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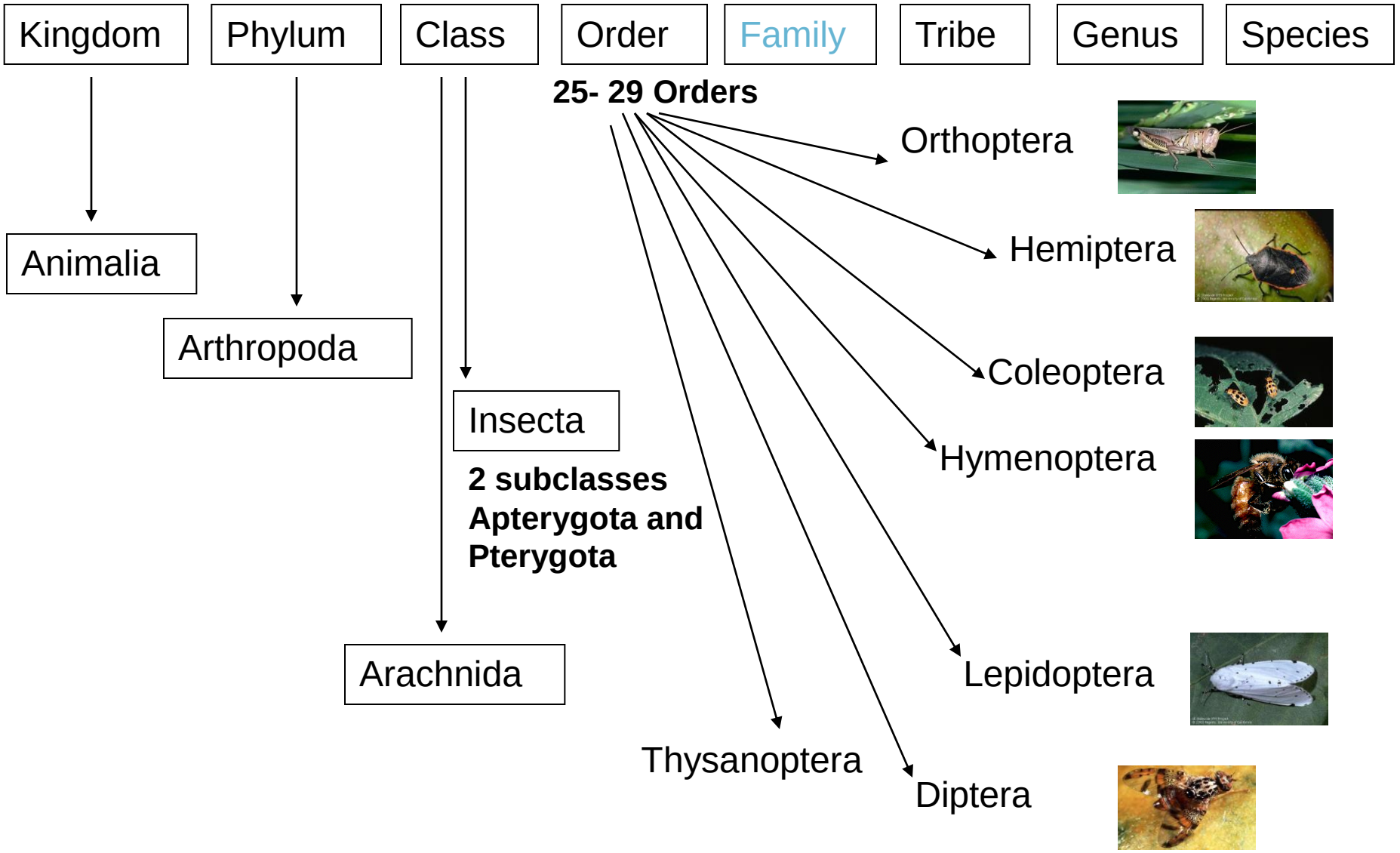
IPM concepts in tobacco entomology

Hannah J. Burrack
Assistant Professor & Extension Specialist
Department of Entomology, NC State
919.513.4344
hannah_burrack@ncsu.edu

Quick Overview of Insect Relationships



Quick Overview of Insect Relationships

Kingdom | Phylum | Class | Order | Family | Tribe | Genus | Species

Animalia

Arthropoda

Insecta

2 subclasses Apterygota and Pterygota

Arachnida

25 - 29 Orders

Orthoptera

Hemiptera

Coleoptera

Hymenoptera

Lepidoptera

Thysanoptera

Diptera

What do Insects do in Agriculture?

- The Good
  - Pollinators
  - Predators
  - Parasitoids
- The Bad
  - Direct Pests
- The Ugly
  - Disease Vectors
  - Contamination Pests

Pollinators

- Numerous crops require bee pollination:
  - Apples, almonds, broccoli, cucumbers, melons, carrots, oranges, squash, onions, etc.
- Estimated value of pollination is $10 billion/year in the US and Canada (1999) and as much as $14.6 billion in the US in 2000 ($4.4 billion in CA in 2002)
  - Beekeepers charge anywhere from $10-$70 for the services of one hive
- Honey bees (*Apis mellifora)*
- Native pollinators (Alfalfa leafcutter bee, many others
- Not all pollinators are bees

Predators and Parasitoids

- Generalists versus Specialists

- Parasitoids, specalized predators
  - Parasitoids are parasites which kill their hosts

Pests

- Several types of injury to crop plants
  - **Damage**
  - **Injury**
  - Cosmetic damage
  - Insect contamination
  - Vectoring of plant viruses

Pests

- Several types of injury to crop plants
  - **Injury**
    - **Indirect: Feeding on non harvested tissue**
    - **Direct: Feeding on harvested tissue**
  - **Damage –** Loss incurred due to injury
  - Cosmetic damage
    - Consider the system
  - Insect contamination
  - Vectoring of plant viruses (quantal injury)

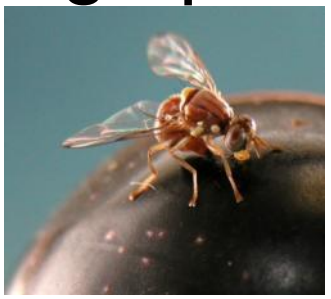
Pests

- How do arthropods damage plants?

