Chapter 7. Chemical Treatment of Crops and Harvested Products

7.1. General Information on Plant Protection

7.1.1. Integrated Pest Management (IPM)

We never rely solely on chemicals. Instead, we use **Integrated Pest Management (IPM)**. Think of IPM as a "toolbox" where chemical control is the last tool you reach for, not the first.

The 5 Steps of IPM:

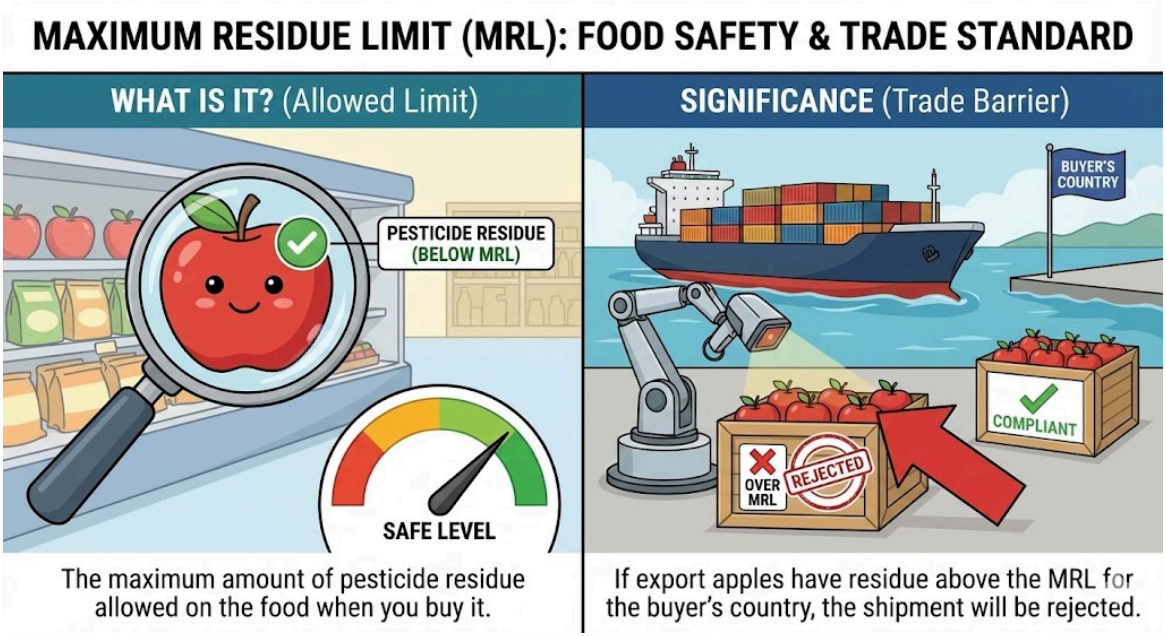
Before spraying, a grower must follow this decision-making process:

1. **Identify the Pest:** Make sure you know exactly what insect or disease is causing the problem. Most bugs are actually beneficial!
2. **Monitor Activity:** Scout the field. How many pests are there? Is the population growing?
3. **Set Action Thresholds:** Determine the "tipping point." This is the specific number of pests where the cost of the damage is higher than the cost of spraying. If pest numbers are below this threshold, **do not spray**.
4. **Explore Options & Treat:** Can you use a bug-eating insect (biological control) or a resistant crop variety (cultural control) first? If those fail, select the safest chemical option.
5. **Evaluate Results:** Did it work? Did you harm any non-target organisms?

