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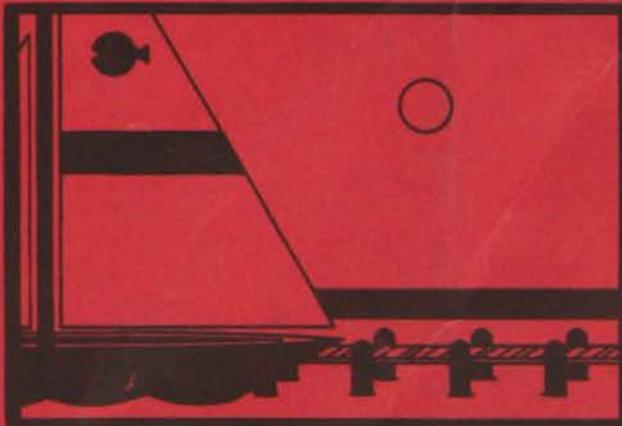
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Pesticide Applicator Training Manual



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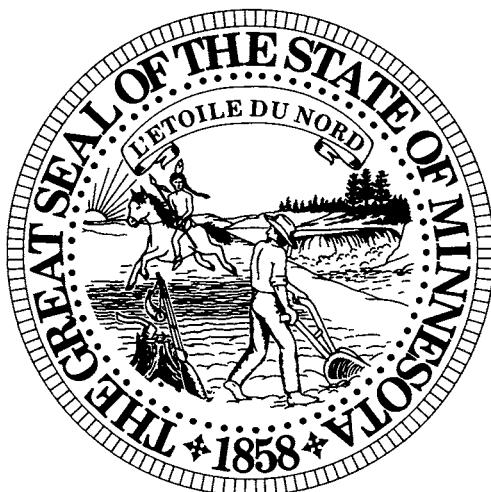
DEPARTMENT OF AGRICULTURE

PESTICIDE CONTROL LAW

CHAPTER 18B

**Extract from 1996 Minnesota Statutes
Including amendments adopted in the 1997 Laws Of Minnesota**

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CHAPTER 18B

PESTICIDE CONTROL

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18B.01 DEFINITIONS.

Subdivision 1. **Applicability.** The definitions in this section apply to this chapter.

Subd. 2. Approved agency. "Approved agency" means a state agency, other than the department of agriculture, or an agency of a county, municipality, or other political subdivision that has signed a joint powers agreement under section 471.59 with the commissioner.

Subd. 3. Beneficial insects. "Beneficial insects" means insects that are: (1) effective pollinators of plants; (2) parasites or predators of pests; or (3) otherwise beneficial.

Subd. 4. Bulk pesticide. "Bulk pesticide" means a pesticide that is held in an individual container, with a pesticide content of 56 United States gallons or more, or 100 pounds or greater net dry weight.

Subd. 4a. Collection site. "Collection site" means a permanent or temporary designated location with scheduled hours for authorized collection where pesticide end users may bring their waste pesticides.

Subd. 5. Commercial applicator. "Commercial applicator" means a person who has or is required to have a commercial applicator license.

Subd. 6. Commissioner. "Commissioner" means the commissioner of agriculture or an agent authorized by the commissioner.

Subd. 6a. Container. "Container" means a portable device in which a material is stored, transported, treated, disposed of, or otherwise handled.

Subd. 6b. Corrective action. "Corrective action" means an action taken to minimize, eliminate, or clean up an incident.

Subd. 7. Device. "Device" means an instrument or contrivance, other than a firearm, that is intended or used to destroy, repel, or mitigate a pest, a form of plant or animal life other than humans, or a bacterium, virus, or other microorganism on or in living animals, including humans. A device does not include equipment used for the application of pesticides if the equipment is sold separately from the instrument or contrivance.

Subd. 8. Distribute. "Distribute" means offer for sale, sell, barter, ship, deliver for shipment, receive and deliver, and offer to deliver pesticides in this state.

Subd. 9. Environment. "Environment" means surface water, ground water, air, land, plants, humans, and animals and their interrelationships.

Subd. 9a. Fixed location. "Fixed location" means all stationary restricted and bulk pesticide facility operations owned or operated by a person located in the same plant location or locality.

Subd. 10. FIFRA. "FIFRA" means the Federal Insecticide, Fungicide, Rodenticide Act, United States Code, title 7, sections 136 to 136y, and regulations under Code of Federal Regulations, title 40, subchapter E, parts 150 to 180.

Subd. 10a. Genetic engineering. "Genetic engineering" means the modification of the genetic composition of an organism using molecular techniques. This does not include selective breeding, hybridization, or nondirected mutagenesis.

Subd. 10b. Genetically engineered pesticide. "Genetically engineered pesticide" means an organism that has been modified through the use of genetic engineering, intended to prevent, destroy, repel, or mitigate a pest, and an organism that has been modified through the use of genetic engineering, intended for use as a plant regulator, defoliant, or desiccant.

Subd. 11. Hazardous waste. "Hazardous waste" means any substance identified or listed as hazardous waste in the rules adopted under section 116.07, subdivision 4.

Subd. 12. Incident. "Incident" means a flood, fire, tornado, transportation accident, storage container rupture, leak, spill, emission discharge, escape, disposal, or other event that releases or immediately threatens to release a pesticide accidentally or otherwise into the environment, and may cause unreasonable adverse effects on the environment. "Incident" does not include a release from normal use of a pesticide or practice in accordance with law.

Subd. 13. Label. "Label" means the written, printed, or graphic matter on, or attached to, the pesticide or device or their containers or wrappers.

Subd. 14. Labeling. "Labeling" means all labels and other written, printed, or graphic matter:

- (1) accompanying the pesticide or device;
- (2) referred to by the label or literature accompanying the pesticide or device; or
- (3) that relates or refers to the pesticide or to induce the sale of the pesticide or device.

"Labeling" does not include current official publications of the United States Environmental Protection Agency, United States Department of Agriculture, United States Department of Interior, United States Department of Health, Education and Welfare, state agricultural experiment stations, state agricultural colleges, and other similar federal or state institutions or agencies authorized by law to conduct research in the field of pesticides.

Subd. 14a. Local unit of government. "Local unit of government" means a statutory or home rule charter city, town, county, soil and water conservation district, watershed district, another special purpose district, and local or regional board.

Subd. 15. Noncommercial applicator. "Noncommercial applicator" means a person who has or is required to have a noncommercial applicator license.

Subd. 15a. Organism. "Organism" means an animal, plant, bacterium, cyanobacterium, fungus, protist, or virus.

Subd. 15b. Owner of real property. "Owner of real

property" means a person who is in possession of, has the right of control, or controls the use of real property, including a person who has legal title to property and a person who has the right to use or contract use of the property under a lease, contract for deed, or license.

Subd. 16. Repealed, 1996 c 310 s 1

Subd. 17. **Pest**. "Pest" means an insect, rodent, nematode, fungus, weed, terrestrial or aquatic plant, animal life, virus, bacteria, or other organism designated by rule as a pest, except a virus, bacteria, or other microorganism on or in living humans or other living animals.

Subd. 18. **Pesticide**. "Pesticide" means a substance or mixture of substances intended to prevent, destroy, repel, or mitigate a pest, and a substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

Subd. 19. **Pesticide dealer**. "Pesticide dealer" means a person who has or is required to have a pesticide dealer license.

Subd. 19a. **Pesticide end user**. "Pesticide end user" means a farmer or other person who uses, intends to use, or owns a pesticide. Pesticide end user does not include a dealer, manufacturer, formulator, or packager.

Subd. 20. **Plant regulator**. "Plant regulator" means a substance or mixture of substances intended through physiological action to accelerate or retard the rate of growth or rate of maturation of a plant, or to otherwise alter the behavior of ornamental or crop plants or the produce of the plants. Plant regulator does not include substances to the extent that they are intended as plant nutrients, trace elements, nutritional chemicals, plant inoculants, or soil amendments.

Subd. 21. **Private applicator**. "Private applicator" means a person certified or required to be certified to use restricted use pesticides.

Subd. 22. **Registrant**. "Registrant" means a person that has registered a pesticide under this chapter.

Subd. 22a. **Release**. "Release" means the placement or use of a genetically engineered organism outside a contained laboratory, greenhouse, building, structure, or other similar facility or under other conditions not specifically determined by the commissioner to be adequately contained.

Subd. 23. **Responsible party**. "Responsible party" means a person who at the time of an incident has custody of, control of, or responsibility for a pesticide, pesticide container, or pesticide rinsate.

Subd. 24. **Restricted use pesticide**. "Restricted use pesticide" means a pesticide formulation designated as a restricted use pesticide under FIFRA or by the commissioner under this chapter.

Subd. 24a. **Returnable container**. "Returnable

container" means a container for distributing pesticides that enables the unused pesticide product to be returned to the distributor, manufacturer, or packager, and includes bulk, mini-bulk, or dedicated containers designed to protect the integrity of the pesticide and prevent contamination through the introduction of unauthorized materials.

Subd. 25. **Rinsate.** "Rinsate" means a dilute mixture of a pesticide or pesticides with water, solvents, oils, commercial rinsing agents, or other substances, that is produced by or results from the cleaning of pesticide application equipment or pesticide containers.

Subd. 26. **Safeguard.** "Safeguard" means a facility, equipment, device, or system, or a combination of these, designed to prevent an incident as required by rule.

Subd. 27. **Site.** "Site" means all land and water areas, including air space, and all plants, animals, structures, buildings, contrivances, and machinery whether fixed or mobile, including anything used for transportation.

Subd. 28. **Structural pest.** "Structural pest" means a pest, other than a plant, in, on, under, or near a structure.

Subd. 29. **Structural pest control.** "Structural pest control" means the control of any structural pest through the use of a device, a procedure, or application of pesticides in or around a building or other structures, including trucks, boxcars, ships, aircraft, docks, and fumigation vaults, and the business activity related to use of a device, a procedure, or application of a pesticide.

Subd. 30. **Structural pest control applicator.** "Structural pest control applicator" means a person who has or is required to have a structural pest control applicator license.

Subd. 30a. **Substantially altering; substantially alter; substantial alteration.** "Substantially altering," "substantially alter," or "substantial alteration" means modifying a bulk agricultural chemical storage facility by:

(1) changing the capacity of a safeguard;
(2) adding storage containers in excess of the capacity of a safeguard as required by rule; or

(3) increasing the size of the single largest storage container in a safeguard as approved or permitted by the department of agriculture. This does not include routine maintenance of safeguards, storage containers, appurtenances, piping, mixing, blending, weighing, or handling equipment.

Subd. 31. **Unreasonable adverse effects on the environment.** "Unreasonable adverse effects on the environment" means any unreasonable risk to humans or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.

Subd. 31a. **Waste pesticide.** "Waste pesticide" means a pesticide that the pesticide end user considers a waste. A waste pesticide can be a canceled pesticide, an unusable

pesticide, or a usable pesticide.

Subd. 32. **Wildlife.** "Wildlife" means all living things that are not human, domesticated, or pests.

HIST: 1987 c 358 s 43; 1989 c 326 art 5 s 1-15; 1991 c 250 s 6-9; 1993 c 367 s 1,2

18B.02 PREEMPTION OF OTHER LAW.

Except as specifically provided in this chapter, the provisions of this chapter preempt ordinances by local governments that prohibit or regulate any matter relating to the registration, labeling, distribution, sale, handling, use, application, or disposal of pesticides. It is not the intent of this section to preempt local responsibilities for zoning, fire codes, or hazardous waste disposal.

HIST: 1987 c 358 s 44

18B.03 POWERS AND DUTIES OF COMMISSIONER.

Subdivision 1. **Administration by commissioner.** The commissioner shall administer, implement, and enforce this chapter and the department of agriculture is the lead state agency for the regulation of pesticides.

Subd. 2. **Delegation of duties.** The functions vested in the commissioner by this chapter may be delegated to designated employees or agents of the department of agriculture.

Subd. 3. **Delegation to approved agencies.** The commissioner may, by written agreements, delegate specific inspection, enforcement, and other regulatory duties of this chapter to officials of approved agencies.

HIST: 1987 c 358 s 45

18B.04 PESTICIDE IMPACT ON ENVIRONMENT.

The commissioner shall:

(1) determine the impact of pesticides on the environment, including the impacts on surface water and groundwater in this state;

(2) develop best management practices involving pesticide distribution, storage, handling, use, and disposal; and

(3) cooperate with and assist other state agencies and local governments to protect public health and the environment from harmful exposure to pesticides.

HIST: 1987 c 358 s 46; 1989 c 326 art 5 s 16

18B.045 PESTICIDE MANAGEMENT PLAN.

Subdivision 1. **Development.** The commissioner shall develop a pesticide management plan for the prevention, evaluation, and mitigation of occurrences of pesticides or pesticide breakdown products in groundwaters and surface waters of the state. The pesticide management plan must include components promoting prevention, developing appropriate responses to the detection of pesticides or pesticide breakdown

products in groundwater and surface waters, and providing responses to reduce or eliminate continued pesticide movement to groundwater and surface water. Beginning September 1, 1994, and biennially thereafter, the commissioner must submit a status report on the plan to the environmental quality board for review and then to the legislative water commission.

Subd. 2. Coordination. The pesticide management plan shall be coordinated and developed with other state agency plans and with other state agencies through the environmental quality board. In addition, the University of Minnesota extension service, farm organizations, farmers, environmental organizations, and industry shall be involved in the pesticide management plan development.

HIST: 1989 c 326 art 5 s 17; 1994 c 557 s 8

18B.05 PESTICIDE REGULATORY ACCOUNT.

Subdivision 1. Establishment. A pesticide regulatory account is established in the state treasury. Fees and penalties collected under this chapter must be deposited in the state treasury and credited to the pesticide regulatory account.

Subd. 2. Expenditures. Subject to appropriation by the legislature, money in the account, including the amount of interest attributable to money in the account and any money appropriated for the purposes of this chapter, may be used by the commissioner for the administration and enforcement of this chapter.

HIST: 1987 c 358 s 47; 1991 c 199 art 2 s 4; 1993 c 172 s 23

18B.06 RULES.

Subdivision 1. Authority. The commissioner shall adopt rules to implement and enforce this chapter including procedures addressing local control of pesticide regulation. Rules adopted under this chapter are part of this chapter and a violation of the rules is a violation of a provision of this chapter.

Subd. 2. Conformity with FIFRA. Rules adopted under this chapter:

(1) may not allow pesticide use that is prohibited by FIFRA; or

(2) relating to private applicators of restricted use pesticides and special local needs registrations, may not be inconsistent with the requirements of FIFRA.

Subd. 3. Pesticide use, handling, and disposal. The commissioner shall adopt rules to govern the distribution, use, storage, handling, and disposal of pesticides, rinsates, and pesticide containers.

HIST: 1987 c 358 s 48; 1995 c 233 art 2 s 56

18B.063 STATE USES OF PESTICIDES AND NUTRIENTS.

The state shall use integrated pest management techniques in its management of public lands, including roadside rights-of-way, parks, and forests; and shall use planting regimes that minimize the need for pesticides and added nutrients.

HIST: 1989 c 326 art 5 s 18

18B.064 PESTICIDE USE INFORMATION.

The commissioner shall monitor urban and rural pesticide use on a biennial basis. Information shall be collected and automated consistent with section 103B.151, subdivision 1.

HIST: 1989 c 326 art 5 s 19; 1990 c 391 art 10 s 3

18B.065 WASTE PESTICIDE COLLECTION PROGRAM.

Subdivision 1. Collection and disposal. The commissioner of agriculture shall establish and operate a program to collect waste pesticides. The program shall be made available to pesticide end users whose waste generating activity occurs in this state.

Subd. 2. Implementation. (a) The commissioner may obtain a United States Environmental Protection Agency hazardous waste identification number to manage the waste pesticides collected.

(b) The commissioner may limit the type and quantity of waste pesticides accepted for collection and may assess pesticide end users for portions of the costs incurred.

Subd. 2a. Disposal site requirement. The commissioner must designate a place that is available at least every other year for the residents of each county in the state to dispose of unused portions of pesticides.

Subd. 3. Information and education. The commissioner shall provide informational and educational materials regarding waste pesticides and the proper management of waste pesticides to the public.

Subd. 4. Consultation with pollution control agency. The commissioner shall develop the program in this section in consultation and cooperation with the pollution control agency.

Subd. 5. Waste pesticide collection account. A waste pesticide account is established in the state treasury. Assessments collected under subdivision 2 shall be deposited in the state treasury and credited to the waste pesticide account. Money in the account is appropriated to the commissioner to pay for costs incurred to implement the waste pesticide collection program.

Subd. 6. Repealed, 1996 c 310 s 1

Subd. 7. Cooperative agreements. The commissioner may enter into cooperative agreements with state agencies and local units of government for administration of the waste pesticide collection program.

HIST: 1989 c 326 art 5 s 20; 1993 c 367 s 3

18B.07 PESTICIDE USE, APPLICATION, AND EQUIPMENT CLEANING.

Subdivision 1. **Pesticide use.** Pesticides must be applied in accordance with the product label or labeling and in a manner that will not cause unreasonable adverse effects on the environment within limits prescribed by this chapter and FIFRA.

Subd. 2. **Prohibited pesticide use.** (a) A person may not use, store, handle, distribute, or dispose of a pesticide, rinsate, pesticide container, or pesticide application equipment in a manner:

(1) that is inconsistent with a label or labeling as defined by FIFRA;

(2) that endangers humans, damages agricultural products, food, livestock, fish, or wildlife; or

(3) that will cause unreasonable adverse effects on the environment.

(b) A person may not direct a pesticide onto property beyond the boundaries of the target site. A person may not apply a pesticide resulting in damage to adjacent property.

(c) A person may not directly apply a pesticide on a human by overspray or target site spray.

(d) A person may not apply a pesticide in a manner so as to expose a worker in an immediately adjacent, open field.

Subd. 3. **Posting.** Sites being treated with pesticides through irrigation systems must be posted throughout the period of pesticide treatment. The posting must be done in accordance with labeling and rules adopted under this chapter.

Subd. 4. **Pesticide safeguards at application sites.**

A person may not allow a pesticide, rinsate, or unrinsed pesticide container to be stored, kept, or to remain in or on any site without safeguards adequate to prevent an incident.

Subd. 5. **Use of public water supplies for filling equipment.** A person may not fill pesticide application equipment directly from a public water supply, as defined in section 144.382, unless the outlet from the public water supply is equipped with a backflow prevention device that complies with the Minnesota Plumbing Code under Minnesota Rules, parts 4715.2000 to 4715.2280.

Subd. 6. **Use of public waters for filling equipment.**

(a) A person may not fill pesticide application equipment directly from public or other waters of the state, as defined in section 103G.005, subdivision 15, unless the equipment contains proper and functioning anti-backsiphoning mechanisms. The person may not introduce pesticides into the application equipment until after filling the equipment from the public waters.

(b) This subdivision does not apply to permitted applications of aquatic pesticides to public waters.

Subd. 7. Cleaning equipment in or near surface water.

(a) A person may not:

(1) clean pesticide application equipment in surface waters of the state; or

(2) fill or clean pesticide application equipment adjacent to surface waters, ditches, or wells where, because of the slope or other conditions, pesticides or materials contaminated with pesticides could enter or contaminate the surface waters, ground water, or wells, as a result of overflow, leakage, or other causes.

(b) This subdivision does not apply to permitted application of aquatic pesticides to public waters.

Subd. 8. Pesticide, rinsate, and container disposal.

A person may only dispose of pesticide, rinsate, and pesticide containers in accordance with this chapter and FIFRA. The manner of disposal must not cause unreasonable adverse effects on the environment.

HIST: 1987 c 358 s 49; 1989 c 326 art 5 s 21-24; 1990 c 391 art 8 s 4; 1994 c 482 s 1; 1994 c 619 s 4; 1995 c 95 s 1

18B.08 CHEMIGATION.

Subdivision 1. Permit required. (a) A person may not apply pesticides through an irrigation system without a chemigation permit from the commissioner. A chemigation permit is required for one or more wells or other sources of irrigation water that are protected from contamination by devices as required by rule. The commissioner may allow irrigation to be used to apply pesticides on crops and land, including agricultural, nursery, turf, golf course, and greenhouse sites.

(b) A person must apply for a chemigation permit on forms prescribed by the commissioner.

Subd. 2. Pesticide. A pesticide used under a chemigation permit must be suitable and labeled for application through an irrigation system.

Subd. 3. Equipment. A chemigation system must be fitted with effective antisiphon devices or check valves that prevent the backflow of pesticides or pesticide-water mixtures into water supplies or other materials during times of irrigation system failure or equipment shutdown. The devices or valves must be installed between:

(1) the irrigation system pump or water source discharge and the point of pesticide injection; and

(2) the point of pesticide injection and the pesticide supply.

Subd. 4. Application fee. A person initially applying for a chemigation permit must pay a nonrefundable application fee of \$50. A person who holds a fertilizer chemigation permit under section 18C.205, is exempt from the fee in this subdivision.

Subd. 5. Repealed, 1996 c 310 s 1

HIST: 1987 c 358 s 50; 1989 c 326 art 5 s 25-27

18B.09 PESTICIDE APPLICATION IN CITIES.

Subdivision 1. **Applicability.** This section applies only to statutory and home rule charter cities that enact ordinances as provided in this section.

Subd. 2. **Authority.** Statutory and home rule charter cities may enact an ordinance containing the pesticide application warning information contained in subdivision 3, including their own licensing, penalty, and enforcement provisions. Statutory and home rule charter cities may not enact an ordinance that contains more restrictive pesticide application warning information than is contained in subdivision 3.

Subd. 3. **Warning signs for pesticide application.** (a) All commercial or noncommercial applicators who apply pesticides to turf areas must post or affix warning signs on the property where the pesticides are applied.

(b) Warning signs must project at least 18 inches above the top of the grass line. The warning signs must be of a material that is rain-resistant for at least a 48-hour period and must remain in place up to 48 hours from the time of initial application.

(c) The following information must be printed on the warning sign in contrasting colors and capitalized letters measuring at least one-half inch, or in another format approved by the commissioner. The sign must provide the following information:

(1) the name of the business organization, entity, or person applying the pesticide; and

(2) the following language: "This area chemically treated. Keep children and pets off until ... (date of safe entry)..." or a universally accepted symbol and text approved by the commissioner that is recognized as having the same meaning or intent as specified in this paragraph. The warning sign may include the name of the pesticide used.

(d) The warning sign must be posted on a lawn or yard between two feet and five feet from the sidewalk or street. For parks, golf courses, athletic fields, playgrounds, or other similar recreational property, the warning signs must be posted immediately adjacent to areas within the property where pesticides have been applied and at or near the entrances to the property.

HIST: 1987 c 358 s 51

18B.10 ACTION TO PREVENT GROUND WATER CONTAMINATION.

The commissioner may, by rule, special order, or delegation through written regulatory agreement with officials of other approved agencies, take action necessary to prevent the contamination of ground water resulting from leaching of

pesticides through the soil, from the backsiphoning or backflowing of pesticides through water wells, or from the direct flowage of pesticides to ground water.

HIST: 1987 c 358 s 52

18B.11 SALE AND USE OF TCDD.

A person may not sell, offer for sale, or use a pesticide containing in excess of 0.1 parts per million of 2,3,7, 8-tetrachlorodibenzo-para-dioxin (TCDD).

HIST: 1987 c 358 s 53

18B.115 USE OF CHLORDANE PROHIBITED.

The state, a state agency, a political subdivision of the state, a person, or other legal entity may not sell, use, or apply the pesticide chlordane or its derivative heptachlor within the state.

HIST: 1989 c 326 art 5 s 28

18B.12 SALE AND DISTRIBUTION OF ADULTERATED PESTICIDES.

A person may not offer for sale or distribute a pesticide that is determined by the commissioner to be adulterated, including a pesticide that has:

- (1) a strength or purity that does not meet the standard of quality expressed on its label;
- (2) a constituent entirely or partially substituted; or
- (3) an important or necessary constituent entirely or partially removed.

HIST: 1987 c 358 s 54

18B.13 SALE AND DISTRIBUTION OF MISBRANDED PESTICIDES AND DEVICES.

A person may not offer for sale or distribute a pesticide or device determined by the commissioner to be misbranded, including a pesticide or device that:

- (1) is an imitation of or is offered for sale under the name of another pesticide or device; or
- (2) does not comply with the labeling requirements under this chapter or FIFRA.

HIST: 1987 c 358 s 55

18B.135 SALE OF PESTICIDES IN RETURNABLE CONTAINERS AND MANAGEMENT OF UNUSED PORTIONS.

Subdivision 1. Acceptance of pesticide containers.

(a) A person distributing, offering for sale, or selling a pesticide must accept empty pesticide containers from a pesticide end user if:

- (1) the person does not participate in a designated collection program for pesticide containers after July 1, 1994;
- (2) the empty container is prepared for disposal in accordance with label instructions and is returned to the place

of purchase within the state; and

(3) a collection site that is seasonably accessible on multiple days has not been designated either by the county board or by agreement with other counties, the agricultural chemical dealer(s) in their respective counties, or the commissioner for the public to return empty pesticide containers for the purpose of reuse or recycling or following other approved management practices for pesticide containers in the order of preference established in section 115A.02, paragraph (b), and the county or counties have notified the commissioner of their intentions annually by February 1, in writing, to manage the empty pesticide containers.

(b) This subdivision does not prohibit the use of refillable and reusable pesticide containers.

(c) A person who has been notified by the county or counties of the designated collection site and who sells pesticides to a pesticide end user must notify purchasers of pesticides at the time of sale of the date and location designated for disposal of empty containers.

(d) For purposes of this section, pesticide containers do not include containers that have held sanitizers and disinfectants, containers made of metal or paper, plastic bags, bag-in-a-box, water soluble bags, and aerosol packaging, pesticides labeled primarily for use on humans or pets, or pesticides not requiring dilution or mixing.

Subd. 2. Rules. The commissioner may adopt rules to implement this section, including procedures and standards prescribing the exemption of certain pesticide products and pesticide containers.

HIST: 1989 c 326 art 5 s 29; 1993 c 367 s 4; 1994 c 557 s 9

18B.14 PESTICIDE STORAGE.

Subdivision 1. Display and storage. (a) A person may store or display pesticides and their containers only in the original container and separated from food, feed, seed, livestock remedies, drugs, plants, and other products or materials stored, displayed, or offered for sale in a manner that prevents contamination which would cause injury or damage to the other products or materials.

(b) A person may not allow open pesticide containers to be displayed for sale under any circumstances.

Subd. 2. Bulk pesticide storage. (a) A person storing pesticides in containers of a rated capacity of 500 gallons or more for more than ten consecutive days at a bulk pesticide storage facility must obtain a pesticide storage permit from the commissioner as required by rule.

(b) Applications must be on forms provided by the commissioner containing information established by rule. The initial application for a permit must be accompanied by a nonrefundable application fee of \$100 for each location where

the pesticides are stored. An application for a facility that includes both fertilizers as regulated under chapter 18C and bulk pesticides as regulated under this chapter shall pay only one application fee of \$100.

(c) The commissioner shall by rule develop and implement a program to regulate bulk pesticides. The rules must include installation of secondary containment devices, storage site security, safeguards, notification of storage site locations, criteria for permit approval, a schedule for compliance, and other appropriate requirements necessary to minimize potential adverse effects on the environment. The rules must conform with existing rules of the pollution control agency.

(d) A person must obtain a permit from the commissioner on forms provided by the commissioner before the person constructs or substantially alters a bulk pesticide storage facility. If an application is incomplete, the commissioner must notify the applicant as soon as possible. The permit must be acted upon within 30 days after receiving a completed application.

(e) An application to substantially alter a facility must be accompanied by a \$50 fee. An application for a facility that includes both fertilizers regulated under chapter 18C and bulk pesticides regulated under this chapter shall pay only one application fee of \$50.

(f) An additional fee of \$250 must be paid by a person who begins construction of or substantially alters a bulk agricultural chemical storage facility before a permit is issued by the commissioner, except that the \$250 additional fee may not be assessed if the person submits a permit application with the required fee to the commissioner before completing the construction or substantial alteration.

HIST: 1987 c 358 s 56; 1990 c 597 s 1; 1993 c 367 s 5

18B.15 Repealed, 1989 c 326 art 5 s 53

18B.16 Repealed, 1989 c 326 art 5 s 53

18B.17 COOPERATIVE INSPECTION AND ENFORCEMENT AGREEMENTS.

Subdivision 1. **Cooperative agreements.** The commissioner may enter into cooperative agreements with federal and state agencies for training, certification, inspection, and enforcement programs and may make reports to the United States Environmental Protection Agency and other federal agencies as required or requested. The commissioner may adopt and enforce federal standards, regulations, or orders relating to pesticide regulation when determined to be in the best interest of citizens of the state.

Subd. 2. **Training agreements.** For purposes of training only, the commissioner may enter into agreements with qualified public or private organizations that wish to offer training programs.

HIST: 1987 c 358 s 59

18B.18 Repealed, 1989 c 326 art 5 s 53

18B.19 Repealed, 1989 c 326 art 5 s 53

18B.20 Repealed, 1989 c 326 art 5 s 53

18B.21 Repealed, 1989 c 326 art 5 s 53

18B.22 Repealed, 1989 c 326 art 5 s 53

18B.23 Repealed, 1989 c 326 art 5 s 53

18B.24 UNSATISFIED JUDGMENTS.

(a) An applicant for a commercial, noncommercial, or structural pest control license and a commercial, noncommercial, or structural pest control applicator may not allow a final judgment against the applicant or applicator for damages arising from a violation of a provision of this chapter to remain unsatisfied for a period of more than 30 days.

(b) Failure to satisfy within 30 days a final judgment resulting from these pest control activities will result in automatic suspension of the applicator license.

HIST: 1987 c 358 s 66

18B.25 Repealed, 1989 c 326 art 5 s 53

18B.26 PESTICIDE REGISTRATION.

Subdivision 1. Requirement. (a) A person may not use or distribute a pesticide in this state unless it is registered with the commissioner. Pesticide registrations expire on December 31 of each year and may be renewed on or before that date for the following calendar year.

(b) Registration is not required if a pesticide is shipped from one plant or warehouse to another plant or warehouse operated by the same person and used solely at the plant or warehouse as an ingredient in the formulation of a pesticide that is registered under this chapter.

(c) An unregistered pesticide that was previously registered with the commissioner may be used for a period of two years following the cancellation of the registration of the pesticide, unless the commissioner determines that the continued use of the pesticide would cause unreasonable adverse effects on the environment, or with the written permission of the commissioner. To use the unregistered pesticide at any time after the two-year period, the pesticide end user must demonstrate to the satisfaction of the commissioner, if requested, that the pesticide has been continuously registered under a different brand name or by a different manufacturer and

has similar composition, or, the pesticide end user obtains the written permission of the commissioner.

(d) Each pesticide with a unique United States Environmental Protection Agency pesticide registration number or a unique brand name must be registered with the commissioner.

Subd. 2. **Application.** (a) A person must file an application for registration with the commissioner. The application must include:

(1) the name and address of the applicant and the name and address of the person whose name will appear on the label, if other than the applicant;

(2) the brand name of the pesticide;

(3) other necessary information required by the registration application form;

(4) a true and complete copy of the labeling accompanying the pesticide as provided for in FIFRA; and

(5) current material safety data sheets for each pesticide.

(b) As part of the application, the commissioner may require the submission of any relevant information including the complete formula of a pesticide, including the active and inert ingredients. The commissioner may also require the registrant to supply analytical standards and methods for the pesticide, pesticide breakdown products, or metabolites.

Subd. 3. **Application fee.** (a) A registrant shall pay an annual application fee for each pesticide to be registered, and this fee is set at one-tenth of one percent for calendar year 1990, at one-fifth of one percent for calendar year 1991, and at two-fifths of one percent for calendar year 1992 and thereafter of annual gross sales within the state and annual gross sales of pesticides used in the state, with a minimum nonrefundable fee of \$250. The registrant shall determine when and which pesticides are sold or used in this state. The registrant shall secure sufficient sales information of pesticides distributed into this state from distributors and dealers, regardless of distributor location, to make a determination. Sales of pesticides in this state and sales of pesticides for use in this state by out-of-state distributors are not exempt and must be included in the registrant's annual report, as required under paragraph (c), and fees shall be paid by the registrant based upon those reported sales. Sales of pesticides in the state for use outside of the state are exempt from the application fee in this paragraph if the registrant properly documents the sale location and distributors. A registrant paying more than the minimum fee shall pay the balance due by March 1 based on the gross sales of the pesticide by the registrant for the preceding calendar year. The fee for disinfectants and sanitizers shall be the minimum. The minimum fee is due by December 31 preceding the year for which the application for registration is made. Of the amount collected after calendar year 1990, at least \$600,000 per fiscal year must

be credited to the waste pesticide account under section 18B.065, subdivision 5.

(b) An additional fee of \$100 must be paid by the applicant for each pesticide to be registered if the application is a renewal application that is submitted after December 31.

(c) A registrant must annually report to the commissioner the amount and type of each registered pesticide sold, offered for sale, or otherwise distributed in the state. The report shall be filed by March 1 for the previous year's registration. The commissioner shall specify the form of the report and require additional information deemed necessary to determine the amount and type of pesticides annually distributed in the state. The information required shall include the brand name, amount, and formulation of each pesticide sold, offered for sale, or otherwise distributed in the state, but the information collected, if made public, shall be reported in a manner which does not identify a specific brand name in the report.

Subd. 4. Effect of registration after renewal application. If a registration is in effect on December 31 and a renewal application has been made and the application fee paid, the registration continues in full force and effect until the commissioner notifies the applicant that the registration is denied or canceled, or the renewed registration expires.

Subd. 5. Review and registration. (a) The commissioner may not deny the registration of a pesticide because the commissioner determines the pesticide is not essential.

(b) The commissioner shall review each application and may approve, deny, or cancel the registration of any pesticide. The commissioner may impose state use and distribution restrictions on a pesticide as part of the registration to prevent unreasonable adverse effects on the environment.

(c) The commissioner must notify the applicant of the approval, denial, cancellation, state use or distribution restrictions.

(d) The applicant may request a hearing on any adverse action of the commissioner within 30 days after being notified.

Subd. 6. Discontinuance of registration. To ensure complete withdrawal from distribution or further use of a pesticide, a person who intends to discontinue a pesticide registration must:

(1) terminate a further distribution within the state and continue to register the pesticide annually for two successive years;

(2) initiate and complete a total recall of the pesticide from all distribution in the state within 60 days from the date of notification to the commissioner of intent to discontinue registration; or

(3) submit to the commissioner evidence adequate to document that no distribution of the registered pesticide has

occurred in the state.

HIST: 1987 c 358 s 68; 1989 c 326 art 5 s 30-33; 1990 c 597 s 2; 1991 c 309 s 11; 1992 c 439 s 1; 1992 c 513 art 2 s 15; 1992 c 603 s 22; 1993 c 226 s 15; 1993 c 367 s 6,7

18B.27 PESTICIDE REGISTRATION FOR SPECIAL LOCAL NEEDS.

Subdivision 1. **Application.** (a) A person must file an application for a special local need application with the commissioner. The application must meet the requirements of section 18B.26, subdivision 2, and the commissioner may require other relevant information.

(b) The commissioner may require a full description of tests and test results upon which claims are based for:

(1) a pesticide use that is not registered under section 18B.26 or FIFRA; or

(2) a pesticide on which restrictions are being considered.

(c) The applicant may request in writing privacy of information submitted as provided in section 18B.38.

Subd. 2. **Application review.** (a) After reviewing the application accompanied by the application fee, the commissioner shall, subject to the terms and conditions of the authorization by the administrator of the United States Environmental Protection Agency to register pesticides to meet special local needs, register pesticides if the commissioner determines that:

(1) the pesticide's composition warrants the proposed claims for the pesticide;

(2) the pesticide's label and other material required to be submitted comply with this chapter;

(3) the pesticide will perform its intended function without unreasonable adverse effect on the environment;

(4) the pesticide will not generally cause unreasonable adverse effects on the environment when used in accordance with label directions; and

(5) a special local need for the pesticide exists.

(b) The commissioner may revoke or modify a special local need registration if the commissioner determines that the terms or conditions of the registration do not comply with paragraph (a).

Subd. 3. **Application fee.** An application fee for a special local need registration must be accompanied by a nonrefundable fee of \$150.

HIST: 1987 c 358 s 69; 1990 c 597 s 3

18B.28 EXPERIMENTAL USE PESTICIDE PRODUCT REGISTRATION.

Subdivision 1. **Requirement.** A person may not use or distribute an experimental use pesticide product in the state until it is registered with the commissioner. Experimental use pesticide product registrations expire on December 31 of each year and may be renewed on or before that date.

Subd. 2. **Application review and registration.** (a)

After reviewing the application accompanied by the application fee, the commissioner may issue an experimental use pesticide product registration if the commissioner determines that the applicant needs the registration to accumulate information necessary to register a pesticide under section 18B.26. The commissioner may prescribe terms, conditions, and a limited period of time for the experimental use product registration. After an experimental use pesticide product registration is issued, the commissioner may revoke or modify the registration at any time if the commissioner finds that its terms or conditions are being violated or are inadequate to avoid unreasonable adverse effects on the environment.

(b) The commissioner may deny issuance of an experimental use pesticide product registration permit if the commissioner determines that issuance of a registration is not warranted or that the use to be made of the pesticide under the proposed terms and conditions may cause unreasonable adverse effects on the environment.

Subd. 3. Application. A person must file an application for experimental use pesticide product registration with the commissioner. An application to register an experimental use pesticide product must include:

- (1) the name and address of the applicant;
- (2) a federal environmental protection agency approval document;
- (3) the purpose or objectives of the experimental use product;
- (4) an accepted experimental use pesticide product label;
- (5) the name, address, and telephone number of cooperators or participants in this state;
- (6) the amount of material to be shipped or used in this state; and
- (7) other information requested by the commissioner.

Subd. 4. Application fee. (a) An application for registration of an experimental use pesticide product must be accompanied by a nonrefundable application fee of \$150.

(b) An additional fee of \$200 must be paid by the applicant for each pesticide distributed or used in the state before an initial experimental use pesticide product registration was issued for the pesticide.

HIST: 1987 c 358 s 70; 1990 c 597 s 4

18B.285 EXPERIMENTAL GENETICALLY ENGINEERED PESTICIDE PRODUCT REGISTRATION.

Subdivision 1. Requirement. (a) A person may not use, distribute, or conduct release experiments with a genetically engineered pesticide in any amount in the state until it is registered under this section or section 18B.26. Use, distribution, or release of a genetically engineered pesticide must be registered under this section until the

commissioner determines by rule or order that the genetically engineered pesticide may be subject to section 18B.26.

Experimental genetically engineered pesticide product registrations expire on December 31 of each year and may be renewed on or before that date.

(b) After reviewing a completed application, the commissioner may issue an experimental genetically engineered pesticide product registration if the commissioner determines that the applicant has adequately demonstrated that the proposed release does not have the potential for unreasonable adverse effects on the environment. The commissioner may prescribe terms and conditions, including, but not limited to, the period for the experimental genetically engineered pesticide product registration, the amount or number of genetically engineered pesticide product to be used, monitoring activities, department inspection schedules, reporting of experiment results, and experiment termination procedures. A person may not violate terms or conditions of a registration issued under this section. After an experimental genetically engineered pesticide product registration is issued, the commissioner may revoke or change the registration at any time if the commissioner finds that its terms or conditions are being violated or are inadequate to avoid unreasonable adverse effects on the environment.

(c) The commissioner may deny issuance of an experimental genetically engineered pesticide product registration if the commissioner determines that the use to be made of the pesticide under the proposed terms and conditions may cause unreasonable adverse effects on the environment.

Subd. 2. Application. A person must file an application for experimental genetically engineered pesticide product registration with the commissioner. An application to register an experimental genetically engineered pesticide product must include:

- (1) the name and address of the applicant;
- (2) any United States Environmental Protection Agency regulatory application or approval document required under federal law or rule;
- (3) the purpose or objectives of the product;
- (4) an experimental genetically engineered pesticide product use label;
- (5) the name, address, and telephone number of cooperators or participants in this state;
- (6) the amount of material to be shipped or used in this state; and
- (7) other information requested by the commissioner.

Subd. 3. Application fee. An application for registration of an experimental genetically engineered pesticide product must be accompanied by a nonrefundable application fee of \$125.

HIST: 1991 c 250 s 10

18B.29 RECIPROCAL LICENSING AND CERTIFICATION AGREEMENTS.

The commissioner may waive all or part of the examination requirements provided for in sections 18B.29 to 18B.35 on a reciprocal basis with any other jurisdiction which has substantially the same requirements. Licenses or certificates issued under sections 18B.29 to 18B.35 may be suspended or revoked upon suspension or revocation of the license or certificate of another jurisdiction supporting the issuance of a Minnesota license or certificate and in the same manner as other licenses and certificates.

HIST: 1987 c 358 s 71

18B.30 PESTICIDE USE LICENSE REQUIREMENT.

A person may not use a restricted use pesticide without a license or certification required under sections 18B.29 to 18B.35 and the use may only be done under conditions prescribed by the commissioner.

HIST: 1987 c 358 s 72; 1997 c 131 s 2

18B.305 PESTICIDE EDUCATION AND TRAINING.

Subdivision 1. **Education and training.** (a) The commissioner shall develop, in conjunction with the University of Minnesota extension service, innovative educational and training programs addressing pesticide concerns including:

- (1) water quality protection;
- (2) endangered species;
- (3) pesticide residues in food and water;
- (4) worker protection;
- (5) chronic toxicity;
- (6) integrated pest management; and
- (7) pesticide disposal.

(b) The commissioner shall appoint educational planning committees which must include representatives of industry.

(c) Specific current regulatory concerns must be discussed and, if appropriate, incorporated into each training session.

(d) The commissioner may approve programs from private industry and nonprofit organizations that meet minimum requirements for education, training, and certification.

Subd. 2. Training manual and examination development.

The commissioner, in conjunction with the University of Minnesota extension service, shall continually revise and update pesticide applicator training manuals and examinations. The manuals and examinations must be written to meet or exceed the minimum standards required by the United States Environmental Protection Agency and pertinent state specific information. Questions in the examinations must be determined by the responsible agencies. Manuals and examinations must include pesticide management practices that discuss prevention of pesticide occurrence in groundwaters of the state.

Subd. 3. Pesticide applicator education and examination

review board. (a) The commissioner shall establish and chair a pesticide applicator education and examination review board. This board, consisting of 15 members, must meet at least once a year before the initiation of pesticide educational planning programs. The purpose of the board is to discuss topics of current concern that can be incorporated into pesticide applicator training sessions and appropriate examinations. This board shall review and evaluate the various educational programs recently conducted and recommend options to increase overall effectiveness.

(b) Membership on this board must include applicators representing various licensing categories, such as agriculture, turf and ornamental, aerial, aquatic, and structural pest control and private pesticide applicators, and other governmental agencies, including the University of Minnesota, the pollution control agency, department of health, department of natural resources, and department of transportation.

(c) Membership on the board must include representatives from environmental protection organizations.

(d) This board shall review licensing and certification requirements for private, commercial, and noncommercial applicators and provide a report to the commissioner with recommendations by January 15, 1998. This board shall review category requirements and provide recommendations to the commissioner. This board expires on June 30, 2001.