Pests

- How do arthropods damage plants?



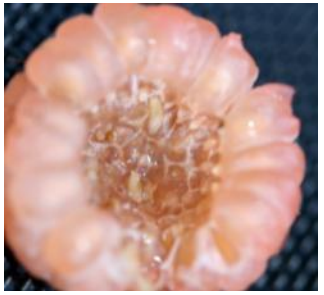














Pests

- How do arthropods damage plants?
  - CHEWING
  - SUCKING
  - CONTAMINATION
  - RASPING
  - EGG LAYING
  - VECTORING PLANT DISEASES
- Depending on developmental strategy (hemi- or holometabolis), life stages may differ in feeding behavior & damage potential

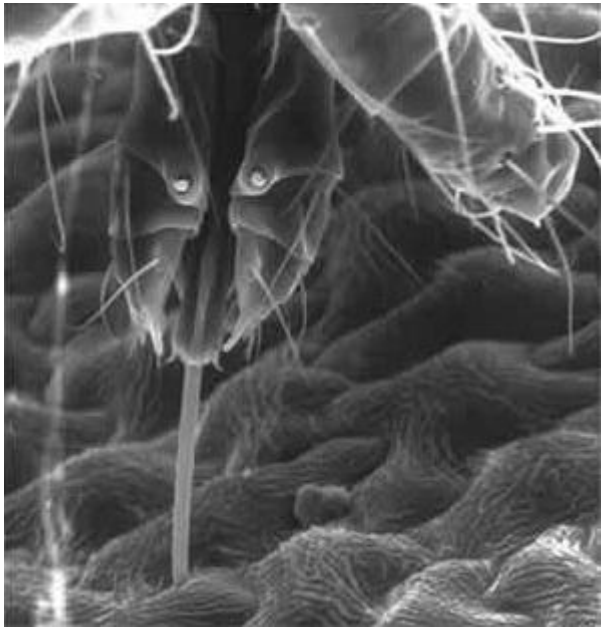
Pests

- Insect mouthparts

Beetles, caterpillars, grasshoppers & others have chewing mouthparts

Butterflies and moths have sucking mouthparts but are rarely pests

Flies have lapping, sucking mouthparts but are rarely pests. Their offspring (maggots) may have chewing mouthparts and can be pests.



Spider mites, aphids, leafhoppers, plant bugs, stink bugs, and others have piercing, sucking mouthparts

Photos: J. Meyer, ENT 425

Photo: Washington State Univ.

Integrated Pest Management

What does the term integrated pest management (IPM) mean?

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PAMS

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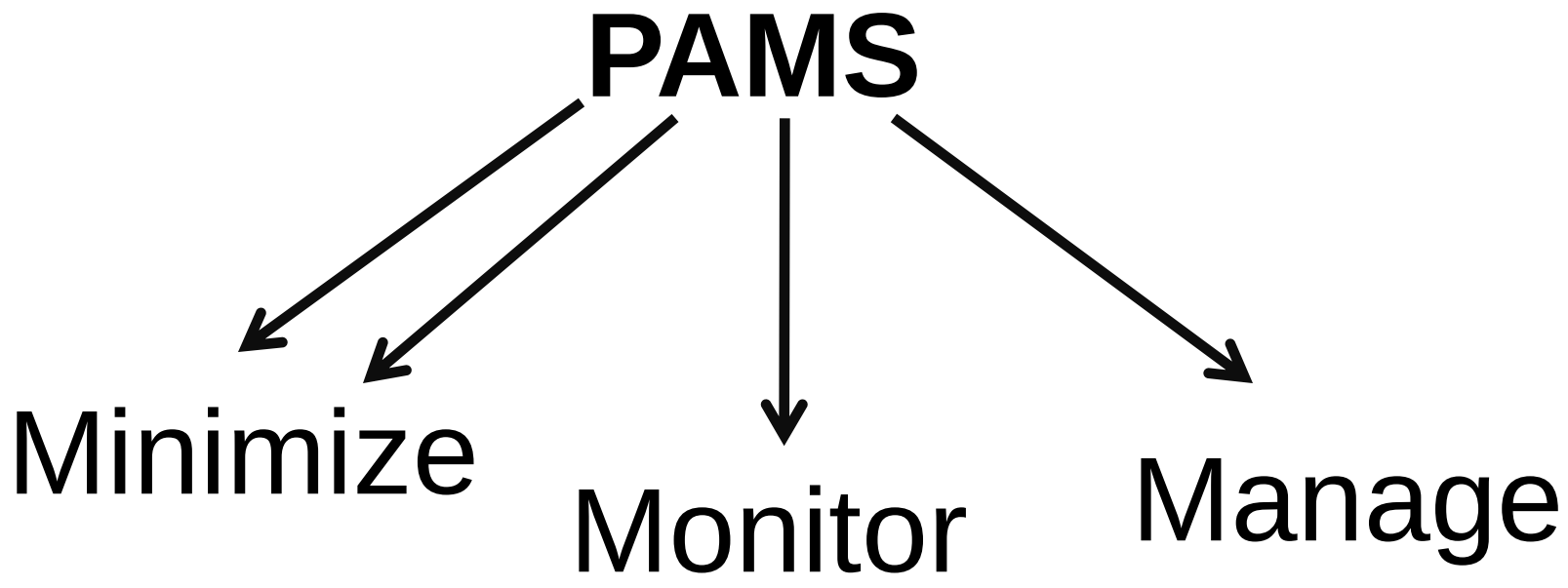


