Herbicide and Other Chemical Toxicology

regulatory foundations for chemical use

Bob Krieger, Ph. D.
Personal Chemical Exposure Program
Department of Entomology
UC Riverside
Our Living Chemical World

Known 22,000,000+

- Commercial Products 100,000
  - “Toxic Substances” 50,000
    - Pesticides 1,000
    - Products 13,000

--not a body burden!
### Chemical Risk: Dose/Exposure

<table>
<thead>
<tr>
<th>Experimental</th>
<th>Human Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard</td>
<td>Use</td>
</tr>
<tr>
<td>Dose-Response</td>
<td>Exposure</td>
</tr>
<tr>
<td>Risk Assessment</td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
</tr>
</tbody>
</table>
## Toxicity
### LD50, LOAEL, NOAEL

<table>
<thead>
<tr>
<th>Lethal Dosage 50% population LD50</th>
<th>Low Observed Adverse Effect Level (threshold)</th>
<th>No Observed Adverse Effect Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>Organs Reproduction Growth</td>
<td>No effects in most sensitive species</td>
</tr>
</tbody>
</table>
Toxicology Profile: Imazapyr

- Skin, eye and respiratory irritant.

  ORL-RAT LD$_{50}$ $> 5000$ mg kg$^{-1}$
  ORL-MUS LD$_{50}$ $> 2000$ mg kg$^{-1}$
  SKN-RBT LD$_{50}$ $> 2000$ mg kg$^{-1}$
  ORL-QAL LD$_{50}$ $> 2150$ mg kg$^{-1}$
  ORL-DCK LD$_{50}$ $> 2150$ mg kg$^{-1}$

- *From the MSDS*
Product Profile: Imazapyr

**Chopper®:** imazapyr (22.6%), isopropylamine (5.4%), and other inert ingredients (72%)

**Arsenal®:** imazapyr (27.6%), and inert ingredients (72.4%)

**Chopper® RTU:** isopropylamine salt of imazapyr (3.6%), propylene glycol (30%), isopropanol (5.0%), and other inert ingredients (61.4%)
**Toxicity Profile: Glyphosate**

- **LD50 (oral rat)**: more than 2,000 mg/kg
- **LOAEL (rabbit dermal)**: 5,000 mg/kg
- **NOAEL (rabbit dermal)**: 1,000 mg/kg
Toxicity Issues: Glyphosate

- Effectiveness
- Formulations
- Aquamaster 63.8% vs Roundup Pro 41%
Toxicity Issues: Triclopyr

- Clothing retains residue
- Poor skin absorption
- No body burden
- Plant death
Toxicity Profile: Triclopyr

- LD50 (rat, oral) 630-729 mg/kg
  (dermal) more than 2,000 mg/kg
- LOAEL (subchronic, oral) 20 mg/kg
- NOAEL (subchronic, oral) 5 mg/kg
Toxicity Profile: Clopyralid

- **Carcinogenicity:** no evidence in a 2 year feeding study in mice at 2,000 mg/kg (highest dose tested)

- **Developmental:** no evidence in rats or rabbits at 250 mg/kg (highest dose tested).

- **Reproduction:** No effects in a two generation study in rats at 1500 mg/kg (highest dose tested)
Clopyralid Environmental Persistence

- Mobile in soil
- Adsorption reduces water levels
- Degradation by microorganisms
- Found above 2 feet in soil
- Half-life in compost
  - 6 to 66 days
  - Average 22 days
Chlorsulfuron Breakdown
(not a burden!)
Toxicity Profile: 2, 4-D

- **LD50**: 800-2000 mg/kg
- **LOAEL**: 60 mg/kg kidney, 300 mg/kg testes
- **NOAEL**: 15 mg/kg kidney, 100 mg/kg testes
# 2,4-D Reference Dose

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NOAEL</strong></td>
<td>15 mg/kg kidney</td>
</tr>
<tr>
<td><strong>Uncertainty Factors</strong></td>
<td></td>
</tr>
<tr>
<td>– Species: animal to human (0.1)</td>
<td>1.5 mg/kg</td>
</tr>
<tr>
<td>– Person-to-person (0.1)</td>
<td>0.15 mg/kg</td>
</tr>
</tbody>
</table>

\[
\text{RfD} = \text{NOAEL} \times 0.1 \times 0.1
\]
Dandelions!

APPLICATION OF THE MOUSE LIMB MICROMAS ASSAY FOR SCREENING WHOLE-FOODS EXTRACTS.

B Tornesi¹, GD Charles¹, JL Mattsson², E.W. Carney¹ and BB Gollapudi¹.

¹Toxicology & Environmental Research & Consulting, The Dow Chemical Co., Midland MI, USA; ²Global Toxicology, Dow AgroSciences, Indianapolis IN, USA.

Presented at 2002 Annual Meeting of the Teratology Society
Gestation day 11

Day 11 embryo

Limb-buds are pooled and trypsinized

Plate undifferentiated cells

5 days later
Table: Effect of selected plant test materials on the differentiation and proliferation of micro mass cultures of embryonic mouse limb buds.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Ratio diff/cytox</th>
<th>Teratogenic Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retinoic Acid</td>
<td>0.02</td>
<td>+++</td>
</tr>
<tr>
<td>Soy Beans</td>
<td>0.20</td>
<td>++</td>
</tr>
<tr>
<td>Pea Pods</td>
<td>0.30</td>
<td>++</td>
</tr>
<tr>
<td>Dandelion stems &amp; flowers</td>
<td>0.30</td>
<td>++</td>
</tr>
<tr>
<td>Dandelion leaves</td>
<td>0.40</td>
<td>++</td>
</tr>
<tr>
<td>Broccoli</td>
<td>0.50</td>
<td>( + )</td>
</tr>
<tr>
<td>Garlic</td>
<td>0.95</td>
<td>-</td>
</tr>
<tr>
<td>Corn</td>
<td>0.80</td>
<td>-</td>
</tr>
<tr>
<td>Carrots</td>
<td>1.70</td>
<td>-</td>
</tr>
<tr>
<td>Asparagus</td>
<td>1.05</td>
<td>-</td>
</tr>
<tr>
<td>Bean Sprouts</td>
<td>0.70</td>
<td>-</td>
</tr>
<tr>
<td>Spinach</td>
<td>0.90</td>
<td>-</td>
</tr>
<tr>
<td>Coffee</td>
<td>2.25</td>
<td>-</td>
</tr>
<tr>
<td>Lettuce</td>
<td>N/C</td>
<td>N/C</td>
</tr>
<tr>
<td>Injured Lettuce</td>
<td>N/C</td>
<td>N/C</td>
</tr>
<tr>
<td>Tomato</td>
<td>N/C</td>
<td>N/C</td>
</tr>
<tr>
<td>Injured Tomato</td>
<td>N/C</td>
<td>N/C</td>
</tr>
<tr>
<td>Corn</td>
<td>1.95</td>
<td>-</td>
</tr>
</tbody>
</table>
Minimizing Your Pesticide Exposures

- Use good judgment
- Know your labels
- Clean clothing
- Work gloves
- Shower or bathe promptly
Chemical exposures—you can’t live without ‘em!

- Chemical exposure is essential
- Exposure can be measured
- Exposure is not a disease

- Dose is the chemical part of risk
- Risk reduction is an ongoing process!