HIST: 1989 c 326 art 5 s 34; 1997 c 192 s 13

18B.31 PESTICIDE DEALER LICENSE.

Subdivision 1. Requirement. (a) Except as provided in paragraph (b), no fixed location may offer for sale or sell a restricted use or bulk pesticide to a pesticide end user without a pesticide dealer license.

(b) A pesticide dealer license is not required for:

(1) a licensed commercial applicator, noncommercial applicator, or structural pest control applicator who uses restricted use pesticides only as an integral part of a pesticide application service;

(2) a federal, state, county, or municipal agency using restricted use pesticides for its own programs;

(3) a licensed pharmacist, physician, dentist, or veterinarian when administering or dispensing a restricted use pesticide for use in the pharmacist's, physician's, dentist's, or veterinarian's practice; or

(4) a person at a fixed location that is not used to offer for sale or sell restricted use or bulk pesticides including, but not limited to, warehouses or other storage sites.

(c) A licensed pesticide dealer may sell restricted use pesticides only to an applicator licensed or certified by the commissioner, unless a sale is allowed by rule.

(d) A pesticide dealer license is required for an

individual not located in Minnesota who offers for sale or sells a restricted use or bulk pesticide to a pesticide end user located in Minnesota.

(e) Only one pesticide dealer license is required per fixed location from which a restricted use or bulk pesticide is offered for sale or sold to a pesticide end user.

Subd. 2. **Responsibility.** A pesticide dealer is responsible for the acts of a person who assists the dealer in the solicitation and sale of restricted use pesticides.

Subd. 3. **License.** A pesticide dealer license:

(1) expires on December 31 of each year unless it is suspended or revoked before that date;

(2) is not transferable to another location; and

(3) must be prominently displayed to the public in the pesticide dealer's place of business.

Subd. 4. **Application.** (a) A person must apply to the commissioner for a pesticide dealer license on the forms and in the manner required by the commissioner.

(b) The commissioner may require an additional demonstration of dealer qualification if the dealer has had a license suspended or revoked, or has otherwise had a history of violations of this chapter.

Subd. 5. **Application fee.** (a) An application for a pesticide dealer license must be accompanied by a nonrefundable application fee of \$50.

(b) If an application for renewal of a pesticide dealer license is not filed before January 1 of the year for which the license is to be issued, an additional fee of \$20 must be paid by the applicant before the license is issued.

HIST: 1987 c 358 s 73; 1989 c 326 art 5 s 35-37; 1993 c 367 s 8; 1995 c 95 s 2

18B.315 AQUATIC PEST CONTROL LICENSE.

Subdivision 1. **Requirement.** (a) A person may not engage in aquatic pest control applications:

(1) for hire without an aquatic pest control license; and

(2) as a sole proprietorship, company, partnership, or corporation unless the person is or employs a licensed master in aquatic pest control operations.

(b) An aquatic pest control licensee must have a valid license identification card when applying pesticides for hire and must display it upon demand by an authorized representative of the commissioner or law enforcement officer. The license identification card must contain information required by the commissioner.

Subd. 2. **Licenses.** (a) An aquatic pest control license:

(1) expires on December 31 of the year for which the license is issued;

(2) is not transferable; and

(3) must be prominently displayed to the public in the aquatic pest controller's place of business.

(b) The commissioner shall establish categories of master and journeyman for a person to be licensed under an aquatic pest control license.

Subd. 3. **Application.** (a) A person must apply to the commissioner for an aquatic pest control license on forms and in a manner required by the commissioner. The commissioner shall require the applicant to pass a written, closed-book, monitored examination or oral examination, or both, and may also require a practical demonstration regarding aquatic pest control. The commissioner shall establish the examination procedure, including the phases and contents of the examination.

(b) The commissioner may license a person as a master under an aquatic pest control license if the person has the necessary qualifications through knowledge and experience to properly plan, determine, and supervise the selection and application of pesticides in aquatic pest control. To demonstrate the qualifications and become licensed as a master under the aquatic pest control license, a person must:

(1) pass a closed-book test administered by the commissioner;

(2) have direct experience as a licensed journeyman under an aquatic pest control license for at least two years by this state or a state with equivalent certification requirements, or have at least 1,600 hours of qualifying experience in the previous four years as determined by the commissioner; and

(3) show practical knowledge and field experience under clause (2) in the actual selection and application of pesticides under varying conditions.

(c) The commissioner may license a person as a journeyman under an aquatic pest control license if the person:

(1) has the necessary qualifications in the practical selection and application of pesticides;

(2) has passed a closed-book examination given by the commissioner; and

(3) is engaged as an employee of or is working under the direction of a person licensed as a master under an aquatic pest control license.

Subd. 4. **Renewal.** (a) An aquatic pest control applicator license may be renewed on or before the expiration of an existing license subject to reexamination, attendance at workshops approved by the commissioner, or other requirements imposed by the commissioner to provide the applicator with information regarding changing technology and to help assure a continuing level of competency and ability to use pesticides safely and properly. The commissioner may require an additional demonstration of applicator qualification if the applicator has had a license suspended or revoked or has otherwise had a history of violations of this chapter.

(b) If a person fails to renew an aquatic pest control license within three months of its expiration, the person must obtain an aquatic pest control license subject to the requirements, procedures, and fees required for an initial license.

Subd. 5. **Financial responsibility.** (a) An aquatic pest control license may not be issued unless the applicant furnishes proof of financial responsibility. The financial responsibility may be demonstrated by:

(1) proof of net assets equal to or greater than \$50,000; or

(2) a performance bond or insurance of a kind and in an amount determined by the commissioner.

(b) The bond or insurance must cover a period of time at least equal to the term of the applicant's license. The commissioner shall immediately suspend the license of a person who fails to maintain the required bond or insurance. The performance bond or insurance policy must contain a provision requiring the insurance or bonding company to notify the commissioner by ten days before the effective date of cancellation, termination, or any other change of the bond or insurance. If there is recovery against the bond or insurance, additional coverage must be secured to maintain financial responsibility equal to the original amount required.

(c) An employee of a licensed person is not required to maintain an insurance policy or bond during the time the employer is maintaining the required insurance or bond.

(d) Applications for reinstatement of a license suspended under this section must be accompanied by proof of satisfaction of judgments previously rendered.

Subd. 6. **Fees.** (a) An applicant for an aquatic pest control license for a business must pay a nonrefundable application fee of \$100. An employee of a licensed business must pay a nonrefundable application fee of \$50 for an individual aquatic pest control license.

(b) An application received after expiration of the aquatic pest control license is subject to a penalty of 50 percent of the application fee.

(c) An applicant that meets renewal requirements by reexamination instead of attending workshops must pay the equivalent workshop fee for the reexamination as determined by the commissioner.

HIST: 1996 c 330 s 4

18B.32 STRUCTURAL PEST CONTROL LICENSE.

Subdivision 1. **Requirement.** (a) A person may not engage in structural pest control applications:

(1) for hire without a structural pest control license; and

(2) as a sole proprietorship, company, partnership, or corporation unless the person is or employs a licensed master in

structural pest control operations.

(b) A structural pest control licensee must have a valid license identification card when applying pesticides for hire and must display it upon demand by an authorized representative of the commissioner or a law enforcement officer. The license identification card must contain information required by the commissioner.

(c) Notwithstanding the licensing requirements of this subdivision, a person may control the following nuisance or economically damaging wild animals, by trapping, without a structural pest control license:

(1) fur-bearing animals, as defined in section 97A.015, with a valid trapping license or special permit from the commissioner of natural resources; and

(2) skunks, woodchucks, gophers, porcupines, coyotes, moles, and weasels.

Subd. 2. Licenses. (a) A structural pest control license:

(1) expires on December 31 of the year for which the license is issued;

(2) is not transferable; and

(3) must be prominently displayed to the public in the structural pest controller's place of business.

(b) The commissioner shall establish categories of master, journeyman, and fumigator for a person to be licensed under a structural pest control license.

Subd. 3. Application. (a) A person must apply to the commissioner for a structural pest control license on forms and in the manner required by the commissioner. The commissioner shall require the applicant to pass a written, closed-book, monitored examination or oral examination, or both, and may also require a practical demonstration regarding structural pest control. The commissioner shall establish the examination procedure, including the phases and contents of the examination.

(b) The commissioner may license a person as a master under a structural pest control license if the person has the necessary qualifications through knowledge and experience to properly plan, determine, and supervise the selection and application of pesticides in structural pest control. To demonstrate the qualifications and become licensed as a master under a structural pest control license, a person must:

(1) pass a closed-book test administered by the commissioner;

(2) have direct experience as a licensed journeyman under a structural pest control license for at least two years by this state or a state with equivalent certification requirements or as a full-time licensed master in another state with equivalent certification requirements; and

(3) show practical knowledge and field experience under clause (2) in the actual selection and application of pesticides

under varying conditions.

(c) The commissioner may license a person as a journeyman under a structural pest control license if the person:

(1) has the necessary qualifications in the practical selection and application of pesticides;

(2) has passed a closed-book examination given by the commissioner; and

(3) is engaged as an employee of or is working under the direction of a person licensed as a master under a structural pest control license.

(d) The commissioner may license a person as a fumigator under a structural pest control license if the person:

(1) has knowledge of the practical selection and application of fumigants;

(2) has passed a closed-book examination given by the commissioner; and

(3) is licensed by the commissioner as a master or journeyman under a structural pest control license.

Subd. 4. Renewal. (a) A structural pest control applicator license may be renewed on or before the expiration of an existing license subject to reexamination, attendance at workshops approved by the commissioner, or other requirements imposed by the commissioner to provide the applicator with information regarding changing technology and to help assure a continuing level of competency and ability to use pesticides safely and properly. The commissioner may require an additional demonstration of applicator qualification if the applicator has had a license suspended or revoked or has otherwise had a history of violations of this chapter.

(b) If a person fails to renew a structural pest control license within three months of its expiration, the person must obtain a structural pest control license subject to the requirements, procedures, and fees required for an initial license.

Subd. 5. Financial responsibility. (a) A structural pest control license may not be issued unless the applicant furnishes proof of financial responsibility. The financial responsibility may be demonstrated by:

(1) proof of net assets equal to or greater than \$50,000; or

(2) a performance bond or insurance of a kind and in an amount determined by the commissioner.

(b) The bond or insurance must cover a period of time at least equal to the term of the applicant's license. The commissioner must immediately suspend the license of a person who fails to maintain the required bond or insurance. The performance bond or insurance policy must contain a provision requiring the insurance or bonding company to notify the commissioner by ten days before the effective date of cancellation, termination, or any other change of the bond or

insurance. If there is recovery against the bond or insurance, additional coverage must be secured to maintain financial responsibility equal to the original amount required.

(c) An employee of a licensed person is not required to maintain an insurance policy or bond during the time the employer is maintaining the required insurance or bond.

(d) Applications for reinstatement of a license suspended under the provisions of this section must be accompanied by proof of satisfaction of judgments previously rendered.

Subd. 6. Fees. (a) An applicant for a structural pest control license for a business must pay a nonrefundable application fee of \$100. An employee of a licensed business must pay a nonrefundable application fee of \$50 for an individual structural pest control license.

(b) An application received after expiration of the structural pest control license is subject to a penalty fee of 50 percent of the application fee.

(c) An applicant that meets renewal requirements by reexamination instead of attending workshops must pay the equivalent workshop fee for the reexamination as determined by the commissioner.

HIST: 1987 c 358 s 74; 1989 c 326 art 5 s 38; 1993 c 283 s 1; 1994 c 623 art 1 s 8; 1996 c 330 s 5

18B.33 COMMERCIAL APPLICATOR LICENSE.

Subdivision 1. Requirement. (a) A person may not apply a pesticide for hire without a commercial applicator license for the appropriate use categories or a structural pest control license or aquatic pest control license.

(b) A person with a commercial applicator license may not apply pesticides on or into surface waters without an aquatic pest control license under section 18B.315, except an aquatic pest control license is not required for licensed commercial applicators applying pesticides for the purposes of:

- (1) pest control on cultivated wild rice;
- (2) mosquito and black fly control operations;
- (3) pest control on rights-of-way;
- (4) aerial pest control operations for emergent vegetation control;
- (5) aerial application of piscicides; and
- (6) pest control for silvicultural operations.

(c) A commercial applicator licensee must have a valid license identification card when applying pesticides for hire and must display it upon demand by an authorized representative of the commissioner or a law enforcement officer. The commissioner shall prescribe the information required on the license identification card.

Subd. 2. Responsibility. A person required to be licensed under this section who performs pesticide applications for hire or who employs a licensed applicator to perform

pesticide application for pro rata compensation is responsible for proper application of the pesticide or device.

Subd. 3. License. A commercial applicator license:

(1) expires on December 31 of the year for which it is issued, unless suspended or revoked before that date;

(2) is not transferable to another person; and

(3) must be prominently displayed to the public in the commercial applicator's place of business.

Subd. 4. Application. (a) A person must apply to the commissioner for a commercial applicator license on forms and in the manner required by the commissioner. The commissioner must prescribe and administer a closed-book, monitored examination, or equivalent measure to determine if the applicant is eligible for the commercial applicator license.

(b) Aerial applicators must also fulfill applicable requirements in chapter 360.

Subd. 5. Renewal application. (a) A person must apply to the commissioner to renew a commercial applicator license. The commissioner may renew a commercial applicator license accompanied by the application fee, subject to reexamination, attendance at workshops approved by the commissioner, or other requirements imposed by the commissioner to provide the applicator with information regarding changing technology and to help assure a continuing level of competence and ability to use pesticides safely and properly. The applicant may renew a commercial applicator license within 12 months after expiration of the license without having to meet initial testing requirements. The commissioner may require additional demonstration of applicator qualification if a person has had a license suspended or revoked or has had a history of violations of this chapter.

(b) An applicant that meets renewal requirements by reexamination instead of attending workshops must pay the equivalent workshop fee for the reexamination as determined by the commissioner.

Subd. 6. Financial responsibility. (a) A commercial applicator license may not be issued unless the applicant furnishes proof of financial responsibility. The financial responsibility may be demonstrated by: (1) proof of net assets equal to or greater than \$50,000; or (2) by a performance bond or insurance of the kind and in an amount determined by the commissioner.

(b) The bond or insurance must cover a period of time at least equal to the term of the applicant's license. The commissioner must immediately suspend the license of a person who fails to maintain the required bond or insurance. The performance bond or insurance policy must contain a provision requiring the insurance or bonding company to notify the commissioner by ten days before the effective date of cancellation, termination, or any other change of the bond or

insurance. If there is recovery against the bond or insurance, additional coverage must be secured to maintain financial responsibility equal to the original amount required.

(c) An employee of a licensed person is not required to maintain an insurance policy or bond during the time the employer is maintaining the required insurance or bond.

(d) Applications for reinstatement of a license suspended under the provisions of this section must be accompanied by proof of satisfaction of judgments previously rendered.

Subd. 7. Application fees. (a) A person initially applying for or renewing a commercial applicator license must pay a nonrefundable application fee of \$50.

(b) If a renewal application is not filed before March 1 of the year for which the license is to be issued, an additional penalty fee of \$10 must be paid before the commercial applicator license may be issued.

(c) An application for a duplicate commercial applicator license must be accompanied by a nonrefundable application fee of \$10.

HIST: 1987 c 358 s 75; 1989 c 326 art 5 s 39-41; 1993 c 283 s 2,3; 1996 c 330 s 6; 1997 c 7 art 1 s 8

18B.34 NONCOMMERCIAL APPLICATOR LICENSE.

Subdivision 1. Requirement. (a) Except for a licensed commercial applicator, certified private applicator, a licensed aquatic pest control applicator, or licensed structural pest control applicator, a person, including a government employee, may not use a restricted use pesticide in performance of official duties without having a noncommercial applicator license for an appropriate use category.

(b) A licensed noncommercial applicator may not apply pesticides into or on surface waters without an aquatic pest control license, except an aquatic pest control license is not required for licensed noncommercial applicators applying pesticides for the purposes of:

- (1) mosquito and black fly control operations;
- (2) pest control on rights-of-way;
- (3) pest control operations for purple loosestrife control;
- (4) application of piscicides; and
- (5) pest control for silvicultural operations.

(c) A licensee must have a valid license identification card when applying pesticides and must display it upon demand by an authorized representative of the commissioner or a law enforcement officer. The license identification card must contain information required by the commissioner.

Subd. 2. License. A noncommercial applicator license:

- (1) expires on December 31 of the year for which it is issued unless suspended or revoked before that date;
- (2) is not transferable; and
- (3) must be prominently displayed to the public in the

noncommercial applicator's place of business.

Subd. 3. **Application.** A person must apply to the commissioner for a noncommercial applicator license on forms and in the manner required by the commissioner. The commissioner must prescribe and administer a closed-book, monitored examination, or equivalent measure to determine if the applicant is eligible to acquire a noncommercial applicator license.

Subd. 4. **Renewal.** (a) A person must apply to the commissioner to renew a noncommercial applicator license. The commissioner may renew a license subject to reexamination, attendance at workshops approved by the commissioner, or other requirements imposed by the commissioner to provide the applicator with information regarding changing technology and to help assure a continuing level of competence and ability to use pesticides safely and properly. The commissioner may require an additional demonstration of applicator qualification if the applicator has had a license suspended or revoked or has otherwise had a history of violations of this chapter.

(b) An applicant that meets renewal requirements by reexamination instead of attending workshops must pay the equivalent workshop fee for the reexamination as determined by the commissioner.

(c) An applicant has 12 months to renew the license after expiration without having to meet initial testing requirements.

Subd. 5. **Fees.** (a) A person initially applying for or renewing a noncommercial applicator license must pay a nonrefundable application fee of \$50, except an applicant who is a government employee who uses pesticides in the course of performing official duties must pay a nonrefundable application fee of \$10.

(b) If an application for renewal of a noncommercial license is not filed before March 1 in the year for which the license is to be issued, an additional penalty fee of \$10 must be paid before the renewal license may be issued.

(c) An application for a duplicate noncommercial applicator license must be accompanied by a nonrefundable application fee of \$10.

HIST: 1987 c 358 s 76; 1989 c 326 art 5 s 42-44; 1993 c 283 s 4,5; 1996 c 330 s 7

18B.35 APPLICATION CATEGORIES WITHIN APPLICATOR LICENSES.

Subdivision 1. **Establishment.** (a) The commissioner may establish categories of structural pest control, commercial applicator, and noncommercial applicator licenses for administering and enforcing this chapter. The categories may include pest control operators and ornamental, agricultural, aquatic, forest, and right-of-way pesticide applicators. Separate subclassifications of categories may be specified as to ground, aerial, or manual methods to apply pesticides or to the use of pesticides to control insects, plant diseases, rodents,

or weeds.

(b) Each category is subject to separate testing procedures and requirements.

Subd. 2. **No additional fee.** A person may not be required to pay an additional fee for a category or subclassification of a category of a license.

HIST: 1987 c 358 s 77

18B.36 PRIVATE APPLICATOR CERTIFICATION.

Subdivision 1. **Requirement.** (a) Except for a licensed commercial or noncommercial applicator, only a certified private applicator may use a restricted use pesticide to produce an agricultural commodity:

(1) as a traditional exchange of services without financial compensation;

(2) on a site owned, rented, or managed by the person or the person's employees; or

(3) when the private applicator is one of two or fewer specified individuals employed as agricultural labor as defined by section 268.04, subdivision 12, paragraph (15), clause (a), and the owner or operator is a certified private applicator or is licensed as a noncommercial applicator.

(b) A private applicator may not purchase a restricted use pesticide without presenting a certified private applicator card or the card number.

Subd. 2. **Certification.** (a) The commissioner shall prescribe certification requirements and provide training that meets or exceeds United States Environmental Protection Agency standards to certify private applicators and provide information relating to changing technology to help ensure a continuing level of competency and ability to use pesticides properly and safely. The training may be done through cooperation with other government agencies and must be a minimum of three hours in duration.

(b) A person must apply to the commissioner for certification as a private applicator. After completing the certification requirements, which must include an examination as determined by the commissioner, an applicant must be certified as a private applicator to use restricted use pesticides. The certification shall expire March 1 of the third calendar year after the initial year of certification.

(c) The commissioner shall issue a private applicator card to a private applicator.

Subd. 3. **Fees.** (a) A person applying to be certified as a private applicator must pay a nonrefundable \$10 application fee for the certification period.

(b) A \$5 fee must be paid for the issuance of a duplicate private applicator card.

HIST: 1987 c 358 s 78; 1989 c 326 art 5 s 45,46; 1993 c 367 s 9; 1995 c 95 s 3; 1997 c 131 s 3

18B.37 RECORDS, REPORTS, PLANS, AND INSPECTIONS.

Subdivision 1. **Pesticide dealer.** (a) A pesticide dealer must maintain records of all sales of restricted use pesticides as required by the commissioner. Records must be kept at the time of sale on forms supplied by the commissioner or on the pesticide dealer's forms if they are approved by the commissioner.

(b) Records must be submitted annually with the renewal application for a pesticide dealer license or upon request of the commissioner.

(c) Copies of records required under this subdivision must be maintained by the pesticide dealer for a period of five years after the date of the pesticide sale.

Subd. 2. Commercial and noncommercial applicators.

(a) A commercial or noncommercial applicator, or the applicator's authorized agent, must maintain a record of pesticides used on each site. Noncommercial applicators must keep records of restricted use pesticides. The record must include the:

(1) date of the pesticide use;

(2) time the pesticide application was completed;

(3) brand name of the pesticide, the United States

Environmental Protection Agency registration number, and dosage used;

(4) number of units treated;

(5) temperature, wind speed, and wind direction;

(6) location of the site where the pesticide was applied;

(7) name and address of the customer;

(8) name and signature of applicator, name of company,

license number of applicator, and address of applicator company; and

(9) any other information required by the commissioner.

(b) Portions of records not relevant to a specific type of application may be omitted upon approval from the commissioner.

(c) All information for this record requirement must be contained in a single page document for each pesticide application, except a map may be attached to identify treated areas. For the rights-of-way and wood preservative categories, the required record may not exceed five pages. An invoice containing the required information may constitute the required record. The commissioner shall make sample forms available to meet the requirements of this paragraph.

(d) A commercial applicator must give a copy of the record to the customer.

(e) Records must be retained by the applicator, company, or authorized agent for five years after the date of treatment.

Subd. 3. **Structural pest control applicators.** (a) A structural pest control applicator must maintain a record of each structural pest control application conducted by that person or by the person's employees. The record must include

the:

(1) date of structural pest control application;

(2) target pest;

(3) brand name of the pesticide, United States

Environmental Protection Agency registration number, and amount used;

(4) for fumigation, the temperature and exposure time;

(5) time the pesticide application was completed;

(6) name and address of the customer;

(7) name and signature of structural pest control applicator; name of company and address of applicator or company, applicator's signature, and license number of applicator; and

(8) any other information required by the commissioner.

(b) All information for this record requirement must be contained in a single-page document for each pesticide application. An invoice containing the required information may constitute the record.

(c) Records must be retained for five years after the date of treatment.

(d) A copy of the record must be given to a person who ordered the application that is present at the site where the structural pest control application is conducted, placed in a conspicuous location at the site where the structural pest control application is conducted immediately after the application of the pesticides, or delivered to the person who ordered an application or the owner of the site. The commissioner must make sample forms available that meet the requirements of this subdivision.

Subd. 4. Storage, handling, and disposal plan. A commercial, noncommercial, or structural pest control applicator or the business that the applicator is employed by must develop and maintain a plan that describes its pesticide storage, handling, and disposal practices. The plan must be kept at a principal business site or location within this state and must be submitted to the commissioner upon request on forms provided by the commissioner. The plan must be available for inspection by the commissioner.

Subd. 5. Inspection of records. The commissioner may enter a commercial, noncommercial, or structural pest control applicator's business and inspect the records required in this section at any reasonable time and may make copies of the records. Unless required for enforcement of this chapter, the information in the records in this section is private or nonpublic.

HIST: 1987 c 358 s 79; 1989 c 326 art 5 s 47-50; 1993 c 367 s 10

18B.38 PROTECTION OF TRADE SECRETS.

Subdivision 1. **Requirements.** In submitting data required by this chapter, the applicant may:

(1) clearly mark any portions that in the applicant's opinion are trade secrets, commercial, or financial information; and

(2) submit the marked material separately from other material.

Subd. 2. **Information revealed.** After consideration of the applicant's request submitted under subdivision 1, the commissioner shall not make any information public that in the commissioner's judgment contains or relates to trade secrets or to commercial or financial information obtained from an applicant. When necessary, information relating to formulas of products may be revealed to any state or federal agency consulted with similar protection of trade secret authority and may be revealed at a public hearing or in findings of facts issued by the commissioner.

Subd. 3. **Notification.** If the commissioner proposes to release information that the applicant or registrant believes to be protected from disclosure under subdivision 2, the commissioner shall notify the applicant or registrant by certified mail. The commissioner shall not make the information available for inspection until 30 days after receipt of the notice by the applicant or registrant. During this period the applicant or registrant may institute an action in an appropriate court for a declaratory judgment as to whether the information is subject to protection under this section.

HIST: 1987 c 358 s 80

18B.39 EXISTING RULES.

Rules of the commissioner of agriculture in effect on July 1, 1987, relating to the distribution, use, storage, handling, and disposal of pesticides, rinsates, and pesticide containers remain in effect until they are superseded by new rules.

HIST: 1987 c 358 s 81; 1996 c 305 art 2 s 2

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DOCUMENTS

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Category A
General Ground

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General Ground
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Preface

This Category A: General Ground Pesticide Applicator Training manual is designed as:

- 1) A study guide for the commercial and noncommercial Category A: General Ground Application initial closed book examination;
- 2) A study guide for the Category A: General Ground Application recertification correspondence course;
- 3) A general reference manual and information guide for Minnesota commercial and noncommercial pesticide applicators.

For more information regarding certification and licensing of pesticide applicators see the chapter titled "Laws and Regulations."

This edition of the Category A manual is completely new. It has a clearer format, expanded graphics, and the most current information available. It also represents a close cooperation with Extension Service Pesticide Applicator Training (PAT) programs from other states. This cooperative effort reduces manual production time and expenses, while expanding our access to a broader array of expertise and resources. The old edition of this manual should no longer be used and should be offered for paper recycling.

We hope to revise and update this manual in future years. This will help to improve the manual as a training, education, and reference tool. Your comments in the past have been very useful. Feedback from manual users is the most valuable source of information for improving the manual. We welcome comments from users of this manual — both what you have found useful and suggestions for improvement. Comments about this manual may be sent to:

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Mike Fresvik, Rick Hansen, Jenny Hance, and the MDA Information and Certification Unit for overall cooperative support and for managing and funding the printing of the manual which, in turn, reduced the manual's purchase price to pesticide applicators.

Three PAT manuals used as models for content and format:

Minnesota Private Pesticide Applicator Training Manual by Minnesota Extension Service's Pesticide Applicator Training Program, revised 1994.

Pesticide Applicator Core Training Manual by Pesticide Education Program, Michigan State University Extension, revised 1995.

Applying Pesticides Correctly: A Guide for Private and Commercial Applicators produced by the United States Environmental Protection Agency and the Extension Service, United States Department of Agriculture, revised 1991.

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The Extension Pesticide Applicator Coordinators and their staffs in the Upper Midwest and throughout the nation for their informal contributions and their willingness to share PAT training and education materials, ideas, and support.

Finally, and most importantly, the commercial and noncommercial pesticide applicators of the State of Minnesota for the professional work they do.

Dean Herzfeld
Pesticide Applicator Training Program Coordinator

Introduction

Professionalism and Pesticide Application

The Pesticide Applicator Training Program itself neither endorses nor opposes the use of pesticides. The primary objective of the PAT program is to ensure that when an applicator decides to use a pesticide, it is handled safely and responsibly. All pesticide-use decisions should be made within an Integrated Pest Management program that uses a combination of pest control measures — not just pesticides. The decision to use a pesticide must be based on sound economics and safety considerations to the applicator, the public, and the environment. If a pesticide applicator does not want to follow the guidelines, recommendations, and requirements for using pesticides, then the applicator should choose some other method of pest control. Applicators who disregard the importance of safety and the legal requirements of pesticide use, risk harming themselves and others, and also damage the professional stature of all pesticide applicators.

The PAT program supports the professional development and professional standards of pesticide applicators. Minnesota commercial and noncommercial applicators first must be certified to be licensed by the Minnesota Department of Agriculture. To become certified, a pesticide applicator must successfully complete certain training requirements.

Pesticide applicator training, certification, and licensing is an important way for pesticide applicators to demonstrate their professional competency and to demonstrate their respect for their customers, employers, the public, and for themselves.

The History of the Pesticide Applicator Training Program

Nationally PAT programs have existed since 1964. They have come about because of public and governmental concerns regarding chemical uses in food production and in the environment. Significant changes have evolved since the first "pure food laws" were established nearly one hundred years ago. The following time line shows the development of protective federal laws and programs that have regulated pesticide usage in the United States.

1945-46: The US Fish and Wildlife Service released a series of reports summarizing research studies linking DDT to effects on wildlife.

1947: The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was established. Under FIFRA federal pesticide regulation was placed in the United States Department of Agriculture (USDA).

1954: The Miller Pesticide Amendment to FIFRA required USDA to set safe tolerances for allowable amounts of pesticide residues on fresh fruits and vegetables.

1958: The Food Additive Amendment was passed by Congress, which included the Delaney Clause, setting the stage for pesticide regulation in the United States for decades to come. The Delaney Clause used a zero-tolerance (no detection) as the amount of man-made cancer-causing materials (including some pesticides) allowed in processed foods.

1959: A well-publicized national Thanksgiving scare over possible unsafe pesticide residues on cranberries triggered greater concern over the way pesticides were regulated. The cranberry scare was only the first in an ongoing series of national media-related pesticide events.

1962: A biologist named Rachel Carson published her book *Silent Spring*, which dramatically outlined the problems associated with pesticide use. The book triggered an instant national public outcry against DDT.

1964: A FIFRA amendment created the Pesticide Applicator Training and Certification (PAT) program in the USDA Extension Service Pesticide Coordinator positions were established in every state to provide statewide leadership for pesticide-related outreach and education programs.

1970: The US Environmental Protection Agency (EPA) was created and assumed administration of the federal pesticide laws and regulations.

1972: FIFRA was amended, leading the EPA to suspend the use of the insecticide DDT. The Federal Environmental Pesticide Control Act was passed, which greatly expanded the tests and other requirements needed before a pesticide could be registered for sale. The EPA is allowed to classify pesticides as "Restricted Use" as an alternative to the outright cancellation of the product.

1974: The EPA issued the original Worker Protection Standard that was not revised until August of 1992.

1977: The EPA and USDA formally embraced Integrated Pest Management (IPM) by establishing the IPM and Pesticide Impact Assessment programs in the Extension Service. By this year, formal PAT agreements were reached between EPA, USDA, Minnesota Department of Agriculture, (as state lead agency), and the Minnesota Extension Service (through the Pesticide Applicator Training Coordinator) on development and implementation of Minnesota's PAT program.

1978: The EPA greatly expanded the list of "Restricted Use" pesticides to include a number of commonly used products resulting in more pesticide applicators becoming certified.

Since 1978 public attitudes about pesticides have continued to change. In the late 1980s, widespread concern over pesticide contamination of groundwater brought about strengthened federal and state regulations. The 1989 national scare over Alar on apples provided comparisons to the cranberry scare of 1959. More recently, pesticide use in urban, suburban, residential, and recreational settings has become a greater public concern.

The content and perspectives of the PAT program reflect the concerns for greater public and personal safety associated with pesticide use. Today many people in industry, government, education, and science as well as environmental advocacy groups are seeking better ways to discuss the risks, benefits, and issues of pesticide use. As experienced and trained individuals, pesticide applicators are an essential part of that ongoing discussion.

Integrated Pest Management

What's in this Chapter:

Integrated Pest Management (IPM)

Pest Monitoring

Pest Identification

Threshold Levels

Pest Management Strategies

Pest Management Goals

Tactics Used in Pest Management

Natural Controls

Applied Controls

Evaluation of a Pest Management Program

Pest Resistance

Other Reasons for Failure

Evaluation and Recordkeeping

Learning Objectives

After you complete your study of this unit, you should be able to:

- Explain “monitoring” as it relates to pest management and explain why it is important to pest management strategy;
- Explain why identification of the pest is an important step in developing an effective pest control strategy;
- Determine your pest management goals as they relate to prevention, suppression, and eradication of pests;
- Describe “thresholds” and why they are an important consideration in developing a pest management strategy;
- Define “integrated pest management” and list several possible management tactics that may be used in an IPM strategy;
- Avoid factors that can cause pesticide applications to fail to control pests;
- Help prevent pest resistance to pesticides.

Terms to Know

Host. A plant or animals on or in which a pest lives.

IPM. Integrated pest management.

Juvenile hormones. Natural insect chemicals that keep the earlier stages of an insect from changing into normal adult form.

Labeling. The pesticide product label and other accompanying materials that contain directions which pesticide users are legally required to follow.

Nematodes. Small, usually microscopic, eel-like roundworms.

Nontarget organism. All plants, animals, and microorganisms other than the intended target(s) of a pesticide application.

Mycoplasmas. The smallest known living organisms that can reproduce and exist apart from other living organisms. They obtain their food from plants.

Parasite. An organism living on, in, or with another living organism for the purpose of obtaining food.

Pathogen. An organism that causes disease in other organisms.

Pest. An unwanted organism (animal, plant, bacteria, fungus, etc.).

Pesticide. A substance or mixture of substances used to destroy or control undesirable organisms.

Pheromones. Chemicals emitted by an organism to influence the behavior of other organisms of the same species.

Predator. An organism that attacks, kills, and feeds on other organisms.

Scouting. Monitoring a crop or site on a regular basis and in a prescribed manner to determine pest population levels and the extent of pest damage.

Introduction

In this chapter, you will become familiar with ways to start your own Integrated Pesticide Management program. This chapter presents alternatives to relying only on pesticides to control pests. Pesticides alone will not solve the problem of controlling pests. In fact, the widespread use of pesticides has created new problems, including damage to the environment, hazards to human health, and increased resistance of pests to some pesticides.

IPM is a systematic plan that brings together different pest control tactics into one program. With IPM, a pest manager uses pesticides as one tool in an overall pest control program.

To better understand how an IPM works, consider what each of the words in the phrase Integrated Pest Management means.

Integrated. A focus on interactions of pests, crops, control methods, and the environment rather than on individual weeds, insects, or diseases. This approach considers all available tactics and how they fit in with other practices and the environment.

Pest. A species that conflicts with our profit, health, or convenience. If a species does not exist in numbers that seriously affect these factors, it is not considered a pest.

Management. A way to keep pests below the levels where they can cause economic damage. Management does NOT mean eradicating pests. It means finding tactics that are both effective and economical and that keep environmental damage to a minimum.

To better understand how an IPM program works, it will be helpful to look at what exactly a pest is. A pest is anything that:

- Competes with humans, domestic animals, or desirable plants for food or water;
- Injures humans, animals, desirable plants, structures, or possessions;
- Spreads disease to humans, domestic animals, wildlife, or desirable plants;
- Annoys humans or domestic animals.

Pests also come in a variety of types that include:

- Insects, such as roaches, termites, mosquitoes, aphids, beetles, fleas, and caterpillars;
- Insect-like organisms, such as mites, ticks, and spiders;
- Microbial organisms, such as bacteria, fungi, nematodes, viruses, and mycoplasmas;
- Weeds, which are any plants growing where they are not wanted;
- Mollusks, such as snails, slugs, and shipworms; and
- Vertebrates, such as rats, mice, other rodents, birds, fish, and snakes.

Most organisms are not pests. A species may be a pest in some situations and not in others. An organism should not be considered a pest until it is proven to be one.

Integrated Pest Management (IPM)

IPM considers the pest and its life cycle, economic return on a pest management practice, and the protection of the environment. Using many different tactics to manage a pest problem tends to cause the least disruption to nontarget organisms and the surroundings at the application site. Relying only on pesticides for pest control can cause pests to develop resistance to pesticides, harm or kill beneficial organisms that help keep pests in check, and may cause outbreaks of other pests.

Solving pest problems with IPM involves monitoring, pest identification, use of action threshold levels, selecting management tactics, and evaluation. Steps in IPM include:

- Determine your pest management goal(s);
- Detect and identify the pest(s) and determine whether control is warranted;
- Know what management strategies are available;
- Evaluate the benefits and risks of each tactic or combination of tactics;
- Choose a strategy that will be most effective and will cause the least harm to people, nontarget organisms, and the environment;
- Observe local, state, and federal regulations that apply to the situation;
- Evaluate the effectiveness of each strategy and make adjustments as necessary.

Pest Monitoring

In most pest management situations, the area to be protected should be regularly monitored (visually inspected or scouted). Regular monitoring can answer several important questions:

- What kinds of pests are present?
- Are the numbers great enough to do damage and to warrant control?
- When is the right time to begin control?
- Have the management efforts successfully reduced the number of pests?

Monitoring of insect, insect-like, mollusk, and vertebrate pests usually involves trapping or scouting. Weeds are monitored by visual inspection (scouting); and microbial pest detection involves looking for injuries or damages the pests cause. Signs of the presence of a pest can also be helpful in pest identification.

Environmental conditions should also be monitored in the area being managed. Temperature and moisture levels, especially humidity, are often important clues in predicting when a pest outbreak will occur or will hit threshold levels.

Pest Identification

Never attempt a pest control program until you are sure of what the pest is. The more you know about the pest and the factors that influence its development and spread, the easier, more cost-effective, and more successful your pest management program will be. Correct identification of a pest allows you to determine basic information about it, including its life cycle, in what stage it is most destructive, and the time that it is most susceptible to being controlled.

Be familiar with the pests you are likely to encounter in your line of work. To be able to identify and manage pests, you need to know:

- The physical features of the pests;
- Characteristics of the damage they cause;
- Their development and biology; and
- What your management goal is.

An organism should not be classified or treated as a pest until it is proven to be one. A species may be a pest in some situations and not in others. If you need help identifying a pest, contact your commodity or industry organizations, or the Minnesota Extension Service at the University of Minnesota.

Threshold Levels

Thresholds are the levels of pest populations at which pest management action should be taken to prevent the pests from causing unacceptable damage. These levels, which are known as "action" thresholds, have been identified for many pests. Thresholds may be based on aesthetic, health, or economic considerations.

A threshold often is set at the level where the projected economic losses caused by an uncontrolled pest are greater than the cost of controlling the pest at the right time. These types of thresholds sometimes are called "economic thresholds." In other cases, aesthetics are more important than economic considerations in determining the action threshold.

In some pest management situations, the threshold level is zero: even a single pest in such a situation is unreasonably harmful. For example, the presence of any rodents in food-processing facilities forces action. In homes, people generally take action to control some pests, such as rodents or roaches, even if only one or a few have been seen.

In contrast, some pest species in low numbers may cause limited injury and the threshold level for taking pest management action is likely to be much higher. As the pest manager, you and your customer or client may establish the threshold that requires action.

Pest Management Strategies

Any time you are considering whether pest management is necessary, remember:

- Control a pest only when it is causing or is expected to cause more harm or damage than is reasonable to accept.
- Use a tactic or combination of tactics that will reduce the pest numbers to an acceptable level.
- Cause as little harm as possible to everything except the pest.

Even though a pest is present, it may not do very much harm. Total eradication of a pest is rarely cost effective or needed for most outdoor pest problems. Knowing if, when, and how to take action to manage a pest saves money and time, and prevents unnecessary pesticide use.

Pest Management Goals

Whenever you manage a pest, you will want to achieve one or a combination of these three goals:

- Prevention — keeping a pest from becoming a problem;
- Suppression — reducing pest numbers or damage to an acceptable level; and
- Eradication — destroying an entire pest population.

Prevention

Prevention may be a goal when the pest's presence or abundance can be predicted in advance. For example, some plant diseases occur only under certain environmental conditions. If such conditions are present, you can take steps to prevent the plant disease organisms from harming the desirable plants.

Suppression

Suppression is a common goal in many pest situations. The intent is to reduce the number of pests to a level where the harm they are causing is acceptable. Once a pest's presence is detected and the decision is made that control is necessary, suppression and prevention often are joint goals. The right combination of management measures can often suppress the pests already present and prevent them from building up again to a level where they cause unacceptable harm.

Eradication

Eradication is a rare goal in outdoor pest situations because it is difficult to achieve. Usually the goal is prevention and/or suppression. Eradication is occasionally attempted when a foreign pest has been accidentally introduced but is not yet established in an area. Such eradication strategies often are supported by the government. For example, the Minnesota Department of Agriculture leads gypsy moth and Japanese beetle eradication programs in Minnesota.

In indoor areas, eradication is a more common goal but still difficult to achieve for some pests. Enclosed environments usually are smaller, less complex, and more easily controlled than outdoor areas. In many enclosed areas (dwellings, schools, office buildings, water heating and cooling systems, health care, food processing and food preparation facilities), certain pests cannot or will not be tolerated.

Tactics Used in Pest Management

Natural and applied techniques are used to manage pests. Many techniques are not aimed directly at killing a pest but at manipulating the environment to prevent or suppress pest outbreaks. Pest managers need to understand how natural and applied techniques work to select the best combination of pest management control tactics.

Natural Controls

Natural forces act on all organisms, causing the populations to rise and fall. These natural forces act independently of humans and may either help or hinder pest control. Natural forces that affect pest populations include climate, natural enemies, natural barriers, availability of shelter, and food and water supplies.

Climate

Weather conditions, especially temperature, day length, and humidity, affect pests' activity and their rate of reproduction. Pests may be killed or suppressed by rain, freezing temperatures, drought, or other adverse weather.

Natural enemies

Birds, reptiles, amphibians, fish, and mammals feed on some pests and help control their numbers. These are sometimes called beneficial organisms. Many *predatory* and *parasitic* insect and insect-like species feed on other organisms, some of which are pests. *Pathogens* that cause disease in pests may often suppress pest populations. It is important to identify these beneficial organisms when scouting the site you manage. These natural enemies may already be hard at work reducing a pest outbreak, reducing or eliminating the need for your intervention.

Geographic barriers

Features such as large bodies of water and mountains restrict the spread of many pests. Other smaller features of the landscape can have similar effects.

Food and water supply

Pest populations can thrive only as long as their food and water supplies last. Once the food source — plant or animal — is exhausted, the pests die or become inactive. The life cycle of many pests depends on the availability of water.

Shelter

The availability of shelter from predators or for overwintering can affect some pest populations.

Applied Controls

Unfortunately, natural controls often do not control pests quickly or completely enough to prevent unacceptable injury or damage. Then other management measures must be used. Those available include:

- Host resistance,
- Biological control,
- Cultural control,
- Mechanical control,
- Habitat modification and sanitation, and
- Chemical control.

Host resistance

Some plants, animals, and structures resist pests better than others. Use of resistant types helps keep pest populations below harmful levels by making conditions less favorable for the pests.

