Eastern NY Apple IPM Training
IPM Theory: What is IPM and Why Do It?

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IPM - The Dreaded Definitions

Classic Definition of IPM (for Agricuture)

"The application of an interconnected set of principles and methods to problems caused by insects, diseases, weeds and other agricultural pests. IPM includes pest prevention techniques, pest monitoring methods, biological controls, pest-resistant plant varieties, pest attractants and repellents, biopesticides, and synthetic organic pesticides. It also involves the use of weather data to predict the onset of pest attack, and cultural practices such as rotation, mulching, raised planting beds, narrow plant rows, and interseeding."

An Operational Definition of IPM

"Use of the most effective, economical, practical and nondisruptive tactic available to manage a pest population in a given situation. Requires controlling a pest when the need arises, and not controlling if it's not necessary."

NYS IPM Program

Mission Statement (2000s)

"…pest management methods that incorporate all available pest abatement tactics wisely and in a manner that minimizes potential environmental impacts of agriculture, conserves natural resources, and enhances food safety and the profitability and growth of NY agriculture."

Components of an Integrated Crop and Pest Management System

- **Monitoring (Scouting)** — Detecting, identifying, and determining level of pest populations on a timely basis
- **Forecasting** — Use of weather data and crop phenological stage to predict when specific pest events will occur
- **Thresholds** — To determine when pest populations have reached a level that could cause economic damage
- **Management Tactics** — Cultural, biological, physical, as well as chemical control, when needed
- **Recordkeeping** — Annual records of pest occurrence are valuable tools for avoiding pests in future

Monitoring Process

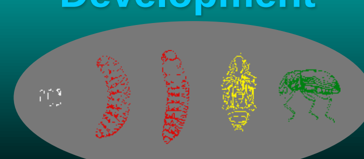
Physical Evidence
- Egg mass, pupal case, excrement

Plant/Fruit Damage
- Oviposition punctures, feeding damage, entrance holes, webbing

Traps
- Detection (presence)
- Establishment of biofix (e.g., 1st sustained flight)
- Determination of pest level
- Chart developmental progress (e.g., peak flight)

Threshold Prediction
- Developmental model (start/end of egg laying; progression of hatch; development of specific stages)
- Estimation (number of days until desired stage reached)

Methods of Measuring and Predicting Insect Pest Development

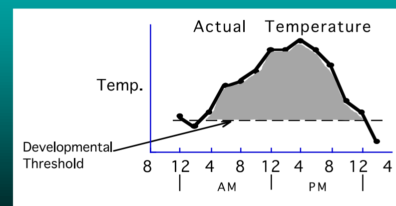


Developmental Rates and Thresholds

- Mammals are warm-blooded, develop at constant rate regardless of environmental temperature, because they can regulate their internal temperature (biochemical processes progress normally).
- Insects are poikilothermic, do not generate body heat, therefore remain at same temperature as their environment, and depend on a favorable external temperature.
- Developmental Base or Threshold: The temperature below which an insect's biochemical reactions cannot proceed and development therefore stops.
- Charting ambient temperature makes it possible to track insect development, which is directly proportional to the amount of time accumulated above the Developmental Base. We divide this time arbitrarily into heat units or Degree Days.

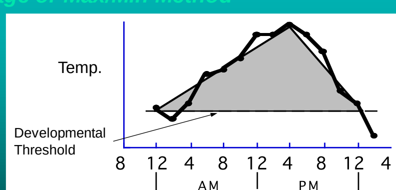
Degree Day Calculation Methods

- There are different ways to determine the quantity of heat units accumulated; this is equivalent to the area under a temperature-vs.-time graph on a given day.



Degree Day Calculation Methods

Average or Max/Min Method



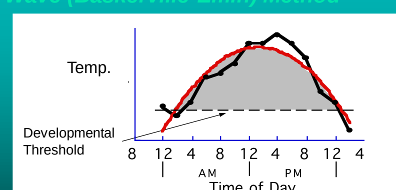
- Simplest and least precise; assumes that the daily temperature graph is linear and the area beneath it is triangular:

$$DD = \frac{(\text{Max temp} + \text{Min temp*})}{2} - \text{Devel. Threshold}$$

* or Developmental Threshold, whichever is higher

Degree Day Calculation Methods

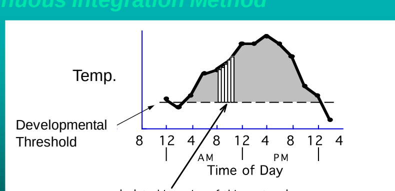
Sine Wave (Baskerville-Emin) Method



- More precise; assumes the daily temp cycle takes the form of a sine wave. Area beneath the curve determined by integration (calculus). This method tends to accumulate more DD's than the Max/Min Method, particularly during the early part of the season.

Degree Day Calculation Methods

Continuous Integration Method



- Most precise method; requires multiple temperature readings hourly or more frequently throughout the day, to obtain a graph that is truly representative of the field situation. Area beneath the curve again calculated using integration; data collection most efficient if handled by a computer.

