Unit G: Pest Management

Lesson 1: Understanding Integrated Pest Management (IPM)

Student Learning Objectives: Instruction in this lesson should result in students achieving the following objectives:

1. Define integrated pest management (IPM) and identify the principles and concepts associated with it.
2. Identify the benefits of integrated pest management (IPM) to agriculture and the environment.
3. Identify and describe the types of pests.
4. Describe types of pest control strategies.

Recommended Teaching Time: 2 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

- A PowerPoint has also been developed for use with this lesson plan

List of Equipment, Tools, Supplies, and Facilities:

Writing surface
PowerPoint Projector
PowerPoint Slides
Transparency Masters
Copies of Lab Sheets for students

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slides 2 and 3):

- Abiotic
- Annual weed
- Bacteria
- Biennial weed
- Biological control
- Biotic
- Causal agent
- Chemical control
- Clean culture
- Cultural control
- Economic injury level
- Economic threshold
- Eradication
- Fungi
- Genetic control
- Hyphae
- Integrated pest management (IPM)
- Key pest
- Mechanical control
- Mycelium
- Nematodes
- Noxious weed
- Perennial weed
- Pest
- Pesticide resistance

- Pest population equilibrium
- Pest resurgence
- Plant disease
- Quarantine
- Regulatory control
- Summer annuals
- Targeted pest
- Trap crop
- Viruses
- Weeds
- Winter annuals

Interest Approach: Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Ask students to identify a pest and describe the best method of control. Lead a discussion on their ideas and how they relate to integrated pest management.

Summary of Content and Teaching Strategies

Objective 1: Define integrated pest management (IPM) and identify the principles and concepts associated with it.

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I. Plant pests cause huge losses. Methods are available to minimize or eliminate the losses that pests cause. Strategies are used that manage pest populations to keep losses below a level where profit is reduced.

A. Promoting plant growth involves insect, weed, and disease management using integrated approaches.

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1. ***Integrated pest management (IPM)*** is an organized program in which the best management methods available are used to keep pest populations below the economic injury level, and to avoid adverse effects to humans, wildlife, and the environment. IPM is a pest control strategy that relies on multiple control practices. It establishes the amount of damage that will be tolerated before control actions are taken.

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2. ***Economic injury level*** is the point at which the cost of pest control equals the revenue loss caused by a pest. Economic injury level is determined by estimating the potential yield loss, the value of the crop, and the cost of treatment. It also clearly defines how much damage can be tolerated.
3. ***Economic threshold*** is the number of insects per plant or the amount of damage to the plant that economically justifies the use of control measures. If a control is applied when a pest population reaches the economic threshold, the population will be suppressed before it reaches the economic injury level.

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B. The key to a successful IPM program is the use of a scout, either the grower or a hired individual, who regularly monitors pest populations and crop conditions.

1. The scout collects data about which pests are causing damage, what stage of life each pest is in, and whether the pest population is increasing or decreasing.
2. Knowing how to identify key pests and their biological characteristics is important. The weakest link in each pest's biology must be found if management of the pest is to be successful. A ***key pest*** is one that occurs on a regular basis for a given crop.

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C. An understanding of the biology of the crop and its ecosystem is essential for successful IPM. The ecosystem of the crop consists of the biotic and abiotic influences in living environment of the crop.

1. The ***biotic*** components of the ecosystem are the living organisms, such as plants and animals. The ***abiotic*** components of the ecosystem are nonliving factors, such as soil and water.
2. IPM attempts to understand the influence of ecosystem manipulation on lowering pest populations. ***Pest population equilibrium*** occurs when the number of pests stabilizes or remains steady.

****Use TM: G1-1 and G1-2 as visual material for lecture and discussion. PowerPoint Slides 9 and 10 can also be used. Talk about the different pesticides people might use in your area. Have the students brainstorm reasons why we would want to find other methods? Give specific examples where pesticides would be bad.**

Objective 2: Identify the benefits of integrated pest management (IPM) to agriculture and the environment.

