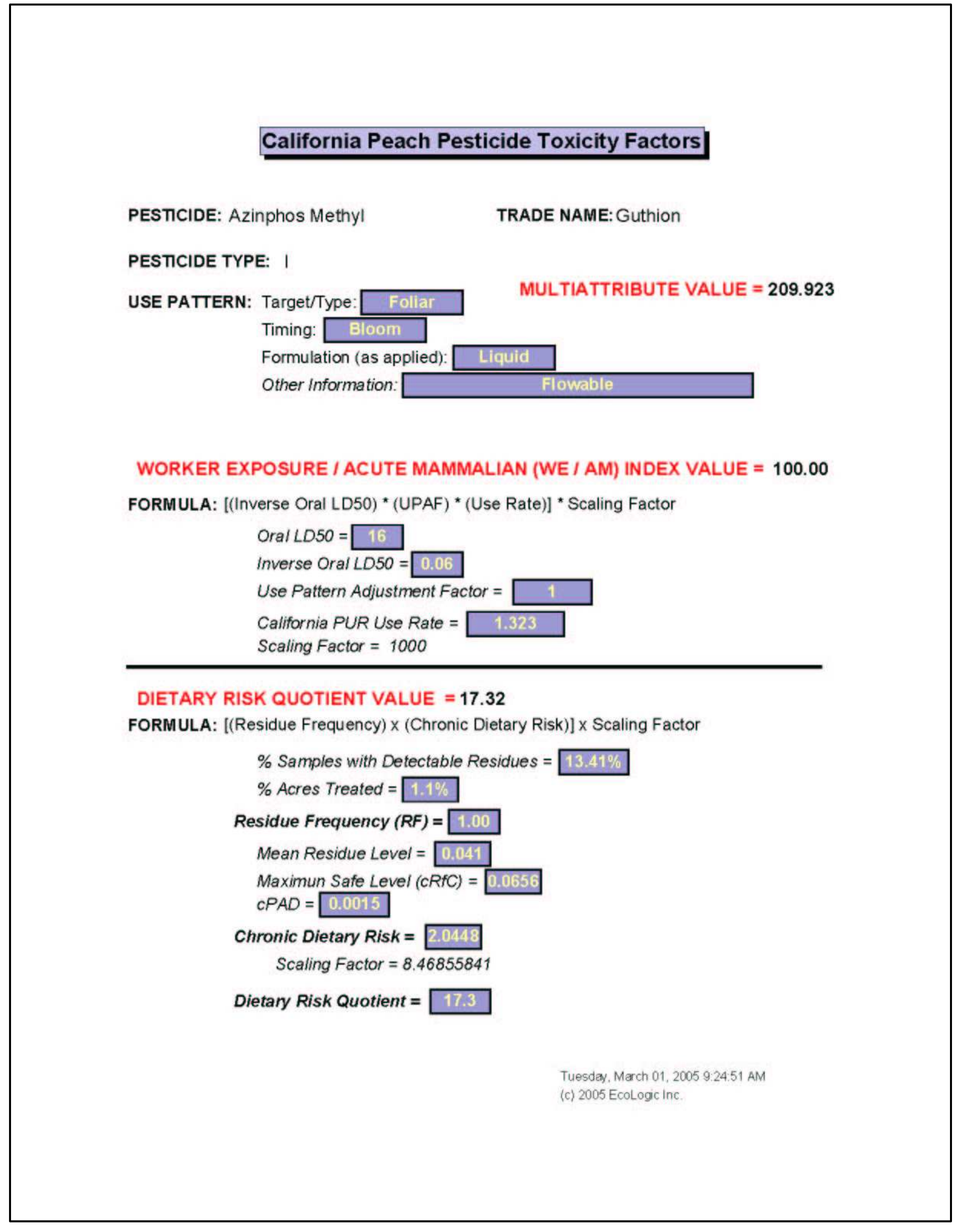
USE PATTERN:
Target/Type: Foliar
Timing: In-season
Formulation (as applied): Liquid
Other Information: unspecified

WORKER EXPOSURE / ACUTE MAMMALIAN (WE / AM) INDEX VALUE = 0.028

FORMULA: [(Inverse Oral LD50) * (UPAF) * (Use Rate)] * Scaling Factor

Oral LD50 = 300
Inverse Oral LD50 = 0.003
Use Pattern Adjustment Factor = 1
Use Rate = 0.0235364
Scaling Factor = 351.35

Worker Exposure/Acute Mammalian *and* Dietary Toxicity Indices (CA Peach)



California Peach Pesticide Toxicity Factors

PESTICIDE: Azinphos Methyl **TRADE NAME:** Guthion

PESTICIDE TYPE: I

MULTIATTRIBUTE VALUE = 209.923

USE PATTERN: Target/Type: Foliar
Timing: Bloom
Formulation (as applied): Liquid
Other Information: Flowable

WORKER EXPOSURE / ACUTE MAMMALIAN (WE / AM) INDEX VALUE = 100.00

FORMULA: [(Inverse Oral LD50) * (UPAF) * (Use Rate)] * Scaling Factor

Oral LD50 = 16
Inverse Oral LD50 = 0.06
Use Pattern Adjustment Factor = 1
California PUR Use Rate = 1.323
Scaling Factor = 1000