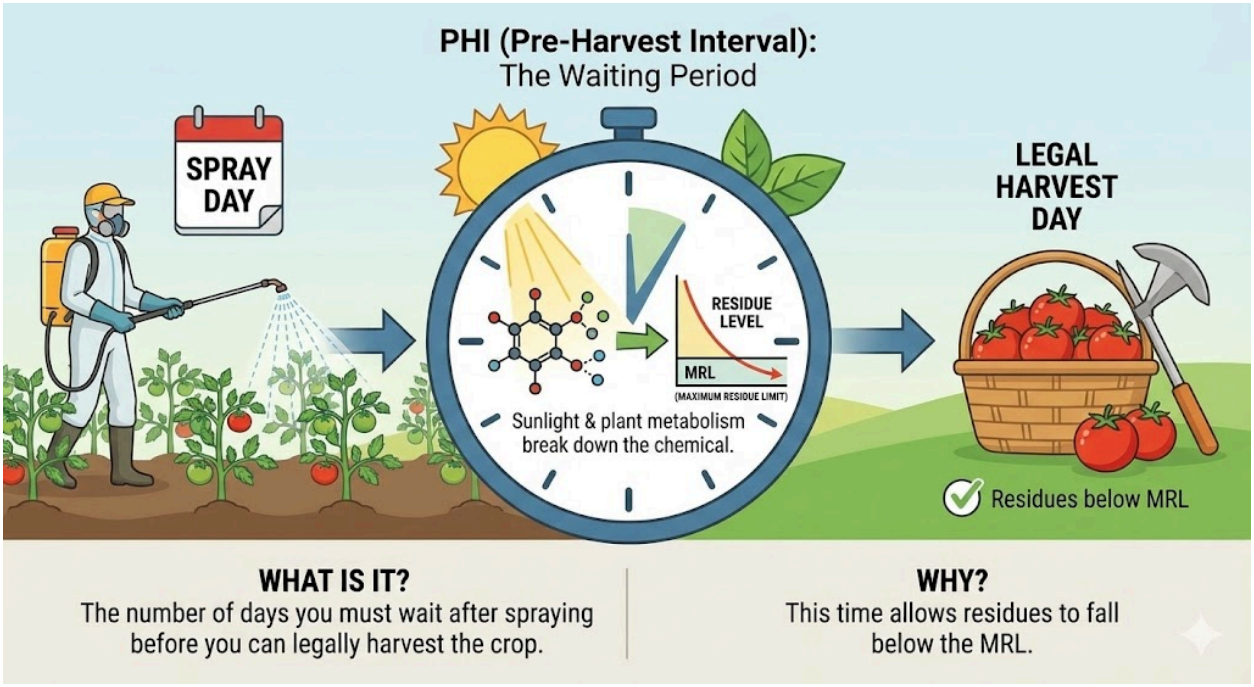
7.1.2. Key Safety Standards

You must memorize these three acronyms to keep consumers and workers safe.