(PowerPoint Slide 11)

II. There are many benefits of IPM to agriculture and the environment. These benefits help sustain the ability of the earth to meet the needs of an increasing human population.

A. The benefits to agriculture vary with the crop and the extent to which pests interfere with economical production. Careful planning is required to make effective use of IPM. The benefits of IPM to the agriculture industry are:

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1. Reduced pesticide costs—fewer pesticides are used with IPM. Not only is the cost of pesticide reduced, but also less equipment is needed.
2. Reduced application costs—time and cost of labor for pesticide application are reduced.

3. Less pesticide resistance—insects, weeds, and other pests will be less likely to develop pesticide resistance. This means that a pesticide is more effective when its use is required.

(PowerPoint Slide 13)

B. Benefits of IPM to agriculture are also environmental benefits. The environment is made more sustainable and friendly to people. Benefits of IPM to the environment are:

1. Reduced contamination—the environment suffers less degradation through the use of IPM. Pesticide residues do not build up in soil, water, and other natural resources.
2. Fewer residues on food—food products will have less pesticide residue with IPM. This reduces the chance of people contracting diseases associated with pesticides.
3. Improved human health—IPM supposedly results in food products that promote good health. Cancer-causing residues are present in smaller amounts or are not on food at all.

**** Ask the students if they have ever heard of IPM and if they practice this type of pest management. Encourage them to talk about their experiences. PowerPoint Slide 14 can be used for some possible beneficial insects. Find out if you have any of these in your area.**

Objective 3: Identify and describe the types of pests.

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III. Damage by pests to agricultural crops in the United States as been estimated to be one-third of the total crop production potential.

A. An understanding of the major pest groups and their biology is required to ensure success in reducing crop losses due to pests.

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Pest is a general term for any organism that may adversely affect human activities. Examples and classes of pesticides or chemicals used for killing them are:

Type of Pest	Class of Pesticide
mites, ticks	acaricide
birds	avicide
fungi	fungicide
weeds	herbicide
insects	insecticide
nematodes	nematacide
rodents	rodenticide

(PowerPoint Slide 17)

B. ***Weeds*** are plants that are undesirable and are often considered out of place. Weeds can be divided into three categories based on their life

spans and their periods of vegetative and reproductive growth. An ***annual weed*** is a plant that completes its life cycle within one growing season. Two types of annual weeds occur, depending upon the time of year in which they germinate.

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1. ***Winter annuals*** germinate in the fall and will actively grow until late spring when they produce seed, and die during periods of heat and drought stress.
2. ***Summer annuals*** germinate in the late spring and actively grow during the summer months. They produce seed by late summer and die during periods of low temperatures and frost.

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3. A ***biennial weed*** is a plant that will live for two growing seasons. Only vegetative growth occurs in the first year where the plant produces leaf, stems, and root tissue. During the second year the plant completes reproductive growth when it produces flowers and seeds.
4. A ***perennial weed*** can live for more than two growing seasons and may reproduce by seed and/or vegetative growth.

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5. A ***noxious weed*** is a plant that causes great harm to other organisms by weakening those around it. Most noxious weeds are very difficult to control and require extended periods of treatment followed by close monitoring.

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C. There are more species of insects than any other class of organisms. Part of their success is due to the large numbers of offspring they are capable of producing and the short time they require to reach physical maturity. Insects can cause economic loss by feeding on cultivated crops, stored products, and forests.

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1. Insects have either chewing or sucking mouthparts.
2. Damage symptoms caused by chewing insects are leaf defoliation, leaf mining, stem boring, and root feeding.
3. Insects with sucking mouthparts produce distorted plant growth, leaf stippling, and leaf burn.
4. As an insect grows from an egg to an adult, it passes through several growth stages, called metamorphosis. There are two types of metamorphosis, gradual or incomplete, and complete.

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5. Gradual or incomplete metamorphosis consists of three life stages: egg, nymph, and adult. As a nymph, the insect will grow and pass through several instars or the state of the insect between molts. Each time the insect sheds its exoskeleton, or molts, it passes into the next instar.

