KNOWLEDGE EXPECTATIONS FOR PEST CONTROL ADVISORS: INTEGRATED PEST MANAGEMENT

I. ECOLOGICAL PRINCIPLES AS THEY RELATE TO PEST MANAGEMENT

A. Levels Of Ecological Organization

Define:

- natural selection;
- ecological niche;
- habitat;
- population density;
- ecotype;
- species diversity.

Distinguish between a population and a community of organisms.

List factors that impact population regulation.

Describe how age distribution impacts growth rate of a population.

Contrast density dependent and density independent limiting factors.

List three types of population dispersal patterns.

Describe how a community and the abiotic (nonliving) environment function together as an ecological system or ecosystem.

B. The Ecosystem Concept

Describe how energy flows through an ecosystem.

Describe the role of photosynthesis in an ecosystem.

Describe a biogeochemical cycle in an ecosystem.

List examples of abiotic components.

Describe a food chain.

List common trophic levels in an ecosystem.

Describe a food web in an ecosystem.

C. Managed Ecosystems

Define:

- agroecosystem;

managed ecosystem.

Define limiting factors and describe their importance to pest management.

D. The Ecology of Pest Problems

Define equilibrium population density.

Distinguish between r and K strategists.

E. Biodiversity

Describe the importance of biodiversity to agroecosystems.

II. THE INTEGRATED PEST MANAGEMENT CONCEPT

A. The Purpose Of Pest Management

Compare/contrast preventative, suppressive, and eradicative approaches to pest management.

List the factors to be considered in pest management decision making.

Define:

pest;
key pest;
occasional pest;
secondary pest.

Recognize that pest species can exist at tolerable levels.

B. What Is Integrated Pest Management?

Define:

integrated pest management;
treatment threshold;
host resistance;
biological control;
cultural control;
mechanical control;
pesticide resistance;
pest resurgence;
secondary pest outbreaks.

Describe the relationship of treatment threshold to economic injury level.

Recognize the relationship between pest population levels and damage.

Recognize the relationship of personal preferences on aesthetic injury levels on pest management decisions.

List the types of management options available in integrated pest management.

Recognize the importance of natural enemies to IPM.

List factors of the physical environment that impact pest populations.

Describe the role of water management on crop biology/pests.

Recognize the importance of soil on crop biology/pests.

Describe how soil type can impact success of chemical and cultural pest control.

Describe the importance of crop biology and pest biology to IPM.

Recognize how weed species composition can change due to repeated herbicide use.

Describe how IPM programs support more reliable control options.

III. UNDERSTANDING THE PESTS

Identify the characteristics of a successful pest.

Describe the importance of knowing a pest's life cycle in an IPM system.

A. Pest Identification

Recognize the levels in classification systems.

Describe the benefits of knowing both common and scientific names.

Describe the importance of proper pest identification when selecting control strategies.

Identify the drawbacks of relying only on symptom identification for pest identification.

Describe the importance of lab analysis in plant pathogen identification.

B. Types of Pests

Distinguish the following invertebrate classes:

insects (Insecta);
spiders and mites (Arachnida);

centipedes (Chilopoda);
millipedes (Diplopoda).

Define:

invertebrate;
arthropod;
molt;
instar;
metamorphosis;
exoskeleton;
nymph;
larva;
pupa;
nematode;
vertebrates;
weed;
plant disease;
vector;
fungi
bacteria;
virus.

List the major invertebrate groups that are pests.

Recognize the following body parts on an insect:

head;
thorax,
abdomen;
antenna;
pronotum;
forewing;
hindwing;
compound eye.

Identify the types of mouthparts found on insects.

Recognize the following body parts of mites:

gnathosoma;
idiosoma;
palp;
chelicera.

Recognize the following body parts of spiders:

cephalothorax;
abdomen;
leg;

spinnerets;
pedipalp;
chelicera;
eyes.

Compare/contrast gradual and complete metamorphosis.