Host resistance works in three main ways:

- Naturally occurring chemicals in the host repel the pest or prevent the pest from completing its life cycle (some crops have this ability).
- The host is more vigorous or tolerant than other varieties and thus less likely to be seriously damaged by pest attacks (this may be true for plants and animals).
- The host has physical characteristics that make it more difficult to attack (certain buildings are designed to be less attractive or prone to insect invasions).

Biological control

Biological control involves the use of natural enemies — parasites, predators, and pathogens. There is a time lag between pest population increase and the corresponding increase in natural controls. You can supplement this natural control by releasing more of a pest's enemies into the target area. The degree of control fluctuates, but, under proper conditions, sufficient control can be achieved over time. Managing the habitat to create a welcoming environment for a pest's enemies and to avoid harming a pest's enemies when using pesticides are also important when using biological control.

Biological control also includes methods by which the pest is biologically altered, as in the production and release of large numbers of sterile males, and the use of pheromones or juvenile hormones. Pheromones are chemicals emitted by an organism to influence the behavior of other organisms of the same species.

Pheromones can be useful in monitoring pest populations. When placed in a trap, they can attract the insects in a sample area so that pest numbers can be estimated. Pheromones also can be a control tool. A manufactured copy of the pheromone that a female insect uses to attract males can be used to attract and trap males and prevent mating, resulting in lower numbers of pests. Applying juvenile hormones to an area can reduce pest numbers by keeping some immature pests from becoming reproducing adults.

Cultural control

Cultural practices sometimes are used to reduce the numbers of pests that are attacking cultivated plants. These practices alter the environment, the condition of the host plant, or the behavior of the pest to prevent or suppress an infestation. They disrupt the normal relationship between the pest and the host plant and make the pest less likely to survive, grow, or reproduce. Common cultural practices include rotating crops, cultivating the soil, varying time of planting or harvesting, planting trap crops, adjusting row width, pruning, thinning, and fertilizing cultivated plants.

Mechanical (physical) control

Devices, machines, and other physical methods used to control pests or alter their environment are called mechanical or physical controls. Traps, screens, barriers, fences, nets, radiation, and electricity sometimes can be used to prevent the spread of pests into an area or to remove pests from an area.

Lights, heat, and refrigeration can alter the environment enough to suppress or eradicate some pest populations. Altering the amount of water, including humidity, can control some pests, especially insects and diseases.

Habitat modification and sanitation

Sanitation practices help to prevent and suppress some pests by removing the pests themselves or their sources of food and shelter. Urban and industrial pests can be reduced by improving cleanliness, eliminating pest harborage, and increasing the frequency of garbage pickup. Management of pests attacking domestic animals is enhanced by good manure management and other sanitation practices. Carryover of agricultural pests from one planting to the next can be reduced by crop residue management. Modifying a structure by repairing water leaks and rotting wood can often eliminate structural pest problems.

Other forms of sanitation that help prevent pest spread include:

- Using pest-free seeds or transplants; and
- Decontaminating equipment, animals, and other possible carriers (before allowing them to enter a pest-free area or leave an infested area).

The proper design of food-handling areas can reduce access and shelter for many pests.

Chemical control

Chemical control is the use of pesticides that are either naturally derived or man-made chemicals that kill, repel, attract, sterilize, or otherwise interfere with the normal behavior of pests. In some instances, pesticides are the only control tactic available. Examples of chemical control include pentachlorophenol to protect telephone poles from wood-damaging pests; chlorine in drinking water to control bacteria; mothballs to repel clothes moths; sex pheromones of gypsy moth to reduce mating incidence; herbicides to kill weeds; insecticides to manage insects; and fungicides to manage fungal diseases.

Evaluation of a Pest Management Program

Sometimes even though you applied a pesticide or other pest control method, the pest was not controlled. You should review the situation to try to determine what went wrong. There are several possible reasons for the failure of pest control.

Pest Resistance

Pesticides fail to manage some pests because the pests are resistant to the product. Rarely does a pesticide application kill all the target pests. Each time a pesticide is used, it selectively kills the most susceptible pests. Some pests avoid the pesticide. Others withstand its effects. Pests that are not destroyed may pass along to their offspring the trait that allowed them to survive.

When one pesticide is used repeatedly in the same place, against the same pest, the surviving pest population may be more resistant to the pesticide than the original population was. The opportunity for resistance is greater when a pesticide is used over a wide geographic area or when a pesticide is applied repeatedly to a rather small area where pest populations are isolated. Rotating the pesticides used by selecting among different chemical families may help reduce the development of pest resistance. Use of controls other than pesticides helps to minimize pest control failures due to pest resistance.

Other Reasons for Failure

Make sure that you have used the correct pesticide and the correct dosage and that you have applied the pesticide according to the label directions. Improper mixing of chemicals and poorly calibrated application equipment cause pest control failures. If a pest was mis-identified the wrong pesticide could have been chosen. Other applications fail because the pesticide was not applied at an appropriate time — the pest may not have been in the area during the application or it may have been in a life cycle stage or location where it was not susceptible to the pesticide.

Evaluation and Recordkeeping

It is extremely important to evaluate the results of your pest management program. This can be done in several ways. Calculate the cost effectiveness of the pest management strategy you used. Monitor pest populations or infection before and after treatment and compare damage ratings. Take note of the conditions during your pest management activities such as timing, pest numbers, temperature, and any other factor that may influence the outcome of your efforts. Record the results from your evaluation for future reference.

Pest management records are valuable for providing insight into adjusting future pest management programs. They can help you consider other options that may be easier to implement, reduce equipment costs, or offer greater flexibility. Over time, records can also help you evaluate long-term considerations of your pest management program.

Summary

Pest management involves more than simply identifying a pest and using a control strategy. The treatment site, whether it is an outdoor area or inside a structure, usually contains other living organisms (such as people, animals, and plants) and nonliving surroundings (such as air, water, structures, objects, and surfaces). Most treatment sites are disrupted to some degree by pest management strategies. The actions of every type of organism or component sharing the site usually affect the actions and well-being of many others. When the balance is disrupted, certain organisms may be destroyed or reduced in number, and others — sometimes the pests — may dominate. Unless the possible effects on the entire system where the pest exists are considered, your pest management effort could cause harm or lead to continued or new pest problems. Use good judgment and, when pesticides are part of the strategy, follow the pesticide labeling for safe and effective use.

Review Questions for Integrated Pest Management

1. What is the first thing you should do when you detect the presence of a pest that you think you may need to control?

2. How can pest identification help you develop a good pest control strategy?

3. Explain what is meant by prevention, suppression, and eradication of pests.

4. What is a threshold as it relates to IPM?
 - A. The level of pesticide required to control a pest.
 - B. The levels of pest populations at which you must take pest control action to prevent unacceptable damage or injury.
 - C. A type of structure designed to be more resistant to pest invasion.
 - D. The levels of heat and moisture required for a pest to survive.

5. Why should you consider thresholds when you develop a pest control strategy?

6. What is pest monitoring ?
 - A. Watching your pesticide application kill the pest.
 - B. Recordkeeping of the pesticide used.
 - C. Checking or scouting for pests in an area to determine what pests are present, how many, and how much damage they are causing.
 - D. Identifying the pest's predators.

7. How can pest monitoring be important to pest management?

8. Define "integrated pest management" (IPM).

9. List several possible control tactics that may be used in an IPM strategy.

10. You applied a pesticide, but it did not control the pest. Name four reasons why your control effort might have failed.

11. What can you do to keep the pests you are trying to control from becoming resistant to the pesticides you use?

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Pesticides and Pesticide Formulations

What's in this Chapter:

**Pesticides Classified According to
the Types of Pests They Control**

Pesticides Classified by Chemical Groups

Inorganic Pesticides

Organic Pesticides

Pesticide Mode of Action

Pesticide Terminology

Factors Influencing Reactions to Pesticides

Life Stage

Pesticide Uptake

Pest Resistance

Pesticide Formulations

Active and Inert Ingredients

Mixing Pesticide Ingredients

How to Choose a Formulation

Different Types of Formulations

Liquid Formulations

Dry Formulations

Adjuvants

Combining Different Formulations

Learning Objectives:

After completing this chapter, students will be able to:

- Explain that pesticides are classified by both the pests they control and by their chemical make-up;
- Explain what organic and inorganic pesticides are and provide examples;
- Distinguish between "contact" and "systemic" pesticides;
- Explain what a pesticide formulation is;
- Identify the factors to consider when choosing a formulation;
- Apply their knowledge of the characteristics, advantages, and disadvantages of different types of pesticide formulations;
- Identify factors to consider when choosing a formulation;
- Explain how and when pesticides may be incompatible;
- Distinguish between "active" and "inert" ingredients;
- Recognize the purpose of adjuvants and list several types.

Terms to Know:

Botanical pesticide. Organic pesticide derived or extracted directly from plants.

Carrier. The primary material used to allow a pesticide to be dispersed effectively, such as water (when mixed with a wettable powder) or air (in air blast sprayers).

Emulsion. A mixture of two or more liquids that are not soluble in one another. One is suspended as small droplets in the other.

Inorganic. Of mineral origin; does not contain carbon.

Insoluble. Does not dissolve in liquid.

Microbial pesticides. Bacteria, viruses, and fungi used to cause disease in given pests.

Nontarget. Any site or organism other than the site or pest toward which the control measures are being directed.

Organic. Contains carbon.

Persistence. The ability of a pesticide to resist breaking down quickly after application.

Pesticide. Substances or mixtures of substances intended to prevent, destroy, repel, or control pests.

Pesticide handler. Person who directly works with pesticides, such as during mixing, loading, transporting, storing, disposing of, and applying pesticides, or working on pesticide equipment.

Soluble. Able to be dissolved in another substance, usually a liquid.

Solvent. A liquid, such as water, kerosene, xylene, or alcohol, which will dissolve a pesticide (or other substance) to form a solution.

Systemic pesticide. A pesticide that is taken into and moves throughout the blood of an animal or the sap of a plant. It is intended to kill the pest without harming the host.

Target pest. The pest toward which control measures are being directed.

Introduction

"Pesticide" is a broad term that represents many types of chemicals used for pest control. The legal definition of a pesticide, according to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is:

...any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating insects, rodents, nematodes, fungi, or weeds, or any other forms of life declared to be pests; and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

The FIFRA definition illustrates the broad range of pests that pesticide handlers must be familiar with. It also shows the wide variety of pesticide substances that pesticide handlers must know how to properly use.

As a pesticide handler you must be able to make informed choices about pesticide usage. In order for you to make these choices, you must be aware of how pesticides are defined and categorized. Understanding some basic concepts of pesticide chemistry, pesticide functions, and pesticide modes of action will help you make more informed choices. Understanding the uses, advantages, and disadvantages of various formulations will help you make effective choices when selecting pesticides to control various pests under specific circumstances.

This chapter will cover how pesticides are classified according to:

- The types of pests they control;
- Their chemical make-up;
- Their modes of action;
- Their pesticide formulation.

Pesticides Classified According to the Types of Pests They Control

When classifying pesticides according to the target pests they control, it is important to note that not all pesticides are designed to kill target organisms. Different pesticides have different functions. Some pesticides interact with the site that pests inhabit. Other pesticides target either the host plant or animal. Many pesticides are designed to attack the target pest.

For example, insecticides control insects, herbicides control weeds, and fungicides inhibit the growth of fungi. The term "pest control" refers to a pesticide's function, such as preventing, destroying, repelling, or controlling pests. The terms insecticide, fungicide, herbicide, and others refer to a specific functional class of pesticides. See the following table for information on pesticides classified according to the types of pests they control, or the functions they perform.

Pesticides classified according to type of pest controlled OR function	
Pesticide classification	Pests managed
Algaecide	Algae
Biocide	Microbial organisms
Fungicide	Fungi
Insecticide	Insects & other related animals
Herbicide	Weeds
Miticide	Mites
Nematocide	Nematodes
Rodenticide	Rodents
Avicide	Birds
Piscicide	Fish
Molluscicide	Slugs & snails
Ovicide	Eggs of organisms
Predacide	Vertebrates
Other chemicals classified as pesticides	Function
Growth regulator	Modifies plant or insect development
Defoliant	Removes plant foliage
Desiccant	Dries plant foliage
Repellent	Diverts a pest
Attractant	Lures a pest
Pheromone	May attract pests or disrupt behavior
Sterilant	Renders pest unable to reproduce

Many specific pesticides can be used to control more than one group of pests. A pesticide that controls more than one pest is called broad spectrum and multipurpose.

Pesticides Classified by Chemical Groups

Pesticides that are categorized by chemical groups are generally divided first into organic and inorganic pesticides. The main difference between organic and inorganic pesticides is the presence or absence of carbon. Inorganic pesticides do not contain carbon. Most pesticides in use today are organic pesticides. They may be either natural or synthetic. Groups with similar chemical structure tend to be similar in their modes of action, fate in the environment, and pest control properties — but not necessarily in their levels of toxicity.

Inorganic Pesticides

Inorganic pesticides do not contain carbon. Most inorganic compounds are of mineral origin. Inorganic pesticides are widely used today to manage a variety of plant diseases. In most cases inorganic pesticides have a relatively low toxicity for humans. Uses for inorganic compounds that pose concerns for human health and the environment, such as those that contain lead, mercury, and arsenic, have been curtailed and in some cases have been banned. Inorganic pesticides commonly contain either arsenic, copper, boron, mercury, sulfur, tin, or zinc. Some examples include sulfur dust, bordeaux mix, and paris green.

Organic Pesticides

Organic pesticides contain carbon. They may contain hydrogen, oxygen, nitrogen, phosphorus, sulfur, or other elements. Since the 1940s, the production of synthetic organic compounds has influenced the rapid expansion of pesticide use.

Organic pesticides include naturally occurring chemicals such as botanical and microbial pesticides. Botanical pesticides are derived or extracted from plants. These substances are naturally poisonous to pests.

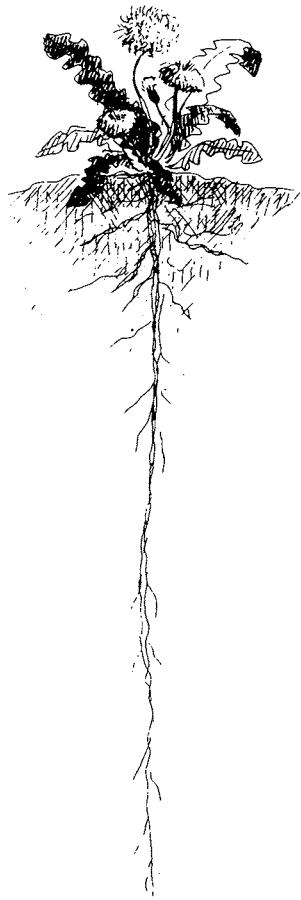
Microbial pesticides are a distinct group of pest management compounds. They consist of bacteria, viruses, and fungi that cause disease in specific pest species. Although they may occur naturally in certain areas, they are mass produced and intentionally introduced by humans in sufficient quantities so that a relatively high level of control becomes possible. The best known example is the bacterium *Bacillus thuringiensis* (Bt), which has been used effectively against some species of caterpillars including the gypsy moth. For further information about pesticides classified by chemical groups, see Appendix A.

Pesticide Mode of Action

Another way that pesticides may be grouped or classified is by their mode of action. A pesticide's mode of action is the method by which it destroys or controls the target organism. For instance, an insecticide may act as a stomach poison, an herbicide may prevent root development in seedlings, or a biocide may disrupt cell membranes of microorganisms. Generally, pesticides within a chemical class have the same mode of action on specific types of pests. They may also have similar characteristics such as chemical structure, persistence in the environment, and types of formulations.

The types of injury caused by a pesticide to a target organism may be either local or systemic. Local injury usually involves damage to tissues that initially come in contact with the pesticide, such as leaves. Pesticides with systemic action move after application to other tissues where damage may occur. Systemic activity involves the application of pesticides to host plants or animals to protect them from damage by pest organisms. For example, systemic insecticides may be applied to soil where cultivated plants are growing. The applied insecticide may be picked up by the roots and delivered throughout the plant's system, causing its foliage to be toxic to foliage-feeding insects.

Pesticide Terminology



Several common terms describe how pesticides interact with the site, host plant or animal, target pest, and environment. Certain terms listed below are more appropriate to a specific functional class of pesticide (such as insecticide, fungicide, or herbicide) than others.

Broad-spectrum. Pesticides that control more than one pest are considered nonselective. For instance, where no plant growth is wanted, such as fence rows, ditch banks, and greenhouse floors, a nonselective herbicide may be used.

Contacts. Pesticides that kill pests by contacting the pest are known as contact pesticides.

Nonpersistent. Pesticides that control pests at the time of application and then break down quickly are nonpersistent.

Persistent. Persistent pesticides remain active for a period of time after application, giving continued protection against the pest. These may also be referred to as residual pesticides. Persistence may range from a few days to a few years.

Protectants. Pesticides applied to plants, animals, structures, mechanical systems, and products to prevent pest establishment are considered protectants. These may include repellents. Many fungicides are used as protectants and are intended to be applied before or during infection of the host by the pathogen. Biocides are added to water treatment systems to prevent microbial buildup. Wood products may be protected with pesticides to prevent insect infestations and rots caused by fungi.

Selective. A pesticide is selective if it is effective against one organism and not another. Herbicides that control one plant without harming other plants close by demonstrate selective control. Microbial insecticides are usually specific to a given species but are not harmful to other insect species. Selectivity can be accomplished through the pesticide's chemistry, timing and/or placement, environmental conditions, and characteristics of the target pest.

Sterilants. Pesticides that manage pests by rendering them incapable of normal reproduction.

Systemics. Pesticides that are absorbed by one part of the animal or plant and distributed internally to other parts of the animal or plant. Systemic pesticides kill the pest without harming the host such as heartworm control in dogs, or insecticide treatments for control of boring insects.

Many synthetic organic pesticides work in one or more of the above listed ways. For example a pesticide may be a nonselective, contact, and persistent chemical; or a product may be persistent, a protectant, and act as a sterilant. Read the pesticide label to find out how the pesticide you are using will react once applied.

Factors Influencing Reactions to Pesticides

Several factors can influence how a pest reacts to a pesticide. Primary among these are the life stages of the pest and the ability of the pesticide to reach the active site within the organism (pesticide uptake).

Life Stage

The life stage of a target organism may influence its response to a pesticide. For instance, young plants are generally more susceptible to herbicides than older ones, and perennial plants that are beginning to flower often will be more difficult to control once they have developed rhizomes or nutlets.

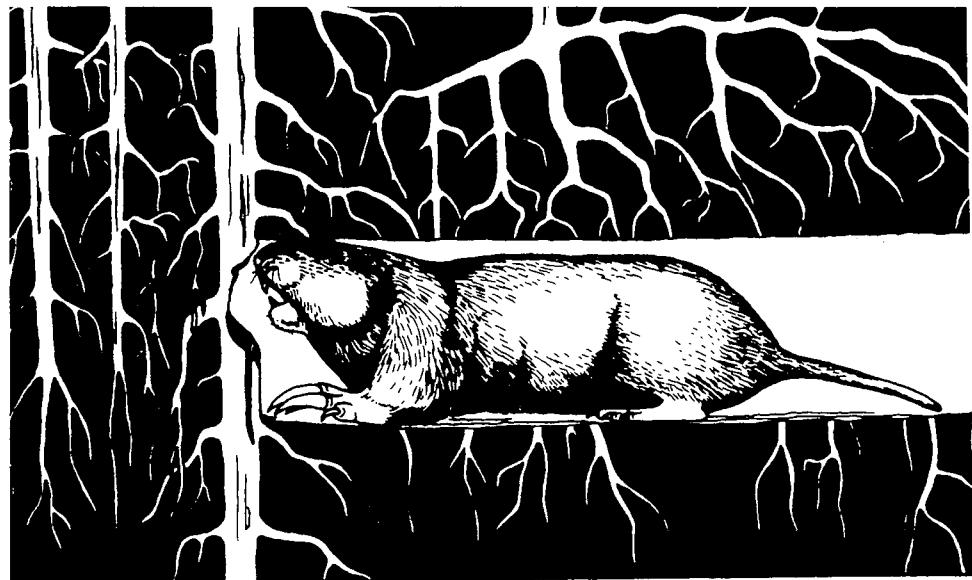
Insects may go through several life stages including eggs, nymphs or larvae, pupae, and finally adults. Each stage has different susceptibilities to insecticides due to biological and physical characteristics, feeding habits, and the physical location of the organism. Similarly, success of rodent control with toxic baits depends on the rodent's life stage and food preferences at different times of year.

Pesticide Uptake

Pesticide uptake is the method and route a pesticide uses to pass through the system of a target organism. Pesticides with contact activity pass through the target organism's outer covering. Some insecticides and rodenticides, known as stomach poisons, must be fed upon to cause poisoning. Pesticides with fumigant activity must be vaporized and taken into the tissues of the target plant or animal through respiration or breathing channels, or by passing through the skin or cuticle. Certain pesticides include all of these types of uptake.

Most pesticides have specific sites of action. Before they can act they must be taken into the tissues of intended target organisms and reach these sites. Structural differences, protective coatings, and habits of the pest may influence pesticide entry.

Some insecticides and rodenticides, known as stomach poisons, must be fed upon to cause poisoning.



Pest Resistance

When making repeated pesticide treatments to a system or area for the same pest, it is recommended that pesticide products with different modes of action be used. This helps reduce the possibility that surviving pest populations will become resistant to a particular pesticide. When chemicals with different modes of action are used, it is less likely that a pest population will develop resistant traits. Integrated pest management (IPM) is the current method for preventing pest resistance. Integrated pest management is covered in detail in chapter 1 (Integrated Pest Management).

Pesticide Formulations

Active and Inert Ingredients

A pesticide product or formulation consists of two parts: active and inert ingredients. Active ingredients are chemicals that actually control the pest. The active ingredients in pesticide products come from many sources. Some are extracted from plants, others have a mineral origin or are derived from microbes. Inert ingredients are primarily solvents and carriers that help deliver the active ingredients to the target pest; they serve to enhance the utility of the product. Inert ingredients may be liquids into which the active ingredient is dissolved or chemicals that keep the product from separating or settling. They may even be compounds that help secure the pesticide to its target after application. An active ingredient usually must be formulated in a manner that

increases pesticide effectiveness in the field, improves safety features, and enhances handling qualities.

A mixture of an active ingredient with a compatible inert ingredient is called a pesticide formulation. Pesticides may be formulated for a number of different reasons. A pesticide active ingredient in a relatively pure form is rarely suitable for field application. The reason for mixing the active ingredient with other substances is to make handling and application safer, easier, and more accurate.

Mixing Pesticide Ingredients

Regardless of their source, pesticide active ingredients have different solubilities. Some dissolve readily in water, others only in oils. Some active ingredients may be relatively insoluble in either water or oils. These different solubility characteristics, coupled with the intended use of the pesticide, in large measure define the types of formulations in which the active ingredient may be delivered.

Some active ingredients are to be used directly from the package, while others need to be diluted with water, oil, or other carriers. In cases where it is not feasible to use the active ingredient in the original form, it may become necessary to alter the active ingredient in order to change its solubility characteristics.

Some active ingredients do not dissolve in water or oil. Others can only be manufactured as solids. Still others are liquids or gases in their original forms. By mixing the active ingredient with other materials (such as solvents, wetting agents, stickers, powders, or granules) manufacturers produce formulations that can be handled accurately and safely by application machinery. A few pesticides are now formulated for controlled release. These pesticides allow the active ingredient to be slowly released after application. This provides better control for certain pests at possibly lower rates and over a longer period of time.

Pesticide formulations consist of the following elements:

- The pesticide active ingredient;
- The carrier;
- Surface-active ingredients; and
- Other ingredients.

How to Choose a Formulation

A single pesticide is often sold in different formulations. It is important to choose the formulation that is best for your particular pest management situation. Different formulations of the same active ingredient often behave differently. For example, some types of formulation may mix well with water but increase the chance of crop injury. Choose the formulation that is suitable for the job. Things to consider when choosing a pesticide formulation include the following.

Applicator safety. Different formulations present various degrees of hazard to the applicator. Some products are easily inhaled, while others readily penetrate skin or cause injury when splashed in the eyes.

Environmental concerns. Special precautions need to be taken with formulations that are prone to drift in air or move off target into water. Wildlife can also be affected to varying degrees by different formulations. Birds may be attracted by granules, and fish or aquatic invertebrates can prove especially sensitive to specific pesticide formulations.

Pest biology. The growth habits and survival strategies of a pest will often determine what formulation provides optimum contact between the active ingredient and the pest.

Available application equipment. Some pesticide formulations require specialized application equipment. This includes safety equipment, spill control equipment, and in special cases, containment structures.

Birds may be attracted by granules, and fish or aquatic invertebrates can prove especially sensitive to specific pesticide formulations

Surfaces to be protected. Applicators must be aware that certain formulations can stain fabrics, discolor linoleum, dissolve plastic, or burn foliage.

Cost. Product prices may vary substantially, based on the ingredients used and the complexity of delivering active ingredients in specific formulations.

Different Types of Formulations

Formulations are classified as solids or liquids on the basis of their physical state in the container at the time of purchase. Pesticide chemicals in their "raw" or unformulated state are usually not suitable for use in pest control because they are highly concentrated, may not mix well with water, and may be chemically unstable. For these reasons, manufacturers add substances to improve storage, handling, and application effectiveness, and to make the chemical safer to use. The final product is known as a pesticide formulation.

The formulation consists of:

- The pesticide active ingredient;
- The carrier; and
- Chemicals that enhance or improve the action of the pesticide.

A formulation can contain more than one active ingredient, and many have to be further diluted with an appropriate carrier (e.g., water) prior to use.

Liquid Formulations

Emulsifiable concentrates (EC or E)

An emulsifiable concentrate formulation usually contains a liquid active ingredient, one or more petroleum-based solvents, and an agent that allows the formulation to be mixed with water to form an emulsion. An emulsion is one liquid dispersed, usually as very small drops, throughout another liquid. ECs mix with water to form a milky emulsion. Each gallon of EC usually contains 25 to 75 percent (2 to 8 pounds) active ingredient. ECs are among the most versatile formulations. They are used against agricultural, ornamental and turf,



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forestry, structural, food-processing, livestock, and public health pests. They are adaptable to many types of application equipment, from small portable sprayers to hydraulic sprayers, low-volume ground sprayers, mist blowers, and low-volume aircraft sprayers.

Advantages:

- Relatively easy to handle, transport, and store.
- Little agitation required — will not settle out or separate when equipment is running.
- Not abrasive.
- Do not plug screens or nozzles.
- Little visible residue on treated surfaces.

Disadvantages:

- High concentration makes it easy to overdose or underdose through mixing or calibration errors.
- May be phytotoxic (cause unwanted chemical damage) to plants.
- Easily absorbed through skin of humans or animals.
- Solvents may cause rubber or plastic hoses, gaskets, and pump parts and surfaces to deteriorate.
- May cause pitting or discoloration of painted finishes.
- Flammable — should be used and stored away from heat or open flame.
- May be corrosive.
- When ECs are combined with other products, particularly liquid fertilizers, compatibility can be a problem. Therefore, special mixing, agitation, or compatibility agents may be needed to prevent separation. Compatibility and mixing pesticides of different formulations will be discussed later in this chapter.

Solutions (S)

Some pesticide active ingredients dissolve readily in a liquid solvent, such as water or a petroleum-based solvent. When mixed with the solvent, they form a solution that will not settle out or separate.

Formulations of these pesticides usually contain the active ingredient, the solvent, and one or more other ingredients. Solutions may be used in any type of sprayer indoors or outdoors.

Ready-to-use (RTU) solution. Some solutions are products that contain the correct amount of solvent when purchased, requiring no further dilution before application. These formulations contain small amounts (often 1 percent or less) of active ingredient per gallon.

Concentrate solutions (C or LC). Other solutions are sold as concentrates, which must be further diluted with a liquid solvent before application. Occasionally the solvent is water, but more often the solvent is a specially refined oil or petroleum-based solvent.

Some uses of solutions are:

- Control of some household pests;
- Livestock and poultry pest control;
- Shade tree pest control;
- Mosquito control.

Advantages: No agitation necessary.

Disadvantages: Limited number of formulations of this type available.

Ultra-low-volume (ULV)

These concentrates may approach 100 percent active ingredient. They are designed to be used as is or to be diluted with only small quantities of specified solvents. These special purpose formulations are used mostly in outdoor applications, such as in agricultural, forestry, ornamental, and mosquito control programs.

Advantages:

- Relatively easy to handle, transport, and store.
- Little agitation required.
- Not abrasive to equipment.
- No plugging of screens and nozzles.
- Little visible residue on treated surfaces.

Disadvantages:

- Difficult to keep pesticide in the target site — high drift hazard.
- Specialized equipment required.
- Easily absorbed through skin of humans or animals.

Flowables (F or L)

Some active ingredients are insoluble solids. These may be formulated as flowables in which the finely ground active ingredients are mixed with a liquid, along with inert ingredients, to form a suspension.

Flowables are mixed with water for application and are similar to EC formulations in ease of handling and types of pest control operations.

Advantages:

- Seldom clog nozzles.
- Easy to handle and apply.

Disadvantages:

- Require moderate agitation.
- May leave a visible residue.

Aerosols (A)

These formulations contain one or more active ingredients and a solvent. Most aerosols contain a low percentage of active ingredient.

There are two types of aerosol formulations — the ready-to-use type and those made for use in smoke or fog generators.

Ready-to-use aerosols. These aerosol formulations are usually small, self-contained units that release the pesticide when the nozzle valve is triggered. The pesticide is driven through a fine opening by an inert gas under pressure, creating fine droplets. These products are used in greenhouses, in small areas inside buildings, or in localized outdoor areas. Commercial models, which hold 5 to 10 pounds of pesticide, are usually refillable.

Advantages:

- Ready to use.
- Easily stored.
- Convenient way to buy small amount of a pesticide.
- Retain potency over fairly long time.

Disadvantages:

- Practical for very limited uses.
- Risk of inhalation injury.
- Hazardous if punctured, overheated, or used near an open flame.
- Difficult to confine to target site or pest.

Formulations for smoke or fog generators. These aerosol formulations are not under pressure. They are used in machines that break the liquid formulation into a fine mist or fog (aerosol) using a rapidly whirling disk or heated surface. These formulations are used mainly for insect control in structures such as greenhouses and warehouses and for mosquito and biting fly control outdoors.

Advantages:

- Easy way to fill entire space with pesticide.

Disadvantages:

- Highly specialized use and equipment.
- Difficult to confine to target site or pest.
- May require respiratory protection to prevent risk of inhalation injury.

Invert emulsions

This mixture contains a water-soluble pesticide dispersed in an oil carrier. Invert emulsions require a special kind of emulsifier that allows the pesticide to be mixed with a large volume of petroleum-based carrier, usually fuel oil. When applied, invert emulsions form large droplets that do not drift easily. Invert emulsions are most commonly used in vegetation control along rights-of-way where drift to susceptible nontarget plants can be a problem.

Dry Formulations

Dusts (D)

Most dust formulations are ready to use and contain a low percentage of active ingredient (usually 0.5 to 10 percent), plus a very fine, dry, inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The individual dust particles vary in size.

Dusts are always used dry, and they easily drift into nontarget sites. They sometimes are used for agricultural applications. In structures, dust formulations are used in cracks and crevices and for spot treatments. They are widely used in seed treatment. Dusts also are used to control lice, fleas, and other parasites on pets and livestock.

Advantages:

- Usually ready to use, with no mixing. (Note: If the dust is applied with equipment that requires "loading" prior to application, then it would not be considered a ready-to-use; e.g., a bulb duster.)
- Effective where moisture from a spray might cause damage.
- Require simple equipment.
- Effective in hard-to-reach indoor areas.

Disadvantages:

- Easily drift off target during application.
- Residue easily moved off target by air movement or water.
- May irritate eyes, nose, throat, and skin.
- Do not stick to surfaces as well as liquids.
- Difficult to get an even distribution of particles on surfaces.

Baits (B)

A bait formulation is an active ingredient mixed with food or another attractive substance. The bait either attracts the pests or is placed where the pests will find it. Pests are killed by eating the pesticide the bait contains. The amount of active ingredient in most bait formulations is quite low, usually less than 5 percent.

Baits are used inside buildings to control ants, roaches, flies and other insects, and rodents. Outdoors they sometimes are used to control snails, slugs, and some insects, but their main use is for control of vertebrate pests such as rodents, other mammals, and birds.

Advantages:

- Ready to use. (Note: if the bait is packaged in bulk amounts and then transferred or loaded into individual bait boxes, it is not an RTU.)
- Entire area need not be covered, because pest goes to bait.
- Control pests that move in and out of an area.

Disadvantages:

- Can be attractive to children and pets.
- Domestic animals and nontarget wildlife may encounter and be killed by baits more readily than other formulations outdoors.
- Pest may prefer the crop or other food to the bait.
- Dead pests may cause odor problem if not disposed of properly.
- If baits are not removed when the pesticide becomes ineffective, they may serve as a food supply for the target pest or other pests.

Granules (G)

Granular formulations are similar to dust formulations except that granular particles are larger and heavier. The coarse particles are made from an absorptive material such as clay, corn cobs, or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them. The amount of active ingredient is relatively low, usually ranging from 1 to 15 percent.

Granular pesticides are most often used to apply chemicals to the soil to control weeds, nematodes and insects living in the soil. Granular formulations are sometimes, used in airplane or helicopter applications to minimize drift or to penetrate dense vegetation.

Granular formulations also are used to control larval mosquitoes and other aquatic pests. Granules are used in agricultural, structural, ornamental, turf, aquatic, right-of-way, and public health (biting insect) pest control operations.

Advantages:

- Ready to use — no mixing. (Note: if the product requires loading into application equipment, it is not an RTU, e.g., granular weed-and-feed turfgrass products.)
- Drift hazard is low, and particles settle quickly.
- Little hazard to applicator — no spray, little dust.
- Weight carries the formulation through foliage to soil or water target.
- Simple application equipment, such as seeders or fertilizer spreaders.
- May break down more slowly than WPs or ECs because of a slow-release coating.

Disadvantages:

- Do not stick to foliage or other nonlevel surfaces.
- May need to be incorporated into soil or planting medium.
- May need moisture to start pesticidal action.
- May be hazardous to nontarget species, especially waterfowl and other birds that mistakenly feed on the grain- or seedlike granules.

Wettable powders (WP or W)

Wettable powders are dry, finely ground formulations that look like dusts. Usually they must be mixed with water for application as a spray.

Wettable powders contain 5 to 95 percent active ingredient, usually 50 percent or more. Wettable powder particles do not dissolve in water — they settle out quickly unless constant agitation is used to keep them suspended.

Wettable powders are one of the most widely used pesticide formulations. They can be used for most pest problems and in most types of spray equipment where agitation is possible.

Advantages:

- Easy to store, transport, and handle.
- Less likely than ECs and other petroleum-based pesticides to cause unwanted harm to treated plants, animals, and surfaces.
- Easily measured and mixed.
- Less skin and eye absorption than ECs and other liquid formulations.

Disadvantages:

- Inhalation hazard to applicator while pouring and mixing the concentrated powder.
- Require good and constant agitation (usually mechanical) in the spray tank and quickly settle out if agitation is turned off.
- Abrasive to many pumps and nozzles, causing them to wear out quickly.
- Difficult to mix in very hard or very alkaline water.
- Often clog nozzles and screens.
- Residues may be visible.

Soluble powders (SP or WSP)

Soluble powder formulations look like wettable powders. However, when mixed with water, soluble powders dissolve readily and form a true solution. After they are mixed thoroughly, no additional agitation is necessary. The amount of active ingredient in soluble powders ranges from 15 to 95 percent; it usually is over 50 percent. Soluble powders have all the advantages of wettable powders and none of the disadvantages (except the inhalation hazard) during mixing. Few pesticides are available in this formulation because few active ingredients are soluble in water.

Water-soluble packets (WSP)

Water-soluble packets are not a specific formulation of active and inert ingredients — rather, they serve as a package for wettable powders, soluble powders, and gels. Measured amounts of pesticide formulation are packaged in bags that dissolve when they are put into water. This is becoming a popular packaging system because of reduced applicator exposure during mixing and loading and limited packaging material to dispose of.

Microencapsulated pesticides (M)

Microencapsulated formulations are particles of pesticides (liquid or dry) surrounded by a plastic coating. The formulated product is mixed with water and applied as a spray. Once applied, the capsule slowly releases the pesticide. The encapsulation process can prolong the active life of the pesticide by providing a timed release of the active ingredient.

Advantages:

- Increased safety to applicator.
- Easy to mix, handle, and apply.
- Releases pesticide over a period of time.

Disadvantages:

- Constant agitation necessary in tank.
- Some bees may pick up the capsules and carry them back to their hives where the released pesticide may poison the entire hive.

Water-dispersible granules (dry flowables) (WDG or DF)

Water-dispersible granular formulations are like wettable powder formulations except that the active ingredient is prepared as granule-sized particles. Water-dispersible granules must be mixed with water to be applied. Once in water, the granules break apart into fine powder. The formulation requires constant agitation to keep it suspended in water. Water-dispersible granules share the advantages and disadvantages of wettable powders except:

- They are more easily measured and mixed; and
- They cause less inhalation hazard to the applicator during pouring and mixing.

Impregnates

Some pesticide active ingredients are formulated into plastic, soap, wood, or other hard material. Pet collars and tags, livestock ear tags, adhesive tapes, and plastic pest strips are impregnated with pesticides. These formulations are often used as repellents and for localized control of pests.

Fumigants

Fumigants are pesticides that form poisonous gases when applied. Some active ingredients are liquids when packaged under high pressure but change to gases when they are released. Other active ingredients are volatile liquids when enclosed in an ordinary container and so are not formulated under pressure. Others are solids that release gases when applied under conditions of high humidity or in the presence of water vapor.

Fumigants are used for structural pest control, in food and grain storage facilities, and in regulatory pest control at ports of entry and at state and national borders. In agricultural pest control, fumigants are

used in soil and in greenhouses; for commodities such as Christmas trees, flower bulbs, or blueberries; and in grain bins.

Advantages:

- Toxic to a wide range of pests.
- Can penetrate cracks, crevices, wood, and tightly packed areas such as soil or grains.
- Single treatment usually will kill most pests in treated area.

Disadvantages:

- The target site must be enclosed or covered to prevent the gas from escaping.
- Highly toxic to humans and all other living organisms.
- Require the use of specialized protective equipment, including respirators.
- Require the use of specialized application equipment.
- Require special pesticide certification credentials even for private applicators.

Abbreviations for Formulations*

A	Aerosol
AF	Aqueous Flowable
AS	Aqueous Solution or Aqueous Suspension
B	Bait
C	Concentrate
CM	Concentrate Mixture
CG	Concentrate Granules
D	Dust
DF	Dry Flowables
DS	Soluble Dust
E	Emulsifiable Concentrate
EC	Emulsifiable Concentrate
F	Flowable
G	Granules
GL	Gel

*Though these suffixes represent common formulations, new formulations are constantly being developed for improved safety and ease of handling. Some manufacturers use initials on their labels that may not reflect what is listed here. Some suffixes may not describe the formulation but rather how the pesticide should be used or labeled uses in special locations; e.g., H/A = harvest aid, GS = for treatment of grass seed, SD = for uses as a side-dressing, or TVA = for use in the waterways of the Tennessee Valley Authority.

L	Liquid
LC	Liquid Concentrate or Low Concentrate
LV	Low Volatile
M	Microencapsulated
MTF	Multiple Temperature Formulation
P	Pellets
PS	Pellets
RTU	Ready to Use
S	Solution
SD	Soluble Dust
SG	Soluble Granule
SP	Soluble Powder
ULV	Ultra Low Volume
ULW	Ultra Low Weight or Ultra Low Wettable
WS	Water Soluble
WSG	Water-Soluble Granules
WSL	Water-Soluble Liquid
W	Wettable Powder
WDG	Water-Dispersible Granules
WP	Wettable Powder
WSP	Water-Soluble Powder or Water-Soluble Packet

Adjuvants

An adjuvant is any compound that facilitates the action of pesticides or modifies characteristics of pesticide formulations or spray solutions. An adjuvant is a chemical added to a pesticide formulation or tank mix that helps increase the effectiveness of the active ingredient. Most pesticide formulations contain at least a small percentage of additive. Some applicators also add adjuvants when mixing for special applications. Some of the most common adjuvants are surfactants — “surface active ingredients” — that alter the dispersing, spreading, and wetting properties of spray droplets.

There are three basic types of adjuvants used with pesticides:

- Activator adjuvants include surfactants, wetting agents, penetrants, and oils. Activator agents are the best known class of adjuvants because they are normally purchased separately by the user and added to the pesticide solution in the spray tank.
- Spray modifier agents include stickers, film formers, spreaders, spreader/stickers, deposit builders, thickening agents, and foams.

- Utility modifier agents are usually found as part of the pesticide formulation and thus are added to the pesticide product by the manufacturer.

Common Adjuvants

Wetting agents	Allow wetable powders to mix with water.
Emulsifiers	Allow petroleum-based pesticides (ECs) to mix with water.
Invert emulsifiers	Allow water-based pesticides to mix with a petroleum carrier.
Spreaders	Allow pesticides to form a uniform coating layer over the treated surface.
Stickers	Allow pesticides to stay on the treated surface.
Penetrants	Allow the pesticide to get through the outer surface to the inside of the treated area.
Foaming agents	Reduce drift or can be used for marking treated sections of the target site.
Thickeners	Reduce drift by increasing droplet size.
Safeners	Reduce the toxicity of a pesticide formulation to the pesticide handler or to the treated surface.
Compatibility agents	Aid in combining pesticides (and fertilizers) effectively.
Buffers	Allow pesticides to be mixed with dilutents or other pesticides of different acidity or alkalinity.
Anti-foaming agents	Reduce foaming of spray mixtures that require vigorous agitation.

Combining Different Formulations

Pesticide handlers often prefer to combine two or more pesticides and apply them at the same time. Such mixtures can save time, labor, and fuel. Manufacturers sometimes combine pesticides for sale as a pre-mix, but pesticide handlers also sometimes combine pesticides at the time of application. Some pesticides are registered for use in combination with a liquid fertilizer. If pesticides may be combined safely and effectively, they are called compatible. If not, they are called incompatible. Incompatibility can be physical or chemical.

Physical incompatibility

The chemicals cannot physically be mixed together. Solid materials may become deposited at the bottom of the spray tank or the ingredients may become separated into two or more layers following agitation. In some cases, separate parts may come together or foaming or curdling may occur. If chemicals are physically incompatible, the mixture may not be sprayable or the concentrations may vary.

Chemical incompatibility

Even if some chemicals can be mixed together physically, there may be other kinds of incompatibility that may reduce effectiveness or cause injury to the plant.

Under federal law, combining pesticides is legal unless the pesticide labeling of any of the pesticides involved instructs you not to combine them. However, not all pesticides work well when used together. They must be compatible — that is, mixing them together must not reduce their safety or effectiveness in any way. The more pesticides you mix together, the greater the chance of undesirable effects. Pesticide manufacturers try to anticipate combinations and provide warnings on the label for incompatible mixtures. If you cannot find information on the compatibility of the two pesticides (or the pesticide and other chemicals) that you wish to mix, test a small amount of the mixture before you mix large quantities.