Integrated Pest Management

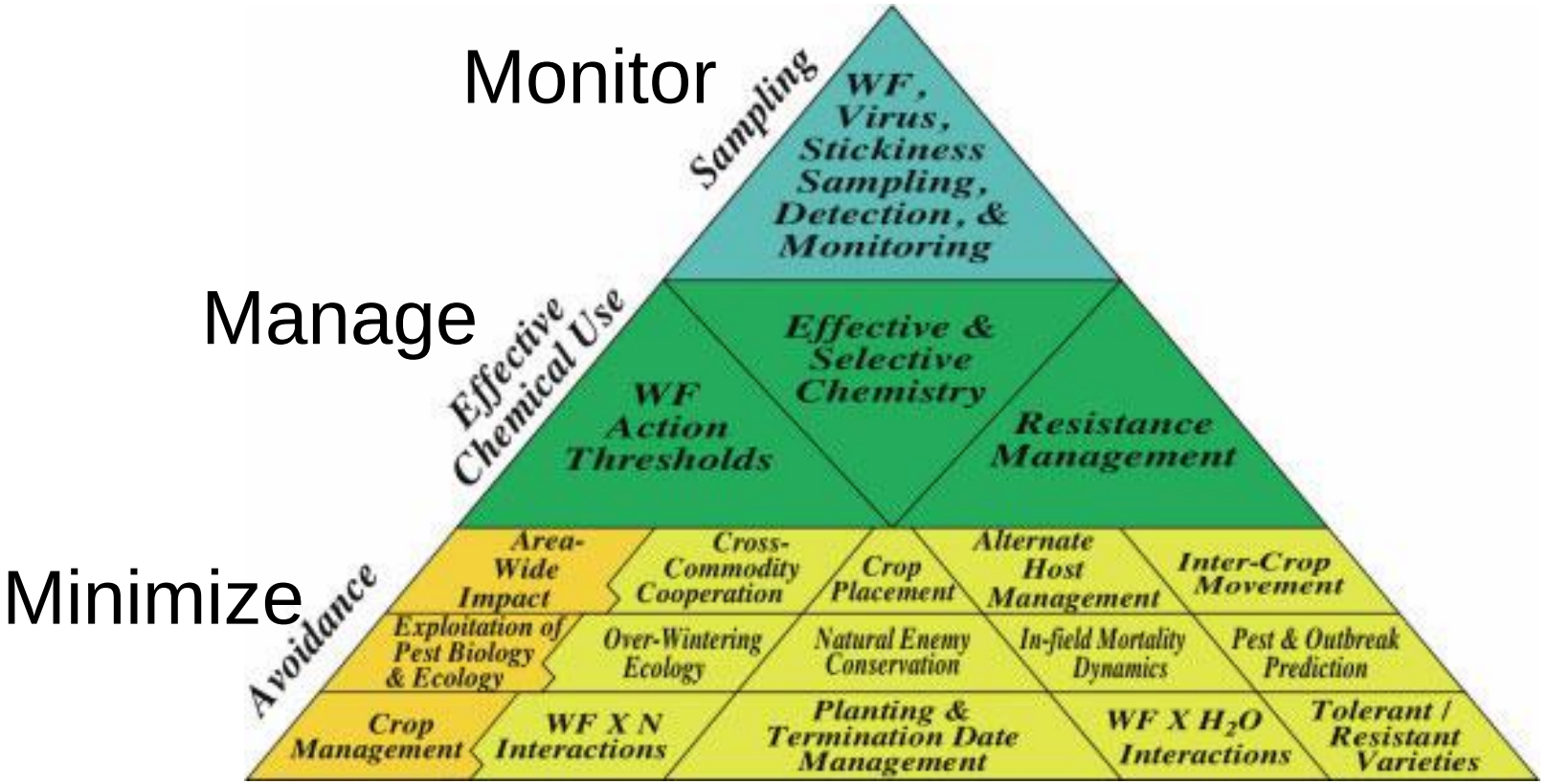