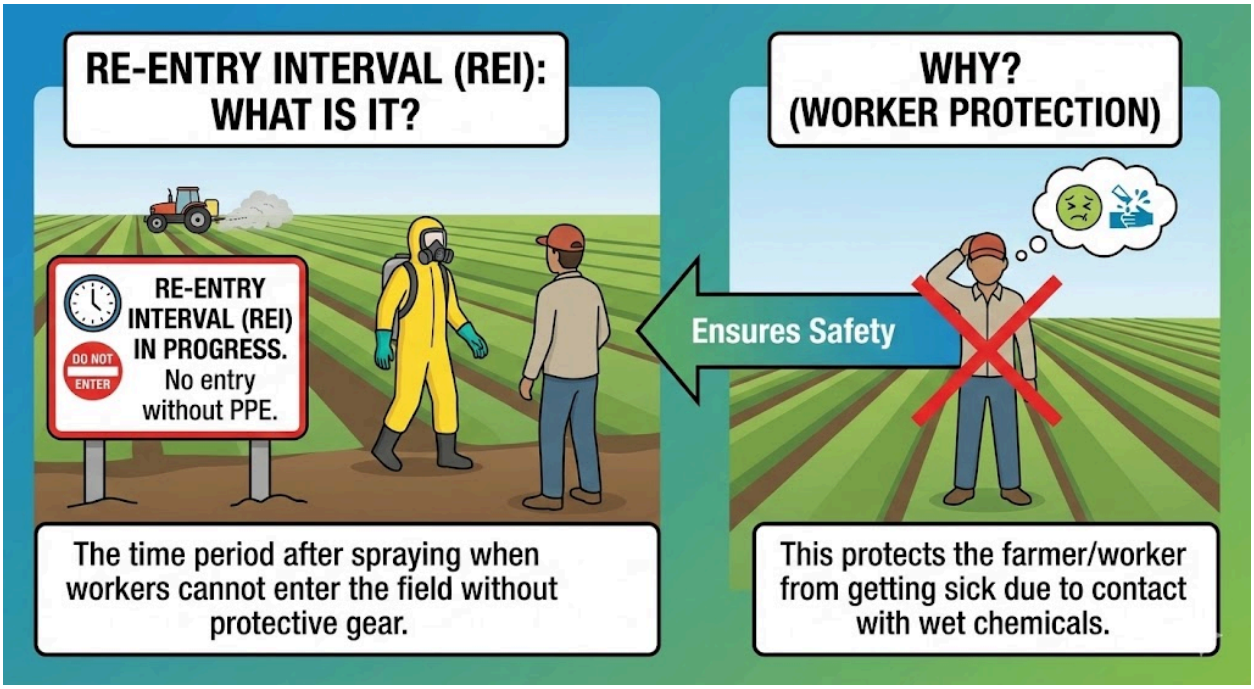
- **MRL (Maximum Residue Limit):**



- **PHI (Pre-Harvest Interval):**



- **REI (Restricted Entry Interval):**



7.2. Properties and Modes of Action of Insecticides

Definition: An insecticide's Mode of Action (MoA) is the specific biological system in the insect that the chemical destroys.

7.2.1. Nerve and Muscle Targets (The "Short-Circuit" Killers)

Most insecticides work by attacking the insect's nervous system. They cause the nerves to fire uncontrollably, leading to tremors, paralysis, and death.

- **Group 1: Acetylcholinesterase Inhibitors (Organophosphates & Carbamates)**
    - *How they work:* Nerves send signals using a chemical called *acetylcholine*. Once the signal is sent, an enzyme cleans it up. These insecticides block that "clean-up" enzyme. The nerve keeps firing forever, like a light switch stuck in the "on" position.
- **Group 2: Sodium Channel Modulators (Pyrethroids)**
    - *How they work:* They jam the "gates" (sodium channels) on the nerve cell open. This causes a massive electrical surge (shock) that knocks the insect down immediately.
    - *Note:* These are synthetic versions of pyrethrum, which comes from chrysanthemum flowers.

- **Group 3: Neonicotinoids**
    - *How they work:* They mimic the nerve signal itself, plugging into the insect's receptors and over-stimulating them.
    - *Key Feature:* They are **systemic**, meaning plants absorb them through the roots. They are great for sucking pests like aphids.

7.2.2. Growth Regulators (The "Development" Blockers)

These do not kill quickly. Instead, they stop the insect from growing up.

- **Chitin Inhibitors:** Prevent the insect from forming a new exoskeleton (skin). When it tries to molt, it dies.
- **Juvenile Hormone Mimics:** Trick the insect's body into thinking it is still a baby. It never turns into an adult and cannot reproduce.

7.2.3. Respiration Targets (The "Energy" Blockers)

- **Bt Toxins (Microbial):** Proteins from bacteria (*Bacillus thuringiensis*) that tear holes in the insect's stomach. They are very safe for humans because our stomachs are acidic, while insect stomachs are alkaline.
- **Fumigants (Phosphine):** Gases used in stored grain (silos). They penetrate deep into the grain pile to kill weevils inside the kernels.

7.3. Properties and Modes of Action of Fungicides

Fungicides prevent or cure plant diseases. We classify them by how they move in the plant.

7.3.1. Movement: Contact vs. Systemic

- **Contact (Protectant):**
    - *Action:* Stays on the leaf surface. Like a "paint" or shield.
    - *Limitation:* If it rains, it washes off. It protects only the parts you sprayed; new leaves are vulnerable.
    - *Examples:* Copper, Sulfur, Mancozeb.
- **Systemic (Penetrant):**
    - *Action:* Absorbed into the plant tissue. It can cure an infection that has already started

(within 24-48 hours).

- *Advantage:* Cannot be washed off by rain once dry. Can move up to protect new leaves.

