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Pesticide Applicators PAPA Professional Association

Pesticide Certification & Licensing in California

QUALIFIED APPLICATOR CERTIFICATE & LICENSE

EXAM PREPARATION STUDY GUIDE

Six Edition, December 2015

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QAL = Commercial Pest Control For hire (1 per company / Branch)

QAC = Pest Control Not for hire

1. INTRODUCTION

QAC or QAL?

Here's the difference… the Qualified Applicator License (QAL) is intended for people who are involved in pest control **for hire**. The Qualified Applicator Certificate (QAC) is for people who apply pesticides **not for hire**.

While there are a number of different situations where pest control work could be considered "not for hire", the most common example involves people who work for government agencies. Other situations include golf course employees that apply pesticides or people who work for businesses that use pesticides like plant nurseries or food processing facilities.

The QAC and QAL exams are similar in terms of the types of questions they ask. Because QAL-holders often have managerial roles in commercial pest control companies, a higher level of professional competency is required. For that reason, the QAL exam is more comprehensive and has more questions than the QAC exam. In general, the QAL pest control category exams have about twice as many questions as the QAC exams.

Which exam should I take?

DPR regulations require companies that apply pesticides for hire to have at least one QAL-holder on staff. Having more than one QAL-holder per business location is not required by DPR, but may be the employer's policy or practice.

When it comes to the QAC, there are only two situations where it's legally required…

1. **The use of restricted pesticides* by government agencies or other "not for hire" entities or businesses.** Note: It's very common for government agencies to require their applicators to be QAC-holders even if they're only using non-restricted pesticides (i.e. most herbicides).

   ** The U.S. Environmental Protection Agency and DPR designate certain pesticides as "restricted materials" based on their high hazard to people and/or the environment.*

2. **Maintenance Gardeners.** These are businesses that apply pesticides for hire, but their pesticide use is so minor that it's considered to be "incidental" to primary business activities such as lawn mowing or fertilizer application. These "for hire" companies are allowed to work under a QAC rather than a QAL.

Exam Categories

To obtain a QAC or QAL, you must pass a Laws & Regulations exam and at least one of the following pest control category exams...

A. Residential, Industrial & Institutional
B. Landscape Maintenance
C. Right-of-Way
D. Plant Agriculture
E. Forest
F. Aquatic
G. Regulatory
H. Seed Treatment
I. Animal Agriculture
J. Demonstration & Research
K. Health Related
L. Wood Preservation
M. Antifouling-Tributyltin
N. Sewer Line Root Control
O. Field Fumigation
P. Microbial Pest Control
Q. Maintenance Gardener (QAC only)

Signing Up for the Test

Information for signing up for the tests can be found on DPR's website. Exam applications must be mailed in to DPR; electronic applications are not used. Examinations are held at various locations and dates throughout the state. The final filing date (i.e. postmark date) for exam applications is generally one month before the exam date.

Other Study Materials

In addition to this study guide, other study materials for the exams are available from DPR and the University of California. Consult DPR's website for more information.

What if I Fail?

You must pass the Laws and Regulations test AND one pest control category test in order to receive your QAC or QAL.

If you pass one of these tests and not the other, you have 12 months to retake the test you failed without having to retake the test you passed. Waiting longer than one year to retest will require you to retake both exams.

You're allowed to take four tests at one time (Laws & Regs and three category exams). You don't have to pass all four tests to obtain your QAC or QAL; only one category exam and Laws & Regs. Once you are certified/licensed you can add any other pest control categories whenever you choose. You are also allowed to retake any tests that you failed. There are no limits to the number of times you can retake an exam you have failed.

2. PESTICIDES

According to DPR, substances are considered pesticides if they:

- **Control pests** - this includes any type of pest species such as weeds, insects, rodents or plant disease agents like fungi, bacteria or viruses;

- **Defoliate plants** - defoliants are chemicals used to remove plant leaves. The most common examples of defoliants are those used as harvest aids in cotton production. Note: even though there's no pest species being controlled when a cotton defoliant is applied, these chemicals still fall under the legal definition of the term "pesticide"

- **Regulate plant growth** - these are chemicals used to regulate how plants grow. Plant growth regulators (PRGs) may be used to prevent the production of unwanted fruit (i.e., ornamental olives) or may slow the growth of golf course turf to increase the time between mowings. Just like the defoliants, the PGRs are legally considered to be pesticides even though they don't actually control pests. Note: fertilizers, even though they affect plant growth, are not PGRs. PGRs affect plant hormone function. Fertilizers affect plant nutrition.

- **...are pesticide adjuvants** - Adjuvants are chemical products that improve pesticide performance. Common examples include surfactants, stickers, buffers and drift control agents.

The following groups of pest control chemicals are all pesticides:

- insecticides
- fungicides
- herbicides
- rodenticides
- toilet bowl cleaners or other disinfectants

Pesticide Formulations

Most pesticide products are formulations made of two parts...the "pesticide part" (the active ingredient) and the "non-pesticide part" (the inert ingredients). The inert ingredients are added to the formulation to improve the pesticide's performance. Common inert ingredients include solvents, stickers and surfactants.

Here are some different types of pesticide formulations. You'll notice that the abbreviations for these formulation types are often part of the product name. For example the insecticide product Demon WP is a wettable powder.

- **Wettable Powders (WP)** - are mixed with water, but are not entirely soluble. They require agitation to keep them in solution. They can also be abrasive to spray equipment.

- **Emulsifiable Concentrates (EC)** - These oil-based formulations include emulsifying agents to help them mix with water. Because they are easily absorbed through skin, they can be more hazardous to applicators than other formulation types.

- **Soluble Powders (SP)**- because they're more soluble in water they generally require much less agitation and are less abrasive then the wettable powders.

- **Dry Flowables (DF)**- these are similar to the wettable powders, but the active ingredient is combined with larger granules that must be mixed with water before use. The pesticide is suspended in water and does not dissolve. They require agitation to remain in solution.

- **Flowables (F)**- concentrated emulsions made up of finely-ground pesticide particles mixed with water and emulsifiers. Flowables require agitation to remain well-mixed in the spray tank.

- **Dusts (D)** - finely-ground pesticide particles combined with clay or other mineral-type carriers. Most dust formulations contain between 1 to 10% active ingredients and are applied in dry form.

- **Granule (G)** - larger in particle size than the dust formulation. Granular formulations are applied as dry materials that need to be incorporated in to the soil by cultivation, irrigation or rainfall shortly after applications. Because they are dry, larger-sized granules this type of formulation is unlikely to drift away from the target site during application.

Mode of Action

The term "mode of action" (MOA) refers to the specific way that the pesticide controls a target pest. Here are several different types of pesticide modes of action:

- **Central nervous system poisons** - many insecticides have this mode of action such as the organophosphate and carbamate insecticides
- **Anticoagulants** - blood-thinners that cause rodent pests to bleed to death after they consume treated bait

** to prevent resistance
Do not use same
mode of action over + over. ***

- **Amino acid synthesis inhibition** - Some herbicides affect the synthesis (production) of essential amino acids.

- **Auxin mimics** - these herbicides mimic growth regulator hormones like auxin.

Pesticide Toxicity

How poisonous a pesticide is…or its toxicity…is generally described by its LD_{50} value. "LD" is an abbreviation for "lethal dose". The LD_{50} is the dose that will kill 50% of a test population of animals (i.e. rats).

LD_{50} values are generally expressed as milligrams (mg) of the pesticide per kilogram (kg) of test animal body weight, or mg/kg. Another way to describe mg/kg is parts per million or ppm. Mg/kg, parts per million and ppm all mean the same thing.

LC_{50} tests are similar to LD_{50} tests except they involve lethal "concentrations" and not lethal "doses". LC_{50} values are generally expressed as milligrams (mg) of the pesticide per liter of water (or air). 1 mg/L is equal to 1 part per million or 1 ppm.

Here's an easy way to remember the difference between the two test types:

- LD_{50} tests involve the test animals ingesting the poison orally (i.e. rats in cages).

- LC_{50} tests often involve fish or aquatic invertebrates as the test species. In this case, the fish do not ingest the poison, but are exposed to the pesticide after it has been applied to the aquaria water.

Another type of LC_{50} test is an inhalation test. An inhalation LC_{50} would be expressed as mg of the pesticide per liter of air. Rats are a common test organism for inhalation toxicity tests.

A Small LD_{50} = High Toxicity

One of the most important things to remember about both the LD_{50} and LC_{50} tests is that small numbers means high toxicity. Here's why…

A chemical with an LD_{50} of 3000 mg/kg has low toxicity. It will take at least 3,000 milligrams of the pesticide for each kilogram of body weight to kill the lab rats.

A chemical with an LD_{50} of 1 mg/kg is very highly toxic. In this case, it only takes 1 milligram of the pesticide for each kilogram of body weight to be lethal.

Some Important Terms

The term "acute" refers to a short term pesticide exposure or test. A 24-hour rat LD_{50} test is an acute test. Acute tests are used to determine how much pesticide exposure is required

to kill the test organisms in a relatively short time period (i.e. 24 hrs).

The term "chronic" refers to a long-term pesticide exposure or test. A two-year dog feeding study is a chronic test. Instead of measuring how much pesticide it takes to kill the test animals, chronic tests measures how much exposure is required to produce sub-lethal effects such as:

- cancer
- tumors
- developmental disorders
- reproductive disorders

The "No Observable Effect Level (NOEL)" is the maximum dose or exposure level of a pesticide that has no detectable effect on the test population. NOEL values are used to establish legal resides of pesticides in food. These tolerances have safety margins 100 to 1000 times the NOEL.

Pesticide Incompatibility

Some pesticides don't mix well with others. Just like water and oil, they separate or produce clumps or other solids. This may result in plugged spray equipment and uneven spray distribution. To avoid these types of problems you should:

- read and follow label instructions regarding potential compatibility problems;
- use the jar test…mix small amounts of the pesticides together in a jar to see if they're compatible; !!!
- follow label directions about the order in which certain pesticide types should be mixed; and

Pesticide Performance Factors

Here are some factors that can influence how well a pesticide will work:

- **The life stage of the pest** - Most pesticides will be more effective if applied during the early life stages of target pests.
- **Persistence** - How long will the pesticide last? Persistent pesticides can provide a longer control period than pesticides that are non-persistent. Pesticide persistence is often measured in half-lives. The half-

life of a chemical is the amount of time it takes for the chemical to break down to 50% of its original concentration in soil, water or other media.

- **Weather** – Rainy weather can wash pesticides off of target plants. Many herbicides will not work well if the weather is too hot or too cold. In general, most pesticides will work best when weather conditions are optimal for the pesticide to be absorbed into target pests.

- **Coverage** - Did the application provide good pesticide coverage or contact with the target pest? Here are some of the factors that can effect pesticide coverage:

  - Nozzle type - The smaller the spray droplets, the better the coverage, but smaller droplets can also mean an increase in the potential for spray drift.

  - Tank pressure - Higher tank pressures produce smaller droplets and therefore, better coverage. But, smaller droplets will drift further!

- **Mix Water Quality** – Depending on the pesticide that's used, dirty mix water can reduce pesticide performance. This happens when the suspended dirt in the spray mix binds to the pesticide. sometimes less effective.

REVIEW QUESTIONS

1. Which of the following are pesticides?

a. disinfectants

b. insecticides

c. herbicides

d. all of the above

2. Which formulation is the most abrasive to application equipment?

a. emulsifiable concentrates

b. dry flowables

c. soluble powders

d. wettable powders

3. The way a pesticide controls its target pesticide is referred to as its:

a. half-life

b. mode of action

c. toxicity

d. efficacy

4. Which of the following statements is true about LD_{50} values?

a. they provide information about acute health hazards

b. large LD_{50} values mean high toxicity

c. the LD_{50} is 50% of the amount it takes to kill 50% of the test population

d. it refers to kilograms of the pesticide divided by milligrams of the weight of the test animals

5. Which of the following statements is true about chronic pesticide exposure?

a. it can cause long-lasting or permanent health effects

b. it always results in the death of the laboratory animal

c. it may affect the offspring of the organism that's exposed

d. a and c

6. Which of the following would be a common LC_{50} test?

a. a rat inhalation test

b. a rat feeding test

c. a bird feeding test

d. a rat skin exposure test

7. The jar test is used to prevent problems with which of the following?

a. phytotoxicity

b. persistence

c. incompatibility

d. efficacy

8. Which LD_{50} value is the most toxic?

a. 1 mg/kg

b. 10 mg/kg

c. 100 mg/kg

d. 0.5 kg/mg

9. Pesticide persistence is measured in:

a. half-lives

b. mg/kg

c. parts per million

d. ppm

10. Which of the following is NOT a pesticide?

a. a plant defoliant

b. a disinfectant

c. a fertilizer

d. b and c

11. Which of the following factors could influence a pesticide's effectiveness?

a. the life stage of the pest

b. weather

c. how clean the mix water is

d. all of the above

12. Pesticide incompatibility can result in which of the following:

a. clogged spray nozzles

b. reduced pest control

c. increased persistence

d. a and b

Answers:

1.d	6. a	11.d
2.d	7.c	12.d
3.b	8.a	
4.a	9.a	
5.d	10.c	

3. REGULATING PESTICIDES

Regulatory Agencies

Pesticides are regulated at the federal, state and local levels by the following agencies in California:

- Federal: The U.S. Environmental Protection Agency (USEPA)
- State: California Department of Pesticide Regulation (DPR)
- Local: county agricultural commissioner's offices (CACs)

States are not required to have their own pesticide regulatory programs, but the USEPA allows them to have these programs.

In California, the CACs enforce DPR's regulations at the local level. CAC's don't usually develop their own pesticide regulations, but they may if given authority by DPR.

Other Agencies

These additional agencies may work cooperatively with DPR and the counties on pesticide issues or incidents:

- U.S. Food & Drug Administration (pesticide residues in food)
- CA Department of Health & county health departments (pesticides & human health issues)
- U.S. Fish & Wildlife Service (pesticide effects on wildlife)
- CA Department of Fish & Wildlife (pesticide impacts on wildlife)
- Air Resources Board (pesticides & air pollution)
- State Water Resources Control Board (pesticides & water pollution)
- Regional Water Quality Control Boards (pesticides & water pollution)

The Purposes of Laws & Regulations

Here are some of the purposes of pesticide laws and regulations:

- provide for the proper, safe, and effective use of pesticides
- protect the environment
- assure that agricultural and pest control workers have safe working conditions

- authorize pest control and make sure that it is done by competent, responsible individuals under strict control of DPR and the county agricultural commissioners

- assure applicators, consumers, and other users that the pesticides they use are properly labeled and are appropriate for the uses designated on the label

- encourage the development and implementation of integrated pest management systems

The Difference between Laws & Regulations

Laws and regulations are not the same things. Here are some essential differences:

- **Laws start out as bills written by state legislators (the Assembly and Senate).** They become laws when approved and signed by the governor of California. Pesticide Regulations are adopted by state agencies (like DPR) after a hearing by the Office of Administrative Law (OAL)).

- Pesticide Laws are found in the CA Food & Agricultural Code. Regulations are found in the CA Code of Regulations.

- Laws give legal authority to state agencies (like DPR) to write regulations. Regulations help agencies like DPR carry out the laws that have been written by the legislature.

Penalties

Anyone breaking pesticide laws or regulations is guilty of a misdemeanor and is subject to warnings, penalties, and/or jail.

Pesticide Registration

The term "pesticide registration" refers to the approval process used by both the USEPA and DPR. All pesticides that are registered by DPR must first be registered by the USEPA. In making pesticide registration decisions, the USEPA and DPR take into account the economic, social, and environmental costs and benefits associated with the use of that pesticide.

Special Registrations

The federal laws that govern the pesticide registration process are part of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). In addition to the "general type" of pesticide registration (FIFRA section 3), there are several other special types of registrations:

- **Section 18** authorizes the USEPA to allow an unregistered use of a pesticide for a limited time if it determines that emergency conditions exist.

- **Section 24(c)** gives the state authority to issue a use registration not previously issued for a USEPA-registered pesticide. This might include an additional crop or site that was not included on the original USEPA approval. Section 24(c) registrations are also known as Special Local Needs or "SLNS".

- **Research Authorizations** allow DPR to authorize the research use of an unregistered pesticide.

Lapsed, Suspended or Canceled Registrations

The party that registers a pesticide… for example, the pesticide manufacturer… is known as the registrant.

- Registrants must register their products annually with DPR. They cannot sell their product in the state without this annual registration. Failure to obtain annual registration is referred to as a "registration lapse".

- Registrants cannot sell pesticides with lapsed registrations.

- Pesticide dealers (i.e. retailers) have 2 years to sell any lapsed pesticide products that have in storage.

- End-users have an unlimited amount of time to use the lapsed pesticide products they have in storage.

Sometimes a pesticide product or use will be canceled or suspended by either the USEPA or DPR. Anyone possessing pesticide products that have uses that have been canceled or suspended is required to follow all USEPA or DPR cancelation or suspension requirements. Unlike with lapsed registrations, pesticides or pesticide uses that have been suspended or canceled may be subject to immediate use restrictions with no grace periods for dealers or end users.

Restricted Pesticides

From a regulatory standpoint, there are two basic groups of pesticides, general use and restricted use. A pesticide is classified as "restricted use" if it's potentially more hazardous than other pesticides. Restricted status may be based on:

- toxicity to people, including any special hazards to eyes or skin

- environmental effects

- how the pesticide will be used

All federally restricted-use pesticides have a Restricted-Use Statement displayed on the pesticide label.

Pesticides that are restricted by the USEPA are automatically designated as restricted by DPR. Additionally, DPR has established a list of restricted-use pesticides that the USEPA does not consider restricted. If a pesticide is only DPR-restricted and not USEPA-restricted, the pesticide label will not include a Restricted Use statement.

Only certified persons can purchase and use restricted use pesticides. There are two ways to become certified:

1. Farmers become certified by taking the Private Applicator Certificate exam thru their local CAC.

2. Non-farmers obtain certification by passing either the QAC or QAL exam.

Restricted Pesticide Permits A person must obtain a restricted materials permit from the local county agricultural commissioner before buying or using any pesticide that's restricted by DPR, but not restricted by the USEPA.

The purpose of the permit process is to review the legality of the proposed use and to mitigate any adverse effects or hazards to the environment. Before the permit can be issued, the CAC must:

- determine if there are any adverse environmental impacts
- determine if there are any feasible alternatives available
- mitigate any potential hazards

Agricultural permits are issued to the property operator. Non-agricultural permits can be issued to the property operator of the pest control operator who will be making the application.

A pesticide dealer must obtain a copy of the grower's permit before selling a restricted-use pesticide.

Notices of Intent

Before a permittee uses a restricted pesticide, they must submit a Notice of Intent (NOI) to the CAC. The NOI must be submitted at least 24 hours before the intended pesticide use.

If the following information isn't included on the original permit, the NOI must include it:

- restricted materials permit number
- name and address of the permittee and the applicator name
- location of areas to be treated
- crop, commodity or site

- approximate acres or other units
- method of application
- restricted pesticide(s) that will be used
- dilution or the volume per acre
- pest or pests to be controlled
- date the intended application is to commence, and
- locations and identities of areas that have changed since the permit was issued and that may be adversely impacted

Pesticide Labels

Label = Law = Legal

All pesticide products sold in the United States must include product labeling. According to the USEPA, a product label is…

"…any written, printed or graphic material with pest control directions, requirements, prohibitions and other information such as health and safety requirements."

Sometimes the pesticide container will also have a small booklet encased in a plastic pouch that includes more detailed information. This small booklet is a **supplemental label**.

The pesticide label and all supplementary labeling that prescribes how that pesticide is to be used are legal documents.

During any pesticide application (mixing, loading, or application) the pesticide label must be present at the job site. Pesticide handlers must read, know and follow label instructions when using pesticides.

Parts of the Pesticide Label

1. **Brand Name**
2. **Formulation** - The type of formulation such as emulsifiable concentrate or liquid. The product name often identifies the formulation type. For example, Malathion 50 WP would be a 50% malathion product formulated as a wettable powder.
3. **EPA Registration & Establishment numbers.** These numbers are assigned to the product by the USEPA. The "Reg. No." identifies the product and the "Est No." identifies where that container was packaged.
4. **Ingredients Statement**. Listed as the percentages of active and inert materials in the product.
5. **Pesticide Common Name**
6. **Pesticide Chemical Name**
7. **Signal Word**
8. **Statement of Use Classification**; either "General or "Restricted" use.

9. **Statement of Practical Treatment** – first-aid procedures.
10. **Precautionary Statements** – summarizes the hazards the pesticide product poses to humans or domestic animals.
11. **Manufacturer**
12. **Directions for Use**. This section would include mixing and loading instructions and use rates. It might also include restrictions on how long you have to wait until you plant a subsequent crop after using a pesticide. Here's an example of this type of plantback statement…*Don't plant spinach to fields where this pesticide has been used for 12 months after application.*
13. **Misuse Statement**
14. **Re-entry Statement.** The period of time (in days) that agricultural workers must wait before re-entering treated fields.
15. **Contents**
16. **Storage and Disposal**
17. **Warranty**

Buggoff* 4 EC Insecticide

EPA Reg. No. 10854-2-549
EPA EST. No. 10854-1000

Active Ingredient:
Parathion... 20%
Inert Ingredients..... 80%

This product contains 4 lbs of parathion per gallon.

KEEP OUT OF REACH OF CHILDREN

DANGER – POISON

RESTRICTED USE PESTICIDE

Due to very high acute toxicity to humans and birds

For retail sale to and use only by certified applicator or persons under their direct supervision and only for those uses covered by the certified applicator's certification. Direct supervision for this product is defined as the certified applicator being physically present during applications, mixing, loading, repair and cleaning of application equipment. Commercial certified applicators must also ensure that all persons involved in these activities are informed of the precautionary statements.

STATEMENT OF PRACTICAL TREATMENT

If in eyes, flush with plenty of water for 15 minutes and get medical attention.

If swallowed, drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person. Get medical attention.

If inhaled, remove patient from contaminated area and get medical attention.

If on skin, remove contaminated clothing and wash skin with soap and water.

For Emergency Assistance Call Poison Control

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

Danger

Corrosive, causes eye damage. Do not get in eyes. Wear goggles or face shield. Harmful if swallowed. Do not inhale spray mist. Avoid contact with skin. After handling, wash thoroughly with soap and water.

