Toxicology Update/Exposure Insights: Long Beach, CA

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Why do we keep *updating pesticide toxicology* if our regulations are based on “no effect” levels of exposure?

Personal Chemical Exposure Program

Manufacturers, regulators, universities, users, and others who should know better have done a very poor job of public education.
Toxicology

Scientific study of adverse effects of chemicals

- **Effects** are determined by dose

- Principle codified by a physician, alchemist, philosopher: *Paracelsus*, 1450

- If dose determines a poison, there must be a safe level of everything!
Pesticides
Very special chemicals!

Preserve safe uses!

You make a difference—
know your stuff!
We *live in a chemical world!*  

More than 32,000,000 known  
• Origin  
  Natural and Synthetic  
• Class  
  Organic and Inorganic  
• Sustainable Use  
  Process •• *Commercial Products* •• Pollutants  
  Foods • Drugs • Cosmetics • Pesticides
“Dose-Response Curve”

- **Response**: none, 50% ->, 100%
- **Dose (Exposure)**: none, increasing dose
Safety Evaluation: Exposure-Response Relationships

- RfD
- "No Effect" NOAEL
- Effective Dose or "Side-Effect"
- ED50
- LOAEL
- LD50
What about everyday exposures?
**Dose** is the *amount* of exposure in a specified *time*.

**Response** is *toxicity* or the *adverse effect*.

**Effective Dose** for 50% of the test population (ED50)

2 “threshold”; 3 LOAEL; 4 NOAEL; 5 estimated NOAEL; 6 Reference Dose (3)/(10 x 10)
Exposed to a pesticide!

What?
Which compound is **LEAST** toxic to a human applicator (based on acute oral LD$_{50}$):

<table>
<thead>
<tr>
<th>Name of insecticide</th>
<th>Mammalian Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sevin</td>
<td>300 mg/kg</td>
</tr>
<tr>
<td>Guthion</td>
<td>13 mg/kg</td>
</tr>
<tr>
<td>Kryocide</td>
<td>35 mg/kg</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>250 mg/kg</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>869-1271 mg/kg</td>
</tr>
</tbody>
</table>
How do we come to a “safe dose?”

- **LD50 rat oral** 250 mg/kg
  
  *Toxicity testing: Developmental effects in rats-decreased weight gain and feed consumption*

- **LOAEL (threshold)** 25 mg/kg

- **NOAEL** 12.5 mg/kg

  *Uncertainty factors: \((1/10)(1/10)(1/10) = 1/1000*

- **Reference Dose** 0.0125 mg/kg
How does contact occur?
Testing and On-the-Job Exposures

- Carrier or vehicle in lab rats, LD50
- Route

- Corn oil  250 mg/kg
  Water  4123 mg/kg
- Mouth  250 mg/kg
  Skin  >4000 mg/kg
So What?

Personal Views of Pesticide Exposure

- "How little is OK?"
- "How much is too much?"
- "Dose makes the poison"
- "All-or-none"

Amount

Safe levels of everything

Laboratory Studies

Awareness of limitations of toxicity testing in animals

Small exposures cause certain harm

Little confidence in relevance of toxicity testing
Hazard and Risk

**Hazards** do not become **risks** unless a vulnerable population is exposed producing an adverse effect.
Getting the numbers right for risk assessment!
<table>
<thead>
<tr>
<th>Surface Exposure Potential: Determined by Spray Deposition (ug/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room Average</td>
</tr>
<tr>
<td>• Crack and Crevice</td>
</tr>
<tr>
<td>• Perimeter (Band)</td>
</tr>
<tr>
<td>• Fogger (Area)</td>
</tr>
<tr>
<td>• Spot Spray</td>
</tr>
</tbody>
</table>

And you are the sprayer!
Deltamethrin Deposition Following Crack and Crevice Application
Chlorpyrifos Deposition Following Perimeter Applications

Distance From Wall (cm)

Chlorpyrifos Deposition Following Perimeter Applications

Heavy Application
Light Application
Cypermethrin Deposition Following Fogger Application

Distance From Wall (cm)

ug/cm^2
Cypermethrin Deposition Following Spot Application
<table>
<thead>
<tr>
<th>Surface Exposure Potential</th>
<th>6-yr old child</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>ug/cm²</th>
<th>mg/day&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>C &amp; C</td>
<td>1.4</td>
<td>3.2 0.5 (15%)</td>
</tr>
<tr>
<td>Band</td>
<td>1.8</td>
<td>4.2 2.1 (50%)</td>
</tr>
<tr>
<td>Area</td>
<td>4.1</td>
<td>9.8 9.8 (100%)</td>
</tr>
<tr>
<td>Spot</td>
<td>0.2</td>
<td>0.6 0.01 (2%)</td>
</tr>
</tbody>
</table>

<sup>a</sup>EPA 18 mg/day

And you are the sprayer!
An estimated 90% of the people who buy organic produce do so to avoid pesticide residues....

The Organic Center

Personal Chemical Exposure Program, UC Riverside

Manufacturers, regulators, universities, users, and others who should know better, have done a very poor job of public education.
Chensheng Lu, holding a Washington apple, studied the pesticide levels in Mercer Island children. The children ate a variety of conventional produce from area groceries and then switched to organic.

**Harmful pesticides found in everyday food products**

Mercer Island children tested in yearlong study
What about the pesticide residue exposure in food that the consumer wants to avoid…

Residue to Dose

<table>
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<th>Residue level, ppm to ppb</th>
<th>Dosage is amount per body weight</th>
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<td>Amount eaten, g</td>
<td>50 ug/100 kg or 0.5 ug/kg</td>
</tr>
</tbody>
</table>

- 50 g strawberries
- 1 ppm insecticide
- 50 g x 1 ug/g = 50 ug

If 2 tablets acetaminophen per 100 kg
- 10,000 ug/kg

*Pesticide residues are tiny!*
Insecticide and fungicide residues may be on produce in tiny amounts...parts per billion

For a child to get even a NO EFFECT dose, they would have to eat over 1000 average servings and their parents more than 3-times that much!

But it just can’t happen, because the natural Vitamin C in the berries would make both of them sick long before they could even get to the NO EFFECT dose!
Your experiences with pesticides and Public and Regulatory Perceptions of Pesticide Safety and Risk, 2009

Simply don’t match! Get it right!
My personal recommendation: Demonstrate safe pest management...

- Everything goes someplace.
- Exposure is inevitable at some level.
- Even zero isn’t none!
- Exposure is not an effect.
- How little is OK? Usual amounts.
- What is usual? Read and heed label.