2009

Pesticide Safety 2009 - New Insecticides and their Comparative Safety

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New insecticides and their comparative safety

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New insecticides and their comparative safety

- In cranberry, old chemistries are generally toxic to humans and other non-targets

- New chemistries are generally non-toxic to humans

- Variation in toxicity to other non-targets

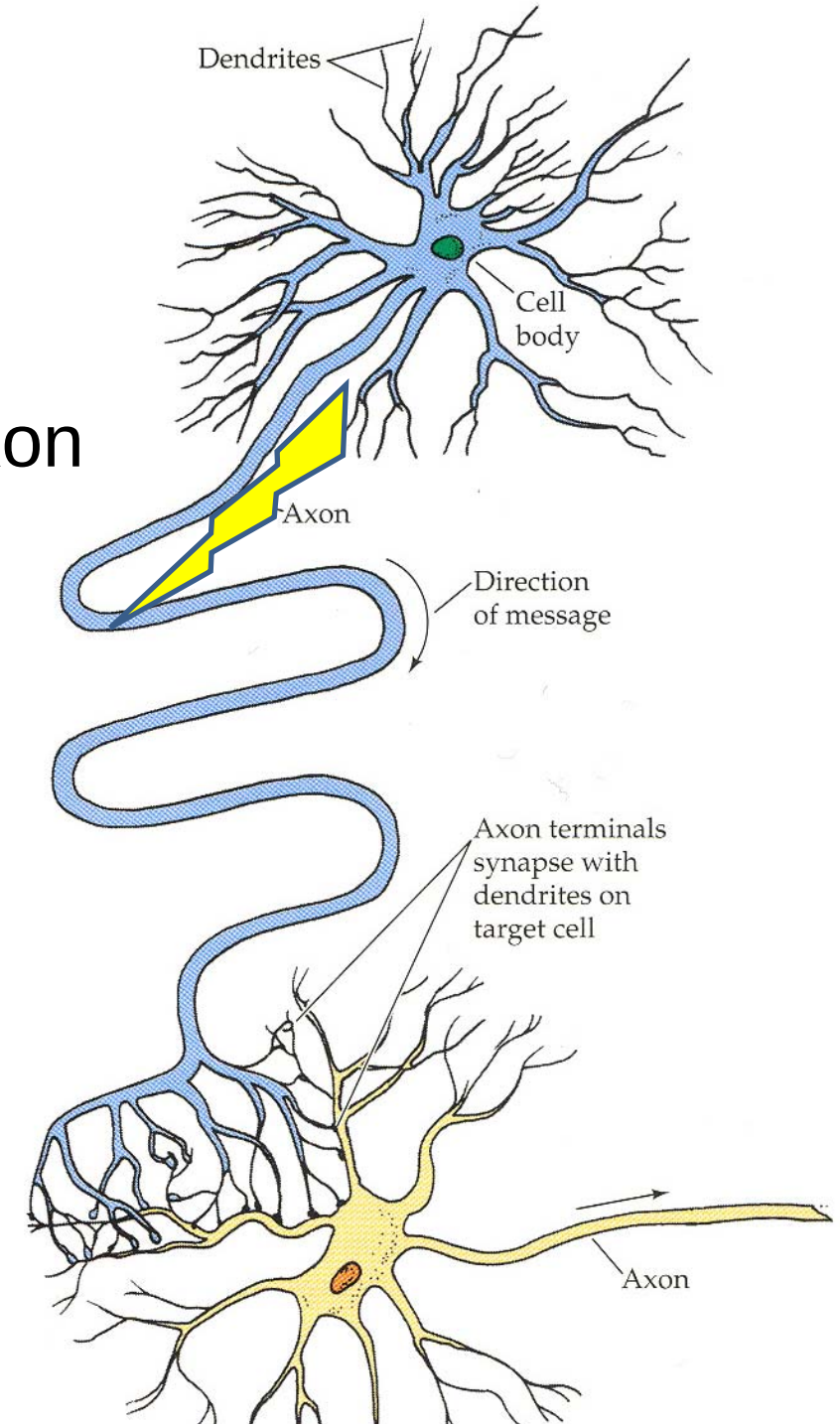
Why some insecticides are a human health risk

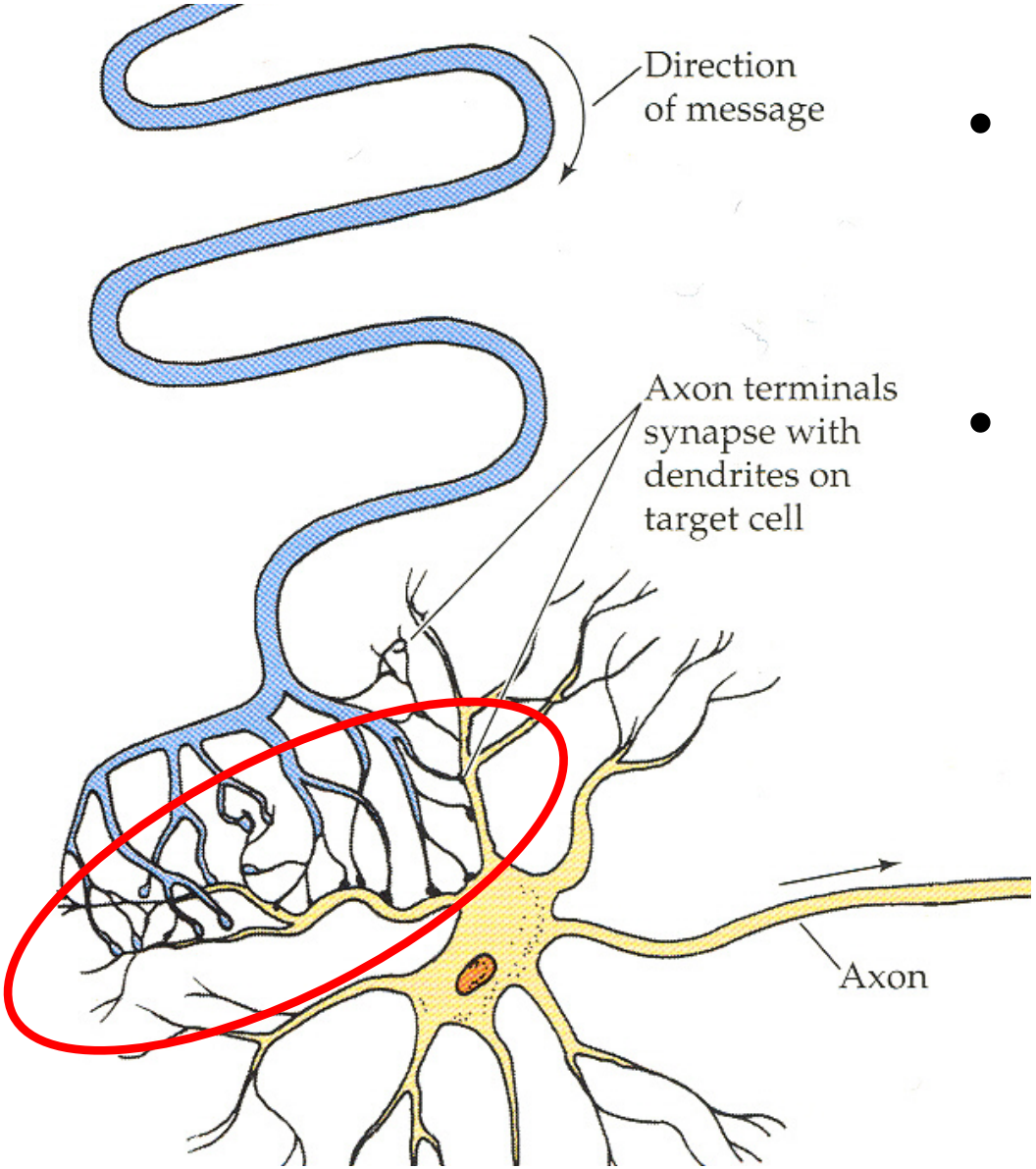
- The nervous system of the insect is targeted by certain insecticides
- Human and insect nervous systems have similar characteristics
- Organophosphates
  - Diazinon
  - Lorsban
  - Orthene
  - Imidan
- Carbamates
  - Sevin

Nervous system

- Neuron (nerve cell)
  - basic cell unit of system
- When neuron stimulated, electrical signal passes down axon of nerve