PestBusters Inc
P.O. Box 3421
Wilton, CA 95111

Environmental Hazards

Keep out of lakes, ponds and streams. Do not contaminate water by cleaning of equipment or disposal of wastes. Apply this

product only as specified on this label.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. For use as a insecticide for the control of insects.

Do not apply this product in such a manner as to directly or through drift expose workers or other persons. The area being treated must be vacated by unprotected persons.

REENTRY

Do not enter treated areas without protective clothing until spray has dried.

Protective clothing means, at least, a hat or other suitable head covering, a long sleeved shirt and long legged trousers or a coverall type garment (all closely woven fabric covering the body, including the arms and legs), shoes and socks.

Apply when pests first appear and repeat as necessary. Use sufficient solution to thoroughly cover foliage. By ground use 200 gallons water carrier per acre, and by air apply 5 to 10 gallons of water carrier per acre.

Apples: Codling Moth - Use 2 pints. Eyespotted Bud Moth, Forbes Scale, Woolly Aphid - Use 1 pint. Tent Caterpillars - Use 1 to 1 1/2 pints. Mealybug - Use 1 to 2 pints. Green Apple Aphid, Rosy Apple Aphid - Use 1 1/2 pints. For Codling Moth control apply at petal fall and every 10 to 14 days thereafter until control is achieved. Applications of this material may cause injury to McIntosh and related varieties of apples.

Ornamentals: Aphids, Whitefly, Mealybug - Use 1 1/2 pints per 100 gallons of water. Birch Leafminer, Bagworms, Tent Caterpillars, Brown Soft Scale and Monterey Pine Scale - Use 2 1/2 pints per 100 gallons of water. Apply to completely cover foliage.

Net Contents: 2 1/2 Gallons

STORAGE AND DISPOSAL

Pesticide Storage

Do not Store below 40*F.

Do not use or store near heat, or open flames.

Keep out of reach of children and animals. Store in original containers only. Store in a cool, dry place and avoid excess heat. Do not put concentrate or dilute material into food or drink containers. Do not contaminate other pesticides, fertilizers, water, food, or feed by storage or disposal.

In case of spills, avoid contact, isolate area and keep out animals and unprotected

persons. Confine spill by diking surrounding area or absorbing with sand, cat litter or commercial clay. Place damaged package in a holding container and identify the holding container.

Pesticide Disposal

Waste resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Disposal

Triple rinse (or equivalent). Then offer for recycling or recondition, or puncture and dispose of in a sanitary landfill, or incinerate, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke

CONDITIONS OF SALE AND WARRANTY

ARENA warrants that this product conforms to its chemical description and is reasonably fit for the purpose stated on the label only when used in accordance with the label directions. ARENA makes no other express or implied warranties. Handling, storage and use of this product by Buyer or User are beyond the control of ARENA and Seller. Risks such as crop injury, ineffectiveness or other unintended consequences resulting from, but not limited to, weather or soil conditions, presence of other materials, disease, pests, drift to other crops or property or failure to follow label directions will be assumed by the Buyer or User.

Conflict with Labeling

For the most part, it's illegal to use a pesticide in a manner that conflicts with its registered labeling.

BUT…here are a few activities that are NOT considered to be "use in conflict with labeling"…unless the label expressly forbids them:

- a decrease in the rate per acre
- a decrease in the concentration
- a decrease in use frequency
- use to control a target pest not listed on the label, as long as the commodity or site is listed on the label
- using a different application method
- mixing with another pesticide or fertilizer, or
- ~~increasing the concentration of the mixture, provided the increase corresponds with the current published recommendations of the University of California~~

Shall and May

Pesticide labeling often uses "shall or may" language. A "shall" or "must" statement is a legal requirement. Not following a "shall or must" requirement is considered "use in conflict with labeling".

A "may" statement is permissive. The pesticide user has a choice to follow or ignore a "may" statement.

Hazard Categories & Signal Words

The USEPA generally uses acute LD_{50} values to establish pesticide toxicity categories. These categories are designated on pesticide labels by the following signal words:

- **DANGER** – Category I pesticides are highly toxic. In addition to the DANGER signal word, most Category I pesticide labels also include the word "POISON" and a graphic of the skull and crossbones. Category I pesticides have acute oral LD_{50} values that are less than 50 ppm.
- When a pesticide label only has the DANGER signal word and does not include "POISON" and the skull and crossbones it means that the pesticide is an eye or skin hazard.
- **WARNING** – Category II pesticides are moderately toxic. Category II pesticides have

acute oral LD_{50} values that are between 50 – 500 ppm.

- **CAUTION** – Category III pesticides are slightly toxic. Category III pesticides have acute oral LD_{50} values that are between 500 and 5,000 ppm.

- **NO SIGNAL WORD** – If the pesticide label has no signal word, the pesticide is in Category IV. Category IV pesticides are practically non-toxic. Category IV pesticides have acute oral LD_{50} values that are greater than 5,000 ppm.

In addition to the signal word, all pesticide labels (even Category IV) include the warning "Keep out of Reach of Children".

Certification & Licensing

Agricultural Use Definition

It's important to have a good understanding of the term 'agricultural use" as it applies to pesticides. According to DPR, all pesticide uses are considered to be agricultural uses except the following:

- home use pest control
- structural pest control
- industrial pest control
- institutional pest control
- animal disease control by veterinarians
- special districts working with the California Dept of Health Services (i.e. vector control districts)

In addition to the QAC and QAL, DPR offers several other different types of certificates and licenses including:

- **Private Applicators** – are farmers, ranchers or other owners or managers of private properties. Private landowners DO NOT need to obtain their QAC or QAL to become certified. They take the private applicators certificate exam offered by the local CAC. Certified private applicators can obtain a restricted materials permit.

- **Commercial Applicators** – are everyone except private applicators. A certified commercial applicator is one who has obtained either their QAC or their QAL.

- **Journeyman or Apprentice Aircraft Pilot Certificate** - A pilot that has been certified by DPR to apply pesticides by aircraft. There are two levels of the pilot's certificate… the apprentice and the journeyman. Both are passed by taking DPR-offered exams. An apprentice can become a journeyman after spending one year working

under a journeyman. This one year apprenticeship must include 150 hours flying fixed wing aircraft or 50 hours flying a helicopter. Like a QAC-holder or QAL-holder, a pilot who has their Journeyman certificate is a certified commercial applicator.

- **Agricultural Pest Control Advisers** - Licensed PCA's have met minimum college educational requirements and have passed a DPR exam. People who make recommendations for agricultural pesticide uses must be DPR-licensed PCAs. Here are some other important requirements for PCAs:
  - They must put their recommendations in writing.
  - Copies of recommendations must be provided to the property operator (i.e. grower or rancher), the pesticide dealer and the pesticide applicator.
- **Pest Control Business Licenses** - Companies that apply pesticides for hire must have at least one QAL-holder on staff AND must obtain a pest control business license from DPR.

DPR issues several different types of these business licenses. Unlike the QAC, QAL, pilot certification or PCA license, these business licenses are issued to companies, not individuals and there are no exams required. Here are two specialized versions of the business licenses:

- **No-Fee Pest Control Business License** - Allows a company to conduct pest control for hire in the vicinity of his or her own property (i.e. neighboring farms or ranches). The No-Fee license applicant must hold a QAL in the Plant Agriculture category (Category D).
- **Maintenance Gardener Pest Control Business License** - Unlike the other pest control business licenses, the maintenance gardener business license can be obtained with a QAC. A QAL is not required. This license is only for businesses whose pesticide use is "incidental" to their company's primary business of landscape maintenance (i.e., mowing lawns, trimming shrubs and applying fertilizers. This license DOES NOT allow the company to apply pesticides for hire in parks or on golf courses or in cemeteries.

Pest Control Dealers License

Companies that engage in the following activities must have a Pest Control Dealer license from DPR:

- selling pesticides for agricultural uses
- selling any method or device to control agricultural pests
- soliciting pesticides sales by making agricultural use recommendations through field representatives (i.e. PCA's)
- selling restricted use pesticides

In order for a company to receive a Pest Control Dealer license at least one person in that company must possess one of the following:

- a pest control dealer designated agent license (you must pass this DA exam)
- a PCA license
- a pest control pilot certificate (apprentice or journeyman) or
- a QAL

If the pest control dealer business has branch locations, each branch must have its own license or certificate-holder.

Before a pesticide dealer can sell a pesticide, the buyer must provide one of the following:

- a copy of their restricted materials permit from the county agricultural commissioner (for DPR-only restricted pesticides)
- a copy of a QAC or QAL (for USEPA-restricted pesticides)
- an operator identification number from the county agricultural commissioner of each county where pest control work will be performed (for general use pesticides)

If you are not a licensed pest control dealer or the registrant (manufacturer) of the pesticide being sold you may have to obtain a pesticide broker's license from DPR. You must have this license if you are the first to sell, offer to sell, distribute into or bring into California any pesticide product. Unlike with the pesticide dealer license, the broker's license does not require a licensed designated agent.

County Registration

All principle and branch offices of a pest control business, PCAs and pilots must register annually with the CAC in

each county where they conduct business.

The following must be provided:

- name and address of company
- number and types of units used
- type of pests to be controlled
- any other information required
- registration fee

If the county has no CAC, registration must be with DPR

Continuing Education

All QAC-holders, QAL-holders, pilots and PCAs must renew their certificates/licenses every two years.

With few exceptions, QAC and QAL-holders must obtain 20 hours of continuing education units (CEUs) every two years with at least 4 of those units being in laws and regulations. PCA's must obtain 40 CEUs every two years.

REVIEW QUESTIONS

1. Which of the following agencies regulates pesticides in California?

a. USEPA

b. DPR

c. CACs

d. all of the above

e. a and b

2. Which of the following are reasons for pesticide laws and regulations?

a. ensure that pest control is done by competent individuals

b. ensure that integrated pest management is used

c. ensure that pests are adequately controlled

d. all of the above

e. a and b

3. Which of the following are true about pesticide laws?

a. written by the legislature

b. start out as regulations

c. are authorized by regulations

d. are written by DPR

4. Which of the following is true about breaking pesticide laws?

a. it's a misdemeanor

b. may result in penalties

c. it's an infraction

d. all of the above

e. a and b

5. Which of the following is true regarding pesticide registration?

a. must first be done by the USEPA

b. must first be done by DPR

c. isn't necessary by DPR if completed by the USEPA

6. A Section 18 registration allows:

a. the temporary use of a pesticide that has not received USEPA registration

b. gives the state authority to issue a use registration not previously issued by the USEPA

c. allows the experimental use of a pesticide

d. cancels a pesticide approval

7. Which of the following are true?

a. registrants can't offer their products for sale without annual registration with DPR

b. registrants can sell pesticides with lapsed registration for two years

c. end-users have 2 years to use products with lapsed registrations

d. a and b

8. Pesticide uses canceled by the USEPA can only be used when:

a. when approved by DPR

b. when a Section 24c registration has been issued

c. for two years after the cancelation

d. canceled pesticides cannot be used

9. Which of the following are true about restricted use pesticides?

a. can only be possessed and used by certified applicators

b. are restricted because of high toxicity or environmental effects

c. may require a permit from the county agricultural commissioner's office

d. all of the above

10. Which of the following is considered to be pesticide labeling or supplemental labeling?

a. printed material that includes directions, requirements or prohibitions

b. advertisements from the manufacturer

c. any direction or warning information that is encased in a plastic pouch attached to the primary container

d. a and c

e. all of the above

11. The precautionary statements section of the label contains information about the:

a. application rate

b. legal use sites

c. personal protective equipment

d. hazards to people and domestic animals

12. Plant back restrictions are found in what section of the pesticide label?

a. directions for use

b. statement of practical treatment

c. precautionary statements

d. a and c

13. Exceeding the maximum use rate on the label is an example of:

a. Section 24c

b. Section 18

c. use in conflict with labeling

14. Which signal word would you find on a label for a pesticide that is extremely corrosive to the eyes?

a. Warning

b. Caution

c. Danger

d. Danger/Poison

15. What must apprentice pilots obtain before they qualify for the journeyman pilot exam?

a. 150 hours of fixed wing aircraft or 50 hours of helicopter flight time

b. 150 hours of fixed wing aircraft and 50 hours of helicopter flight time

c. at least one year working as an apprentice under the supervision of a journeyman

d. a and c

e. b and c

16. Which pest control business license is appropriate for incidental pest control work?

a. Maintenance Gardener

b. No Fee

c. Landscape Maintenance

e. all of the above

Answers:

1.d	6. a	11.d	16. a
2.d	7.a	12.a	
3.a	8.d	13. c	
4.e	9.d	14. c	
5.a	10.d	15. d	

4. APPLICATION SAFETY

Application Equipment

Using the proper equipment is essential to safe and effective pesticide applications. Here are some different types of application equipment:

Back packs & B+G's

Hand-held Low Volume: this type of equipment is suitable for small-scale work. Inexpensive, easy to use and maintain this type of equipment generally does not produce significant drift.

- trigger pump sprayers (1-2 pts)
- compressed air sprayers (1-2 gals)
- backpacks (2-4 gals)
- wicks or ropes: used to apply saturated solutions directly to target plants by wiping action. These pose almost no risk of drift or other type of off-target movement.

Powered Low or High Volume: this type of equipment is generally used for larger-scale work. Some are used in landscape settings while others may be used in farming. Depending on the type and how they're used, they may produce significant drift or other off-target movement.

- Controlled droplet applicators: CDAs can be used to apply low volume applications. Their design produces relatively uniformly-sized, large droplets which can helps prevent drift. They can be hand-held or mounted on equipment.
- low volume boom or hand-held sprayers
- high-volume hand-guns
- Air blast sprayers: These are primarily used in orchard or vine crops. Fans or blowers force spray mixtures in to dense foliage or up in to tree canopies.
- Electrostatic sprayers: These apply low spray volumes (i.e.10 gals/acre) of small droplets. The droplets are given a negative electric charge by a transformer attached to a tractor's electrical system. Spray drift is reduced when negatively-charged spray droplets are attracted to positively-charged foliage.
- Ultra-low volume (ULV): these sprayers apply very low spray volumes to target plants. High pesticide concentrations are often used.

Spray Pumps

Most liquid pesticide sprayers use a pump to generate tank pressure that moves the pesticide from the tank out through the nozzles. Here are some different pump types:

- Centrifugal: best for high-volume applications, spinning impellers move the spray through the pump via centrifugal force. They're especially useful for applying abrasive formulations like wettable powders because they work without much contact between moving parts.

- Diaphragm: often used for low-volume applications with low to high tank pressures. Like the centrifugal pumps, they're good to use with abrasive formulations.

- Piston: these relatively expensive pumps are good to use when high pressures are needed. Some designs are easily damage by abrasive products.

- Roller: this type of pump is relatively inexpensive, and is best when low-moderate pressure is used. They are easily damaged by abrasive products.

The applicator must know which equipment to use and the limitations of that equipment before any pesticide application including.

Spray Nozzles

Using the correct spray nozzles may be the most important component of sprayer design and function. Spray nozzles control the following:

- application rate
- droplet size
- spray pattern

Here's some important information about nozzle types:

- Flat-fan: produces a flat, fan-shaped spray pattern. **Regular** tapered **flat fan** nozzles release more spray droplets in the center of the fan with a lesser number of droplets at the fan's edges. This design is good for use with spray booms because it allows for spray overlap between adjacent nozzles. The spray pattern of an **even flat fan** nozzle has a uniform distribution of droplets. This even distribution makes them less suitable for use on booms. They're generally used on handguns and spray wands.

!!

vs.

- Cone: these nozzles are often used to make applications to dense foliage. Hollow-cone nozzles are used for a wide-variety of spray situations. Solid-

cone nozzles produce larger, heavier droplets and are often used when high-volume applications are necessary.

- Solid-stream: used to produce a single, solid stream for spraying distant targets with hand-guns.

- Flood: used for large volume applications. Typically used for fertilizers and not for pesticides.

Nozzle Construction

Spray nozzles can be made of a number of different materials.

- Plastic: inexpensive and wears rather easily.

- Brass: inexpensive, but subject to wear.

- Aluminum: resists corrosion but is susceptible to abrasion.

- Stainless Steel: resists both corrosion and abrasion but can be expensive.

- Carbide and Ceramic: resists both corrosion and abrasion but are expensive.

Sprayer Maintenance

Here are some important sprayer maintenance facts:

- Make certain all the nozzles on a boom are the same type and volume rating.

- Replace worn spray nozzles especially if you use abrasive products like wettable powders.

- Clean plugged nozzles using a toothpick, small brush or compressed air. Never try to clean out plugged nozzles by blowing through them or by using a needle or wire.

- Replace or repair worn pumps, fittings and hoses.

- Make certain that the tank agitation is working properly and is adequate for the type of formulation that's used. For example, wettable powders require more agitation than liquid formulations.

Pesticide Drift

According to DPR regulations, no pesticide application can be made if there's the potential to:

- contaminate people who are not involved in the application

- create a human health hazard

- damage non-target crops, animals or property or
- contaminate non-target public or private property

Pesticide drift is influenced by several factors including:

- **Wind speed and Direction**: Wind speeds less than 5 miles per hour are generally safe for most pesticide applications. In some cases, wind speeds up to 10-12 mph may be appropriate.
- **Droplet Size**: Larger droplets are less likely to drift. Most pesticide droplets are 50 and 500 microns in diameter. Droplets smaller than 150 microns…about the diameter of a human hair…are generally responsible for drift.

Here are the most effective ways to prevent pesticide drift problems:

- avoid spraying when wind speeds are excessive (i.e. >10 mph)
- use nozzles that produce larger droplets (>150 microns)
- decrease tank pressure
- add drift control agents to the spray tank to make droplets larger and heavier by increasing viscosity
- use buffer zones, untreated areas between the pesticide use site and sensitive adjacent sites like houses, busy roads or waterways

Certain pesticides with a high potential for damaging nearby non-target crops have specific DPR regulations regarding maximum wind speeds. An example of this is the 10 mph limit for the agricultural herbicides paraquat and 2,4-D.

Other Weather-related Issues

Weather can have a significant influence in the effectiveness and safety of pesticide applications.

Warm weather can affect pesticides in two important ways; increasing drift and increasing volatization.

- Increasing Drift: Warm air temperatures cause pesticide spray droplets to become smaller due to evaporation. Smaller droplets tend to drift further than larger droplets.
- Volatization: Some pesticides can volatilize rapidly when air temperatures are high. Volatization occurs when the pesticide evaporates from the treated foliage in to the air. The ester formulations of the herbicides triclopyr and 2,4-D tend to volatize when air temperatures are above 85˚F.

Temperature Inversions: Under typical weather conditions, the warmer air is found closer to the ground and the air gets increasingly cooler air as you go up in elevation. A temperature inversion is formed when the typical situation is reversed; the cooler air is near the ground and a layer of warmer air…like a lid…lays above it.

Don't spray = Inversion

In general, a temperature inversion forms…

- at night, before dawn,
- when the weather is cold,
- when there is no cloud cover,
- when wind speeds are < 3 mph

The lack of air mixing and generally stagnant nature of the temperature inversion air mass prevent the very small (i.e. <150 micron) spray droplets from falling to the ground. This can result in the formation of a potentially large pesticide "cloud". Later in the morning, as warming temperatures create winds, this pesticide cloud can move offsite and fall on to non-target sites.

Rainfall: Rainfall that occurs soon after pesticide applications can have the following negative effects on pesticide applications:

- reducing pest control effectiveness by washing the pesticide off target foliage or other target surfaces
- contaminating nearby waterways when pesticides move offsite in surface water flow
- increasing groundwater contamination, especially when sandy soils and highly water-soluble pesticides are involved

Cleanup, Storage & Disposal

Pesticide waste can be reduced or eliminated by implementing the following:

- Triple rinse empty pesticide containers, adding the rinsate to the tank mix before application.
- Field rinse spray tanks, when possible, applying rinsate in the general area of the pesticide use application.
- Keep application equipment in good working condition. This will help contamination from leaky and broken equipment.
- Use only the amount of pesticide needed for the job.
- Clean up pesticide spills immediately.
- Proper calibration enables the applicator to apply the proper amount of pesticide to the target area without excess.

REVIEW QUESTIONS

1. Which type of application equipment produces uniformly-sized droplets?

a. controlled droplet applicators

b. electrostatic sprayers

c. ultralow volume sprayers

d. none of the above

2. Which type of pump is best for wettable powder applications?

a. centrifugal

b. diaphragm

c. roller

d. a and b

3. Spray nozzles influence which of the following?

a. application rate

b. droplet size

c. spray pattern

d. all of the above

4. The primary factors related to spray drift are:

a. wind speed

b. wind direction

c. spray droplet size

d. all of the above

5. Drift control agents reduce drift by:

a. increasing droplet size and weight

b. decreasing spray solution viscosity

c. decreasing droplet temperature

d. a and b

6. Volatilization generally occurs:

a. when wind speeds exceed 10 mph

b. when air temperatures are warm (i.e. exceed 85° F)

c. when a warm air layer overlays a cold air layer

d. all of the above

7. The damage caused by pesticide drift can be prevented by using:

a. buffer zones

b. drift control agents

c. low tank pressures

d. all of the above

8. Which of the following are conditions that are related to temperature inversions?

a. occur at night

b. warm weather

c. volatilization

9. Which type of spray nozzle is best for wettable powders?

a. plastic

b. brass

c. stainless steel

d. none of the above

10. Which type of nozzle is best for use on spray booms because they allow for spray overlap with adjacent nozzles?

a. cone

b. solid stream

c. flood

d. none of the above

Answers:

1.a	6. b
2.d	7.d
3.d	8.a
4.d	9.c
5.a	10.d

New Added Landscape Test:

(Interiorscape + indoor plants)

shopping malls
offices
govt buildings
Hotels + Resorts

- Reduce Interior sprayings
  - prevention
  - exclusion
  - Physical control
  - Biological control
  - sanitation
  - Trapping

- Issues related to Pesticide Use:
  - Disrupts
  - Human exposure
  - Damage to surfaces
  - Drift (HVAC)
  - plant species?
  - spills

- Reducing Human Risk
  - offsite applications if possible
  - proper - precise equipment
  - only Low Toxicity pesticides
  - Avoid long residue + bad smell

5. WORKER SAFETY

Some pesticides are highly toxic and handling them requires extreme care. Of all the pesticide use activities, mixing and loading is the most hazardous because it involves handling the concentrated pesticide product. Once a pesticide is diluted with water its lower concentration poses much less risk to the user.

