What's Bugging Me?: Integrated Pest Management Part 1

Brief Description:

Pest management is required for all types of gardens. Integrated Pest Management (IPM) is using more than one practice to control and prevent pests. In this lesson students will learn about the different practices that can and are being used in agriculture today. Students will test the effectiveness of some of the practices by designing their own bioassay experiments.

Objectives:

Students will be able to:

1. Understand the types and benefits of integrated pest management strategies.
2. Learn the concept of bioassays and how to set up a protocol for a bioassay.
3. Design and set up a bioassay experiment.

Time:

Part A. Integrated Pest Management: two hours
- Introduction: 45 minutes
- Activity 1: 60 minutes
- Activity 2: 50 to 75 minutes

Part B. Least Toxic Chemicals: two and a half hours
- Introduction: 10 minutes
- Activity 1: 45 minutes
- Activity 2: 90 minutes

Materials:

- Dish soap
- Vegetable oil
- Soluble fertilizer
- Sugar water
- Salt water
- Different water sources (distilled, deionized, tap, spring or ocean)
- Seeds
- Plants

Part A. Integrated Pest Management

Vocabulary:

beneficial insects, cover crop, cultural practices, integrated pest management, intercropping, limiting factors, parasitoids, pathogens, pests, plant density, population growth curves, scouting, soil solarization and symbiotic relationship

Background:

Pests:

Garden pests are generally considered insects, but also include caterpillars, nematodes (parasitic round worms) and weeds.

Florida Standards for IPM Part 1-3:

SC.7.N.1.1, SC.7.N.1.4, SC.7.N.3.2, SC.7.L.17.1, SC.7.L.17.2, SC.7.L.17.3, MAFS.7.RP.1.2, SC.8.N.1.1, SC.8.N.1.2, SC.8.N.1.3, SC.8.N.1.4, SC.8N.3.1, SC.8.N.4.2, MAFS.8.F.1, MAFS.8.F.2, SC.912.L.14.10, SC.912.L.14.7, SC.912.14.9, SC.912.L.15.6, SC.912.L.17.1, SC912.L.16.12, SC.912.L.17.12, SC.912.L.17.15, SC.912.L.17.16, SC.912.L.17.17, SC.912.L.17.6, SC.912.L.17.9, SC.912.N.1.2, SC.912.N.1.3, SC.912.N.1.4, SC.912.N.1.5, SC.912.N.2.1, SC.912.N.2.4, SC.912.N.2.5, SC.912.N.3.5, SC.912.N.1.1, SC.912.N.1.6, SC.912.N.1.7, MAF.912.F-LE, MAFS.912.A-REI, MAFS.912.S-ID, MAFS.912.S-IC, MAFS.912.S-MD.2

Pests feed on plant roots, leaves and fruit. In all cases, infestation reduces yield. Pathogens include bacteria and fungi that that infect roots, tissue and fruit, also reducing yield. Many IPM strategies can discourage the growth of pathogens. For example, proper water management includes supply and drainage of water, preventing long-lasting soaked soil conditions. This tends to discourage fungal growth which can rot roots, and algal growth which can prevent gas exchange between the soil and atmosphere. (There is one important example of a beneficial symbiotic relationship between *Mycorrhizae* fungi and plant roots. *Mycorrhizae* helps extend the surface area for nutrient absorption in plant roots, while the plant provides food for the *Mycorrhizae*.)

Integrated Pest Management (IPM):
Integrated pest management involves using a variety of techniques to reduce pest populations in an environmentally sound and cost efficient manner. Such techniques include:

1. Use cultural practices to discourage pests. Plan to rotate crops and intercrop to break up high plant density. Between seasons, sterilize soil with the heat of the sun. Cover plant beds with plastic mulch to reduce weeds and water use (if using with drip irrigation). Use pest-free plants or transplants at planting time.
2. Monitor for pest outbreaks by scouting. Walk the garden frequently (Monday, Wednesday, Friday) and look at plants for signs and symptoms. Carry a spray bottle of diluted soap solution (two tablespoons/gallon) to spot-treat problems.
3. Do not kill beneficial insects and parasitoids. They are the natural ecosystem at work to keep pest numbers down.
4. Use proper water management to reduce fungal growth and to encourage strong, healthy plants.