Comparison of Some Pesticide Formulations						
Formulation	Mixing/loading hazards	Phyto-toxicity	Effect on application equipment	Agitation required	Visible residue	Compatible with other formulations
Wettable powders	Dust inhalation	No	Abrasive	Yes	Yes	Highly
Dry flowables/water dispersable granules	Minimal	No	Abrasive	Yes	Yes	Good
Soluble powders	Dust inhalation	Not likely	Nonabrasive	No	Some	Fair
Emulsifiable concentrates	Spills & splashes	Maybe	May affect rubber pump parts	Yes	No	Fair
Flowables	Spills & splashes	Maybe	May affect rubber pump parts; abrasive	Yes	Yes	Fair
Solutions	Spills & splashes	No	Nonabrasive	No	No	Fair
Dusts	Severe inhalation hazards	No	-	Yes	Yes	-
Granules and pellets	Minimal	No	-	No	No	-
Microencapsulated formulations	Spills & splashes	No	-	Yes	-	Fair

Summary

This chapter covered the four major classification methods of pesticides according to:

- The types of pests they control;
- Their chemical make-up;
- Their modes of action;
- Their pesticide formulation.

Understanding each of these classification methods provides you with important information about pesticide usage. These classification methods will help you make knowledgeable choices about pest management.

Understanding some basic concepts about pest types, pesticide chemistry, pesticide modes of action, and pesticide functions will help you make more informed choices about which pesticides to use under particular conditions. For more effective pest management, it is essential for pesticide handlers to understand that repeated use of pesticides with similar modes of action may result in eventual pesticide resistance. Pesticide groups with similar chemical structures tend to be similar in their modes of action, fate in the environment, and pest control properties — but not necessarily in their levels of toxicity. It is important to know which type of formulation is the safest and most effective for the crop and pest you wish to treat.

Do not combine pesticides that are physically or chemically incompatible. Pesticides come in various formulations. Some are easier to use than others. Some are more effective than others in certain situations. The most commonly used formulations are emulsifiable concentrates and wettable powders, but there are many other types available.

Review Questions for Pesticides and Pesticide Formulations

1. What type of pesticide is designed to control weeds?
 - A. Insecticide
 - B. Herbicide
 - C. Fungicide
 2. List several classification methods of pesticides and give an example of each.
 - 1.
 - 2.
 - 3.
 - 4.
 3. What is the main difference between organic and inorganic pesticides?
 4. Inorganic pesticides are always synthetic. (true/false)
-

-
5. A pesticide that controls more than one pest is called
A. Systemic
B. Broad-spectrum
C. Multipurpose
D. A and C
E. B and C
-
6. Microbial pesticides:
A. Kill microorganisms
B. Are derived from plants
C. May be fungi, bacteria or viruses
D. Are broad-spectrum
-
7. When attempting to control pest resistance, why is it best to choose chemicals with the lowest effective rates?
-
8. Which of the following factors affects how a pest reacts to a pesticide?
A. The life stage of a target organism
B. The method and route a pesticide uses to pass through the system of a target organism.
C. The pesticide's mode of action
D. All of the above
-
9. What factors should you consider when you have a choice of formulations for a pest management task?
-
10. An emulsifiable concentrate (EC) is a _____ formulation of a pesticide that can be mixed with another _____ to form an emulsion.
A. Dry, dry formulation
B. Liquid, dry formulation
C. Liquid, liquid
D. Dry, liquid
-
11. What is a "flowable" formulation?
-
12. Why are adjuvants sometimes added to pesticide formulations?
-
13. Which of the following are examples of pesticide incompatibility?
A. Solid materials may become deposited at the bottom of the spray tank.
B. Chemicals behave as inert ingredients.
C. Ingredients may become separated into two or more layers.
D. A and B
E. A and C
-

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Pesticide Laws and Regulations

What's in this Chapter:

Federal Laws and Regulations

FIFRA

Worker Protection Standard

OSHA Requirements

Federal Recordkeeping Requirements

Shipment of Pesticides

Aerial Application of Pesticides

Pesticide Residues in Agricultural Products

Emergency Planning and Community Right-to-Know*

State Laws and Regulations

Pesticide Applicator Training

Reporting Pesticide Spills

State Recordkeeping Requirements

Posting Pesticide-treated Sites and Fields

Chemigation

Waste Pesticides and Container Disposal

Pesticides in Aquatic Environments

Learning Objectives

After completing this chapter, students will be able to:

- Understand the laws and regulations that affect pesticide applicators;
- Identify which agencies administer and enforce the laws and regulations that affect pesticide applicators;
- Explain changes to pesticide laws and/or regulations;
- Identify who needs to be certified as a pesticide applicator;
- Understand the process required to become a certified applicator;
- Identify categories of licensed pesticide applicators;
- Follow the recommended procedure for reporting pesticide spills;
- Understand the procedure to follow when posting signs near pesticide-treated fields;
- Report and keep accurate records of pesticide treatments.

Terms to Know

MDA. Minnesota Department of Agriculture.

Private applicators. Persons, usually farmers, who apply pesticides on land or sites, or in buildings, that they own, lease, or rent for production of agricultural commodities

Commercial applicators. Persons who apply pesticides as a for-hire service.

Noncommercial applicators. Persons who, during the course of their employment by a company, institution, or unit of government, apply pesticides on land, sites, or buildings owned, rented, or leased by their employer.

Chemigation. Applying pesticides through irrigation systems.

EPA. US Environmental Protection Agency.

FIFRA. Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

OSHA. Occupational Safety and Health Administration.

USDA. US Department of Agriculture.

WPS. Worker Protection Standard.

General Use Pesticide. Pesticides offered for use to uncertified applicators.

Restricted Use Pesticide. Pesticides for use only by certified applicators.

Posting. Placing information signs on pesticide-treated sites or fields.

Introduction

This chapter describes some of the laws and regulations that may affect pesticide applicators. Many federal and state laws and regulations have been adopted to help protect pesticide handlers, workers, the public, and the environment from possible adverse effects caused by pesticide use. Be sure to keep informed and up-to-date on legal requirements at all governmental levels—regulations are constantly evolving as pesticide application becomes more complex and as more is learned about potential hazards.

The two main sections of this chapter include "Federal Laws and Regulations" and "State Laws and Regulations." While most pesticide laws are implemented and enforced at the national level by the US Environmental Protection Agency (EPA), almost all state pesticide law and pesticide regulations are implemented and enforced by the Minnesota Department of Agriculture (MDA). The state law, in some cases, may be more restrictive than the federal laws. Under an agreement with the EPA, the MDA enforces federal pesticide law in Minnesota. Consequently, some legal requirements, such as recordkeeping and certification of pesticide applicators, are covered in both sections of this chapter.

Remember, it is illegal to use, store, handle, distribute or dispose of pesticides in a manner prohibited by law. Also remember that the pesticide label is a legal document. All label directions must be followed or the pesticide application will be illegal. Penalties may include fines or, in the worst cases, criminal penalties.

Federal Laws and Regulations

Federal laws apply to all states. The EPA is the federal agency charged with the regulation of pesticides, pesticide registration and classification, pesticide use, and pesticide distribution in the United States.

FIFRA

The most important law for pesticide applicators is the federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). It was passed by Congress in 1947 and substantially amended in 1972, 1975, 1978, and 1988. Under FIFRA, all pesticides must be registered with the EPA. FIFRA authorizes EPA to regulate the registration, manufacture, sale, transportation, and use of pesticides. It also requires that some pesticide applicators be certified.

Major provisions of FIFRA

FIFRA affects pesticide applicators in many ways. Listed below are the main provisions of FIFRA:

- All pesticides for sale in the US must be registered by the EPA;
- Pesticides will be labeled with appropriate instructions, precautions, and warnings;
- Requires the EPA to classify pesticides meeting certain criteria as "restricted use." Unclassified pesticides are termed "general use" (see "Classification of Pesticide Uses Under FIFRA" for definitions);
- The distribution, purchase, and use of restricted use pesticides must be regulated through pesticide training and certification programs;



- Persons who use pesticides in a way that is "inconsistent with the pesticide labeling" will be penalized;
- States may impose more restrictive standards governing pesticide use in that state.

Penalties under FIFRA

If FIFRA regulations are violated, responsible parties are subject to civil and possibly criminal penalties. Civil penalties may be as much as \$5,000 for each offense. However, before a fine is imposed by the EPA or the state, the accused individual has the right to ask for a hearing in his or her own city or county. Criminal penalties may include fines as high as \$25,000 or one year in prison, or both. States may establish higher penalties.

Classification of pesticide uses under FIFRA

The EPA may classify some pesticides as "restricted use." Unclassified pesticides are known as "general use."

General Use Pesticides present little potential danger to humans or the environment when applied according to label directions.

Restricted Use Pesticides (RUPs) cause harm to humans (pesticide handlers or other persons) or to the environment even when used as directed on the label.

Pesticides may be classified by the EPA as RUP for several reasons, including: acute toxicity to humans; adverse affect on nontarget organisms; likelihood of contamination of groundwater; cancer risk from exposure; and reproductive problems and other health concerns for humans. The term "use" in "restricted use pesticide" refers to such activities as mixing and loading, applying, transporting, storing, or handling pesticides after the manufacturer's seal is broken; maintaining application and handling equipment; and disposing of pesticides and their containers.

Under FIFRA in Minnesota, an applicator must be "certified" and licensed to use or apply RUPs. Pesticide applicators can easily identify RUPs by looking at the pesticide label. An RUP statement is clearly displayed on all labels of pesticides classified as restricted use (see Appendix B for a listing of RUPs).

Some pesticides may be classified as "general use" for certain formulations and "restricted use" for others. For example, lindane is an RUP for some commercial uses, but not for homeowner use. In these cases, entirely different packaging and labeling is necessary.

Certification of pesticide applicators

The EPA sets national certification standards. These standards have different requirements for each category of pesticide applicators (private, noncommercial, and commercial). Certification requirements may also differ between states according to individual state laws. The Minnesota Department of Agriculture (MDA), the certification state lead agency, administers Minnesota's pesticide applicator certification program. The Minnesota Extension Service at the University of Minnesota partners with the MDA to provide leadership for education, training, and outreach support for the pesticide applicator training (PAT) program (see "State Laws" in this chapter for Minnesota's pesticide applicator certification program).

Worker Protection Standard

The Worker Protection Standard (WPS) is a federal rule under FIFRA. This rule authorizes the US EPA to take steps to reduce illness in and injury to agricultural employees due to pesticide exposure. The WPS applies to businesses, farms, greenhouses, nurseries, forests, and other commercial producers of plants as well as institutions engaged in the research of these plants. Under the WPS employers are required to provide employees (and, in some cases themselves and their family members) with: information about, protection against, and mitigation of pesticide exposure.

This section will help you decide if you or persons you work with are covered by the WPS.

Pesticide Uses Covered by the WPS

Most pesticides used in the production of agricultural plants on farms, nurseries, greenhouses, and forests are covered by the WPS. This includes both General Use and Restricted Use pesticides used: on plants; in the soil; or in the planting medium the plants are (or will be) grown in.

To tell if a pesticide is covered by the WPS look on the pesticide labeling (under the Direction for Use area) for the box titled Agricultural Use Requirements. There you will find information about the WPS and WPS product-specific requirements. Some pesticides may have labels that include uses of the product that are covered by WPS and other uses that are not. It is up to you to be sure to follow WPS requirements for all WPS covered uses of a pesticide.

Employees covered by the WPS

Employees covered by the WPS are considered either handlers or workers. WPS handlers include anyone employed (including self-

Worker Protection Standard



The WPS does NOT cover pesticides used for : post-harvest applications, production of livestock and other animals, pastures, rangelands, control of vertebrate pests, maintenance of turf, landscapes or ornamentals, home fruit and vegetable gardens, rights-of-way, attractants or repellents in traps, mosquito abatement or other similar government-sponsored wide-area public pest control programs, education or demonstration purposes, research uses of unregistered pesticides, and structural pest control.

employed such as family-owned farms, greenhouses, and nurseries) by an establishment to:

- Mix, load, transfer, or apply pesticides;
- Handle open containers of pesticides;
- Act as a flagger for pesticide application;
- Clean, handle, adjust, or repair the parts of mixing, loading, or application equipment that may contain pesticide residues;
- Assist with the application of pesticides, including incorporating the pesticide into the soil after the application has occurred;
- Enter a greenhouse or other enclosed area after application and before the inhalation exposure level listed on the product labeling has been reached or one of the WPS ventilation criteria has been met;
- Enter a treated area outdoors after application of any soil fumigant to adjust or remove soil coverings, such as tarpaulins;
- Perform tasks as a crop advisor during application, the Restricted-Entry Interval, or before any inhalation exposure level or ventilation criteria listed on the labeling has been reached or one of the WPS ventilation criteria has been met; and/or
- Dispose of pesticides and pesticide containers covered by WPS.

NOTE: A person is NOT a handler if she or he ONLY handles unopened pesticide containers or pesticide containers that have been either triple- or pressured-rinsed or cleaned according to instructions on the pesticide labeling.

WPS-covered workers include anyone who is:

- Employed (including self-employed) for any type of compensation; and
- Doing tasks such as harvesting, weeding, or watering relating to the production of agricultural plants on farms, forests, nurseries, or greenhouses.

An employee may be considered a handler on one occasion and a worker on another depending upon the tasks the employee is performing at the time. Commercial and noncommercial pesticide applicators in the following categories may be covered by the WPS:

C: Agricultural Herbicide

D: Agricultural Fungicide-Insecticide

E: Turf and Ornamental

G: Forest Spraying

H: Seed Treatment

NOTE: Not all commercial and noncommercial applicators in these categories are covered by the WPS. For example, applicators in

Owners of agricultural establishments (farming, greenhouses, nurseries, and forestry) and members of their immediate family who are handlers or workers are exempt from some — but not all — WPS requirements. See the Worker Protection Standard How-to-Comply manual for more information.

category E (Turf and Ornamental) are not covered by the WPS when they are applying pesticides on golf courses, cemeteries, parks, building grounds, or other landscapes.

Many private applicators may also be covered by the WPS. Production and crop advisors, consultants, and their scouts are considered handlers under the WPS.

Employers covered by the WPS

Employers of handlers and workers are required under the WPS to perform certain duties for their handler and worker employees. WPS duties for employers differ somewhat for worker and handler employees. Some of WPS requirements are straightforward, others are more complex. See the WPS How-to-Comply manual for more detailed information about WPS requirements. To get the most current information regarding WPS requirements contact the Minnesota Department of Agriculture or the Minnesota Extension Service.

Duties for All Employers:

- Provide information about pesticide applications and safety at a central location on the agricultural establishment;
- Provide pesticide safety training for workers and handlers;
- Provide employee decontamination sites;
- Facilitate information exchange between employers of commercial applicators (owners of the for-hire services) and operators of agricultural establishments contracting for pesticide application services
- Provide emergency assistance in the event of pesticide exposure.

Additional Duties for Employers of Handlers:

- Provide application restrictions and applicator monitoring;
- Provide specific instructions for handlers (product specific safety information, PPE, and so on);
- Teach equipment safety;
- Provide personal protective equipment (PPE) and provide for use, care, cleaning, and disposal of same.

Additional Duties for Employers of Workers:

- Explain restrictions required during application;
- Explain and enforce worker Restricted-Entry Intervals (REIs);
- Provide notice of applications (posting and oral notification);
- Provide early-entry workers with product-specific WPS information such as the REI and PPE requirements found on pesticide labeling of WPS-covered products (general WPS requirements that apply to all pesticide uses covered by the WPS are not listed on the label).

NOTE: Pesticide applicators who are currently certified and licensed through the Pesticide Applicator Training program are exempt from the WPS pesticide safety training requirement.

Information about WPS and WPS requirements can be found in the manual: *Worker Protection Standards for Agricultural Pesticides-How to Comply: What Employers Need to Know*

For information regarding WPS requirements, any recent changes to WPS requirements, obtaining the How-to-Comply Manual, WPS training items, and other WPS support materials contact:

Steve Poncin
Agronomy Services Division
Minnesota Department of Agriculture
90 West Plato Blvd.
St. Paul, MN 55107

(612) 296-6121

Dean Herzfeld
Minnesota Extension Service
Department of Plant Pathology
495 Borlaug Hall
1991 Upper Buford Circle
St. Paul, MN 55108

(612) 624-3477

or contact your local county extension office or Minnesota Department of Agriculture field staff person.

OSHA Requirements

An employer with 11 or more employees is required to keep records and make reports to the Occupational Safety and Health Administration (OSHA) in the federal Department of Labor. The records must include all work-related deaths, injuries, and illnesses. The employer does not have to record minor injuries, those needing only first aid treatment. However, a record must be made if the injury involves any of the following: medical treatment; loss of consciousness; restriction of work or motion; and/or transfer to another job.

Federal OSHA requirements are designed to protect employees from the hazards of most chemicals found in the workplace, including pesticides. OSHA also requires employee Right-to-Know training for some employees in some businesses.

Federal Recordkeeping Requirements

Commercial and noncommercial applicators must meet the pesticide recordkeeping requirements defined by FIFRA. The State of Minnesota has specific requirements for commercial and noncommercial applicators that meet FIFRA recordkeeping requirements (see "State Recordkeeping Requirements," under "State Laws and Regulations," for more information). Commercial applicators may also be affected by the recordkeeping requirements for private applicators (see the next section for more information).

Pesticide recordkeeping requirements for private applicators

The United States Department of Agriculture (USDA) RUP record-keeping rule requires certified private applicators to keep a record of each RUP application on their farm. This includes private applicators

who are crop farmers, producers of fruits and vegetables, livestock growers, greenhouse and nursery growers, sod growers, and others. Under this rule, applicators are responsible for making and keeping their own RUP application records.

NOTE: The information that must be recorded under the rule is also recommended for good farm recordkeeping, as part of an integrated pest management or farm financial management program.

When private applicators hire commercial applicators

Commercial applicators may also be affected by the USDA rule if, for example, the commercial applicator was hired to apply RUPs to a farmer's field. Commercial applicators who apply RUPs for private applicators must give a copy of the RUP application record to their customers within 14 days of the application. If the customer signs a statement agreeing to the arrangement, commercial applicators may retain the records of RUP applications for their customers. Commercial applicators must make these records available to their customers upon request in a timely manner. They must maintain separate records for each client.

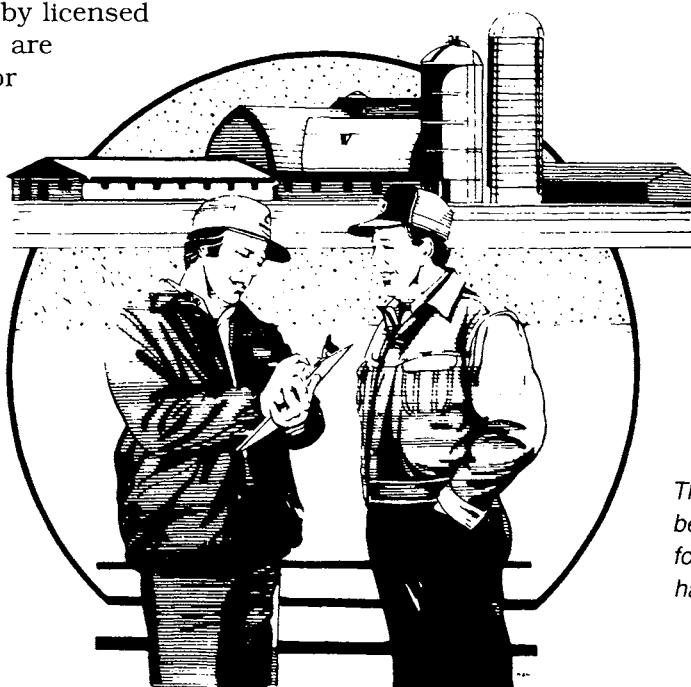
Recordkeeping forms

Private applicators are required to keep the original records and to allow government regulators access to the records when requested to do so. The information may be recorded in any form, including handwritten notes, a computer, or other farm recordkeeping system. While there is no official required form for keeping RUP records, the Minnesota Extension Service does offer a fact sheet about this rule that includes a suggested RUP recordkeeping form (AG-FS-0915 Pesticide Application Record).

Access to pesticide records

Private applicators must provide access to their RUP records when access is requested by personnel from USDA, MDA, and/or health care providers. The USDA and MDA may inspect a private applicator's RUP records for compliance. The rule also allows prompt access to the records by licensed health care professionals who are providing medical treatment or first aid to someone who may have been exposed to the RUP for which the records are maintained. If a licensed health care professional determines the situation to be a medical emergency, access to the records of the RUP relating to the medical emergency must be provided immediately.

NOTE: Under this rule, anyone who has access to these records must keep all information strictly confidential at all times.



The information may be recorded in any form, including handwritten notes.

The following information is required to be recorded for all applications of RUPs by private applicators and commercial applicators who apply RUPs to private applicator fields:

- Brand or product name of RUP applied;
- EPA registration number of RUP applied (from the label);
- Total amount of RUP applied (of the product, not the active ingredient);
- Location of the application, according to one of four options: 1) county, range, township, and section number system; 2) personal identification system using maps and/or written description that accurately and clearly identifies the location of the RUP application; 3) an identification system used by a USDA agency, such as map systems used by ASCS or SCS; 4) legal property description.
- Size of the area treated;
- Crop, commodity, stored product, or site to which the RUP was applied;
- Month, day, and year the RUP was applied;
- Name and certification number of the applicator who applied the RUP;

NOTE: Spot treatments have fewer information requirements.

Shipment of Pesticides

Rules for shipping pesticides and other dangerous substances across state lines are issued by the US Department of Transportation (DOT). These rules explain which pesticides are dangerous to humans and could create a health hazard during transportation. Applicators who transport pesticides between states need to know these rules.

- Pesticides must be in their original package. Each package must meet DOT standards.
- The vehicle must have correct warning signs. Manufacturers must put correct warning signs on each package.
- Pesticides may not be transported in the same vehicle at the same time with food products.

Minnesota law requires persons to immediately notify the Minnesota Department of Transportation (MNDOT) if:

- Someone is killed or injured badly enough to go to a hospital;
- The damage is more than \$50,000; or
- A spill occurs during shipment.

To report any of these occurrences:

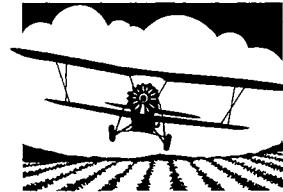
- 1) Contact the Division of Emergency Management (DEM) of the Minnesota Department of Public Safety. The DEM duty officer can be

reached 24 hours a day. In the Twin Cities call (612) 649-5451. In Greater Minnesota 1-800-422-0798.

- 2) Ask the DEM duty officer to contact MNDOT and any other appropriate state agencies.

Aerial Application of Pesticides

The application of pesticides from planes is regulated by the Federal Aviation Administration (FAA) and by the state. FAA rules state that an aerial applicator may only apply pesticides according to label directions, and in a manner that does not put citizens at undue risk. In Minnesota all commercial and noncommercial aerial applicators who use RUPs must be certified to apply pesticides in Category B: Aerial. Contact the Minnesota Department of Agriculture for more information.



Pesticide Residues in Agricultural Products

Any pesticide that stays in or on raw farm products or processed food is called a residue. The amount of residue allowed on raw farm products or processed food is determined by the EPA under regulations authorized by the Federal Food, Drug, and Cosmetic Act.

The EPA sets what are called "residue tolerances." A tolerance is the concentration of a pesticide that is judged safe for normal human consumption. Tolerances are expressed in parts per million (ppm) or parts per billion (ppb). One ppm equals one part (by weight) of pesticide for each million parts of farm or food products. For example, using pounds as a measure, 50 ppm would be 50 pounds of pesticide in a million pounds of the product. Plants differ in the amount of pesticides they absorb and retain, so a pesticide may have different residue tolerances on different foods. For example, the residue tolerance for one pesticide might be 50 ppm on grapes and 25 ppm on apples.

If too much residue is found on a farm or food product, the product may be seized or condemned. To make sure you are not breaking the law, follow label directions exactly. The pesticide label will indicate the number of days before harvest a pesticide cannot be applied to a crop so that illegal pesticide residues are avoided.

Emergency Planning and Community Right-to-Know*

The Emergency Planning and Community Right-to-Know Act of 1986 requires some persons who use and store certain hazardous materials to notify their state Emergency Response Commission. This notification helps state and local emergency response personnel to plan and respond to fires, spills, and other incidents that may involve hazardous materials. Two purposes of this law are to:

- 1) Identify facilities to be considered in emergency plans; and,
- 2) Involve facility managers in emergency plan development.

*Source materials for this section came from the Minnesota Emergency Response Commission, Paul Aasen, Executive Director.

Some pesticides are included in the EPA's list of 360 "Extremely Hazardous Materials." Use or storage of these listed pesticides may require you to notify the Minnesota State Emergency Response Commission. For more information about these requirements contact:

Minnesota State Emergency Response Commission
B-5
State Capitol
75 Constitution Avenue
St. Paul, MN 55155-1612
(612) 297-7372

State Laws and Regulations

In Minnesota, pesticides are regulated under the Minnesota Pesticide Control Law as enacted and amended by the state legislature. The Minnesota Department of Agriculture (MDA) is the designated state lead agency for administration and enforcement of this law. This law is found in Chapter 18 of the Minnesota State Statutes. The Minnesota law addresses: pesticide use; protection of the environment; pesticide sales, storage, and facilities; applicator training and licensing; and much more. A table listing provisions of this law is included in the summary of this chapter.

Pesticide Applicator Training

The Pesticide Applicator Training (PAT) program has four broad goals:

- 1) To protect the applicator and the applicator's family;
- 2) To protect the public;
- 3) To protect the environment; and
- 4) To inform pesticide applicators of the legal requirements of pesticide use.

The PAT program also has two broad purposes:

- 1) To assure the general public that pesticide applicators meet minimum standards, and
- 2) To train and educate pesticide applicators.

Persons who use general-use pesticides for applications in their own home, lawn, and garden or general-use pesticides as a private applicator are not required to be certified or licensed.

Under federal and state law, the PAT program is required to cover a wide range of pesticide related topics. To ensure that pesticide applicators also receive the specific training they need, however, PAT topics are tailored to meet the needs of specific categories of applicators.

Types of pesticide applicators

There are five types of pesticide applicators in Minnesota, each with different certification and licensing requirements:

1. *Private applicators* are persons, usually farmers, who apply pesticides on land or sites, or in buildings, that they own, lease, or rent for production of agricultural commodities. In Minnesota, only certified

private applicators may apply RUPs. Proof of pesticide applicator license is required to purchase RUPs.

NOTE: Unlike some states, Minnesota does not allow uncertified private or noncommercial applicators to apply RUPs — even when they are supervised by a certified applicator.

II. Noncommercial applicators are persons who during the course of their employment by a company, institution, or unit of government apply pesticides on land, sites, or buildings owned, rented, or leased by their employer. Only certified and licensed noncommercial applicators may apply RUPs. Proof of applicator license is required to purchase RUPs.

NOTE: Employees who apply pesticides for a pesticide application service company, such as a lawn spraying, farm custom application, or other for-hire service, must be certified and licensed as commercial applicators.

III. Commercial applicators are persons who apply pesticides as a for-hire service. Commercial applicators must be certified and licensed to apply all pesticides, not just RUPs. To become a certified and licensed commercial applicators must demonstrate both technical competence and "financial responsibility" (through proof of net assets equal to or greater than \$50,000 or through a performance bond or insurance).

IV. Aquatic pest control applicators (APCAs) are "for-hire" aquatic applicators. Under Minnesota state law, APCAs have specific certification and licensing requirements. For more information, contact the MDA.

V. Structural pest control applicators are "for hire" structural and building applicators. Under Minnesota state law, SPCAs have specific certification and licensing requirements. For more information, contact the MDA.

PAT programs for certification and licensing

The MDA administers the pesticide applicator certification program so that it meets federal standards. The Minnesota Extension Service provides the pesticide applicator training (PAT) program in cooperation with the Minnesota Department of Agriculture (and under agreements with EPA, MDA, and the University of Minnesota). Minnesota PAT is divided into two separate programs:

- 1) private PAT*, and
- 2) commercial/noncommercial PAT*.

New and renewal commercial and noncommercial pesticide applicators must complete the training requirements for certification before applying to the MDA for a pesticide

Pesticide Applicator Training Topics:

- Water quality; ;
- Endangered species;
- General environmental protection;
- Pesticide container and waste management;
- Laws and regulations;
- Applicator safety;
- Personal protective equipment;
- Pesticide label;
- Short and long term pesticide health concerns;
- Routes of pesticide exposure;
- Food safety;
- Integrated pest management;
- First aid and pesticide emergency response;
- Application equipment, formulations, and types of pesticides.

*This manual is intended for commercial and noncommercial applicators for general ground application (category A). Other manuals and training materials are available for private pesticide applicators and commercial and noncommercial pesticide applicators seeking certification in other categories

applicator license. All commercial and noncommercial pesticide applicators must be certified and licensed in either Category A, General Ground, or Category B, General Aerial, or both. Each applicator must also be certified for each category of pesticide application they intend to perform (see the following table).

Commercial and Noncommercial Categories

Category	For Application of:
A: General Ground	pesticides using hand or ground equipment
B: General Aerial	pesticides with an aircraft
C: Agricultural Herbicide	herbicides to agricultural lands and crops
D: Agricultural Fungicide-Insecticide	fungicides and insecticides to agricultural lands and crops
E: Turf and Ornamental	pesticides for propagation of ornamental plants or for landscape maintenance (lawns, parks, athletic fields, golf courses, nurseries, greenhouses)
F: Aquatic <i>Noncommercial only</i>	pesticides to water for control of pest plants, animals and other pests. A permit may be required from the Minnesota Department of Natural Resources.
G: Forest Spraying	pesticides in forest management
H: Seed Treatment	insecticides and fungicides to seeds
I: Shade Tree	pesticides to shade trees
J: Rights-of-Way	pesticides to roadside, utility, and other rights-of-way
K: Agricultural Pest Control <i>Animal</i>	pesticides to farm buildings, sites, and animals to control pests of animals
L: Mosquito Control	insecticides for mosquito and black fly control
M: Food Processing Pest Control <i>Noncommercial only</i>	restricted use pesticides in food-processing facilities
N: Fumigation <i>Noncommercial only</i>	fumigants and other pesticides to stored grain and stored grain facilities
O: Fumigation - Stored Grain <i>Commercial only</i>	fumigants and other pesticides to stored grain and stored grain facilities
P: Pocket Gopher	restricted use pesticides for pocket gopher control
Q: Wood Preservatives	chemical wood preservatives to lumber (utility poles, fence posts, structural lumber, railroad ties)
T: Tributyltin	antifouling boat paint
APCA: Aquatic Pest Control Applicator	pesticides to water for control of pest plants, animals, and other pests. A permit may be required from the Minnesota Department of Natural Resources.
SPCA: Structural Pest Control Applicator	pesticides with and around structures (homes and buildings)

Initial certification

Minnesota commercial and noncommercial pesticide applicators are initially certified by passing a closed-book, monitored exam for each category in which they are seeking to be licensed. This initial exam is administered by the MDA. Passing the initial exam satisfies the certification requirement (necessary for applying for license) for the rest of the calendar year in which the exam was taken and for license renewal for the following year. Study materials for the initial exams are available from the Minnesota Extension Service's PAT program at the University of Minnesota. For current information regarding initial certification, testing, fees, and procedures contact the Minnesota Department of Agriculture.

Recertification for license renewal

Commercial and noncommercial pesticide applicators are required to renew their licenses annually through the MDA. To apply for annual license renewal applicators must annually complete an approved PAT recertification training option for each category in which they seek license renewal*. Also, the recertification training option must be completed in the calendar year preceding license renewal. For example, the recertification training option must be completed in 1996 when seeking license renewal for 1997. Applicators in most PAT categories have the recertification option of either attending a PAT recertification workshop or completing a correspondence course. A few categories require attendance at a workshop. Other categories only offer the correspondence course.

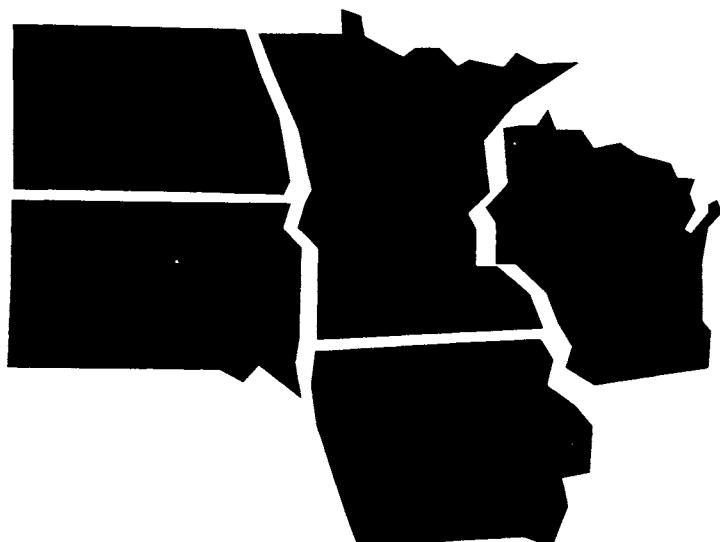
PAT programs for recertification

PAT recertification workshops are sponsored by the Minnesota Extension Service, industry associations, and other groups and organizations. Each workshop has an official planning committee that includes a representative from both the Minnesota Department of Agriculture and the Minnesota Extension Service. The PAT recertification correspondence courses are provided by the Minnesota Extension Service.

Reciprocity with adjacent states

An applicator who is currently licensed in Wisconsin, Iowa, North Dakota, or South Dakota seeking to be a Minnesota commercial or noncommercial applicator may be exempt from the Minnesota certification requirements but not licensing and fees. To be eligible for reciprocity, the applicator must complete a Minnesota application form and return it to the MDA together with the following:

1. A complete copy of his or her pesticide license from the adjacent state;



*For all categories except C-Agricultural Herbicides and D-Agricultural Fungicides-Insecticides. Recertification for these two categories may be met by attendance at an approved PAT recertification workshop once every three years or by completing the correspondence courses every year.

2. Workers' compensation information; and
3. Financial responsibility documents (commercial applicators only).

Contact the MDA for current information regarding Minnesota reciprocity requirements.

Also, currently certified and licensed Minnesota commercial and noncommercial applicators may be exempt from the certification requirements of adjacent states. For more information contact the state's PAT lead agency:

Iowa:

Pesticide Division
Iowa Department of Agriculture and Land Stewardship
First Floor Wallace State Office Building
900 East Grand Ave.
Des Moines, IA 50319
tel: (515) 281-8591

North Dakota:

North Dakota State University
North Dakota State University Pesticide Programs
PO Box 5051
Fargo, ND 58105
tel: (701) 231-7180

South Dakota:

Division of Agricultural Services
South Dakota Department of Agriculture
523 East Capitol
Foss Building
Pierre, SD 57501
tel: (605) 773-4432

Wisconsin:

Division of Agricultural Resource Management
Wisconsin Department of Agriculture, Trade, and Consumer Protection
PO Box 8911
Madison, WI 53708-8911
tel: (608) 224-4500

PAT program contacts

For general information or questions about any aspect of the PAT program contact the PAT Program Coordinator:

Dean Herzfeld, Minnesota Extension Service
Department of Plant Pathology
495 Borlaug Hall
1991 Upper Buford Circle
St. Paul, MN 55108
tel: (612) 624-3477 fax: (612) 625-9728

For information about requirements for certification, licensing, recertification, and license renewal contact:

Wayne Dally
Minnesota Department of Agriculture
90 West Plato Boulevard
St. Paul, Minnesota 55107-2094
tel: (612) 297-2746 fax: (612) 297-2271

For information about initial testing and recertification workshop schedules contact:

Sue Conrin
Minnesota Department of Agriculture
90 West Plato Boulevard
St. Paul, Minnesota 55107-2094
tel: (612) 296-5137 fax: (612) 297-2271

For information on obtaining PAT commercial/noncommercial manuals and study materials contact:

Extension Special Programs, Minnesota Extension Service
405 Coffey Hall
1420 Eckles Avenue
St. Paul, MN 55164-0780
tel: (612) 625-8215 or 1-800-367-5363 fax: (612) 625-2207

For information about PAT recertification correspondence courses and private pesticide applicator training program contact:

Pat DeSteno, Minnesota Extension Service
405 Coffey Hall
1420 Eckles Avenue
St. Paul, MN 55164-0780
tel: (612) 625-5267 or 1-800-367-5363 fax: (612) 625-2207

Reporting Pesticide Spills

Under Minnesota law most incidents (releases, spills, etc.) involving agricultural chemicals must be immediately reported, by the responsible party or property owner, to the Minnesota Department of Agriculture Incident Response Program. Examples of an "incident" include flood, fire, tornado, motor vehicle accident, spills, or leaking containers.

NOTE: An agricultural chemical incident must be reported to be eligible for reimbursement of cleanup costs from the Agricultural Chemical Response and Reimbursement Account (ACRRA).

The only exceptions to the reporting requirement are incidents that meet ALL of the following conditions:

- 1) The responsible party or property owner is a licensed commercial or certified private applicator, AND
- 2) The total amount of pesticide involved in the incident at the site during the year is less than can be legally applied to one acre of cropland; AND
- 3) The incident was not into or near public water or groundwater.

To report spills or releases of agricultural chemicals (pesticides or fertilizers):

- 1) Contact the Division of Emergency Management (DEM) of the Minnesota Department of Public Safety. The DEM duty officer can be reached 24 hours a day:

In the Twin Cities call (612) 649-5451

In Greater Minnesota 1-800-422-0798

- 2) Ask the DEM duty officer employee to contact the Minnesota Department of Agriculture and any other appropriate state agencies.

See Chapter 6 (Safe Handling of Pesticides) for more information on pesticide spills and reporting of pesticide incidences.

State Recordkeeping Requirements

The following excerpt from the Minnesota Pesticide Control Law explains the state recordkeeping requirement for Minnesota commercial and noncommercial licensed pesticide applicators. Sample recordkeeping forms are available from the Commissioner of Agriculture.

A commercial or noncommercial applicator, or the applicator's authorized agent, must maintain a record of pesticides used on each site. Noncommercial applicators must keep records of restricted use pesticides. Noncommercial applicators do not need to keep records of general use pesticides.

The record must include the:

- (1) date of the pesticide use;
- (2) time the pesticide application was completed;
- (3) brand name of the pesticide, the United States Environmental Protection Agency registration number, and dosage used;
- (4) number of units treated;
- (5) temperature, wind speed, and wind direction;
- (6) location of the site where the pesticide was applied;
- (7) name and address of the customer;
- (8) name and signature of applicator, name of company, license number of applicator, and address of applicator company; and,
- (9) any other information required by the commissioner

All information for this record requirement must be contained in a single page document for each pesticide application, except a map may be attached to identify treated areas. For the rights-of-way and wood preservative categories, the required record may not exceed five pages. An invoice containing the required information may constitute the required record. The commissioner shall make sample forms available to meet the requirements of this paragraph.

A commercial applicator must give a copy of the record to the customer.

Subd. 3. Structural pest control applicators.

(a) A structural pest control applicator must maintain a record of each structural pest control application conducted by that person or by the person's employees. The record must include the:

- (1) date of structural pest control application;
- (2) target pest;
- (3) brand name of the pesticide, United States Environmental Protection Agency registration number, and amount used;
- (4) for fumigation, the temperature and exposure time;
- (5) time the pesticide application was completed;
- (6) name and address of the customer
- (7) name and signature of structural pest control applicator; name of company and address of applicator or company, applicator's signature, and license number of applicator; and

- (8) any other information required by the commissioner.
- (b) All information for this record requirement must be contained in a single-page document for each pesticide application. An invoice containing the required information may constitute the record.
- (c) Records must be retained for five years after the date of treatment.
- (d) A copy of the record must be given to a person who ordered the application that is present at the site where the structural pest control application is conducted immediately after the application of the pesticides, or delivered to the person who ordered an application or the owner of the site. The commissioner must make sample forms available that meet the requirements of this subdivision.

Posting Pesticide-treated Sites and Fields

When you apply pesticides you sometimes may be required to warn others in the vicinity that pesticides are being used near them. This warning, when written, is called "posting." There are four cases that may require posting a pesticide-treated field or site in Minnesota:

- 1) Posting to comply with Worker Protection Standard requirements;
- 2) Posting when pesticides are applied through irrigation systems (chemigation);
- 3) Posting required by the pesticide label; and
- 4) Posting to comply with pesticide application in cities.

Case 1: Worker Protection Standard (WPS) requirements

Some commercial and noncommercial applicators may be covered by the WPS. The WPS requires agricultural employers (in farms, greenhouses, nurseries, and forestry) to notify employees of pesticide applications that occur on the farm or business. Employees must also be informed of the pesticide's restricted-entry interval (REI), which is the time interval between the pesticide application and the time workers can reenter a pesticide-treated area.

REIs usually range from 12 to 48 hours. However, there are a few REIs that extend to 72 hours in drier climates. REIs for WPS-covered pesticides are listed on the label of WPS-covered pesticides. The WPS also has special REI requirements for greenhouse and nursery pesticide applications.

NOTE: There are a few exceptions under the WPS where early entry by workers into a treated area is permitted before the REI expiration. See the WPS How-to-Comply manual for more information about WPS requirements and REIs.

For most pesticides, the WPS gives employers a choice of either:

- 1) Telling their WPS-covered workers which fields are being treated with pesticides, how long the REI is in effect for each field, and to stay out of the treated areas until the REI is over; OR,
- 2) Posting the treated field.



A standard, EPA - approved posting sign.

Some pesticides, due to safety concerns, require both verbal warning and written posting. Pesticides requiring double worker notification will display the following statement:

"Notify workers of the application by warning them orally and by posting signs at entrances to treated areas."

NOTE: Self-employed operators of farms, forestry, nurseries, and greenhouses with no employees (other than immediate family members) are exempt from the WPS employer-provided worker notification requirement (see the WPS How-to-Comply manual for more information about this exemption).

The following items are required by the WPS when posting pesticide-treated areas. Check the How-to-Comply manual for further information.

- 1) Posted warning signs must be at least 14" by 16" in size and the letters must be at least 1" in height.
- 2) Signs must have a background color that contrasts with red.
- 3) The sign must include the words "DANGER" and "PELIGRO," and "PESTICIDES" at the top of the sign; the words "KEEP OUT" and "NO ENTRE" at the bottom of the sign; and the letters for all words must be clearly legible.
- 4) Additional information, such as the name of the pesticide and the date of application, should appear on the warning sign if it does not detract from the appearance of the sign or change the meaning of the required information.
- 5) Signs must be visible from all usual points of worker entry to the treated area. These include: each access road; each footpath and other walking route that enters the treated area; and each border with any adjacent labor camp.
- 6) Signs cannot be posted sooner than 24 hours BEFORE the pesticide application and must be taken down within three days after the REI is over.
- 7) The person responsible for posting the warning sign is the employer or owner/operator of the farm, not the pesticide applicator.

Information regarding WPS posting and WPS warning signs is available at county extension offices and the Minnesota Department of Agriculture.

Case 2: State chemigation law

Chemigation requires posting throughout the entire period of chemigation. See Chapter 8 (Chemigation) in this manual. See Case 1 (above) and the WPS How-to-Comply manual for specific information about how to properly post chemigated fields.