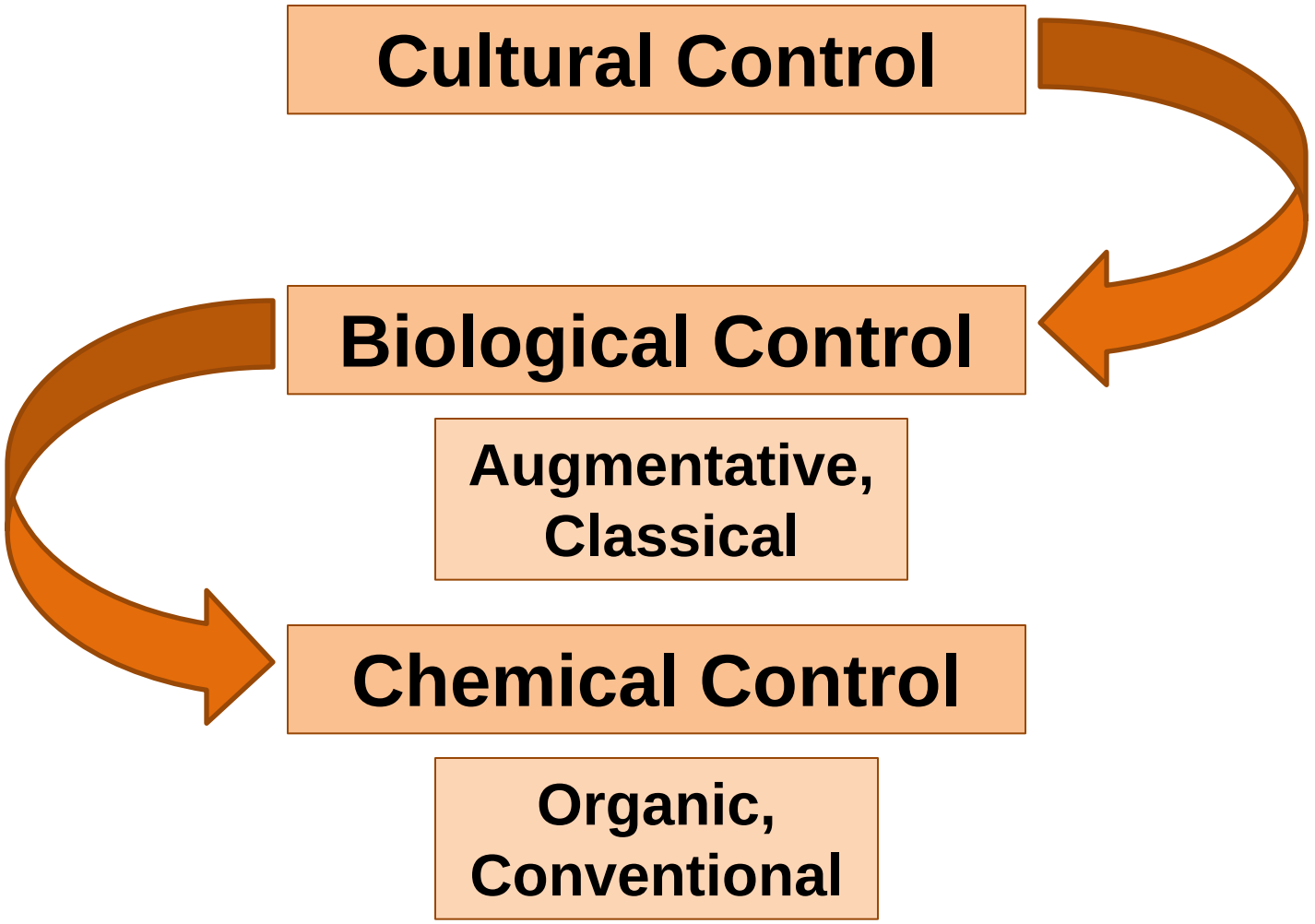
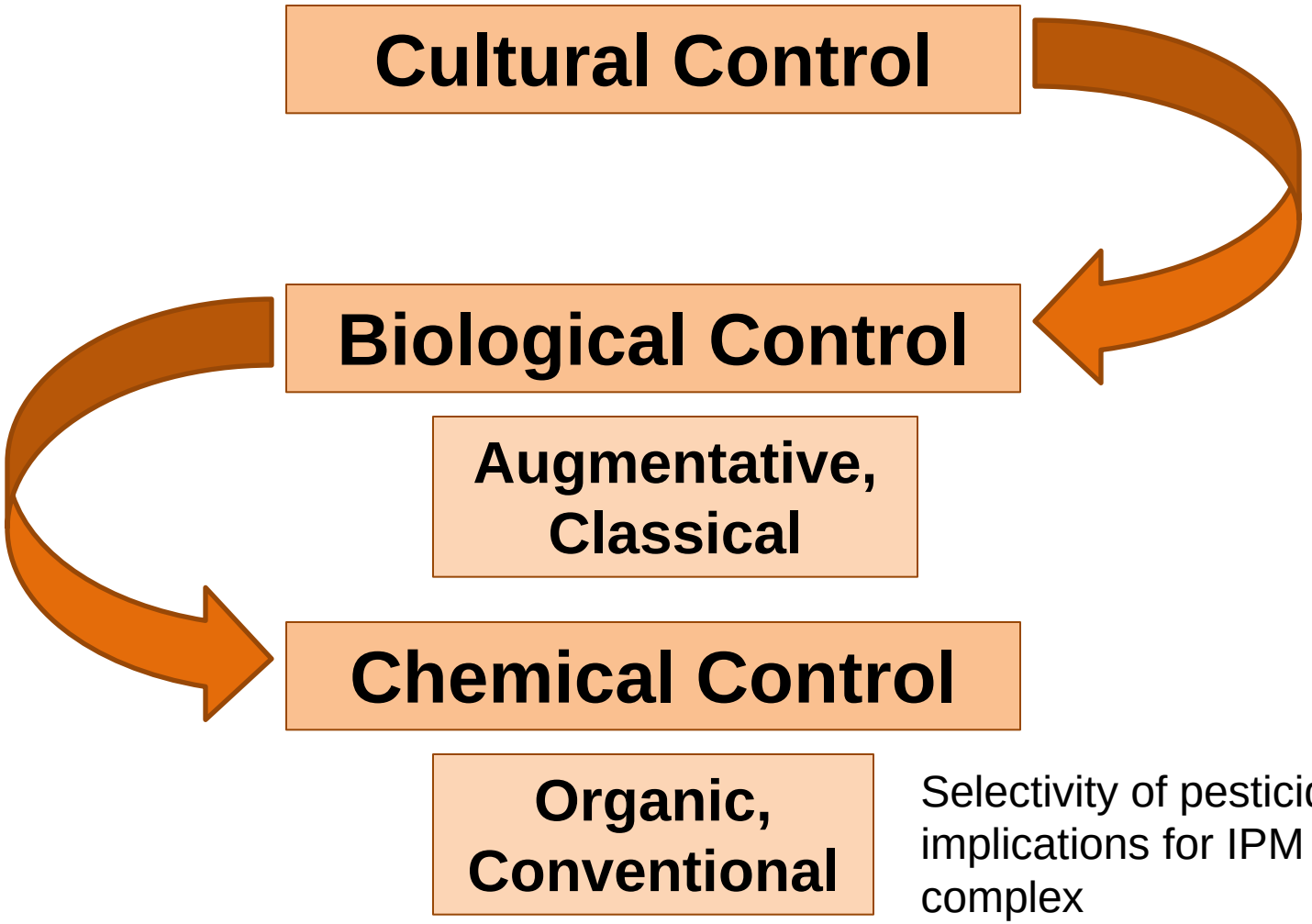