6. Complete metamorphosis consists of four life stages: egg, larva, pupa, and adult. The larva stage is the period when the insect grows. The pupa is a resting period where a dramatic morphological change from larva to adult occurs.

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E. A ***plant disease*** is any abnormal plant growth. The occurrence and severity of plant disease is based on three factors. A susceptible plant or host must be present. The disease organism, or causal agent (an organism that produces a disease), must be present. A ***causal agent*** is an organism that produces a disease. Environmental conditions conducive to the causal agent must occur.

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1. The relationship of these three factors is known as the disease triangle. Disease control programs are designed to affect each or all of these factors.
2. Diseases may be incited by either abiotic factors or biotic agents.
3. Abiotic diseases are nonliving and are caused by environmental or manmade stress.
4. Biotic diseases are caused by living organisms. Organisms are parasites if they derive their nutrients from other living organisms.

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F. Examples of causal agents or organisms are fungi, bacteria, viruses, nematodes, and parasitic seed plants.

1. Fungi are the principal causes of plant disease. ***Fungi*** are plants that lack chlorophyll. Their bodies consist of threadlike vegetative structure know as ***hyphae***. When hyphae are grouped together, it is called ***mycelium***. Fungi can reproduce and cause disease by producing spores or mycelia. The fungus can produce spores asexually or sexually.

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2. ***Bacteria*** are one-celled or unicellular microscopic plants. Bacteria can enter a plant only through wounds or natural openings.

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3. ***Viruses*** are composed of nucleic acids surrounded by protein sheaths. They are capable of altering a plant's metabolism by affecting protein synthesis. Plant viruses are transmitted by seeds, insects, nematodes, fungi, grafting, and mechanical means. Viral diseases produce several symptoms. A symptom is the visible change to the host caused by a disease. Ring spots, stunting, malformations, and mosaics are symptoms. A mosaic symptom is a leaf pattern of light and dark green color.

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4. ***Nematodes*** are roundworms that may live in the soil or water, within insects, or as parasites of plants or animals. Nematodes are quite small and produce damage to plants by feeding on root, stem, or leaf tissue.

****Use TM: G1-3, G1-4, G1-5 as visual material for lecture and discussion. PowerPoint Slides 30 and 31 can also be used. Use LS: G1-1 to strengthen the understanding of the concepts**.

Objective 4: Describe types of pest control strategies.

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IV. The reason for using IPM methods of pest control and crop protection is that reliance on chemicals as the only means of pest control can lead to pest resistance, pest resurgence, and possible harmful effects to humans and the environment.

A. IPM uses both chemical and non-chemical control methods to help reduce losses from pests. Choosing which method or methods to use will depend on an accurate assessment of the problem as well as information about the crop, the field, and the type of management. IPM methods include biological, chemical, cultural, mechanical, regulatory, and genetic control.

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1. ***Biological control*** is the use of living organisms to reduce pest populations. These beneficial organisms are natural enemies of pests. They attach, live in, or infect their pest hosts. Parasites, predators, and pathogens are all used as biological controls.

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2. Chemical control is an integral part of an IPM program. ***Chemical control*** is the use of pesticides to reduce pest populations. ***Pesticide resistance*** is the ability of an organism to tolerate a lethal level of a pesticide. ***Pest resurgence*** refers to a pest's ability to repopulate after control measures have been eliminated or reduced.

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3. ***Cultural control*** is used to make the crop environment unsuitable for pests to feed, live, or reproduce, and to improve the health of the crop. Examples of cultural controls include soil tillage, crop rotation, adjustment of harvest or planting dates, irrigation schemes, variety selection, clean culture, and trap crops. ***Clean culture*** refers to any practice that removes breeding or over-wintering sites of a pest. A ***trap crop*** is a susceptible crop planted to attract a pest to a localized area, where the trap crop is either destroyed or treated with a pesticide.

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4. ***Mechanical control*** is used to physically remove or exclude pests. It includes hand destruction as well as the use of screens to keep out insect and traps to catch them.
5. In some areas, federal governments have created laws that prevent the entry or spread of known pests into uninfested areas, this is referred to as ***regulatory control***.

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6. Regulatory agencies also attempt to contain or eradicate certain types of pest infestations. Plant or animal quarantines are implemented if shipments are infested with targeted pests. A ***quarantine*** is the isolation of pest-infested material. A ***targeted pest*** is a pest that, if introduced, poses a major economic threat. If a targeted pest becomes established, an eradication program will be started. ***Eradication*** means total removal or destruction of a pest. This type of pest control is extremely difficult and expensive to administer.

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7. ***Genetic control*** involves the use of genetically engineered organisms to fight pests. Plant breeders are constantly working to develop varieties and hybrids that are resistant to, or tolerant of, pests.

****Use TM: G1-6 or PowerPoint Slide 39 as visual material for lecture and discussion.**

Review/Summary: Use the student learning objectives as a guide to summarizing the lesson. Have students explain terms, processes outlined in the lesson, and the content associated with each objective. Student responses can be used in determining which objectives require greater review or whether further instruction is necessary. Questions at the end of each chapter in the recommended textbooks may also be used in the review/summary.

Application: Use TM: G1-1 thru TM: G1-6 to work with students on establishing an IPM system for the school farm.

Evaluation: Focus the evaluation of student achievement on mastery of the objectives stated in the lesson. Measure student performance on classroom participation, laboratory assignments, and written tests or quizzes.

Answers to Sample Test:

Part One: Matching

1 = i, 2 = m, 3 = a, 4 = k, 5 = b, 6 = h, 7 = j, 8 = c, 9 = d, 10 = e, 11 = g, 12 = l, 13 = f

Part Two: Completion

1. economic injury level
2. population equilibrium
3. Noxious weed
4. Economic threshold
5. Biological control

6. regulatory control
7. trap crop

Part Three: Short Answer

1. An organized program in which the best management methods available are used to keep pest populations below the economic injury level, and to avoid adverse effects to humans, wildlife, and the environment.

2. Estimating the potential yield loss, the value of the crop, and the cost of treatment.

Sample Test Name_____

Test

Unit G Lesson 1: Understanding Integrated Pest Management (IPM)

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. Annual weed	f. Cultural control	k. Summer annuals
b. Biennial weed	g. Mechanical control	l. Targeted pest
c. Causal agent	h. Perennial weed	m. Weeds
d. Chemical control	i. Pest	
e. Clean culture	j. Plant disease	

_____ 1. A general term for any organism that may adversely affect human activities.
_____ 2. Plants that are undesirable and are often considered out of place.
_____ 3. A plant that completes its life cycle within one growing season.
_____ 4. Germinate in the late spring and actively grow during the summer months.
_____ 5. A plant that will live for two growing seasons.
_____ 6. A plant that can live for more than two growing seasons and may reproduce by seed and/or vegetative growth.
_____ 7. Any abnormal plant growth.
_____ 8. An organism that produces a disease.
_____ 9. The use of pesticides to reduce pest populations.
_____ 10. Refers to any practice that removes breeding or over-wintering sites of a pest.
_____ 11. Used to exclude pests.
_____ 12. A pest that, if introduced, poses a major economic threat.
_____ 13. Used to make the crop environment unsuitable for pest to feed, live, or reproduce, and to improve the health of the crop.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. The point at which the cost of pest control equals the revenue loss caused by a pest is known as _____ _____ _____.

2. Pest _____ _____ occurs when the number of pests stabilizes or remains steady.
3. _____ _____ is a plant that causes great harm to other organisms by weakening those around it.
4. _____ _____ is the number of insects per plant or the amount of damage to the plant that economically justifies the use of control measures.
5. _____ _____ is the use of living organisms to reduce pest populations.
6. Federal or state governments have created laws that prevent the entry or spread of known pests into uninfested areas, this is referred to as _____ _____.
7. A _____ _____ is a susceptible crop planted to attract a pest to a localized area, where the crop is either destroyed or treated with a pesticide.

Part Three: Short Answer

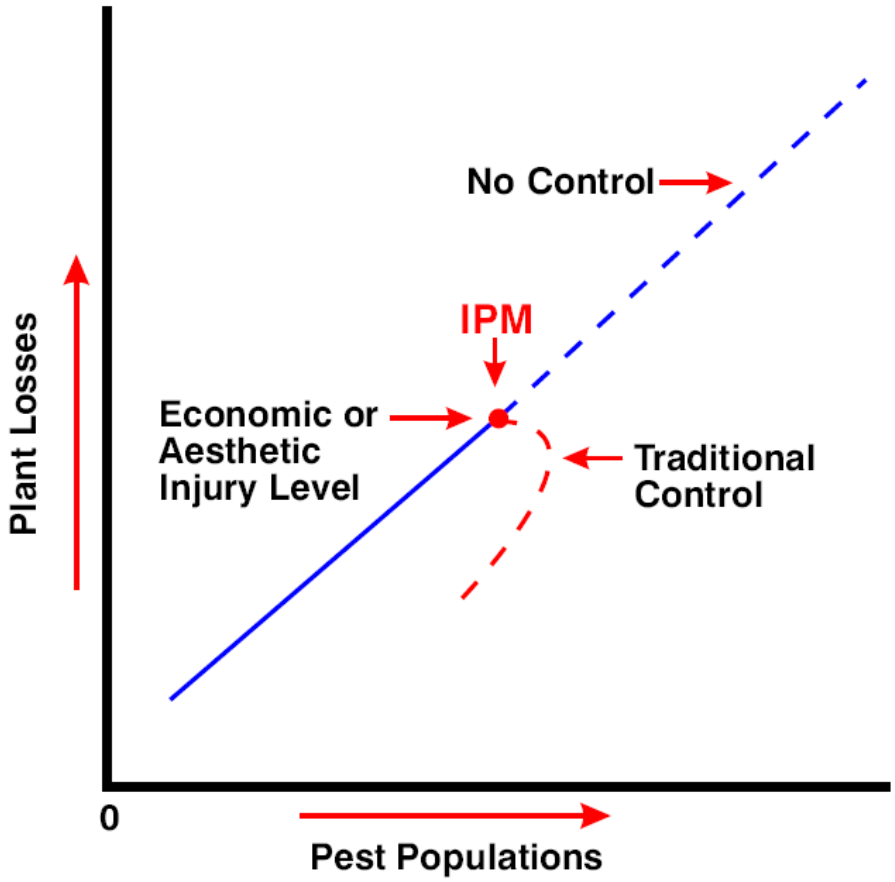
Instructions. Provide information to answer the following questions.