Relating Degree Days to Life Cycle and Development

- Several methods attempt to correlate a pest event or activity with another event that can be measured more precisely. Events in an insect's life cycle often occur after the same number of heat units have accumulated each year, but many years' observations must be collected to measure them precisely. Degree days can be used to predict events where weather data are available.
  - *Temperature* - Monitor temp and pest activity simultaneously for many years; possible to build a database of events & their corresponding DD range.
  - *Phenology* - Some pest events occur at same time as easily observed biological field events; e.g., mite hatch from tight cluster to pink bud, sawflies lay eggs from bloom to petal fall.
  - *Biofix* - A distinct, easily monitored event in an insect's life history, used to fine-tune our predictions of its activity; e.g., 1st flight, 1st egg laid, 1st mine observed.

Sampling to Make Pest Management Decisions

Sampling to Assess "Population" Density

- "Population" - All the members of a group in which you have an interest.
  Examples:
  - All the mites in an orchard
  - All the adult mites in an orchard
  - All the live adult European red mites in an orchard
- "Sample" - A portion of the population that is examined in order to make an inference about the complete population.
  Example:
  - Population of interest: all the mites on leaves in an orchard
  - Sample: the mites on 50 leaves selected from all possible leaves
  - Inference made: estimated density of mites per leaf

Sampling Guidelines

- To ensure a fair, representative sample:

1 - Sample must be representative of the population.
  - Should not take all samples from a single tree or from along the border when trying to make inference about the entire block.

2 - Samples should be selected randomly.
  - Leaves or fruits should not be chosen based on some other factor (i.e., choosing leaves with visible injury instead of randomly selecting each leaf).

Sampling and Variability

- A sample is a random variable:
  An event or observation that is not identical each time it occurs.
  - examples: a roll of the dice; the flip of a coin.
  - random events; the labels used to describe these events (i.e., which side of the coin faces up) are called random variables.
- Described by assigning a likelihood or probability to each of their possible outcomes.
  - example: probability of obtaining a 'heads' with a coin toss is 1/2.
- The result from a sample of insects or mites is a random variable.
  - example: average # of mites on a leaf determined from a sample of 50 leaves is a random variable whose value will vary with each new sample.
  - However, if repeated a number of times, the values of representative samples will tend to congregate around a true mean value.

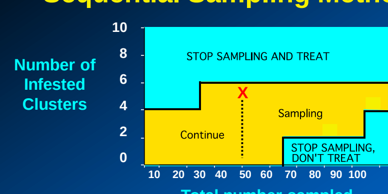
Sample Uses and Types

- Thresholds - The most common type of inference made from samples of insects is whether enough of them are present (i.e., in the true population) to justify a control action. This is called an action threshold, and is based on a comparison of the costs of control vs. the potential economic loss if no action is taken.
- Fixed vs. Sequential Samples - refers to the sample size

  Fixed Sample: more basic, assumes little about the appropriate number of samples needed to draw some conclusion.
  - Accepts the possibility that you may be taking too many.

  Sequential Sample: more advanced concept, requires greater familiarity with pest's distribution. Information from each sample used to determine whether further samples are needed.
  - More time-efficient because it allows a rapid decision to be made in extreme cases – very high or low populations.

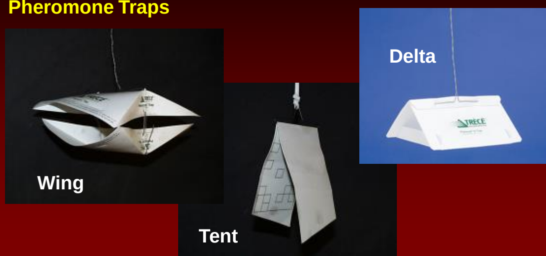
Sequential Sampling Method



- How close you are to the edge of the "Continue Sampling" region has nothing to do with how close the population is to the threshold — it merely shows how close you are to being able to make a population estimate (= treatment decision) based on the number of samples you have taken so far.

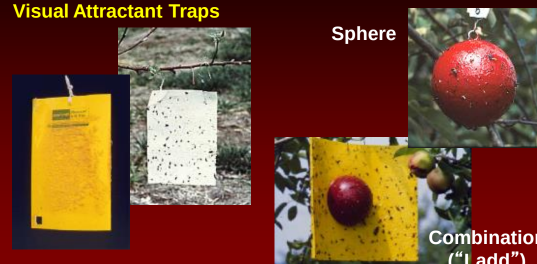
Types of Monitoring Devices

Pheromone Traps



Types of Monitoring Devices

Visual Attractant Traps



Yellow/White Panels

Types of Monitoring Devices

Odor Attractant Traps

plant volatiles

food extracts
(bait)

Physical Traps

sticky tape

Methods of Sampling

Methods of Sampling

Mite-Brushing Machine