Employee Training

Here are some important requirements for employers who have employees who handle pesticides:

- All employees must receive annual safety training as well as initial safety training when they're first hired.
- The training must be "pesticide-specific".
- Employers must keep training records for 2 years.

At a minimum, pesticide safety training programs must include the following topics for each pesticide that's handled:

- the format and meaning of pesticide label warning statements
- pesticide use hazards, both acute (short term) and chronic (long term)
- the four routes by which pesticides enter the body…oral, dermal, inhalation and ocular (eye)
- the symptoms of pesticide overexposure
- emergency first aid for overexposure
- how to obtain emergency medical care
- routine and emergency decontamination
- personal protective equipment
- heat-related illness
- safety procedures and engineering controls
- environmental concerns
- warnings not to take pesticide containers home
- other appropriate DPR regulations
- medical supervision (blood tests)

- the location of hazard communication program information
- employee rights, including the right to pesticide information, physician's records and other similar information

Who Can Provide Training?

There are no specific legal requirements for pesticide trainers who work outside of production agriculture settings like farming or timber production.

Trainers who work in production agriculture must be one of the following:

- a certified applicator (QAC-holder or QAL-holder)
- a CAC inspector or biologist
- a UC Farm Adviser
- a PCA
- a CA registered professional forester
- a person who has completed DPR's "Train the Trainer" program
- someone who is otherwise approved by DPR

Hazard Communication

Employers are required to provide employees with hazard communication information about the pesticides they use. Here's what's required:

- post a completed copy of one of these DPR Pesticide Information Series (PSIS) leaflets
  - A-8. Safety Rules for Pesticide Handlers on Farms or
  - N-8, Safety Rules for Pesticide Handlers in Non-Agricultural Settings.
- pesticide use records
- pesticide labels
- safety data sheets
- copies of other PSIS leaflets

Emergency Medical Care

There are 3 items to remember:

1. The employer must post the contact information for a doctor, hospital or clinic at the pesticide use site.
2. Employees that have been injured or made ill by a pesticide exposure must be taken to the doctor. It's illegal

for the employer to require the employee to drive themselves.

3. A copy of the pesticide label should be brought to the medical care facility with the injured/ill employee

Age Requirements

No one younger than 18 can handle a pesticide that has a label that requires any of the following:

- air-supplied respiratory protection
- closed-system mixing equipment
- full-body chemical resistant clothing (this is not the same as cotton or Tyvek® coveralls).

Working Alone

When an employee working in agricultural production handles a Category 1 pesticide, they must have contact (in-person, radio, cell phone) with their supervisor…

- during the day, every 2 hours
- at night, every hour

Safe Equipment

Equipment used for mixing and applying pesticides must be kept in good repair and be inspected daily.

Here are some other important requirements:

- **Hatches, Doors and Hoses**: Any flexible hose under pressure carrying a liquid pesticide labeled with the signal word "DANGER" or "WARNING" must not pass unshielded through the cockpit of an airplane or helicopter.
- **Shutoff Devices**: A shutoff device must be installed on the exit end of all hoses carrying a liquid pesticide from mixing tanks when the signal word "DANGER" or "WARNING" is on the pesticide label. A reverse action pump or similar system that will empty the hose and eliminate dripping may be used as an alternative.
- **Adequate Lighting**: When working at night, the mixing and loading operation area must have adequate lighting.
- **Overflow Prevention**: Each tank with a capacity of more than 49 gallons, being used for Category I or II pesticides must:

- have a properly functioning means to externally indicate the internal liquid level, (i.e. site gauge or tank you can see thru), or

- have a tank or filler nozzle with a device that automatically stops the filling operation before the pesticide spills over the top.

- **Equipment Maintenance**: People who own or operate pesticide application equipment must inform anyone who may be involved in the cleaning, servicing, and repair of such equipment about pesticide hazards and how they can protect themselves.

- **Closed Systems**: Employers must provide closed systems* for employees that mix or load Category I liquid pesticides or diluted liquid mixes derived from dry Category I pesticides. Closed systems are required only when the pesticide is applied to an agricultural commodity. Closed system requirements do not apply to employees who handle a total of one gallon or less per day from original containers that are one gallon or less in volume.

** Important definition: a closed system is a mechanized procedure for removing a liquid pesticide from its original container, rinsing the emptied container and transferring the pesticide and the container rinseate to the spray tank. A closed system reduces mixer/loader pesticide exposure by eliminating hand pouring.*

Change Areas

Employers must provide change areas for employees that regularly handle* Category I and II pesticides in non-ag settings. For agricultural production settings this requirement applies to all Categories I, II and III. At a minimum, this change area must include:

- a place to wash and change clothes at the end of the work day

- clean towels, soap, and adequate water

- a clean, pesticide-free place where employees may store personal clothing while handling pesticides

**Important Definition: "Regularly handling a pesticide" means handling the pesticide for more than 6 days in any 30-day period. The 6*

days don't have to be consecutive. Any part of a day would be considered 1 day. For example, if you spend one minute mixing up a small amount of a pesticide, that counts as 1 day in your 6 days towards "regularly handling".

Decontamination Facilities

The following must be available at the pesticide use site for emergency decontamination:

- clean water,
- soap
- disposable towels

These items are only required for Category I and II pesticides when the use setting is not for agricultural production.

At least one pint of water must be immediately available if:

- if the pesticide label requires eye protection, and
- the setting is agricultural

Here's how close the decontamination facilities must be to the mix and load site:

- for ag production: at the mix and load site and no further than 0.25 miles from all applicators

Farming

- for non-ag: no further than 100 ft from the mix and load site

Medical Supervision

Some insecticides work by affecting the central nervous systems of insect pests. These pesticides reduce the amount of a blood stream enzyme called cholinesterase. These cholinesterase-inhibiting chemicals are either organophosphate or carbamate insecticides.

- **Organophosphates**: these pesticides are central nervous system poisons and like the n-methyl carbamates are among the most toxic pesticides that are used today. Examples from this group include;
  - diazinon
  - malathion
  - parathion
- **N-methyl carbamates**: like the organophosphates, the "carbamates" are central nervous system poisons and are generally very toxic to non-target animals. Examples of the carbamates include:
  - carbaryl
  - carbofuran
  - methomyl

A blood test can tell if humans have been exposed to these chemicals. An overexposure to organophosphate or carbamate insecticides would result in blood test results with low cholinesterase levels.

Here's some basic information about the medical supervision requirements:

- the requirements only apply to agricultural production
- they only apply to employees who regularly handle these pesticides
- Employee Exposure Records: Employers must keep records of the amount of time their employees handle Category I and II organophosphate or carbamate insecticides. The employer must keep these records for three years.
- Medical Supervision Agreements: Employers must have written medical supervision agreements with physicians. Copies of these agreements must be given to county agricultural commissioners before employees can regularly handle these pesticides.
- Blood Tests: When required, employees must have their baseline cholinesterase levels determined by having 3 blood tests taken at 30-day intervals.
- The testing interval established by the physician should be at least every 60 days while the employee regularly handles these pesticides.

Hazard, Toxicity & Exposure

Hazard is the risk of illness or injury from pesticide exposure. The hazard level depends on both the pesticide's toxicity and the amount of exposure a person has to the pesticide. Look at the following equation:

(Risk)

Hazard = Toxicity X Exposure

With the hazard equation in mind, let's look at the following combinations:

Reducing exposure is the most effective way to reduce the hazards associated with using pesticides.

There are 3 mains methods that can be used to reduce exposure:

1. **Engineering controls** include enclosed cabs and closed loading systems. These devices create a barrier between you and the pesticide, reducing the hazard.
2. **Safety equipment** such as coveralls, eye protection and chemical-resistant gloves

3. **Hygiene practices** for example, washing hands before you handle food or drink and taking a shower at the end of the work day

Routes of Exposure

There are four routes of pesticide exposure:

1. oral (ingestion)
2. dermal (skin)
3. inhalation (breathing)
4. ocular (eye)

The majority of pesticide exposures are via the dermal route. Here are some ways this happens…

- not washing hands after handling pesticides
- splashing or spraying pesticides on unprotected skin or eyes
- wearing pesticide-contaminated clothing,
- wearing inadequate personal protective equipment while handling pesticides
- touching, rubbing, or handling pesticide-treated surfaces, or foliage

Oral exposure is when pesticides are swallowed. Oral pesticide exposure is caused by:

- not washing hands before eating, drinking, or smoking
- splashing pesticide into the mouth through carelessness or accident
- eating produce with high pesticide residues

Inhalation exposure is when pesticides are inhaled. Inhalation exposure is caused by:

- prolonged contact with pesticides in enclosed or poorly ventilated spaces
- breathing vapors, dust, or mist while handling pesticides without appropriate protective equipment
- using a respirator that fits poorly, is old, or has an inadequate filter, cartridge, or canister

Ocular exposure is when pesticides come in contact with the eyes. It's caused by:

- splashing or accidentally spraying pesticides in the eyes
- mixing or applying pesticides without eye protection
- rubbing the eyes or forehead with contaminated gloves or hands

Coveralls

DPR regulations define "coveralls" as any one or two piece article of clothing that covers the entire body except the head, hands and feet.

Here are some important requirements related to coveralls:

- the employer must provide coveralls to employees that handle Category I and II pesticides
- the employer is responsible for washing the coveralls…not the employee
- at least one extra pair of coveralls must be available at the mix and load site

Personal Protective Equipment

The purpose of personal protective equipment (PPE) is to reduce pesticide exposure. When it comes to PPE, there are two legal standards that the pesticide handler must follow:

1. the pesticide label
2. DPR regulations

In some cases, the label requirements for PPE conflict with DPR regulations. When this happens, the pesticide handler must follow the strictest standard.

Eye Protection: DPR regulations require eye protection for most pesticide applications…even if the pesticide label doesn't require it.

Unless the pesticide label requires a particular type of eye protection, one of the following types of eyewear or eye protective devices must be worn:

- safety glasses that provide front, brow, and temple protection
- goggles
- face shield

If the pesticide labeling identifies a specific type of protective eyewear, that specified eyewear or more protective eyewear, must be worn.

The eyewear must indicate that it's in compliance with American National Standard for Occupational and Education Personal Eye and Face Protection Devices ANSI Z87.1 - 2010

In California, there are very few exceptions to the eye protection requirement. Here are the exceptions:

- if pesticides are being injected or incorporated into the soil
- if pesticides are being applied through vehicle-mounted spray nozzles located below and behind the operator

- if the operator is working in an enclosed cab, and
- if the pesticides being applied are not in a liquid or gaseous form

Chemical Resistant Gloves: DPR regulations require the use of chemical-resistant gloves for nearly all pesticide use situation...even if gloves are not specifically required by the label.

Employers are required to provide gloves and require their use for all pesticides, except when the pesticide label specifies that gloves must not be worn. The employer shall assure that appropriate chemical-resistant gloves are worn by employees when their use is required.

If the barrier material is specified by a category on the product labeling, the required glove material must be:

- **Category A**: barrier laminate, butyl rubber, nitrile rubber, neoprene, natural rubber, polyethylene, polyvinyl chloride (PVC), or Viton®
- **Category B**: barrier laminate or butyl rubber
- **Category C**: barrier laminate, butyl rubber, nitrile rubber, neoprene, PVC, or Viton®
- **Category D**: barrier laminate or butyl rubber
- **Category E**: barrier laminate, nitrile rubber, neoprene, or Viton®
- **Category F**: barrier laminate, butyl rubber, nitrile rubber, or Viton®
- **Category G or H**: barrier laminate, or Viton®.

If pesticide labeling is not specific about the type of barrier material, the gloves may be made of any material in Category A.

All barrier materials must be 14 mils or thicker except barrier laminate and polyethylene materials.

When chemical-resistant gloves are used to make fine adjustments that require high dexterity the gloves must be made of an appropriate barrier material, as specified in (a) and (b) above, and only be used for a maximum of 15 minutes. Such gloves may only be used once for such specific tasks and must be discarded after this use.

Separable glove liners made of cotton or other absorbent materials may be worn under chemical-resistant gloves unless expressly prohibited by pesticide product labeling. The glove liners must not extend beyond the end of the chemical-resistant glove. Glove

liners must be disposed of at the end of the workday, or immediately if any portion of the liner comes in contact with pesticide during the workday.

Flocked gloves or those with other types of non-separable liners are prohibited.

Leather gloves may be worn over chemical-resistant gloves when required by working conditions. Once leather gloves have been used for this purpose, they must not be worn without being worn over chemical-resistant gloves.

Other Types of PPE

There are no specific DPR regulations that address the following types of PPE. Their use is only required when specified by product labeling.

- **Chemical-resistant headgear**
- **Chemical-resistant footwear** The pant legs should be worn on the outside of the boots to keep materials from running down into the footwear.
- **Chemical-resistant aprons** They should be made of durable waterproof material, and long enough to cover your chest and reach below the tops of your boots.
- **Respiratory protection**...There are several different types of respiratory protection:
  - **Filtering facepiece:** these simple respirators look like dust masks, but they have a sturdier construction. The whole facepiece acts as a respirator
  - **Cartridge:** generally consist of a rubber face-piece and replaceable cartridge-type filters. They may be half-face or full-face.
  - **Powered air cartridge**...These are very similar to other cartridge-type respirators except that a battery-powered motor forces filtered air in to the facepiece or helmet.
  - **Air-supplied**...This type provides the greatest level of respiratory protection by using an outside source of clean air (i.e. a tank). Their use is required when oxygen levels are below 19.5% (i.e. fumigation).

Respiratory Protection

Here are several requirements for respiratory protective equipment that are not required for other types of PPE.

Be properly trained: Employees must be trained initially and at least every year on the respiratory equipment they are required to use. Training must cover:

- why the respirator is needed
- proper use
- how to do a fit-check
- proper cleaning and storage
- limitations of the equipment

3M has on-line evaluations

Receive a medical evaluation: High blood pressure, heart disease, lung disease and perforated eardrum are examples of conditions that may make using a respirator unsafe. Employers must make sure their employees receive medical evaluations before they are fit tested or use a respirator in the workplace.

Fit-testing: employees that use respiratory protection must be fit-tested. These tests use a strong-smelling or tasting chemical to determine if the respirator fits to the wearer's face without leakage. If the test subject can smell or taste the test chemical they have failed the test and must try a different respirator size or model. Facial hair (beards, sideburns, etc.) is one of the common reasons people fail fit tests. People with long facial hair may need to use full-face respirators in order to achieve an adequate fit.

Chemical-resistant Clothing

This type of PPE is NOT the same as regular cotton or Tyvek®-type coveralls. Chemical-resistant clothing is made of materials that allow no measurable movement of the pesticide through it during use. Pesticide handlers that use this type of equipment are at high risk of developing heat-related illnesses.

If the outside temperature exceeds 80°F during the day or 85°F during the night, pesticides that have labels that require chemical-resistant full-body protective clothing cannot be used.

First Aid

Pesticide poisoning symptoms can vary widely depending on the type of pesticide involved. The cholinesterase-inhibiting insecticides (i.e. the organophosphate and carbamates) have the most severe symptoms. Overexposure to these pesticides may cause:

- blurred vision
- dizziness
- heavy sweating
- weakness
- nausea
- stomach pain
- vomiting
- diarrhea

More significant exposures may cause convulsions, unconsciousness, coma, and possible death.

Whenever there is an accident involving pesticides, immediate attention must be focused on the potential danger to people and/or the environment.

Important Pesticide Label Sections

These two sections of pesticide labeling are especially important for pesticide emergencies:

1. **Precautionary Statements** describe the hazards to people and domestic animals, environmental hazards, and physical and chemical hazards

2. **Statement of Practical Treatment** on the label describes what to do in the event someone is accidentally exposed to the pesticide. For example, information on emergency first aid and when to seek medical attention.

Routes of Exposure & First Aid

There are specific first aid procedures for each route of exposure.

Dermal Exposure

- remove the victim from the contaminated area

- restore breathing

- prevent further exposure by:

  - removing contaminated clothing
  - washing affected areas with soap and water

- seek medical attention, bring the pesticide label with you

Oral Exposure

- dilute the pesticide by having the conscious victim drink liquids

- induce vomiting if advised by a medical profession

- seek medical attention

Respiratory Exposure

- protect yourself from exposure
- remove victim from area
- loosen victim's clothing
- restore breathing
- treat for shock
- seek medical attention

Ocular Exposure

- wash the eyes out for 15 minutes
- seek medical care
- cover eyes with clean, wet cloth while transporting
- seek medical attention, bring a label with you

Fieldworker Safety

Farming

The primary purpose of the fieldworker safety regulations is to protect agricultural field workers from pesticide residues in their workplaces.

Fieldworker Training

Before employees enter a treated field they must receive pesticide safety training. Training must be given at least every 5 years and must cover the following subjects. This training is similar to the training required for pesticide applicators but includes fewer requirements.

Restricted Entry Intervals

No employee may enter any field treated with a pesticide until the pesticide spray has dried or the pesticide dust has settled, except in the case of a life or health-threatening emergency. The waiting period for the drying or settling of a pesticide need not exceed 24 hours.

In addition to the "spray has dried/dust has settled" standard, DPR regulations or pesticide labels may require longer waiting periods called restricted entry intervals (REIs).

An REI is a waiting period from the time of the pesticide application to the time when workers may legally reenter that field. REIs allow pesticide residues on crop foliage to break down to levels that are safe for worker contact.

REI Adjustment, Organophosphates

Whenever a mixture of two or more organophosphate pesticides is applied, the reentry interval is determined by adding the longest applicable reentry interval to 50% of the next longest applicable reentry interval.

For example, when treating a crop with a combination of the organophosphate pesticides A and B. Pesticide A has a reentry of 14 days and Pesticide B has a reentry of 2 days. The total reentry interval would be 15 days (14 days + 2 days x 0.5 = 15).

Posting (Warning Sign) Requirements

Warning signs: must be posted when:

- required by labeling,
- the pesticide has a labeled REI of 7 days or more, and
- there are greenhouse applications with REIs and greenhouse entry cannot be adequately controlled

Other Posting Requirements

Here are some other important things to remember about field posting:

- the signs must be posted at the usual points of entry or at the field corners
- if the field is next to a road, the signs must be posted every 600 feet
- the signs must be legible for the entire reentry interval
- the word "DANGER" and two skull and crossbones symbols must be visible from 25 feet
- the signs must be in English and Spanish
- the signs must be posted before the application begins but no sooner than 24 hours before
- the signs cannot be removed during the reentry interval
- the signs must be removed within 3 days after the end of the reentry interval

Fumigation Worker Safety

This section deals with worker safety requirements for employees that use fumigants in field settings or in enclosed areas.

Fumigation Exposure Limits

The permissible exposure limit (PEL) is the maximum concentration of an airborne chemical that a person is allowed to be exposed to over an 8-hour period without using respiratory protective equipment.

If fumigation concentrations are likely to exceed the PEL, the employer must require employees to use respiratory protective equipment.

Whenever an employee may be exposed above an exposure standard (i.e., PEL) for methyl bromide, sulfuryl fluoride or other fumigants for which only air-supplied respiratory equipment is approved, the employer has the option of:

- requiring the use of air-supplied respiratory equipment,
- employing continuous monitoring to warn employees before the PEL is reached; or
- Developing a Fumigation Safety Program that describes how employees will not be exposed above the PEL. This plan must be approved by DPR.

Fumigation: Other Requirements

Here are some other requirements for fumigations:

- the employer must have an accident response plan

- Two trained employees must be present at all times during introduction of the fumigant and when the enclosed space is entered to facilitate aeration or for determining the concentration of the fumigant.

- Warning signs must be posted at all entrances to the space under fumigation.

- Warning signs must be printed in red on white background and must contain, in English and Spanish, the following statement in letters not less than two inches in height: "DANGER FUMIGATION." The signs must also have a skull and crossbones not less than one inch in height and state in letters not less than one-half inch in height the name of the fumigant, the date and time the fumigant was injected, and the name, address and telephone number of the applicator performing the fumigation.

Field Fumigations

Whenever methyl bromide or chloropicrin is used for field fumigation, at least two trained employees must be present during the introduction of the fumigant and removal of the tarps. Warning signs must be posted and shall remain in place until aeration is complete.

Posting Public Areas

- schools parks public places
- for pesticides that are label-imposed
- Always < 24 Hours
- Skip signs if Areas can be Secured
- English + Espanol
- Sign Removed 24 hrs.

REVIEW QUESTIONS

1. Which of the following are NOT topics that must be reviewed during employee safety training?

a. pesticide exposure routes

b. heat-related illness

c. pesticide reporting requirements

d. warnings not to take pesticide containers home

2. Which pesticide handing activity is the most hazardous?

a. mixing and loading

b. rinse and drain procedures

c. aerial applications

d. low volume applications

3. Who can provide pesticide safety training for applicators working in agricultural production?

a. a licensed PCA

b. a UC Farm Advisor

c. a registered professional forester

d. all of the above

e. a and c

4. No one younger than 18 can handle pesticides that require which of the following?

a. a closed system

b. full body chemical-resistant clothing

c. full face respirators

d. all of the above

e. a and b

5. Spray tanks that are larger than 49 gallons must have which of the following when used for Category I or II pesticides?

a. an emergency spill kit

b. an external volume gauge

c. a see-thru tank

d. all of the above

e. b and c

6. When must a closed system be used?

a. for all Category I liquids

b. only when required by labeling

c. for Category I and II pesticides

d. for Category I liquids used for production agriculture

7. "Regularly handling" a pesticide is:

a. more than 6 days in any 30-day period

b. prohibited for Category I cholinesterase inhibitors

c. more than 10 days in any 30-day period

d. none of the above

8. Which of the following can be used to reduce pesticide exposure?

a. closed systems

b. personal protective equipment

c. hand-washing after handling pesticides

d. all of the above

9. What's the most common route of pesticide exposure?

a. ocular

b. inhalation

c. dermal

d. ingestion

10. Which of the following are true about coveralls?

a. they can be one-piece or two-piece articles of clothing

b. they must be used whenever employees handle pesticides

c. employees can wash them at home when Category II or III pesticides are use

d. they must be disposable

11. What must occur when the air temperature exceeds 85° F and employees are using pesticides that require chemical-resistant clothing?

a. they must take breaks in a shaded area every hour

b. they must drink 1 quart of water each hour

c. a and b

d. they must stop using those pesticides

12. Which of the following are symptoms of Category I herbicide exposure?

a. sweating and nausea

b. blurred vision

c. weakness

d. all of the above

e. none of the above

13. Which label section provides information on risks to people and domestic animals?

a. use directions

b. Statement of Practical Treatment

c. Precautionary Statements

d. signal word

14. How often must agricultural fieldworkers receive pesticide safety training?

a. never

b. every year

c. every other year

d. every 5 years

15. What is the re-entry period when two organophosphate insecticides are used and their re-entry periods are 6 days and 2 days?

a. 6 days

b. 7 days

c. 8 days

d. 10 days

Answers

1.c	6. d	11. d
2.a	7. a	12. e
3.d	8. d	13. c
4.e	9. c	14. d
5.e	10. a	15. b

6. ENVIRONMENTAL SAFETY

Pesticide Residues

Pesticide residues may be found in air, soil and water. They may also be found in harvested crops and in living organisms like wildlife.