Stimulus creates electrical activity that travels along axon to next neuron



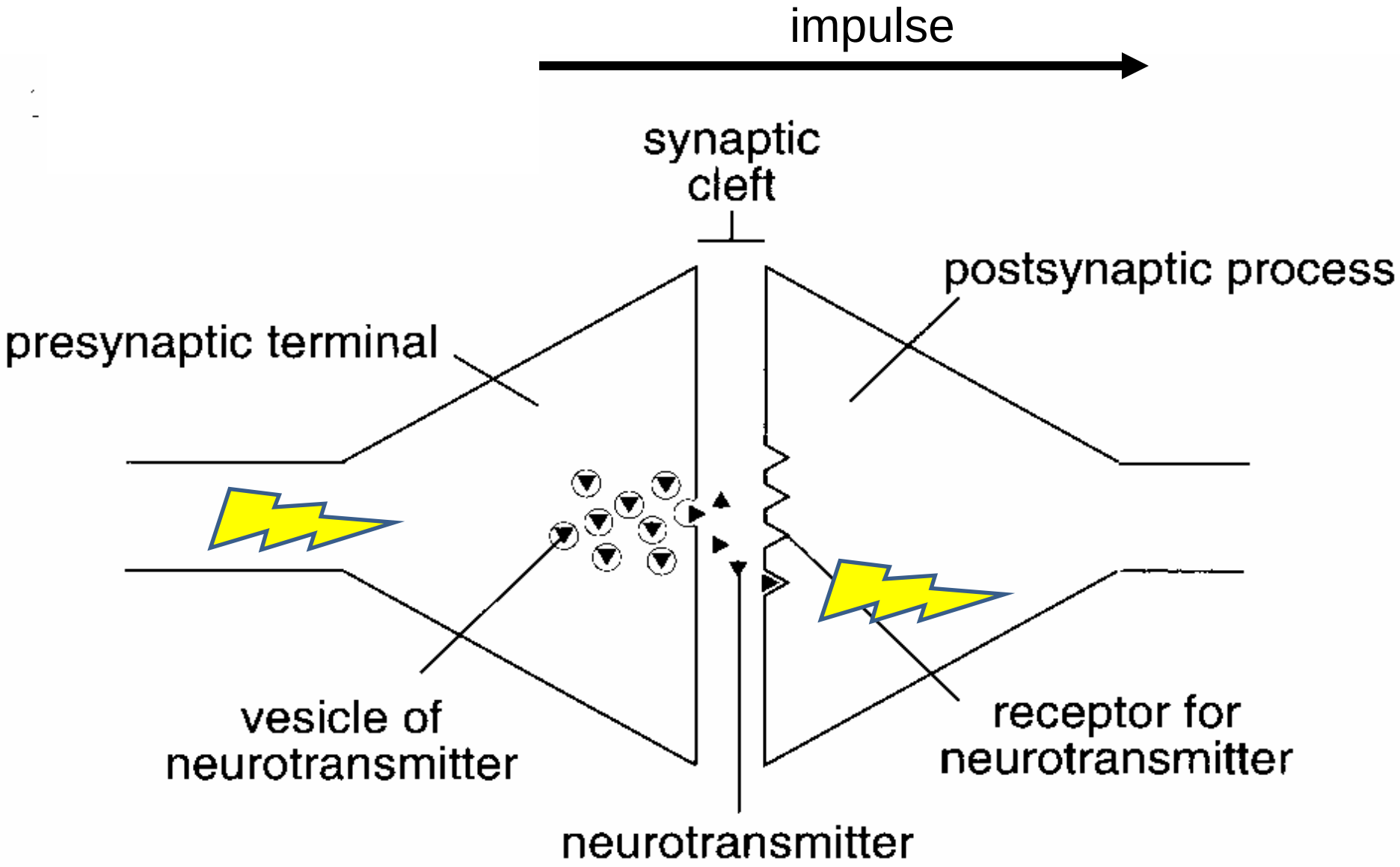


- Space exists between neurons
- Gap = synapse

Synapse

- Transmission across synapse is chemical
- Signal arrives>>>chemical released across synapse is called “neurotransmitter”
- Neurotransmitter travels to next neuron, next neuron stimulated

Events at the synapse



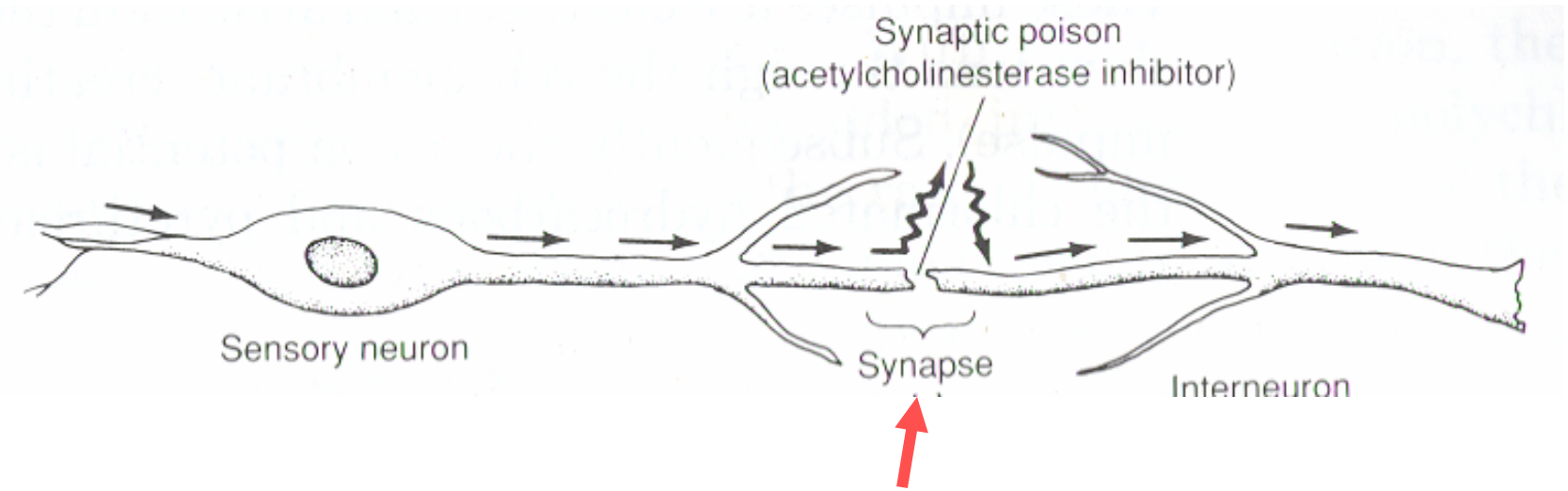
Synapse

- One neurotransmitter is acetylcholine
- Once job is done, acetylcholine needs to be broken down

Acetylcholine + choline → Acetic acid +

Enzyme **cholinesterase**, breaks down acetylcholine
Stops signal

Synaptic poisons



Organophosphates, carbamates, poison system by acting at the synapse

Mode of action against insects

- Inhibit breakdown of neurotransmitter
- Bind up breakdown enzyme, cholinesterase
- Neurons continue to fire

- Nerves continuously send message to muscles
  - Twitching
  - Convulsions
  - Siezures