Describe the life cycle of a:
moth;
aphid;
stink bug;
spider mite.

Identify the importance of recognizing the eggs of insects and mites.

Identify types of damage insects cause to plants.

Identify the phylum of snails and slugs.

Describe how nematodes injure plants.

Describe the life cycle of a typical plant parasitic nematode.

Describe some above ground and root symptoms that can be associated with nematode damage.

Distinguish ectoparasitic nematodes from endoparasitic nematodes.

List types of vertebrates that can be pests.

Describe how the following signs can be used to help identify vertebrate pests:
tracks;
toothmarks;
droppings;
dens;
burrows;
trails.

Distinguish monocots from dicots.

List major plant parts used to identify mature broadleaf weeds.

Recognize the key features used to identify:
grass seedlings
broadleaf seedlings.

Describe the life cycle of:
- annual weeds;
- perennial weeds;
- biennial weeds.

Differentiate between summer and winter annual weeds.

Describe the different vegetative reproductive structures of perennial weeds:
- rhizomes;
- bulbs,
- stolons,
- tubers.

Describe how differing weed germination requirements affect management decisions.

List the characteristics that make weeds successful competitors.

List the mechanisms by which weed seeds are disseminated.

Differentiate between parasitic and nonparasitic (abiotic) diseases.

Describe the relationship between the three components of the plant disease triangle.

Distinguish between the terms:
- "pathogen" and "disease";
- "signs" and "symptoms" of disease.

Describe the importance of identifying the causal agent of disease symptoms.

Describe the following stages in the development of a disease:
- inoculation;
- penetration;
- establishment of infection;
- growth;
- reproduction;
- dissemination;
- survival.

Identify the importance of the overwintering stage of a pathogen on pest control strategies.

Describe the impact of insects as vectors of disease.

Describe the overwintering/oversummering mechanisms for:

fungi;
bacteria;
virus.

List the mechanisms of dispersion for:
fungi;
bacteria;
virus.

IV. MANAGEMENT METHODS FOR IPM PROGRAMS

A. Host Resistance or Tolerance

Explain how physical factors such as variations in temperature, nutrition, and water stress can affect the degree of host plant resistance.

Define:
tolerance;
true resistance;
apparent resistance;
hybrid;
transgenic;
rootstock;
scion.

Compare and contrast horizontal and vertical resistance.

Explain how an IPM program can help prolong the useful life of a resistant cultivar.

Describe the classical breeding techniques used to develop resistant plants.

Explain how tissue culture and genetic engineering techniques are used in the development of resistant cultivars.

List situations where use of non-host plants may be a feasible management solution.

B. Biological Control

Describe the major biological control approaches used in pest management:
importation;
conservation and enhancement;
augmentation.

Define and give an example of:
predator;
parasite;

parasitoid;
antibiosis;
antagonist;
allelopathy;
competitor.

Describe some approaches to encourage naturally occurring biological control agents.

Compare/contrast the role of inundative releases versus inoculative releases in a biological control program.

Describe how the following practices can be used to conserve or enhance the activities of insect natural enemies:
selection of pesticide;
selective timing or placement of pesticide;
plant diversity;
ant control;
harvest practices.

Identify the following common generalist predators of insect and mite pests in immature and adult stages:
lady beetles;
lacewings;
syrphid fly;
spider;
minute pirate bug.

Describe the typical life cycle of an insect parasitoid.

List the two orders to which most insect parasitoids belong.

Describe the use of nematodes in the biological control of insects.

List three types of organisms that are common insect pathogens.

List the major group of natural enemies used for the biological control of weeds in California.

Identify a weed pest successfully controlled through the use of natural enemies.

Explain why biological control of weeds has been more successful against rangeland and aquatic weeds than weeds of agricultural crops.

Describe the role of crop competitiveness as a biological approach to weed control.

Define disease suppressive soils.

C. Cultural Pest Control

Describe the advantages of using cultural controls in an integrated pest management program.