Pesticide residues are typically measured in milligrams of the pesticide divided by the weight of the substance in which it's measured. For example, a concentration of 10 milligrams of the insecticide diazinon per kilogram of soil can be abbreviated as10 mg/kg.

It's important to remember that milligrams/kilogram is the same thing as parts per million or ppm. So, a concentration of 10 mg/kg is the same as 10 parts per million and 10 ppm.

Depending on the chemical that's being analyzed, analytical laboratories can often measure down to the parts per billion level (ppb) and in some cases down to parts per trillion (ppt).

Pesticide Breakdown

Here are the most common ways pesticides are broken down in the environment:

- by sunlight (photolysis)
- by water (hydrolysis)
- by soil micro-organisms, like bacteria (microbial breakdown)

The amount of time it takes for pesticide residues to break down depends on several environmental factors including:

- temperature (i.e. soil or water)
- soil type (sand, loam or clay)
- oxygen content (i.e. soil or water)
- biological activity (i.e. soil or water)

In general, warm environments with lots of oxygen and plenty of micro-organisms like bacteria and fungi will break down pesticide residues quickly. Cold, oxygen-poor, biologically-dead environments tend to cause pesticide residues to persist.

Pesticide Persistence

Some pesticides tend to break down more slowly than others. These persistent pesticides have the ability to resist mechanisms that would break down other pesticides more quickly. The organochlorines are a good example of a group of pesticides that are very persistent.

- **Organochlorines**: also known as the chlorinated hydrocarbons, most of these chemicals are no longer used. They tend to be very persistent in the environment which can cause a variety of environmental

problems. For example, the insecticide DDT caused significant declines in the populations of some bird species like the bald eagle. DDT use in the United States was banned in 1972. Here are some examples of chlorinated hydrocarbons:

- chlordane
- DDT
- endosulfan

Pesticide persistence is measured in half-lives. A half-life is the amount of time it takes for the pesticide to break down from its original concentration to one-half of its original concentration.

The half-lives of many modern pesticides are measured in days. But, some older pesticides have half-lives that are measured in years. Depending on environmental conditions, DDT's soil half-life can be as long as 30 years. DDT, like most of the other organochlorines is no longer legal to use in the United States. It was banned in the 1970's.

Pesticide Residues in Food

A tolerance is the maximum legal concentrations of pesticides that can be present in foods. Pesticide tolerances are established by the USEPA, and are based on both the pesticide and the food product in which it may be found. For example, the tolerance for malathion on fresh cherries is 8 milligrams of malathion per kilogram of cherries or 8 mg/kg.

DPR...often with the assistance of the local county agricultural commissioner...collects produce samples from wholesale and retail markets for pesticide analysis. Illegal residues are uncommon but when they occur, investigators track them to their source. Sampled produce that have residues that exceed established tolerances are quarantined and may be seized and destroyed.

Produce that has pesticide residues for which no tolerance has been established are treated in the same way. For example, let's say that laboratory analysis has determined that a sample of harvested persimmons contains malathion residues. Because there is no federal tolerance for malathion on persimmons, that contaminated crop will be quarantined and may ultimately seized and destroyed.

One of the most important ways to avoid illegal pesticide residues in foods is observing the preharvest interval (PHI). The PHI is the legally-required waiting period from the time of the pesticide application to harvest. The PHI is established by the USEPA and...when required...is found on the pesticide label. For example the

product labels for abamectin-based insecticides require a 14-day PHI for avocados.

The length of the PHI is based on two factors:

1. the pesticide's toxicity to humans

2. how long it takes for that pesticide to break down to below the established tolerance for that crop

Tolerance Combinations

Sometimes produce that's been sampled for pesticide residues will have a combination of several pesticides. In order to determine if the pesticide residues are legal, you have to consider each individual tolerance on a percentage basis.

If the pesticides are related to each other (i.e. they're in the same chemical group), you add the percent tolerance together. If the sum of these percentages exceeds 100%, the combined residues are ILLEGAL.

Here's an example of **RELATED** pesticides. Pesticides X and Y are both organophosphates.

Pesticide	**Tolerance**	**Residue**	**%**
X	2	1	50
Y	6	4	67
			117

In this case the combined residues are ILLEGAL because the sum exceeded 100% (117%).

If the pesticides are NOT related you don't add each percentage together. Each pesticide tolerance is considered on its own.

Here's the example of **UNRELATED** pesticides. Pesticide X is an organophosphate and Pesticide Y is a synthetic pyrethroid.

Pesticide	**Tolerance**	**Residue**	**%**
X	2	2	100
Y	6	6	100
			200

Because the 2 pesticides are NOT related, you don't add the percent tolerances. Each pesticide residue can be 100% of its tolerance.

Groundwater Contamination

Pesticides can enter groundwater two ways, leaching and through soil openings.

- Sandy soils are at greater risk for leaching because they're more porous than loam or clay soils.

- Pesticides can also contaminate groundwater by entering through soil openings like cracked well heads or heavily-cracked clay soils.

A pesticide's tendency to contaminate groundwater is based on several factors:

- **Water Solubility**. The more water soluble the pesticide is, the greater it's leaching potential in soil.

- **Soil-absorption Potential**. Some pesticides are more strongly bound to soils than others. Chemicals that are strongly bound to the soil are less like to leach in to the groundwater. Additionally, some soils are better at absorbing pesticides than others. For example, clay soils and soils with heavy organic matter (OM) content tend to bind pesticides more readily than sandy or low OM soils.

Chemical Bond?

- **Persistence.** Pesticides that are more persistent in soil (i.e. have longer soil half-life times) pose a greater groundwater contamination risk than pesticides that break down quickly.

DPR has identified the pesticides that are known and suspected groundwater contaminants in California. As a group, the pre-emergent herbicides have the greatest tendency to become groundwater contaminants. This is because they tend to be highly water-soluble, are not strongly-bound to soil and have relatively long soil half-lives.

DPR has a program for protecting groundwater from pesticide contamination. This program has 3 basic elements:

1. Regulations that identify specific geographic areas in the state where soils are vulnerable to groundwater contamination. These areas are called Groundwater Protection Areas (GWPAs). There are two types of GWPAs, leaching and run-off.

2. Regulations that identify which pesticides are known or suspected groundwater contaminants, and

3. Restrictions on the use of known groundwater contaminant pesticides within GWPAs.

Surface Water Contamination

Pesticide contamination of surface water areas like streams, rivers, ponds and lakes is also an important issue.

While many different pesticides can contaminate surface water, the fungicides insecticides applied to orchards and vineyards during the winter dormant season are especially important. This is because they're applied during the winter when rainfall and flooding can move these pesticides off-site to creeks and other water bodies during...and after...pesticide applications.

The synthetic pyrethroid insecticides used in both crop production and residential pest control settings is another example of a pesticide group that can contaminate waterways.

- **Synthetic Pyrethroids**: Originally developed from a chemical extracted from chrysanthemum flowers, the man-made (synthetic) versions are among the most commonly used insecticides today. In general, they are less toxic to people and domestic animals than the organophosphates and carbamates, but are highly toxic to fish and other aquatic organisms.

Here are some ways that surface water areas can be protected from pesticide contamination:

- limiting the use of certain pesticides during the dormant season
- limiting applications to sites that don't produce run-off that can flow in to nearby water bodies
- requiring run-off water to be held on-site to allow for pesticide breakdown

Non-point vs Point Source

Chemical pollution in water can be separated in to two basic sources; non-point sources and point sources.

Non-point sources are generally:

- from normal pesticide applications
- involve numerous applications and application sites
- involve large geographic areas
- result in lower pesticide concentrations in off-site waters that do not pose significant human or ecological risks

Point pollution sources may:

- involve spills or accidents

- occur at one or few sites in a small geographic area
- result in high pesticide concentrations that cause human or ecological harm

Avoiding Pesticide Pollution

Here are some ways to avoid causing pesticide pollution:

- **Proper storage.** Store pesticide containers where they're protected from the weather. Make sure storage areas have flooring that protects containers from contact with damp soil.
- **Proper Handling**. Avoid spills during mixing and loading. Clean up spills immediately after they occur. Identify leaky containers and transfer contents in to new containers.
- **Proper Application.** Reduce pesticide drift that occurs during windy weather and pesticide run-off in surface water, especially when rainfall is expected shortly after pesticide applications.
- **Proper Disposal**. Follow triple-rinsing procedures when using liquid pesticides, and make sure that dry pesticide containers are completely empty before disposal. Make sure to follow all the container disposal procedures required by either regulations or product labels. Never dump unwanted pesticides in to storm drains or water ways.
- **Proper Cultural Practices.** Know and follow all the product label requirements that address post-application procedures. For example, some soil-applied pesticide products must be incorporated in to the soil by tillage or irrigation immediately after application.

Pesticide Container Disposal

DPR regulations require that pesticide containers that have held 28 gallons or less must be tripled rinsed at the time of use. Here are some important points regarding this requirement:

- empty containers should be refilled with water: 25% of the container volume for containers < 5 gals and 20% for containers >5 gals
- re-cap the container, shake and then pour the contents in to the spray tank
- repeat 2 more times

- rinsate should be sprayed out at the use site

Triple rinsed liquid pesticide containers are NOT hazardous waste and can be placed in a dumpster or other trash management receptacle.

Pesticide containers larger than 28 gals should be returned to the pesticide manufacturer for reconditioning or recycling.

In some counties, pesticide handlers may be required to have their triple-rinsed containers inspected by the county agricultural commissioner before disposal at an approved site.

Disposal: Dry Pesticides

DPR does not have specific regulations regarding the disposal of pesticide bags. Pesticide handlers should follow label instructions and DPR's guidelines for bag disposal. Here's a summary of DPR's bag disposal guidelines:

- open and empty the bag as completely as possible for at least 5 seconds
- straighten the seams so that the bag is in its original "flat" condition and pour out any remaining contents for another 5 seconds
- shake the bag twice and hold for another 5 seconds
- empty bags can be burned under a grower's agricultural burn permit at the pesticide application site

Emergencies

Pesticide safety training programs should include procedures on what to do in the event an accident occurs. The following procedures can be used for a wide range of different types of accidents:

- clear the area of unprotected people or domestic animals
- administer first aid and seek immediate medical care for people who are injured or ill
- prevent fires by extinguishing all sources of ignition and ventilate if needed
- in case of fire, call the fire department, keep people away from the fire, and evacuate the downwind areas
- clean up spilled pesticides, using absorbent materials and put contaminated materials into labeled, sealable containers
- decontaminate the area using information from the chemical's label and safety data sheet (SDS)
- all hazardous material waste must be transported to a Class I landfill under the proper permits

The Endangered Species Act

While pesticides can affect non-target plants and wildlife, they're rarely the main reason wildlife species become endangered.

When it comes to impacts on plants and wildlife, habitat loss…not pesticide use…is the most important factor.

For those issues where pesticides may affect plant and wildlife species, the Federal Endangered Species Act (FESA) provides the necessary environmental protection. FESA is enforced primarily by the U.S. Fish and Wildlife Service (USFWS).

The main way that FESA protects plant and wildlife species from pesticide impacts is through pesticide label restrictions. Pesticide labels may:

- have specific restrictions on pesticide uses within the habitats of specific endangered species
- may refer the pesticide user to bulletins or other similar information sources that provide strategies to minimize pesticide risks

Another source of information on pesticides and endangered species is DPR. DPR has a program that provides mapping information and mitigation

strategies for endangered species protection in California.

The Healthy Schools Act

California's Healthy Schools Act (HAS) was enacted to protect the health and safety of children and staff in certain public schools and daycare centers.

Here are the basic elements of the HSA:

- prohibits the use of pesticides that have conditional or canceled registrations or are in the cancelation process
- posting warning signs for pesticide applications
- notification of staff and families of pending pesticide applications
- pesticide application record-keeping

Some pesticides are exempt from HSA requirements:

- self-contained baits and traps
- crack & crevice gels and pastes
- pesticides that are exempt from USEPA registration because of their low potential for human health impacts

REVIEW QUESTIONS

1. Pesticide residues are generally measured in what units?

a. half-lives

b. tolerance units

c. parts per million

d. a and c

2. Which of the following are mechanisms that break down pesticides?

a. microbial breakdown

b. inversion

c. fusion

d. all of the above

3. Which of the following conditions is best for pesticide breakdown in soil?

a. warm temperatures and high oxygen levels

b. warm temperatures and low oxygen levels

c. cold temperatures and high oxygen levels

4. A half-life is defined as:

a. 50% of the time it takes the pesticide to break down to non-detectable levels

b. the amount of time it takes for the pesticide to break down to 50% of its legal tolerance

c. how tolerances are measured

d. none of the above

5. Which pesticide group has the longest half-life?

a. organochlorines

b. n-methyl carbamates

c. organophosphates

d. synthetic pyrethroids

6. The legally allowable pesticide residue level in food is called a:

a. residue limit

b. tolerance

c. quarantine level

d. none of the above

7. Produce that has illegal pesticide levels must be:

a. washed adequately to remove all pesticide residues

b. put under quarantine

c. destroyed

d. reanalyzed

8. How do pesticides leach into groundwater?

a. directly through the soil profile especially in heavy clay soils

b. directly through the soil profile especially in sandy soils

c. through cracked well-heads

d. b and c

e. a and b

9. The more water soluble a pesticide is, the greater its:

a. leaching potential

b. groundwater contamination potential

c. surface water contamination potential

d. all of the above

10. Most groundwater contaminants belong to which pesticide group?

a. post-emergent herbicides

b. chlorinated hydrocarbons

c. organophosphates

d. pre-emergent herbicides

11. Which of the following are examples of point source pollution?

a. illegal pesticide dumping in to a creek

b. a crop duster crash in to a lake

c. leaky pesticide containers in a pesticide storage area

d. all of the above

12. Pesticides containers that have held a liquid pesticide and are less than 28 gals must be:

a. triple rinsed at the time of use

b. taken to a Class I landfill

c. can be reused for any purpose

d. none of the above

Answers:

1.c	6. b	11.d
2.a	7.b	12. a
3.a	8.d	
4.d	9.d	
5.a	10.d	

7. PEST MANAGEMENT

What Are Pests?

A pest is any organism that competes or interferes with the production of food or fiber products, damages ornamental plants or personal belongings, or transmits disease. Obviously, not all organisms are pests. In fact, a species may be a pest in one circumstance and beneficial in another.

Different Pest Types

There are four major pest groups:

- invertebrates
- plant diseases
- vertebrates
- weeds

Pest Classification

There are many different ways to categorize or classify pests. One common method is based on pest priority:

Key Pests: A key pest is the most significant and perhaps the most common pest of a crop or site. For example, codling moths are a key pest in apple production and cockroaches are key pests in commercial kitchens.

Secondary Pests: These are generally less important or prevalent than the key pest species, but they may become problems as a result of the successful control of the key pest. They may also become a greater problem when pesticide use has eliminated the natural insect predators that keep them under control.

Occasional Pests: These species are unlikely to become serious problems. They may be present, but the damage they cause is insignificant economically or aesthetically.

Pest Management

There are several different pest management methods:

Biological Control: uses beneficial species such as insects or plant diseases to control pests. Here are some important facts about biological control agents:

- many are imported from other countries under strict government control
- they're for pest suppression not eradication
- most are host-specific, they control only one…or just a few…pest species

Biological control programs can be improved by the following:

- carefully monitoring the populations of both pest and beneficial species;
- using management strategies (i.e. planting, irrigation, etc) that encourage beneficial species populations; and
- **Narrow-spectrum pesticides** that don't harm beneficials because they affect a limited number of species should be used. **Broad-spectrum** pesticides that affect both pest and beneficial species should be avoided.

Chemical Control: involves using either natural or man-made (synthetic) chemicals. Air - Curtain

Mechanical & Physical Control:

Mechanical and physical methods control pests directly or make the environment unsuitable for them.

- disking – mechanical
- mowing – mechanical
- plowing – mechanical
- trapping – mechanical
- barriers – physical
- hand-pulling/picking – physical

Cultural Controls include practices that reduce pest establishment, reproduction, dispersal, and survival. Here are some examples:

- excluding pests by using window screens, air curtains
- weed control to eliminate insect or rodent pest habitat
- sanitation, such as removing garbage that may harbor cockroaches in a restaurant
- modifying schedules for irrigation, pruning or harvest to discourage or eliminate pest species
- using hot or cold temperatures in processing or storage

Here are a few other pest management terms that are important:

Host Resistance: Involves the use of crops or crop varieties that are resistant to pest infestation or can tolerate pest damage.

Regulatory Pest Control: This is a specialized pest control system that involves government regulatory control of specific pest species. Government regulatory programs may include the following:

- **Quarantine** prevents entry of a pest into areas that are free of that pest.
- **Eradication** involves the use of methods that can eliminate a pest from a defined area.

- **Abatement** involves government agencies using their regulatory authority to require pest control actions to be taken. The most common example of this would be the declaration of a public nuisance.

Integrated Pest Management

Integrated pest management (IPM) combines the following strategies to prevent pest damage:

- information about pests & pest control strategies
- monitoring: pests & beneficials
- pest prevention strategies
- chemical control strategies
- non-chemical control strategies

An important aspect of IPM involves establishing thresholds. **A threshold is predetermined point at which pest populations or environmental conditions indicate that pest control action should be taken**. Once a pest management threshold has been exceeded, failing to take pest control action can have significant economic or aesthetic impacts.

Protecting Beneficial Species

Beneficial species can be protected from pesticide-caused impacts by using the following principles:

- **Proper Application Timing**: Pesticide applications can be made in early morning, late afternoon, or at night when honeybees are not foraging.
- **Proper Pesticide Selection**: Use narrow-spectrum pesticides instead of broad-spectrum pesticides.
- **Adjusting Dosages**: Whenever possible, use lower dosages to reduce risk to beneficial species.
- **Using Spot Treatments**: apply pesticides to smaller areas to minimize the effects on beneficials

Beekeeper Notification

Special procedures must be followed when using certain pesticides near bee hives (apiaries).

Pesticides that are toxic to honeybees will have the following warning in the Precautionary Statements section of the label:

This pesticide is highly toxic to bees

The person in charge of the pesticide application must check with the county agricultural commissioner to find out if any beekeeper has requested to be

notified of nearby pesticide applications.

The beekeeper must be notified at least 48 hours before the scheduled application when:

- pesticides that are toxic to bees are used (i.e. have pesticide warning statements about bee hazards)
- these pesticides are applied to blossoming crops
- the pesticide is used within one mile of the hives

The notice to the beekeeper must include the following information:

- time and place of application
- crop and acreage to be treated
- the method of application
- pesticide name and use rate
- application method
- how the person performing pest control can contact the beekeeper

REVIEW QUESTIONS

1. Which of the following are considered to be pest species?

a. weeds

b. invertebrates

c. abiotic factors

d. all of the above

e. only a and b

2. A pest that is the most significant pest of a crop or site is considered to be which of the following?

a. a summit pest

b. a biotic pest

c. a key pest

d. none of the above

3. Which type of pesticide provides the most protection for beneficial species?

a. narrow spectrum

b. organic

c. broad-spectrum

d. green

4. Which of the following statements is false about biological control?

a. uses beneficial species

b. eradicates pests

c. always involves pesticide use

d. all the above are true

e. b and c are false

5. Which of the following are mechanical control methods?

a. plowing

b. trapping

c. mowing

d. all of the above

e. only a and c

6. Modifying schedules for irrigation to discourage or eliminate pest species is considered to be what type of pest control method?

a. biological

b. abiotic

c. natural

d. cultural

7. Using crop varieties that can tolerate pest damage is which of the following?

a. natural pest control

b. genetic modification

c. host resistance

d. rarely successful

8. Regulatory pest control may include which of the following:

a. eradication efforts

b. quarantines

c. pesticide bans

d. all of the above

e. a and b only

9. An IPM threshold is:

a. the optimal level of a beneficial organism

b. a biological agent that controls 50% of the pest damage

c. a predetermined pest population level at which pest control activities are initiated

d. a and c

10. The beekeeper notification regulations apply to which of the following scenarios?

a. all pesticides used within one mile of bee hives

b. any pesticide that is applied to blossoming crops used within one mile of bee hives

c. only certain pesticides applied to blossoming crops used within one-half mile of bee hives

d. none of the above

Answers:

1. e	6. d
2. c	7.c
3. a	8.e
4. e	9.c
5. d	10.d

memory

8. CALIBRATION

Calibration involves determining the correct amount of pesticide that should be applied to a given area. Proper calibration involves the following factors:

- spray tank volume
- the size of the area to be treated
- the pesticide application rate
- the pesticide dilution rate
- the flow rate
- the speed of the equipment.

The application rate is the amount of pesticide to be applied to an area. Application rates are usually in ounces, pints, quarts, gallons, or pounds per acre or square feet.

The dilution rate is the total volume of the tank mix (i.e. pesticide and mix water), usually in gals per acre.

The total amount of pesticide needed is determined by multiplying the application rate by the number of acres or square feet.

Flow rates are in gallons per minute (gpm). This rate can be for one nozzle or the entire spray system. Flow rates for spray rig calibration must include all nozzles in operation at time of application.

Speed is given in miles per hour (mph).

Sprayer Output

There are three ways to change sprayer output:

1. **Change the pressure**: Changes in tank pressure actually have very little effect on total output. To double the output of a spray system, the pressure must be increased by a factor of four.

2. **Change the nozzles**: This is the most effective way to change sprayer output. Larger orifice nozzles to increase output and smaller nozzles for less output.

3. **Change the speed**: This is the simplest way to increase or reduce application rate.

memory!