1. What is integrated pest management (IPM)?

2. How is economic injury level determined?

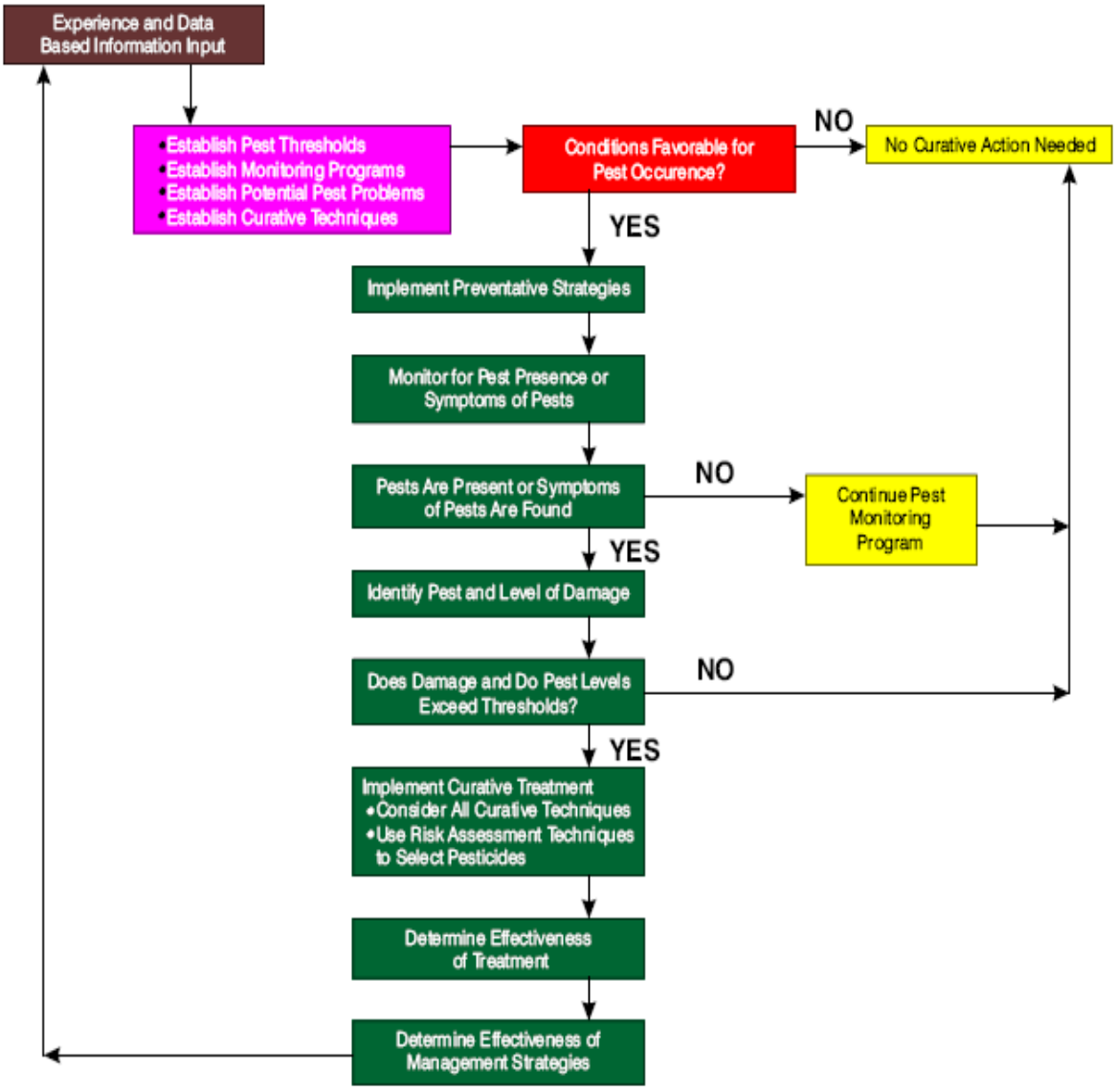
TM: G1-1

OPTIMAL IPM



TM: G1-2

INTEGRATED PEST MANAGEMENT



TM: G1-3

PESTICIDES AND PESTS CONTROLLED

PESTICIDE	PEST CONTROLLED
Insecticide	Insects
Miticide	Mites
Acaricide	Ticks and Spiders
Molluscicide	Snails and Slugs
Fungicide	Fungi
Avicide	Birds
Rodenticide	Rodents
Nematicide	Nematodes
Bactericide	Bacteria
Herbicide	Weeds
Piscicide	Fishes
Predacide	Predatory Animals

