Discipline: Agriculture	Sub-discipline: Sustainable Agriculture
General Course Title: **Basic Integrated Pest Management (IPM) Concepts**	Min. Units: **3 Semester**
	Proposed Suffix:

Course Description:
Applied principles of integrated pest management (IPM) in agricultural, landscape, and other environments in which they work. Cultural, biological, mechanical/physical, preventive, and chemical control methods, with an emphasis on practical application.

Required Prerequisites or Co-Requisites[1]

Advisories/Recommended Preparation[2]

Course Objectives: *At the conclusion of this course, the student should be able to:*

- Define Integrated Pest Management (IPM) and explain its benefits.
- Outline the key components of an IPM program.
- Identify the major types of agricultural and landscape pests and differentiate pest damage from other symptoms.
- Monitor pests in agricultural and landscape settings to obtain data with which to make pest management decisions.
- Develop and implement a sampling program.
- Describe the basic methods of biological, cultural, mechanical/physical, and chemical pest control.
- Evaluate injury and treatment thresholds and describe conditions necessitatingcontrol action.
- Adapt IPM techniques and strategies to fit specific pest management situations.
- Identify and utilize IPM online and print resources.

Course Content:

1. Introduction
    A. What is Integrated Pest Management (IPM)?
        1. IPM is an ecosystem-based strategy that focuses on long-term prevention of pests and their damage
        2. Reliance on a combination of techniques, including biological and cultural controls habitat manipulation, and use of resistant varieties
        3. Pesticide use only after monitoring indicates need according to established guidelines
        4. Pest control materials selected and applied in a manner that minimizes risks to human health, beneficials, non-target organisms and the environment

2. Benefits of using IPM
    A. Reliance on multiple strategies
    B. Selective use of pesticide to avoid environmental and health risks
    C. Reduces selection for pesticide resistance
    D. Reduces development of pest resurgence, secondary pest outbreaks
    E. Reliable long-term pest control

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3. Components of an IPM program
    A. Pest identification

[1] Prerequisite or co-requisite course need to be validated at the CCC level in accordance with Title 5 regulations; co-requisites for CCCs are the linked courses that must be taken at the same time as the primary or target course.

[2] Advisories or recommended preparation will not require validation but are recommendations to be considered by the student prior to enrolling.

B. Field monitoring and population assessment
C. Control action guidelines
D. Prevention of pest problems
E. Integrating biological, chemical, cultural, and physical/mechanical management tools

4. Diagnosing the problem
   A. Causes
      1. Caused by a pest
      2. Caused by weather (frost, hail, wind)
      3. Caused by nutrition deficiency
      4. Caused by machinery, inadequate irrigation
   B. Importance of identification
      1. Many symptoms look similar
      2. Presence of a pest doesn't mean it caused the damage
      3. Not all damage needs to be treated (thresholds)
      4. Pests may no longer be present
      5. Pest may be difficult to find (especially soil-borne pathogens/ nematodes)
      6. Symptoms may be caused by improper cultural practices.
      7. Importance of pest identification
      8. Proper identification is essential for choosing the right control actions
   C. Requires identifying:
      1. Pest organisms
      2. Beneficial organisms
      3. Population levels
      4. Requires correlating pests to damage
   D. Pest identification
      1. Insects and mites
      2. Snails and Slugs (mollusks)
      3. Pathogens and Nematodes
      4. Weeds
      5. Vertebrates

5. Monitoring
   A. Field monitoring and population assessment
      1. Start monitoring when populations are likely to occur but before they begin to build
      2. Assess both pest and beneficial densities or disease risks
      3. Continue monitoring through the pest's damaging stages
      4. Sample more frequently when conditions are ideal for rapid development of populations
      5. Monitor after treatment to assess control
      6. Keep written records

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   B. Why monitor?
      1. Improve ability to make good pest management decisions
      2. Early warning of potential pest problems
      3. Site-specific information
      4. Determine specific cause and severity of problem
      5. Proper timing for control measures
      6. Use slower-acting methods that are more environmentally friendly
      7. Determine pattern of infestations over time

8. Justify pest management decisions to client
9. Post-treatment monitoring for effectiveness of treatment

C. Designing a monitoring plan: Steps
1. Identify the pests
2. Establish monitoring guidelines for each pest species:
   a. Select a sample unit (leaf, fruit, length)
   b. Define the sampling universe (block, plant)
   c. Determine the number and size of sample
   d. Determine how often to sample
   e. Establish a predetermined pattern of inspection of plant and field
3. Establish injury levels and action thresholds for each pest species
4. Determine what host or crop developmental stages must be monitored to assess normal growth, predict timing of pest activity, or evaluate damage
5. Determine the environmental factors that must be monitored
6. Determine the production practices that can impact the development of the pest species

D. Factors affecting sampling reliability
1. Sample size
2. Effect of time of day, temperature
3. Stage of the plant
4. Pest life cycle/activity

E. Sampling techniques
1. Visual inspection
2. Beating trays
3. Traps
4. Sticky, pheromone, double-sided sticky tape, pitfall
5. Honeydew monitoring
6. Weed transect or quadrant
7. Soil/root monitoring
8. Weather monitoring

F. Sampling efficiency
1. Triggers
2. Pheromone traps indicate adult flying/mating
3. Monitor environmental conditions that trigger disease development
4. Presence-absence sampling
5. Efficient for thrips, aphids, whitefly and spider mites
6. Visual injury scale
7. Indicator plants
8. Cost effectiveness (trade-off between required sampling size and time available)

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G. Keep good records and learn from your experience
1. Start simple
2. Keep good written records of:
   a. Scouting results
   b. Management actions
   c. Description of your sampling and inspection methods
   d. Weather data

6. Control action guidelines
A. Injury and treatment thresholds

1. Injury level
   a. How much damage will the users tolerate?
2. Economics
   a. How much will it cost to treat?
   b. Would the losses be greater than the cost of treating?

B. Control action is taken if a pest problem is expected to occur to prevent crop loss or damage (*e.g.* weather conditions indicate a disease outbreak if no action is taken)

7. Prevention: The first line of defense
   A. Tactics:
      1. Use pest-free seedlings
      2. Correct fertilization, irrigation, mowing
      3. Prevent weeds from reproducing
      4. Sanitation of equipment
      5. Disinfest soil
   B. Look at the long term:
      1. Preserve biological diversity
      2. Conserve natural enemies
      3. Use resistant varieties
      4. Sanitation
      5. Site selection

   C. Preventing pest problems
      1. Plant selection:
         a. Select variety or crop for location
         b. Chose resistant varieties
         c. Prepare the site correctly
      2. Site selection
         a. Getting the crop off to a good start
         b. Proximity to sources of pests
         c. Prevailing wind direction
         d. Harvest period relative to other sources of pests
         e. Previous crop; field history
         f. Soil type, slope, water table

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8. Integrating practices
   A. Biological Control
   B. Cultural Control
   C. Mechanical and Physical Control
   D. Habitat manipulation
   E. Use of resistant varieties
   F. Chemical Control

9. Biological control
   A. Broadly defined as any activity of one species that reduces the adverse effects of another
   B. All types of pests have natural enemies:
      1. Plant pathogens and nematodes
      2. Weeds
      3. Insects and mites
   C. Biological control of plant pathogens and nematodes

1. Biopesticides
2. Competition & exclusion, *e.g. Pseudomonas fluorescens* A506 bacteria for fireblight prevention
3. Antibiosis, *e.g. Agrobacterium radiobacter* strain K84 crown gall prevention
4. Disease-suppressive compost & soil amendments
5. Suppressive soils associated with beneficial microorganisms

D. Biological control of weeds
1. Competition & allelopathy
2. Pathogenicity, *e.g.* rust fungus on rush skeletonweed
3. Herbivory
   a. Invertebrates
   b. Verterbrates, *e.g.* yellow starthistle

E. Biological control of arthropods
1. Controlling insects and mites with:
   a. Pathogens
   b. Predators
   c. Parasites

2 . Types of natural enemies
   a. Predators
      i. Feed on more than one individual host during their lifetime
      ii. Many feed on a variety of insects and mites, pollen, nectar, and honeydew
   b. Parasites
      i. Insect parasitoids smaller than host, develop inside, or attached to outside of host's body. Kills only one host individual during its development
      ii. Pathogens
      iii. microorganisms such as fungi, viruses, bacteria, certain nematodes

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F. Tactics for using natural enemies
   1. Classical Biological Control
      a. Introduction of exotic natural enemies
      b. Conservation
      c. Preservation of resident natural enemies
      d. Augmentation
      e. Purchase and release of commercially available beneficial species.

G. Populations of natural enemies lag behind prey

H. Types of predators
   1. Birds and other vertebrates
   2. Spiders and mites
   3. Green and brown lacewings
   4. True bugs: minute pirate, assassin
   5. Beetles: lady, ground, rove, soldier
   6. Predaceous flies: syrphid (hover flies)

I. Parasites
   1. Female lays egg in or on host. The immature kills the one host during its development
   2. Many parasites are species-specific
   3. Attack all stages: eggs, nymphs, larvae, pupae
   4. Mummification of the host or a round exit hole are signs of

parasitism

J. Parasitic nematodes
1. Life cycle of *Steinernema* nematodes
2. 1-2: invasion and colonization of insect
3. 3-4: development within insect
4. 5: exit from dead insect and invasion of new host

O. Examples of pathogens as bio-control agents
1. BT (*Bacillus thuringiensis*)
a. Kurstaki strain (Dipel) for control of caterpillars
b. Israelensis strains for control of mosquito and fly larvae
c. Granulosis virus, *e.g.* control of codling moth.

10. Management methods
A. Cultural pest control
1. Sanitation
2. Destruction of alternate hosts
3. Habitat modification
4. Smother & cover crops
5. Host resistance
6. Crop rotation
7. Intercropping
8. Planting & harvest dates
9. Flooding
10. Irrigation and water management
11. Fertilizers & soil amendments
12. Mechanical & physical control
13. Soil tillage

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14. Mowing
15. Mulches, barriers
16. Temperature manipulation, solarization

B. Avoidance
1. Pest populations exist but the impact is avoided through cultural practice
2. Fertilization program to promote rapid plant development
3. Not planting in certain areas where pest populations are likely to cause problems
4. Host-free periods.
5. Crop rotation (*e.g.* rotate sugarbeets on a 3 to 10 year cycle to reduce sugarbeet cyst nematode)
6. Planting or harvesting date modification (*e.g.* pink bollworm management).
7. Tactics for prevention and avoidance strategies may overlap

11. Habitat modification
A. Companion cropping, strip cropping, intercropping.
B. Cover cropping.
C. Draining standing water for mosquito control.
D. Eliminating pest host or habitat.

12. Mechanical and physical control
A. Cultivation

B. Barriers
    1. Reflective mulch to repel aphids and whiteflies
    2. Plastic mulch to manage weeds, nematodes, soil-dwelling pathogens
    3. Physical barriers, screens
C. Sanitation
    1. Removal of overwintering mummy nuts for navel orangeworm in almonds
    2. Crop plow-down
    3. Preventing dust for mite management, air quality
    4. Pruning

13. Chemical control
    A. Pesticides
        1. Any substance (natural or synthetic) for preventing, destroying, repelling or mitigating a pest (animal, plant, pathogen)
    B. Before you use a chemical Consider unintended impacts
        1. Water quality
        2. Drift, runoff
        3. Bees, beneficial insects
        4. Plants (phytotoxicity)
        5. Human exposure

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14. Integrated pest management
    A. Summary
        1. Diagnose the problem
        2. Keep plants healthy
        3. Monitor pests
        4. Tolerate some injury
        5. Integrate practices
        6. Use appropriate pesticides
    B. IPM is dynamic: Keep evaluating the program
    C. IPM resources
        1. University resources:
            a. www.ipm.ucdavis.edu
            b. UC Cooperative Extension
        2. Government resources
            a. US EPA
            b. USDA
            c. DPR www.cdpr.ca.gov
            d. CDFA www.cdfa.ca.gov

15. Resources for taking the Pest Control Adviser license exam
    A. Exam Helper: http://www.ipm.ucdavis.edu/PCA/index.html
    B. License issued by: Department of Pesticide Regulation

Laboratory Activities: Individual Laboratory Activities are designed to support course objectives.

Methods of Evaluation: Lecture	Methods of Evaluation: Laboratory
Comprehensive Quizzes and Exams Written Critical Thinking Scenarios	Laboratory Skill Validation by Observation Laboratory Projects and Reports

Problem Analysis and Solution Research and Term Papers	Laboratory Research Projects and Reports Laboratory Skill Practicum Exams
Typical Textbooks, Manuals, or Other Support Materials IPM in Practice: Principles and Methods of Integrated Pest Management. Flint, Mary Louise and Gouveia, Patricia. University of California Statewide Integrated Pest Management Project, Agriculture and Natural Resources Publication 3418. Regents of the University of California, 2001. PowerPoint Presentation: Basic Integrated Pest Management Concepts. Varela, Lucia and Wilen, Cheryl. University of California Statewide IPM Program: Santa Rosa, CA, 2005.	
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