Conversions

1 pound	= 16 ounces
1 gallon	= 128 ounces,
	= 4 quarts
	= 8 pints
1 mile	= 5,280 feet
1 acre	= 43,560 square feet

REVIEW QUESTIONS

1. How many square feet are in a plot measuring 100 feet by 150 feet?

a. 150 square feet

b. 1500 square feet

c. 15,000 square feet

d. 10,000 square feet

2. How many acres are in a plot measuring 300 feet by 150 feet?

a. 1 acre

b. 0.69 acre

c. 0.40 acre

d. 1.69 acres

3. If the label of a pesticide you are using recommended applying 2 pints per acre how much would you need for a plot measuring 200 feet by 300 feet?

a. 0 .50 gallon

b. 0 .65 gallon

c. 0.35 gallon

d. 1.5 gallons

4. You are making a preventive treatment for brown patch and dollar spot on a golf green. The treatment area measures 50 feet by 100 feet. How much fungicide will you need if the use rate is 1 pound per 5,000 square feet?

a. 1 ounce

b. 1 pound

c. 1.25 pounds

d. 14 ounces

5. You are treating ornamentals around a park for aphids. The use rate is 2 pints of insecticide in 100 gallons of water and your spray tank holds 50 gallons of total mix. How much insecticide should you add per tank mix?

a. 2 pints

b. 3 pints

c. 1 pint

d. 0 .5 gallon

6. How many gallons of pesticide would you need to treat an area measuring 300 feet by 485 feet if the use rate is 3 quarts per acre?

a. 1 gallon

b. 3 gallons

c. 2.5 gallons

d. 3.3 quarts

7. You are using a boom sprayer with 14 nozzles to band spray 20 inch beds. What is your swath width (net swath width) in feet and inches?

a. 18 feet, 6 inches

b. 20 feet, 2 inches

c. 23 feet, 4 inches

d. 12 feet, 6 inches

8. A spray rig traveling 300 feet in 41 seconds is traveling at how many miles per hour?

a. 5

b. 3

c. 2

d. 1

9. If you are spraying an open field at 5 mph with a swath width of 50 feet, how many acres per minute are you covering?

a. 1 acre per minute

b. 2 acres per minute

c. 0.5 acre per minute

d. 0.25 acre per minute

10. If a sprayer has a 400 gallon spray tank and the application rate is 75 gallons per acre, how many acres can be treated with each tank mix (based on 400 gallons)?

a. 4.0 acres

b. 5.3 acres

c. 10.0 acres

d. 40.0 acres

11. A sprayer with a 600 gallon tank applies 100 gallons per acre. The use rate is 2.5 pounds of wettable powder per acre. How much wettable powder do you need to add to each tank mix (based on 600 gallons of tank mix)?

a. 15 pounds

b. 10 pounds

c. 30 pounds

d. 6.5 pounds

12. If a sprayer treats 5.2 acres per hour and its flow rate is 6 gallons per minute, how many gallons of tank mix are being applied per acre?

a. 23.00 gallons per acre

b. 69.23 gallons per acre

c. 31.50 gallons per acre

d. 50.00 gallons per acre

13. A spray rig has a 300 gallon spray tank. The pesticide recommendation calls for 50 gallons of tank mix per acre and 2.5 pints of pesticide per acre. How much pesticide will you need to add to each tank mix?

a. 1.9 gallons

b. 2.5 gallons

c. 1.0 gallon

d. 5.0 gallons

SOLUTIONS

1. Find the area. 100 ft x 150 ft = 15,000 sq ft

2. a. Find the area. 300 ft x 150 ft = 45,000 sq ft

   b. Find acres. 45,000 sq ft * 43,560 sq ft/acre = **1.03 or 1 acre**

3. a. Find the area. 200 ft x 300 ft = 60,000 sq ft

   b. Find acres. 60,000 sq ft * 43,560 sq ft/acre = 1.38 or 1.4 acres

   c. Find amount needed. 1.4 acres x 2 pints/acre = 2.8 pints

   d. Convert pts to gals 2.8 pints * 8 pints/gallon = **0.35 gallons**

4. a. Find total area. 50 ft x 100 ft = 5,000 sq ft

   b. 5,000 sq ft x 1 lb/5,000 sq ft = **1 lb**

5. a. Find how many 100 gallon units/tank. 50 gals/100 gals/unit = 0.5

   b. Find the amount of pesticide/tank 2 pts x 0.5 units = **1 pint**

6 a. Find the area to be treated. 300 ft x 485 ft = 145,500 sq ft

   b. Find acres. 145,500 sq ft * 43,560 sq ft/acre = 3.34 acres

   c. Find the amount of pesticide.3.34 acs x 3 qts/acre = 10.qts

   d. Convert qts to gals. 10 qts * 4 qts/gal = **2.5 gallons**

7. a. Find the swath width: 20 inch bands x 14 bands = 280 inches

   b. Convert in. to ft: 280 in * 12 in/ft = **23.3 feet or 23 ft and 4 inches.**

8. a. Convert into ft/min: 300 ft/41 sec x 60 sec/1 min = 439 ft per minute

b. 439 ft/min x 60 min/hr x 5280 ft/mile = **4.99 or 5 mph**

9. a. Convert mph to ft/min: 5 mph x 1 hr/60 min x 5280 ft/mi = 440 ft/min

b. Calculate rate: 50 ft swath x 440 ft/min = 22,000 sq ft/min

c. Convert sq ft to acres: 22,000 sq ft * 43,560 sq ft/acre = **0.5 acres**

10. Calculate how many acres/tank: 400-gal tank/75 gals/ac = **5.3 acres**

11. a. Find how many acres/tank: 600-gal tank/100 gals/ac = 6 acs/tank

b. Calculate the amount needed: 6 acs/tank x 2.5 lbs/ac = **15 lbs**

12. a. Convert gpm to gph: 6 gpm x 60 min/hr= 360 gals/ hr

b. Calculate gpa: 360 gals/hr x 1 hr/5.2 acres = **69.23 gals/acre**

13. a. Calculate acres/tank: 300-gal tank/ 50 gals/ac = 6 acs/tank

b. Calculate pesticide needed: 6 acs/tank x 2.5 pts/ac = 15 pints

c. Convert pts to gals: 15 pts/8 pts/gal = **1.9 gals**

9. PRACTICE TEST

LAWS AND REGULATIONS

1. How many hours of approved continuing education must a QAC/QAL obtain for re-certification?

a. 30 hours every two years

b. 20 hours every two years

c. 20 hours every two years with at least 2 hours in laws and regulations

d. 20 hours every two years with at least 4 hours in laws and regulations

2. Which of the following is true with regards to certification of pesticide applicators?

a. Certified applicators have at least 100 hours of on-the-job experience.

b. Certified applicators are not required to have insurance.

c. Certified applicators have demonstrated they are capable of handling and applying pesticides safely.

d. Only college graduates can become certified.

3. Which of the following signal words signifies highly toxic Category 1 pesticides?

a. "Keep out of reach of children

b. "DANGER"

c. "WARNING"

d. "CAUTION"

4. Which of the following are pesticides?

a. Chlorine

b. Toilet bowl disinfectants.

c. Herbicides

d. all of the above

5. A pesticide in Category 2 would have which of the following on its label?

a. "Caution"

b. "Warning"

c. "Keep out of reach of children"

d. b and c

6. If a pesticide has an LD50 of 25 mg/kg what category is it in?

a. Category 1

b. Category 2

c. Category 3

d. Category 4

7. The toxicity of a pesticide is.....

a. a measure of its toxicity.

b. measured by its LD50.

c. a basic characteristic of the chemical.

d. All of the above.

8. Which of the following is not true regarding LD50 values?

a. they provide information about a pesticide's immediate or acute health hazards.

b. they are lower for pesticides that are more toxic.

c. they are the lethal dose of pesticide that will kill 50% of a test population.

d. they provide information to the potential long-term or chronic health effects of a pesticide.

9. Which of the following is used to control weeds?

a. acaricides

b. insecticides

c. fungicides

d. herbicides

10. Which of the following could be part of a pesticide formulation?

a stickers and spreaders

b. mineral clay

c. antifreeze

d. all of the above

11. What does the "Statement of Practical Treatment" on the label mean?

a. Recommended first aid treatments in case of poisoning.

b. It describes how to use the pesticide properly.

c. It describes the hazards associated with that pesticide.

d. It tells when and where to use the pesticide.

12. What information is found in the "Precautionary Statement" of a pesticide label?

a. The type of medical treatment that must be provided to a person who has been exposed.

b. The types of crops a pesticide must not be used on.

c. Hazard statements associated with the use of the pesticide

d. The maximum rate of application

13. Which of the following is true about the "Reentry Statement" on pesticide labels?

a. It tells what to do in case the pesticide is swallowed.

b. It describes how and where to dispose of leftover spray material.

c. It tells the user the toxicity of the pesticide.

d. It's the period of time a person has to wait before they may legally enter a treated field.

14. What is the primary responsibility of the state legislature?

a. to enforce regulations.

b. to develop policies.

c. to pass laws

d. to adopt regulations.

15. Which government agency registers pesticides at the federal level?

a. U.S. Food and Drug Administration.

b. U.S. Environmental Protection Agency.

c. California Department of Pesticide Regulation.

d. California Department of Health.

16. Which of the following is a Restricted-Use pesticide?

a. 2,4-D

b. Round-up

c. Malathion

d. All of the above

17. Which of the following statements is true about employee training?

a. Employees must be trained before handling any pesticides and at least annually thereafter.

b. Training is required within 30 days of handling any pesticides.

c. The employer is responsible for employee training.

d. a and c.

18. Which of the following is true about pesticide storage areas?

a. Pesticides with the signal word "Danger" or "Warning" on the label must be stored in a storage area that has warning signs visible from any direction of approach.

b. Storage areas must be locked whenever a responsible person is not present.

c. Pesticides must be stored in accordance with the storage recommendations stated on the label.

d. All of the above.

19. Before a state restricted-use pesticide can be purchased, the purchaser must have what from the commissioner?

a. a pesticide use clearance.

b. a notice-of-intent.

c. a restricted material permit.

d. a notice-of-application.

20. A service container label is required on what type of pesticide container?

a. All pesticide containers.

b. Any container used to hold a pesticide or pesticide mix, except the original container.

c. All glass containers.

d. None of the above.

21. A backflow prevention device is required when:

a. Drawing water from an outside source to the pesticide mix tank.

b. Transferring pesticides from the mix tank to the application tank.

c. Using a closed system.

d. Using a state-approved enclosed cab.

22. Why should the use of medications, alcohol or drugs be avoided when using pesticides?

a. They often cause drowsiness.

b. They may impair judgement.

c. They may impair your ability to apply pesticides safely.

d. They may alter the toxicity of pesticides within your body.

e All of the above.

23. Under what conditions can a person with a beard legally use a respirator?

a. If the there is no odor.

b. If the wearer cannot detect the taste or smell of the pesticide.

c. When they are using only a dust mask.

d. When they are using a powered air cartridge respirator.

24. Which of the following statements best describes the term "dose" when referring to pesticide exposure?

a. The amount of pesticide that will cause an illness.

b. The amount of pesticide sprayed on a crop.

c. The amount of pesticide that a person is exposed to.

d. The amount of pesticide remaining on a treated surface.

25. If a person is working in an area where he is exposed to pesticides and he's experiencing pesticide illness symptoms he should...

a. Say nothing for fear of losing his job.

b. Take the rest of the day off.

c. Seek immediate medical attention.

d. Finish the work shift then inform his supervisor.

26. When pesticide exposure occurs...

a. The employees responsible for the incident should be reassigned to another job that does not require them to handle pesticides.

b. The chemical manufacturer should be notified.

c. The reason for the exposure should be identified and steps should be taken to prevent the exposure scenario from happening again.

d. Employees responsible for the exposure incident should be disciplined.

27. Which of the following are not examples of acute or immediate symptoms of pesticide poisoning?

a. Blurred vision.

b. Skin rash.

c. Dizziness.

d. Sterility

e. All the above.

28. Which of the following could be examples of chronic or long-term health effects from pesticide exposure?

a. Cancer.

b. Nerve disorders.

c. Diarrhea.

d. a and b

29. Which of the following must be done when there is a pesticide exposure and the person has pesticide poisoning symptoms?

a. Have someone take the person to a medical facility.

b. Decontaminate the person as much as possible.

c. Bring a copy of the pesticide label to the medical facility.

d. Bring a copy of the hazard communication plan with you to the medical facility.

e. a, b, and c.

30. When should vomiting be induced after a person swallows a pesticide?

a. Immediately.

b. Immediately after the person has drank a glass of milk of magnesia.

c. Only when indicated by the pesticide label and if the victim is conscious.

d. Only when three ounces or more of the pesticide has been swallowed.

e. None of the above.

31. When can pesticides be transported in the same compartment with persons and/or food?

a. Only when they are low toxicity pesticides.

b. Only Category 3 pesticides.

c. Never.

d. Only Category 2 and 3 pesticides approved by the USEPA.

32. A notice-of-intent to use a restricted material must be submitted...

a. to the County Agricultural Commissioner at least one week before the application date.

b. to the Department of Pesticide Regulation.

c. only when the restricted material is in Category 1.

d. to the County Agricultural Commissioner at least 24 hours before the application date.

33. Posting a field after a pesticide application is the responsibility of:

a. The applicator.

b. The operator of the property

c. The Commissioner's office.

d. The farm labor contractor.

34. When mixing 2 or more organophosphate pesticides the re-entry interval is determined by:

a. Adding both of the intervals together.

b. Adding the longest interval to 50% of the second longest interval.

c. The longest interval.

d. The shortest interval.

35. When can you store a pesticide in containers other than the original container?

a. Only with Category 3 pesticides.

b. Only with herbicides.

c. In a service container that has the name and address of the person or firm responsible for that container, the name of the pesticide and the pesticide's signal word.

d. None of the above.

36. LC_{50} refers to:

a. The dose that will kill 50% of a test population.

b. The concentration that will kill 50% of a test population.

c. Both a and b.

d. None of the above.

37. Pesticide storage areas that contain pesticides with the Danger or Warning signal word must be posted with signs that are legible from how many feet?

a. 25 feet.

b. 50 feet.

c. 10 feet.

d. None of the above.

38. Which of the following must be posted at the work site or on the work vehicle?

a. Poison Control Center phone number

b. The Highway Patrol phone number

c. The name, address and telephone number of a facility able to provide emergency medical care.

d. The County Agricultural Commissioner's office.

39. Which of the following statements must be on all pesticide labels?

a. Warning.

b. Danger.

c. Caution.

d. Keep out of reach of children.

40. What must moderately toxic pesticides have on their labels?

a. The signal word Warning.

b. The signal word Danger.

c. The statement "Keep out of reach of children".

d. a and c.

41. Which of the following has the highest risk?

a. Loading and mixing pesticides.

b. Flagging.

c. Applying pesticides with a ground rig.

d. Loading and unloading pesticide containers.

42. Which of the following types of pesticides are among the most toxic to people?

a. Carbamates.

b. Organophosphates.

c. Chlorinated hydrocarbons.

d. a and b.

43. Which of the following pesticide formulations pose the greatest dermal hazard to applicators?

a. Dusts.

b. Wettable powders.

c. Emulsifiable concentrates.

d. Soluble powders.

44. What are the symptoms of organophosphate and carbamate poisoning?

a. Difficulty in seeing and breathing.

b. Nausea, vomiting, stomach pain, and diarrhea.

c. Sweating, numbness, fatigue, and thirstiness.

d. all of the above.

45. When handling emulsifiable concentrates what is the most likely route of exposure?

a. Skin (dermal).

b. Lungs (respiration).

c. Eyes (ocular).

d. Mouth (oral).

46. What should you do if you get pesticides on your skin?

a. Immediately wash with soap and water.

b. Wash at the end of the day.

c. Wash as soon as it's convenient for you.

d. Go to the doctor, then wash with soap and water.

47. What should be done if you experience pesticide poisoning symptoms?

a. Stop working and lay down.

b. Continue working.

c. Seek immediate medical attention.

d. Go to the doctor after work.

48. What is the cause of most pesticide-related accidents?

a. Improper pesticide handling.

b. Lack of training.

c. The use of highly toxic pesticides.

d. b and c.

49. Which of the following is the best type of gloves to use when handling pesticides?

a. Cotton

b. Leather

c. Silk

d. Rubber

50. Under what conditions can you ignore the safety equipment requirements found on the pesticide label?

a. After you have had three years of pesticide application experience.

b. Never.

c. When the ambient air temperature exceeds 85°F.

d. When using low pressure application equipment.

51. A cholinesterase inhibitor affects which of the following?

a. Central nervous system enzymes.

b. Central nervous system synaptic transmission.

c. Hormones.

d. a and b.

52. Which of the following is not considered to be "use in conflict with labeling"?

a. A decrease in the dosage rate.

b. A decrease in the concentration of the mixture.

c. Application at a frequency less than specified.

d. All of the above.

53. What is the most important phone number to have posted at the work facility?

a. the nearest emergency medical care facility

b. Haz Mat team

c. the local fire department.

54. If the pesticide label does not specify a particular type of eye protection, what type can be used?

a. A face shield.

b. Goggles.

c. Safety glasses that provide front, brow, and temple protection.

d. All of the above.

55. What signal word requires the use of closed-loading mixing equipment when a liquid pesticide is applied to an agricultural crop?

a. Danger.

b. Warning.

c. Caution.

d. All of the above.

56. Which of the following is true in regards to posting treated fields?

a. The signs must not be posted unless a pesticide application is scheduled within the next 24 hours.

b. The signs cannot be removed during the reentry interval.

c. The signs must be removed within 3 days after the end of the reentry interval.

d. All of the above.

57. Who can provide pesticide safety training to employees that will make pesticide applications in production agriculture settings?

a. A DPR-certified applicator

b A University of CA farm advisor

c. A DPR-licensed pest control adviser

d. All of the above

58. Which of the following provides valuable information about pesticide hazards?

a. Pesticide labels.

b. Material safety data sheets (MSDS).

c. Pesticide advertisements

d. a and b.

59. Which of the following is considered to be minimal protective clothing?

a. Full-length pants and a long-sleeved shirt.

b. A baseball cap.

c. A short-sleeved shirt.

d. All of the above.

60. Which of the following would be good head protection?

a. A baseball cap.

b. A straw hat.

c. A water resistant and wide-brimmed hat.

d. All of the above.

61. When can you use a dust mask?

a. When handling nontoxic, nuisance dusts.

b. When handling liquid sprays.

c. When handling moderately toxic dusts.

d. None of the above.

62. Which of the following can contribute to significant drift?

a. High tank pressure.

b. Windy conditions.

c. Small nozzle orifice.

d. All of the above.

63. The law requires waste minimization, which of the following methods meet this requirement?

a. Triple rinse empty containers and pour the rinsate into the spray tank.

b. Applying the rinsate to the field in accordance with the label.

c. Maintain equipment in good working order.

d. All of the above.

64. Pesticides that are classified as restricted use pesticides are potentially more hazardous than other pesticides because...

a. They may have a high toxicity.

b. They may be used in a manner that poses a greater hazard.

c. They may have significant environment effects.

d. All of the above.

65. Who is in charge of pest abatement programs?

a. Private companies.

b. Universities.

c. Government agencies.

D None of the above.

66. The term "quarantine" refers to...

a. system that prevents pests from being transported out of infested areas.

b. A pest control system that is used to kill all the target pests in a given area.

c. Pest control systems that use only biological pesticides.

d. All of the above.

67. Pesticides with low toxicity, but that present a significant eye hazard are in what category?

a. Category 2.

b. Category 3.

c. Category 4.

d. Category 1.

68. Which of the following is true when conducting experimental applications of unregistered pesticides:

a. You must first obtain a restricted materials permit from the county agricultural commissioner.

b.You must first obtain a research authorization from DPR.

c. You must first obtain a permit from the U.S. Dept of Agriculture.

d. You can only do experimental work on your own land.

69. Who is responsible for employee medical care?

a. The county medical director.

b. The employer.

c. The county health service.

d. The county agricultural commissioner.

70. Which of the following must be done when a non-restricted pesticide application is completed?

a. A notice of intent must be filed with the county agricultural commissioner.

b. A notice of intent must be filed with DPR.

c. A pesticide use report must be sent to the county agricultural commissioner.

d. No use report here is necessary but the applicator must maintain application records for 2 years.

Practice Test Answers

1. d	23. d	45. a	67. d
2. c	24. c	46. a	68. b
3. b	25. c	47. c	69. b
4. d	26. c	48. a	70. c
5. d	27. d	49. d	
6. a	28. d	50. b	
7. d	29. e	51. d	
8. d	30. c	52. d	
9. d	31. c	53. a	
10. d	32. d	54. d	
11. a	33. b	55. a	
12. c	34. b	56. d	
13. d	35. c	57. d	
14. c	36. b	58. d	
15. b	37. a	59. a	
16. a	38. c	60. c	
17. d	39. d	61. a	
18. d	40. d	62. d	
19. c	41. a	63. d	
20. b	42. d	64. d	
21. a	43. c	65. c	
22. e	44. d	66. a	

10. WEEDS

This chapter reviews basic information about weed management principles, and is important for the following QAC and QAL pest control category exams:

- Landscape Maintenance
- Right of Way
- Plant Agriculture

Right-of-Way Sites

Controlling weeds is often the most important pest management activity in right-of-way sites. Right-of-ways are lands used for transportation or utility services; examples include lands associated with the following:

- roads and paths
- railroads
- airports
- managed waterways
- pipelines
- powerlines

weeds!

Weed Impacts

One of the most significant impacts caused by weeds is competition, especially in landscape and crop production settings. Weeds compete with desirable plant species for:

- soil water
- soil nutrients
- light
- space

Weeds may also:

- reduce driver visibility
- increase fire risk
- damage roads or other paved surfaces or infrastructure
- contaminate crops
- clog waterways
- cause skin irritations
- harbor other pests

Grass, Sedge and Broadleaf Weeds

Most weed species can be separated in to three basic groups, grasses, sedges and broadleaf plants.

Grasses have the following characteristics:

- they have only one seed leaf or cotyledon (they're monocots)
- strap-like leaves (blades)
- hollow stems
- leaves that grow along the stem in an alternate pattern
- parallel leaf veins
- shallow, fibrous root systems
- their growing points are at, or near, the soil surface

Some common grass weeds include:

- annual bluegrass
- Italian ryegrass
- medusahead
- wild oat

Sedges have the following characteristics:

Sedges have edges

- they resemble grasses
- solid stems
- stem cross-sections are triangular
- leaves are in groups of 3
- fibrous root systems
- perennial species may produce rhizomes or tubers

Common sedge species include:

- blunt spikerush
- hardstem bulrush (tules)
- yellow nutsedge
- purple nutsedge

Broadleaf plants have the following characteristics:

- they have two seed leaves or cotyledons (they're dicots)
- broad-shaped leaves
- branching leaf veins
- deep and spreading roots
- their growing points are located at the tips of shoots

Common broadleaf weed species include:

- common chickweed
- sow thistle
- bull thistle
- field bindweed

Plant Growth Stages

Plants have four basic growth stages:

1. **Seedling**: This stage is characterized by the presence of the seedling leaves (cotyledons). In general, the seedling stage is the easiest to control.