DIETARY RISK QUOTIENT VALUE = 17.32

FORMULA: [(Residue Frequency) x (Chronic Dietary Risk)] x Scaling Factor

% Samples with Detectable Residues = 13.41%
% Acres Treated = 1.1%
Residue Frequency (RF) = 1.00
Mean Residue Level = 0.041
Maximun Safe Level (cRfC) = 0.0656
cPAD = 0.0015
Chronic Dietary Risk = 2.0448
Scaling Factor = 8.46855841
Dietary Risk Quotient = 17.3

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Bee, Avian and Aquatic Toxicity Indices (CA Peach)

California Peach Pesticide Toxicity Factors

PESTICIDE: Azinphos Methyl **TRADE NAME:** Guthion

BENEFICIAL / BEE INDEX VALUE = 15.684

FORMULA: [(Inverse ug/bee) * (Use Pattern Adjustment Factor) * (Use Rate)] * Scaling Factor

ug/b LD50 Toxicity Value = 0.29

Inverse ug/b (contact) = 3.51

Use Pattern Adjustment Factor = 1.2

California PUR Use Rate = 1.323

Scaling Factor = 2.7914965986

AVIAN (AV) INDEX VALUE = 9.920

FORMULA: [(Mineau Avian Risk Value) * (Use Pattern Adjustment Factor) * Scaling Factor

Mineau's Avian Risk Value (Orchard model) = 0.1

Use Pattern Adjustment Factor = 1

Scaling Factor = 100

WATER / dahpnia magna INDEX VALUE = 44.888

FORMULA: [(Inverse daphnia EC5050) * (Use Rate)] * Scaling Factor

ppm EC50 Toxicity Value = 0.001

Inverse ppm EC50 = 909

California PUR Use Rate = 1.323

Scaling Factor = 0.01

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Input	Chemical	Rate per Acre	Units	Pounds AI per Acre	Impact Units per Pound AI	Impact Units per Acre
3/30/2001	Sulfur dust	15	lbs	14.7	0.157	2.88
4/5/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
4/10/2001	Sulfur dust	20	lbs	19.6	0.157	8.08
4/10/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
4/17/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
4/24/2001	Elite 45 WP	4	ozs	0.11	3.273	0.59
4/24/2001	Wettable Sulfur 92	2	lbs	1.84	0.154	0.46
5/1/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
5/10/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
5/17/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
5/22/2001	Roundup Original	3.6	pints	1.8	0.116	0.12
5/25/2001	Sulfur dust	15	lbs	14.7	0.157	2.6
6/1/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
6/8/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
6/14/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
6/27/2001	Omite 30W	5	lbs	1.6	1.413	3.63
6/27/2001	Flint	2	ozs	0.09	2.3	0.32
6/27/2001	Provado Solupak 75%	0.25	ozs	0.01	116.28	2.2
7/6/2001	Roundup Original	3.4	pints	1.7	0.116	0.12
7/7/2001	Sulfur dust	15	lbs	14.7	0.157	3.71
				Total Impact Units:		**58.1**

Pesticide Environmental Impact Summary Report: Organic Grower, BIFS Project Vineyard, 2001 crop year

Date	Chemical	Rate per Acre	Units	Pounds AI per Acre	Impact Units per Pound	Impact Units per Acre
4/14/2001	THAT flowable sulfur	0.33	pints	0.26	2.576	0.66
4/22/2001	THAT flowable sulfur	0.5	pints	0.39	2.576	1.00
5/5/2001	THAT flowable sulfur	1	pints	0.78	2.576	2.01
5/18/2001	THAT flowable sulfur	1	pints	0.78	2.755	2.01
6/3/2001	Sulfur dust	11	lbs	10.78	0.157	1.69
6/24/2001	THAT flowable sulfur	1	pints	0.78	2.576	2.01
7/2/2001	Sulfur dust	10	lbs	9.8	0.157	1.54
7/8/2001	THAT flowable sulfur	1	pints	0.78	2.576	0.45
7/10/2001	Sulfur dust	10	lbs	9.8	0.157	1.54
7/24/2001	Sulfur dust	10	lbs	9.8	0.157	1.54
				Total Impact Units:		**14.45**

Pesticide Environmental Impact Summary Report: "Typical" Lodi Grower, BIFS Project Vineyard, 2001 crop year						
Date	**Chemical**	**Rate per Acre**	**Units**	**Pounds AI per Acre**	**Impact Units per Pound**	**Impact Units per Acre**
2/8/2001	Roundup Original	1.3	pints	0.65	0.116	0.05
2/8/2001	Goal 1.6E	0.5	pints	0.05	0.227	0.01
4/23/2001	Sulfur dust	1	lbs	16.66	0.157	5.2
5/12/2001	Sulfur dust	1	lbs	15.68	0.157	4.9
5/15/2001	Roundup Ultra Dry	11	lbs	0.71	0.328	0.16
5/30/2001	Rally 40W	1	ozs	0.1	3.137	0.65
6/19/2001	Sovran	10	ozs	0.12	0.185	0.05
7/6/2001	Rally 40W	1	ozs	0.08	3.137	0.5
8/6/2001	Provado Solupack 75%WP	10	ozs	0.02	116.28	4.35
			Total Impact Units per Season:			**15.87**