Loss from Insects (and diseases & weeds)

- Reduced Yields
- Reduced Quality
- Increased Production & Harvesting Costs
- Increased Expense Through Control Measures

Goal of Insect Management

- Maximum control at minimal "cost"
  - "Cost" should include possible harm to environment
- Maximizing control requires recognizing onset of problem
  - Early infestations require less drastic control measures
  - Need to understand the biology of the insect
Insect Life Cycles

- **Complete**
  - Four distinct stages:
    - Egg, larva, pupa and adult
  - Examples of these insects are beetles and moths
- **Incomplete**
  - Hatch from eggs into tiny nymphs that resemble the adult stage
  - Many insects in this category have piercing, sucking mouthparts and suck juice from plants (also grasshoppers)
  - Adults have fully developed wings; nymphs cannot fly

Insect Injury to Plants

- **Injury by Chewing Insects**
  - Visible chewing on plant parts; include moths & beetles
- **Injury by Piercing-Sucking Insects**
  - Wounds generally invisible, but other symptoms visible
- **Injury by Internal Feeders**
  - Entry wound generally invisible; exit wounds may be large
  - What growth stage would you target control of these insects?
- **Injury by Subterranean Insects**
  - Some or all of their life-cycle may be below ground
  - Chewers, sap suckers, root borers and gall insects

Insects as Disseminators of Plant Diseases

- Discovered in 1892 that honeybees spread fire blight bacteria between fruit trees
- Now known that more than 200 diseases are spread by insects (mostly viruses)
- **How?**
  - Creating an entrance wound
  - Transporting the disease organism on or in their body, and delivering the organism on or in the plant
  - Serve as an essential host for a portion of the life cycle of the disease causing organism
Beneficial Insects

• “There is no doubt that the greatest single factor in keeping plant-feeding insects from overwhelming the rest of the world is that they are fed upon by other insects”
• Considered in two groups:
  – Predators
    • Larger & Stronger than prey
  – Parasites
    • Smaller & Weaker than host, host survives at least for a time
• Any control measure should consider impact on beneficial insects

Control Measures

• Soil Insects
  – wireworms, white grubs, fire ants, cutworms, seed maggots and the sweet potato weevil
  – Often soil insects, especially cutworms, are common in uncultivated soil sites that have had grass and weeds growing the previous season
  – Controlling soil insects is much easier if done prior to planting

Control Measures

• Chewing Insects
  – Many chewing insects have a complete life cycle (except grasshoppers); therefore, depending on species, there may be one or two damaging stages
  – Control of chewing insects is basically twofold:
    • Monitor for eggs and small larvae that begin to feed
    • Monitor for the adults and control them when necessary
  – Control of these insects is important in the early infestation of the plant
Control Measures

- **Sucking Insects**
  - aphids, stink bugs, squash bugs, leafhoppers and spider mites
  - Usually attracted to the most succulent part of the plant
  - Major disease vectors
  - Control is easiest to obtain soon after the insects hatch from eggs

Pest Control with a Minimum Use of Chemicals

- Overuse of pesticides has a number of adverse effects:
  - Food products may contain unsafe pesticide residues if improperly treated with pesticide
  - Beneficial insects, earthworms and birds may be harmed or killed along with harmful insects if pesticides are carelessly used
  - Each time producers spray, they expose themselves to the possibility of inhalation or absorption of the toxin
  - Careless use of pesticides near water may contaminate water supplies
  - Misuse of pesticides can lead to the development of chemical resistance in the target pest
  - The use of pesticides can lead to outbreaks of secondary pest species

Non-Chemical Insect Control

- Resistant Plant Cultivars
- Cultural Practices
- Mechanical Control Methods
- Biological Control Methods
  - *Nosema locustae* (Protozoan)
  - *Trichogramma* wasp
  - Green lacewings
  - Praying Mantis
  - Lady beetles
  *Biological control methods require a certain pest population to maintain the population of biologicals*
Chemical Insect Control

• Natural Insecticides
  – Pyrethrum (flower extract), Nicotine (tobacco extract), Sabadilla (seed extract), Rotenone (root extract), *Bacillus thuringiensis* (bacterial extract), Safer’s Insecticidal Soap®
• Synthetic Insecticides

Rules for Insecticide Application

• Only use registered products and follow label
  – Regardless of whether it is “natural” or “synthetic”
• Apply insecticides based on close field monitoring
  – Apply early during infestation
• Rotate insecticides to avoid build-up of resistant insects
• Select insecticides and application timing to minimize damage to non-target organisms
• Should be part of an Integrated Pest Management (IPM) program that includes all available methods for control
Weed Management
What is a weed?
• Any plant that is growing where it is not wanted.
• A plant which is especially adept at quickly colonizing areas disturbed by human beings or livestock.
• A plant that has no known benefit to man.
• A weed is a plant out of place whose undesirable qualities outweigh its good points.