Case 3: Posting required by the pesticide label

A few pesticide labels may require posting of pesticide-treated fields or sites for some or all uses of that pesticide not covered by the WPS. As is always the case, all pesticide label directions must be followed, including this posting requirement.

Case 4: Posting to comply with pesticide application in cities

Some Minnesota cities have enacted ordinances requiring commercial and/or noncommercial licensed pesticide applicators to post pesticide applications to turf. Cities that decide to enact such posting requirements may enact ordinances that are less – but not more – restrictive than allowed by state law. The following excerpt from the Minnesota Pesticide Control Law explains state requirements for cities choosing to enact this posting ordinance.

Subd. 3. WARNING SIGNS FOR PESTICIDE APPLICATION.

- (a) All commercial or noncommercial applicators who apply pesticides to turf areas must post or affix warning signs on the property where the pesticides are applied.
 - (b) Warning signs must project at least 18 inches above the top of the grass line. The warning signs must be of a material that is rain-resistant for a least a 48-hour period and must remain in place up to 48 hours from the time of initial application.
 - (c) The following information must be printed on the warning sign in contrasting colors and CAPITALIZED LETTERS measuring at least one-half inch, or in another format approved by the commissioner. The sign must provide the following information:
 - (1) the name of the business organization, entity, or person applying the pesticide; and
 - (2) the following language: "This area chemically treated. Keep children and pets off until...(date of safe entry)..." or a universally accepted symbol and text approved by the commissioner that is recognized as having the same meaning or intent as specified in this paragraph. The warning sign may include the name of the pesticide used.
 - (d) The warning sign must be posted on a lawn or yard between two feet and five feet from the sidewalk or street. For parks, golf courses, athletic fields, playgrounds, or other similar recreational property, the warning signs must be posted immediately adjacent to areas within the property where pesticides have been applied and at or near the entrances to the property.
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Chemigation

Chemigation is the application of pesticides or fertilizers through irrigation systems. Concern about water contamination and other environmental issues has led to changes in the regulation of pesticide applicators who chemigate. For information on chemigation and Minnesota requirements for chemigation, see Chapter 8 (Chemigation).

Waste Pesticides and Container Disposal

Federal and state waste disposal laws regulate the proper disposal of hazardous wastes. Some pesticide wastes are either listed under federal and state hazardous waste laws, or have characteristics that make them hazardous wastes. In Minnesota, disposal of pesticide containers and excess pesticides is under control of the Minnesota Department of Agriculture. The MDA has programs for collection of both waste pesticides and empty pesticide containers. See Chapter 6 (Safe Handling of Pesticides) for more information on how to dispose of pesticide containers and residues.

NOTE: The disposal of solid and hazardous waste is regulated by the Minnesota Pollution Control Agency (PCA). The PCA also controls the burning of solid waste.



Pesticides in Aquatic Environments

The Minnesota Department of Natural Resources regulates the use of pesticides in public waters (which may include lakes, rivers and streams, and so on). To apply pesticides in public waters, applicators are required to obtain a Minnesota Department of Natural Resources Aquatic Nuisance Control permit. Commercial and noncommercial licensed pesticide applicators will need to be certified in the aquatics pesticide applicator category to perform work under a MN DNR permit. Applicators of pesticides to aquatic environments will also need to comply with a number of other laws and regulations. Contact the Minnesota Department of Natural Resources' Ecological Services Section for more information.

Summary

The federal and state laws that control the use of pesticides are intended to promote safety to humans and the environment. In some cases, there are both federal and state requirements for pesticide use. It is important that all pesticide applicators be aware of their responsibilities under both federal and state laws. Civil and/or criminal penalties may be imposed on applicators who use pesticides in ways not allowed by law.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires that some pesticides be classified as "restricted use." State law requires that all commercial applicators and all noncommercial and private applicators who apply restricted use pesticides (RUPs) be certified and licensed.

The Environmental Protection Agency (EPA) is the federal agency regulating pesticides under FIFRA, and the Minnesota Department of Agriculture is the state lead agency for regulating proper pesticide usage. On the next page is a list of federal and state agencies and the types of pesticide use under their jurisdiction.

Minnesota pesticide laws are updated and changed periodically to ensure safety to persons and to the environment. Be sure to keep up with recent changes in pesticide laws and regulations. Some areas where there have been recent changes in pesticide laws and regulations are:

- Certification of pesticide applicators;
- New worker protection standards;
- Reporting pesticide spills;
- New pesticide recordkeeping requirements;
- Chemigation; and
- Posting pesticide-treated fields.

Pesticide Regulatory Agencies

Federal Agencies	Duty
US Department of Transportation (USDOT)	Shipment of pesticides across state lines
US Environmental Protection Agency (EPA)	Pesticide classification and use; certification of applicators; residues in agricultural products; worker protection standards; federal registration of pesticides; protection of water, air, and land from pollution
Federal Aviation Administration (FAA)	Aerial application of pesticides
Occupational Safety & Health Administration (OSHA)	Worker safety
US Department of Agriculture (USDA)	Meat and poultry quality; RUP pesticide recordkeeping
US Food and Drug Administration (FDA)	Pesticide residues in food
State Agencies	Duty
Minnesota Department of Agriculture (MDA)	Registration, sale, misuse, incidents, and cleanup of pesticides; licensing and certification of applicators and dealers; handling and disposal of pesticide wastes, containers, and contaminated materials; environmental protection; chemigation
Minnesota Department of Health (MDH)	Coordination of poison information centers in Minnesota; state drinking water standards; regulation of wells; public health protection
Minnesota Department of Natural Resources (DNR)	Pesticides in aquatic environments; protection of natural resources
Minnesota State Emergency Response Commission (SERC)	Emergency response planning for hazardous chemical incidents and releases
Minnesota Pollution Control Agency (MPCA)	Disposal of hazardous and solid wastes; environmental protection
Minnesota Department of Transportation (MNDOT)	Regulation of transportation of pesticides on public roadways

Index of Selected Minnesota State Pesticide Control Laws

18B Pesticide Control

18B.02 Preemption of other law. State preemption of local government ordinances regulating pesticides

18B.045 Pesticide management plan. Development of a state pesticide management plan for the prevention, evaluation, and mitigation of occurrences of pesticides or pesticide breakdown products in groundwaters and surface waters of the state.

18B.065 Waste pesticide collection program. Establishes a program to collect waste pesticides.

18B.07 Pesticide use, application, and equipment cleaning.

Subd. 1. Pesticides must be applied in accordance with the product labeling

Subd. 2. Prohibited pesticide use: inconsistent with a label or labeling; harms people, property and the environment;

Subd. 4. Pesticide safeguards at application sites.

Subd. 5. Use of public water supplies and public waters for filling pesticide application equipment and backflow prevention.

Subd. 7. Requirements for cleaning equipment in or near surface application of aquatic pesticides to public waters.

Subd. 8. Pesticide, rinsate, and container disposal.

18B.08 Chemigation.

Subd. 1. Chemigation permitting

Subd. 3. Chemigation equipment requirements.

Subd. 4. Chemigation application fee.

18B.09 Pesticide application in cities: Authority for statutory and home rule charter cities to enact an ordinance requiring commercial or noncommercial applicators who apply pesticides to turf areas to post or affix warning signs.

18B.12 Sale and distribution of adulterated pesticides (prohibition).

18B.13 Sale and distribution of misbranded pesticides and devices (prohibition).

18B.135 Sale of pesticides in returnable containers and management of unused portions.

18B.14 Pesticide storage. Container and bulk pesticide storage requirements.

18B.26 Pesticide registration. State requirements and fees for registering any pesticide distributed or used in Minnesota.

18B.27 Pesticide registration for special local needs. Requirements, procedure, and fees to register a pesticide for special local needs use.

18B.28 Experimental use pesticide product registration. Requirements, procedure, and fees to register a pesticide for experimental use.

18B.285 Experimental genetically engineered pesticide product registration. Requirements, procedure, and fees to register an experimental genetically engineered pesticide product for use or release.

18B.29 Reciprocal licensing and certification agreements. Authorizes the Commissioner of Agriculture to waive some licensing and certification requirements of pesticide applicators licensed and certified in other states.

18B.30 Pesticide use license requirement. Requires anyone using or supervising the use of a Restricted Use Pesticide to be certified.

18B.305 Pesticide education and training. Requirements for the Commissioner of Agriculture, in conjunction with the University of Minnesota Extension Service, to develop education and training programs addressing pesticide concerns that meet federal and state minimum standards. Also establishes the Pesticide Applicator Education and Examination Review Board.

18B.31 Pesticide dealer license. Requirements, procedures and fees for licensing retail pesticide dealers.

18B.32 Structural or aquatic pest control license. Requirements, procedures and fees for licensing structural and aquatic pesticide applicators.

18B.33 Commercial applicator license. Requirements, procedures and fees for licensing commercial pesticide applicators.

18B.34 Noncommercial applicator license. Requirements, procedures and fees for licensing noncommercial pesticide applicators.

18B.35 Application categories within applicator licenses. Authorizes the Commissioner of Agriculture to establish categories and subcategories of structural pest control, commercial and noncommercial pesticide applicators.

18B.36 Private applicator certification. Requirements, procedures and fees for licensing private pesticide applicators.

18B.37 Records, reports, plans, and inspections. Requirements for recordkeeping and plans for storage, handling and disposal of pesticides for retail pesticide dealers, structural pest control, commercial and noncommercial pesticide applicators.

18D Chemical Liability

18D.101 Liability for application. Limiting liability for applications made according to state law and pesticide label directions.

18D.103 Report of incidents required. Requires reporting of pesticide incidents immediately to the Commissioner of Agriculture

18D.105 Corrective action orders; and 18D.1051 Response to agricultural chemical incidents. The Commissioner of Agriculture may take corrective action or response and remedial action or both in responding to an agricultural chemical incident, release, or threatened release.

18D.111 Liability for costs (by the responsible party).

18D.201 Inspection, sampling, analysis. Conditions covering access and entry by the Commissioner of Agriculture for inspection, sampling and analysis of agricultural chemicals.

18D.301 Enforcement.

18D.305 Administrative action. Administrative action by the Commissioner of Agriculture to remedy violations.

18D.311 Damages against state for administrative action without cause.

18D.315 Administrative penalties.

18D.321 Appeal of commissioner's orders.

18D.325 Civil penalties.

18D.331 Criminal penalties.

18E Agricultural Chemical Response and Reimbursement Law.

18E.03 Agricultural chemical response and reimbursement account. Establishes the agricultural chemical response and reimbursement account in the state treasury; the conditions for expenditure for reimbursement of costs related to an agricultural chemical incident; and establishment of fees.

18E.04 Reimbursement or payment of response costs. Eligibility requirements for reimbursement

18E.05 Agricultural chemical response compensation board.

Review Questions for Pesticide Laws and Regulations

1. What is the basic federal law regulating pesticides referred to as?
 - A. FFDCA
 - B. FIFRA
 - C. MPCO
 - D. USEPA
 2. What federal government agency is mandated to regulate pesticides and pesticide use?
 - A. DOT
 - B. USDA
 - C. MDA
 - D. EPA
 3. What state government agency is mandated to regulate pesticides and pesticide use?
 - A. DOT
 - B. USDA
 - C. MDA
 - D. EPA
 4. Who are the only people that can apply Restricted Use Pesticides?
 - A. Government agencies
 - B. Private applicators
 - C. Commercial applicators
 - D. Certified applicators
 5. Records of restricted use pesticide applications must be made and kept by all applicators.
 - A. True
 - B. False
 6. Where can the EPA "extremely hazardous substance" list be obtained?
 7. The Worker Protection Standard applies to pesticides that are used in the production of agricultural plants on farms, and in forests, nurseries, or greenhouse.
 - A. True
 - B. False
 8. People performing which of the following tasks are considered 'handlers' under the Worker Protection Standard?
 - A. Harvesting
 - B. Maintaining application equipment contaminated with pesticides
 - C. Weeding
 - D. Watering
 9. What are the five types of pesticide applicators in Minnesota?
 10. How often must any business established to apply pesticides for hire obtain a Minnesota commercial pesticide applicator license?
 - A. Annually
 - B. At least once
 - C. Every three years
 - D. Every two years
 11. Commercial and noncommercial applicators may be fined for violation of federal pesticide laws.
 - A. True
 - B. False
-

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12. State law requires noncommercial applicators to keep a record of temperature, wind speed, and wind direction for each Restricted Use Pesticide application.
- A. True
 - B. False
-
13. Where must nearly all pesticide incidents be immediately reported?
- A. Minnesota Department of Agriculture
 - B. Minnesota Pollution Control Agency
 - C. Minnesota Extension Service
 - D. Minnesota Department of Natural Resources
-
14. When should posting signs be put up under the Worker Protection Standard?
- A. At the end of a pesticide application
 - B. Two days before a pesticide application
 - C. No sooner than 24 hours before the start of an application
 - D. During the pesticide application
-

References

Environmental Protection Agency. 1991. *Applying Pesticides Correctly: A Guide for Private and Commercial Applicators*. Revised.

Minnesota Extension Service. 1994. *Private Pesticide Applicator's Training Manual*. St. Paul: University of Minnesota.

Minnesota Department of Agriculture Pesticide Control.

Category A Pesticide Applicator Training Manual

The Pesticide Label

What's in this Chapter:

Product Testing and EPA Approval

EPA Labeling Requirements

Types of Registration

Information on the Label

Pesticide Name

Type of Pesticide

Formulation

Classification

Ingredient Statement

Net Contents

Directions for Use

Warnings and Precautions

Learning Objectives:

After completing this chapter, students will be able to:

- Interpret the terms "label" and "labeling;"
- Identify the parts of a label;
- Explain where to look for "restricted use" classification on pesticide labeling;
- Distinguish among the terms "common name," "chemical name," and "brand name;"
- Interpret the signal words on pesticide labeling;
- Know the types of hazard precautionary statements on pesticide labeling;
- Interpret the statement "It is a violation of Federal law to use this product in a manner inconsistent with its labeling;"
- Explain the pesticide user's responsibility to follow all directions contained in labeling and supplemental materials.

Terms to Know:

Distributor products. Products that are produced and registered by a manufacturer or formulator and sold under a different name by a distributor.

Brand name. The manufacturer's trade name, used in advertisements and by company sales people.

Chemical name. The name, often listed in the ingredients statement on the label, that identifies the chemical components and structure of the pesticide.

Label. The printed material attached to or on the product container.

Labeling. Includes the label itself, plus all other manufacturer's information about the product.

Precautionary statements. Pesticide labeling statements that alert you to possible hazards from use of the pesticide product and that sometimes indicate specific actions to take to avoid the hazards.

EPA registration number. The number assigned by the federal government and displayed on the pesticide label to indicate federal approval of the pesticide.

EPA establishment number. Indicates the specific manufacturing plant where the pesticide was made.

Special local need (SLN). Allows states to further control how a pesticide is used in their state.

Emergency exemption from registration. Used when an emergency pest situation arises for which no pesticide is registered.

Common name. Name of the active ingredient in a pesticide.

Preharvest interval. The minimum amount of time that must pass between a pesticide treatment and harvest.

Restricted entry and reentry intervals. The length of time that must pass after a pesticide treatment before a person can enter a treated area.

Introduction

Pesticide product labeling is the main method of communicating information from pesticide manufacturers to pesticide users. The information printed on or attached to the pesticide container is the label. Labeling includes the label itself, plus all other information you receive from the manufacturer about the product that you buy. The labeling may include brochures, leaflets, and other information that accompanies the pesticide product. Pesticide labeling gives you instructions on how to use the product safely and correctly. Pesticide users are required by law to comply with all the instructions and directions for use in pesticide labeling.

Product Testing and EPA Approval

The pesticide label contains information that is the result of years of research and testing. Each pesticide that is put on the market is put through a battery of tests. A manufacturer may make and screen 7,500 compounds before finding one that can pass all the tests needed to receive clearance from the Environmental Protection Agency (EPA). Once a product passes all necessary tests, a product label is then issued. Product tests include the following:

- Toxicological tests to determine possible health hazards to humans and animals;
- Metabolism studies to see how long it takes a compound to break down into simple, less toxic materials;
- Residue tests to find out how much of the pesticide or its breakdown products remain on farm products, such as crops, meat, milk, and eggs;
- Soil movement tests to determine how long a pesticide stays in the soil and how it moves in the soil, the groundwater, and the surface water;

The pesticide label contains information that is the result of years of research and testing.



- Nontarget organism tests to determine the immediate and long-range effects on wildlife, endangered and threatened species, and other plants and animals.

The EPA reviews these test results and determines whether to approve the pesticide. Once it is approved, the pesticide is registered.

EPA Labeling Requirements

No pesticide may be sold in the United States until the EPA has reviewed the manufacturer's application for registration and determined that the use of the product will not present an unreasonable risk to humans or the environment. As part of the product registration process, the EPA has certain labeling information requirements. The EPA must approve all language that the manufacturer proposes to include in the product labeling.

The EPA reviews the labeling to make sure that it contains all the information needed for safe and effective use of the pesticide product and that the information is backed up by data submitted (or cited) by the manufacturer. The EPA may require the manufacturer to change the labeling if it does not contain enough information or if the information is incorrect. EPA also may require that the labeling include other information about laws or regulations that have been adopted to protect humans or the environment.

Only after the EPA has reviewed the labeling and registered the product can a pesticide product be sold for use. If the manufacturer wants to change the information on the labeling after the product and labeling are registered, the EPA must approve the change. The EPA may also require changes in labeling. Both the label and labeling are legally binding documents and must be followed exactly.

Applicators should also have state labels, as well as special local needs and emergency labels, at the time of application.

EPA REG. NO. 241-310

All pesticides must list the EPA registration number. This shows that the label has been approved by the federal government.

In addition, there is an establishment number that indicates the specific manufacturing plant where the pesticide was made. The establishment number is important in case a product is recalled. The name and address of the manufacturer are also listed.

Types of Registration

It is your responsibility to be sure the pesticides you apply are registered, so always check the label for registration information. You may encounter three major types of registration:

- Federal registration;
- Special local needs registration;
- Emergency exemptions from registration.

Federal EPA registrations are the most common. Look for the official EPA registration number (which must appear on the label) to be sure you are buying an approved product.

Special local needs registration (known as SLN or 24(c) registrations) allow states to further control how the pesticide is used in their jurisdiction. States may register additional uses or add limitations for a

federally registered pesticide. These registrations often involve adding application sites, pests, or alternate control techniques to those listed on the federally registered labeling.

Supplemental labeling must be provided for each SLN registration. Applicators must have a copy of the SLN labeling in their possession in order to apply the pesticide for that purpose. The registration number of SLN labeling will include the initials "SLN" and the standard two-letter abbreviation code for the state that issued the registration. These registrations are legal only in the state or local area specified in the labeling. Any application in another state or region is subject to civil and criminal penalties. Extension personnel, pesticide dealers, and other professionals will help keep you informed of SLN registrations that pertain to your local area needs.

Emergency exemptions from registration are used when an emergency pest situation arises for which no pesticide is registered. If both federal and SLN registrations would take too long to enact, an emergency registration can be used. Known as "Section 18 exemptions," these registrations are handled by the highest governing official involved — usually a state governor or federal agency head. This provision allows a pesticide product to be sold and used for a nonregistered purpose for a specified period of time. Strict controls and recordkeeping are required for all these emergency uses. You must understand all of the special requirements and responsibilities involved whenever you use pesticides with emergency exemptions. The agency that has granted the emergency exemption will supply you with the necessary application rates, safety precautions, and other vital information.

Information on the Label

The information on pesticide labeling usually is grouped under headings to make it easier to find the information you need. Some information is required by law to appear on a certain part of the labeling or under certain headings. Other information may be placed wherever the manufacturer chooses.

Pesticide labeling contains basic information that helps users clearly identify the product. Some of these items will be on the front panel of every label, because the EPA requires that they appear there.

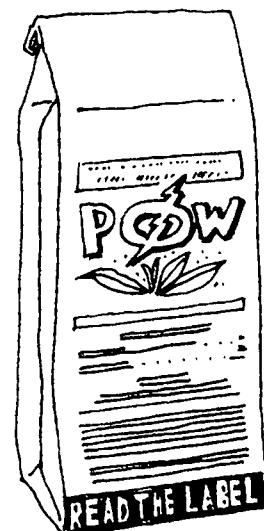
The pesticide label has several different parts. Below is an explanation of these parts. See the sample label at the end of the chapter.

Pesticide Name

Pesticides go by several names. The different types of names a pesticide may have are listed below.

Brand, trade, or product name

This is the name registered by a company for a specific pesticide formulation. Most companies register each brand name as a trademark, so no other company is allowed to use that name. Be very careful about choosing a pesticide product by brand name alone. Companies use the same name with minor variations for entirely different chemicals. For example, Tersan LSR is zinc and maneb, but Tersan 1991 is benomyl.



Be very careful about choosing a pesticide product by brand name alone.

Common name

The common name is the name of the active ingredient in a pesticide. This name is approved and formally adopted by official agencies and societies. For example, carbaryl is the common name of the active ingredient in Sevin.

Chemical name

The chemical name indicates the chemical parts and structure of the active ingredient. It is usually listed following the common name. For example, on the Sevin label, the common name for the active ingredient, carbaryl, is followed by the chemical name (1-naphthyl N methyl carbamate).

Type of Pesticide

The type of pesticide is usually listed on the front of the label. This short statement indicates in general terms what the product will control. Examples:

Insecticide for control of certain insects on fruits, nuts, or ornamentals;

Soil fungicide;

Herbicide for control of trees, brush, and weeds.

For a more complete list of pesticide types, see the table in Chapter 2.

Formulation

The front panel of some pesticide labels will indicate the type of formulation that is contained in the product. The formulation may be named or the label may show only an abbreviation for the formulation, such as WP for wettable powder, D for dust, or EC for emulsifiable concentrate. For a more complete listing of formulations and abbreviations, see the table in Chapter 2.

Classification

Restricted use pesticides are labeled with the restricted use statement near the top on the front page of the label. The label will state "Restricted Use Pesticide" in a box at the top of the front panel. The reason why the pesticide is classified for restricted use may also be included on the label.

Ingredient Statement

The ingredient statement lists the name and percentage of the active ingredients and the percentage of the inert ingredients. If the active ingredient is an acid, the ingredient statement will list the acid equivalent percentage. In liquid formulations, there may also be a statement of the weight per gallon of active ingredient.

Net Contents

The net contents shows the amount of the formulation in the containers. It may be listed by weight (as pounds or ounces) or it may be listed by volume (in pints or gallons).

Directions for Use

Directly under the heading "Directions for Use" on all pesticide product labeling is the following statement:

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

General information about the product and specific directions for using the product are listed under this statement.

The general statement usually gives the following information:

- The crops, livestock, or sites to be treated;
- The pests to be controlled (if an unlisted pest is found on the site, it may also be treated, but only if the application is to a crop, animal, or site that the label allows);
- Method of application (for example, ground application or aerial application);
- Amount (for example, the amount to use per treatment);
- Geography (for example, certain states or regions listed on special local need labels);
- Wildlife (for example, endangered species);
- Incompatibilities with other pesticides;
- How to mix and apply;
- What equipment to use;
- Whether to agitate;
- Whether to mix the pesticide with oil or water;
- When and where the material should be applied;
- How to incorporate it into the soil;
- The type of spray pattern; and
- Other how-to-do-it information.

NOTE: Remember, it is illegal to apply any pesticide to plants, crops, livestock, or sites not listed on the label.

Specific directions for using the product include:

- How much to use (the application rate, the weight or volume per acre or thousand feet of row, or the amount to mix in a given volume of water and, sometimes, limitations on the number of treatments that can be given);
- Method of application (broadcast, band, furrow, foliage, or other method); and
- When to apply.

Preharvest intervals may also be given here, or they may appear in a separate limitations section of the label. These tell the minimum time that must pass between treatment and harvest.

Common terms used in the timing of application include:

Preplant. *Applying the pesticide before planting.*

Preemergence. *Applying the pesticide before the seedlings come up.*

Postemergence. *Applying the pesticide after the seedlings come up.*

Postharvest. *Applying the pesticide after the crop or plants are harvested.*

Preharvest interval. *The minimum amount of time that must pass between treatment and harvest.*

Warnings and Precautions

This part of the label contains important safety information. In some cases, the label may not contain certain warnings, but the absence of a warning does not rule out the need for safety precautions.

All pesticide labels must include the statement:
KEEP OUT OF THE REACH OF CHILDREN.

Other important safety warnings on pesticide labels are listed below.

Signal words

The signal words DANGER, WARNING, or CAUTION must appear in large letters on the front panel of the pesticide label to indicate how acutely toxic the product is to humans and domestic animals:

- DANGER/POISON means the product is highly hazardous — just a taste to a teaspoonful taken by mouth can kill (there will also be a drawing of a skull and crossbones and the word "poison" printed in red);
- DANGER means the product is either a severe skin or eye irritant or corrosive;
- WARNING means the product is moderately hazardous — as little as a teaspoonful to a tablespoonful by mouth could kill an average-sized adult;
- CAUTION means the product is slightly hazardous to relatively nontoxic — an ounce to more than a pint taken by mouth could kill an adult.

Further explanations of these signal words are given in Chapter 5 (Protecting the Applicator).

Route of entry/hazards to humans statement

This part comes right after the signal words. It tells which route of entry (mouth, skin, lungs) you must take special care to protect. Many pesticides are hazardous by more than one route, so study this part of the label carefully. For example, a Danger/Poison signal word may be followed by one or all of the following statements:

Fatal if swallowed;

Poisonous if inhaled;

Extremely hazardous by skin contact — rapidly absorbed through skin;

Corrosive — causes eye damage and severe skin burns.

Specific action statements come right after the route of entry/hazard to humans statement. This part of the label tells what to do to prevent poisoning accidents, for example, "Do not breathe vapors or mist."

Protective clothing and equipment

Some labels fully describe the protective clothing and equipment to use when handling the pesticide. Others may list some recommendations, for example, goggles, but may not mention important items like gloves. Some labels may not carry any statement at all. If the label has a statement, be sure to follow the advice given. But also check the signal word and the route of entry to decide if additional protection is necessary.



*All pesticide labels must
include the statement:
**KEEP OUT OF THE
REACH OF CHILDREN.***

Safe handling

Labels often list precautions for safe handling, for example:

Do not contaminate food or feed;

Wash thoroughly after handling and before eating and smoking.

Applicators should always take care to handle all pesticides safely, even if there are no warnings on the label. See Chapter 5 (Protecting the Applicator) for more information.

First aid

This part tells what to do in case of poisoning, for example:

If swallowed, drink large quantities of milk, egg white, or water. Do not induce vomiting.

All Danger/Poison labels contain a note to physicians describing the medical treatment for poisoning emergencies. Some Warning and Caution labels may also have this information.

Environmental hazards

This tells if the pesticide is especially hazardous for fish, wildlife, or other nontarget organisms, for example:

This product is highly toxic to bees.

Also, there are usually warnings on how to avoid contaminating the environment, for example:

Do not apply when runoff is likely to occur;

Do not allow drift on desirable plants or trees.

If these statements do not appear, still take proper precautions. See Chapter 7 (Protecting the Environment) for more information.

See "Protecting the Environment" for more information on environmental hazards..

Physical or chemical hazards

This part will tell you of any special fire, explosion, or chemical hazards, for example:

Flammable: do not use, pour, spill, or store near heat or open flame.

This information and the information about environmental hazards are not located in the same place on all pesticide labels. Be sure to search the label for these statements before handling the pesticide.

Reentry intervals or restricted entry intervals

This is the length of time that must pass before a person can enter the treated area. The safe reentry interval varies by the pesticide. The reentry interval for pesticides covered by the Worker Protection Standard is 12 to 48 hours. Other pesticide labels may recommend waiting until the pesticide dries or dusts have settled. The label may also state whether a field must be posted to warn people about reentry limitations.

Storage and disposal

This information explains how to store the pesticide, how to clean the equipment, and how to dispose of unused product. See Chapter 6 (Safe Handling of Pesticides) for more information.



Summary

Pesticide labels include the label on the container and all supplementary labeling. Before buying, using, storing, or disposing of any pesticide, read the label carefully. The pesticide label and all supplementary labeling are legally binding documents and must be followed exactly.

All pesticides must be registered with the Environmental Protection Agency (EPA). Pesticides must pass rigorous tests before being registered.

Information on the pesticide label includes the name of the pesticide, the formulation, a restricted use statement if applicable, a list of ingredients including percentage of active ingredients, net contents, directions for use, and warnings and precautions. It is essential to read and understand *every* part of the pesticide label.

Review Questions for The Pesticide Label

1. Explain the differences between the terms "label" and "labeling."

2. The label and labeling are legally binding documents.
A. True
B. False

3. Where would you look to find out whether a pesticide is classified as Restricted Use?

4. Where do the signal words "DANGER", "WARNING", or "CAUTION" appear on the pesticide label?

5. Match the signal words and symbols you may see on a pesticide product with its meaning :
CAUTION _____ 1. Highly hazardous
WARNING _____ 2. A severe skin or eye irritant or corrosive
DANGER _____ 3. Moderately hazardous
POISON and the skull and crossbones [symbol] _____ 4. Slightly hazardous to relatively nontoxic

6. As an applicator, you must have in your possession a copy of the Special Local Needs (SLN) labeling when applying a pesticide with SLN registration.
A. True
B. False

7. Lists the different types of precautions, warnings, and hazard statements that may be found on pesticide labeling.

8. Explain what a preharvest interval is.

9. Where on a pesticide label can you find the routes of pesticide entry into the body you must take special care to protect?

NOTE: To answer questions 10-16 refer to the PURSUIT label on the following pages.

10. Match the following terms with the type of label information it is providing:

CAUTION! _____	A. Brand name
imazethapyr _____	B. Common name
Pursuit _____	C. Signal word
77.13% _____	D. Inerting ingredients

11. The EPA registration number refers to the facility where the pesticide product was made.

A. True
B. False

12. What is the net active ingredient contents of this package of Pursuit?

A. 3.8%
B. 20.25%
C. 22.87%
D. 77.13%

13. How is Pursuit classified?

A. Unclassified, General Use
B. Restricted use

14. If Pursuit was considered nontoxic, then it would not be required to have the statement

"Keep out of reach of children" on the label.

A. True
B. False

15. What is the Restricted Entry Interval for Pursuit?

A. Until the spray has dried
B. 4 hours
C. 10 hours
D. 12 hours

16. List the personal protective equipment required to be worn by Pursuit applicators and other handlers:
-
-

References

Minnesota Extension Service. 1994. *Private Pesticide Applicator's Training Manual*. St. Paul: University of Minnesota.

Environmental Protection Agency. 1991. *Applying Pesticides Correctly: A Guide for Private and Commercial Applicators*. Revised.



FOR USE IN FIELD CORN*, SOYBEANS AND PEANUTS

(Apply only on IMI-Corn™ hybrids)

ACTIVE INGREDIENT:	Ammonium salt of imazethapyr (\pm -2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid**	22.87%
INERT INGREDIENTS		77.13%
TOTAL		100.00%

**Equivalent to 21.6% (\pm -2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid (1 gallon contains 2.0 pounds of active ingredient as the free acid)

EPA Reg. No. 241-310

KEEP OUT OF REACH OF CHILDREN CAUTION! ¡PRECAUCION!

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

STATEMENT OF PRACTICAL TREATMENT

IF ON SKIN: Wash with plenty of soap and water. Get medical attention if irritation persists.

IF IN EYES: Flush with plenty of water.

IF INHALED: Remove victim to fresh air.

In case of an emergency endangering life or property involving this product, call collect, day or night, area code 201-835-3100.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS

CAUTION!

Harmful if inhaled or absorbed through skin. Avoid breathing spray mist. Avoid contact with skin, eyes or clothing.

Personal Protective Equipment (PPE):

Applicators and other handlers must wear:

- long-sleeved shirt and long pants
- waterproof gloves
- shoes plus socks

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations:

Users Should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark.

DO NOT contaminate water when disposing of equipment washwaters.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

This labeling must be in the possession of the user at the time of pesticide application.

Observe all cautions and limitations on this label and on the labels of products used in combination with PURSUIT. Do not use PURSUIT other than in accordance with the instructions set forth on this label. The use of PURSUIT not consistent with this label may result in injury to crops. Keep containers closed to avoid spills and contamination.

DO NOT apply this product through any type of irrigation system.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours. Exception: if the product is soil-injected or soil-incorporated, the Worker Protection Standard, under certain circumstances, allows workers to enter the treated area if there will be no contact with anything that has been treated.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- coveralls – waterproof gloves – shoes plus socks

STORAGE AND DISPOSAL

PROHIBITIONS: KEEP FROM FREEZING. DO NOT store below 32°F. DO NOT contaminate water, food or feed by storage or disposal.

PESTICIDE DISPOSAL: Wastes 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 reconditioning, or puncture and dispose of in a sanitary landfill, by incineration or, if allowed by State and local authorities by burning. If burned, stay out of smoke.

DISCLAIMER

The label instructions for the use of this product reflect the opinion of experts based on research and field use. The directions are believed to be reliable and should be followed carefully. However, it is impossible to eliminate all risks inherently associated with use of this product. Crop injury, ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, herbicide resistant weed populations, or the use of, or application of the product contrary to label instructions, all of which are beyond the control of American Cyanamid Company. All such risks shall be assumed by the user. American Cyanamid Company shall not be responsible for losses or damages resulting from use of this product in any manner not set forth on this label. User assumes all risks associated with the use of this product in any manner not specifically set forth on this label.

American Cyanamid Company warrants only that the material contained herein conforms to the chemical description on the label and is reasonably fit for the use therein described when used in accordance with the directions for use, subject to the risks referred to above. **CYANAMID DOES NOT MAKE OR AUTHORIZE ANY AGENT OR REPRESENTATIVE TO MAKE ANY OTHER WARRANTIES, EXPRESS OR IMPLIED AND EXPRESSLY EXCLUDES AND DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

BUYER'S EXCLUSIVE REMEDY AND AMERICAN CYANAMID'S EXCLUSIVE LIABILITY, WHETHER IN CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY OR OTHERWISE, SHALL BE LIMITED TO REPAYMENT OF THE PURCHASE PRICE OF PURSUIT. In no case shall Cyanamid or the seller be liable for consequential, special or indirect damages resulting from the use or handling of this product.

Uses With Other Products (Tank-mixes)

If this product is used in combination with any other product except as specifically recommended in writing by American Cyanamid Company, then American Cyanamid Company shall have no liability for any loss, damage or injury arising out of its use in any such combination not so specifically recommended. If used in combination recommended by American Cyanamid Company, the liability of American Cyanamid Company shall in no manner extend to any damage, loss or injury not directly caused by the inclusion of the American Cyanamid Company product in such combination use, and in any event shall be limited to return of the account of the purchase price of the American Cyanamid Company product.

GENERAL INFORMATION

PURSUIT can be applied as an early preplant, preplant incorporated, preemergence, at ground-cracking (peanuts) or early post-emergence. The application method of choice will depend on the anticipated weed spectrum and the preference of the applicator.

PURSUIT kills weeds by root and/or foliage uptake and rapid translocation to the growing points. Adequate soil moisture is important for optimum PURSUIT activity. When adequate soil moisture is present, PURSUIT will provide residual control of susceptible germinating weeds; activity on established weeds will depend on the weed species and the location of its root system in the soil.

Apply PURSUIT herbicide only on selected field corn hybrids (IMI-Corn) warranted by the seed company to possess resistance/tolerance to direct application of PURSUIT. DO NOT apply PURSUIT to corn hybrids which lack resistance/tolerance to PURSUIT herbicide. Contact your seed supplier, chemical dealer or American Cyanamid to obtain information regarding IMI-Corn hybrids.

Crops growing under stressful environmental conditions can exhibit various injury symptoms which may be more pronounced if herbicides are used. Corn plants treated with PURSUIT may exhibit yellowing on new growth. Such effects occur infrequently and are temporary. Normal growth and appearance should resume within 1 to 2 weeks.

Occasionally, soybean internode shortening and/or temporary yellowing of crop plants may occur following PURSUIT applications.

These effects occur infrequently and are temporary. Normal growth and appearance should resume within 1 to 2 weeks. These effects will not affect crop yields.

Use of PURSUIT herbicide in accordance with label directions is expected to result in normal growth of rotational crops in most situations; however, various environmental and agronomic factors make it impossible to eliminate all risks associated with the use of this product and, therefore, rotational crop injury is always possible.

Following the use of this product and chemically related products with the same mode of action, naturally occurring biotypes* of some of the weeds listed on this label cannot be effectively controlled by this and related products. This product should be tank mixed or applied sequentially with an appropriate registered herbicide having a different mode of action to ensure control of resistant biotypes.

* A weed biotype is a naturally occurring individual within a given species that has a slightly different, but distinct, genetic makeup from other individuals.

Replanting: If replanting is necessary in a field previously treated with PURSUIT, the field may be replanted to soybeans, peanuts or IMI-Corn™ (imidazolinone resistant/tolerant corn), lima beans or Southern peas. Rework the soil no deeper than the treated zone. Do not apply a second treatment of PURSUIT.

MIXING INSTRUCTIONS

POSTEMERGENCE APPLICATIONS OF PURSUIT REQUIRE THE ADDITION OF AN ADJUVANT AND A LIQUID FERTILIZER SOLUTION.

I. ADJUVANTS

SURFACTANTS: Use a non-ionic surfactant containing at least 80% active ingredient. Apply the surfactant at the rate of 1 quart per 100 gallons. An organo-silicone surfactant may be used in place of a non-ionic surfactant.

OR

CROP OIL CONCENTRATE: Instead of a surfactant, a petroleum or vegetable seed based oil concentrate (such as SUN-IT II⁵) may be used. SUN-IT II is recommended when weeds are under moisture or temperature stress. Use SUN-IT II or other methylated seed oils at the rate of 1.5 to 2 pints per acre (use the higher rate when weeds are at the maximum label size), or use a crop oil concentrate at 2 pints per acre.

AND

II. LIQUID FERTILIZER SOLUTION

Recommended nitrogen based fertilizers include liquid fertilizers (such as 28%N, 32%N or 10-34-0) at the rate of 1-2 quarts per acre. Use the higher rate when weeds are under moisture or temperature stress. Instead of a liquid fertilizer, spray grade ammonium sulfate may be used at the rate of 2.5 lbs per acre.

NOTE: Liquid fertilizer solutions are not required in PURSUIT applications in use areas south of Interstate highway 40.

Fill the spray tank one-fourth to one-half full with clean water. Use a calibrated measuring device to measure the required amount of PURSUIT. Add PURSUIT to the spray tank while agitating. Add adjuvants and fill the remainder of the tank with water.

TANK MIX COMBINATIONS WITH OTHER HERBICIDES

If other herbicides are tank-mixed with PURSUIT, while agitating, add components in the following order:

- 1) Fill spray tank 1/4 to 1/2 full with clean water.
- 2) Add soluble packet products and thoroughly mix.
- 3) Add WP (wettable powder), DG (dispersible granule), DF (dry flowable) or liquid flowable formulations not in soluble packets.
- 4) Add PURSUIT and thoroughly mix.
- 5) Add other aqueous solution products.
- 6) Add EC (emulsifiable concentrate) products.
- 7) Add surfactant or crop oil to the spray tank.
- 8) Add liquid fertilizer.
- 9) While agitating, fill the remainder of the tank with water.

If dicamba sprayer contamination is possible, refer to the appropriate dicamba label (Banvel⁶, Clarity⁶, or Marksman⁶) for sprayer

cleanup directions. Clean the sprayer prior to PURSUIT applications to avoid dicamba injury to soybeans.

To avoid injury to sensitive crops, spray equipment used for PURSUIT applications must be drained and thoroughly cleaned with water before being used to apply other products.

When PURSUIT is used in combination with another herbicide, refer to the respective label for rates, methods of application, proper timing, weeds controlled, restrictions and precautions. Always use in accordance with the more restrictive label restrictions and precautions. No label dosages should be exceeded. PURSUIT cannot be mixed with any product containing a label prohibiting such mixtures.

SPRAYING INSTRUCTIONS

DO NOT apply when wind velocity is greater than 10 mph, or when spray may be carried to sensitive crops. Sensitive crops include leafy vegetables and sugar beets.

GROUND APPLICATIONS:

Uniformly apply with properly calibrated ground equipment in 10 or more gallons of water per acre. A spray pressure of 20 to 40 psi is recommended.

To ensure thorough coverage, use a minimum of 20 gallons of water per acre when applying PURSUIT to minimum or no-till crops. Use higher gallonage for fields with dense vegetation or heavy crop residues.

Adjust the boom height to ensure proper coverage of weed foliage (according to the manufacturer's recommendation). Use only flat-fan nozzle tips for postemergence applications.

Avoid overlaps when spraying.

PURSUIT APPLICATIONS WITH A LOW VOLUME SPRAYER

PURSUIT may be applied to soybeans with a low volume (Spray-Coupe-type) sprayer. When applying PURSUIT with a low volume sprayer, spray the weeds before they reach the maximum size listed in this label. Adequate control of weeds is dependent upon good spray coverage of the weeds. The sprayer must be calibrated to deliver the recommended spray volume and pressure to ensure adequate spray coverage of the weeds.

When applying PURSUIT with a low volume sprayer, apply a minimum of 10 gallons per acre of spray solution with a nozzle pressure between 40-60 psi for optimum coverage. When spraying combinations including Banvel or dicamba containing products, do not exceed 40 psi sprayer pressure.

AERIAL APPLICATION:

PURSUIT herbicide may be applied by air only to soybeans and IMI-Corn. DO NOT apply by air to other crops.

Uniformly apply with properly calibrated aerial equipment in 5 or more gallons of water per acre. When applied POSTEMERGENCE, the addition of a non-ionic surfactant AND fertilizer solution are required for optimum weed control. Apply a non-ionic surfactant at the rate of 1 quart per 100 gallons of spray mixture OR a crop oil concentrate at the rate of 1.5 - 2 pints per acre AND a liquid fertilizer at the rate of 1 quart per acre. (See instructions under APPLICATION INSTRUCTIONS - POSTEMERGENCE).

To avoid injury to sensitive crops from drift, aerial applicators must adhere to the following SPECIAL AERIAL USE DIRECTIONS AND PRECAUTIONS.

- Nozzle height above ground must be a maximum of 10 feet.
- Nozzles must be pointed toward the rear of the aircraft. The downward angle of the nozzle should not be greater than 20 degrees.
- To minimize wing-tip vortex roll, nozzles or spray boom must not be located any closer to end of wing or rotor than three-fourths the distance from the center of the aircraft.
- Use a maximum spray pressure of 40 psi.
- A buffer zone must be established between the area to be sprayed and sensitive crops.
- DO NOT spray when wind velocity is greater than 5 mph. Coarse sprays (larger droplets) are less likely to drift.

Applicator is responsible for any loss or damage which results from spraying PURSUIT in a manner other than recommended in this label. In addition, applicator must follow all applicable state and local regulations and ordinances in regard to spraying.