Soil solarization:
During the months of June, July and August, you can cover garden soil with clear plastic. Not only are these the most effective months to solarize soil, but it is also during summer break of the school year— *perfect timing*! The heat of the sun will cause high temperatures in the soil, killing pathogens and insects. The plastic will need to be completely buried along the edges to prevent heat escape. Plastic must be clear, not opaque, and remain in place for at least six weeks. If small holes appear, seal with duct tape. If no weeds are present under the plastic, then soil solarization is successful. If green weeds appear, remove plastic and start again.

Natural predators:
In a food web, one organism eats another as a food source. This can be used to our advantage in the garden. Predators of garden pests are referred to as beneficial insects, and may occur naturally in the garden ecosystem. Predatory insects, usually mites, can also be purchased and placed in the garden to eat insect pests. A special group, called parasitoids (usually parasitic wasps), lay eggs in pests, and then the larvae eat the pest before hatching.

Intercropping:
Marigolds have the ability to reduce nematodes, which are small roundworms that can infect plant roots. Planting marigolds in between plant types can help prevent nematode populations from spreading in the soil. Another use would be to plant the entire garden with marigolds once the final harvesting is complete. Any area not used for cold season crops can be planted with marigolds as a cover crop to lower soil nematode populations.

Choosing the desired plants to be grown, as well as available space, may dictate how much intercropping can be accomplished (Ratnadass et. al., 2012).

Special example – IPM for whiteflies:
Whiteflies are a VERY common plant pest, and some interesting techniques have been developed to discourage their presence. First, whiteflies are attracted to yellow, and bright yellow sticky traps are commercially available. The idea is that the whitefly will be attracted to the yellow, and then become stuck to the sticky glue. Second, whiteflies are confused by metallic or reflective surfaces, which may be offered in plastic mulch. In this case, the shiny surface causes whiteflies to become disoriented in relation to the location of the sky.

Special example – IPM for other insect pests:
Depending how big your gardening project will be, you can construct a screened, polypropylene, polyester, or polyvinyl alcohol, cheesecloth enclosure using PVC as the structure support. This will provide a barrier to insects, such as the leaf miner, to enter the garden. Cutworm collars can protect young plants from cutworms. Tar paper shields can prevent cabbage root maggots from laying eggs. Slugs can be monitored with a pie tin filled with beer. Pheromone (sex hormone for a specific insect) and feeding attractant traps can assist in controlling specific insects.

Introduction:

1. Ask students, "Why do we need pesticides?" **Answer:** To control pests and allow plants to grow and provide a higher yield.
2. Ask students, "What would happen if a farmer didn't use pesticides?" **Answer:** Their entire crop could be wiped

out quickly by one insect or disease. It would be very costly to the farmer.

3. Teach the PowerPoint (found at www.faitc.org/teachers/STEMming-Up) in class to ensure students understand the concept of integrated pest management.
4. Ask students about their gardening experiences, or if they have seen IPM strategies in use (i.e., farm experiences, seeing raised beds with plastic mulch, screened gardens, etc.).

Activity 1: Intercrop Plan

1. Have students work in groups of three to four. Ask them to choose four vegetables, two herbs and two annual ornamental plants.
2. Research together as a class or lead a discussion on Section 4: Pest Deterrence or Repellence and Section 6: The "Push-Pull" Strategy from "Plant species diversity for sustainable management of crop pests and diseases in agroecosystems: a review" (Ratnadass, A et al. Agron. Sustain. Dev. (2012) 32: 273. doi:10.1007/s13593-011--0022-4). http://link.springer.com/article/10.1007/s13593-011-0022-4). This should prompt the students to think about what they could plant in and around their garden and when.
3. Using the *Intercropping Worksheet*, have students design a garden plan using intercropping and push and pull plants to help control insects. Students will present their designs and defend why they chose the plants for their garden.

Activity 2: IPM Calendar

1. Integrated Pest Management is a yearlong plan; it is management of your garden. Explain to students that in order for the garden to stay as pest-free as possible, it is best to stay ahead to prevent the pests. This can be done by making a monthly calendar for your garden. Things to think about: weather, temperature, what crops will be in the ground and school vacations.
2. Provide students with an *IPM Calendar Worksheet*. Allow students time to research and ask them to list IPM strategies by the appropriate month for your area of Florida (North, Central and South Florida may differ due to temperature). The UF/IFAS Extension Office in your county is a great place to start. See example below for a completed IPM calendar for Central Florida.