Describe how site selection can affect pest problems.

List six important sanitation techniques.

Describe the benefits of destroying alternate hosts in a pest management program.

Define:

habitat modification;
intercropping.

Describe how smother crops and cover crops can be used in an IPM program.

List the potential advantages and disadvantages of cover crops.

List the attributes of pests successfully managed with crop rotation practices.

Describe how adjusting the planting date can benefit weed control.

Describe how early harvest can reduce pest problems.

Describe how poor irrigation practices can lead to pathogen and weed pest problems.

List three pest problems associated with excess nitrogen applications.

D. Mechanical And Physical Methods Of Control

Describe how proper site preparation can reduce pest problems.

Describe how soil tillage can reduce or increase certain pest problems.

Define conservation tillage.

Describe the importance of timing when mowing is used as a weed control practice.

Describe the use of flaming as a weed management tool.

Describe the benefits of mulches.

List some organic and synthetic materials that are suitable as mulches.

Describe how to solarize the soil.

Describe two kinds of situations where temperature manipulation is used in pest management.

Describe situations where chaining and dredging are used for weed control.

List the pests that can be managed with the following types of traps:
- sticky traps;
- glue traps;
- box traps;
- conibear traps.

E. Using Pesticides in an IPM Program

List the application site factors that can impose limitations on pesticide selection.

Give examples of how formulation can change how a pesticide reacts with target pests, nontarget organisms, and the environment.

Describe why each of the following is an important consideration when selecting pesticides:
- mode of action;
- site of action;
- persistence;
- selectivity.

Define:
- botanical insecticide;
- microbial insecticide;
- contact poison;
- stomach poison;
- systemic insecticide;
- pyrethroid;
- chlorinated hydrocarbon;
- organophosphate insecticide;
- carbamate insecticide;
- insecticidal oil;
- insecticidal soap;
- desiccant;
- selective herbicide;
- nonselective herbicide;
- contact herbicide;
- translocated herbicide;
- eradicant fungicide;

systemic fungicide;
surface protectant fungicide;
antibiotic;
fumigant;
adjuvant.

Describe how insect growth regulators work.

Describe the importance of plantback restrictions on herbicide selection.

List the three categories of pesticides used for disease control.

List factors that influence the efficacy of a nematicide in the field.

List the five categories of pesticides used for vertebrate control.

Describe how an anticoagulant bait works.

List considerations when choosing a pesticide for vertebrate control.

Explain the function of the following types of adjuvants:
surfactants;
stickers;
spreader-sticker;
buffer;
defoamer;
deposition aid;
attractant.

Describe how the following application methods can be used to reduce pesticide use:
spot treatments;
band treatments;
treating alternate rows or blocks;
low volume application;
reducing dosage level of pesticide.

Describe the importance of application timing in the selective use of a pesticide.

Describe when to apply insecticides to avoid hazards to bees.

F. Resistance Management

Compare and contrast cross resistance and multiple resistance.

Define biotypes and their importance in resistance management.

Describe practices that can be applied to discourage development of pesticide resistance.

G. Other Related Pest Management/Production Systems

Define sustainable agriculture.

Describe how sustainable agriculture, organic, and residue-free programs use IPM principles in their management strategies.

List common features of many organic certification programs.

V. MONITORING AND DECISION-MAKING GUIDELINES

Define monitoring.

List the main objectives for monitoring in a pest management program.

Differentiate between monitoring and sampling.

A. Defining the Sampling Universe

Define:

- sampling universe;
- sampling unit.

Compare/contrast absolute samples and relative samples.

List examples of sampling units appropriate for different types of pests.

Describe ways to improve sampling accuracy.

B. Sampling Methods

List factors to consider when determining the number of samples to take.

Describe how the following types of methods can be used to improve sampling efficiency:

- triggers;
- specialized tools;
- presence/absence sampling;
- injury scales;
- sequential sampling;
- multiple pest sampling.