TM: G1-4

EXAMPLES OF BENEFICIAL INSECTS

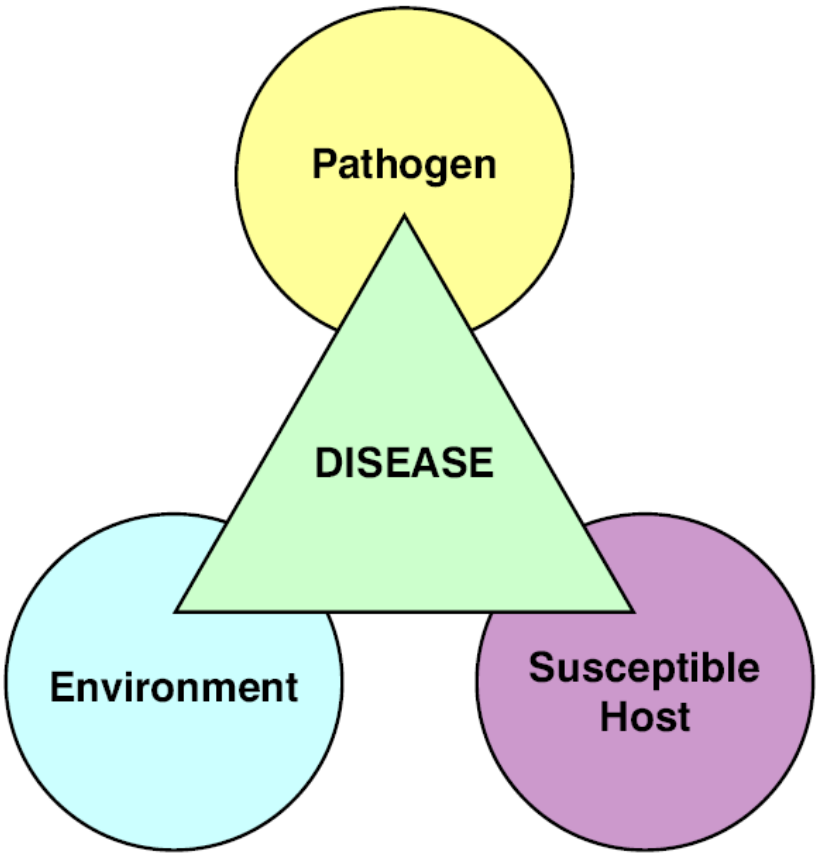
Common Name	Benefit
bees, butterflies, moths, and flies	pollinate plants
honeybees	produce honey and beeswax
ants	aerate soil
ladybug beetles, mantids, and lacewings	prey on harmful insects
silkworm moth	cocoons provide silk fiber
honey ants, flying ants, and grasshoppers	human food
scarab beetles	help decompose carrion (dead flesh), dung, and vegetation

EXAMPLES OF INSECTS HARMFUL TO PLANTS

Common Name	Damage Caused
grasshoppers, aphids, some beetles, and caterpillars	feed on plant foliage
ear worms and bud worms	feed on fruit and buds of plants
some weevils	feed on grain and other fruit, such as cotton bolls
ants, including fire ants	undermine plant root systems, damage turf and ornamental plants

TM: G1-5

COMPONENTS OF THE DISEASE TRIANGLE



TM: G1-6

SUMMARY OF THE METHODS USED IN IPM

Methods	Practices
Cultural	Use resistant varieties; rotate crops; chop stalks and dispose of refuse after harvest; tillage approaches; times for planting and harvesting; pruning and thinning with some crops; fertilizing based on crop needs; sanitation; water and runoff control; using trap crops
Mechanical	Trapping and collecting; mowing, chopping, crushing, and grinding plant residues, pests, and other forms; hand pulling and picking
Physical	Using high and low temperatures; irradiation, particularly with seed and food grains; light traps
Biological	Using natural predators, such as beneficial insects; using parasites, such as bacteria; using genetically engineered crops; releasing sterile or incompatible pests
Chemical	Poisons; growth regulators; attractants and repellants; sterilants
Regulations	Quarantines; government-sponsored eradication and supression programs

LS: G1-1 Name_____

Lab Sheet

Economic Injury Level (EIL)

Economic Injury Level (EIL) is the pest infestation point at which the cost of control equals the loss of estimated crop yield. It is necessary to calculate these two values and compare them to know whether the economic injury level has been reached. Given the following information, determine if this field has reached EIL.

Problem #1
Cost of control = $18.00
Application = $4.50
Crop market value = $2.25
Estimated yield loss =500 kg/hectare
Estimated control in percent = 75 percent
Cost of control = $ _____/hectare for material + $ _____/hectare for application = $ _____/hectare
Loss of estimated crop yield = $ _____ crop market value × _____ estimated yield loss × _____ estimated control in percent.
Is this field at EIL? Explain.

Problem #2
Cost of control = $14.00
Application = $14.00
Crop market value = $2.25
Estimated yield loss = 500 kg/hectare
Estimated control in percent = 75 percent
Is this field at EIL? Explain.