2. **Vegetative**: This is the stage when plants produce most of their leaves, stems and roots. Like the seedling stage, this is also a good growth stage for weed control.

3. **Bud and Flowering**: This stage is when plants divert their resources from vegetative growth to the development of reproductive structures like flowers, fruits and seeds.

4. **Maturity**: This is the growth stage when the plant has completed its vegetative growth and has produced seed. Controlling mature plants is often very difficult.

Plant Life Cycles

Most plants can be categorized into three life cycle types:

1. **Annuals**: These plants complete their life cycle from seed germination to death in one year or less. There are two basic types of annuals:

   - Summer annuals germinate in the spring, grow vegetatively in the summer and set seeds and die in the fall to the early winter. Examples of summer annuals include common lambsquarters and Russian thistle (tumbleweeds).

   - Winter annuals germinate in the fall and continue to grow and develop during the next spring and summer. They often die by the early or mid-summer. Some may survive for a longer period, dying in the fall. Redstem filaree and yellow starthistle are winter annual species.

   Annuals are generally easiest to control in the seedling stage. Controlling annuals before seed production is critical.

2. **Biennials**: These species live for two growing seasons. The first year is primarily vegetative growth, and flower and seed development occur in the second year. Some biennials may behave as annuals under certain environmental conditions, for example if they grow in areas with longer growing seasons. Biennials should be controlled in the first season during the seedling and vegetative stages. Control during the second season is often less effective. Bull thistle and poison hemlock are biennial species.

3. **Perennials**: Perennials live for more than two years. They may go dormant in the winter with new growth occurring the next spring. Perennials may be separated in to the following 3 groups based on reproduction:

   - Simple: those that reproduce only by seed or when root segments are cut up. Wild fennel and French broom are simple perennials.

   - Creeping: These species spread by seed or vegetatively by creeping stolons or rhizomes. Stolons are modified stems that grow along the ground surface. Rhizomes are also modified stems, but they grow underground. Creeping perennials can spread rapidly when rhizomes or stolons are cut up and distributed as small pieces during cultivation. Each small segment can develop in to a new plant. Examples of creeping perennials include field bindweed and perennial pepperweed.

- Bulbous: These species reproduce by seed or by underground bulbs or tubers. Like the creeping perennials, the bulbous perennials can be spread by the soil disturbance that occurs during cultivation. The nutsedge species, purple and yellow, are bulbous perennials.

Perennial species are generally easiest to control during the seedling or vegetative stages. Control after these stages is usually not as effective. Once perennial species become established control generally requires one of the following strategies;

- Deplete the food storage reserves of the root system by repeatedly destroying the plant's top growth. This can be accomplished by repeated mowing, cutting or other similar process. Contact herbicides can also be used for this purpose.

- Apply translocated herbicides at or after flowering when food reserves are moving from the leaves down towards the roots. This allows for a more complete kill of the target plant…both the roots and top growth will be affected.

Weed Control Methods

Both non-chemical and chemical methods are used for weed control. Successful vegetation management programs, however, often involve integrating these methods.

Non-Chemical Control: There are several different non-chemical control strategies.

- Mechanical: such as the use of mowers or tillage equipment. Mowing done too early in the season may need to be repeated because of weed regrowth.

- Manual: includes hand-pulling or the use of hand-held equipment like hoes or weed-eaters. While effective in small areas, these methods are often less effective once infestations grow in size or when target plants are in the later developmental stages.

- Cultural: are modifications in management activities that can provide pest control benefits. A common example in right-of-way settings involves establishing healthy, competitive landscape plants. Well-established landscapes can prevent weed infestations. Selecting plant species that are well-adapted to the site is an important way to establish competitive plantings. Proper irrigation and fertilization can also

increase landscape plant competiveness.

- Structural control involves using hardscapes like paved surfaces to prevent weed growth.

- Thermal control includes the use of specialized equipment like propane-fueled flamers or stream applicators to kill weeds.

- Biological control involves the use of beneficial organisms such as insects or plant diseases that can be used to control weeds. Here are a few common biocontrol strategies:

    - Importation involves introducing a non-native agent after collecting it from its native range.

    - Augmentation involves releasing the biocontrol agent in to an area where it is already present, but its population has been too low to be effective.

    - Conservation involves protecting biocontrol agents that are present at the pest control site. Using pesticides that are safe for biocontrol agents is an example of this strategy.

While often effective against agricultural pests, the use of biological control in right-of-way or landscape settings may be limited for the following reasons:

- It may be difficult to establish sustainable populations.

- The site may have more than one weed species. Biological control agents generally affect only one pest species.

Chemical Control: Herbicides are often categorized as:

Non-Selective or Selective: Non-selective herbicides control both grasses and broadleaf species, while selective herbicides will control either grass or broadleaf weeds. Some selective herbicides may control a narrower range of species. For example, an herbicide may affect only annual broadleaf species and have no effect on perennial broadleaf species or grasses.

It's important to know that selectivity may be influenced by the use rate or application timing. For example a lower use rate of aminopyralid will control only broadleaf weeds, but higher rates, especially those that exceed the legal rate prescribed by the product label, will also kill grasses.

Pre-Emergent or Post-Emergent: The distinction between these two groups is when the herbicide is applied.

Pre-emergent herbicides are applied before weed seedlings emerge through the soil surface. They are often completely ineffective for controlling emerged weeds.

Pre-emergent herbicides kill weed seedlings shortly after seed germination. This gives the appearance that they kill the seeds; in reality, they kill the new seedlings while they're underground.

Here are some other important characteristics of pre-emergent herbicides:

- They're usually applied to the soil and not to emerged plants.
- Because their residues are persistent in the soil, they can provide season-long weed control.
- They often require rainfall or overhead irrigation within 2 weeks of application to be effective. Rainfall or irrigations moves the herbicide down in to the top several inches of the soil…the zone where the weed seeds are present.
- They are sometimes tankmixed with post-emergent herbicides to provide a wider spectrum of weed control.

Post-emergent herbicides are applied after weed seedlings have emerged.

Here's some additional information about this type of herbicide:

- They work best when target plants are actively growing, especially translocated herbicides (see below).
- Some have both pre-emergent and post-emergent activity.
- They may have either contact or translocated activity.

Contact or Translocated?: Post-emergent herbicides may have either contact or translocated activity. The effects of contact herbicides are primarily limited to the sprayed foliage of target plants. They tend to give quick results, but don't provide long-term control of well-established target plants, especially perennials. Well-established weeds often recover and regrow after contact herbicide applications.

Translocated herbicides are absorbed in to sprayed foliar tissue and then move within the target plant's vascular system. Translocated herbicides are also called systemic herbicides. Translocation is usually in a downward direction from sprayed leaves in to the root system, but some translocated herbicides can move upwards as well. Because they can kill the top-growth and the root systems of target plants, translocated herbicides are more effective than contact herbicides for

XXXX
What two herbicides used to prevent resistance in weeds? XXX
– Pick answer with 3 different sounding names!

controlling established weeds, especially perennial species.

The speed at which translocated herbicides work is greatly influenced by target plant metabolism. In general, they work best when target plants are actively growing.

Integrated Vegetation Management: Sometimes using an integrated management approach is the most successful way to manage weeds. A good example of this involves roadways. An integrated vegetation management plan for a roadway could include the following strategies:

- Use paving or other hardscapes to prevent plant growth in non-vegetated areas.
- Plant desirable landscape plants in vegetated areas.
- Use herbicides to selectively control weeds around landscape plants.
- Mowing can be used to maintain plants in vegetated areas.

Herbicide Foliar Penetration

Before a foliar-applied herbicide can work, it must first penetrate the leaf. Some barriers to herbicide penetration include:

Leaf Shape: Narrow-leaved, upright-growing plants (i.e. tules or cattails) are not particularly good herbicide spray targets. Spray droplets may roll off the sprayed foliage of these types of weeds.

Cuticle Layer: The leaves and stems of terrestrial plants are usually covered by a waxy layer called the cuticle. Depending on the plant species, the cuticle can be thin or thick. The cuticle is often a very effective barrier to herbicide penetration. The waxier the cuticle, the more difficult it is for the herbicide to penetrate the leaf.

Younger plants (i.e. those in the seedling stage) often have thinner, less waxy cuticles. This is one of the reasons why seedlings are easier to control with herbicides than are mature plants.

Leaf Hairs: Some plant species have small hairs that cover the surfaces of leaves and stems. These leaf hairs can prevent herbicide penetration. Herbicide applications made to younger weeds…with fewer or shorter leaf hairs…are often more effective than applications made to mature plants.

Temperature: Leaves have openings called stomata that close during hot and dry weather. Stomatal closing helps prevent plants from drying out. Herbicide applications that are made when the stomata are closed are often

must use surfactant!

less effective than they would be if they were done when the weather was cooler and the stomata were open.

Using Surfactants: Surfactants are a type of adjuvant that help herbicides penetrate leaf cuticles. When foliar herbicide applications are made without surfactants, spray solutions tend to form hard, spherical droplets on the leaf's waxy cuticle. Adding surfactants to herbicide tankmixes reduces droplet "bead-up" and will improve the herbicide's ability to cover and penetrate weed foliage.

Soil Conditions and Pre-Emergent Herbicides

Soil conditions often have a strong influence on the performance of pre-emergent herbicides. The two major factors that affect the performance of pre-emergent herbicides are:

Soil Texture: Sand, silt and clay are the three primary building blocks of soils. The relative amounts of these 3 components can influence how well a pre-emergent herbicide efficacy.

Sand: In order for pre-emergent herbicides to work effectively, they must move down in to…and remain…in the top 2-3 inches of soil. This is where most of the weed seeds will germinate. Highly leachable sandy soils may be too porous to hold herbicide residues.

Clay: Clay soils generally have negative electrical charges that can bind pre-emergent herbicides and reduce their effectiveness.

Organic Matter Content: As with clay soils, soils with high levels of organic matter can bind herbicides and cause them to be less effective.

Controlling Trees & Shrubs

As a general rule, brush and shrubs are less than 15 feet tall and have multiple stems. Trees generally have a single trunk and are greater than 15 feet tall.

While mechanical methods may be used to control shrubs or trees in right-of-way or landscape settings, there are several herbicide application methods that can also be used.

Basal Bark or Basal Stem Treatment: With this method, the herbicide is applied to the uncut basal portion of the stem (i.e. the lower 18 inches). An oil product is often mixed with the herbicide along with…or instead of…water to improve penetration through the bark. This method is generally used with smaller shrubs or trees (i.e. stem diameters < 6 inches).

Cut-Surface or Cut-Stem Treatment: This method is often called "frill cut" or "hack and squirt". With this technique, the herbicide or herbicide/oil mixture is applied to cuts made in the bark with a hatchet or similar tool. In some cases, the herbicide may be applied in to holes made in the stem with a drill. This technique is often used on shrubs and trees that are too large for the cut-surface technique (i.e. stem diameters > 6 inches).

Cut-Stump Treatment: This method involves cutting down the shrub or tree with a chain saw and applying the herbicide or herbicide/oil mixture to the cut surface. The entire stump does not have to be treated; only the relatively-thin cambial layer…found between the outer bark and the center wood…must be treated.

REVIEW QUESTIONS

1. Which of the following is NOT true about grass weeds?

a. they are monocots

b. they have parallel leaf veins

c. their growing points are at the tips of shoots

d. they have shallow, fibrous roots

2. Which of the following plant life stages is the easiest to control?

a. mature, post-flowering

b. vegetative

c. seedling

d. all of the above are easy to control

3. Which of the following is true concerning annual plants?

a. they are generally easier to control than biennials and perennials

b. there are two basic groups; summer and winter annuals

c. preventing seed production is the best way to control them

d. all of the above are true

4. Which of the following are commonly used weed control strategies?

a. manual

b. genetic

c. cultural

d. a and c

5. Which of the following describes a translocated herbicide?

a. destroys only the tissue it comes in contact with

b. works by killing the foliage and stopping photosynthesis

c. is very fast-acting

d. none of the above

6. The _____ is the waxy outer layer on plant leaves and stems.

a. cotyledon

b. cuticle

c. stomata

d. monocotyledon

7. What do surfactants do?

a. help herbicides penetrate leaves

b. reduce herbicide spray "bead up"

c. improve herbicide coverage

d. all of the above

8. What do clay soils and soils with high organic content have in common?

a. they both have slight positive charges

b. they can reduce the effectiveness of all herbicides

c. a and b

d. none of the above

9. Which herbicide use technique typically involves using a chainsaw?

a. basal bark

b. cut stump

c. drench

d. girdling

10. A cotyledon is also known as a...

a. seed coating

b. root tip

c. seed leaf

d. epicotyl

11. What are the 3 types of perennial plants?

a. monocot, dicot and bulbous

b. simple, creeping and bulbous

c. simple, creeping and prostrate

d. emersed, creeping and prostrate

12. Which of the following are important for weed reproduction?

a. seeds

b. rhizomes

c. stolons

d. all of the above

13. Which of the following are leaf openings?

a. cotyledons

b. epicotyls

c. stomatas

d. all of the above

14. Translocated herbicides are also known as...

a. systemic herbicides

b. synergized herbicides

c. contact foliar herbicides

d. all of the above

Answers:

1.c	6. b	11.b
2.c	7.d	12. d
3.d	8.d	13. c
4.d	9.b	14. a
5.d	10.c	

11. VERTEBRATES

This chapter reviews basic information about vertebrate management principles, and is important for the following QAC and QAL pest control category exams:

- Landscape Maintenance
- Right of Way
- Plant Agriculture

Basic Information

This chapter provides basic information about the primary outdoor vertebrate pests found in California. Information on indoor vertebrate pest species (i.e. rats and mice) can be found in Chapter 15.

Because ground squirrels, gophers, moles and voles are considered non-game mammals by the California Department of Fish and Wildlife (CDFW), they can be taken at any time, and by any means, when they're found to be injuring crops, landscape plantings or other property. Other animals such as deer, some rabbit species and native tree squirrels are game species that cannot be killed without restriction. Additionally, some native animals are protected species that cannot be disturbed or killed except under very special circumstances. Persons who are considering killing animal species for pest management purposes should contact the California Department of Fish and Wildlife to find out about regulatory restrictions.

Ground Squirrels

These rodents are common throughout California. They're frequently found above-ground near their burrow sites on warm, sunny days.

Be aware that the Mojave ground squirrel in southeastern California and the Nelson's antelope squirrel in the San Joaquin Valley are protected species; it's illegal to harm them or damage their habitat.

Ground squirrels are active during the daylight hours. They have both winter and summer hibernation periods. Summer hibernation is called *estivation.* During hibernation, the animals remain relatively inactive in their burrows. Ground squirrels that live in the more temperate areas of the state (i.e. near the coast) may not hibernate and can remain active all year long.

They can cause significant feeding or chewing damage on landscape plants, chewing damage on plastic irrigation pipe and burrow-building damage. They can also cause serious damage to earthen structures like dams and

levees. This type of damage can cause severe erosion and structural failure.

Control strategies...

- removing habitat sites such as rock piles
- frequent tillage or mowing to reduce plant cover
- trapping
- burrow fumigants
- Poison grain baits are also very effective especially if they're used in the summer and fall when the squirrels are feeding on seeds. They are less effective in the winter and spring when the animals are feeding on green vegetation like grasses.

Gophers (Pocket Gophers)

Gophers are burrowing rodents that are common throughout California. While they occasionally feed on plants near their burrow entrances, they are less likely to be seen above ground than are ground squirrels. They live and feed in extensive burrow systems.

Except for females with young, there is rarely more than one gopher per burrow system.

They create crescent (c-shaped) mounds. The mounds...which are usually plugged...are made from the soil that is pushed up to the surface during burrow construction. Gophers are active during both the day and night, and they do not hibernate.

Gophers feed primarily underground and can cause significant damage to the underground portions of landscape plants. They also cause chewing damage to underground cables or plastic water lines and burrow-building damage.

Control strategies...

- flooding
- underground fencing (3 ft deep) with wire mesh
- trapping
- burrow fumigation
- poison grain baits

Moles

Smaller than gophers, moles feed on earthworms and underground insects. They are common throughout California. They're rarely seen above ground. They live and feed in extensive burrow systems.

Moles create volcano-shaped mounds of cloddy soil. Like gophers, moles create these mounds from the soil that is pushed up to the surface during burrow construction. They may also produce raised ridges of soil that connect their mounds. These are shallow feeding burrows.

Moles are active during both the day and night, and they do not hibernate.

Their burrowing and mound-building activity can cause significant damage to turf areas or landscaped plantings.

Control strategies...

- Flooding and burrow fumigation are often unsuccessful because of the depth of the burrow system and because moles are adept at quickly plugging burrows.
- underground fencing (3 ft deep) with wire mesh
- Trapping is often very effective. The traps used for moles are usually not the same types of traps used for gophers or ground squirrels.

Voles

These are small field or meadow mice; they are not the same species as the house mouse.

Voles are generally found in areas with dense grass cover. They construct shallow burrow systems and narrow (approx. 2 inch) raceways under the grass.

They're active during the day and night, and they do not hibernate. They are poor climbers and rarely enter buildings.

They can cause significant feeding damage to landscape plants and may cause chewing damage on the stems of landscape shrubs or young trees.

Voles reproduce quickly which often causes rapid population growth. High vole populations typically decline rapidly also as food resources become scarce.

Control strategies...

- Habitat modification is often successful. Voles prefer dense grass cover which allows them to hide from predators like raptors. Mowing grass areas down to 2 inches or lower can be effective.
- Flooding and fumigation are rarely successful because voles construct shallow burrow systems.
- Trapping can be successful but labor intensive, especially when populations are high.
- poison grain baits

Other Important Species

In addition to the non-game mammals described in the previous section, here are a few other species that you should know. Please note: most of these are considered game species by CDFW; a permit or license is required to kill them.

Deer and Elk: These species can cause serious damage to landscape plantings. They tend to tear terminal buds and shoots from plants instead of causing the neatly clipped feeding damage caused by smaller animals. Look for their hoof prints or fecal pellets near damaged landscape plants.

Rabbits and Hares: These species tend to damage smaller plants by eating buds or shoots or by chewing bark off of stems. Generally, only younger or smaller plants are affected. Look for their small (i.e. <0.5 inch diameter) circular droppings.

Tree Squirrels: These species can cause significant chewing damage to desirable plants. They can be distinguished from grounds squirrels by their long, bushy tails. Unlike ground squirrels which live in burrows, they live and nest in trees. There are both native and introduced tree squirrel species. The most common native species is the western grey squirrel (a CDFW game species). There are two introduced species; the eastern grey squirrel and the red fox squirrel.

Control Methods

Traps: Here's some basic information:

Ground squirrels: Trapping can be effective when populations are small. Traps should be set when the animals are active (i.e. not hibernating). Box traps are often used as well as Conibear or other body-gripping kill-type traps. If live-traps are used, the trapped animals must be killed or immediately released at the same spot. Live-trapped animals cannot be transported to a different location for release.

Pocket gophers: Trapping is often a very effective method. Pincer, Macabee or box traps are often used. Traps are most effective when set within the main tunnel. Locating the main tunnel is often accomplished by probing with a metal bar. Once the burrow is located, dig a hole into it and place and set the trap. The trap hole is usually re-covered with loose soil.

Moles: Trapping is generally considered to be the most reliable control method for moles. Harpoon or scissor-type traps are used. The traps can most easily be set in the shallow feeding tunnels or can be placed in the deeper, main burrow system in a similar manner used to place gopher traps.

Fumigants: Various fumigant chemicals can be used to control ground squirrels and gophers.

While fumigation can be used for mole control, it is often unsuccessful because the depth of the burrow system often prevents gas penetration. Also, moles are adept at plugging burrows after they detect the fumigant.

The fumigant chemicals include:

Acrolein: a toxic gas that's injected directly in to the burrow system. It is primarily used for ground squirrel control.

Aluminum phosphide: Aluminum phosphide tablets are placed within the burrow system. The tablets release toxic phosphine gas after they become wet from soil moisture. It is not necessary to add water to the burrow. Unless the soil is very dry, it will have enough moisture to activate the tablets.

Gas cartridges: these "smoke bombs" release toxic carbon monoxide gas after being lit and then placed within the burrow system.

Fumigants are often very effective when used during the winter when the animals are hibernating and soil moisture levels are high enough to prevent the fumigants from escaping through the cracks in dry soil.

Rodenticide Baits: Several different types of poison baits are used to control ground squirrels, gophers, moles and voles. Poison baits should only be used when target animals are active. It is also important to confirm that the target animals will accept the bait. Bait acceptance is sometimes confirmed by pre-baiting with grain that does not contain the toxicant. The toxic bait is only dispensed once the non-toxic pre-bait is eaten.

Strychnine: Used for gopher control, Strychnine is a fast-acting (acute) poison mixed with a grain bait.

Zinc phosphide: mixed with a grain, the bait releases toxic phosphine gas after being consumed by the target animal. Zinc phosphide is used to control ground squirrels, gophers and voles. Like strychnine, this chemical is a fast-acting (acute) poison.

Mole baits: Because grain baits are generally unsuccessful, the poison baits that are used must appear attractive to moles. Gels containing warfarin (an anti-coagulant) or earthworm-shaped baits containing the central nervous system poison bromethalin are used.

Anticoagulants: Many of the rodenticide products used to control vertebrate pests are anticoagulants. Target pests die from internal bleeding after consuming the poison bait. Effective for controlling outdoor pests like ground squirrels, gophers and voles, they are also commonly

used to control rats and mice that are infesting structures.

The anticoagulants can be categorized in to two basic groups: first-generation and second generation.

First-generation: The first generation compounds require multiple feedings to be effective. While they are commonly used to control ground squirrels and gophers, they can also be used to control "indoor" pests (i.e. rats and mice). They are generally less toxic than the second generation compounds. Chlorophacinone and diphacinone are first-generation anti-coagulants.