Describe the advantages and disadvantages of presence/absence sampling.

Describe the following sampling patterns and situations in which they should be used:

- random;
- stratified;
- circular or systematic.

List some techniques that help to keep samples random.

Describe some visual sampling methods.

Recognize common sampling methods for:

- weeds;
- insects;
- mites;
- pathogens;
- nematodes;
- vertebrates.

Recognize situations and pests where the following tools would be used for monitoring:

- sticky traps;
- light traps;
- pheromone;
- D-vac;
- sweep-net;
- seed germination tests;
- soil samples;
- beat trays;
- timed searches.

List two groups of pests whose identity must almost always be confirmed by trained laboratory specialists.

Describe the proper collection and handling of samples sent to the laboratory for nematode identification.

Describe the limitations of using plant damage estimates in pest management decisions.

List pests whose presence may be indicated by the following clues:

- frass;
- honeydew;
- runways;
- burrows;
- plugged entrances to burrows.

List some pests for which ELISA testing kits are valuable.

C. Meteorological Monitoring Systems

List the most important weather parameters for making pest management decisions.

Describe some instruments useful for setting up a standard weather station.

Describe components of computer-assisted weather stations.

Describe how data loggers can assist in collecting meteorological information.

Describe some ways to obtain local weather data without a weather station.

D. Predictive Tools

Describe the limitations of predictive tools in forecasting pest development.

Describe phenology models and how they are used.

Describe how to use a biofix, along with meteorological data to forecast insect or plant development.

Describe how to calculate degree-days.

Describe how disease forecasting can be used in pathogen control.

Define:

expert system;
geographic information system (GIS);
global positioning system (GPS).

Describe the use of plant mapping in predicting pest problems.

E. Pesticide Resistance Monitoring

Describe the purpose of early detection of pesticide resistance.

Explain how discriminating concentrations can be used to detect pesticide resistance.

F. How To Keep Monitoring Records

List information that should be noted and kept with monitoring records.

Describe the advantage of graphing sampling counts.

Describe the advantages of keeping field maps for each field monitored.

Describe the advantages of using computer databases for keeping monitoring records.

G. Interpreting and Using Monitoring Results

List the conditions that can cause treatment thresholds to vary.

Describe how monitoring guidelines from one crop can be adapted for use in another.

Describe how cumulative monitoring data taken over months or years can be used in decisionmaking.

List factors other than monitoring results to consider when making pest management decisions.

Describe the importance of follow-up monitoring and its role in a management program.

VI. HOW TO SET UP MONITORING PROGRAMS AND FIELD TRIALS

A. How to Design A Monitoring Plan

Describe each step needed to design a monitoring program.

Describe how using a sample size formula can help determine how many samples to take to increase accuracy.

Explain the factors that help determine sampling frequency.

List some factors that help determine when to begin sampling.

Describe why monitoring host development is important in pest management decisions.

List environmental factors that should be monitored in a pest management program.

Describe how pest development can influence the timing of sampling.

Describe why keeping records of production practices is important in pest management decisionmaking.

Describe how to use scouts effectively in a monitoring program.

B. Field Trials

Describe the major reasons for conducting a field trial.

Describe the limitations of non-replicated field trial data and how to best use the information.

Define and describe how the following are used in an experiment:
- randomization;
- replication;
- blocking;
- controls.

Describe the importance of establishing pre-treatment counts in a field trial.

Explain why the following factors might make research results questionable:
- no control;
- no replication;
- large standard error;
- no significance of results given;
- different treatments tested at different locations.

Discuss the factors to consider when choosing a site for a field trial.

VII. HEALTH AND ENVIRONMENTAL CONCERNS ASSOCIATED WITH PESTICIDE USE

A. Pesticides in the Environment

List where pesticides may be found in the environment after an application.

Describe how the following play a role in airborne pesticide dispersion:
- volatilization;
- vapor pressure;
- drift;
- dustborne particles.