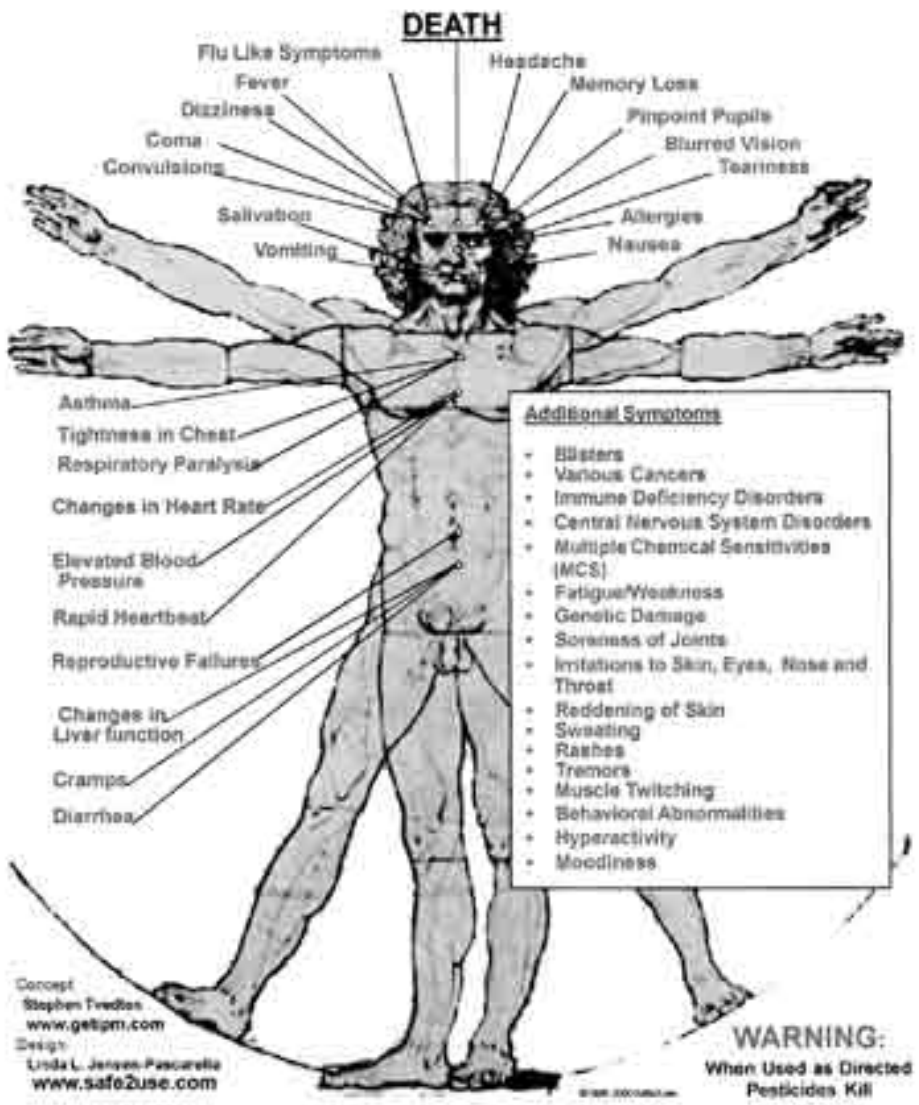
Why some insecticides are a health risk

- Organophosphates
  - Diazinon
  - Lorsban
  - Orthene
  - Imidan
- Carbamates
  - Sevin

- Organophosphate poisoning not reversible
- Body must manufacture new cholinesterase
- Carbamates somewhat reversible; some enzyme recovered

Symptoms of Pesticide Poisoning

Sources: National Cancer Institute, National Academy of Science, Office of Technology Assessment, EPA, OSHA



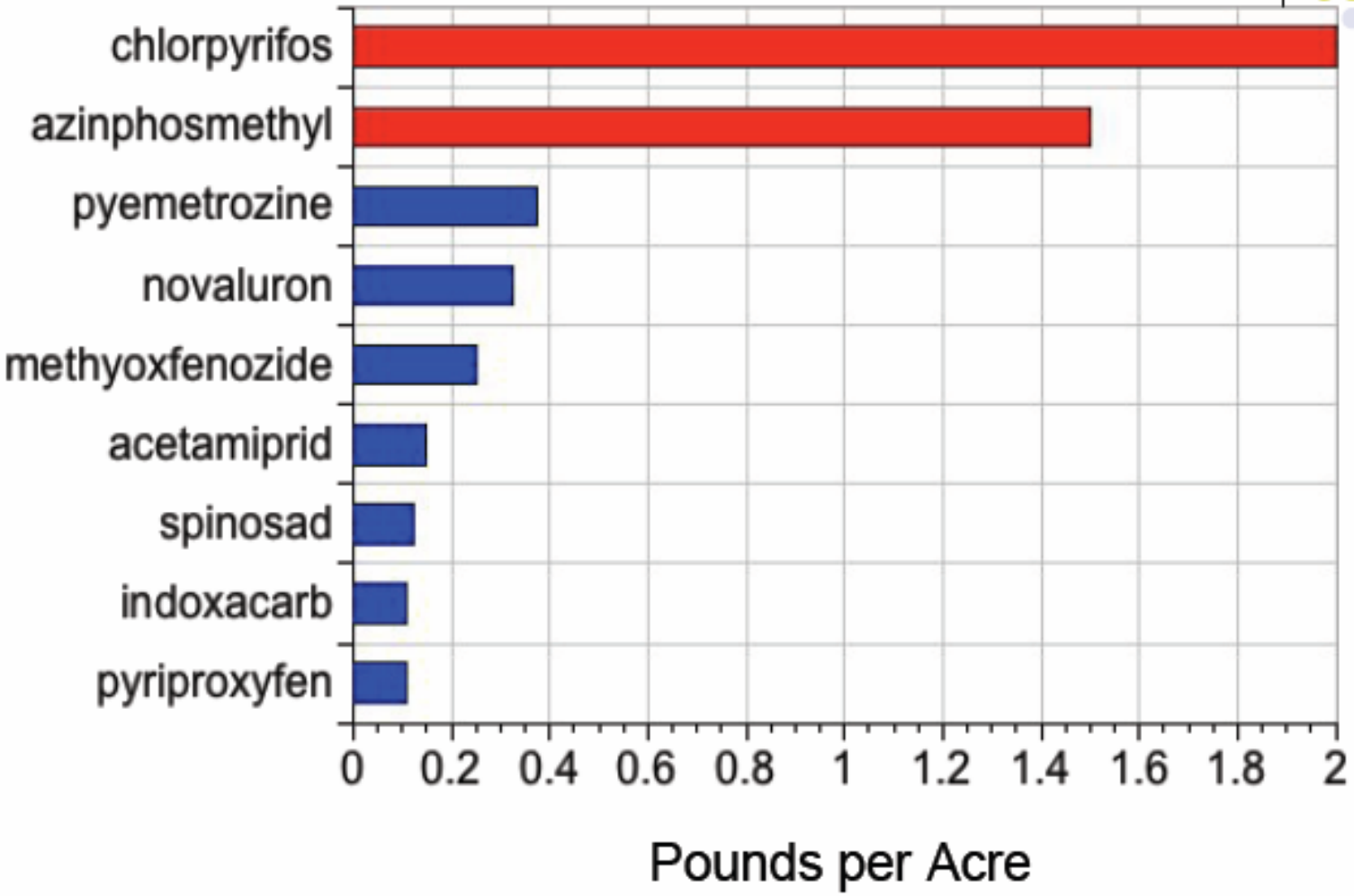
Concept
Stephen Tvedten
www.getipm.com
Design
Linda L. Jensen-Pascarella
www.safe2use.com

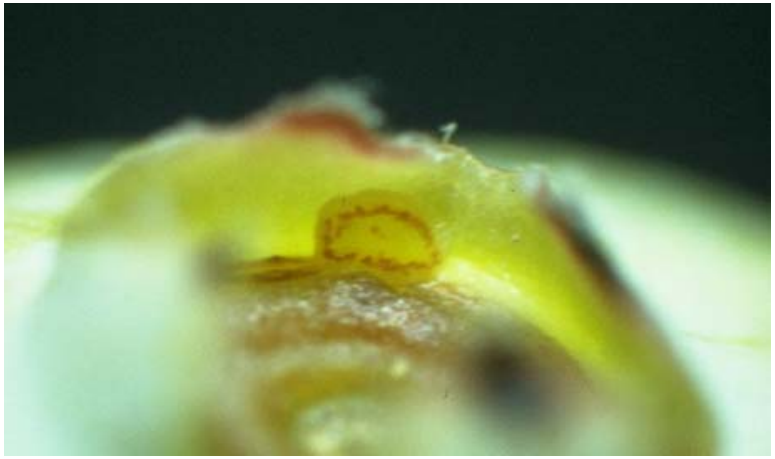
WARNING:
When Used as Directed Pesticides Kill

Overview, new compounds

- Different chemistries!
- Usually reduced risk
  - Very low mammalian toxicity
  - Low ecotoxicity
  - Selectivity
- Often good residual, often systemic
  - Low application rate