APPLICATION INFORMATION

POSTEMERGENCE

PURSUIT is effective in controlling weeds in conservation tillage as well as in conventional production systems. **Apply PURSUIT herbicide as an early postemergence treatment when weeds are actively growing and before they exceed a height of 3 inches, unless otherwise indicated.** Delay application until the majority of the weeds are at the recommended growth stage. Application timing should be based on weed size and not crop growth stage. Apply PURSUIT to crops and weeds that are actively growing.

An adjuvant (either a surfactant or a crop oil concentrate) and a liquid fertilizer must be added to the spray solution for optimum weed control activity. See the ADDITIVE section under MIXING INSTRUCTIONS for specific instructions.

When PURSUIT is applied postemergence, absorption will occur through both the roots and foliage. Susceptible weeds stop growing and either die or are not competitive with the crop. PURSUIT not only controls many existing broadleaf and grass weeds when applied postemergence, it also provides control of susceptible weeds that may emerge after application.

For maximum weed control, cultivate 7-10 days following a post-emergence PURSUIT application. This timely cultivation will enhance residual weed control, especially under dry conditions.

If air temperatures reach or stay below 40° for 10 or more hours, delay a PURSUIT application for 48 hours from the time temperatures increase above 40° or until weeds are actively growing. Unusually cool temperatures (40° or less) reduce photosynthesis and transpiration. This reduces the uptake and translocation (and effectiveness) of PURSUIT in weeds.

PURSUIT should be applied a minimum of one hour before rainfall or overhead irrigation.

NO-TILL/MINIMUM TILLAGE AND DOUBLECROP SOYBEANS:

PURSUIT controls existing weeds and provides residual control of most weeds when applied early postemergence to IMI-Corn or soybeans in no-till or minimum tillage and doublecrop soybean production systems. The application may be applied either before or after emergence of the crop. (Refer to the WEEDS CONTROLLED POSTEMERGENCE chart for weeds controlled and recommended weed size).

If PURSUIT is applied prior to emergence of the crop, and weeds exceed the recommended size, a contact herbicide should be added to PURSUIT to enhance control. (See instructions for NO-TILL OR REDUCED TILLAGE under the PREEMERGENCE section of this label).

SOIL APPLICATIONS

PURSUIT provides effective weed control in conservation tillage systems designed to meet conservation compliance requirements. PURSUIT can be applied as an early preplant, preplant incorporated, or preemergence treatment in soybeans. It can also be applied in conventional, minimum tillage and no-till production systems. The application method of choice will depend on the anticipated weed spectrum and the preference of the applicator.

Adequate soil moisture is required for optimum activity. Rainfall or overhead irrigation is necessary to move PURSUIT into the weed germination zone. The amount of rainfall or irrigation required following application depends on existing soil moisture, soil texture and organic matter content. Sufficient water to moisten the soil to a depth of 2 inches is normally adequate. If adequate moisture is not received within 7 days after treatment, a cultivation is recommended to control escaped weeds. When adequate moisture is received after dry conditions, PURSUIT will provide residual control of susceptible germinating weeds; activity on established weeds will depend on the weed species and the location of its root system in the soil.

PURSUIT controls weeds by uptake by weed roots and translocation to the growing points where it stops weed growth. Susceptible weeds may emerge, growth will stop and the weeds will either die or are not competitive with the crop.

SOIL APPLICATIONS WITH LIQUID FERTILIZERS

PURSUIT can be applied to the soil in liquid fertilizers, alone or in combination with PROWL 3.3 EC, Frontier[®], Lasso[®], or Dual[®] to soybeans or IMI-Corn. Mixtures including trifluralin may be applied to soybeans only. Follow all PURSUIT label recommendations regarding incorporation, timing of application, special instructions and precautions. Apply treatments in 20 or more gallons of liquid fertilizer per acre with ground equipment. Always test the compatibility of PURSUIT with the liquid fertilizer before mixing in the spray tank.

PREEMERGENCE (SURFACE APPLICATIONS)

PURSUIT offers flexibility in that it can be utilized in all production tillage systems. It can be applied prior to planting (up to 45 days prior to planting), at planting in conventional, reduced tillage or no-till production systems, or after planting and before crop emergence.

NO-TILL OR REDUCED TILLAGE:

Apply PURSUIT treatments before, during or after planting. To ensure thorough coverage, use a minimum of 20 gallons of water per acre. Use higher gallonage for fields with dense vegetation or heavy crop residues.

For maximum grass control, tank-mix PURSUIT with PROWL 3.3 EC, Frontier, Lasso or Dual. To kill existing vegetation, Gramoxone Extra⁴, Starfire⁴, Roundup⁷, or 2,4-D (early preplant - see 2,4-D label for limitations) may be tank-mixed with PURSUIT alone or in combination with PROWL 3.3 EC, Frontier, Lasso or Dual. Gramoxone Extra, Starfire, Roundup or 2,4-D should be deleted from the tank-mixture if vegetation is absent at the time of application.

NOTE: Adjust planters to ensure adequate seed coverage.

PREPLANT INCORPORATED APPLICATIONS

PURSUIT may be applied following land preparation and should be **thoroughly incorporated** to a depth of 1 to 2 inches. When applied to beds, maintain PURSUIT in the surface 1 to 2 inches of the finished beds. Application may be made up to 45 days prior to planting soybeans.

If crops are planted on beds, apply and incorporate after bed formation using PTO-driven equipment or a rolling cultivator.

When PURSUIT is soil applied for control of nutsedge in peanuts incorporate with two passes of the incorporation implement. Make the second pass at an offset angle to the first pass to minimize the potential for streaking.

FEDERAL CONSERVATION RESERVE PROGRAM AND AGRICULTURAL RESERVE PROGRAM LAND SEEDED TO FORAGE LEGUME SPECIES AND PERENNIAL FORAGE GRASSES.

DIRECTIONS FOR USE

PURSUIT is effective in controlling many annual broadleaf and grass weeds in **CONSERVATION RESERVE PROGRAMS** and **AGRICULTURAL RESERVE PROGRAMS (SET-ASIDE)** land seeded to forage legume or grass crops. A PURSUIT application may result in temporary reduction in growth of legumes and grasses. Plants overcome temporary effects and become well established due to reduced weed competition.

DO NOT feed or graze legumes or grasses following a PURSUIT application. DO NOT cut treated legumes or grasses for hay or forage. DO NOT harvest legume seed for livestock feed. DO NOT use seed from treated legumes for sprouting. Apply only one application of PURSUIT per year.

COVER CROPS:

LEGUMES: Apply to forage legumes including alfalfa, clovers, crownvetch, birdsfoot trefoil and lespedeza.

GRASSES: PURSUIT may be applied to the following grasses: big bluestem, little bluestem, switchgrass, Russian wildrye, intermediate wheatgrass, crested wheatgrass, western wheatgrass, tall wheatgrass, smooth brome, canarygrass or orchardgrass.

APPLICATION RATE: Apply PURSUIT at 4 fluid ounces per acre.

APPLICATION TIMING: PURSUIT may be applied postemergence to seedling legumes (with at least 3 fully expanded trifoliate leaves) or to established legumes. On established legumes, PURSUIT may be applied in the fall or in the spring before weeds exceed the maximum recommended size for control.

DO NOT apply to seeded grasses until they have 4 leaves.

Refer to the WEEDS CONTROLLED under the SOYBEAN section of this label.

CROPS

IMI-CORN - DIRECTIONS FOR USE

PURSUIT HERBICIDE USE AREA (IMI-CORN)

(Not for use in California)

Do not apply PURSUIT to IMI-Corn in North Dakota or in Minnesota north of state highway 210.

USE RATE (4 OUNCES PER ACRE)

Apply PURSUIT at a broadcast rate of 4 ounces per acre (1/4 pint) for all methods of application: early preplant, preplant incorporated, preemergence, and postemergence (including minimum and no-till). At this broadcast rate, one gallon of PURSUIT will treat 32 acres of IMI-Corn.

NOTE: Only one application of PURSUIT may be made during the season.

WEEDS CONTROLLED

When applied as directed, PURSUIT will control or reduce competition from the weeds listed below. Refer to the MIXING INSTRUCTIONS section on page 4 for recommendations when weeds are at the maximum recommended growth stage, or are under stress.

NOTE: C = Control, R = Reduced Competition

(The number under Maximum Leaf Stage indicates the MAXIMUM number of leaves at which weeds should be sprayed postemergence).

BROADLEAF WEEDS

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Alligator weed		4	1-3
Anoda, spurred	C	2	1-2
Artichoke, Jerusalem		8	6-10
Buffalobur	C*	R	1-3
Bristly starbur		2	1-2
Carpetweed	C		
Cocklebur, common	R	8	1-8
Galinsoga	C		
Jimsonweed	C*	4	1-3
Kochia	C	4	1-3
Lambsquarters, common	C*	R	1-2
Mallow, Venice	R		
Marshelder	C	4	1-3
Morningglory			
entireleaf	R	2	1-2
ivyleaf	R	2	1-2
pitted	R	2	1-2
smallflower	C	4	1-3
tall	R	2	1-2

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Mustard sp.	C	4	1-3
Nightshade			
black	C	4	1-3
Eastern black	C	4	1-3
hairy	C	4	1-3
Pigweed			
redroot	C	8	1-8
smooth	C	8	1-8
spiny	C	8	1-8
Poinsettia, wild	C		
Puncturevine	C		
Purslane, common	C		
Pusley, Florida	C		
Ragweed,			
common	R	4	1-3
giant	R	4	1-3
Sage, barnyard		R	1-3
Sida, prickly	C*		
Smartweed			
ladysthumb	C	4	1-3
Pennsylvania	C	4	1-3
Spurge			
prostrate	C	4	1-3
spotted	C	4	1-3
Sunflower	C*	4	1-3
Thistle, Canada		R	1-3
Velvetleaf	C*	4	1-3

* When PURSUIT is soil applied, these weeds are more consistently controlled by preplant incorporated treatments.

DO NOT count cotyledon leaves when determining weed stage of growth.

GRASS WEEDS*

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Barnyardgrass	R	3	1-3
Crabgrass,			
large	R	3	1-3
smooth	R	3	1-3
Cupgrass, woolly		3	1-3
Foxtail,			
giant	C	6	1-6
green	C	3	1-3
yellow	C	3	1-3
Goosegrass	R		
Johnsongrass,			
seedling	C	6	1-8
rhizome		R	6-12
Millet, wild proso	R	R	1-3
Panicum,			
fall	R		
Texas	R		
Red rice		3	1-3
Sandbur, field	R	R	≤1

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Shattercane	R	6	1-8
Signalgrass, broadleaf	R	4	1-8
Sorghum album	R	6	1-3

SEDGES

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Nutsedge			
purple	R	R	1-3
yellow	R	R	1-3

* When PURSUIT is applied to grasses, preplant incorporated treatments are more consistent.

SEQUENTIAL HERBICIDE COMBINATIONS WITH PURSUIT

PURSUIT Following Early Preplant Application of:

2,4-D	Dual	Lasso EC
Bicep ⁸ , Bicep Lite ⁸	Extrazine II ¹	Lasso MT
Bronco ⁷	Frontier ⁶	Roundup ⁷
Bullet ⁷	Gramoxone Extra ⁴	

PURSUIT Following Preplant Incorporated Application of:

Atrazine*	Eradicane Extra	Lasso EC, Lasso MT
Bicep, Bicep Lite	Extrazine II	Sutan*
Bullet	Frontier	
Dual	Lariat ⁷	

PURSUIT Following Preemergence Application of:

Atrazine	Bronco	Frontier
Banvel ^{6,*}	Bullet	Lariat
Bicep, Bicep Lite	Clarity ^{6,*}	Lasso EC, Lasso MT
Bladex ¹ 4L	Dual	Marksman ^{6,*}
Bladex 90DF	Extrazine II	PROWL 3.3 EC

TANK-MIX HERBICIDE COMBINATIONS WITH PURSUIT

Early Preplant Application of PURSUIT Tank-Mixed With:

2,4-D	Frontier	Lasso MT
Bronco	Gramoxone Extra	Roundup
Dual	Lasso EC	

Preplant Incorporated Application of PURSUIT Tank-Mixed With:

Atrazine	Eradicane Extra	Lasso EC, Lasso MT
Bicep, Bicep Lite	Extrazine II	Sutan*
Bullet	Frontier	
Dual	Lariat	

Preemergence Application of PURSUIT Tank-Mixed With:

Atrazine	Bronco	Frontier
Banvel	Bullet	Lariat
Bicep, Bicep Lite	Clarity	Lasso EC, Lasso MT
Bladex 4L	Dual	Marksman
Bladex 90DF	Extrazine II	PROWL 3.3 EC

Postemergence Applications of PURSUIT Tank-Mixed With:

Atrazine***	Clarity***	Marksman*
Banvel***	Dual	PROWL 3.3 EC
Basagran ^{3,*}	Frontier	Sencor DF ¹⁰
Buctril ^{9,**}	Lasso EC, Lasso MT	Sencor 4L ¹⁰

* In some cases the grass activity of PURSUIT will be reduced when used in combination with atrazine, Buctril, Banvel, Basagran, Clarity, or Marksman.

** Some corn leaf burn may result with Buctril or atrazine postemergence combinations with PURSUIT.

*** Applications of Banvel or Clarity herbicide to corn during periods of rapid growth may result in temporary leaning.

DO NOT use crop oil concentrates as adjuvants in PURSUIT combinations with Banvel, Buctril, Clarity, Marksman, Sencor DF or Sencor 4L.

DO NOT tank-mix PURSUIT with Accent¹ or Beacon².

PURSUIT is active against many broadleaf and grass species. However, for long term weed management, alternate mode of action herbicides are recommended with PURSUIT. The application of a soil applied grass herbicide underlay will control grass weeds not on the PURSUIT herbicide label and enhance the control of certain broadleaf weeds such as common lambsquarters.

When PURSUIT is used in combination with another herbicide, refer to the respective label for rates, methods of application, proper timing, weeds controlled, restrictions and precautions. Always use in accordance with the more restrictive label restrictions and precautions. No label dosages should be exceeded. PURSUIT cannot be mixed with any product containing a label prohibiting such mixtures.

CROPS

SOYBEANS - DIRECTIONS FOR USE

PURSUIT HERBICIDE USE AREA (SOYBEANS)

(Not for use in California)

Do not apply PURSUIT to soybeans in North Dakota or in Minnesota north of state highway 210.

USE RATE (4 OUNCES PER ACRE)

Apply PURSUIT at a broadcast rate of 4 ounces per acre (1/4 pint) for all methods of application: early preplant, preplant incorporated, preemergence, and postemergence (including minimum and no-till). At this broadcast rate, one gallon of PURSUIT will treat 32 acres of soybeans.

NOTE: Only one application of PURSUIT may be made during the season.

WEEDS CONTROLLED

When applied as directed, PURSUIT will control or reduce competition from the weeds listed below. Refer to the MIXING INSTRUCTIONS section on page 4 for recommendations when weeds are at the maximum recommended growth stage, or are under stress.

NOTE: C = Control, R = Reduced Competition

(The number under Maximum Leaf Stage indicates the MAXIMUM number of leaves at which weeds should be sprayed postemergence).

BROADLEAF WEEDS

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Alligator weed		4	1-3
Anoda, spurred	C	2	1-2
Artichoke, Jerusalem		8	6-10
Buffalobur	C*	R	1-3
Bristly starbur		2	1-2

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Carpetweed	C		
Cocklebur, common	R	8	1-8
Galinsoga	C		
Jimsonweed	C*	4	1-3
Kochia	C	4	1-3
Lambsquarters, common	C*	R	1-2
Mallow, Venice	R		
Marshelder	C	4	1-3
Morningglory			
entireleaf	R	2	1-2
ivyleaf	R	2	1-2
pitted	R	2	1-2
smallflower	C	4	1-3
tall	R	2	1-2
Mustard sp.	C	4	1-3
Nightshade			
black	C	4	1-3
Eastern black	C	4	1-3
hairy	C	4	1-3
Pigweed			
redroot	C	8	1-8
smooth	C	8	1-8
spiny	C	8	1-8
Poinsettia, wild	C		
Puncturevine	C		
Purslane, common	C		
Pusley, Florida	C		
Ragweed,			
common	R	4	1-3
giant	R	4	1-3
Sage, barnyard		R	1-3
Sida, prickly	C*		
Smartweed			
ladysthumb	C	4	1-3
Pennsylvania	C	4	1-3
Spurge			
prostrate	C	4	1-3
spotted	C	4	1-3
Sunflower	C*	4	1-3
Thistle, Canada		R	1-3
Velvetleaf	C*	4	1-3

* When PURSUIT is soil applied, these weeds are more consistently controlled by preplant incorporated treatments.

GRASS WEEDS*

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Barnyardgrass	R	3	1-3
Crabgrass, large	R	3	1-3
smooth	R	3	1-3
Cupgrass, woolly		3	1-3
Foxtail, giant	C	6	1-6
green	C	3	1-3
yellow	C	3	1-3
Goosegrass	R		
Johnsongrass, seedling	C	6	1-8
rhizome		R	6-12
Millet, wild proso	R	R	1-3
Panicum, fall		R	
Texas	R		
Red rice		3	1-3
Shattercane	R	6	1-8
Signalgrass, broadleaf	R	4	1-8
Sorghum, alnum	R	6	1-3

SEDGES

Weeds Controlled	SOIL APPLIED	POSTEMERGENCE	
		Maximum Leaf Stage	Size (inches)
Nutsedge			
purple	R	R	1-3
yellow	R	R	1-3

* When soil applied to grasses, preplant incorporated treatments of PURSUIT are more consistent.

Do not count cotyledon leaves when determining weed stage of growth.

PURSUIT is active against many broadleaf and grass species. However, when heavy grass or common lambsquarters pressure is anticipated, PURSUIT should be used in combination with a registered soil-applied grass herbicide (See HERBICIDE COMBINATIONS section).

HERBICIDE COMBINATIONS

GRASS WEEDS

Use a soil applied grass herbicide (such as PROWL® 3.3 EC) to control grass weeds not on the PURSUIT label and to enhance the control of certain broadleaf weeds such as common lambsquarters and pigweeds. Refer to the PROWL 3.3 EC (or other grass herbicide) label for specific use recommendations, rates and precautions.

When applied as directed, PURSUIT preplant incorporated or pre-emergence combination treatments with PROWL 3.3 EC, trifluralin, Frontier, Lasso or Dual will control the weeds listed in following table, in addition to those controlled by PURSUIT alone.

GRASSES	PROWL 3.3 EC ^a	trifluralin ^b	Lasso	Dual	Frontier
Barnyardgrass	X	X	X	X	X
Crabgrass, smooth	X	X	X	X	X
Crabgrass, large	X	X	X	X	X
Crowfootgrass	X	X			
Goosegrass	X	X	X	X	X
Millet, wild proso	X	X			
Panicum, fall	X	X	X	X	X
Panicum, Texas	X	X			
Sandbur, field	X	X			
Shattercane	X ^b	X			
Signalgrass, broadleaf	X ^b	X	X	X	X
Witchgrass	X	X	X	X	X

^a Preplant incorporated tank-mixture applications of PURSUIT plus PROWL 3.3 EC will suppress the growth of itchgrass, and rhizome Johnsongrass.

^b Preplant incorporated treatments only.

A selective postemergence grass herbicide such as Select¹¹, Poast Plus³, Fusilade 2000⁴, Fusion⁴, Assure¹ or Option¹² may be mixed with PURSUIT to control volunteer corn or grasses not controlled by PURSUIT. For best results use SUN-IT II or a crop oil concentrate AND liquid fertilizer with grass herbicide tank-mixtures.

In some cases the activity of the grass herbicide may be reduced when mixed with PURSUIT. The reduction in activity may be overcome by delaying the application of the postemergence grass herbicide 7 days following the application of PURSUIT. If the grass herbicide is applied first, wait 3 days before applying PURSUIT. Refer to the respective grass herbicide label for recommended application rate, weed size and restrictions.

BROADLEAF WEEDS

Broadleaf herbicides that can be tank-mixed with PURSUIT include Basagran³, Blazer³, Bronco⁷, Cobra¹¹, Galaxy³, Gramoxone Extra, Roundup, Storm³ or Reflex⁴. Certain herbicides should not be applied with PURSUIT (see Page 12 for restrictions).

PURSUIT may be applied either preplant incorporated or preemergence in tank-mix combination with metribuzin (Sencor or Lexone¹) or preemergence with linuron (Lorox¹ or Linex¹³). PURSUIT may also be applied preplant incorporated, followed by a preemergence application of metribuzin or linuron. The tank-mix or sequential application of PURSUIT and metribuzin will enhance the control of common cocklebur and common ragweed in addition to the weeds controlled by a soil application of PURSUIT. The addition of linuron to PURSUIT will enhance the control of common ragweed.

CROPS

PEANUTS - DIRECTIONS FOR USE

PURSUIT USE AREA (PEANUTS)

(Not for use in California)

PURSUIT may be used on peanuts in any state where peanuts are grown (except California).

PURSUIT HERBICIDE USE RATE (4 OUNCES PER ACRE)

Apply PURSUIT at a broadcast rate of 4 ounces per acre (1/4 pint) for all methods of application (except sequential - see below): pre-plant incorporated, preemergence, ground-cracking and post-emergence. At this broadcast rate, one gallon of PURSUIT will treat 32 acres of peanuts.

PURSUIT may also be applied in a sequential application (See page 10). Apply 2 ounces in a soil application (preplant incorporated or preemergence) followed by 2 ounces applied at ground-crack or postemergence.

NOTE: Do not apply more than 4 ounces of PURSUIT during the growing season.

WEEDS CONTROLLED

When applied as directed, PURSUIT will control or reduce competition from the weeds listed below. Refer to the MIXING INSTRUCTIONS section on page 4 for recommendations when weeds are at the maximum recommended growth stage, or are under stress.

NOTE: C = Control, R = Reduced Competition

(The number under Maximum Leaf Stage indicates the MAXIMUM number of leaves at which weeds should be sprayed postemergence).

BROADLEAF WEEDS

Weeds Controlled	SOIL APPLIED	AT-CRACK	POSTEMERGENCE	
			Maximum Leaf Stage	Size (inches)
Alligator weed		C	4	1-3
Anoda, spurred	C	C	2	1-2
Buffalobur	C*	C	R	1-3
Bristly starbur			2	1-2
Carpetweed	C	C		
Cocklebur, common	R	C	8	1-8
Devilsclaw	C	C		
Galinsoga	C	C		
Jimsonweed	C*	C	4	1-3
Lambsquarters, common	C*	C	R	1-2
Morningglory				
entireleaf	R	C	2	1-2
ivyleaf	R	C	2	1-2
pitted	R	C	2	1-2
smallflower	C	C	4	1-3
tall	R	C	2	1-2
Mustard sp.	C	C	4	1-3
Nightshade				
black	C	C	4	1-3
Eastern black	C	C	4	1-3
hairy	C	C	4	1-3
Pigweed				
redroot	C	C	8	1-8
smooth	C	C	8	1-8
spiny	C	C	8	1-8
Poinsettia, wild	C	C		
Puncturevine	C	C		
Purslane, common	C	C		
Pusley, Florida	C	C		
Ragweed,				
common	R	R	4	1-3
giant	R	R	4	1-3
Sida, prickly (teaweed)	C*	C		
Smartweed				
ladysthumb	C	C	4	1-3
Pennsylvania	C	C	4	1-3
Spurge				
prostrate	C	C	4	1-3
spotted	C	C	4	1-3
toothed	C	C		
Sunflower	C*	C	4	1-3
Velvetleaf	C*	C	4	1-3

* When PURSUIT is soil applied, these weeds are more consistently controlled by preplant incorporated treatments.

GRASS WEEDS

Weeds Controlled	SOIL APPLIED*	AT-CRACK	POSTEMERGENCE	
			Maximum Leaf Stage	Size (inches)
Barnyardgrass	R	R	3	1-3
Crabgrass,				
large	R	C	3	1-3
smooth	R	C	3	1-3
Cupgrass, woolly			3	1-3
Foxtail,				
giant	C	C	6	1-6
green	C	C	3	1-3
yellow	C	C	3	1-3
Goosegrass	R	R		
Johnsongrass,				
seedling	C	C	6	1-8
rhizome			R	6-12
Panicum,				
fall	R			
Texas	R			
Red rice			3	1-3
Shattercane	R	R	6	1-8
Signalgrass, broadleaf	R	C	4	1-6

SEDGES

Nutsedge				
purple	C	C	3	1-3
yellow	C	C	3	1-3

* When PURSUIT is soil applied to grasses, more consistent control can be obtained from preplant incorporated treatments.

Do not count cotyledon leaves when determining weed stage of growth.

AT CRACK APPLICATION refers to the time when the soil cracks due to the emerging peanut seedling. This generally occurs from 10 to 14 days following planting. At this time weeds have generally not germinated, or are in the seedling stage. If weeds have more than 2 true leaves, refer to the POSTEMERGENCE weed control column for weeds controlled.

In West Texas, New Mexico and Arizona, wait until late cracking (most of the peanuts have emerged) before applying PURSUIT.

PURSUIT is active against many broadleaf and grass species. However, when heavy grass or common lambsquarters pressure is anticipated, PURSUIT should be used in combination with a registered soil-applied grass herbicide (See HERBICIDE COMBINATIONS section).

WEEDS CONTROLLED BY SEQUENTIAL APPLICATIONS OF PURSUIT

The sequential (split) application of PURSUIT consists of an application of 2 ounces of product soil applied (either preplant incorporated or preemergence) followed by 2 ounces applied either at ground-crack or postemergence.

When applied as a sequential treatment, PURSUIT will control the weeds listed under the "SOIL APPLIED" and "AT-CRACK" applications in the BROADLEAF WEEDS and GRASS WEEDS tables (in the peanut section of the label). It enhances the control of yellow and purple nutsedge. Apply the second application before the nut-sedge exceeds 3 leaves.

HERBICIDE COMBINATIONS**GRASS WEEDS**

When applied as directed, PURSUIT preplant incorporated or preemergence combination treatments with PROWL 3.3 EC® herbicide, trifluralin, Lasso, Dual, Balan², Sonolan² or Vernam⁴ will control the weeds listed in following table, in addition to those controlled by PURSUIT alone.

GRASSES	PROWL 3.3 EC^a	trifluralin^b	Lasso	Dual	Balan^b	Sonolan^b	Vernam^b
Barnyardgrass	X	X	X	X	X	X	X
Crabgrass, smooth	X	X	X	X	X	X	X
Crabgrass, large	X	X	X	X	X	X	X
Crowfootgrass	X	X			X		
Goosegrass	X	X	X	X	X	X	X
Panicum, fall	X	X	X	X	X	X	X
Panicum, Texas	X	X			X	X	
Sandbur, field	X	X			X	X	
Signalgrass, broadleaf	X ^b	X	X	X	X	X	
Witchgrass	X	X	X	X		X	

^a Preplant incorporated tank-mixture applications of PURSUIT plus PROWL 3.3 EC will suppress the growth of itchgrass, and rhizome johnsongrass.

^b Preplant incorporated treatments only.

A selective postemergence grass herbicide such as Poast Plus, Bugle¹⁴ or Whip¹⁴ may be mixed with PURSUIT to control grasses not controlled by PURSUIT. In some cases the activity of the grass herbicide may be reduced when mixed with PURSUIT. The reduction in activity may be overcome by delaying the application of the postemergence grass herbicide 7 days following the application of PURSUIT. If the postemergence grass herbicide is applied first, wait 3 days before applying PURSUIT. Refer to the respective grass herbicide label for recommended application rate, weed size and restrictions.

BROADLEAF WEEDS

Broadleaf herbicides that can be tank-mixed with PURSUIT include Basagran and Blazer, Starfire and 2,4-DB. Certain herbicides should not be applied with PURSUIT (see Page 12 for restrictions).

For the control of sicklepod, morningglories, prickly sida and common ragweed, add 2,4-DB to the PURSUIT spray mixture. For the control of Florida beggarweed, add Starfire to the spray mixture. Refer to the 2,4-DB or Starfire label for specific directions for use, application rates and restrictions.

PURSUIT may also be applied postemergence in tank-mixture with Bravo¹⁵, Bravo S¹⁵, Orthene¹¹ or Solubor¹⁶.

CROPS**RED KIDNEY BEANS - DIRECTIONS FOR USE****PURSUIT HERBICIDE USE AREA
(RED KIDNEY BEANS)**

(For use in California only)

Apply PURSUIT herbicide when weeds are actively growing and red kidney beans have at least 1 fully expanded trifoliate leaf. DO NOT apply PURSUIT postemergence when the crop and weeds have been subjected to stress conditions such as temperature and moisture extremes.

For maximum weed control, cultivate 7-10 days following a post-emergence PURSUIT application. This timely cultivation will enhance residual weed control, especially under dry conditions.

USE RATE (3 OUNCES PER ACRE)

Apply PURSUIT at a broadcast rate of 3 ounces per acre post-emergence only. At this broadcast rate, one gallon of PURSUIT will treat 42.7 acres of red kidney beans.

DO NOT apply by aerial application.

Only one application of PURSUIT may be made during the season. Allow at least 60 days between application and harvest.

WEEDS CONTROLLED

When applied as directed, PURSUIT will control or reduce competition from the weeds listed below. Refer to the MIXING INSTRUCTIONS section on page 4 for recommendations when weeds are at the maximum recommended growth stage, or are under stress. (The number under Maximum Leaf Stage indicates the MAXIMUM number of leaves at which weeds should be sprayed post-emergence).

WEEDS

Weeds Controlled	POSTEMERGENCE	
	Maximum Leaf Stage	Size (inches)
Kochia	4	1-3
Mustard, wild	4	1-3
Nightshade,		
black	4	1-3
Eastern black	4	1-3
hairy	4	1-2
Pigweed, redroot	4	1-3

ROTATIONAL CROP GUIDELINE

The following rotational crops may be planted after applying PURSUIT at the recommended rate: (Planting earlier than the recommended interval may result in crop injury).

1. Anytime

Lima beans	Peanuts
Southern peas	IMI-Corn
Soybeans	(resistant/tolerant to PURSUIT)

2. Four months after PURSUIT application:

Rye
Wheat
Edible beans and peas (other than lima beans and Southern peas)

3. Eight and one-half months after PURSUIT application:

Field corn
Field corn grown for seed*

4. Nine and one-half months after PURSUIT application:

Barley
Tobacco

5. Eighteen months after PURSUIT application:

Alfalfa	Popcorn
Cotton	Safflower
Lettuce	Sweettorn
Oats	Sorghumrn

6. Twenty six months after PURSUIT application.

All crops not listed elsewhere in this ROTATIONAL CROP GUIDELINE.

7. Forty months after PURSUIT application.

Sugar beets
Red table beets

* Several seed companies have tested a wide range of inbreds for sensitivity to PURSUIT soil residues and have reported good crop safety. However, due to the proprietary nature of seed production, American Cyanamid has not been given access to the inbred data. Growers are directed to contact the seed company for information and recommendations regarding the planting of corn grown for seed in fields treated with PURSUIT the previous year. Since growing conditions, environmental conditions and grower practices are beyond the control of American Cyanamid Company, all risks and consequences associated with planting seed corn inbreds into fields treated previously with PURSUIT shall be assumed by the user.

Use of PURSUIT herbicide in accordance with label directions is expected to result in normal growth of rotational crops in most situations; however, various environmental and agronomic factors make it impossible to eliminate all risks associated with the use of this product and, therefore, rotational crop injury is always possible.

PRECAUTIONS

IMI-Corn

There should be an interval of at least 45 days between an application of PURSUIT and corn harvest (silage, fodder, or grain). DO NOT graze or feed treated corn forage, silage, fodder, or grain for at least 45 days after an application of PURSUIT.

All soil insecticides, including labeled banded or in-furrow applications, may be used in combination with Pioneer imidazolinone resistant (IR) corn hybrids.

Imidazolinone tolerant hybrids from other seed companies may occasionally exhibit injury symptoms when soil insecticides are used in combination with PURSUIT. Use banded applications of COUNTER® 15G or THIMET® in combination with PURSUIT application. COUNTER® CR® may be used in furrow or banded. DO NOT USE COUNTER 15G soil insecticide in-furrow with imidazolinone tolerant hybrids. American Cyanamid has not tested all hybrids in which the imidazolinone tolerance trait is claimed and cannot be responsible for factors which are beyond its control, such as growing conditions, environmental conditions, grower practices and the specific genetics of each hybrid tolerance to PURSUIT and insecticide applications.

Soybeans

If soybeans are furrow irrigated, till the soil prior to planting winter wheat or barley. The beds should be broken up and the soil mixed with tillage equipment set to cut 4-6 inches deep.

There should be an interval of at least 85 days between an application of PURSUIT and soybean harvest.

PURSUIT applications should be made before soybean bloom.

Do not graze or feed treated soybean forage, hay or straw to livestock.

DO NOT tank-mix PURSUIT with clomazone containing herbicides (Command¹⁷ or Commence¹⁷). PURSUIT may be applied post-emergence following a soil application of Command or Commence.

Peanuts

Do not graze or feed treated peanut forage, vines, hay or straw to livestock.

There should be an interval of at least 85 days between an application of PURSUIT and peanut harvest.

NOTE: Classic may be applied postemergence to peanuts following a PURSUIT application. Refer to the Classic label for specific use recommendations.

DO NOT apply PURSUIT[®] PLUS or PASSPORT[®] to peanuts the same year as PURSUIT.

General

Except where stated on a Supplemental Label or in this label, DO NOT apply products containing chlorimuron ethyl (Classic¹, Canopy¹, Gemini¹, Lorox Plus¹, Preview¹, etc.) imazaquin (SCEPTER[®], SQUADRON[®], TRI-SCEPT[®], SCEPTER[®] O.T.[®], SCEPTER[®] 70DG) or products containing imazethapyr (CONTOUR[®], PURSUIT[®] DG, PURSUIT[®] PLUS, PASSPORT[®]) the same year as PURSUIT or injury to follow crops may occur.

Only rotational crops harvested at maturity may be used for feed or food.

In the event of a crop loss due to weather, soybeans, peanuts or IMI-Corn can be replanted. DO NOT work the soil deeper than 2 inches.

For additional information regarding the use of PURSUIT herbicide, call telephone no. 800-942-0500.

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⁷ Lasso, Roundup, Bronco and Bullet are trademarks of Monsanto Agricultural Company.

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American Cyanamid Company

Agricultural Products Division

Crop Protection Chemicals Department

Wayne, NJ 07470

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Protecting the Applicator

What's in this Chapter:

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Pesticide Exposure and Toxicity

Injuries Caused by Pesticides

Long-term Dangers

How to Know if Someone Has Been Poisoned

What to Do if Someone Is Poisoned

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Handling Contaminated Clothing

Heat Stress

Learning Objectives

After you complete your study of this chapter, you should be able to:

- Explain the concepts of hazard, exposure, and toxicity and how they relate to one another;
- List the four routes by which your body can be exposed to pesticides, and name the route that should be of most concern to you;
- List three factors that determine how quickly pesticides will be absorbed through your skin;
- Explain the three main types of harmful effects that pesticides can cause poisoning in humans;
- Describe how to avoid harmful effects from pesticides;
- Recognize some general signs and symptoms of pesticide poisoning and of pesticide irritation effects;
- Perform appropriate first aid for pesticide exposures;
- Define "heat stress" and recognize some signs and symptoms of heat stress;
- Perform appropriate first aid for heat stress;
- Describe the differences between various respiratory devices and when to use them;
- Explain which types of clothing are necessary when working with pesticides;
- Explain proper steps for laundering pesticide contaminated clothing.

Terms to Know

Active ingredients. The chemicals in a pesticide product that control the target pest.

Acute dermal LD₅₀. The dose of a pesticide applied to the skin that kills 50 percent of the test population of animals.

Acute effects. Illnesses or injuries that may appear immediately after exposure to a pesticide (usually within 24 hours).

Acute inhalation LC₅₀. The concentration of a pesticide in air over a predetermined period of time that kills 50 percent of the test population of animals.

Acute oral LD₅₀. The orally ingested dose of a pesticide that kills 50 percent of the test population of animals.

Acute toxicity. Poisoning that occurs within a few hours or days after an acute exposure.

Chronic effects. Illness or injury that appears a long time, usually several years, after chronic or acute exposure to a pesticide.

Chronic exposure. Exposure to repeated small doses of a pesticide over long a period of time.

Chronic toxicity. A measure of the capacity of a pesticide to cause injury as a result of repeated exposures over a period of time.

Delayed effects. Illnesses or injuries that do not appear immediately (within 24 hours) after exposure to a pesticide or combination of pesticides.

Exposure. Coming into contact with a pesticide; getting a pesticide on a surface or in or on an organism.

Formulation. Pesticide product as sold, usually a mixture of active and inert ingredients.

LD_{50} and LC_{50} . A commonly used unit of measurement for oral or dermal acute toxicity.

Personal protective equipment (PPE). Devices and clothing worn to protect the human body from contact with pesticides or pesticide residues.

Precautionary statements. Pesticide labeling statements that alert you to possible hazards from the use of the pesticide product that sometimes indicate specific actions to take to avoid the hazards.

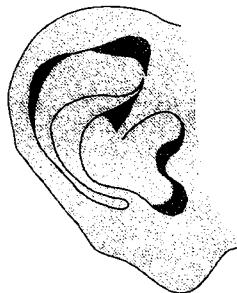
Signal words. Standardized designations of relative levels of toxicity that must, by law, appear on pesticide labels. The signal words used are DANGER, or DANGER/POISON, or WARNING, or CAUTION.

Solvent. A liquid, such as water, kerosene, xylene, or alcohol that will dissolve a pesticide (or other substance) to form a solution.

Introduction

This chapter will discuss the various routes of entry of pesticides into the human body. Pesticides have varying degrees of toxicity, and so the best way to remain safe while applying pesticides is to avoid exposure to your skin, mouth, eyes, and respiratory system. In case an accidental pesticide poisoning occurs, a procedure for taking care of the poisoning victim is covered in this chapter. Personal protective equipment (PPE), which includes respirators, dust masks, and other protective clothing can greatly reduce an applicator's risk of pesticide exposure. Read pesticide labels carefully for applicator protection requirements (such as personal protective equipment).

How A Person Can Be Poisoned



The scalp, ear canal, and forehead all may absorb pesticides easily.

For a pesticide to cause harm to a person, it must first get into the body. This can happen if the pesticide comes into contact with the skin or eyes, if it is swallowed, or if it is inhaled. The greatest chance of accidents and highest risk of exposure resulting in a pesticide poisoning occurs when mixing and loading undiluted pesticide products.

While many pesticides can damage the skin and eyes upon contact, the most harmful toxic effects usually occur when pesticides enter the body. There are four main routes by which pesticides can enter your body:

- Dermal exposure (when you get a pesticide on your skin);
- Oral exposure (when you swallow a pesticide);
- Inhalation exposure (when you breathe in pesticide vapors or dusts); and
- Eye exposure.

You can be exposed to pesticides whenever you handle them: during mixing and loading, applying, or disposing of them. Some of the more common ways in which you can be exposed to pesticides are listed below.

Dermal Exposure

The skin receives the greatest amount of exposure among pesticide handlers. The EPA estimates that 97 percent of all exposure when spraying pesticides is to the skin. The amount of pesticide that your skin absorbs depends on several factors: the chemical itself; the extent of the exposure; the product's formulation; the area of your body that is exposed; and the condition of the exposed skin.

A pesticide can get on your skin or in your eyes:

- If it spills or splashes as you handle it;
- If it drifts as you apply it;
- If you brush against crops or plants that have been treated; or
- If you touch contaminated equipment, clothing, or other items.

Different areas of the body absorb pesticides at different rates. The genital area tends to be the most absorptive. So, always wash your hands before using the bathroom. The scalp, ear canal, and forehead are also highly absorptive. Pesticides enter the body through cuts and scrapes more easily than through unbroken skin. Hot, sweaty skin will absorb pesticides more readily than dry, cool skin.

Oral Exposure

Oral exposure to pesticides is very dangerous but relatively rare among pesticide handlers; it is almost always due to inexcusable carelessness. In fact, the most common cause of oral exposure is a result of putting

pesticides into unlabeled bottles or food containers. If you swallow a pesticide, you may suffer injuries beyond poisoning. You may suffer severe burns in your mouth and throat. Swallowing pesticides can harm the mouth, throat, and digestive organs. From the digestive tract, the pesticide can enter the bloodstream.

Inhalation Exposure

Many pesticides form particles, droplets, or fumes that are easy to breathe in. The lungs can absorb pesticides very quickly. From the lungs, pesticides can move easily into the bloodstream.

Inhalation exposure is particularly hazardous because lungs can rapidly absorb pesticides, especially vapors and extremely fine particles. Inhaled pesticides can damage nose, throat, and lung tissue. The inhalation hazard is generally low when you apply dilute sprays with conventional equipment because such applications produce relatively large droplets. When you make low- or ultra-low-volume applications, however, very small droplets of concentrated materials are produced, which increases the inhalation hazard.

Eye (Ocular) Exposure

Eyes are particularly absorbent. Your eyes may be damaged by a pesticide, but may also absorb enough of it to make you seriously or even fatally ill. Ocular pesticide exposure may result in eye irritation, impaired vision, or temporary or permanent blindness.

Pesticide Exposure and Toxicity

There are two types of pesticide exposure and two types of pesticide toxicity that can affect human health:

- Acute exposure and chronic exposure;
- Acute toxicity and chronic toxicity.

Acute exposure is a relatively large dose of a pesticide in a relatively short period of time. Because the toxicity of pesticides varies, an acute exposure dose for one pesticide may be much smaller than an acute dose for another pesticide.

Chronic exposure is many relatively small doses over a long period of time.

Acute toxicity is the poisoning that occurs within a few hours or days after an acute exposure.

Chronic toxicity is the long-term health effects that may occur months or years after exposure. Chronic toxicity may occur after either acute or chronic exposure.

The Toxicity of Pesticides

Some pesticides are more toxic than others; but toxicity is not the only factor that creates a poisoning risk. The risk of pesticide poisoning depends on the following conditions:

- The class of pesticide and the chemical make-up of the pesticide. Some chemical compounds in pesticides are more dangerous to humans than others.
- The dosage of pesticide that enters the body. With some pesticides, a very small dose could cause permanent harm or even death.
- The amount of time the body is exposed to the pesticide. In general, the longer the exposure, the more harm the poison can do.
- The route of entry (the way the pesticide enters the body). For example, one pesticide may be less harmful if it gets on the skin than if it is swallowed.

Keep in mind that the LD₅₀ refers to results of tests on animals, not humans. The findings may not always apply directly to humans, but they do help as a guide.

Handling a toxic pesticide safely reduces exposure and risk of poisoning.

A simple formula to keep in mind is: Risk = Exposure x Toxicity



Measuring toxicity: LD₅₀ and LC₅₀

A toxicity rating is given to each substance to show how toxic it is. For oral and dermal exposures, the rating is called an LD₅₀. For respiratory exposure, the term LC₅₀ is used. The LD₅₀ or LC₅₀ tells the amount of pesticide that killed 50 percent of the animals tested in research studies. LD stands for lethal dose; LC stands for lethal concentration; 50 represents 50 percent of the test population. The test population is the number of animals that were exposed to the pesticide.