List some practices that can be used to reduce volatilization of pesticides.

Describe how the following factors contribute to drift:
- wind;
- droplet size;
- application method;
- spray pressure;
- height of application off the ground;
- inversion layer.

Describe how the following can reduce drift or drift damage:
- buffer zone;

spray parallel to sensitive area;
adjuvants.

Describe how pesticides become dust borne.

Describe how the following techniques could be used to mitigate problems associated with dust borne movement of pesticides:
irrigation practices;
choice of material.

List the properties of pesticides that make them more likely to persist in water.

List the ways in which pesticides may move into surface water.

Describe how the following practices can prevent runoff:
minimizing tail water runoff;
recirculation;
increase holding time;
product choice;
buffer strips.

Describe the different ways in which ground water contamination can occur.

Describe factors which affect ground water contamination by pesticides.

Describe how the following factors contribute to persistence of pesticides in soil:
persistence of pesticide;
attraction of pesticides to soils;
soil type;
organic matter content in soil;
presence of water.

B. How Pesticides Break Down in the Environment

Describe why residues of certain pesticides are more likely to be found in:
water;
soil or sediment;
air;
living organisms.

Explain the importance of knowing the breakdown products of a pesticide.

Describe how the following mechanisms break down pesticides:
hydrolysis;
photodegradation;
microbial degradation;
oxidation/reduction.

Describe soil conditions that favor pesticide breakdown by microorganisms.

Describe how the following environmental factors can affect pesticide breakdown:

- pH;
- temperature;
- fog;
- soil type;
- soil texture;
- organic content of soil;
- moisture;
- sunlight;
- organisms.

C. General Toxicology

Define:

- toxicology
- toxicity;
- LD_{50};
- LC_{50};
- half life;
- threshold limit value;
- no observable adverse effect levels.

Describe the limitations of using LD_{50} to evaluate the potential risks associated with a pesticide.

Describe how the following factors affect pesticide risk:

- environmental conditions;
- formulation;
- proximity of sensitive organisms, including people.

Describe how the following methods reduce the risk of hazards:

- closed systems;
- water soluble packaging;
- protective clothing;
- restricted entry;
- choice of material.

Describe the following concepts:

- acute illness;
- repeated exposures;
- delayed onset;
- chronic health affects.

Explain the relationship of signal words to oral and dermal toxicity.

List the four major routes of pesticide exposure for humans.

Describe how people can be exposed to pesticides:
- when applying pesticides;
- in treated areas during an application;
- in treated areas after an application;
- in areas off the application site;
- by residues on food and in water.

Describe how the following can reduce human exposure to pesticides:
- personal protective equipment;
- closed systems;
- pesticide formulation;
- water soluble packaging;
- certification of applicators;
- choice of materials;
- drift control;
- restricted entry intervals;
- plantback restrictions;
- pre-harvest intervals;
- awareness of local regulations.

Give an example of how the following effects of pesticides may impact other nontarget organisms:
- destruction of habitat;
- destruction of natural enemies;
- destruction of food sources;
- toxicity to bees and other pollinators.

Describe how you can evaluate the potential impacts to nontarget organisms prior to a pesticide application.

VIII. SETTING UP AN INTEGRATED PEST MANAGEMENT PROGRAM

A. Professionalism

Identify the PCA's responsibility when making a pest management recommendation in the following situations:
- crop loss due to pest damage;
- injury to surrounding areas;
- overtolerance residues;
- illegal residues;
- making a recommendation in unlicensed area.

Describe how the following can help reduce your potential liability:

- the written recommendation;
- the pesticide label;
- back up documentation;
- knowledge of hazards around the property;
- local regulations and restrictions;
- state and federal regulations.

List some ways the written recommendation helps to reduce risks to:

- human health;
- nontarget organisms;
- the environment;
- potential liability.

List the information you may need when making a pesticide recommendation that may not be found on the label.

Identify major resources for information regarding pesticide laws and safety.