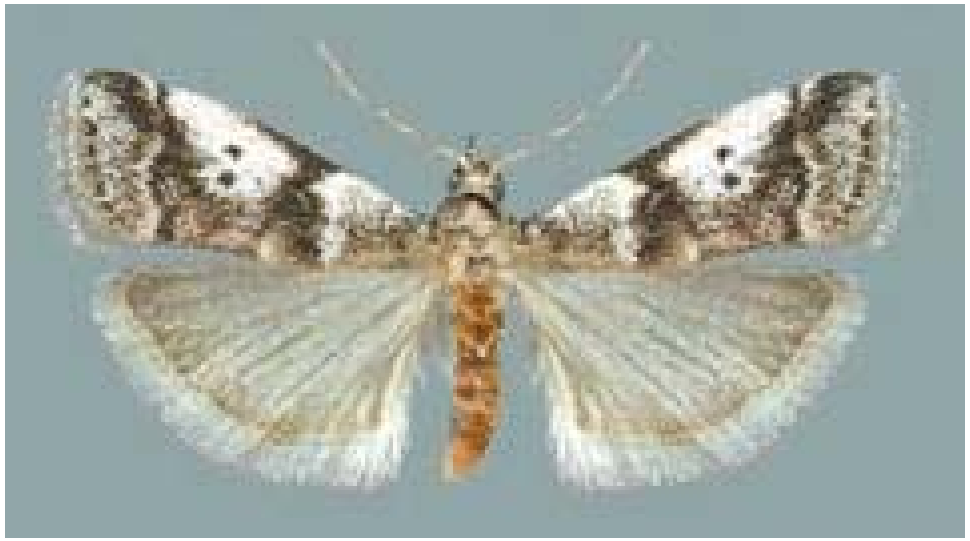
Application Rate of Reduced Risk Insecticides





ACTIVITY!

Screening program:cranberry fruitworm and new insecticides



Worked at EB abandoned bed with mega-infestation of fruitworm, YHFW

Control

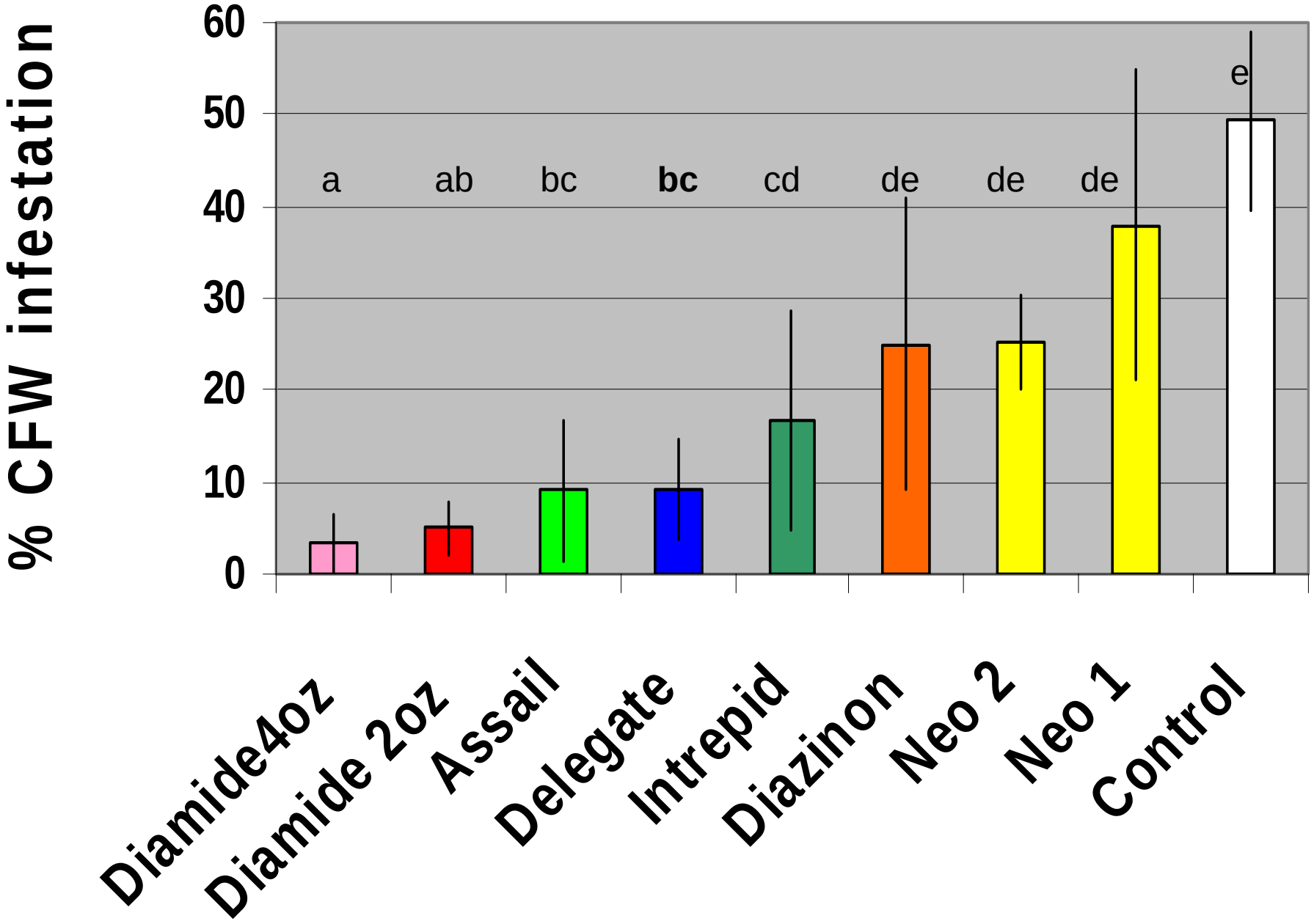
Field trial: methods

- 5 replicates/treatment
- 150 gal/A with CO_2 backpack sprayer
- Two applications
  - 7/10 and 7/19
- Fruit randomly sampled after second spray

First spray: timing based on out-of-bloom counts
Second spray: 9 days later

Treatments

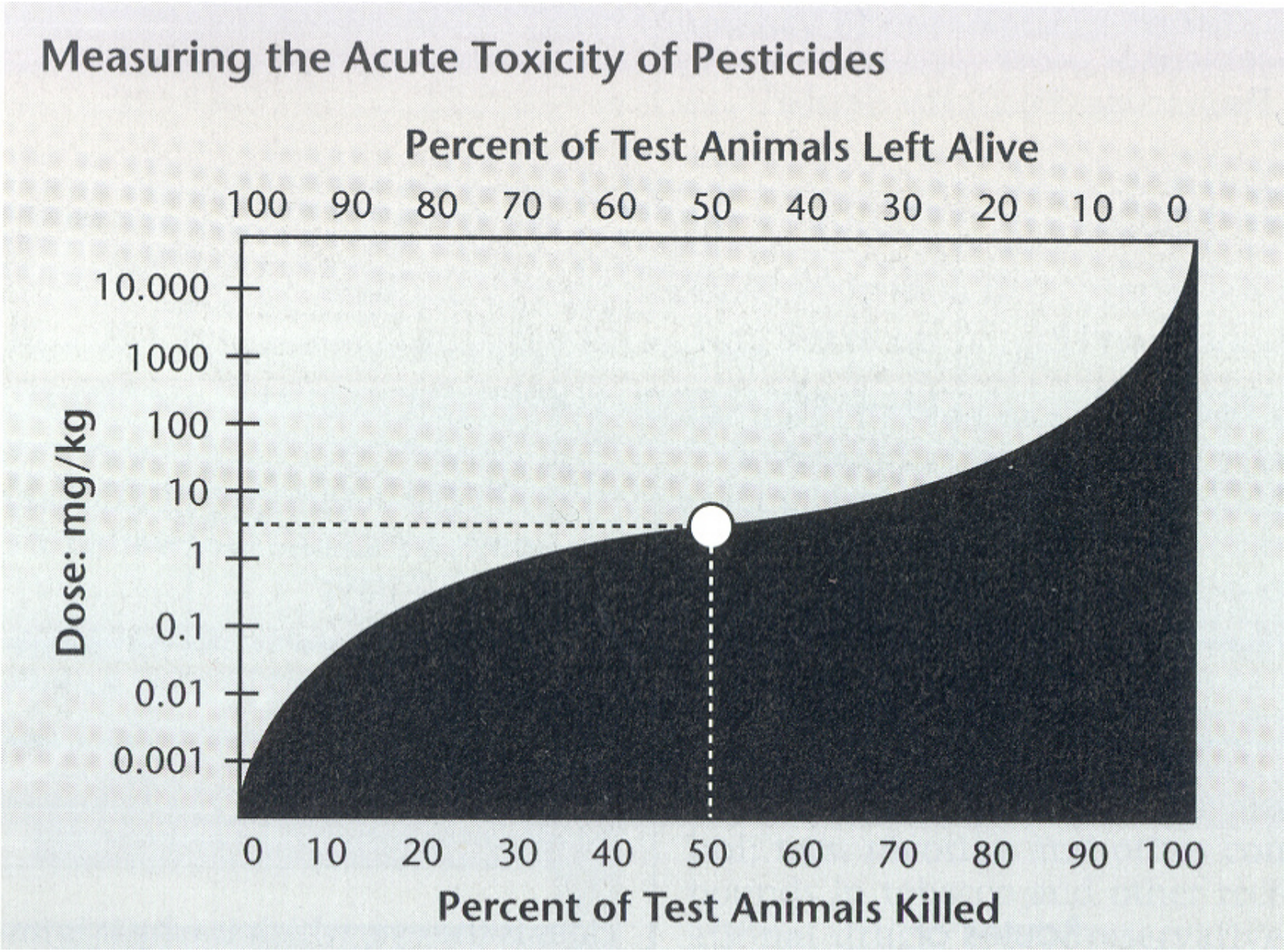
- 3 neonicotinoids
  - **Assail**, **Neo 1, Neo 2**
- Molting hormone mimic
  - **Intrepid**
- 1 anthranilic diamide
  - 2 rates: **Diamide 2 oz** and **Diamide 4 oz**
- New spinosyn
  - **Delegate**
- Industry standard
  - **Diazinon**
- Control--untreated


% CFW infestation
60
50
40
30
20
10
0
a
ab
bc
bc
cd
de
de
de
e
Diamide4oz
Diamide 2oz
Assail
Delegate
Intrepid
Diazinon
Neo 2
Neo 1
Control

Delegate **Diamide 4 oz** **Intrepid** **Diamide 2 oz** **Diazinon**

New insecticides in cranberry

– Tipworm compound	**2012**	
– HGW (2nd generation)	**2012**	**Diamide**
– Zone II Neonic	**2011**	**Neonicotinoid**
– E2Y (1st generation)	**2011**	**Diamide**
– Actara +type	**2010**	**Neonicotinoid**
– Assail (acetamiprid)	**2008**	**Neonicotinoid**
– Delegate (spinetoram)		**2008 Spinosyn**
– Avaunt (indoxacarb)	**2007**	
– Actara (thiamethoxam) **Neonicotinoid**		**2005**
– Intrepid (methoxyfenozide)	**2004**	**IGR**
– Admire (imidacloprid)	**2004**	**Neonicotinoid**
– Spintor (spinosad)	**2002**	**Spinosyn**
– Nexter, Pyramite (pyridaben)	**2001**	



Dose/response tests: lethal does that kills 50% is LD_{50}

HUMAN TOXICITY

new vs old

neonicotinoid

IGR

spinosyn

Formulation	Oral LD50 (mg/kg)	Dermal LD50
Guthion	4.4	155
Lorsban	223	222
Assail	1064	>2000
Advion	1277	>5000
Esteem	4253	>2000
Intrepid	>5000	>2000
Rimon	>5000	>2000
Fulfil,	>5000	>2000
Success	>5000	>2000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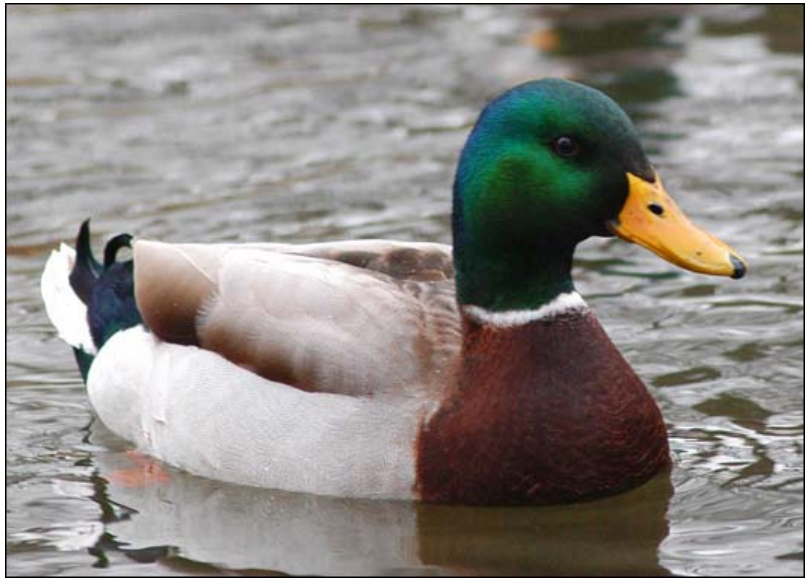
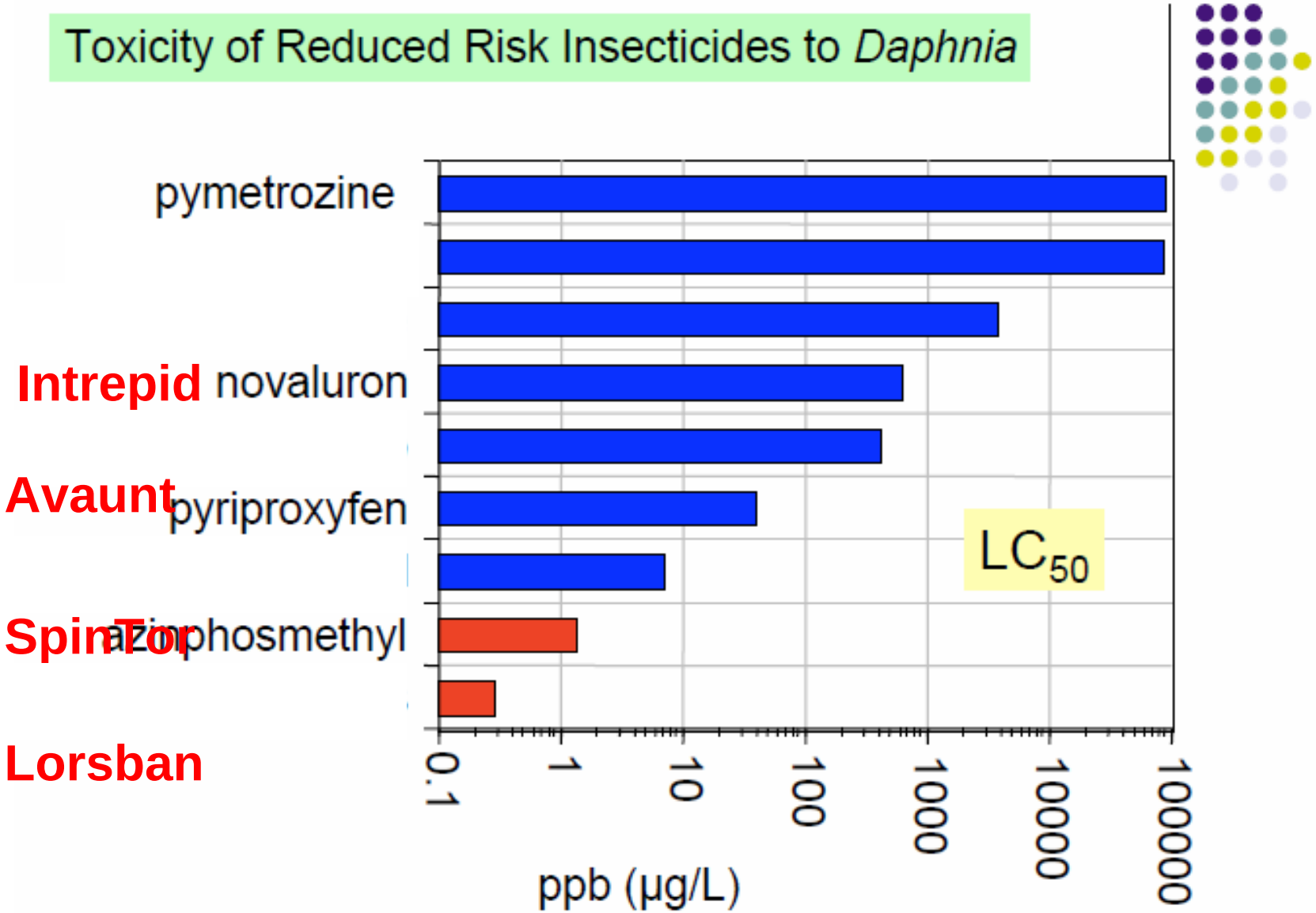


Toxicity of Reduced Risk Insecticides to *Daphnia*

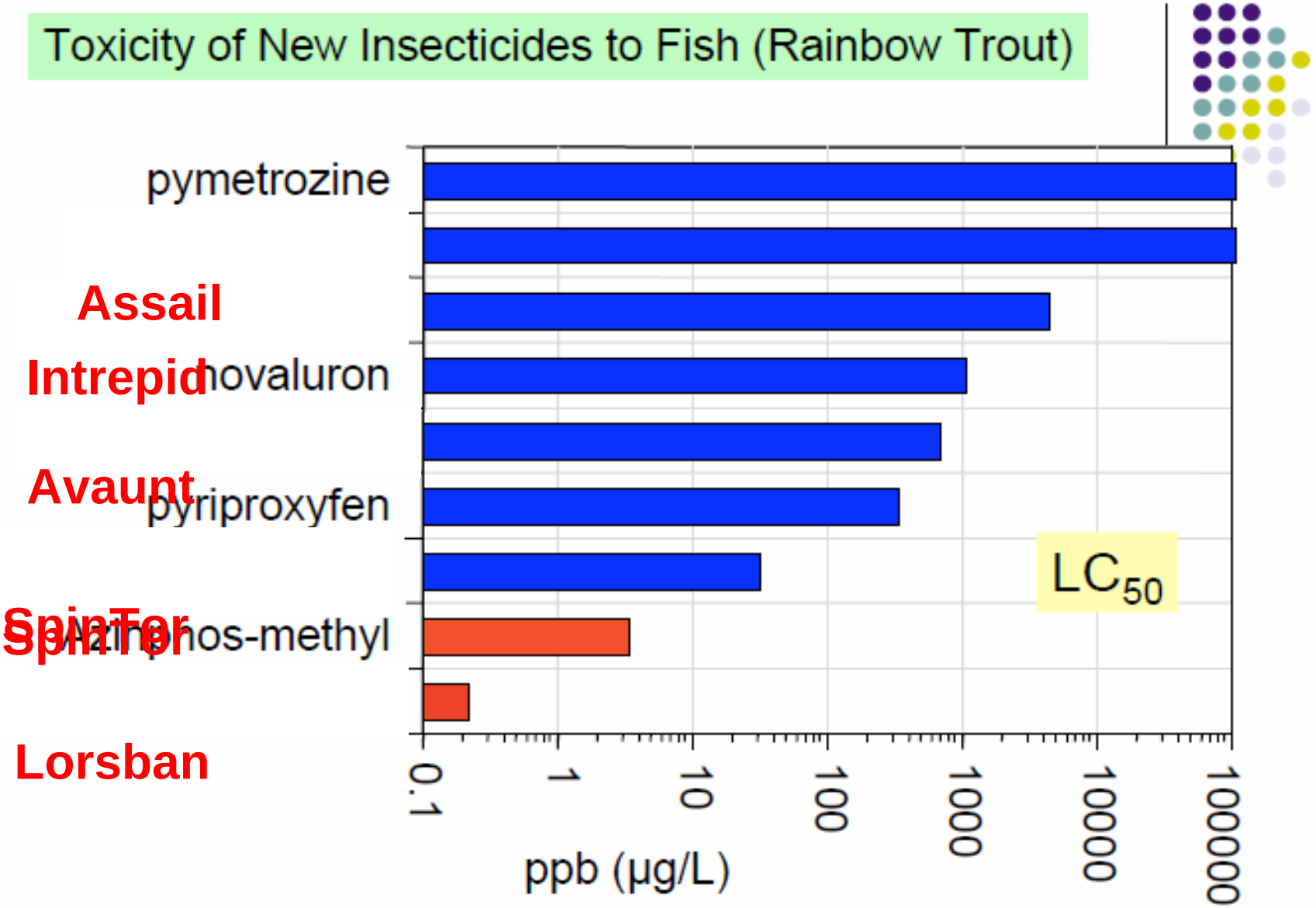


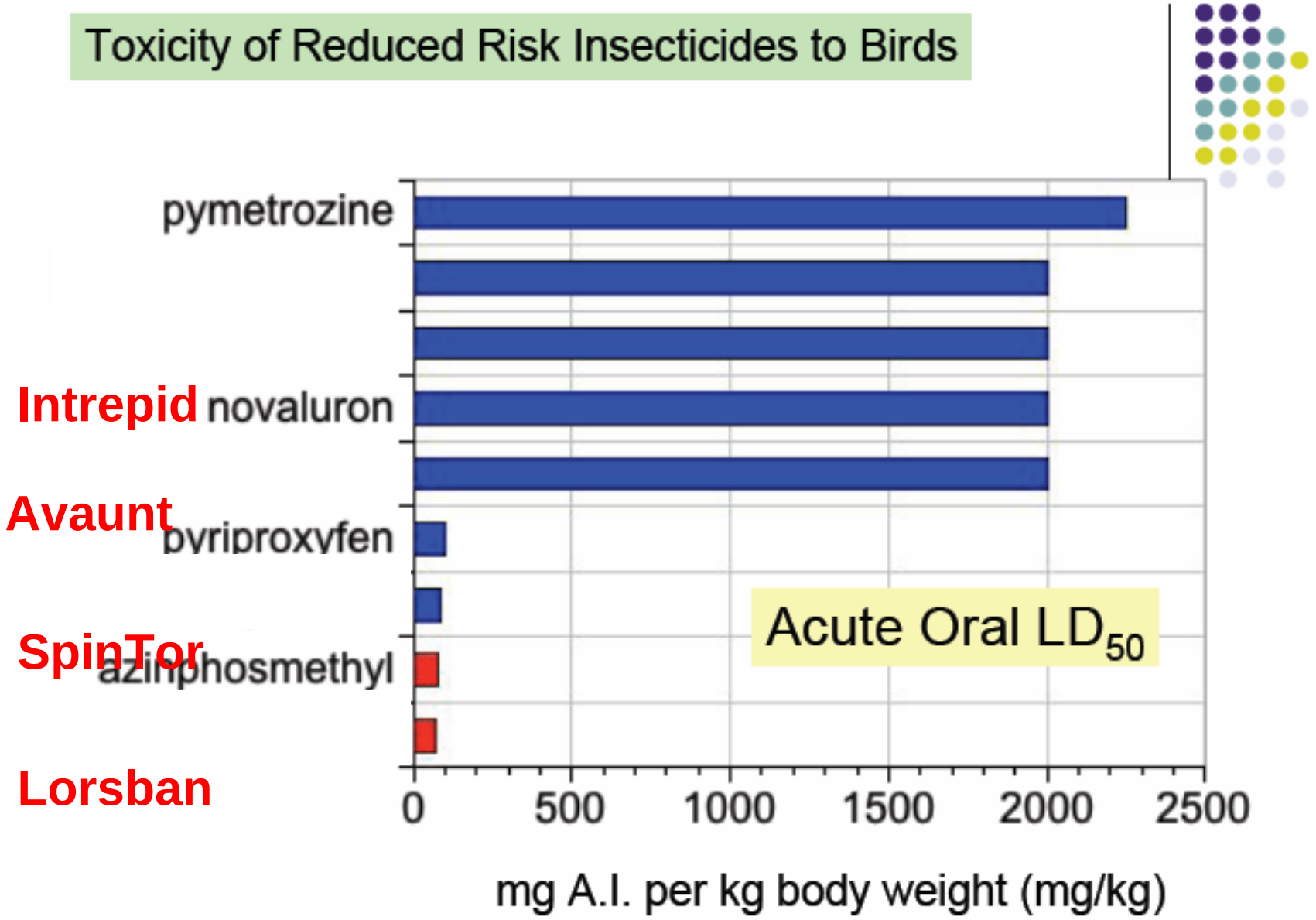
Intrepid

Avaunt

Spin Tor

Lorsban


Toxicity of New Insecticides to Fish (Rainbow Trout)
pymetrozine
Assail
Intrepid
novaluron
Avaunt
pyriproxyfen
SpinTor
azinphos-methyl
Lorsban
LC50
0.1
1
10
100
1000
10000
100000
ppb (µg/L)


Toxicity of Reduced Risk Insecticides to Birds
pymetrozine
Intrepid
novaluron
Avaunt
pyriproxyfen
SpinTor
azinphosmethyl
Lorsban
Acute Oral LD50
0
500
1000
1500
2000
2500
mg A.I. per kg body weight (mg/kg)

New insecticides in cranberry

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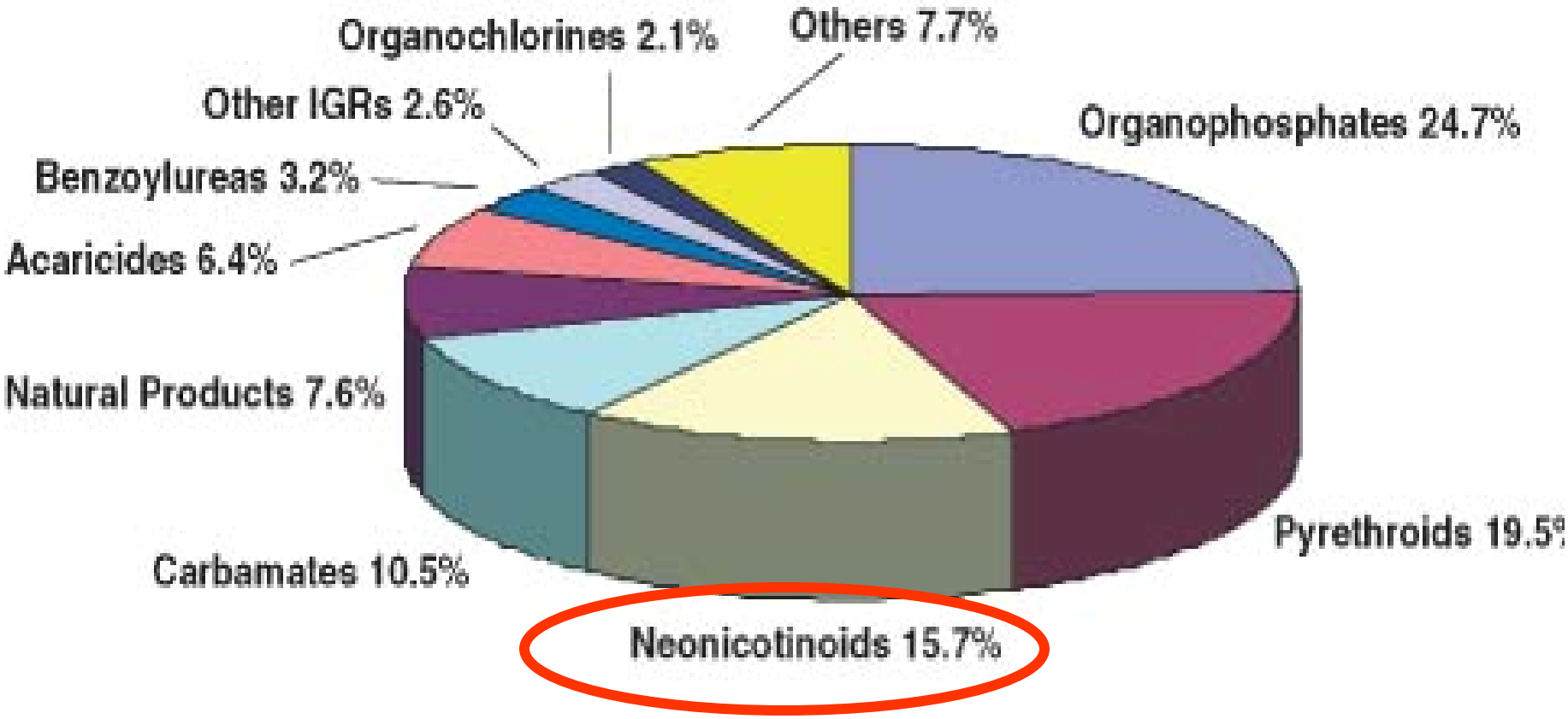
Neonicotinoids

- Now labelled in cranberry
  - Actara (thiamethoxam)
  - Admire (imidacloprid)
  - Assail (acetamiprid)

Neonicotinoids

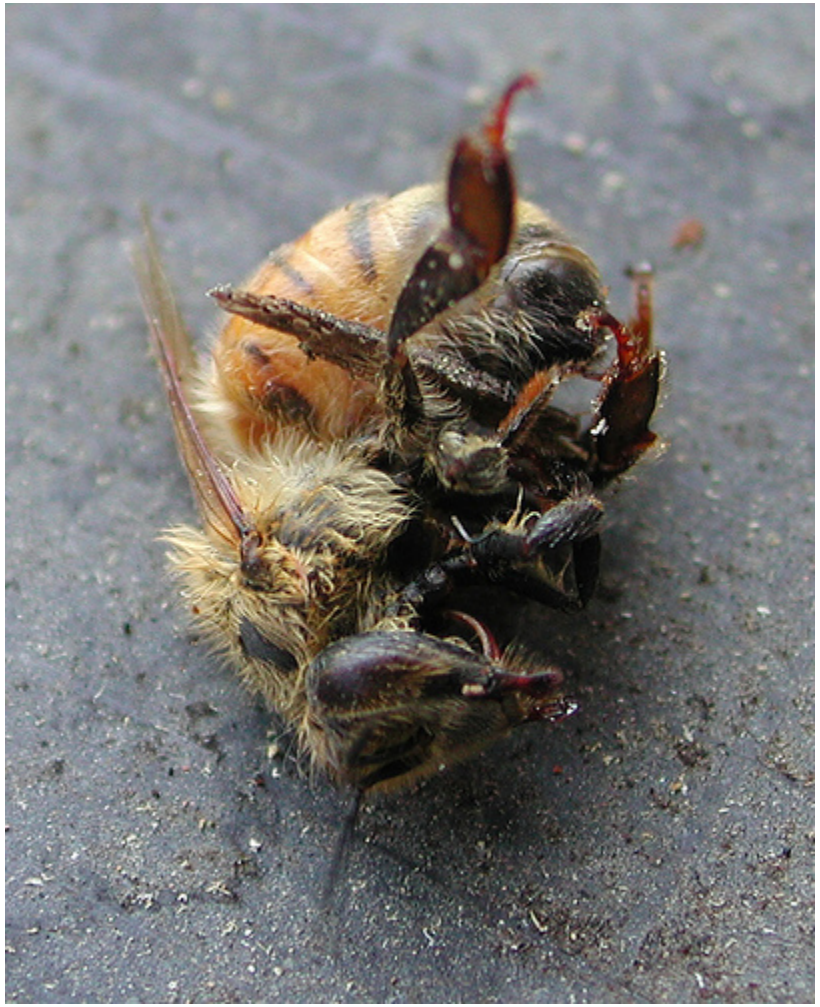
- Most important new class in 30 years



Total Global Insecticide Sales 2003 = $6,650

[Source Phillips McDougall, November 2004]

Acute contact LD_{50}: some neonicotinoids are very toxic to bees



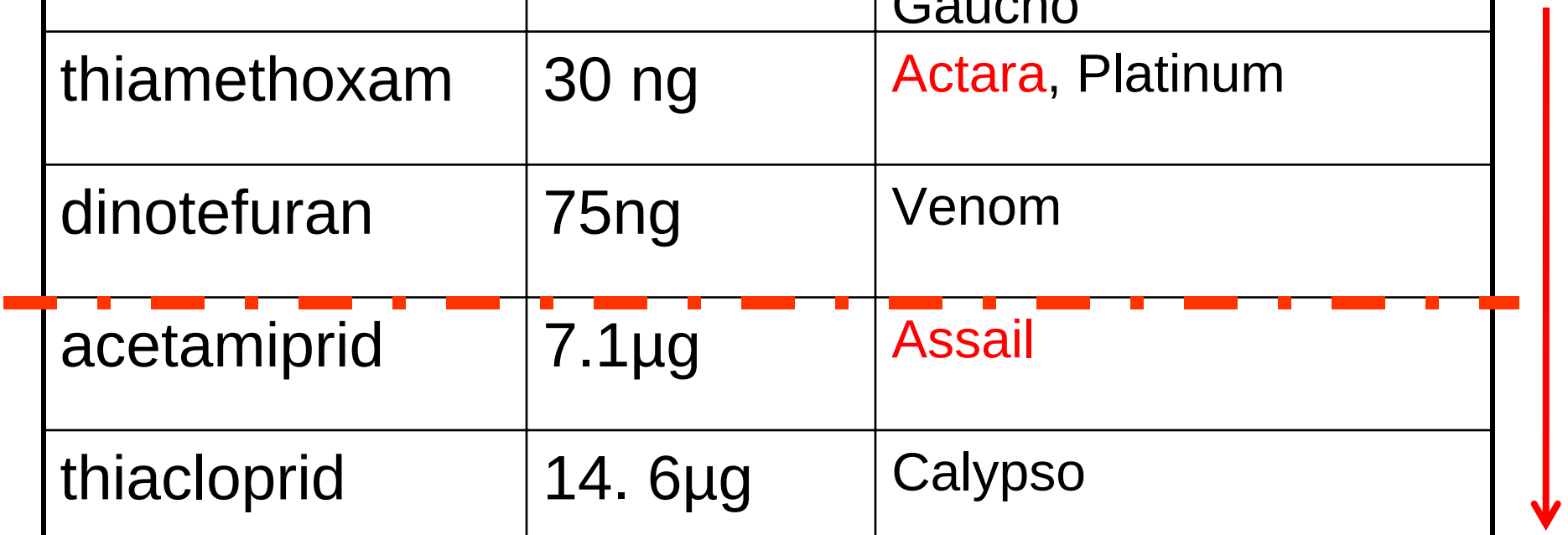
compound	**µg/bee**
Sevin	1.3
Guthion	0.063
Admire (neonic)	0.024

worse

Not all neonicotinoids are as toxic:

acute contact LD_{50}

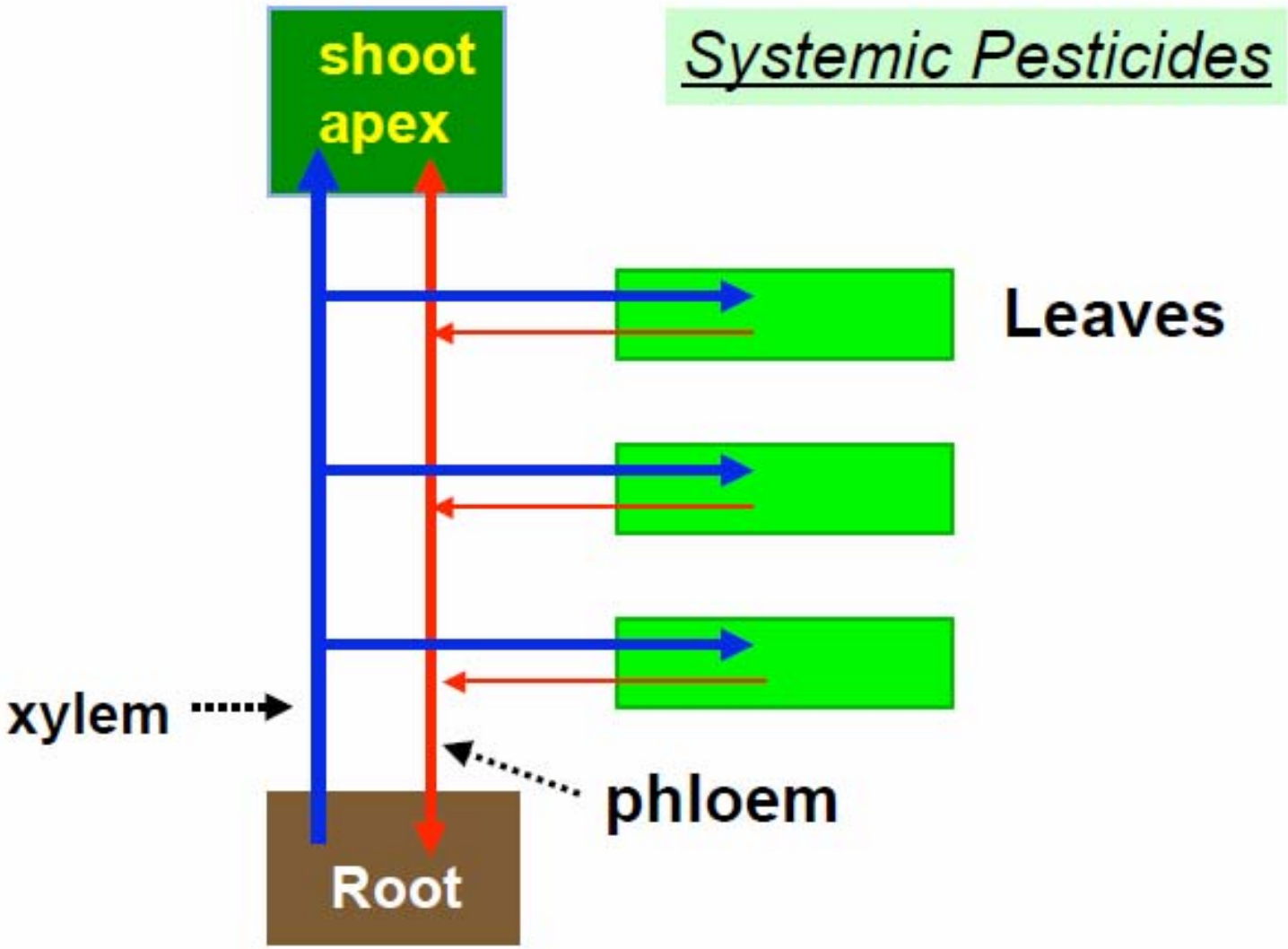
clothianidin	14 ng	Poncho
imidacloprid	18 ng	Admire,Provado, Gaucho
thiamethoxam	30 ng	Actara, Platinum
dinotefuran	75ng	Venom
acetamiprid	7.1µg	Assail
thiacloprid	14. 6µg	Calypso



better

Sublethal effects: pollen and nectar

- Neonicotinoids are moderately water soluble and systemic
- Carried by the vascular system
  - Enter xylem (water transport), rapid movement into leaves
  - to flowers, via phloem – very low levels
    - ppb range



Once pesticides diffuse through the plant cuticle or into the roots, they can be carried by the vascular system to different regions

Uptake in plants>>>pollen

- Imidacloprid levels detected in other pollen: watermelon, corn, canola
- Registrant rule of thumb: < 5ppb expected in general

- Very, very low levels

Neonicotinoids implicated in Europe’s bee problems, some

compounds/use patterns banned, research base out of European labs until recently, role in US CCD?

Sub-lethal effects on honey bee

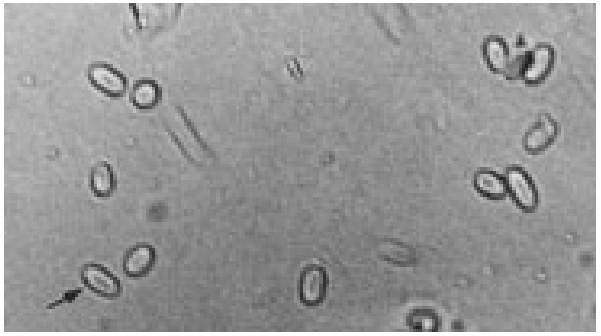
- Physiological or behavioral effects on individuals that survive an exposure to a pesticide
- Could impact worker bee functioning
  - Olfactory learning performance
  - Decreased foraging and activity at hive entrance
- Need to interface amount exposed to in lab with realistic field assays

Contamination at colony

- Contaminated pollen and nectar
  - Eaten by worker bees and larvae

Interactions: pathogen + neonicotinoid

- J. Pettis and cooperators
- *Nosema apis*-- microsporidian
- most widespread of the adult honey bee diseases; big problem
- infects ventriculus thereby causing dysentery



Interactions: pathogen + neonicotinoid

- Larvae exposed to imidacloprid for 2 months (in pollen at ppb level)
- Then challenged adults with *Nosema*
- Imidacloprid-exposed bees
  - Higher spore infection levels (>3x) vs. control

Colony Collapse Disorder Status

Colony Collapse Disorder Status

There is growing evidence that a number of factors, including pathogens, pesticides, mites and other stress factors such as poor nutrition are most likely involved in the overall declining health of honeybee colonies in the US.

June 2008 American Bee Journal

Colony Collapse Disorder Status

- Seems to be adequate pollination
- Migratory beekeepers are compensating
  - adding new queens
  - cleaning hives
  - not reusing combs

– Keep up to date as to beekeeper concerns