Fig 1. Naranjo & Ellsworth 2009

Management strategies



Management strategies



Selectivity of pesticides has implications for IPM & pest complex

Integrated Pest Management

How does IPM differ between agronomy (weed science), plant pathology, and entomology?

Integrated Pest Management
Key Terms

Economic Injury Level:

Economic Threshold:

Integrated Pest Management
Key Terms

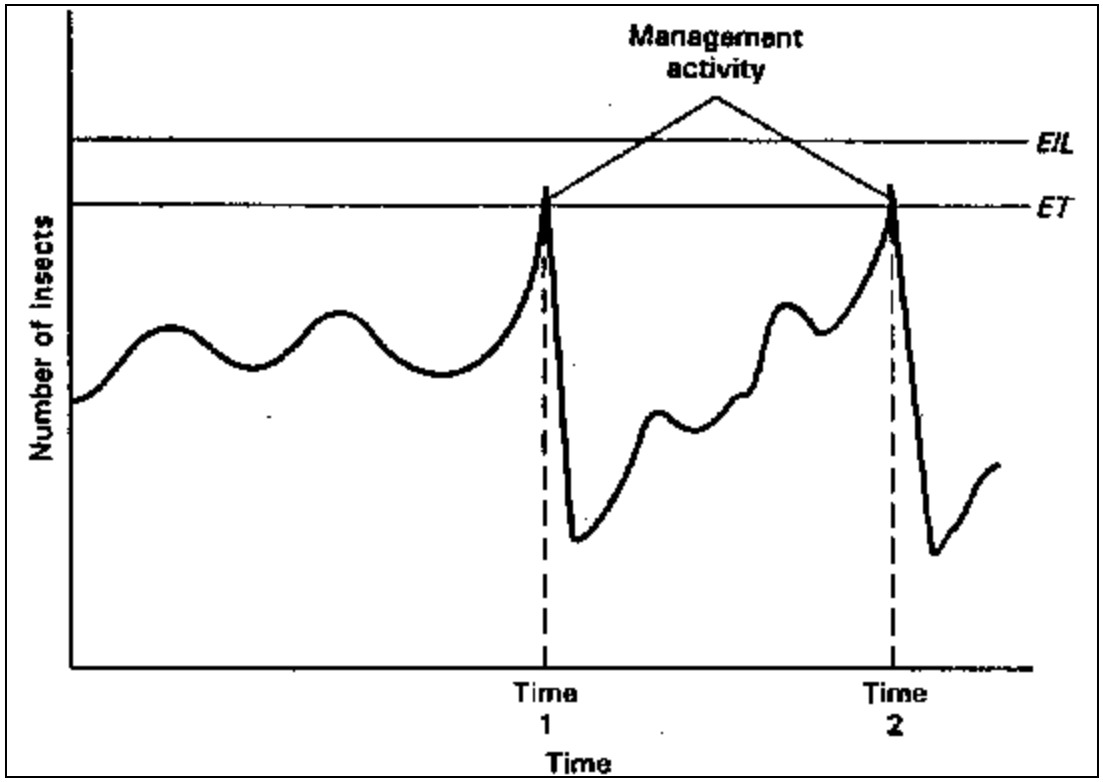
Economic Injury Level:

The point at which damage results in monetary loss

Economic Threshold:

The point at which action should be taken to avoid reaching the EIL

Integrated Pest Management Key Terms



Pedigo (http://ipmworld.umn.edu/chapters/pedigo.htm)

Integrated Pest Management
Key Terms

Economic Injury Level:

$$EIL = C/VIDK$$

Integrated Pest Management
Key Terms

Economic Injury Level:

$$EIL = C/VIDK$$

C = cost of management/production unit
V = value of/unit production
I = injury/pest
D = damage/injury
K = proportional reduction/marginal control

Integrated Pest Management
Key Terms

Economic Injury Level:

EIL = C/VIDK

C = $/acre
V = $/acre
I = leaves consumed/caterpillar
D = yield/leaves consumed
K = no units

Resulting units?

Integrated Pest Management
Key Terms

Economic Injury Level:

How are EILs calculated?