The pesticide is measured in milligrams (mg); the weight of the animal is measured in kilograms (kg). The LD₅₀ or LC₅₀ number represents the pesticide dose (in milligrams) for each kilogram of body weight. When a toxicity rating is given, it should state the species and sex of the test animals, the route of entry (oral, dermal, or respiratory), whether the result was acute or chronic, and the measurement units used.

Example of an LD₅₀: Pesticide A has an acute oral LD₅₀ of 42 for female white rats. This means that a large number of female rats were fed pesticide A. The dose given each animal was 42 milligrams of pesticide for each kilogram of the animal's weight. At that rate, half of the rats died within a prescribed length of time (usually a few hours).

Keep in mind that the LD₅₀ refers to results of tests on laboratory animals, not humans. The findings may not always apply directly to humans, but they do help as a guide.

NOTE: A CAUTION statement (instead of a DANGER or POISON statement) does not mean you can be careless. Careless handling of a safer product may increase your exposure and end up being more risky than properly handling more toxic compounds. Remember: Risk = Exposure x Toxicity

Relative Comparisons of Human Toxicological Risks

A major concern about pesticide use is the risk of exposure and possible impact on human health.

For a pesticide to exert a toxic effect on an organism, it must first enter the body. In humans, the major routes of pesticide entry into the body are the mouth, the respiratory system (breathing in), the skin, and the eyes.

Both acute and chronic toxicity of pesticides are of concern. Acute toxicity may differ according to the way the pesticide enters the body. Chronic toxicity is expressed over a long period of time, when an organism is exposed to single or repeated dosages of a pesticide, and is difficult to assess.

Description of toxicological information

Some toxicological data on pesticide effects on humans is available, often from accidental poisonings. More useful data are available from studies of animals that have been exposed to pesticides under controlled conditions. These data can be used to estimate exposures that are harmful to humans.

Measure of toxicity	I Highly toxic	II Moderately toxic	III Slightly toxic	IV Relatively nontoxic
Oral LD50 (mg/kg)	0-50	50-500	500-5,000	>5,000
Dermal LD50 (mg/kg)	0-200	200-2,000	2,000-20,000	>20,000
Inhalation LC50	0-2 mg/L	From 0.2 thru 2 mg/L	From 2 thru 20 mg/L	>20 mg/L
Eye effects	Corrosive	Irritation persisting for 7 days	Irritation reversible within 7 days	None
Skin effects	Corrosive	Severe Irritation	Moderate Irritation	Mild Irritation
Signal word/ Symbol	DANGER or DANGER/POISON with skull & crossbones symbol	WARNING	CAUTION	CAUTION
*Approx. oral lethal dose for a 150-pound person	A few drops to 1 teaspoon	1 teaspoon to 1 ounce	1 ounce to 1 pint or pound	More than 1 pint or pound

Source: 40 CFR 162.10*

"Basic Guide to Pesticides", Briggs et al., Washington, D.C.: Hemisphere Publishing, 1994, p.12, and "Reading a Pesticide Label", bulletin E-2182, Kamrin, M., Michigan State University Extension, May 1989, p.4.

Signal words

A pesticide product is assigned a signal word based on the most toxic route of entry (acute oral, dermal, or inhalation), or level of skin or eye corrosiveness. For example, a pesticide may be given a Danger/Poison signal word if it has a high acute inhalation toxicity despite a low acute oral toxicity. Signal words are specific for each formulated product.

Signal words are prominently displayed on the pesticide label and are designated as follows:

Danger and Danger/Poison. The product is highly hazardous. Generally, the most acutely toxic pesticides will have the symbol skull and crossbones and the words Danger/Poison on the label. Products

with concerns for severe skin or eye corrosiveness will generally only have the word Danger.

Warning. The product is moderately hazardous.

Caution. The product is slightly hazardous to nonhazardous.

These signal words and their corresponding ranges of toxicity or skin or eye effects are given in the preceding table.

Health risks limits

The Minnesota Department of Health was directed by the 1989 Minnesota Comprehensive Groundwater Act to develop health risk limits (HRL). HRLs are health-based groundwater standards that set a maximum allowable concentration for contaminants in groundwater considered safe for people to drink. All chemicals found in Minnesota groundwater, including pesticides, will be subject to HRLs except chemicals naturally present. State agencies may use HRLs as health standards in their groundwater regulatory activity. For more information contact:

Minnesota Department of Health
Section of Health Risk Assessment
925 S.E. Delaware Street
Minneapolis, MN 55414
tel: (612) 627-5046

Injuries Caused by Pesticides

The chemicals in pesticides may injure humans in a variety of ways. Each chemical has a different effect and causes different symptoms. Some are toxic to the liver, kidneys, and nervous system. Some affect the blood. Others may injure the lungs or the brain. Symptoms of pesticide poisoning range from headache, nausea, and dizziness to convulsions, vomiting, and unconsciousness.

Know the kinds of injury most likely to be caused by the pesticides you use. Knowing how pesticides affect the body makes a person more aware of the need for safe handling. Knowing what the symptoms of poisoning are may help prevent serious injury.

A chart listing the ways pesticides may harm human beings is found in Appendix B, but there are some other important things to know about certain commonly used pesticide chemicals listed here:

Organophosphates

Some of the most widely used chemicals are the organophosphates, which include many insecticides. Many are highly toxic and, due to their wide use, cause more poisonings than any other class of pesticide. In some cases, the symptoms do not appear immediately. It may take small, repeated doses over the course of the growing season before you feel ill. By that time, an added dose could cause death.

A cholinesterase blood test is a way to find out if small doses are harming you, even if there are no visible symptoms. Cholinesterase is an enzyme that affects nerve function. The blood test shows your

cholinesterase level and if any harmful effects have taken place. If the blood test shows that there has been some damage, remember that a small additional dose of an organophosphate can cause illness and a larger dose could be fatal. Check with your doctor to find out if you need a blood test. Some doctors recommend a blood test before you start spraying and periodic tests during the spraying season to monitor the cholinesterase level.

Carbamates

The effect of carbamates and organophosphates are similar — they both inhibit cholinesterase. They differ, however, in that the action of carbamates is naturally reversible (will be degraded in, and/or expelled from, the body). Thus, carbamates can cause severe acute poisoning; however, they don't normally produce long-term, cumulative poisoning. The symptoms of acute carbamate and organophosphate poisoning are essentially the same.

If you work with organophosphate or carbamate insecticides for an extended time (farmers, PCOs, pesticide applicators, pesticide manufacturers, formulators) you should establish a regular cholinesterase test program with your doctor. For a farmer, such a program might consist of one (initial) cholinesterase test to determine a "base-line level." This test should be made "off season" (January or February). Then, when insecticides are used during the summer, similar tests are conducted and the results are compared with the base-line level. Through this testing procedure, you can learn of any changes in cholinesterase levels when you are exposed to pesticides. When cholinesterase levels are low, your doctor may advise you to limit or stop your exposure to these pesticides until the cholinesterase level returns to normal.

NOTE: Because carbamates don't normally cause long-term, cumulative poisoning (as organophosphates do) cholinesterase blood tests for carbamates are not as important.

Anticoagulants

These are used to kill rodents. They prevent blood clotting and cause bleeding. Humans are relatively safe from these pesticides as it takes repeated exposure to cause serious illness.

Fumigants

Most fumigants are highly toxic and very dangerous if inhaled. They must always be used with extreme caution. Some of the symptoms of poisoning resemble drunkenness: poor coordination, confusion, drowsiness, slurred speech. Victims have been jailed or sent to mental hospitals when their condition was not diagnosed correctly.

The fumigant methyl bromide is particularly dangerous because it has no odor and is highly toxic. Chloropicrin, another fumigant, is also highly toxic, has a strong odor, and is very irritating to the eyes. It is often mixed with methyl bromide to provide a strong odor and serve as a warning agent.

Do not drink any alcohol for 24 hours before or after using a fumigant. This is a standard practice for professional fumigators. Alcohol may

make you more sensitive to fumigants. It also makes it hard to diagnose fumigant poisoning.

Botanicals

These are pesticides that are made from plants. They vary greatly in their chemical structure and toxicity. Even though they are made from natural substances, some are quite toxic. For example, strychnine is one of the most toxic pesticides.

Long-term Dangers

If exposure is high certain pesticides may cause serious long-term effects such as cancer, birth defects, and sterility. It may take months or years before the symptoms show up and it may not be possible to prove that a pesticide was the cause.

Most of the studies on these long-term effects have been done with laboratory organisms. In studies, scientists look for the effects defined below.

Carcinogenic. May cause cancer.

Oncogenic. May cause tumors, which may or may not be cancerous.

Mutagenic. May increase mutations; mutations are changes, usually harmful, in inherited genetic material.

Teratogenic. May cause birth defects.

Fetotoxic. May harm a developing fetus; the effect is often fatal.

Neurotoxic. May damage the nervous system.

Some pesticides have been shown to cause birth defects or genetic mutations in laboratory organisms, but it is still unclear if they have the same effects on humans. There is stronger evidence that some pesticides may cause cancer in humans, but it is still not conclusive.

Much research still has to be done. To do this research, people who are exposed to certain pesticides must be identified at the start. The amount of pesticide exposure must be documented as well as the exposure to other potential carcinogens. Then their health must be checked for a number of years or even decades.

How to Know if Someone Has Been Poisoned

It is not always easy to tell if an illness is due to pesticide poisoning. Some illnesses (such as heat exhaustion, asthma, or food poisoning) may have the same symptoms as pesticide poisoning. When someone who handles pesticides becomes ill, however, be aware that pesticide poisoning may be the cause. If you feel ill, think about whether the

symptoms occurred before or after you used pesticides. If you need to see a doctor, be sure to mention any pesticides you have used.

Symptoms of Acute Pesticide Poisoning

Although we may not know exactly how a pesticide acts on the body, some symptoms of poisoning are quite well known. These warning responses of the body can be recognized by anyone working with pesticides. Learn and be alert to early symptoms of acute poisoning. If any sign of poisoning develops, you should be able to respond immediately and appropriately. Doing so may prevent additional exposure and minimize injury; it may even save a person's life. Stop working with pesticides or in known treated areas if you don't feel well; leave the treated area immediately. Symptoms of pesticide poisoning are largely nonspecific; that is, a number of common illnesses such as flu or even a hangover may cause similar symptoms. Nevertheless, if any symptoms appear after contact with a pesticide, assume they are caused by the pesticide and seek medical attention. Acute effects are illnesses or injuries that may appear immediately after exposure to pesticides (usually within 24 hours). Acute effects often are reversible if appropriate medical care is given.

Some of the most common symptoms and signs of acute effects from pesticides are:

- Mouth and throat irritation, chest pains, nausea (stomachache), diarrhea, muscle twitching, sweating, headache, and weakness if the substance was ingested;
- Burning sinuses, throat, and lungs, accompanied by coughing, hoarseness, and upper respiratory congestion if the substance was inhaled;
- Skin irritation (drying and cracking), skin discoloration (reddening or yellowing), or itching if the substance was touched;
- Temporary or permanent blindness or severe irritation if substance got into the eyes. Some pesticides may not irritate your eyes, but pass through your eyes and into your body. These pesticides can travel throughout your body, causing harm in a variety of ways such as those listed above.

What to Do if Someone Is Poisoned

Be prepared! If an accident happens, you need to know exactly what to do. Read this section now. Learn it well. Don't wait for an accident to find out what to do. Any delay could lead to death.

Post emergency phone numbers next to all telephones. A complete list of pesticide related emergency numbers is displayed on the back cover of this manual. These numbers should include the poison center for your area. There are two poison centers for Minnesota. They provide

information on all types of poisoning. They can be reached 24 hours a day. The telephone numbers are:

West Metro area: (612) 347-3141

East Metro area (and the rest of Minnesota):

(612) 221-2113 or 1-800-222-1222

Have a first aid kit ready for a poisoning emergency. Learn CPR. You may need to give artificial respiration if a poisoning victim stops breathing. A CPR (cardiopulmonary resuscitation) course will teach you how.

What to Do in a Poisoning Emergency

Emergency treatment depends on the type of exposure. For dermal exposure (skin or eyes), the most important thing to do is to get the poison off the victim immediately. Use lots of water and remove contaminated clothing. For respiratory exposure (inhaling fumes), the first thing to do is to get the victim away from the fumes. If the poison has been swallowed, your first step is to call the poison center and check the label to find out what to do.

Step-by-step instructions for each type of poisoning are given below. In all cases, be careful not to let the pesticide get on you. Otherwise you could become a victim, too.

As soon as the poison has been removed from the victim, call for help. If it is a life-threatening situation (if the victim is unconscious, having a seizure, or is short of breath) call 911. Almost all of Minnesota is covered by 911; however, if there is no 911 service in your area, call an ambulance service.

In other cases of pesticide exposure, even if it doesn't seem to be a poisoning emergency, call the poison center. The experts at the poison center will know what ingredients are in the pesticide — a doctor may not. Have the pesticide label handy, if possible. Be prepared to give the poison center:

- The name of the pesticide;
- How much pesticide got on or was inhaled or swallowed by the victim;
- How long ago the poisoning occurred; and
- Any symptoms the victim is experiencing.

If you are alone, do not leave to make the phone call until you are sure the victim is breathing and is not further exposed to the poison. Save the pesticide and the label for the doctor.

You need water to wash off the poison. If there is no fresh running water, use any source of fairly clean water such as irrigation canals, lakes, ponds, or watering troughs. Don't let the victim die while you worry about how dirty the water is.

IF POISON HAS BEEN SWALLOWED

First, call the poison control center or check the pesticide label for specific information on poisoning.

911

There are two ways to help people who have swallowed a poison: 1) inducing vomiting, or 2) diluting the poison by having the victim drink milk or water.

Inducing vomiting

Vomiting is the quickest way to get the poison out of the stomach, but there are times when you must not induce vomiting. The pesticide label will tell you when NOT to induce vomiting. Call the poison control center or physician before inducing vomiting.

Never induce vomiting if the victim is unconscious or in convulsions. The victim could choke to death.

Do not induce vomiting if the victim has swallowed a corrosive poison (a strong acid or alkali). A corrosive poison causes severe mouth and throat burns and severe pain. It will burn as severely coming up as it did going down.

Do not induce vomiting if the victim has swallowed *concentrated* petroleum products, such as gasoline, kerosene, oil, lighter fluid, or an emulsifiable concentrate (many liquid pesticides contain petroleum).

Important NOTE: Induce vomiting immediately if the petroleum-based pesticide formulation was diluted with water before it was swallowed.

How to induce vomiting

1. Make sure the victim is lying face down or kneeling forward. Do not let him lie on his back because the vomit could enter the lungs and do more damage.
2. Give the patient lots of milk or water: 1-2 cups for children up to five years old; up to a quart for victims five years or older.
3. Give syrup of Ipecac or a glass of soapy water to induce vomiting. If that is not possible, put your finger or the blunt end of a spoon at the back of the victim's throat. Do not use anything sharp or pointed.
4. Save some of the vomit. The doctor may need it for chemical tests.

Diluting the poison

If the patient has swallowed an acid or alkali, the best first aid is to dilute the poison as quickly as possible. Give the patient water or milk. If the victim is under two years of age, give 1 cup of water or milk. For ages two to five, give 1 to 2 cups. For adults and children over five, give 2 cups.

If Poison Is on the Skin

The faster the poison is washed off the victim, the less injury there will be. Do not allow any pesticide to get on you while helping the victim.

1. Drench the skin and clothing with water (shower, hose, faucet, pond).
2. Remove the clothing. Cut it off if necessary.
3. Wash skin and hair thoroughly with soap and water. Detergents and commercial cleansers are better than soap.
4. Dry and wrap the victim in a blanket.

If the Skin Is Burned

1. Wash the skin with lots of running water.
2. Remove contaminated clothing carefully to avoid harming the skin.
3. Immediately cover the burn loosely with a clean, soft cloth.
4. Do not use ointments, greases, powders, or other drugs.

If Poison Is in the Eye

NOTE: It is most important to wash the eye out as quickly but as gently as possible.

1. Hold the eyelids open and wash the eyes with a gentle stream of clean, running, lukewarm water.
2. Keep washing the eyes for 15 minutes or longer.
3. Do not use chemicals or drugs in the wash water. They may make the injury worse.

If Poison Is Inhaled

Pesticide dusts, vapors, or gases may be breathed in and cause damage to the lungs. If the victim is in an enclosed space such as a room or a building, do not go in the area without an air-supplied respirator.

1. Carry the victim to fresh air immediately. Do not let the victim walk.
2. Open all doors and windows.
3. Loosen all tight clothing.
4. Give artificial respiration if the victim has stopped breathing or if the breathing is irregular.
5. Keep the victim as quiet as possible.
6. If the victim has any convulsions, take action to prevent falls or other accidents that could result in head injury. Also, keep the victim's chin up so the air passage will remain free. Watch to be certain the victim continues breathing.
7. Use a blanket to prevent chills, but don't let the victim get too hot.
8. Do not give alcohol in any form.

If the Victim Is in Shock

Sometimes poisoning victims go into shock. A victim can die from shock even if the poisoning itself is not fatal.

Symptoms of shock:

- Skin is pale, moist, cold, and clammy
- Eyes are vacant, with dilated pupils
- Breathing is shallow and irregular

- Pulse is very weak, rapid, and irregular
- Victim is unconscious or in a faint

Steps to take while waiting for medical help for shock victims

1. Keep the victim flat on the back with legs up 1 feet above the head.
Exception: Do not keep a victim who is vomiting on the back.
2. Keep the victim warm enough to prevent shivering. Do not overheat.
3. Keep the victim quiet and calm.
4. Never try to give anything by mouth to an unconscious person.

Poisoning Prevention

Avoid (as much as possible) all contact with a pesticide. The key to personal safety when using pesticides is to remember that they can enter your body through your mouth, skin, eyes, or lungs. If you block these entry ways, you won't be hurt.

Warnings on the label and toxicity tables tell you if a pesticide is particularly hazardous (for instance, if it can be absorbed through the skin) so you can take special safety precautions.

Protecting yourself from accidental poisoning

To protect your skin and eyes:

- Wear clothing that covers all your skin.
- Wear goggles or shields if there is any chance that sprays or dusts may get in your eyes.
- Wash your hands before using the bathroom and before smoking.

To prevent accidental swallowing:

- Wash your hands before eating or smoking.
- Always keep pesticides in the original, labeled container.
- Never use your mouth to clear a plugged nozzle.
- Never use your mouth to begin siphoning a pesticide.
- Do not eat, drink, or smoke in an area where pesticides are being handled.

To protect your lungs:

- Wear respiratory protection if there is any risk of breathing in pesticides.
- Chapter 6 (Safe Handling of Pesticides) gives more specific information on how to prevent accidents.

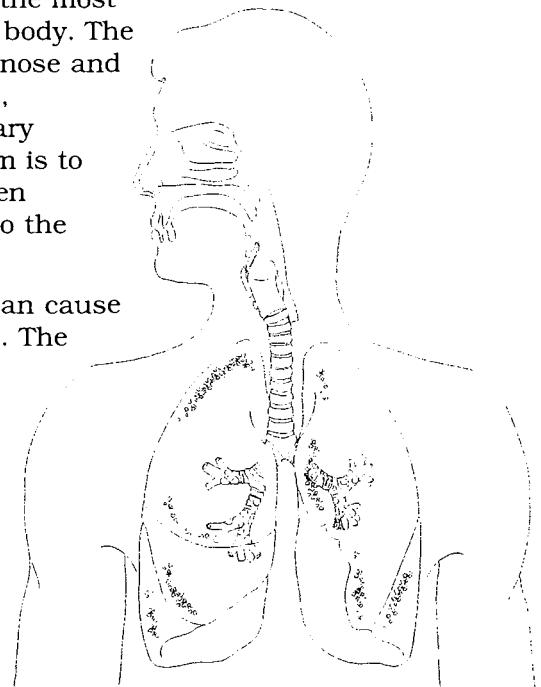
Respiratory Protection

Your respiratory system is one of the most vital and vulnerable parts of your body. The respiratory system includes your nose and mouth, throat, trachea (windpipe), bronchi, and the lungs. The primary purpose of your respiratory system is to provide oxygen to the body. Oxygen passes from the lungs directly into the bloodstream.

When inhaled, many pesticides can cause different types of health problems. The actual effects on your respiratory system and on the rest of your body depend on several factors. These factors include the type and toxicity of pesticide, the type and size of the particles inhaled, and the amount inhaled.

Damaging effects could include:

- Damage, irritation, or obstruction within the respiratory system;
- Acute poisoning resulting from pesticides being transported into the bloodstream through the lungs;
- Long-term health effects resulting from pesticides being brought into the body.



In order to protect yourself from the damaging effects of pesticides entering the respiratory system, wear a good quality respirator. A properly fitted and maintained respirator will help protect you from the effects of airborne pesticides.

How does a respirator work?

A respirator is a protective device used to keep pesticides out of the lungs. Respirators work in one of two ways, either by purifying the air or supplying clean air.

Air purifying respirators filter incoming air. Air supplying respirators provide an external source of clean fresh air, either through a pressurized air tank (often carried on the user's back), or through an air hose.

There are many variations of respirator designs within these two categories (air supplying and air purifying). To be fully effective, the respirator should be used only in accordance with the manufacturer's recommendations.

When should a respirator be worn?

If there is any risk of inhaling pesticide gases, vapors, dusts, mists, or other particles, especially if the label states "Do not breathe vapors or spray mist" or "Harmful or fatal if inhaled," wear a respiratory protective device.

The risk of inhaling pesticides is greatest if:

- You are exposed to pesticides for long periods;
- You dilute or mix concentrates;
- You use sprays, dusts, gases, or vapors;
- You work with highly toxic pesticides;
- You work in an enclosed area.

Under the Worker Protection Standard (WPS), the product label will specify when a respirator is to be used as well as the type. For example, the label might state that "A dust/mist respirator (MSHA/NIOSH approval number prefix TC-21C) is required when handling or mixing this product." The devices can be obtained from farm supply stores and safety equipment companies (located mainly in larger cities). Make sure the equipment has a NIOSH/OSHA seal of approval. This indicates that the item has been tested and certified to provide protection against the listed contaminants.

Even if the label does not require one, a good respirator, properly fitted, can help minimize your overall exposure potential.

Types of Respiratory Protective Devices

There are several types of respiratory devices. Each type is useful for specific activities. There is no all-purpose device. Make sure you use the correct one. Always read and follow instructions indicated on the product label.

How to choose the right type of respirator

Again, the label will specify the type of respirator for a given pesticide and task. In the previous example, notice that the respirator type was given including a "TC" (Tested and Certified) number. This number specifies a respirator has been "Tested and Certified" by the Mine Safety and Health Administration (MSHA), and the National Institute for Occupational Safety and Health (NIOSH). The number following the "TC" designation specifies the actual type of respirator (the following paragraphs provide examples). Only approved respirators carrying the MSHA/NIOSH certification should be used. Noncertified respirators are often available in hardware or department stores, but will not provide adequate protection.

Dust/mist respirators

A TC-21C is a mask designed to screen out solid dust and liquid mist particles. An approved dust/mist respirator will have two straps to assure a tight fit and adequate seal. Some models also have an exhale valve and a "nose clip" to help prevent leakage and improve comfort.

Cartridge respirators

A TC-23C is a respirator with cartridges. These cartridges contain charcoal or other material that selectively "grabs onto" the organic vapors found in many pesticides, while allowing a clean, fresh supply of air to pass through. A NIOSH-approved cartridge respirator for most pesticides will have a black label or band on the cartridge. Most cartridge-style respirators can also be fitted with dust/mist prefilters that snap onto the top of the cartridge for added protection against



Example of "TC-23C" cartridge respirator.



Exploded view of cartridge respirator



Example of "TC-14G" gas mask respirator



Chemical cartridge and gas mask respirators

dusts and mists. The TC-23C respirator can also be purchased as a "full-face" respirator that combines the respiratory protection provided by the cartridges with eye and face protection.

Full-face chemical cartridge respirator

Features: Same as for half-face chemical cartridge respirator, but also protects eyes and face.

When to use: Use with pesticide cartridge when you are exposed to pesticides for a short time, such as when diluting or mixing pesticide concentrates or spraying or dusting animals. Use with ammonia cartridge when transferring anhydrous ammonia to nurse tank or from nurse tank to applicator.

Full-face chemical gas mask with canister

Pesticides with a higher level of toxicity may require either a TC-14G gas mask respirator or a TC-13F self-contained breathing apparatus.

Gas mask respirators (TC-14G) are similar in function to cartridge respirators but have a much greater capacity to absorb toxic substances. Gas masks also generally provide eye and facial protection.

WARNING: The respirators described thus far (dust/mist and gas masks) must NOT be used in areas where there is a lack of oxygen (less than 19.5%) or where toxic gases are present. Such areas include, but are not limited to, silos, manure pits, and fumigated grain storage areas.

Devices for Fumigants or Other Toxic Gases

If you are using fumigants or are exposed to toxic gases, or working in an oxygen deficient environment, you MUST use an air supplying respirator. Two of the most common types of air supplying respirators are described below.

Self-contained breathing apparatus (SCBA)

Self-contained breathing apparatus (SCBA) respirators (TC-13F) supply the user with clean, fresh oxygen. This varies significantly from the masks previously described (dust masks, cartridge respirators, and gas masks). Air is supplied through a tube and face piece, which is fed by an air tank on the user's back. An SCBA is the ONLY type of respirator that can be used in conditions where oxygen is low (below 19.5%) or where contaminant levels are "Immediately Dangerous to Life and Health." Examples include silos, manure pits, or areas where grain has been fumigated and levels of phosphine gas exceed 15 ppm.

Positive-pressure air system with emergency escape cylinder

Another type of respirator, often used in greenhouse operations, is the continuous flow, supplied air respirator (TC-19C). It uses a full face piece, similar to an SCBA, but utilizes a remotely located pump to supply air through a hose to the user. It is extremely important that these types of units be operated with the pump located in an uncontaminated area since the pump does not filter contaminated air!

Powered Air Purifying Respirator (PAPR)

Other types of respirators are sometimes used when mixing, handling, or applying pesticides. For example, people who are uncomfortable with a standard dust/mist respirator mask may choose to wear a powered air purifying respirator (PAPR). These units use a motorized blower to bring cool air in through a filter that removes dust or mist particles. Generally, certified PAPR respirators carry the TC-21C designation. PAPR respirators are not a replacement for an air supplying respirator (such as a self-contained breathing apparatus or positive pressure system).



Wrong Right
Long sideburns, a beard,
or glasses may prevent a
good seal.

How to Assure a Proper Respirator Fit

Select a respirator that fits properly. Most pesticide respirators come in different sizes to accommodate different face sizes and shapes. Beards, sideburns, and mustaches make it impossible to wear a respirator properly. You don't get an adequate seal. Glasses can cause problems, too (especially with full face respirators).

There are two ways to determine whether your respirator fits properly; a fit check and a fit test.

Fit check

A simple "fit check" should be done whenever you put the respirator on. It only takes a few seconds. To check for fit, cover the exhalation valve of the respirator tightly with the palm of your hand. Blow out gently for several seconds. The respirator face piece should bulge out slightly, and you should not feel air leakage around the seal. If you do feel air leaking, readjust the straps, and make sure that the seal touches your face all the way around. If you simply cannot get a good fit, try a different size or different style respirator.



Simple fit check.

Fit test

The fit test is required by most industries with a formal respiratory protection program under OSHA regulation 1910.134. In most fit tests, the user dons the respirator, and is exposed to an inert, nontoxic substance in an enclosed environment. If the wearer can smell or taste the substance, the respirator does not fit properly. The references cited in the end of this chapter can provide additional information on fit testing procedures and equipment.



Fit test procedure

How to Care For and Maintain a Respirator

Proper care and maintenance of respirators will help them work effectively. The respirator should be disassembled and cleaned when the face piece appears dirty or daily when handling more toxic pesticides. Instructions for cleaning are usually provided with your respirator. Generally, cartridges are removed and the face piece is washed with warm soapy water, rinsed, and dried. Always store your respirator in a clean, dry location, out of sunlight.

Do not share a respirator with another person. If you must, the respirator should be properly cleaned and sanitized to prevent passing on colds and other diseases.

Additional Respiratory Protection Requirements under WPS and OSHA

To help use respirators appropriately, there are several requirements that have been developed through the Worker Protection Standard and by OSHA (Occupational Health and Safety Administration). All employers covered by WPS must comply with standards under the WPS. OSHA regulations also apply to all farmers and most other industries involved in application of pesticides. But in most states (Minnesota included), OSHA can only enforce these regulations on farms or other industries with 11 or more employees. The following sections describe the requirements under WPS and OSHA. Although the specific provisions of these requirements may or may not apply directly to your situation, many of them make good sense. Compliance can help to insure that respirators will be used in the manner that does the best job of protecting the health and safety of you and your employees.

WPS requirements

Employers must:

1. Provide the appropriate respirator in clean, operating condition.
2. Make sure handlers wear the respirator properly and use it according to the manufacturer's instructions.
3. Inspect respirators each day of use for damage or wear.
4. Provide a clean place for respirator storage and for putting on and taking off the respirator
5. Take steps to prevent heat illness while a respirator (and other PPE) is being worn.
6. Not allow the employer to take or wear home a pesticide contaminated respirator.

Employers are also responsible for insuring that respirators and respirator parts are inspected and replaced when necessary. Dust and mist respirators and filters are replaced whenever breathing becomes difficult or if the respirator is damaged or torn. The respirator's instructions, supplied by the manufacturer, may specify replacement intervals. If there's no way to tell whether replacement is needed, dust and mist respirator filters should be replaced daily.

Life of organic vapor cartridges and canisters is dependent on contaminant level and length of exposure. One indication that the cartridge is "filling up" is increased resistance while you're inhaling. Also, change cartridges immediately if you taste, smell, or feel irritation from the pesticide. This condition, often called "breakthrough" means the cartridge has lost its ability to absorb the contaminant.

Instructions provided by the manufacturer may also provide guidance regarding cartridge or canister replacement. For "average" exposures, cartridges are changed about every eight hours. Cartridges will not need to be changed as often if you are working in areas with low levels of airborne pesticide, especially if they are cleaned and maintained properly. If you are unsure, change cartridges or canisters at the end of each day of use.

OSHA requirements

Listed below are several items required by OSHA regulations for those industries required to develop a respiratory protection program. For further information, consult with the references listed at the end of this chapter.

Written respiratory protection program policy: Under OSHA requirements, employers who require the use of respirators must develop and follow a written respiratory protection program. A specific person should be designated to oversee and enforce this program.

Medical evaluation of people using respirators: OSHA requires that people who use respirators must be examined by a doctor or other health professional to determine their fitness to use a respirator. A respirator creates additional air resistance while you breathe. The resistance may make breathing more difficult for some users. Your doctor's approval is especially important if you have heart or lung problems, including emphysema, asthma, or heart disease.

Training regarding use and limitations: Under both WPS and OSHA, employers using respirators must receive adequate training regarding respirator use and maintenance. Employees should also be instructed of the limitations of their respirator. For example, air purifying respirators must never be used to enter environments that are deficient of oxygen or in areas where SCBA units are required by the label.

Cleaning and maintenance: Respirators must be properly cleaned and maintained. This ensures that they will work properly. Cleaning helps to reduce the possibility of exposure to pesticides and other substances that can accumulate on respirator parts.

Exclusive use: Employees should never "share" a respirator, since certain illnesses and disease can be spread through contact with a respirator parts, especially when not properly cleaned.

Storage: Respirators should be stored in a clean, dry location, preferably in a plastic bag. Sunlight is also detrimental to respirator performance and can cause rubber or silicone face pieces to crack and weather prematurely.

Surveillance and control of hazards including using engineered controls: OSHA requires that employers evaluate and document the specific contaminants that employees might possibly be exposed to. Whenever possible, measures should be taken to minimize exposure through the use of "engineering controls." Closed handling systems such as locking containers that fit over the top of planter insecticide boxes is a good example of using engineering controls to reduce exposure.



Proper cleaning is crucial



Clean all parts of the respirator face piece



Store respirators in a clean location

Fit testing: According to OSHA, all employees must be fit tested (as described earlier in this chapter) prior to using a respirator.

Program review: The provisions of a written OSHA program must be periodically reviewed to make sure the program adequately protects workers.

Protection Offered by Clothing

Personal Protective Equipment

Wearing protective clothing when applying pesticides can reduce the risk of pesticide poisoning because it reduces the chance of exposure. Many pesticide labels instruct the user to wear personal protective equipment (PPE) — clothing and devices that protect the body from contact with pesticides or pesticide residues. Pesticides covered by the newly revised Worker Protection Standards are now required to have PPE requirements listed more clearly on their labels. If specific clothing such as goggles or a full protective suit is not listed on the label, use the signal words, precautionary statements, and the product formulation as guidelines.

Precautionary statements such as "harmful or fatal if inhaled" indicate that more protection is needed than is normally recommended and that a respirator should be worn. Product formulation is also important to consider when choosing the type of clothing to wear. For example, emulsifiable concentrates (oil-based liquids) are generally easily absorbed through the skin while products that are dusts, wettable powders, and granules are easily inhaled.

Another source of information about PPE for pesticides, and many other chemicals, are the Material Safety Data Sheets, (or MSDS for short). The MSDSs, which are available from pesticide manufacturers, have sections on health hazards and special protection information.

Protection Offered by Clothing

The type of clothing you buy and how you wear it will determine your level of protection from pesticide exposure as well as your comfort. You will have some protection by just wearing regular work clothing. However, specialized liquid-proof, chemical-resistant clothing will provide much greater protection. When the situation requires the greatest protection, combining safety with comfort is more difficult. A summary of clothing guidelines includes:

- Always wear work clothing with long pants and sleeves.
- Wear unlined, liquid-proof, chemical-resistant gloves; unlined neoprene or rubber boots; and a wide-brimmed hat.
- At the very least, in addition to the above, wear a chemical-resistant apron over cloth coveralls when mixing, loading, or handling undiluted pesticides.

- Wear liquid-proof, chemical-resistant coveralls or suit with a hood or wide-brimmed hat if there is any chance of becoming wet with spray.
- Wear a respirator whenever there is a risk of inhaling pesticide vapors, fumes, or dust.
- Wear eye or face shields whenever there is a risk of pesticide coming in contact with the eyes.

Types of Protective Clothing

Regular work clothes

The protection offered by regular work clothing depends upon the fabric, the layering of clothing, and the use of soil-repellent finishes. Cover as much of your body as possible with the work clothes. Wear long pants and sleeves. Button or fasten shirts at the neck and wrists. Do not go barefoot.

Heavyweight and tightly woven fabrics of cotton or polyester/cotton blends (instead of 100 percent synthetic fabrics of equal weight) provide greater protection. However, studies have shown that polypropylene knit's wicking properties make it more effective as an underlayer in preventing pesticide penetration than cotton knit. Layering clothing also helps prevent pesticides from reaching the skin.

Soil-repellent finishes increase the protection offered by regular work clothing, making it similar in protection to uncoated Tyvek®.

Fluorocchemical finishes such as Scotchgard® or Zepel® repel water as well as oil. Renewable finishes must be applied after every second or third wash.

Gloves

Hands should always be protected whenever handling undiluted or diluted pesticides; unopened or empty pesticide containers; or contaminated equipment, clothing, and other materials. Unlined, clean gloves at least 12 inches long with sealed seams are necessary when handling undiluted or highly toxic pesticides. Nitrile, neoprene, and butyl rubber are good choices. Do not wear cotton or leather gloves because neither can be properly cleaned.

Sleeves should be worn outside the glove to prevent pesticides from running down inside the glove. When working with arms raised, wear gloves over the sleeves that have a cuff to catch drips. Duct tape or elastic bands can be used to seal the gloves at the sleeve and are especially useful in activities when arms are both raised and lowered. Wash the outside of the gloves before taking them off to avoid pesticides getting on hands, then wash the inside of the gloves.

Aprons, rainsuits, and other specialized protective clothing

Chemical-resistant clothing should be worn during mixing, loading, or other handling of undiluted pesticides. This can be a butyl rubber, neoprene, or Tyvek® apron over a work coverall, a PVC rainsuit, or one of the newer chemical-resistant coveralls depending upon the label requirements. Aprons with sleeves — but with the back open — may be a good choice if heat stress is a concern and shoulder and arm

protection is needed. The protection offered by chemical-resistant clothing also depends upon the fabric and design features such as flaps over zippers, elastic at the wrist and ankle, and bound or sealed seams.

Footwear

Feet and shoes also need protection from pesticide spills. Pant legs should go over the boot. Unlined neoprene or butyl rubber boots, or Tyvek® shoe- or bootcovers should be worn. Clean socks are also important to wear daily. Leather and canvas shoes cannot be cleaned properly and should never be worn without rubber or neoprene boots. Always clean the outside of the boot before removing it.

Eye protection

Wear goggles, or a face shield, to protect the eyes from splashes and dust particles. Face shields can be purchased to fit on a hard hat. Goggles can be worn with a negative-pressure respirator or a dust mask. For best protection, goggles should have a snug fit around the nose and temple area.

Head and neck protection

A chemical-resistant hood or wide-brimmed hat will help keep pesticides off neck, eyes, mouth, and face. With airblast spraying, covering the head and neck is especially critical. Many PVC or Tyvek® coveralls and rain coats/suits have hoods attached. Hard hats should not have cloth or leather sweatbands. Company or baseball hats made with fabric mesh or designed with open areas do not protect the wearer from exposure.

Chemical Resistant PPE

Some labels require the use of chemical-resistant PPE — items that the pesticide cannot pass through during the time it takes to complete the task. The labels of a few pesticides, such as some fumigants, prohibit the use of chemical-resistant PPE. Most chemical-resistant PPE items are plastic or rubber. However, not all these materials are equally resistant to all pesticides under all conditions.

Chemical resistance

Three factors affect a material's chemical resistance: the exposure time, the exposure situation, and the chemical properties of the pesticide product to which the material is exposed.

Exposure time — Not all types of materials that are resistant to a particular pesticide will provide protection for the same amount of time. Some will keep the pesticide out for a long time. Others will allow the pesticide to reach the skin fairly quickly. Disposable plastic gloves, shoe covers, or aprons may provide enough protection for tasks that can be done in a few minutes. Longer jobs usually require items made of a more resistant material.

A pesticide begins to move into a material as soon as it gets on the surface. The pesticide continues to move into and through the material until the pesticide is removed. Help prevent pesticides from getting through chemical-resistant items, such as gloves, boots, and aprons, by regularly rinsing off pesticides that are splashed or spilled on them. Chemical resistance is often stated in terms of exposure time (the time from first exposure until the chemical breaks through to the other side of the material). For example, neoprene may be resistant to one solvent for 30 minutes or less and to another solvent for more than 4 hours.

Exposure situation — A chemical-resistant material will not continue to be protective if it is damaged. For tasks that involve handling sharp objects or walking through rough terrain, a sturdy material would be necessary to resist punctures or tears.

Type of chemical — No single material can protect against all pesticide products. The chemical resistance of a material depends on whether the pesticide is liquid or dry, and what dilutents or solvents are used.

Chemical-Resistance of PPE Materials

Look for PPE items whose labels state that the materials have been tested using ASTM (American Society for Testing Materials) test methods for chemical resistance, such as test method F739-91. Gloves and footwear made of polyvinyl chloride (PVC) or rubber (butyl, nitrile, neoprene, or natural rubber) must be at least 14 mils thick. Pesticides can leak through stitching holes and gaps in seams. For chemical resistance, PPE should have sealed seams.

Tyvek is a nonwoven olefin fabric that should be worn over regular work clothing. Although fairly strong, it can be punctured when worn around machinery. It is flammable and should not be used near heat, flame, or sparks. Tyvek is intended to be disposable; its protection after washing has not been tested. If you do reuse a disposable garment that is not torn or heavily soiled, hang it in a well-ventilated place between uses.

Tyvek comes uncoated or as a laminate (polyethylene [PE]-coated or Saranex-23P). The effectiveness of uncoated Tyvek is similar to soil-repellent finished cotton or cotton/polyester blends and so is not very chemically resistant. It is suitable for handling granular or powdered formulations and diluted and less toxic pesticides. The laminates of Tyvek, especially Saranex-23P, are suitable for handling undiluted and more highly toxic pesticides.

Goretex, a microporous laminate commonly found in outdoor sportswear, offers good protection and is more comfortable in hot weather, but is expensive.

Barrier-laminate materials are resistant to most pesticides and are a good choice for many situations. Barrier-laminate (Silver shield/4-H) gloves may be uncomfortable and clumsy to wear for some kinds of tasks. Try wearing fitted rubber gloves over barrier-laminate gloves for comfort, protection, and dexterity.

Any plastic or rubber material is resistant to dry pesticides and to water-based pesticides (those that use water as the only dilutent or solvent). Dry pesticides include dusts, granules, pellets, and some baits. Water-based pesticides include wettable powders, soluble powders, some solutions, dry flowables (water-dispersible granules), and microencapsulated pesticides.

The type of material that is resistant to non-water-based liquid pesticides depends on the contents of the formulation. Liquid pesticides that are not water-based may be emulsifiable concentrates, ultra-low-volume and low-volume concentrates, low-concentrate solutions, flowables, aerosols, dormant oils, and invert emulsions. Common solvents are xylene, fuel oil, petroleum distillates, and alcohol.

Choosing chemical-resistant PPE

Materials not listed on label — If the pesticide label requires the use of chemical-resistant PPE but does not indicate the types of materials that are resistant to the product, select sturdy barrier-laminate, butyl, or nitrile materials. Then watch for signs that the material is not chemical-resistant. For example, the material may: change color; become soft or spongy; swell or bubble; dissolve or become jellylike; crack or get holes; become stiff or brittle. If any of these changes occur, discard the item and choose another type of material.

Specific PPE materials listed directly on label

If the pesticide label specifies the PPE materials that must be worn when using the product, follow those instructions.

Some labels may list examples of PPE materials that are highly chemical-resistant to the product. The label may say, for example: "Wear chemical-resistant gloves, such as barrier-laminate, butyl, nitrile, or viton." You may choose PPE items made from any of the listed materials.

Chemical-resistance category listed on label

Pesticide labels that list examples of PPE materials will often also specify a chemical-resistance category (A through H) for the product. This allows you to consult an EPA chemical-resistance chart (such as the one below) to learn whether you have PPE material options other than those listed in the examples on the label.

Using the chemical resistance category selection chart

When pesticide labels list a chemical-resistance category, you can find that category on an EPA chemical-resistance category selection chart (see table) to determine the entire range of PPE materials from which you can choose. The chart indicates how long you can expect the various types of PPE materials to be resistant to the type of pesticide you are using. Failure to replace or clean the PPE items within the time intervals specified on the chart would be considered a misuse of the pesticide, because the items would no longer meet the label's requirements for "chemical-resistant" PPE.

When choosing an appropriate material, also consider the dexterity needed for the task and whether the material will withstand the physical demands of the task. The PPE will protect you for the approximate time listed on the chart, if:

- No punctures, tears, or abrasions allow pesticide to penetrate the material; and
- Pesticide does not get inside the PPE through careless practices, such as allowing pesticide to run into gloves or footwear or putting the PPE on over already contaminated hands or feet.