7.3.2. Major Chemical Groups (FRAC Codes)

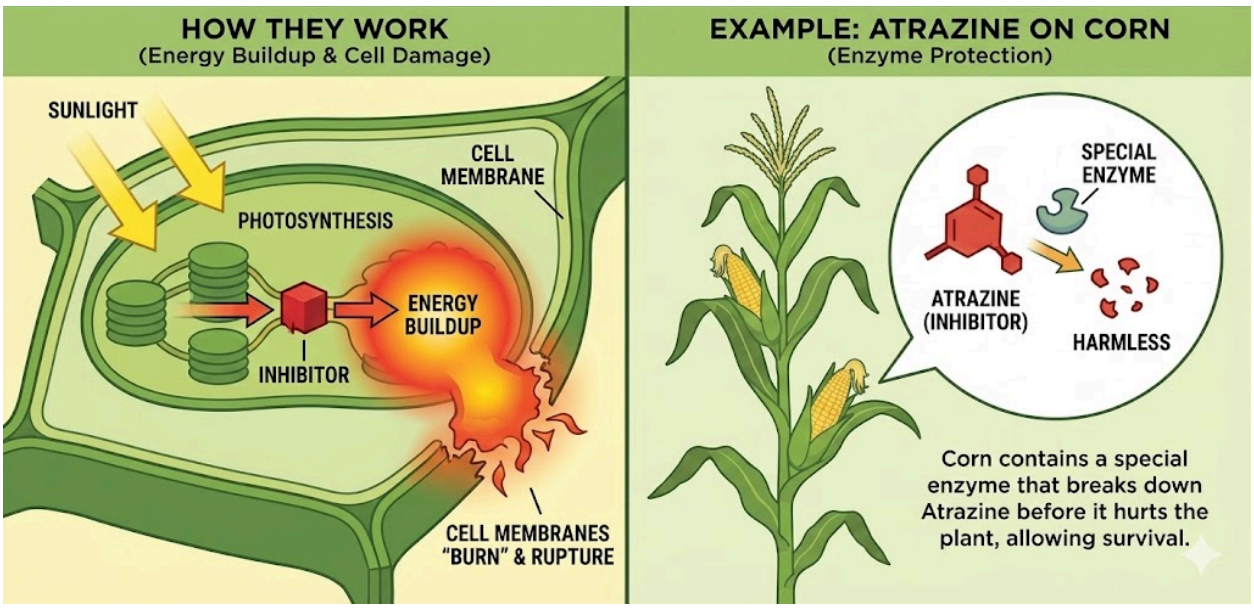
- **Triazoles (FRAC 3):** Stop the fungus from making cell walls.
- **Strobilurins (FRAC 11):** Stop the fungus from breathing (respiration). They are very powerful but fungi can become resistant to them easily.
- **Post-Harvest Fungicides:** Special chemicals (like Imazalil or Fludioxonil) used in packing houses to prevent fruit from rotting during shipping.

7.4. Properties and Modes of Action of Herbicides

Herbicides kill weeds. The key concept here is **Selectivity**: How do we kill the weed without killing the crop?

7.4.1. Photosynthesis Inhibitors

- *How they work:* They block the plant's ability to turn sunlight into energy. The energy builds up and "burns" the cell membranes.
- *Examples:* Atrazine (used in corn). Corn survives because it has a special enzyme that breaks down the chemical before it hurts the plant.



7.4.2. Amino Acid Synthesis Inhibitors

- *How they work:* They stop the plant from making amino acids (the building blocks of proteins).
- *Example:* **Glyphosate (Roundup)**. It kills almost everything (non-selective) unless the crop is genetically modified (GMO) to withstand it.

7.4.3. Growth Regulators (Synthetic Auxins)

- *How they work:* They mimic plant growth hormones. The weed grows so fast and uncontrollably that it twists, curls, and starves itself to death.
- *Target:* Excellent for killing broadleaf weeds (dandelions) in grass crops (corn, wheat, lawns).

7.5. Management of Pesticide Resistance

The Problem: If you use the same chemical over and over, it stops working. This is **resistance**.

- *Mechanism:* It is evolution. A few pests naturally have a mutation that saves them. When you spray, you kill the weak ones. The survivors breed, and soon the whole population is resistant.

7.5.1. The "Avoid, Delay, Reverse" Strategy

To stop resistance, we must confuse the pest.

1. **Rotation (The Golden Rule):** Never use the same Mode of Action (MoA) group back-to-back.
    - *Example:* If you use a Group 1 insecticide today, you **must** use a Group 2 or 3 next time. This kills the survivors of the first spray.
2. **Mixtures:** Tank-mix two chemicals with different modes of action. It is highly unlikely a pest is resistant to *both* at the same time.
3. **Refugia:** Leave a small part of the field untreated. Susceptible (weak) pests survive there and mate with the resistant "super-bugs," diluting the resistance genes.
4. **Correct Dosing:** Always use the full recommended dose. Low doses allow partially resistant pests to survive and adapt.