Integrated Pest Management

Sampling

Techniques

- Visual observation (insects or damage)
- Sweep netting
- Trapping (sticky, pitfall, flight, pheromone)

Program

- Random
- Targeted
- Sequential
- Subsampling

Monitoring

- Sampling over time

Thresholds

- The point at which action should be taken to avoid monetary loss

Integrated Pest Management

Sampling Techniques

Beat sheet

Integrated Pest Management
Sampling Techniques

Sweep netting

Integrated Pest Management

Sampling Techniques

Trapping

Integrated Pest Management

Sampling Techniques

Direct observation of insects or insect damage

Integrated Pest Management
Sampling Programs

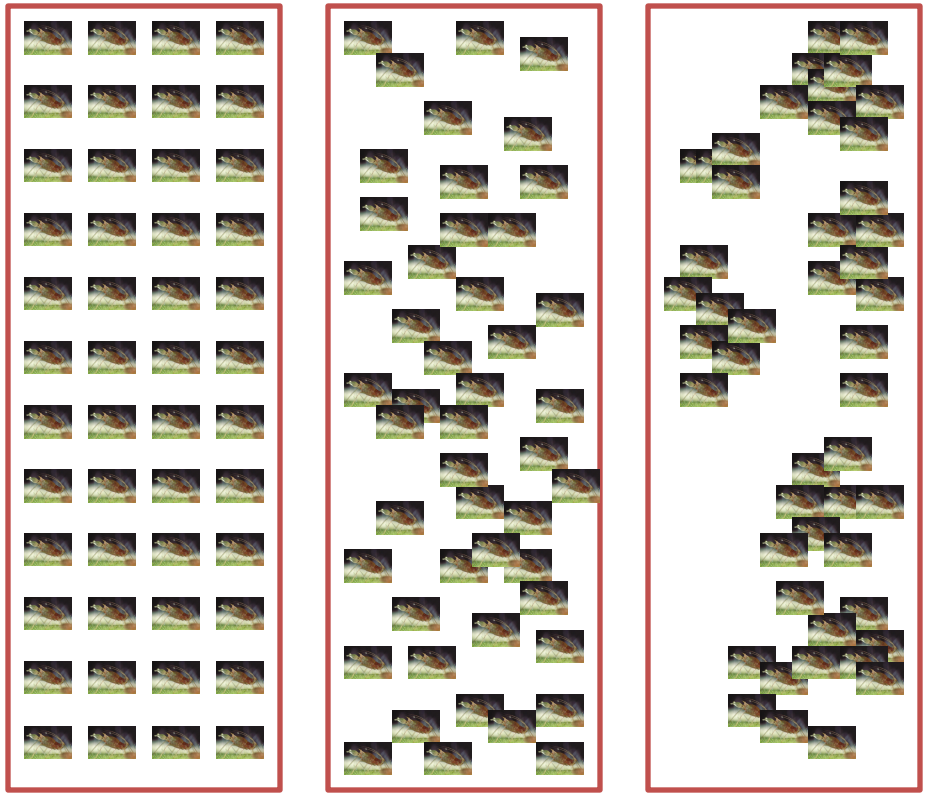
Sampling program determined by:

- Population density
- Distribution
- Type of threshold used

Practically, most sampling programs use a random sample/unit area

Integrated Pest Management
Sampling Programs

- Green peach aphids typically have a clumped distribution
  - What does this means for decision making via sampling?



Recommended Tobacco Sampling:

5 PLANTS IN A ROW AT EACH STOP

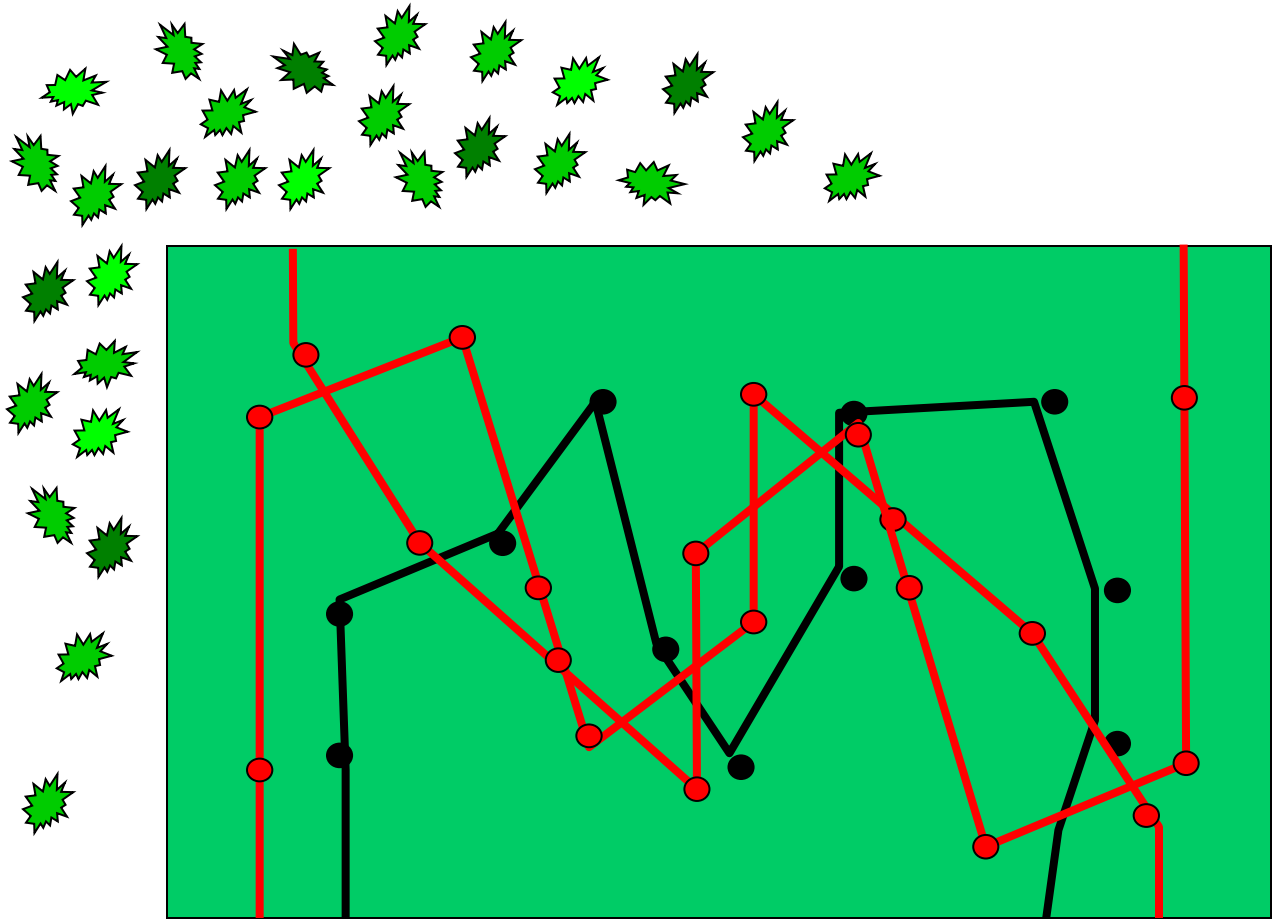
8 STOPS IN FIELDS LESS THAN 3 ACRES

10 STOPS IN FIELDS OF 3-8 ACRES

ADD 2 STOPS FOR EACH ADDITIONAL 4 ACRES

Recommended Tobacco Sampling:

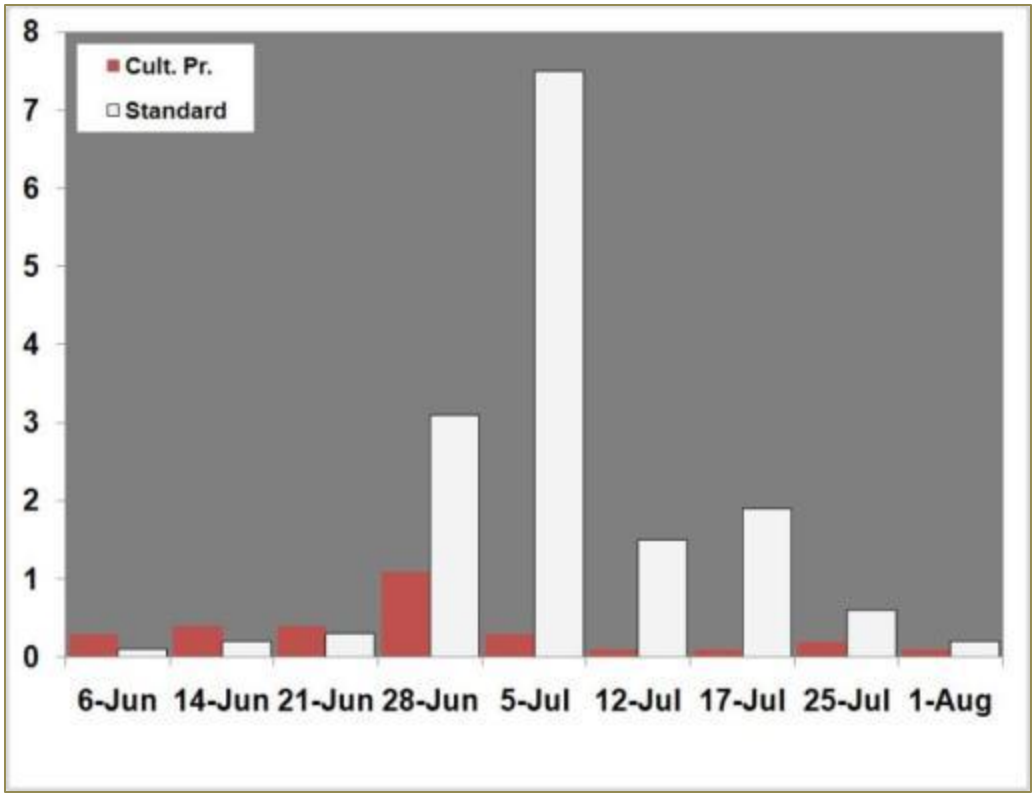
Random unbiased sample



Cultural Control

Cultural Controls:
Early planting date
Recommended N levels
Topped at 50% early button

Standard:
Plant at average date for location (1.5-2 weeks later)
25-30 lbs excess N
Topped at 10 days after 50% early button.
Y = number per plot
Similar effects on aphids