Results of Weed Infestation
• Lower Yields, Less Efficient Use of Land
• Added Costs From Losses Due to Insects and Diseases
• Poor Quality Products
• Added Problems in Water Management
• Less Human Efficiency

Why Control Weeds?
• Weeds are competition for:
  – Nutrients
  – Moisture
  – Light
  – Space
• Weeds Destroy equipment
• Weeds Reduce quality of produce
• Weeds Reduce “profits” to grower
Weed Classification

• Three General Control Groups:
  – Grasses
  – Sedges
  – Broadleaves

• Three General Life Cycles:
  – Annuals
    • Summer Annuals
    • Winter Annuals
  – Biennials
  – Perennials
    • Simple Perennials
    • Creeping Perennials
Weed Control Methods

- Mechanical (tillage)
- Cultural
- Biological
- Chemical
- Preventative
Solar-Powered Robot Weeder

Cultural

- Hand pulling
- Hoeing
- Mowing
- Smother crops (living)
- Mulch (Plastic, dead plants, compost)
- Crop rotation
- Water management

<table>
<thead>
<tr>
<th>Weeding Tool / Process</th>
<th>Weeder Features</th>
<th>Root Type Extraction</th>
<th>California Agricultural Regs Approval</th>
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</thead>
<tbody>
<tr>
<td>36 Inch Consumer Weed Twister</td>
<td>Excellent</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>42 Inch Ergonomic Weed Twister</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>48 Inch Industrial Weed Twister</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>54 Inch Dual Grip Weed Twister</td>
<td>Poor</td>
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<tr>
<td>Traditional Short-handle Hoe</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Traditional Long-handle Hoe</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Precision Short-handle Hoe</td>
<td>Poor</td>
<td>Poor</td>
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<tr>
<td>Precision with Long-handle Hoe</td>
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</tr>
<tr>
<td>Long-handle Short-handle Hoe</td>
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<td>Poor</td>
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</tr>
<tr>
<td>Long-handle Long-handle Hoe</td>
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<tr>
<td>Short-handle Prong</td>
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</tr>
</tbody>
</table>

* Hand weeding is allowed when there is no readily available alternative means of performing the work that is suitable and appropriate.
Biological Weed Management

• Use of host specific insect or disease to integrate into the total weed management strategy

Chemical Weed Control

• Classifications of Herbicides:
  » Grass killers
  » Broadleaf killers
  » Contact
  » Systemic
  » Selective
  » Non-Selective
Principles of Herbicide Selectivity

- Dormancy of crop at time of application
- Herbicide placement
- Anatomical differences
- Foliar retention
- Protected growing points
- Differential susceptibility at various plant growth stages
- Use of antidotes (safeners)
- Internal factors →

Factors Leading to Selectivity of Herbicides (Internal Factors)

- Differential translocation to site of action
- Absorption or accumulation at inactive sites
- Differential metabolism by crop
- Differential quantity/kind of seed reserves
- Resistance at site of action

Timings of Chemical Sprays

1. Preplant incorporated (PPI)
   - Applied before planting, mixed into the soil.
2. Preemergence (PRE)
   - Applied to soil before planting/weed emergence
3. Postemergence (POST)
   - Applied after crop emerges.
4. Post-Directed (P-DIRECT)
   - Applied after crop emergence, directed around crops.
5. Lay-by
   - Sprayed to soil around crop before or after emergence.
What happens to herbicides after they are applied?

- Volatilize and dissipate through air.
- Remain on leaf surface as liquid or crystal.
- Penetrate leaf cuticle (waxy layer) and stay there.
- Penetrate leaf cuticle, enter cell wall and move apoplastically through xylem system.
- Penetrate leaf cuticle, enter cell wall and move symplastically through phloem system.

Spray Additives: Surfactants, Wetting Agents, Stickers, Spreaders

- Uniform spreading of spray solutions.
- Help spray to remain on leaf surface.
- Assure that droplets do not remain suspended on leaf hairs.
- Partially solubilize the plant surface to allow better penetration.