Evaluation:

1. Grade *Intercropping Worksheet* for completion and accuracy.
2. Grade *IPM Calendar Worksheet* for completion and accuracy.
3. Based on your initial presentation of information ask students to:
   a. Make a list of IPM strategies and write them on the board. The list should include: soil solarization, marigold planting, intercropping, identifying beneficial insects and natural preditors, plastic mulch, fertilizing and watering to keep plants healthy, drainage methods, etc.
   b. List what insects are expected? What insects are common?

Intercropping Worksheet

Research whether the plants are compatible with other plants, and if they serve as hosts to different insects. If so, this can break up high plant densities, which are attractive to pests.

ROW 1	ROW 2	ROW 3	ROW 4	ROW 5	ROW 6	ROW 7	ROW 8

IPM Calendar Worksheet

Using the list of strategies on the board, create a calendar for the garden that shows when to implement Integrated Pest Management techniques.

Month	IPM
May	
June	
July	
August	
September	
October	
November	
December	
January	
February	
March	
April	

Example of a Completed IPM Calendar for Central Florida

Month	IPM
May	Manage water and apply fertilizer to maintain strong, healthy plants. Finish harvesting. Remove plants. Cover soil with clear plastic for soil solarization.
June	Maintain soil solarization for at least six weeks.
July	Soil solarization. Possibly plant a legume, a nitrogen fixing cover crop.
August	School starts, remove solarization plastic, make beds. Cover beds with plastic mulch (if using drip irrigation). Start transplants. Plastic mulch can be painted silver or use white on black plastic.
September	Plant garden. Manage water and apply fertilizer to maintain strong, healthy plants. Look for cutworms. Monitor for pests. Start marigold transplants.
October	Monitor for pests. Manage water and apply fertilizer to maintain strong, healthy plants.
November	Manage water and apply fertilizer to maintain strong, healthy plants. Harvest complete by Thanksgiving. Remove plants. Plant with marigolds.
December	Winter break and marigold blooming. Manage water and apply fertilizer to maintain strong, healthy plants.
January	Start transplants.
February	Remove marigolds. Make beds. Use black or silver-painted plastic mulch. Plant by February 15.
March	Monitor for pests. Manage water and apply fertilizer to maintain strong, healthy plants.
April	Monitor for pests. Manage water and apply fertilizer to maintain strong, healthy plants.

Part B. Least Toxic Chemicals

Vocabulary:

bioassay, conclusion, control, data, hypothesis, introduction, least toxic chemicals, question or problem, replication, results, treatment, dependent variable, independent variable and controlled variable

Background:

A bioassay involves use of a biological organism to test for chemical toxicity. Perhaps the oldest and most commonly known example is the canary in the coal mine. Traditionally, coal miners have taken caged canaries down into the mines to help ensure a safe air supply. Canaries are more sensitive than humans to methane, an odorless gas released during the mining process, so they were used to provide an advanced warning of when methane was building up to dangerous levels in the mines. If the canary died, it meant the miners should leave the mine as quickly as possible.

A bioassay is the use of a living organism to test for the presence of a compound or to determine the amount of the compound that is present in a sample. The organism used is sensitive to the compound for which the test is conducted. Thus, the effect observed is typically the death or deteriorated health of the test organism. Depending on the test organism, soil, air, or liquid samples can be assayed.

Read more: Bioassay - Test, Bioassays, Organism, and Compound - JRank Articles http://science.jrank.org/pages/855/Bioassay.html#ixzz4Dp97JU00

Introduction:

1. Pesticides are chemicals that are not allowed to be used by students, and adults need a pesticide license to appropriately apply certain pesticides. Therefore it is important to know what can be used in a school garden.
2. Discuss with students some of the "least toxic chemicals" available to gardeners:
   - Mild dish soap solution (two tablespoons/ gallon water)
   - Vegetable oil solutions (two tablespoons/gallon water)
   - Diatomaceous earth for control of ants
   - Bacillus thuringiensis – a bacteria which prevents soft-bodied caterpillars and insect larvae from digesting food. B. thuringiensis only affects caterpillars and larvae, so it is considered a selective, narrow spectrum insecticide.
   - Sulfur or copper ingredients in fungicides can be the least toxic option as well
3. Explain that scouting identifies a pest or pathogen problem and that sometimes physical removal of a plant or leaf can stop the problem. If not, least toxic chemicals are the first choice.