Second-generation: The second-generation compounds can only be used for "indoor" pests (i.e. rats and mice). They are effective after a single-feeding. It is illegal to use these compounds to control "outdoor" pests (i.e. ground squirrels and gophers). Brodifacoum and bromadialone are second-generation anti-coagulants.

Anticoagulants and Secondary Toxicity: Secondary toxicity occurs when non-target animals (i.e. dog, cat or wild animal) feed on the carcasses of animals that have been exposed to anticoagulant compounds. Secondary toxicity is a very important consideration when using anticoagulant rodenticides.

The second-generation (i.e. indoor) compounds pose a greater secondary toxicity risk than the first-generation compounds. Promptly disposing of anticoagulant-killed rodents is an important way to reduce secondary toxicity risk to pets and wildlife.

REVIEW QUESTIONS

1. Which of the following rodent pests hibernate?

a. voles

b. pocket gophers

c. ground squirrels

d. moles

2. Which of the following is the best control strategy for moles?

a. grain baits

b. flooding

c. trapping

d. burrow fumigation

3. Which of the following are fumigants?

a. zinc phosphide

b. aluminum phosphide

c. warfarin

d. strychnine

4. Secondary toxicity is often a problem with...

a. zinc phosphide

b. carbon monoxide

c. anti-coagulants

d. strychnine

5. Which of the following are considered to be non-game mammals?

a. voles

b. pocket gophers

c. ground squirrels

d. all of the above

6. Which of the following produces crescent-shaped mounds in turf?

a. pocket gophers

b. moles

c. voles

d. both a & c

7. Which of the following species will not eat grain baits?

a. voles

b. pocket gophers

c. ground squirrels

d. moles

8. Which rodent pest constructs narrow raceways under grass cover and shallow burrow systems?

a. voles

b. pocket gophers

c. ground squirrels

d. moles

9. Why is burrow fumigation a poor control method for moles?

a. the burrow system may be too deep or extensive

b. well-ventilated burrow systems

c. they're resistant to fumigants

d. all of the above

10. Placing the trap within the tunnel system is important for which species?

a. moles

b. pocket gophers

c. ground squirrels

d. a & b

11. Which of the following are not anti-coagulant rodenticides?

a. zinc phosphide

b. brodificoum

c. diphacinone

d. all of the above are anti-coagulants

12. Which of the following chemicals produces phosphine gas?

a. zinc phosphide

b. aluminum phosphide

c. acrolein phosphide

d. a & b

e. a & c

Answers:

1.c	6. a	11. a
2.c	7. d	12. d
3.b	8. a	
4.c	9. a	
5.d	10.d	

12. PLANT DISEASES

This chapter reviews basic information about plant disease management principles, and is important for the following QAC and QAL pest control category exams:

- Right of Way
- Landscape Maintenance
- Plant Agriculture

Basic Information

The majority of plant diseases are caused by one of the following organisms (pathogens):

- bacteria
- fungi
- viruses

Of the three pathogen types, fungal pathogens cause the majority of plant diseases.

The Disease Triangle: There's a close relationship between plant diseases and the following 3 factors.

1. the pathogen
2. a favorable environment
3. a susceptible plant host

This relationship is often referred to as the *Plant Disease Triangle*. Reducing or eliminating any of the 3 factors of the triangle will tend to suppress the plant disease. For example, fungicide applications can be used to kill or suppress the pathogen. Also, selecting landscape plants that are not host species for the pathogen (i.e. they're resistant) will also suppress the disease. While it may not be possible to change the environment (i.e. the weather); certain environmental factors can be controlled. For example, if a fungal disease spreads readily under wet foliage conditions, switching from overhead irrigation to drip irrigation could result in lower disease incidence.

Biotic = alive

Biotic vs Abiotic: Here are two important terms that are often used in plant pathology; abiotic and biotic.

The term **"abiotic"** refers to something that is not alive. Sometimes a plant will show symptoms (i.e. yellow leaves or twig die-back) that are caused by an abiotic factor such as moisture stress or frost damage.

The term "**biotic**" refers to something that's alive. When it comes to plant diseases, the 3 main organisms are bacteria, fungi and viruses. Of the 3, fungal-caused diseases are the most common in landscape settings.

Fungal Plant Diseases

- There are lots of different types of fungi; most of them are not plant pathogens.

- They're multicellular.
- They're made of thread-like material known as *hyphae* that grows on or in the host. A mass of hyphae is called the *mycelium*.
- They're parasites...they can't make their own food.
- They produce spores or similar reproductive structures that can survive for years apart from host plants.
- Most fungal organisms do best in warm, moist environments. But, there are exceptions. The pathogen that causes the disease powdery mildew does best under drier conditions.
- Fungal spores can be spread by wind, by people or animals or on equipment.

Types of Fungal Diseases: The fungal-caused plant diseases can be separated in to two groups: root and stem-infecting, and foliar-infecting.

Root/Stem-Infecting Diseases: Here are some basic facts about these diseases:

- Some invade the plant roots through the soil. Other species invade the stem after being transported by insect vectors or by human activities.
- They affect host plants by invading the plant's vascular system which prevents water movement from the roots.
- They are sometimes called *vascular wilt* diseases.

Symptoms include:

- wilted leaves
- leaf drop
- darkened leaf veins
- dead branches (flagging)
- reduced new growth
- dark streaks in wood
-

Control Strategies include...

- proper plant species for site
- proper planting media
- proper drainage
- proper cultural care
- fungicides (not typical)

Foliar-Infecting Diseases: Here are some basic facts about these types of diseases:

- They can infect foliage, stem, flowers or fruit tissue. Some species affect turfgrass.
- They destroy plant tissue via parasitic activity.

Symptoms can vary widely depending on the disease, but may include:

- spotting/discoloration

- yellow/dying patches (turf)
- premature leaf or fruit drop
- stem death (flagging)

Control strategies include:

- proper cultural care
- fungicides (preventative)

Bacterial Plant Diseases

- They're simple, microscopic, one-celled microbes.
- They don't produce spores like fungi. They reproduce by simple cell division.
- They do best in warm, moist environments.
- They often require wounds or other openings to affect their hosts.
- They don't overwinter apart from their hosts like fungi. They need closer contact with their hosts to survive.
- Cells can be spread during rainy/windy weather or on equipment (i.e. pruning shears) or by insects.

Symptoms include:

- wilted leaves or flowers
- leaf spotting
- open wounds (cankers)
- bacterial ooze
- bent stem-tips (epinasty)

Control strategies include:

- planting resistant varieties
- proper cultural care
- reduce plant wounding
- antibiotics (not typical)

Viral Plant Diseases

- Most scientists do not consider them to be living organisms.
- They are sub-microscopic particles of nucleic acid and protein which can multiply only inside living cells.
- A virus cannot replicate itself unless it's in close contact with its host.
- They disrupt normal cell functions and can affect the production of chlorophyll and starch.
- They rarely kill their host plants.

Symptoms include:

- symptoms can be subtle
- similar to nutritional deficiency
- yellow or discolored foliage

- foliage color or shape is "off type"

Control strategies include:

- planting resistant varieties
- proper cultural care
- controlling insect vectors
- no pesticide options available

REVIEW QUESTIONS

1. The term "abiotic" refers to what?

a. a specific type of fungal disease

b. something that's alive

c. something that's not alive

d. non-living organisms like viruses

2. Most plant diseases are caused by what?

a. viruses

b. abiotics

c. bacteria

d. none of the above

3. What does the term "vascular wilt" refer to?

a. root or stem-borne fungal diseases

b. foliar fungal diseases

c. viruses

d. bacteria

4. Which of the following can produce spores that overwinter?

a. abiotic fungi

b. fungi

c. viruses

d. bacteria

5. Which of the following is true about viruses?

a. rarely kill their hosts

b. cannot replicate themselves apart from their hosts

c. are submicroscopic

d. all of the above

6. Which of the following are common control strategies for bacterial diseases?

a. heavy fertilization

b. good cultural practices

c. fungicides

d. all of the above

7. Which of the following pathogens often requires an opening or wound to infect its host?

a. stem-infecting fungi

b. viruses

c. bacteria

d. all of the above

8. Which of the following are true about viral diseases?

a. they cause subtle symptoms

b. they rarely kill their hosts

c. they cause foliage to look "off-type"

d. all of the above

9. Which of the following control methods is generally ineffective for viral diseases?

a. vector control

b. proper cultural care

c. planting resistant varieties

d. biocontrol

10. Which of the following pathogen types has mycelium?

a. fungi

b. bacteria

c. viruses

d. a & b

Answers:

1.c	6. b
2.d	7. c
3.a	8. d
4.b	9. d
5.d	10.a

13. INVERTEBRATES

This chapter reviews basic information about invertebrate pest management principles, and is important for the following QAC and QAL pest control category exams:

- Right of Way
- Landscape Maintenance
- Plant Agriculture

Invertebrates are animals that lack backbones. One of the most important invertebrate groups is the arthropods. Arthropod means "jointed foot". Arthropods share a number of important characteristics including:

- a segmented body,
- paired appendages, and
- an exoskeleton that is periodically shed during growth.

The most important arthropod pest groups include the:

- insects
- spiders
- mites

The non-arthropod pest groups include the:

- snails
- slugs
- nematodes

Many invertebrates are parasitic on plants or animals, including humans, and feed on tissues, contaminate crops, and transmit diseases.

Insects

Insect species share the following characteristics:

- three body parts (head, thorax and abdomen)
- three pairs of legs

Metamorphosis

Insects develop by a growth process called metamorphosis. The word "metamorphosis" means "transformation" and refers to the changes in body structure that many insect species go through during development.

A simple example of metamorphosis involves butterflies that go through four distinct stages: egg, caterpillar, pupa (cocoon) and the winged adult.

There are two basic types of metamorphosis…three-stage also known as incomplete or gradual and four-stage or complete.

3-Stage Metamorphosis: The stages of 3-stage metamorphosis are:

- **Egg**

3-stage vs. 4-stage

- **Nymph**: a stage that may resemble the adult, but is smaller and lacks wings and may have different coloration. Nymphs go through several different stages (or instars), shedding their skin with each successive instar stage. The nymph life stage can be a very destructive stage to crop and landscape plants.

- **Adult**: the completely developed insect, capable of reproduction. This life stage is often very destructive to crop and landscape plants.

The following insect groups develop using 3-stage metamorphosis:

- aphids, scale and whiteflies
- cockroaches
- crickets and grasshoppers
- earwigs
- leafhoppers
- termites

4-Stage Metamorphosis: The stages of 4-stage metamorphosis are:

- **Egg**

- **Larva**: this is the caterpillar stage and the most significant in terms of growth rate. Unlike with 3-stage "nymphs", 4-stage larvae do not resemble the adult life stage. With insects that develop via 4-stage metamorphosis, this is the life stage that does the most damage to crops and landscape plants. Control during this life stage is critical for successful pest management.

- **Pupa**: during this stage, the immature insect develops in to the adult generally within a pupal case. Control during this life stage can be difficult because of the protection provided by the pupal case and because pupae may be protected under bark or in soil.

- **Adult**: the completely developed insect, capable of reproduction. Control during this life stage may be ineffective.

The following insect groups develop using 4-stage metamorphosis:

- ants
- bees and wasps
- beetles
- butterflies and moths
- fleas
- flies

Insect Pest Groups

Read!

Aphids

- small, soft-bodied insects
- piercing-sucking mouthparts

Read

- damage plants by sucking plant fluids
- can cause leaf curling/distortion
- may transmit viral diseases
- excrete honeydew, a sugary substance that attracts ants and can cause the growth of black sooty mold

Beetles

- adults and larvae feed on plants
- chewing mouth parts
- adults are hard-shelled, having a variety of body markings

Caterpillars

- larvae of butterflies or moths
- chewing mouth parts
- can form webs or tents on plants
- some bore into plants

Leafminers

- this group includes certain fly, beetle and moth species
- larvae feed inside leaves
- damage can be tunnels within the leaf or discolored blotches on the leaf surface

Mealybugs

- small, slow-moving insects
- a loose, waxy coating makes them appear "mealy".
- infestations often occur underneath foliage
- piercing-sucking mouthparts
- cause leaf yellowing and decline in vigor
- excrete honeydew

Whiteflies

- similar to mealybugs
- tiny, sap-sucking insects
- infestations often occur underneath foliage
- piercing-sucking mouthparts
- cause leaf yellowing and decline in vigor
- produce honeydew

Scale

- related to mealybugs and whiteflies
- two basic types; soft and armored
- the immature lifestage (crawlers) are mobile on host plants
- adults are immobile
- adults are often oval or circular
- infested plants appear "crusty"
- piercing-sucking mouthparts
- attack foliage, stems and fruit
- produce honeydew

Thrips

- tiny (smaller than a tiny ant)
- slender, fringed-winged
- rasping-sucking mouthparts
- feed on flowers and leaves
- cause leaf distortion, mottling or russeting
- may transmit viral diseases

Borers

- larvae of moths or beetles
- chewing mouthparts

- found under the bark of host plants or within plant shoots
- some species produce tiny holes in tree trunks and branches while others produce larger open tunnels
- may produce frass, a combination of sawdust and insect excrement

Grubs

- larvae of several beetle species or weevils (billbugs)
- some are whitish color with brown heads
- found in the soil
- feed on plant roots or turfgrass crown area
- cause turfgrass yellowing or patchy, dead spots in lawns

Mites & Spiders

Spiders and mites have…

- two body parts
- 4 pairs of legs.

Spiders are beneficial in agricultural and landscape settings because they're predators of a wide variety of pest species. In residential or similar indoor settings, however, spiders may be considered pests.

Pest mites can cause considerable damage to crop and landscape plants by feeding damage.

Mite damage symptoms may include:

- small light-colored spots (stippling)
- yellowing of foliage
- reddish-brown discoloration that may be rough to the touch (russeting)
- webbing

Nematodes

Nematodes are microscopic, eel-shaped roundworms. There are thousands of different types of nematodes. There are so many species that most of them have not been identified or named by scientists.

Here are some facts about plant pest nematodes:

- They live in the soil and feed within or on plant roots.
- Some are pests and other species are beneficial.
- They rarely kill their host plants, but are parasites that can substantially reduce crop yields or cause aesthetic damage to landscape plants.
- Soil fumigants are frequently used as a control strategy in crop production, but less frequently in landscape settings.

REVIEW QUESTIONS

1. Which of the following statements is true?

a. complete metamorphosis has 3 stages

b. all insects have a pupal stage

c. flies develop via 3-stage metamorphosis

d. flies develop via 4-stage metamorphosis

2. What lifestage does the majority of plant damage with 4-stage metamorphosis insect pests?

a. larval

b. instar

c. pupal

d. adult

3. Beetles have which type of mouthpart?

a. rasping-sucking

b. piercing-sucking

c. chewing

d. a or c

4. Which of the following are true about insects?

a. they have 4 pairs of legs

b. they have 2 body parts

c. they do not metamorphosize

d. none of the above are true

5. Aphids have what type of mouthpart?

a. rasping-sucking

b. piercing-sucking

c. chewing

d. a or c

6. Which insect pest has fringed-wings?

a. filarious mite

b. thrips

c. nymphs

d. aphids

7. What are the two groups of scale insects?

a. soft and armored

b. stem and foliar

c. foliar and root

d. stem and root

8. Which of the following statements is true about mites?

a. They are not insects.

b. They are related to spiders.

c. They have 4 pairs of legs.

d. All of the above are true.

9. Which of the following statements is true about nematodes?

a. Some are beneficial.

b. Most species are not pests.

c. They often live in the soil.

d. All of the above are true.

10. Which of the following pest groups produces honeydew?

a. aphids

b. whiteflies

c. mealybugs

d. All of the above produce honeydew.

Answers:

1.d	6. b
2.a	7. a
3.c	8. d
4.d	9. d
5.b	10. d

ONLY Category A

14. PLANT AGRICULTURE: SPECIAL TOPICS

This chapter reviews topics that are important for the *Plant Agriculture* QAC and QAL exams. It should be reviewed along with the information found in the following chapters:

- Chapter 10: Weeds
- Chapter 11: Vertebrates
- Chapter 12: Plant Diseases
- Chapter 13: Invertebrates

Soil Contamination and Plantback Restrictions

Some pesticides can persist in the soil for relatively long periods of time. In some cases, these persistent herbicide residues may be taken up by the roots of crops that are planted long after the pesticide had been applied. This type of unintentional pesticide uptake can cause two significant problems:

1. Illegal pesticide residues
2. Death or damage of subsequent crops.

Here are some strategies that can be followed to prevent these types of problems:

- Use the correct pesticide application rates.
- Use the proper application method(s).
- Follow any plantback restrictions required by the pesticide label. An example of a plantback restriction that might appear on a pesticide label would be "*Do not plant broccoli after the use of this product for 12 months after application.*"

Phytotoxicity

The term "*phytotoxicity*" refers to a chemical's ability to damage or kill plants. Herbicides are phytotoxic; and applicators need to be careful about using them near desirable plant species.

Some non-herbicide pesticides can also cause phytotoxicity problems. Many times, it's not the pesticide active ingredient that is phytotoxic, it's the way the pesticide product is formulated. This is especially true if the formulation contains a petroleum solvent.

Here are some examples of non-herbicide pesticides that can be phytotoxic:

- insecticides formulated as emulsifiable concentrates

- insecticides formulated as flowables
- pesticide tankmixes that include multiple solvents

Here are some ways to avoid phytotoxicity problems:

- follow label directions closely
- reduce pesticide drift
- avoid making pesticide applications during hot and dry weather, especially when the pesticide products contain petroleum solvents

Plant Growth Regulators

Plant growth regulators (PGRs) are chemical compounds that, when applied in small quantities, produce a wide variety of growth responses in plants. Here are some examples of plant physiological processes affected by PGRs:

- cell division
- dormancy
- fruit ripening
- fruit set
- growth rate
- rooting
- seed germination
- stem elongation

PGRs can either be naturally-occurring or manmade (synthetic). When used properly, they can improve crop yield and quality.

Here are some commonly used PGRs:

- Auxins are used to initiate rooting, especially in difficult-to-root stem cuttings. They may also been used to promote fruit thinning in apples, pears and olives.
- Gibberillins are used on grapes to promote berry enlargement and to thin clusters. They have also been used to extend storage life for citrus.
- Ethylene promotes fruit ripening in storage when fruits (i.e. tomatoes) are picked at the mature green stage.
- Growth inhibitors and retardants like maleic hydrazide (MH) are used to reduce sprouting of stored potatoes and onions. It's also used to inhibit tree growth ("chemical pruning" of tree branches).

Here are some important considerations when using PGRs:

- They are generally applied in small amounts.
- Correct mixing is essential to avoid detrimental impacts.

- Results may vary depending on the application method used.

- It's best to apply them alone. Tankmixing may cause unintended results

Cotton Harvest Aid Chemicals

Because the weather in California's cotton producing areas is so mild, cotton plants may behave like perennial plants and may not be completely defoliated at the time of harvest.

Cotton harvest aids are often categorized as either having hormonal or herbicidal action. The hormone-type harvest aides act by increasing the production of ethylene, a naturally-occurring plant hormone that causes leaf drop. Herbicide-type harvest aids work by injuring the plant which, in turn, causes an increase in the plant's ethylene production.

Here are the primary reasons for using cotton harvest aid chemicals:

- stimulate the opening and maturation of cotton bolls

- eliminate excess foliage that interferes with mechanical harvest

- reduce crop staining by green plant fluids/tissues

- improve the overall quantity and quality of harvested cotton

The basic categories of cotton harvest aids include the…

- boll openers/conditioners
- boll openers/defoliants
- true defoliants
- desiccants
- enhancers

REVIEW QUESTIONS

1. "*Do not plant broccoli after the use of this product for 12 months after application*" is an example of what type of label statement?

a. preharvest interval

b. restricted harvest interval

c. plantback statement

d. re-entry statement

2. Which of the following factors can contribute to pesticide-caused phytotoxicity?

a. using emulsifiable concentrate formulations

b. using pesticides that contain solvents

c. cold air temperatures

d. a & b

3. PGR chemicals can affect which of the following plant processes?

a. cell division

b. growth rate

c. rooting

d. all of the above

4. Which of the following are PGR chemicals?

a. abiotics

b. gibberillins

c. cuticles

d. cotyledons

5. Which PGR is commonly used to influence fruit ripening?

a. auxins

b. abiotics

c. ethylene

d. a & c

6. Which of the following are important principles of PGR use?

a. use them in small amounts

b. always tankmix them

c. always use them with surfactants

d. all of the above

7. Why are cotton harvest aid chemicals used?

a. to stimulate the opening and maturation of cotton bolls

b. to eliminate excess foliage that interferes with mechanical harvest

c. to reduce crop staining by green plant fluids/tissues

d. all of the above

Answers:

1. c	3.d	5.c	7. d
2. d	4.b	6. a	

ONLY Category A

15. RESIDENTIAL, INDUSTRIAL & INSTITUTIONAL: SPECIAL TOPICS

This chapter reviews topics that are important for the *Residential, Industrial & Institutional* QAC and QAL exams. It should be reviewed along with the information found in the following chapters:

- Chapter 10: Weeds
- Chapter 11: Vertebrates
- Chapter 12: Plant Diseases
- Chapter 13: Invertebrates

Important Point: Structural pest control for hire is not allowed under this pest control category. Structural pest control involves the control of pests that may invade houses or other structures. A businesses involved in structural pest control must be licensed by the Department of Consumer Affairs, Structural Pest Control Board.

Common Pest Species

The pest species most commonly associated with residential, industrial and institutional settings can be broken down in to the following basic groups:

- Pests of Food Handling Areas
- Pests that Sting or Bite
- Fabric Pests
- Stored-Product Pests
- Termites
- Vertebrate Pests
- Weeds

Pests of Food Handling Areas

Cockroaches

Here are some important facts about cockroaches:

- major pests of homes, restaurants, hospitals and offices
- spread human diseases
- develop via 3-stage metamorphosis

There are 5 important species of cockroaches in California.