Aphids, Johnston County 1991

Cultural Control

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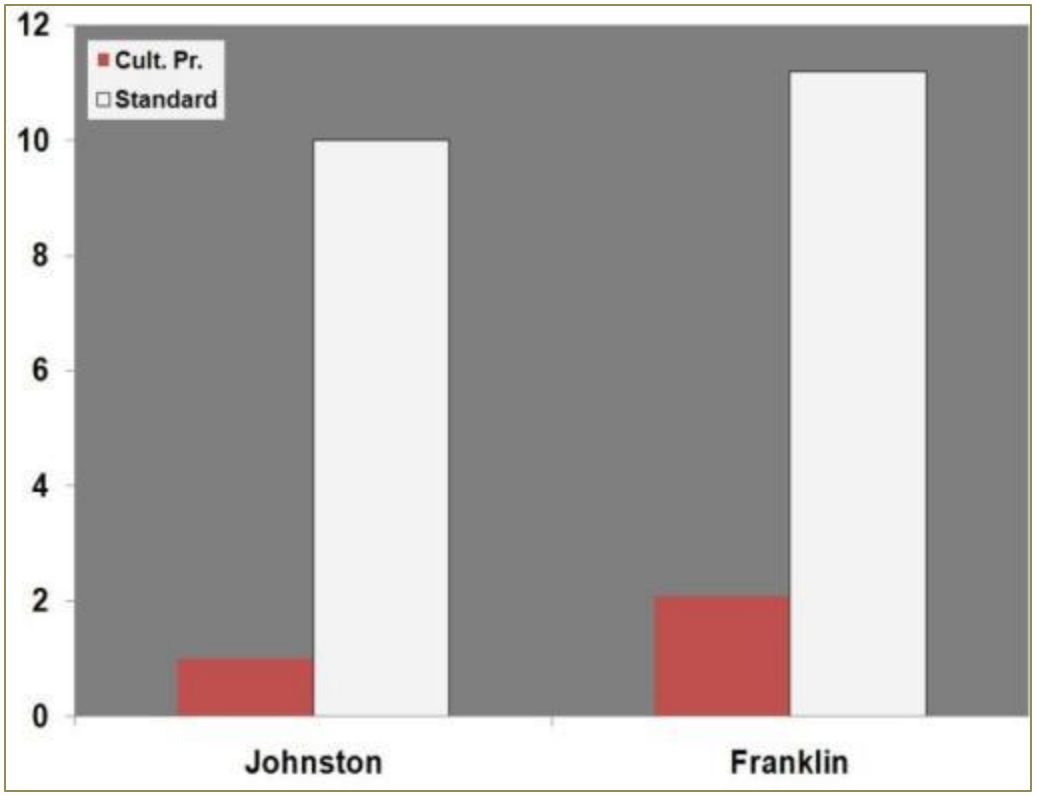

Hornworms, Johnston County 1991

Cultural Control

What are our cultural control options in tobacco?

- **DESTROY OVERWINTERING HOSTS NEAR PLANT BEDS/GREENHOUSES**
- **KEEP GREENHOUSES EMPTY**
- **DESTROY PLANT BEDS OR EMPTY GREENHOUSES PROMPTLY**
- **PREPARE FIELDS EARLY**
- **CONSIDER TRANSPLANT DATE**
- **USE MINIMUM NITROGEN**
- **KEEP BORDERS CLEAN - AVOID HAYING IF GRASSHOPPERS (OR THRIPS) PRESENT**
- **TOP EARLY**
- **CARRY OUT STALK & ROOT DESTRUCTION**

Cultural Control

What are our cultural control options?

- DESTROY OVERWINTERING HOSTS NEAR PLANT BEDS/GREENHOUSES (CUTWORMS, APHIDS)
- KEEP GREENHOUSES EMPTY (APHIDS, OTHER GREENHOUSE PESTS)
- DESTROY PLANT BEDS OR EMPTY GREENHOUSES PROMPTLY (APHIDS)
- PREPARE FIELDS EARLY (CUTWORMS)
- CONSIDER TRANSPLANT DATE
- USE MINIMUM NITROGEN (APHIDS, BUDWORMS)
- KEEP BORDERS CLEAN - AVOID HAYING IF GRASSHOPPERS (OR THRIPS) PRESENT (GRASSHOPPERS, TSWV)
- TOP EARLY (BUDWORMS, HORNWORMS, APHIDS)
- CARRY OUT STALK & ROOT DESTRUCTION (OVERWINTERING BUDWORMS)

Cultural Control

What are our cultural control options?

- **CONSIDER TRANSPLANT DATE**
  - **EARLY = FEWER HORNWORMS**
  - **EARLY OR LATE = FEWER APHIDS**
  - **LATE = FEWER BUDWORMS, LESS YIELD**

Biological Control

What are our biocontrol options?

- Caterpillar predators

Jalysus wickhami

Sinea diadema

Vespid spp.

Biological Control

What are our biocontrol options?

- Aphid predators

Chysopa/Chrysoperla

Syrphid spp.

Coccinelid spp.

Biological Control

What are our biocontrol options?

- Caterpillar parasitiods


Cardiochiles nigriceps


Cotesia congregata


Campoletis sonorensis


Winthemia manducae

Biological Control

What are our biocontrol options?

- Aphid parasitiods

Chemical Control

What are our chemical control options?

- Organic vs. Conventional

- Systemic vs. Contact

What should an implemented IPM program look like?

- Sampling scheme in place
- Treatments based on thresholds
- All practical cultural controls practiced
- Biological control agents used where appropriate
- (If needed) Pesticides selected to minimize non target effects
- Pesticides MOAs rotated

Want to learn more?

- **NCSU Entomology courses**
  - ENT 201: Insects & People
  - ENT 203: Beekeeping
  - ENT 402: Forest Entomology
  - ENT 425: General Entomology
  - ENT 550: Fundamental of IPM
- **Research opportunities**
  - Contact me if you are interested in research/assistantship opportunities

Hannah J. Burrack
Assistant Professor & Extension Specialist
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