Activity 1:

1. Explain Bioassay: A bioassay can use a plant, leaf tissue, seed, or a population of insects. Any of these may be subjected to a chemical solution or mixture at different concentrations or different volumes, and affects measured or deaths recorded.
2. Show images of bioassay experiments (images can be found PM power point www.faitc.org/STEMming-Up). Use the notes section in the PowerPoint as a guide to explain the slides.
3. Below are suggested articles for students to read. Each student chooses one article and summarizes the protocol for bioassay.
   - 'Bioassay Test for Toxicity': http://www.hometrainingtools.com/a/bioassay-test-toxicity-project
   - 'Insect Bioassay Workshop' PowerPoint by Murrary B. Isman: http://projects.nri.org/adappt/docs/M_Isman_bioassays.pdf
   - 'Environmental Inquiry: Authentic Scientific Research for High School Students': http://ei.cornell.edu/toxicology/bioassays/Duckweed/
4. Divide students into three groups, depending on class size with no more than four students per group. The goal is to use an existing scientific experiment to extract the procedure. Using the *Bioassay Article Review Worksheet*, assign each group to research a bioassay journal article on the internet, and ask each group to identify:
   a. The problem
   b. The hypothesis
   c. The test organism
   d. The dependent variable
   e. The independent variable
   f. Data collected
   g. The results
   h. Whether or not the hypothesis was supported
5. Have students design and conduct a bioassay experiment. The easiest bioassay would be using seed or small, whole plants grown in paper cups. Detached plant leaves may also be used, but will be more difficult to keep alive and healthy. To use insects, the teacher may contact a Master Gardener at the local UF/IFAS Extension Office for help with collecting. After choosing seed, plant, leaf or insect, the student needs to choose a test solution that can be mixed to different concentrations. Examples of solutions

include: dish soap, vegetable oil, soluble fertilizer (plant food), sugar water, salt water, or compare water sources (distilled, deionized, tap, spring or ocean). Bioassays should be completed before other factors could cause seed or plant death (i.e., lack of water).

6. Math instructors may continue this lesson using statistics and algebraic functions. Students can create data tables of averages, look for outliers and create graphs. Three common models used in horticulture are the quadratic, logarithmic (called quadratic plateau) and linear plateau functions.

Evaluation:

1. Using the *Bioassay Lab Report Worksheet*, have the students complete a Lab Report on their experiment.

Bioassay Article Review Worksheet

Article Title:

The problem:

The hypothesis:

The test organism:

The dependent variable:

The independent variable:

Data collected:

The results:

Whether or not the hypothesis was supported:

Bioassay Lab Report Worksheet

INTRODUCTION

Question or Problem – This describes what the general purpose for an experiment is.

Introduction – What is known about a problem? Search the internet using credible websites (.edu, .gov, .org). Why do you think your hypothesis will be correct?

HYPOTHESIS

The prediction you want to test. Usually, the hypothesis is written as an "If..., then..." statement.

MATERIALS AND METHODS

Variable (dependent) – The response measured from the seed, leaf tissue, whole plant, or insect.

Variable (independent) – The variable changed by the student (I change); for example, salt concentration.

Variable (controlled) – Variables which are kept consistent to make sure the response is from the treatment (temperature, time, water source, etc.).

Replication – Experiments are repeated to ensure that the results are consistent.

RESULTS

Data – Measurements made (quantitative) or observations (qualitative). It is best to create a scoring system for qualitative data, such as on a scale of 1-10, how dark is the green color, or how strong is a smell? Then the qualitative data can be graphed.

Results – the part of a Lab Report that shows data in tables and graphs, and the mean is calculated from each treatment.

CONCLUSION

After conducting the experiment and evaluating results, was the hypothesis correct? The conclusion should contain a sentence restating the hypothesis, one or two sentences about the experiment procedure, one or two sentences on the measured response, and a sentence stating whether or not the hypothesis was supported.

Integrated Pest Management

Sample Pre-Post Test Assessment

Directions: Answer each question to the best of your ability.

1. Define pest.

2. What is integrated pest management?

3. Why is it important to have a pest management plan?

4. What are two ways to manage pests?