1. German Cockroach
    - the most common indoor cockroach species in CA
    - common in homes, hospitals, ships, planes and buses
    - small, only about ½ inch long
    - they glide rather than fly

- the females carry their egg cases (ootheca) throughout the incubation period

2. Oriental Cockroach

- prefer dark, damp places
- commonly found in drains basements, garbage chutes
- large, 1 – 1 ¼ inches long
- dark brown, almost black
- they don't fly

3. American Cockroach

- prefer warm, humid environments
- common pests in zoos and other animal handling facilities
- also found in sewers, water meter boxes and steam tunnels
- very large; 2 inches long
- reddish-brown color
- they can fly
- attracted to street lights

4. Brownbanded Cockroach

- The second most common cockroach in CA.
- prefer warmer, drier spots (inside radios or televisions)
- common pests in animal pens
- small, ½ inch long
- golden brown color with distinct banding
- males can fly but not females

5. Smokybrown Cockroach

- a very visible species, often seen by people
- common in garages and outdoors in planters and woodpiles
- common in zoos and other animal handling facilities
- large; 1 ¼ inch long
- dark-colored
- they can fly
- attracted to street lights

Controlling Cockroaches

Successful cockroach control is often the result of the 5 following methods:

1. Monitoring
   - survey at night with a flashlight
   - pay close attention to cracks, crevices and other hiding places
   - use sticky traps and jar traps
   - use a flushing agent, such as a synergized pyrethrin insecticide
2. Sanitation
   - eliminate sources of food and water (i.e. trash management)
   - remove hiding places (i.e., stacks of old newspapers and boxes)
   - eliminate water sources (i.e., leaky plumbing)
3. Exclusion
   - seal all openings to the outdoors
   - inspect furniture and appliances for egg cases before you move them in to a building
4. Chemical Control
   - be careful using insecticides in food-handling areas
   - use low-toxicity dessicant dusts (boric acid) near food
   - use residual pesticides for long-term control
   - use low-residual insecticides (i.e., pyrethrins) for quick control
   - combining a slow-acting insect growth regulator (IGR) with a quick-acting, low-residual (i.e. pyrethrins) is often successful
5. Post-treatment Monitoring
   - evaluate how well your control methods worked
   - conduct regular monitoring with sticky traps or baited traps
   - maintain sanitary conditions and eliminate hiding places
   - use follow-up chemical applications if necessary

Ants

Here are some important facts about ants:

- indoor and outdoor pests
- they live in colonies comprised of one or more egg-laying queens, sterile female "workers" and winged, sexual males and females
- develop via 4-stage metamorphosis
- There are more than 12,000 ant species in the world

There are 5 important ant species in California

1. Argentine Ant
   - the most common household ant in central and southern CA
   - common in homes, restaurants and schools
   - difficult to control once it's established
   - small, workers are 1/8 inch long, queens are larger at ¼ inch
   - nest outdoors in the soil and indoors in wall voids or houseplants
   - attracted to sweet substances including the honeydew produced by aphids. Controlling aphids will help control this ant species.
2. Pharoah Ant
   - small, 1/16th inch
   - they nest indoors and prefer warm locations
   - not well-distributed in CA. common in some metropolitan areas
   - a serious pest in hospitals, may infest open wounds and transmit diseases.
3. Odorous House Ant
   - emits a foul order if crushed
   - small, workers are 1/8 inch
   - usually nest outdoors in the soil or under rocks or logs
   - may nest under building foundations, in wall voids or similar protected sites
4. Thief Ant
   - steals food from other ant colonies
   - very small, 1/16th inch long

- nest outdoors, but can nest indoors in wall voids
- attracted to greasy foods
- small size allows them to get in to many containers
- may transmit diseases by contaminating food

5. California Harvester Ant

- 1/4 inch long
- Outdoor nesters that make large, fan-shaped mounds
- not usually an indoor pest
- an aggressive species with a painful sting

Controlling Ants

Successful ant control is often the result of the 3 following methods:

1. Exclusion
   - caulk cracks and crevices around and inside buildings
2. Sanitation
   - control aphids and scale insects on shrubs near buildings (Argentine ant)
   - eliminate indoor food and water sources
3. Chemical Control
   - use an insecticide for immediate knockdown
   - focus chemical control on controlling larvae and queens inside the nests
   - use baits to get insecticides in to the nest

Flies

Here are some important facts about flies:

- can be indoor and outdoor pests
- develop via 4-stage metamorphosis
- some species feed on plants while others feed on animal carcasses and waste
- human disease vectors

There are 4 important pest fly species groups in California

1. House Fly and Little House Fly
   - except for size, these two species are similar in appearance
   - common indoor pests, especially around food preparation sites

- adults feed on decaying organic matter, feces and a variety of liquids
- very important vector for human disease and parasites

2. Blow and Bottle Flies
   - larger than the house fly
   - the bottle flies have brilliant, metallic coloration
   - occasionally indoor pests
   - deposit their eggs in dead/rotted meat
   - human disease vectors
   - common during warm weather
3. Cluster Flies
   - resembles the house fly, but larger and darker
   - not disease vectors
   - occasionally indoor pests
   - characterized by their buzzing and sluggish flight
4. Vinegar Flies (fruit flies)
   - tiny…only about 1/10 inch
   - attracted to overripe fruits and vegetables and other garbage
   - can transmit human disease
   - vectors of bacterial diseases of fruit, causing spoilage

Controlling Flies

Here are some basic methods for controlling flies:

1. Exclusion
   - use door and window screens
   - use air-curtains or fans to prevent entry in to commercial buildings
2. Sanitation
   - eliminate food sources
   - eliminate larval production sites (garbage, dog feces)
3. Trapping
   - traps baited with an attractant
   - keep traps away from building entrances
   - regularly dispose of dead flies in traps

4. Biological Control
    - Parasitic wasps have been used, especially around livestock production facilities.
5. Chemical Control
    - insecticide resistance development can be a problem
    - use poison baits that contain attractants
    - use residual insecticides on outdoor surfaces where adult flies may land

Pests that Bite or Sting

Mosquitoes

Here are some important facts about mosquitoes:

- most species lay their eggs in water and the larvae are aquatic
- adults are winged
- adult males don't eat, adult females need a blood-meal before they lay eggs
- they spread human and animal diseases (i.e. West Nile Virus)
- they develop via 4-stage metamorphosis

Controlling Mosquitoes

Mosquito management is usually done on a region-wide level and is usually the responsibility of public health agencies or mosquito control districts.

Here are some important ways to control mosquitoes:

- eliminate standing water in puddles, old tires, pet etc.
- small ponds (i.e. fish ponds) can be stocked with mosquito fish that will control the aquatic larvae
- keep doors and windows closed or use screens
- use insecticide fogs outdoors
- use insect repellents on skin and clothing.

Fleas

Here are some important facts about fleas:

- tiny, wingless insects
- adult fleas are parasites of warm-blooded mammals

- their bite can cause bleeding, itching and rashes in humans
- they can spread diseases such as murine typhus and bubonic plague
- they develop via 4-stage metamorphosis
- the cat flea, is the most common and troublesome species

Here's some additional information about the cat flea:

- The eggs are laid on the coats of parasitized animals, but usually drop off before hatching.
- Carpets and pet bedding are excellent habitats for egg-hatching and larval development.
- The larvae pupate inside a silken cocoon. Newly-emerged adults seek out pet hosts.

Controlling Fleas

Flea management can be difficult and usually requires an integrated approach that may involve the following methods:

1. Sanitation
   - Areas where fleas or flea eggs may be found must be vacuumed regularly.
   - Flea larvae can resist vacuuming by strongly attaching to carpet fibers.
   - Adult fleas can develop inside vacuum bags.
   - Pet bedding should be laundered in hot, soapy water at least once per week.
2. Indoor Chemical Control
   - Several insecticides are registered for flea control indoors, but many are for outdoor use only.
   - Spray carpets, pet bedding and other places where adults and larvae are found.
   - Combine a quick, knockdown spray with an insect growth regulator (IGR) to provide control of both adults and developing larvae.
3. Chemical Control on Pets
   - consult with a veterinarian
   - Treat pets at the same time that carpets and other infested areas are being treated.
   - Be careful not to use the same type of insecticide (i.e,

organophosphates) on pets that is being used to spray carpets or outdoor areas. This type of activity will cause pets to receive a "double dose" of the insecticide.

- Flea control products that can be used on pets include: repellents, dips, powders and dusts, spray-on liquids, flea collars and internal/systemic medications (i.e. pills).

Bees and Wasps

Here are some important facts about bees and wasps:

- Bees and wasps are social insects.
- Bees live in hives that consist of three specific groups, the queen, the workers and the drones.
- Paper or umbrella wasps construct small nests made of wood that they have chewed in to a pulp.
- Hornets and yellowjackets generally produce large, globular paper nests suspend from tree limbs or building overhangs.
- Mud-daubers or the other so-called solitary wasps, construct small, single-celled, mud nests in protected places like under house eaves.
- generally considered to be beneficial, especially bees
- they can become nuisances species around people or buildings
- Bees and wasps will aggressively protect their hives. This is especially true of Africanized bees (i.e. "killer bees).
- Removing hives from buildings may require construction activities such as wall-removal and repair.
- The incomplete removal of dead bees, larvae and honey from within buildings can cause serious odor and contamination problems.

Controlling Bees

- Use fast-acting insecticides to kill bees that cannot be removed alive.
- Once a hive within a building is removed, block all entrances > than ¼ inch.

- Use moth balls to repel bees from former nesting sites within buildings.
- Use a one-way exit to prevent foraging bees from returning to the hive.

Controlling Wasps

- physically removal nests
- poison baits that include a meat attractant
- quick-acting insecticides
- Blow insecticide dusts in to hives the hive. Dusts, because of their long-residual, can provide extended control.

Fabric Pests

There are two fabric pests of economic importance in California; carpet beetles and clothes moths. Of the two pest types, the beetles are more significant in California.

Carpet Beetles

Here's some basic information about carpet beetles:

- They develop via 4-stage metamorphosis.
- There are 3 carpet beetle species in California; the varied carpet beetle, the furniture carpet beetle and the black carpet beetle.
- The larvae damage carpets, furniture, fabrics and stored food.

Controlling Carpet Beetles

The following strategies can be used to control carpet beetles:

- Monitor for beetles using sticky traps baited with a pheromone.
- Eliminate food sources such as lint, hair, dead insects and other debris.
- Destroy badly damaged furniture or carpets.
- Clean carpets, furniture, draperies and other similar items on a regular basis.
- Use residual insecticides for spot treatments.
- Extensive infestations may require fumigation.

Clothes Moths

Here's some basic information about clothes moths:

- They develop via 4-stage metamorphosis.

- There are 2 primary species; the webbing clothes moth and the casemaking clothes moth. The species are very similar.

- They are occasional pests in California.

- The adults of these species are rarely seen. The silken webs spun by the larvae are often the only sign of an infestation.

Controlling Clothes Moths

The following strategies can be used to control clothes moths:

- Low humidity conditions will help control these species.

- Clean carpets, furniture, draperies and other similar items regularly.

- Use residual insecticides for spot treatments.

Stored Product Pests

There are 3 important stored product pest groups including various species of;

1. beetles
2. weevils
3. moths

Here's some basic information about these pests:

- New infestations are often started accidentally because these pests are small and difficult to detect.

- They not only consume stored food products but their excrement, cast skins, dead bodies and webbing cause contamination problems.

Controlling Stored Product Pests

Here are some strategies that can be used to control these pests:

- Inspection and detection must be done on a regular basis.

- Pheromone traps can be used for both detection and control.

- Inspect incoming materials to prevent infestations.

- Use insect-proof containers.

- Keep areas clean of spilled grains or other stored product materials.

- Regular cleaning of equipment such as conveyor belts is also important.

- Dessicant dusts, such as silica gel, can be used to control pests without creating a pesticide

residue hazard in stored food products.

- Insect growth regulators (IGRs) can often be sprayed directly on food products without causing pesticide residue problems.

- Pyrethroids or other low-residual insecticides can often be used on, or near, food.

- Residual insecticides can be used for spot treatments, but not generally on food.

Termites

Here are some important facts about termites;

- They're highly social insects, living in large colonies in the soil or in living wood.

- They undergo incomplete metamorphosis (egg, nymph and adult)

- Colonies are comprised of 3 groups; soldiers, workers and the reproductive kings and queens.

- Soldiers defend the colony.

- Workers construct the colony and forage for food.

- The kings and queens produce the colony's young.

Important termite species in California include;

- drywood termites
- dampwood termites; and
- subterranean termites

Drywood Termites

- the most common type of termite in southern CA

- infest dry, undecayed wood

- leave piles of fecal pellets near openings in infested wood

- Swarms of winged adults are often seen, particularly in the fall.

Dampwood Termites

- more common in northern CA and along the coast

- nest in wood that is high in moisture content, including live trees

- the largest termites, adults may be up to 1 inch in length.

Subterranean Termites

- probably the most destructive termite in CA

- require a moist environment
- generally nest in the ground
- construct shelter tubes of soil or wood particles
- generally feed on the soft parts of wood
- they produce liquid feces, not dry pellets

Controlling Termites

A successful control program has three critical elements;

1. inspection
2. prevention
3. control

Inspection: A good inspection program incorporates the following elements:

- make sure that swarming adults are termites and not winged ants
- looking for moist soil or wood conditions and soil-to-wood contacts
- Tapping and probing techniques can be used to find termite-damaged areas.

Prevention: Here are some important prevention methods:

- using termite-resistant wood
- using chemically-treated wood
- screening or seal openings
- keep attics dry
- eliminate soil-to-wood contact
- maintain a 12-inch gap between the soil and wood

Drywood termites

- fumigation
- insecticide spot treatments
- liquid nitrogen freezing
- heat (propane burners)
- electrocution
- colony removal

Dampwood and subterranean termites

- Many techniques that work on drywood termites will not work on these termite species because they nest in the soil.
- insecticide spot treatments of nest areas
- insecticide soil drenches applied below the building for larger areas

Vertebrate Pests

Birds

Here are some of the problems birds can cause in residential, industrial or institutional settings:

- noise
- droppings or nests

- consume or contaminate stored products
- physical damage to structures (woodpeckers)
- airport safety hazards (bird & aircraft collisions)

While most bird species are generally considered to be beneficial and desirable for society, the following birds are often pest species

- cliff swallows
- house sparrows
- starlings
- woodpeckers

Important fact: Most bird species are protected by either state, federal law or international treaty. Permits may be needed from either federal or state wildlife agencies.

Controlling Birds

- eliminate food and water supplies
- Eliminate or modify roosting or nesting site; flat surfaces can be modified to a 45° angle or bird spikes can be installed
- block entrances to buildings to prevent entrance
- trapping
- noise devices (i.e. recorded bird distress calls)
- frightening devices (i.e. plastic owls)
- avicides that cause poisoned birds to display distress calls or behaviors

Rodents

Here are some important facts about rats and mice, the most important vertebrate pest species:

- They eat and contaminate stored products.
- They reproduce at a rapid rate.
- They may cause physical damage to structures. They may chew on electrical wiring.
- They may spread human disease such as murine typhus and trichinosis.
- Rats may harbor rat fleas that can spread plague via their bites.
- There are two primary rat species, the Norway rat and the roof rat. The Norway rat is the larger species and its tail is shorter than body and head combined. The roof rat is smaller with a tail that is longer than the body and head.

Mice: The house mouse is the most important mouse pest. Here are some characteristics that are unique to mice:

- They can go long periods without water.
- They rapidly adjust to new environments and foods.
- They generally will travel only short distances from their nests (i.e. 10-15 feet)

Controlling Rats and Mice

- Exclusion is the most important control method. Rats can gain entry into buildings thru holes as small as ½ inch in diameter. Mice can squeeze through holes that are as small as ¼ inch.
- Eliminate habitat sites such as dense ivy patches.
- Sanitation is critical. Make sure sites are free from easily obtainable food sources.
- Trapping can be an effective method, if traps are checked daily.
- Rodenticides may also be used effectively provided that…
    - poison baits are kept fresh and continuously available
    - rodent species are accurately identified for proper bait placement

Special Conditions

Children, pregnant women, people that are ill and the elderly may be at a greater risk from pesticide exposure than the general population. Pets may also be at greater risk than humans when it comes to pesticides. You may need to use extra precautions when using pesticides in areas where these special conditions exist.

Infants and Children

- May be more sensitive to pesticides because of their smaller size and underdeveloped immune systems.
- Don't apply pesticides to the bedding, towels, clothing or carpets.
- Children, especially toddlers, are curious and may put pesticide-treated objects in their mouths.
- Dusts and powders may present a relatively long-lived inhalation hazard

Pregnant Women

- Pesticides that rapidly enter the pregnant mother's bloodstream will likely be passed on directly to the unborn child.

- The unborn child's developing immune system may be especially sensitive.

People with Medical Conditions

- People with allergies and respiratory illnesses (i.e. emphysema, asthma) or other medical conditions may be more sensitive to pesticides.

- It's also possible that medications used to treat illnesses may influence pesticide hazards. In these situations it may be important for the person under medication to consult with their physician about possible pesticide/medication interactions.

The Elderly

- They may have compromised respiratory systems because of diseases.

- Their circulatory and metabolic processes may be compromised making it difficult for their bodies to degrade and eliminate chemicals from their bodies.

- They may have increased exposure to pesticides used in areas where they spend significant amounts of time in bed or in sitting rooms.

Fumigating Commodities

Permanent Fumigation Facilities

Chamber Construction: The interior of the chamber may be constructed of the following materials and, except for galvanized metal, must be painted with 2 coats of epoxy paint:

- masonite
- plywood
- plaster
- brick
- cement blocks
- galvanized

Thermometer: each chamber must be equipped with a thermometer or temperature recording device that is readable from the outside.

False Floors: All chambers must have slatted false floors that will allow free movement of air to the blower intake. The false floor space may be as little as 4 inches, but can be as wide as 10 inches.

Fumigant Introduction System: Here are some requirements:

- It must be a closed system.

- Proper measuring devices must be used.

- Volatilizers must be used, when appropriate.
- The fumigant will be introduced within the chamber through the main air stream.

Circulation and Exhaust Equipment:

- Fans that circulate fumigant must be used, when appropriate.

- The system must draw from the bottom of the load or beneath the false floor.

- Must have fresh air inlet installed at the opposite end of the exhaust opening to allow adequate introduction of fresh air during evacuation.

Other Requirements

- The facility must have the appropriate NIOSH leak detectors.

- The appropriate respiratory protective equipment must be available for employees.

- Proper fumigant storage areas shall be used and shall be posted.

- Bilingual warning signs for fumigation chambers must be used.

- The employer must provide an emergency washing area.

Temporary Fumigation Facilities

Railway Cars and Highway Vans

- These containers are acceptable as long as they have suitable aeration.

- The articles to be fumigated must be on pallets or floor racks.

- Railcars or vans must be gas-tight.

- The doors must be sealed after loading.

- The appropriate leak detector must be used.

Tarpaulin Enclosures

- Must be free from holes, tears, etc.

- Must be at least 6 gauge in weight (6-mil thick).

- Constructed of gas-impervious materials (i.e., vinyl).

- A 6-mil tarp may not be used more than 4 times.

- Heavy-oiled canvas tarps may not be used.

- A tarp cannot exceed 10 ft in height, 25 ft in width or 50 ft in length.

- The fumigation must be conducted on a gas-impervious surface (concrete).

Worker Safety Requirements

- Self-contained breathing apparatus (SCBA) must be worn when employees enter into or open any container that holds fumigated commodities.

- Halide detectors can be used to detect gas leaks but should not be used to determine if it is safe to enter fumigated areas.

- Colorimetric detector tubes (i.e. Draeger tubes) may be used to detect gas concentrations that exceed Permissible Exposure Limit (PEL) values in the parts per million (ppm) range.

REVIEW QUESTIONS

1. Which cockroach is the most common indoor species in California?

a. Oriental

b. smokybrown

c. German

d. brownbanded

2. Which of the following cockroaches do not fly?

a. Oriental

b. American

c. smokybrown

d. all of the above can fly

3. Which cockroach prefers warm, dry areas?

a. smokybrown

b. American

c. German

d. brownbanded

4. Which cockroach is attracted to streetlights?

a. American

b. smokybrown

c. German

d. a & b

5. Which of the following is a good monitoring strategy for cockroaches?

a. sticky traps

b. flashlight surveys

c. flushing agents

d. all of the above

6. Which ant species is the most common household ant in central and southern California?

a. Oriental

b. Harvester

c. Argentine

d. thief

7. Which of the following statements is true?

a. ants are attracted to honeydew

b. aphids can control ants

c. baits cannot be used to control ants

d. all the above are true

8. Which fly species does not spread human disease?

a. little house fly

b. house fly

c. vinegar fly

d. all of the above spread disease

9. Which of the following are true about mosquitoes?

a. only adult males suck blood

b. mosquito fish are used for control

c. they spread typhoid in horses

d. all of the above are true

10. Which flea is the most serious pest of humans and pets?

a. the circus flea

b. the dog flea

c. the rat flea

d. none of the above

11. Which of the following methods are important for flea control?

a. vacuuming carpets

b. insecticide applications

c. washing pet bedding

d. all of the above

12. Which of the following are carpet beetle pests in California?

a. varied carpet beetle

b. furniture carpet beetle

c. black carpet beetle

d. all of the above

13. Which of the following are control methods for carpet beetles?

a. anticoagulants

b. fumigation

c. poison baits

d. all of the above

14. The 2 primary species of clothes moth in California are...

a. the variegated and varied

b. Oriental and webbing

c. casemaking and varied

d. webbing and casemaking

15. Which method is NOT used for clothes moth control?

a. low humidity

b. carpet cleaning

c. pheromone traps

d. insecticide spot treatments

16. The pest group known as the "stored product pests" includes which of the following?

a. beetles, cockroaches, moths

b. ants, cockroaches, moths

c. beetles, weevils and moths

d. none of the above

17. Which of the following methods is appropriate to control stored product pests?

a. pheromone traps

b. clean-up/disposal of spilled grain

c. dessicant dusts

d. all of the above

18. Which of the following is not a type of termite?

a. dampwood

b. subterranean

c. house

d. all of the above are termite types

19. Which of the following is probably the most destructive termite in California?

a. dampwood

b. subterranean

c. house

d. drywood

20. Which statement is false?

a. the control methods for all termite species are the same

b. the control methods used for drywood termites won't work on the other termites because they're pesticide-resistant

c. freezing is good control method for drywood termites

d. a & b are false

21. Which of the following are differences between roof and Norway rats?

a. The roof rat is smaller

b. The Norway rat's tail is longer than the body and head combined.

c. The roof rat is larger.

d. a & b are true

Answers

1. c	9. b	17. d
2. a	10. d	18. c
3. d	11. d	19. b
4. d	12. d	20. d
5. d	13. b	21. a
6. c	14. d	
7. a	15. c	
8.c	16. c	