Classifications of Herbicides

- Wettable Powders (WP)
- Emulsifiable Concentrates (EC)
- Water Dispersable Granules (WDG)
- Granules (G)
- Soluble Powders (SP)
- Liquids (L)
- Microencapsulated (M)
- Aqueous Suspension (AS)
Some Herbicide Active Ingredients & Mode of Action

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Active Ingredient</th>
<th>Mode of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundup</td>
<td>Glyphosate</td>
<td>EPSP synthase</td>
</tr>
<tr>
<td>Gramoxone</td>
<td>Paraquat</td>
<td>Cell membranes</td>
</tr>
<tr>
<td>Treflan</td>
<td>Trifluralin</td>
<td>Mitosis root inhibitor</td>
</tr>
<tr>
<td>Dual Magnum</td>
<td>s-Metolachlor</td>
<td>Shoot inhibitor</td>
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<tr>
<td>Poast</td>
<td>Sethoxydim</td>
<td>Lipid inhibitor</td>
</tr>
<tr>
<td>Sandea</td>
<td>Halosulfuron</td>
<td>Amino acid synthesis</td>
</tr>
<tr>
<td>Aatrex</td>
<td>Atrazine</td>
<td>Photosynthesis inhibitor</td>
</tr>
<tr>
<td>Weedone</td>
<td>2,4-D</td>
<td>Growth Regulator</td>
</tr>
</tbody>
</table>

Preventative Weed Control

- Obey local, state, federal and international laws regulated seed transportation.
- Use certified weed-free crop seed.
- Use weed-free manure and hay.
- Clean cultivation and harvesting equipment between fields.
- Eliminate weed infestations near or around irrigation ditches or cultivated fields.

Integrated Weed Management

The use of two or more of the recognized weed control categories
Chemical Application & Safety

- Licensing Requirements
- Sprayer Calibration

Pesticide Classifications

- **General-use**
  - Can be purchased and used by the general public. Does not require a license to distribute or use.
- **Restricted-use**
  - For use only by certified pesticide applicators or persons under their direct supervision. Designation is placed on the product by EPA, and the label will state restricted-use.
- **State-limited-use**
  - Pesticides containing certain active ingredients, with the potential to cause adverse effects to non-targeted vegetation, are classified as SLU when distributed in containers larger than one quart liquid or 2 pounds dry or solid. Also includes pesticides or devices for predation control.
- **Regulated Herbicide**
  - Herbicides the department determines, if used as directed or in accordance with widespread and commonly recognized practice, require additional restrictions to prevent a hazard to desirable vegetation caused by drift or an uncontrolled application.

Pesticide Applicator Licensing
Regulated by TDA

- **Types of Licenses:**
  - Private Applicator (5 years; 15 CEUs)
  - For purposes of creating an agricultural commodity on personal property
  - Private Applicator Certificate (permanent; 15 CEUs/5 years)
    - Grandfathered since 1989
  - Commercial Applicator/Non-commercial Applicator (1 year; 5 CEUs)
    - Aerial application
    - Agriculture
    - Aquatic pest control
    - Ornamental plant and turf production
    - Forestry
    - Right-of-way maintenance
    - Research
    - Regulatory pest control
    - Seed treatment, commodity fumigation
    - Education and research

- Not for structural pest control (Structural Pest Control Board)
Private Applicator License

- Attend a private applicator training program offered by Texas Cooperative Extension (Extension) or a private entity approved by TDA;
- Pass the TDA private applicator exam
- Purchase a license ($60)
- Required to recertify every five years by obtaining 15 CEUs, including 2 credits in laws and regulations and 2 credits in integrated pest management (IPM), prior to expiration of the license. (May take exam to cover CEUs but cost $50 per attempt)

Pesticide Label

- Label handout
  - Can you name:
    - PPE requirements?
    - REI requirement?
    - PHI (pre-harvest interval)?
    - Rate?

Sprayer Calibration

- Determine Rate (active ingredient or product)
  - What’s the difference?
- Determine volume of water
  - Check label to see if there is a range
    - Most pesticides recommend 20-30 gal/A
- Does pesticide require constant agitation?
  - Are particles suspended (WP) or dissolved (SP)
- Calibrate Sprayer
Sprayer Calibration

- Poor calibration accounts for 90% of control failures
- Refer to handbook or handout; you will need to calibrate backpack sprayer in lab
- Single nozzle backpack sprayer:
  - Determine spray width (nozzle type and height)
  - Determine “calibration distance” from table
  - Measure time needed to walk calibration distance (walk constant speed)
  - Measure volume delivered through sprayer during this amount of time (constant pressure)
  - Ounces of water = gallons per acre

Calibration Example

- Spray width (nozzle spacing) = 20"
- Calibration distance = 204' (from table)
- Measured time to travel 204" = 46 seconds
- Measured volume delivered in 46 seconds = 21 fluid ounces
- Gallons of solution applied per acre = 21
- So, if recommend rate is 1 lb/A, you need 1 lb/21 gal of spray for each acre
- For a 4 gal backpack sprayer:
  \[ \frac{1}{21} = 0.0476 \times 4 = 0.19 \text{ lbs per 4 gal tank} \]
- Each 4 gal sprayer will cover \[ \frac{4}{21} = 0.19 \text{ acres} \]