Highly Resistant PPE — A rating of high means that the material is highly resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for an 8-hour work period. The outside of the PPE, especially gloves, should be washed at rest breaks — about once every 4 hours. Highly resistant PPE is a good choice when handling pesticides, especially concentrates, for long periods of time.

Moderately Resistant PPE — A rating of moderate means that the material is moderately resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for 1 or 2 hours. After that, replace the PPE with clean chemical-resistant PPE or thoroughly wash the outside of the PPE with soap and water.

Moderately resistant PPE may be a good choice for pesticide handling tasks that last only a couple of hours.

Slightly Resistant PPE — A rating of slight means that the material is only slightly resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for only a few minutes after exposure to the pesticide product. After that, replace the PPE or thoroughly wash the outside of the PPE with soap and water. Slightly resistant PPE may be a good choice for pesticide handling tasks that last only a few minutes.

EPA Chemical Resistance Category Selection Chart For use when PPE section on pesticide label lists a chemical resistance cat.								
Selection Category Listed on the Pesticide Label	Type of Personal Protective Material							
	Barrier Laminate	Butyl Rubber > or = 14 mil	Nitrile Rubber > or = 14 mil	Neoprene Rubber > or = 14 mil	Natural Rubber > or = 14 mil	Polyethyl > or = 14 mil	Polyvinyl Chloride (PVC)	Viton > or = 14 mil
A (dry and water-based formulate)	High	High	High	High	High	High	High	High
B	High	High	Slight	Slight	None	Slight	Slight	Slight
C	High	High	High	High	Moderat	Moderate	High	High
D	High	High	Moderate	Moderate	None	None	None	Slight
E	High	Slight	High	High	Slight	None	Moderate	High
F	High	High	High	Moderate	Slight	None	Slight	High
G	High	Slight	Slight	Slight	None	None	None	High
H	High	Slight	Slight	Slight	None	None	None	High

* includes natural rubber blends and laminates

High: Highly chemical-resistant. Clean or replace PPE at end of each day's work period. Rinse off pesticides at rest breaks.

Moderate: Moderately chemical-resistant. Clean or replace PPE within an hour two of contact.

Slight: Slightly chemical-resistant. clean or replace PPE within 10 minutes of contact.

None: No chemical-resistance. Do not wear this type of material as PPE when contact is possible.

Inexpensive disposable gloves or shoe covers, such as those made from polyethylene, may be useful for such brief tasks as:

- Adjusting contaminated parts of equipment;
- Unclogging or adjusting nozzles;
- Opening pesticide containers;
- Moving open pesticide containers or containers with pesticides on the outside;
- Handling heavily contaminated PPE;
- Climbing in and out of cabs or cockpits where the outside of the equipment is contaminated; and
- Operating closed systems.

These disposable PPE items should be used only once, for a very short-term task, and then discarded. At the end of the task, it is a good idea to first wash the outside of the gloves or shoe covers, and then remove them by turning them inside out. Discard them so they cannot be reused.

Handling Contaminated Clothing

Clothing worn while applying liquid, granular, or powdered pesticides may be soiled with pesticide residues even if you can not see or smell the pesticide. Research has shown that pesticides can be transferred from the outer layer of clothing to inner layers of clothing. If the inner layer is close to the skin there is increased risk of exposure to the wearer. Many of the most toxic pesticides are granular. These transfer to clothing (and sweat and body oils increase the transfer).

Clothing worn while applying pesticides should be washed every day. However, clothing soiled with highly toxic and concentrated pesticides must be handled carefully. Since liquid, oil-based concentrates are very difficult to remove from fabrics, clothing soiled with highly toxic liquid pesticides should be discarded. In general, the more water-soluble the pesticide, the easier it is to remove.

Wash pesticide-contaminated items separately from uncontaminated clothing and laundry. Otherwise, the pesticide residues can be transferred onto the other clothing or laundry and can harm you or your family. Wear rubber gloves when you handle clothing with pesticides on it. Keep the clothing separate from other clothing until it has been washed.

Pesticides can cling to and be absorbed by the protective clothing that you wear. Therefore, it is important to use special care when you handle the clothing.

In order to handle and wash clothing as safely as possible, you should know when the clothing was contaminated, which pesticides have been used, and the pesticide formulations used.

Laundering Contaminated Clothing

Most pesticides can be removed from clothing if you follow the washing instructions below. If undiluted emulsifiable concentrates have spilled on any clothing, discard it (except for rubber or neoprene gloves and unlined boots). Washing will not remove enough pesticide to make the clothing safe to wear. In research tests, clothing with undiluted emulsifiable concentrate on it still contained a high amount of pesticide even after 10 washings. If the emulsifiable concentrate pesticide was diluted, then three washings removed nearly all of the pesticide.

Use repeated washings with hard-to-remove pesticides especially when they are highly toxic. Following are guidelines for handling and washing clothing with pesticide residues.

- Wear waterproof gloves when handling clothing with pesticides on it.
- Wash gloves, boots, aprons, suits, goggles, and respirators with detergent and water. Hang or store away from other clothing. When handling pesticides, rinse gloves before removing from hands.
- Empty pesticide granules from cuffs and pockets before washing.
- Wash machine washable items separate from family laundry.
- Wash only a few items at a time. Use the highest water level and longest wash time available on your machine.
- Prerinse or presoak the clothing.
- Wash items soiled with hard-to-remove pesticides two or three times. This is especially important when clothing is soiled with highly toxic pesticides.
- Do small loads with a high water level. Run a second cycle with washers that use less water (such as a front-loading washer).
- Use hot water for washing (146°F).
- Use heavy-duty detergents and liquid detergents for oil-based pesticides. Use 1½ times the recommended amount of detergent for heavily soiled clothes or when a soil repellent finish has been applied. A prewash laundry product is effective at removing oil-based pesticides.
- Clean the washing machine by running a complete cycle with detergent.
- Line dry clothing. Sunlight helps break down some pesticides.

Laundry aids

The use of chlorine bleach in a regular wash cycle is not effective in removing pesticide residue from fabric. However, a three-hour soak in a chlorine solution (1 cup chlorine bleach to 16 gallons of water) effectively removes chlorpyrifos (Lorsban, Dursban) residue from cotton work clothing.

Soil repellent finishes and starch finishes increase protection of regular work clothing. The renewable repellent finishes such as Scotchgard® and Zepel®

repel water as well as oil. Apply the finish after every washing, especially on 10 or 12 oz. heavyweight denim. With soil-repellent finishes, use a prewash product such as Spray and Wash™ or Shout™ and 1½ times the recommended amount of detergent.

A stiff fabric starch finish traps the pesticide, which is washed away with the starch. Apply starch each time the garment is washed using either spray or liquid products. When applying pesticides at ground level, apply starch to pant legs from the knees down.

**Percent of pesticide residue on fabric after laundering
(under laboratory conditions)**

Insecticides	% of Residue
Carbamate	
carbaryl FL (Sevin)	10
carbaryl WP (Sevin)	0
Organophosphate	
methyl parathion L	28
fonofos EC (Dyfonate)	14
Pyrethroid	
cypermethrin WP (Ammo, Cymbush)	55
cypermethrin EC (AMMO, Cymbush)	25
cylfluthrin WP (Baythroid)	10
cylfluthrin EC (Baythroid)	30
deltamethrin EC (Decis)	48
Herbicides	% of Residue
Acetanilide	
alachlor EC (Lasso)	2
Carbamate	
triaallate EC (Far-Go)	42
Dinitroaniline	
trifluralin EC (Treflan)	55
Triazine	
atrazine FL (Aatrex)	21
atrazine WP (Aatrex)	11

Heat Stress

Heat stress occurs when your body is subjected to more heat than it can cope with. Heat stress is not caused by exposure to pesticides, but may affect pesticide handlers who are working in hot conditions.

Personal protective equipment worn during pesticide handling activities can increase the risk of heat stress by limiting your body's ability to cool down.

Signs and Symptoms of Heat Stress

Mild forms of heat stress will make you become tired sooner, feel weak, be less alert, and be less able to use good judgment. Severe heat stress is a serious illness. Unless victims are cooled down quickly, they can die. Severe heat stress is fatal to more than 10 percent of its victims, even young, healthy adults. Many who survive suffer permanent damage, and sometimes remain sensitive to heat for months. Learn the signs and symptoms of heat stress and take immediate action to cool down if you suspect you may be suffering from even mild heat stress.

Signs and symptoms may include:

- Fatigue (exhaustion, muscle weakness);
- Headache, nausea, and chills;
- Dizziness and fainting;
- Severe thirst and dry mouth;
- Clammy skin or hot, dry skin;
- Heavy sweating or complete lack of sweating;
- Altered behavior (confusion, slurred speech, quarrelsome or irrational attitude).

First Aid for Heat Stress

It is not always easy to tell the difference between heat stress illness and pesticide poisoning. The signs and symptoms are similar. Don't waste time trying to decide what is causing the illness. Get medical help. First aid measures for heat stress victims are similar to those for persons who are overexposed to pesticides.

- Get the victim into a shaded or cool area.
- Cool the victim as rapidly as possible by sponging or splashing skin, especially face, neck, hands, and forearms, with cool water or, when possible, immersing in cool water.
- Carefully remove equipment and clothing that may be making the victim too warm.
- Have the victim, if conscious, drink as much cool water as possible.
- Keep the victim quiet until help arrives.

Heat Cramps

Heat cramps can be quite painful. These muscle spasms in the legs, arms, or stomach are caused by loss of body salt through heavy sweating. To relieve cramps, have the victim drink lightly salted water or "sports drinks." Stretching or kneading the muscles may temporarily relieve the cramps. However, if you suspect that stomach cramps are being caused by pesticides rather than heavy sweating, get medical help right away.

Causes of Heat Stress

Several factors work together to cause heat stress. Before you begin a pesticide handling task, think about whether any of these factors are likely to present a problem, including:

- Heat factors—temperature, humidity, air movement, and sunlight;
- Workload;
- Personal protective equipment;
- Water;
- Scheduling.

Consider what adjustments you may need to make in the task itself or in the working conditions.

Heat factors and workload

High temperatures, high humidity, and direct sunlight increase the likelihood that heat stress will occur. You may develop heat-related illness when you are driving a vehicle or flying an aircraft. Since hard work causes the body to produce heat, you are even more likely to become overheated while lifting or carrying heavy containers or equipment. Schedule frequent breaks when the heat stress risk is high.

Air currents provide a cooling effect. Use fans and ventilation systems and provide shade whenever possible to reduce the heat. A work area or vehicle sometimes can be shaded by a tarp or canopy or provided with fans.

Allow time for adjustments to the heat factors and workload. People who have become used to working in the heat are less likely to be affected by heat stress. Do short periods of light work for several days in a row to become adjusted to hot work environments. Then, gradually increase the work period and the workload over several days.

Heat Illness and First Aid Measures			
Illness	Signs and Symptoms	Cause and Problem	Treatment
Early heat illness	Mild dizziness, fatigue, or irritability; decreased concentration; impaired judgment; 30 minutes or more.	Reduced flow of blood to the brain. May lead to heat exhaustion or heatstroke.	Loosen or remove clothing; rest in shade; drink water.
Heat rash ("prickly heat")	Tiny, blister-like red spots on the skin; prickling sensations. Commonly found on clothed areas of the body.	Sweat glands become plugged and inflamed from unrelieved exposure of skin to heat, humidity, and sweat.	Clean skin; apply mild drying lotion or cornstarch. Wear loose clothing. Preventable by regular bathing and drying the skin and by periodic relief from humid conditions of work. See physician if rash persists.
Heat cramps	Painful spasms of leg, arm, or abdominal muscles; heavy sweating, thirst. Occur during or after hard work.	Loss of body salt in sweat. May be totally disabling.	Loosen clothing; drink lightly salted beverages; massage; rest.
Heat exhaustion	Fatigue, headache, dizziness, muscle weakness, loss of coordination, fainting, collapse; profuse sweating; pale, moist, cool skin; excessive thirst, dry mouth; dark yellow urine; fast pulse (if conscious). Low or normal oral temperature, rectal temperature usually 99.5°F to 101.3°F. May also have heat cramps, nausea, urge to defecate, rapid breathing, chills, tingling of the hands or feet, confusion, giddiness, slurred speech, irritability.	Dehydration, lack of acclimatization; reduction of blood in circulation, strain on circulatory system, reduced flow of blood to the brain; May lead to heatstroke.	Worker may resist treatment. Remove to cooler, shaded area as quickly as possible; rest lying down. If conscious, have worker drink as much water as possible; DO NOT GIVE SALT. If unconscious or if heatstroke is also suspected, treat for heatstroke until proven otherwise. Loosen or remove clothing Splash cold water on body Massage legs and arms. Shower in cold water; rest for balance of day and overnight. If worker collapsed, get evaluations by physician, nurse, or EMT before worker leaves for the day.
Heatstroke	Headache, dizziness, confusion, irrational behavior, coma; sweating may slow down or stop; fast pulse (if conscious); rapid breathing; rectal temperature 104°F. May also have convulsions, nausea, incoherent speech, very aggressive behavior.	Sustained exertion in heat, lack of acclimatization; dehydration; individual risk factors; reduced flow of blood to the brain and other vital organs; body's temperature regulating system fails, body cannot cool itself. Risk of damage to vital organs including the heart, brain, central nervous system, liver, and kidneys.	IMMEDIATE TREATMENT REQUIRED! LIFE THREATENING EMERGENCY! BRAIN DAMAGE AND DEATH CAN RESULT. Move to a shaded area; remove outer clothing/shoes; immediately wrap in wet sheet, pour water on and fan vigorously. Avoid over-cooling. Treat shock if present, once temperature is lowered. If worker vomits, make sure all vomit is cleared from mouth and nose to prevent choking on vomit.

Scheduling pesticide applications

Sometimes you have no choice about when to schedule a pesticide application. In those situations, you must be careful to apply the pesticides safely under the existing conditions. If you have a choice about when an application can take place, consider applying during off-hours. Applying pesticides during very early morning hours, in the evening, or even at night, has several advantages:

- It is less likely that people other than pesticide handlers will be nearby;
- It is more likely to be cooler, reducing concerns about heat stress and pesticide vaporization;
- The wind is likely to be low, and indoor ventilation systems may be off or reduced;
- There will be no direct sun in outdoor and glass-roofed sites.

If you do choose to work during off-hours, have another person check on you often. Work only where there is enough light to allow you to apply the pesticide correctly and accurately.

Controlling Heat Stress

People vary in size, body temperature, and resistance to disease, heat, and cold. As a result, heat affects different people in different ways: some people can work comfortably at higher temperatures while others get sick from heat stress. A heat stress control program should be geared to protecting all workers at an establishment, especially those who are not in the best physical shape. The following table outlines a basic program for doing this.

Severe heat stress or heat stroke is a medical emergency! Brain damage and death may result if treatment is delayed.



A BASIC PROGRAM FOR CONTROLLING HEAT STRESS

STEP 1: Assign responsibility for heat stress problems.

STEP 2: Train workers and supervisors.

- Train workers and supervisors in the control of heat stress and the recognition, prevention, and treatment of heat illnesses.
 - Conduct safety meetings during heat spells.
-

STEP 3: Acclimatize workers when they begin to work under hot conditions.

- Assign a lighter workload for 5-7 days.
 - Allow longer rest periods for 5-7 days.
 - Assign work in the heat for at least 100 minutes each day.
 - Gradually increase the time of work in the heat each day.
 - Watch workers' response to working in the heat closely for 5-7 days.
-

STEP 4: Account for the conditions of work and of the workers.

- Check weather conditions.
 - Consider how heavy the work is.
 - Consider whether the worker is to wear protective garments and equipment.
 - Check if the worker is or has recently been sick or has had a sharp loss in weight.
 - Check whether the worker is rested, is taking any medications, or appears to have consumed alcohol that day.
-

STEP 5: Manage work activities.

- Set up rest breaks.
 - Rotate tasks among workers.
 - Schedule heavy work for cooler hours.
 - Postpone nonessential tasks during heat spells.
 - Monitor environmental conditions and workers.
-

STEP 6: Establish a drinking water program.

STEP 7: Take additional measures, as appropriate.

- Provide special cooling garments.
 - Select lightest weight or "breathable" protective garments and cooler respirators that give adequate protection.
 - Provide shade.
 - Use air-conditioned mobile equipment.
 - Modify pesticide usage and handling to reduce need for protective garments and equipment.
-

STEP 8: Give first aid when workers become ill.

- Set up a first aid program.
 - Take heatstroke victims to the nearest medical treatment facility
 - Follow up on incidents of heat illness.
-

Summary

Pesticide poisoning can be acute or chronic. Acute poisoning is a sudden, severe illness. Chronic poisoning is the gradual poisoning that takes place over a period of time and refers to possible effects such as cancer or birth defects that may not show up for years after exposure.

The risk of poisoning depends on the pesticide, the dose, the time of exposure, and the route of entry (oral, dermal, or respiratory). A simple formula to remember is Risk = Exposure × Toxicity. The LD₅₀ (or LC₅₀) value tells how toxic a pesticide is. The smaller the LD₅₀ number, the greater the toxicity.

Each class of pesticides causes different poisoning symptoms. Some of the most common symptoms are nausea, headache, stomach pains, diarrhea, dizziness, and weakness.

A person may be poisoned if a pesticide comes in contact with the skin or eyes, or if it is swallowed or inhaled.

If an accident occurs, get medical help immediately. Call the poison center. In an emergency, call 911 or an ambulance. A delay can lead to death.

Give first aid while waiting for medical help. The most important thing is to get the poison off the victim. Use water to wash it off. If poison was swallowed, either dilute the poison with water or milk or induce vomiting. Check the label first. A person overcome by fumes should be moved into fresh air.

Remember that respiratory devices and protective clothing can do much to reduce the risk of exposure to pesticides.

Review Questions for Protecting the Applicator

1. What is the difference between toxicity and hazard?

2. The scalp, ear canal, and forehead are especially vulnerable to dermal exposure to pesticides.
 - A. True
 - B. False

3. The skin on different parts of the body absorbs pesticides at the same rate.
 - A. True
 - B. False

4. What are the four main routes of human exposure to pesticides?
 - 1.
 - 2.
 - 3.
 - 4.

5. What action/behavior results in the most common oral exposure to pesticides?
 - A. Not washing hands before eating, smoking, or chewing.
 - B. Splashing pesticide into mouth.
 - C. Accidentally applying pesticide to food.
 - D. Storing pesticides in unlabeled bottles or food containers.

-
6. Which pesticide formulation is most readily absorbed through the skin?
- A. Water-based
 - B. Carbamates
 - C. Organophosphates
 - D. Oil-based
 - E. Dusts and powders
7. Match the term with its meaning:
- | | |
|---------------------|---|
| 1. Acute toxicity | A. Poisoning that occurs within a few hours or days after exposure |
| 2. Acute exposure | B. Exposure to repeated small doses of a pesticide over a long period of time |
| 3. Chronic toxicity | C. Relatively large doses of a pesticide in a relatively short period of time |
| 4. Chronic exposure | D. Long-term health effects occurring months or years after exposure |
8. Which LD₅₀ indicates the lowest toxicity?
- A. 64 mg/kg
 - B. 580 mg/kg
 - C. 1,284 mg/kg
 - D. 3,800 mg/kg
-

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NOTE: Graphics of this publication adapted from *National Safety Council's Pocket Guide For Respiratory Protection* and *USDA/EPA Bulletin #825 - Applying Pesticides Correctly*.

Safe Handling of Pesticides

What's in this Chapter:

Mixing and Loading Pesticides

Closed Handling Systems for Mixing and Loading Pesticides

Storing Pesticides

Storage Containers

Storage Areas

How Long Can Pesticides Be Stored?

Reporting of Stored Pesticides

Disposing of Pesticide Wastes

Excess and Waste Pesticides

Management of Containers

Other Pesticide Wastes

Transportation of Pesticides

What to Do if There Is a Spill or Fire

If A Fire Occurs

Minnesota's Agricultural Chemical Response and Reimbursement Account

Checklist for Preventing Agricultural Chemical Accidents

Learning Objectives

After reading this chapter, students will be able to:

- Follow safety practices when mixing and loading pesticides;
- Follow safety practices for storing pesticides;
- Describe safety features of a pesticide storage facility;
- Select pesticide storage supplies;
- Properly rinse and dispose of empty pesticide containers;
- Explain proper pesticide container rinsing methods, triple- and pressure-rinsing;
- Explain what to do with excess pesticides that are still usable;
- Name actions to take when mixing, loading, and application activities are over;
- Describe what to do with rinsates from equipment cleanup;
- Explain “closed handling system;”
- List safety precautions for transporting pesticides in a vehicle;
- Respond correctly when a pesticide container leaks;
- Explain the three C's of spill management and steps to take in each;
- Know who to notify when a pesticide incident occurs.

Terms to Know

Impermeable. Will not let liquids through, as in flooring required for pesticide storage areas

Absorbent materials. Absorbent clay, sawdust, vermiculite, kitty litter, or paper used to soak up spills.

Decontamination. To rid of a polluting or harmful substance.

Waste pesticides. Pesticides that are no longer needed, no longer legal to use, in a container that is missing the pesticide label, or unusable as originally intended for some other reason, such as physical breakdown of the pesticide.

Excess pesticide mixtures. Left over spray solutions from application, left in sprayer boom and hoses, and rinse water from cleaning application equipment.

Poison control center. Provides an emergency number to call for medical help when someone may be poisoned

Division of Emergency Services. In the Minnesota Department of Public Safety. Central calling point to report pesticide spills, fires, and other incidents to the Minnesota Department of Agriculture

Agricultural Chemical Response and Reimbursement Account (ACRRA). Established by the State of Minnesota to reimburse persons for costs of cleaning up pesticide incidents.

Back-siphoning. The movement of liquid pesticide mixture back through the filling hose and into the water source.

Closed handling systems. A closed mixing and loading system is a system designed to prevent pesticide from coming in contact with handlers or other persons and to help prevent spills.

Pesticide handler. Person who works on pesticide equipment or directly handles pesticides, such as during mixing, loading, transporting, storing, disposing of, or applying pesticides.

Pesticide handling. Working on pesticide equipment or directly handling pesticides, such as during mixing, loading, transporting, storing, disposing of, or applying pesticides.

Pesticide wastes. Empty pesticide containers and pesticide contaminated materials such as equipment, rinse water, PPE, soil, and other materials.

Precautionary statement. Pesticide labeling statement that alerts you to possible hazards from use of the pesticide product and that may indicate specific ways to avoid the hazards.

Pressure-rinsing. Rinsing in which a special nozzle is attached to the end of a hose to force the remaining pesticide from the container.

Solvents. A liquid such as water, kerosene, xylene, or alcohol that will dissolve a pesticide (or other substance) to form a solution.

Three C Program. "Control," "Contain," and "Clean up" pesticide spills.

Triple-rinsing. Rinsing an empty pesticide container three times, following triple rinsing directions, to properly clean a pesticide container

Introduction

This chapter on safe handling will explain the safety procedures for mixing and loading, storing, and disposing of pesticides. This chapter will also cover procedures for cleaning up spilled pesticides and steps to take in case an accidental fire involving pesticides occurs.

While handling pesticides, an applicator's safety and the safety of his or her family, co-workers, and the environment is always a priority. In order to maintain safety while working with pesticides, applicators must know the proper ways to store, mix, and load pesticides.

If a spill or fire occurs while working with pesticides, certain procedures must be followed. Steps to control and clean up spills are described in this chapter, and appropriate government agencies that must be contacted are also listed.

Mixing and Loading Pesticides

Mixing and loading are the primary handling tasks for pesticide applicators. They are also among the most hazardous aspects of a handler's job. At these times, you are handling the pesticide in its most concentrated form, and at greater risk of exposure and poisoning.

As soon as you finish mixing, loading, or applying a pesticide, you should do a few important follow-up tasks. Take the time to clean up properly. Wash your pesticide equipment and then wash yourself. Return equipment to its designated place and safely store or dispose of all pesticide materials and other chemicals that you have used. Be sure that your work site presents no hazards to people or to the environment. Never leave the site unattended until everything has been cleaned up and put away.

Protect yourself and others by following the precautions in the following table.

Precautions

Read the label before opening the container to be sure that you are thoroughly familiar with current use directions.

Don't work alone if at all possible. Let someone, a co-worker or other person, know where you are spraying and which pesticides and chemicals you are using.

Never eat, drink, or smoke while handling pesticides. Before eating or drinking, always wash with soap.

Do not handle pesticides if you are taking medication that might make you dizzy. Dizziness can cause accidents. Also, the dizziness could be mistaken for a symptom of pesticide poisoning.

Make sure you wear the right protective clothing and equipment.

Have a plentiful supply of clean water and detergent available in the mixing and loading area.

Work outdoors when pouring and mixing pesticides. If you must work indoors or at night, be sure there is good ventilation and enough light.

Always stand in the crosswind, so that the wind blows across your body from either side. Don't stand with the wind against your back or face.

Open all pesticide containers carefully. Never tear paper containers open. Use a sharp knife. Clean the knife afterwards, and do not use it for other purposes.

Always measure materials accurately. Use only the amount stated on the label.

When pouring a pesticide, keep the container well below eye level to protect your eyes and face from exposure.

Always use a pump or threaded and valved piping if the concentrate has to be removed from a drum or other large container.

Replace pour caps, and close bags or other containers immediately. Return containers to the storage area.

Consider using formulations of pesticides that reduce applicator risk.

Keep the hose or pipe above the level of the mixture at all times, when adding water to a spray mixture. This will prevent the pesticide from back-siphoning into the water source. For extra protection, the water hose should be equipped with a check valve or other device to prevent back-siphoning.

Add the pesticide adjuvants shortly before the tank is completely full (if you use one). These materials tend to cause foaming.

Be extremely careful to avoid overflow. Never leave a spray tank unattended while it is being filled.

Triple-rinse or pressure-rinse metal or plastic containers that have been emptied, and empty the rinse water into the spray tank. Measuring cups should also be rinsed and the rinse water emptied into the spray tank.

Thoroughly clean all mixing and loading equipment after each use.

If you splash or spill a pesticide while mixing or loading, stop what you are doing immediately and clean up the spill. If any concentrate has spilled on your clothes, remove the contaminated clothing.

NOTE: Remember that all spills must be reported immediately to the Minnesota Department of Agriculture. Speed is essential!

Closed Handling Systems for Mixing and Loading Pesticides

You can reduce exposure to concentrated pesticides by using a closed handling system. This system is a series of interconnected pieces of mixing and loading equipment or pesticide packaging that allows you to do the following without coming into contact with the pesticide:

- Remove a pesticide from the original container,
- Rinse the empty container, and
- Transfer the pesticide and rinse solution to the spray tank .

The advantages of a closed handling system are increased safety, less need for protective clothing and equipment, fewer spills, and more accurate measurement.

Many different types of closed handling systems are appearing on the market. Some involve major changes in container design or packaging, but are very simple to use. Other systems may be more complicated and cumbersome. There are two primary types of closed mixing and loading systems. One type uses mechanical devices to deliver the pesticide from the container to the equipment; the other type uses water soluble packaging. Closed handling systems are also being developed for dry products.

The labeling of some pesticides may require you to use a closed mixing and loading system when handling the product. This requirement usually appears on products that have a high risk of causing acute effects or that may cause delayed effects, or to provide protection from spills that could contaminate the environment. Typical statements on the labeling of such products include:

Must be transferred and mixed using closed-system equipment.

Do not use open mixing vats or tanks, or open pouring.

Must be transferred into the spray tank through the use of a mechanical transferring device.

Storing Pesticides

Proper pesticide storage ensures safety to children, pets, livestock, and the environment. If pesticides and pesticide handling equipment are not stored in a safe place, accidents can happen: children, pets, and livestock can be poisoned; air, water, and soil can become polluted; pesticide containers can be damaged; and pesticides can be ruined. Read the label to see if any special steps should be taken before storing the pesticide. Then store the material immediately.

Legal requirements for pesticide storage areas may change and the storage of bulk pesticides have additional requirements. Contact the Minnesota Department of Agriculture for current storage regulations.

Storage Containers

Carefully handling pesticide containers can greatly reduce the chance of accidental spills or poisonings. Only qualified pesticide applicators should come in contact with pesticide containers. Never keep containers in a place where children or unqualified adults can use them.

Information on how to dispose of containers, in accordance with federal and state laws and regulations, can be found on the label directions.

The following safety practices will help keep you and others safe around pesticide containers:

- Store pesticides in their original containers with the labels intact. Never put pesticides in other containers, such as pop bottles, feed bags, or open buckets.
- If you have any unlabeled containers, dispose of them. You can't expect to remember such things as contents, directions, precautions, and antidotes.
- Check periodically for leaking containers. If a container is defective, it should be repaired. If this is not possible, then transfer the contents to another container with an intact label which has held exactly the same product. Then dispose of the defective container in a proper manner.

One of the best ways to reduce the need for storage is to buy only the amount needed for immediate use. If you need to keep a larger inventory, use the older materials first.

Storage Areas

It is important to store containers in a separate area away from unauthorized people, or animals. This protects them from accidental exposure. Make sure the storage site is securely locked. Post signs on doors and windows to alert people that pesticides are stored there. The following information describes conditions needed for safe pesticide storage.

Store pesticides in a locked storage room or cabinet where children, unauthorized people, or animals cannot enter. Make sure the windows are tight; board them up if necessary.

The storage facility can be in a separate building or in a separate area within a building. The area should be used only for pesticides and pesticide equipment. Never store pesticides with food, feed, seed, planting stock, fertilizers, veterinary supplies, clothing, respirators, or other protective equipment.

Locate the storage building downwind and downhill from sensitive areas such as houses, recreational areas, schools, or barns.

The storage area should have a concrete floor which is impermeable (that is, it will not let fluids pass through) and easy to wash.

Ideally, the structure should be fire-resistant. If you store large amounts of pesticide, install fire-detection devices and have fire extinguishers and other fire fighting equipment readily available. As an extra precaution, let your fire department know that you have large quantities of stored pesticides, giving them the location and the kind of pesticides. Post warning signs for firefighters and others.

The storage area should be well lit, well ventilated, and well insulated against extremes in temperature.

Never allow pesticides to become overheated. Do not store them close to any source of heat. Heat may cause liquid formulations to expand, and an accident could occur when the containers are opened. Some pesticide formulations catch fire if they become overheated.

Protect pesticides, especially liquids, against freezing. Some pesticide formulations separate at low temperatures, making it difficult or impossible to mix them. Low temperatures can also cause pesticide containers to rupture. The labels of most liquid products state the lowest temperatures allowed for safe storage.

Store dry formulations packaged in sacks, fiber drums, boxes, or other water-permeable containers on pallets or metal shelves. Do not store dry materials below shelves containing liquid material; if the liquids leak, they could contaminate the dry formulations.

Place metal pesticide containers on pallets or shelves to help reduce corrosion.

Have the following supplies available in the storage area:

- Detergent;
- Hand cleaner;
- Water;
- Absorbent material such as absorbent clay, sawdust, vermiculite, kitty litter, or paper to soak up spills;
- A shovel;
- A broom and dustpan;
- A fire extinguisher rated for ABC fires.

NOTE: A pesticide storage facility should never be used for other purposes, even if pesticides are no longer stored there. It is almost impossible to totally decontaminate a pesticide storage facility.

How Long Can Pesticides Be Stored?

The shelf life is difficult to predict; manufacturers recommend no more than two years for many products. Before storing pesticides, mark the date of purchase on the container. Once a container is opened, the shelf life is greatly reduced.

Use older material first. If the product has a shelf life listed in the labeling, the purchase date will indicate whether it is still usable. Excessive clumping, poor suspension, layering, or abnormal coloration may be indications that the pesticide has broken down. If you have doubts about the shelf life of a pesticide, call the dealer or manufacturer for advice.

Reporting of Stored Pesticides

Under the federal Superfund and Reauthorization Act (SARA) Title III, persons storing certain hazardous substances, for even a few hours, must notify the State Emergency Response Commission. This notification will help state and local emergency response personnel to plan and respond to fires, spills, and accidents where hazardous materials may be present. Notification is required if large enough amounts of specified chemicals, such as anhydrous ammonia and a number of pesticides, are stored at any one time. See Chapter 3 (Laws and Regulations) for more information.

Disposing of Pesticide Wastes

Pesticides become wastes when they become unusable as originally intended. Some undergo physical changes as a result of improper storage or age. Other pesticide products become wastes because of state or federal restrictions prohibiting their use: an example is DDT. When the label is off the pesticide container, it is considered a waste pesticide, because it is no longer possible to identify which pesticide the container holds.

Pesticide users are responsible for properly disposing of empty pesticide containers, excess usable pesticides, and waste material that contain pesticides or their residues. Improper disposal of pesticide wastes can create serious hazards for humans and the environment. There have been recent changes in Minnesota law affecting waste disposal. Currently, the only legal way of disposing of empty pesticide containers is in an approved landfill. It is illegal to bury or burn any type of pesticide container in Minnesota.

Improper disposal of pesticide wastes can create serious hazards for humans and the environment. These wastes include excess pesticides, empty pesticide containers, and materials containing pesticide residues.

Excess and Waste Pesticides

The Minnesota Waste Pesticide Collection Program, sponsored by the Minnesota Department of Agriculture, helps pesticide users dispose of waste pesticides safely, economically, and conveniently. All waste pesticides are eligible for disposal through the Waste Pesticide Collection

program. Waste pesticides must be disposed of according to EPA and state regulations. It is illegal to bury, burn, or discard a pesticide or its container in a manner inconsistent with instructions found on the label. State sponsored waste pesticide collections provide a means for pesticide users to remove these wastes and comply with the law while ensuring the safety of our environment.

The Minnesota Department of Agriculture also sponsors a pesticide container recycling program. Clean, rinsed plastic containers are collected through a partnership with county governments, the Minnesota Extension Service, and pesticide retail dealers. The containers are reprocessed through a national program involving pesticide manufacturers. Used containers are recycled into new pesticide containers. The state provides collection opportunities around the state. Properly rinsed containers may be recycled. Large pesticide drums may be returned to the manufacturer or to drum reconditioners. No containers of pesticides used in agriculture, industry, commercial application or other work, and professional settings should be recycled with household plastic recycling programs.

Waste pesticide is a problem. You can help reduce potential problems by following these guidelines.:

Follow Practices and Techniques for Waste Pesticide Reduction.

Use Integrated Pest Management practices to avoid unnecessary pesticide use.

Purchase only the amount needed to reduce the amount of pesticide stored.

Store all pesticides in a well ventilated, dry, and safe areas free from accidental mechanical contact and temperature extremes.

Make sure all containers are labeled.

Management of Containers

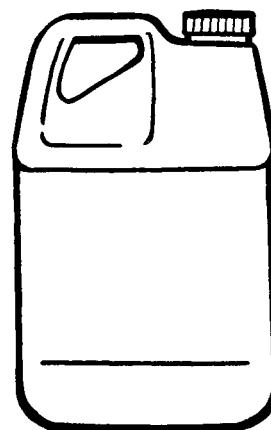
There have been recent changes in Minnesota law affecting on-farm waste disposal. Currently, the only legal way of disposing of pesticide containers is in an approved landfill or recycling and reconditioning. It is illegal to bury or burn any type of pesticide container. Check with local authorities, state agencies, or your local county extension office for more information.

To be eligible for the Minnesota Pesticide Container Recycling Program, containers must be cleaned. Even if it appears that all the pesticide product has been removed from a container, it usually is not truly empty. The pesticide that clings to the inside of the container can be dangerous to you, other people, and the environment. Take care of empty containers at once. Applicators who cannot recycle rinsed containers should have them buried at an approved landfill.

Rinsing plastic, glass, and metal containers

Proper rinsing is the most important step in handling empty pesticide containers. Proper rinsing is required by federal and state regulations and is a good, sound environmental practice. Containers that have been properly rinsed pose less hazard to people and the environment than unrinsed containers.

Two different procedures are effective for proper rinsing of pesticide containers: pressure-rinsing and triple-rinsing. *Pressure-rinse or triple-rinse all empty containers.* All empty rigid plastic, glass, and non-pressurized metal pesticide containers must be properly rinsed before they can be recycled, disposed, or reconditioned. Plastic-lined paper or cardboard containers, and even unlined paper or cardboard containers that can withstand the rinsing process, should be triple-rinsed or pressure-rinsed as well. The liquid you use for rinsing should be the dilutent (water, kerosene, high-grade oil, or another liquid) listed on the pesticide labeling for diluting the pesticide for application. This is the most important step in handling empty pesticide containers.



NOTE: More information about waste pesticide collection and container recycling programs may be obtained by calling the Minnesota Department of Agriculture at: (612)-297-7102 or 1-800-657-3986.

Rinsing at the time of use allows the rinse water to be added into the spray tank. This eliminates the need to store unrinsed containers and to store the rinse water. In addition, some pesticides will solidify quickly and be difficult to clean from the container if not rinsed immediately.

Empty, unrinsed pesticide containers

Container storage locations, preferably indoors, should be managed so that unrinsed containers are not placed with properly rinsed containers. Empty, unrinsed pesticide containers must be capped, stored upright in a secure (locked) area, and placed on an impervious surface. Rinsing empty pesticide containers after the contents have dried may require additional steps and/or the use of cleansing material for rinsing. The best tactic is to rinse containers at the time of use to avoid having any unrinsed containers to store.

Two different procedures are effective for proper rinsing of pesticide containers: pressure-rinsing and triple-rinsing.

Pressure-rinsing

In pressure-rinsing, a special nozzle is attached to the end of a hose to force the remaining pesticide from the container. The liquid used for rinsing is pumped through the hose and nozzle that sprays the inside of the container to wash the remaining pesticide from the container. Pressure-rinsing may be faster and easier than triple-rinsing and can be used with plastic and non-pressurized metal pesticide containers.

To pressure-rinse containers:

1. Empty contents of container into spray tank, turning the container so that any product trapped in the handle is allowed to flow out. Once flow is down to a drip, allow the container to drain for an additional 30 seconds.
2. Immediately begin rinsing procedures or the product may become difficult to remove.
3. Hold the container so the opening can drain into the spray tank.
4. Force tip of the pressure nozzle through the lower portion of the side closest to the handle.
5. Connect nozzle to a clean water source of at least 40 psi. Turn the nozzle inside the container to ensure good coverage of all sides, including the handle.
6. Rinse for at least 30 seconds.
7. Drain all rinse water into the spray tank.



Triple-rinsing

Triple-rinsing can be used with plastic, non-pressurized metal, and glass containers.

To triple-rinse containers:

1. Empty contents of container into spray tank, turning the container so that any product trapped in the handle is allowed to flow out. Once flow is down to a drip, allow the container to drain for an additional 30 seconds.

2. Immediately begin rinsing procedures or the product may become difficult to remove.
3. Fill the empty container one-fourth full of water.
4. Replace the cap on the container. With the container opening facing left, shake the container left to right over a distance of four to six inches. Shake the container about twice per second for 30 seconds.
5. Drain rinse water into spray tank as described in step 1.
6. Fill the container one-fourth full with clean water a second time.
7. Recap the container. With the opening of the container pointed toward the ground, shake the container as described in step 4. Then drain the rinse water into the spray tank.
8. Finally, fill the container one-fourth full with clean water a third time.
9. Recap the container. With the container in the normal, upright position, shake the container as you did before. Shake with a four- to six-inch vertical motion, twice per second for 30 seconds.
10. Pour the rinse water into the spray tank. Carefully rinse and spray residue from the outside of the container.

Paper and other containers

Before disposing of paper, plastic, and composite pesticide bags, make sure they are completely empty. Thoroughly empty the contents into application equipment. Then dispose of the bag at an approved landfill. Do not attempt to rinse. If you are not sure whether you should rinse a container or not, check the label. The following table shows how to dispose of different containers.

Pesticide container disposal

Type of container	Disposal options
Plastic jugs	Recycle or landfill
Metal	Recycle or landfill
Plastic bags	Landfill
Paper bags	Landfill
Aerosol	Landfill
Mini-bulk	Check with the dealer

NOTE: Landfill operators are not required to and may not accept pesticide containers. Landfill operators are legally liable for environmental problems that may occur because of unrinsed containers or paper and plastic pesticide bags in their landfill.

Other Pesticide Wastes

Excess pesticide mixtures

Excess pesticide mixtures include:

- Leftover solutions after spraying is done.
- Water used to wash the outside or rinse the inside of the sprayer.
- Spray left in the boom or hoses.
- "Haul-back" solutions from a spraying job interrupted by weather or equipment breakdown.
- Small quantities of material spilled during mixing.

Excess pesticide mixtures should be collected and used again. They can be used on a crop or other site listed on the label or stored for mixing future solutions of the same pesticide. To make it easy to collect these excess pesticide mixtures, mix pesticides and clean equipment on an asphalt or cement pad equipped with an above-ground tank to hold runoff.

Diluting the pesticide will not solve the hazardous waste problem. In fact, it can make it worse. Ten gallons of hazardous waste diluted with 90 gallons of water creates 100 gallons of hazardous waste. Likewise, mixing hazardous waste with nonhazardous waste makes the whole mixture hazardous.

Other materials

Other types of materials that must be disposed of properly include:

- Contaminated material from the cleanup of spills.
- Clothing on which liquid concentrates have spilled.
- Pesticides that have been damaged by fire, water, or other substances.
- Pesticides that have been stored beyond their shelf life.
- Pesticides with some or all uses canceled.

Contaminated clothing and similar small items can be enclosed in a plastic bag and thrown into the garbage. For other pesticide materials, check with the Minnesota Department of Agriculture (MDA) before you dispose of them. The MDA may recommend that these materials be used in some way according to the label. If the MDA finds that the contaminated material cannot be reused, then it will be considered a pesticide waste. Information on proper disposal of these pesticide wastes can be obtained from the Minnesota Department of Agriculture.

Transportation of Pesticides

You are responsible for the safe transport of pesticides in your possession. Accidents can occur even when transporting materials a short distance. Do all you can to prevent a mishap, but be prepared in case of emergency. Carry a spill cleanup kit.

Before transporting pesticides, know what to do if a spill occurs. If any pesticide is spilled in or from the vehicle, take immediate action to clean up the spill.

Vehicle Safety

The safest way to transport pesticides is in the back of a truck. Flatbed trucks should have side and tail racks. Steel or plastic-lined beds are best, because they can be more easily cleaned if a spill occurs.

Never carry pesticides in the passenger section of your car, van, or truck. Hazardous vapors may be released and make the driver and other passengers ill. If spills occur, it is nearly impossible to completely remove chemicals from the fabric of seats and floor mats.

Never allow children, other passengers, or pets to ride with pesticides.

Never transport pesticides with feed, food, clothing, or other things meant to be eaten by or be in contact with people or animals. Even small amounts of pesticide could contaminate these highly sensitive items.

Never leave your vehicle unattended when transporting pesticides in an unlocked trunk compartment or open-bed truck. You are responsible and liable if curious or careless people are accidentally poisoned by the pesticides. Whenever possible, transport pesticides in a locked compartment.

Consider transporting highly volatile pesticides in separate trips from other chemicals.

Transporting pesticides

Transport pesticides only in containers with undamaged and readable labels. Inspect containers before loading to be sure that all caps, plugs, and other openings are tightly closed and that there are no pesticides on the outside of the containers.

Anchor all containers securely to keep them from rolling or sliding. