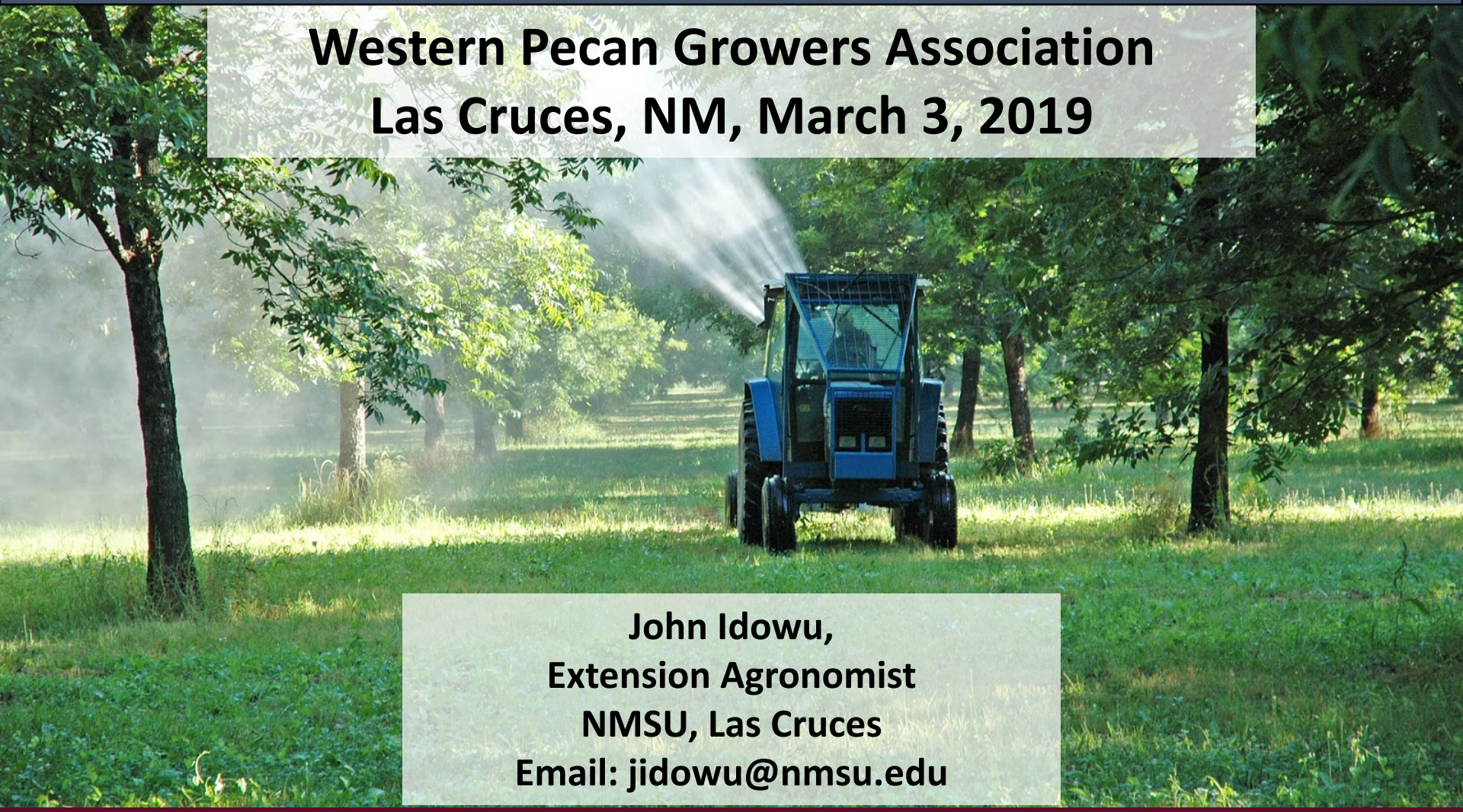
Pesticide Fate in the Orchard



Western Pecan Growers Association
Las Cruces, NM, March 3, 2019

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Topics to be covered

- What Happens after Pesticides Application?
- Pesticide Movement
- Degradation or Breakdown Processes
- Minimizing Pesticide Impacts

What Happens to Pesticides?

Beneficial effects

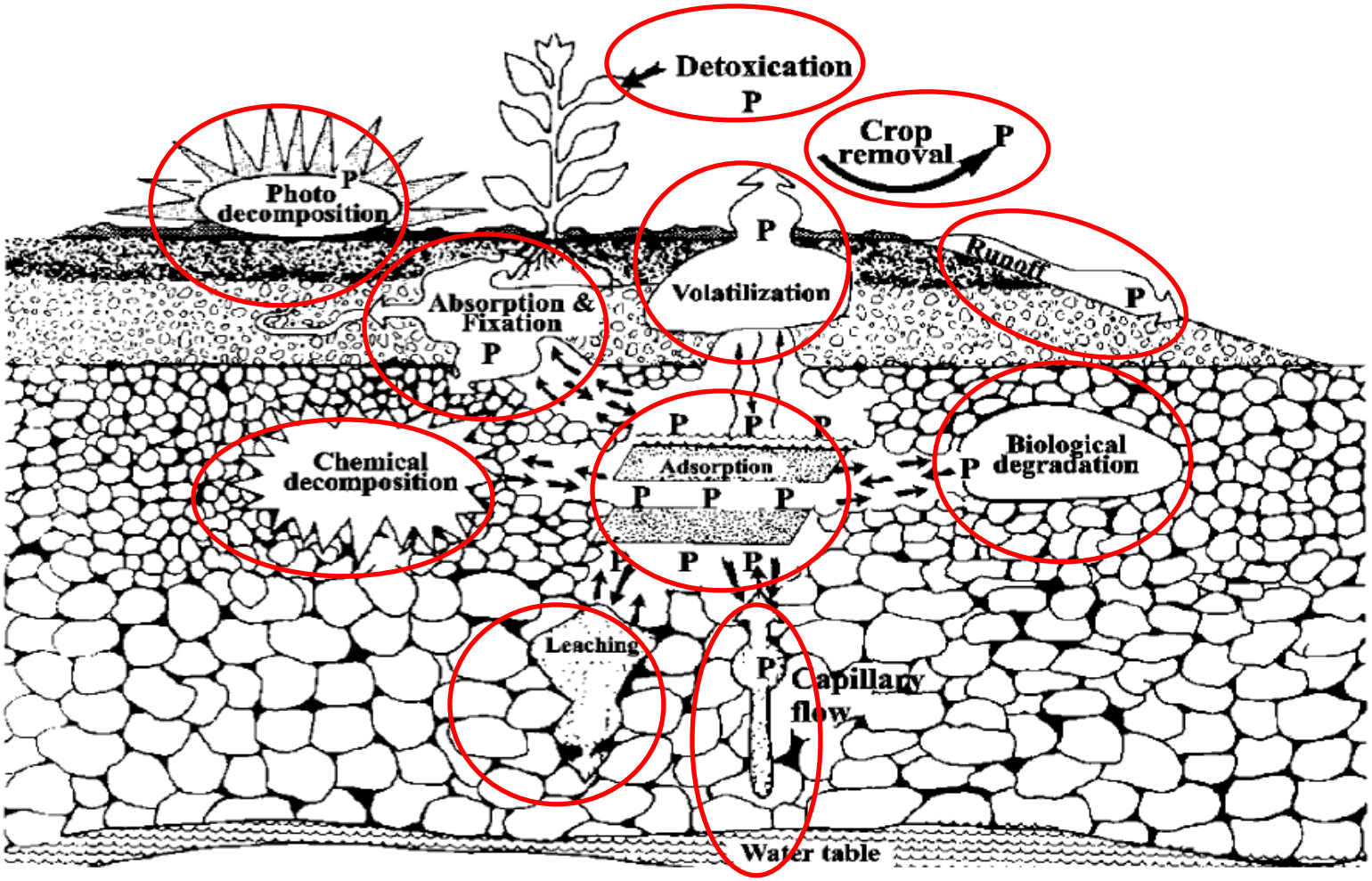
- Pest in question is controlled
- Herbicide leached into root zone to control weeds
- Farm income improved due to increased yields
- Relatively low food cost
- Human health can be enhanced

What Happens to Pesticides?

Unintended consequences

- Not all of the applied chemical reaches the target site
- Ineffective control because of drift and leaching losses
- May harm other plants and animals that were not targeted
- May cause pollution of surface and ground water
- Pesticide residues may enter the food chain

Transformation of Pesticides in the Soil



Pathways of pesticide loss. P=pesticide.
[Adapted from Skrotch and Sheet. 1981.]

Why are we concerned?

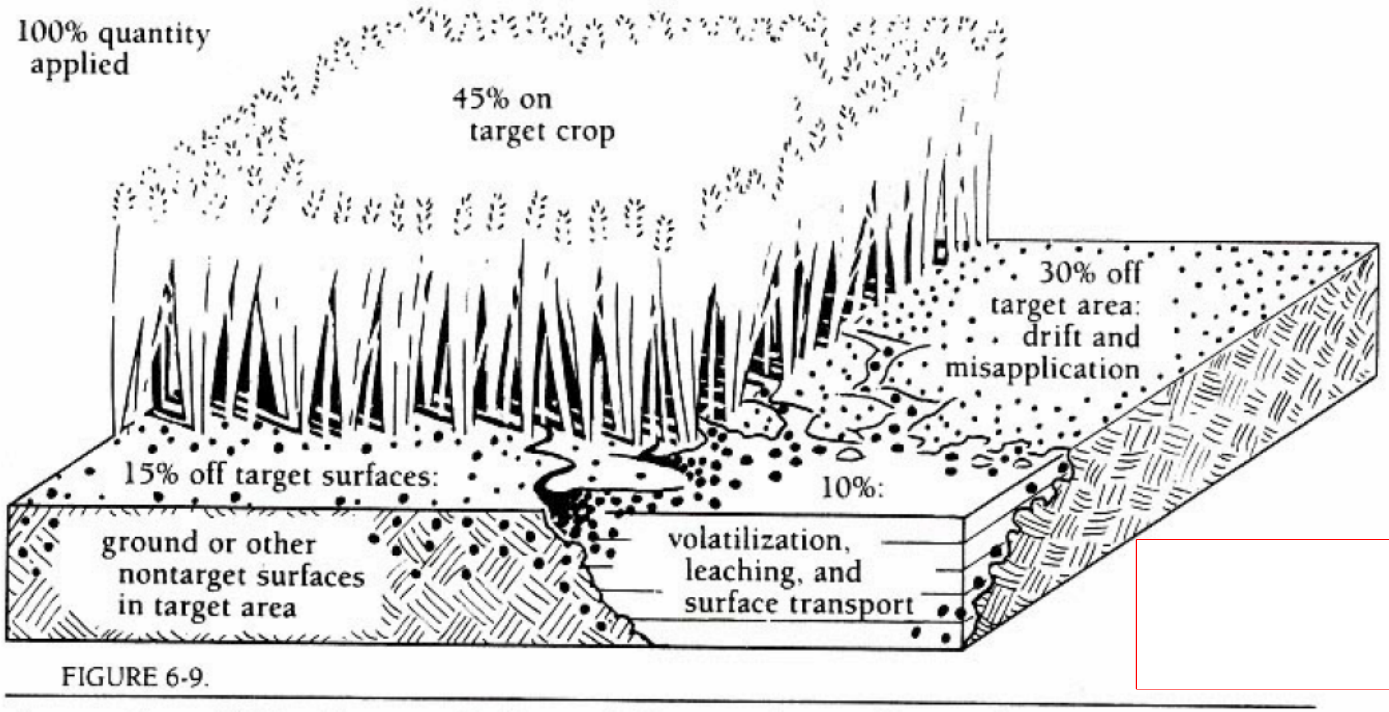


FIGURE 6-9.

As much as 55% of an applied pesticide may leave the application site due to spray drift, volatilization, leaching, runoff, and soil erosion.

Implications:

- ***Money is lost ($$$)***
- ***Some other plants or people can be hurt***

Pesticide Movement

Pesticides can be mobile and subject to different processes in the environment called:

"**Transfer Process**"

- **Adsorption**
- **Spray drift**
- **Volatilization**
- **Runoff**
- **Leaching**
- **Crop removal (pesticide residues in food and feed)**

Adsorption

Binding of pesticides to soil particles

Depends on

- **Pesticide**
- **Soil type**
- **Soil moisture**
- **Soil pH**
- **Soil texture**

Pesticides are strongly adsorbed to soils that are **high in clay** or **organic matter** than in **sandy soils.**

Impact of Adsorption

Soil-bound pesticides

- less likely to give off vapors or leach through the soil
- Less likely to affect plants (some of the pesticide rendered inactive due to soil adsorption)

In some cases, when soil is high in clay or organic matter, **higher pesticide rates** may be needed for effective control

Spray Drift

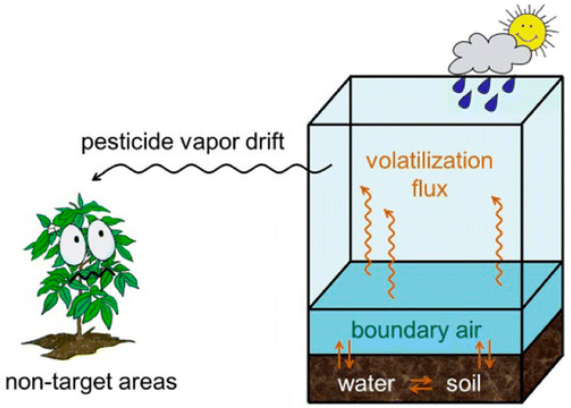
Movement of airborne droplets away from treatment sites during application

- **Spray droplet size** - the smaller the droplets, the more likely they will drift
- **Wind speed** - the stronger the wind, the more pesticide spray will drift
- **Distance between nozzle and target plant or ground** - the greater the distance, the more the wind can affect the spray
- Spraying with aircraft can cover large areas quickly but are not as efficient as Airblast Sprayers and are more subject to drift

Effect of Spray Drift

- Reduces the effectiveness of treatment
- Can damage nearby sensitive crops
- Can humans living close
- Can affect domestic animals
- Can affect pollinating insects
- Can cause general pollution

Volatilization



Movement of pesticide vapors through the air

Solids or liquids converted into a gas

- Movement from the application site
- Can damage nearby crops
- Volatilization more in wet and sandy soils
- Hot, dry and windy weather favor volatilization
- Small spray drops also favor volatilization
- Pesticide incorporation into soil can reduce volatilization

Crop Damage from Herbicide Dicamba a Growing Problem Across U.S. Farm Belt

By Mario Parker | August 2, 2017

- **Consider the environmental conditions at the time of application**
- **Use the right nozzle**
- **Consider using another product**

Runoff

Movement of pesticides in surface water over a sloping surface

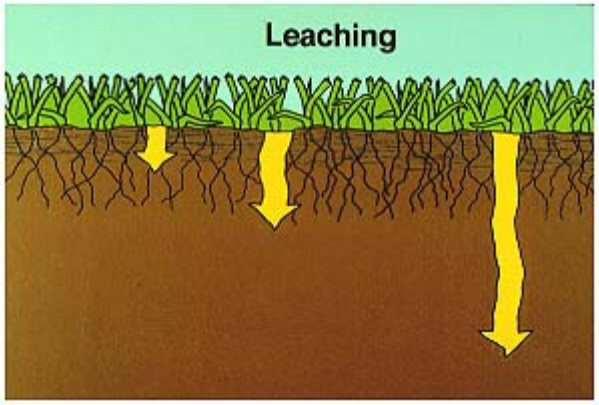
Runoff occurs when rainfall or irrigation exceed infiltration (soil water intake)

Amount of pesticide in runoff depend on:

- Slope
- Soil texture
- Soil moisture content
- Amount and timing of irrigation or rainfall
- Type of pesticide used

Prevention: Plan your sprays to avoid heavy rainfall

Leaching



- Movement of pesticides in water through the soil
- Leaching can occur downwards, upwards and sideways
- **Leaching is increased when:**
  - Soil is sandy (water moves faster through soil)
  - Rain/irrigation event occurs shortly after spraying
  - Pesticide is water soluble
  - Pesticide is not strongly adsorbed to the soil

Soil Leaching Factors

Soil factors affecting pesticide leaching

- **Organic Matter**
- **Texture**
- **Soil structure – relates the soil porosity**
- **Soil compaction**
- **pH**
- **Preferential flow – cracking soils**

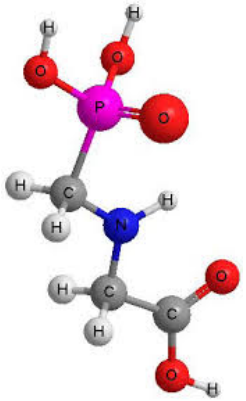
Breakdown and Degradation

- Chemical Breakdown
- Photo-degradation
- Microbial Breakdown

Chemical Breakdown

Breakdown of pesticides due to chemical reactions in the soil

Affected by:



- Binding of pesticides to the soil
- Soil temperatures
- pH levels - Many pesticides, especially the organophosphate insecticides, break down more rapidly in alkaline soils
- Moisture

Photo-degradation

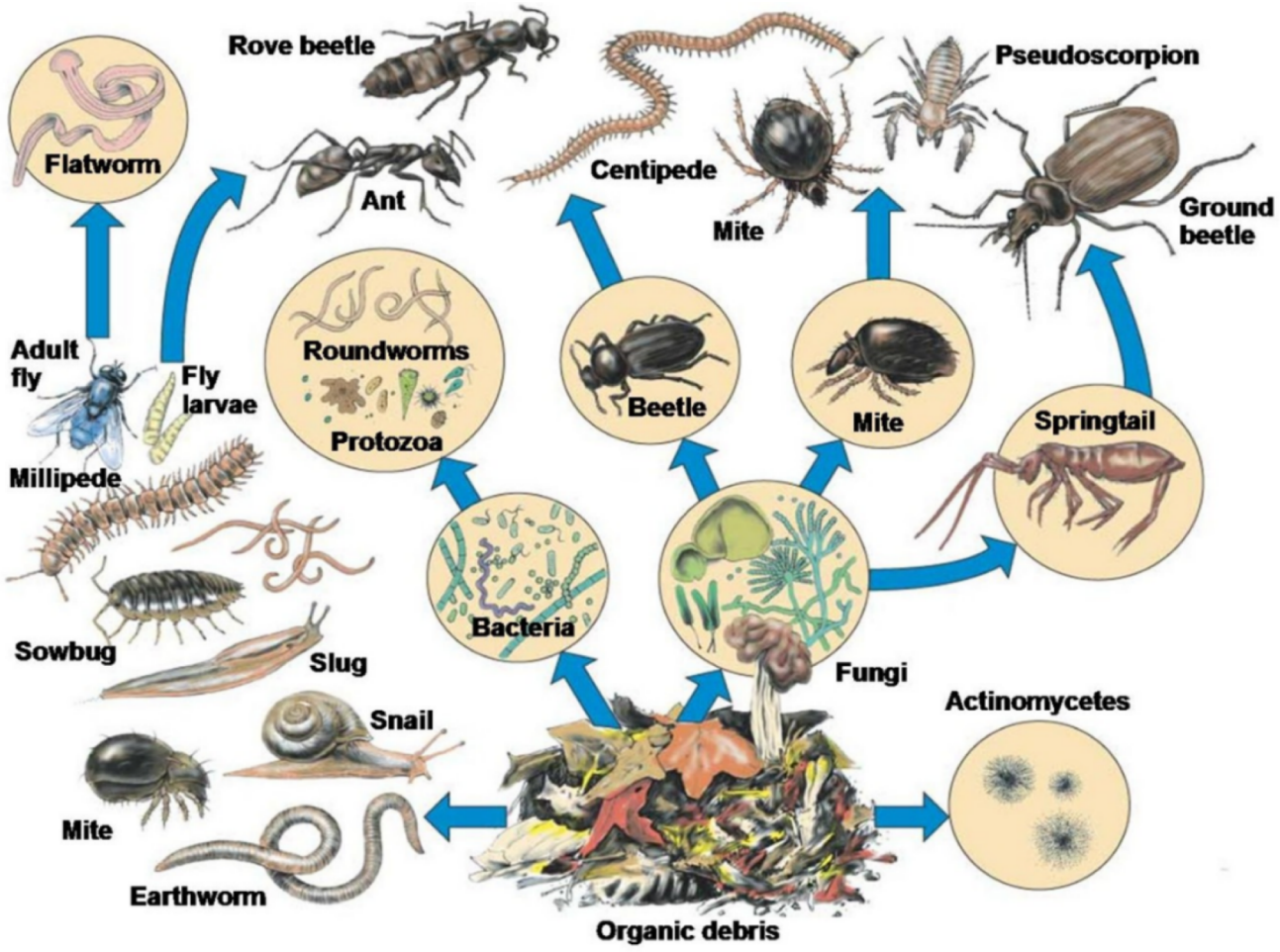
Breakdown of pesticides by sunlight

Photo-degradation affected by:

- Intensity and spectrum of sunlight
- Length of exposure,
- Properties of the pesticide

Foliage applied pesticides more susceptible to photo-degradation than soil incorporated pesticide

Biological Breakdown



- Happens in the soil
- A healthy soil is active and full of life

Organic Matter is the DRIVER for soil biology

Soil Biology: Organisms

- **Those we can see with our eyes**
  - **Earthworms**
  - **Insects**
  - **Burrowing animals**

- **Those we cannot see with our eyes**
  - **Bacteria**
  - **Fungi**
  - **Actinomycetes**
  - **Nematodes**
  - **Protozoa**

Soil Organisms

Bacteria	100 million to 1 billion
Fungi	6-9 ft fungal strands put end to end
Protozoa	Several thousand flagellates & amoeba One to several hundred ciliates
Nematodes	10 to 20 bacterial feeders and a few fungal feeders
Arthropods	Up to 100
Earthworms	5 or more

Microorganisms are most active in soils having high organic matter

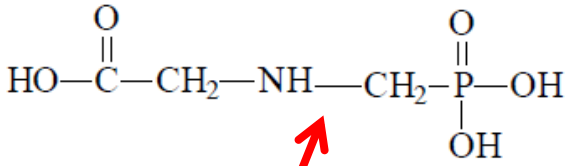
Table 1 Effect of pesticides on soil microorganisms

Pesticide	Microbial species	Comments	References
Atrazine, isoproturon, metribuzin, and sulfosulfuron	*Bradyrhizobium* sp.	Adversely affected *Bradyrhizobium* sp.	Khan *et al.* (2006)
Phorate, carbofuran, carbosulfan, thiamethoxam, imidacloprid, chlorpyrifos, monocrotophos	Soil microflora	No significant change in total viable count of bacteria	Sarnaik *et al.* (2006)
Methamidophos	Soil microflora	Decreased microbial biomass (41–83%)	Wang *et al.* (2006)
Metsulfuron methyl	Soil microorganisms	Inhibited heterotrophic S-oxidizing and S-reducing bacteria but increased fungi	He *et al.* (2006)
Metalaxyl	Microbial biomass	Decreased microbial biomass	Sukul and Spiteller (2001)
Mefenoxam, metalaxyl	Soil microorganisms	Inhibited N-fixing bacteria	Monkiedje *et al.* (2002)
Carbendazim, imazetapir, thiram	Soil microorganisms	Combination of fungicide and herbicide reduced while herbicide alone increased soil microorganisms	Niewiadomska (2004)
Carbofuran, ethion, hexaconazole	Soil microorganisms	Adversely affected soil microorganisms	Kalam and Mukherjee (2001)
Bensulfuron methyl, metsulfuron methyl	Microbial biomass	Decreased microbial biomass-C, and N	El-Ghamry *et al.* (2001)

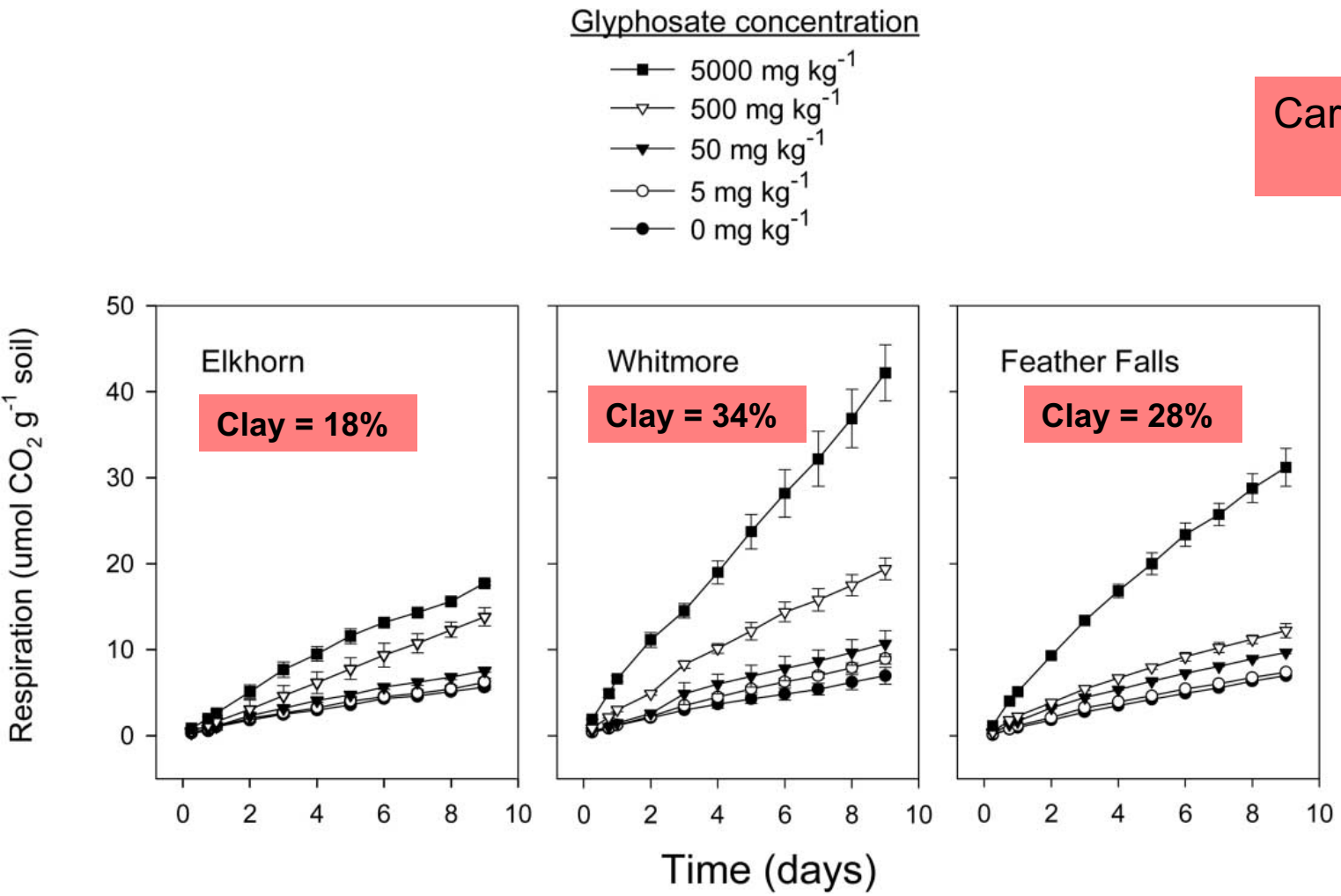
Hussain et al. 2009. Impact of Pesticides on Soil Microbial Diversity, Enzymes and Biochemical Reactions. Advances in Agronomy vol. 102: 159-200.

Example of Glyphosate 1

M.D. Busse et al. / Soil Biology & Biochemistry 33 (2001) 1777–1789



Carbon, Hydrogen, Phosphorus



Effect of pesticides on soil organisms

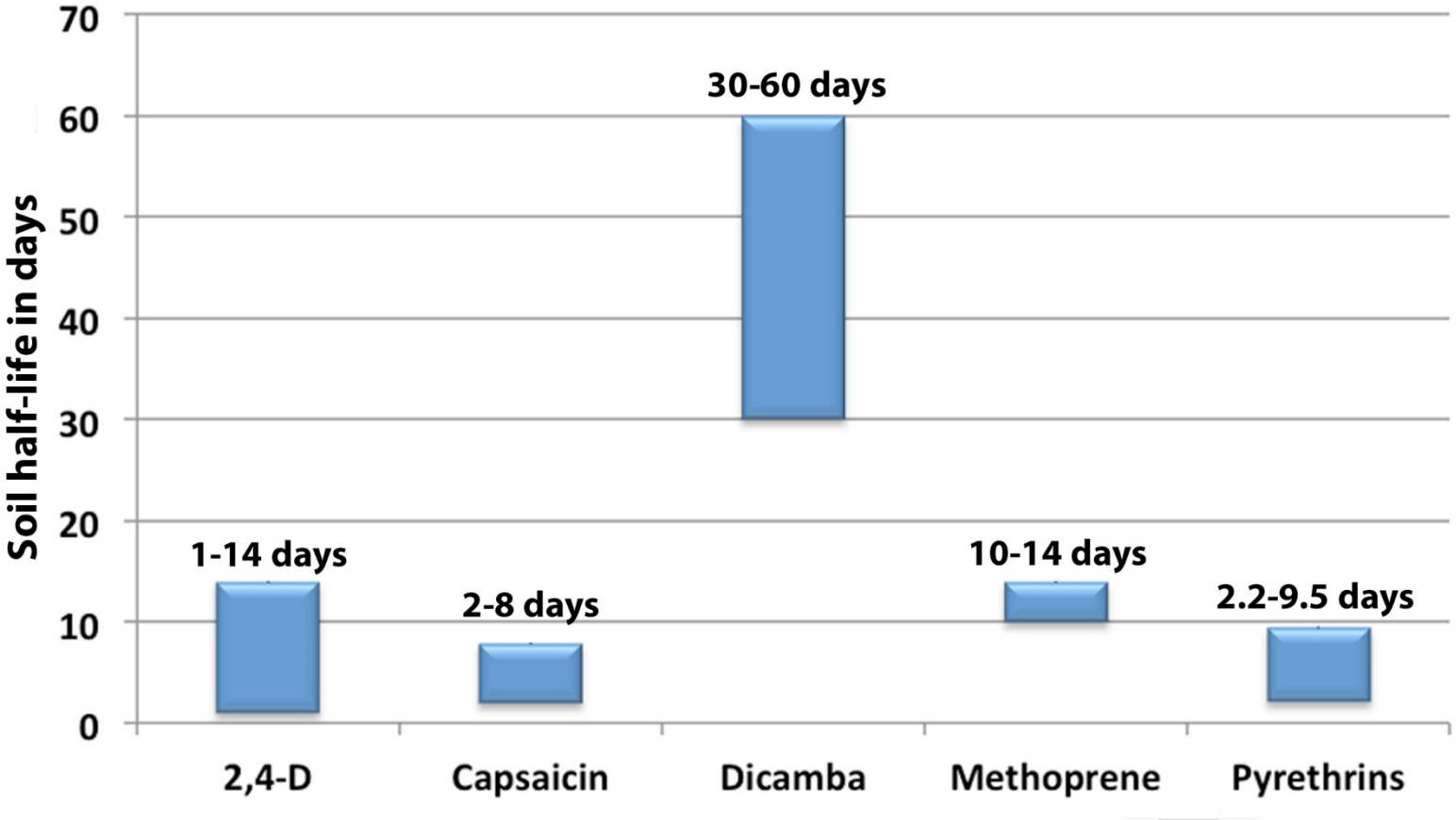
- No generalized effect can be assumed
- Complex interaction between active ingredients and soil organisms
- Some effects are temporary while some last longer
- Some agents can act positively on soil organisms while some are negative
- Some pesticides don't have any effect at all
- Same pesticide can affect a soil organism differently in varied soil type
- Temporary changes in count and/or diversity may occur
- Soil type; nature and concentration of pesticide; initial level and diversity of microbes; and weather conditions affect microbial response to pesticides

Important facts

- Rate of application is important
- Frequency of application is important
- Effect of combination of chemicals may be different from individual chemicals
- Avoid spillage
- Use it the right way!!! – by reading the label

Half-life of some pesticides (in days)

A half-life is the time it takes for a certain amount of a pesticide to be reduced by half.



http://npic.orst.edu/factsheets/half-life.html

Minimizing Pesticide Impact

Integrated Pest Management

To achieve necessary level of control

- **Biological control**
- **Cultural practices**
- **Timely chemical applications**

Resistance of pests to active ingredient is a real problem!

Pesticide use and storage

- Read the label directions on container
- Use pesticide only when economic thresholds are reached
- Use appropriate protective equipment and clothing
- Avoid mixing pesticides near wells or water sources
- Store pesticide safely according to legal requirements and label directions
- Maintain application equipment and calibrate regularly

Disposal of excess pesticides

- Dispose excess pesticides and pesticide containers according to the label directions
- Triple-rinse empty pesticide containers
- Punch holes in containers
- Dispose them at the appropriate disposal sites

Consider weather and irrigation plans

- Use weather forecast to plan application program
- Time application to be compatible with irrigation
- Avoid application when rain is coming
- Avoid application when wind favors drift
- Use appropriate nozzle/equipment to minimize drift

Effectiveness of orchard sprays

- Use effective chemicals
- At the proper rate (concentration)
- Apply appropriately (consider tree size and spacing)
- At the proper time
- Using smart sprayer can enhance spray efficiency


Thanks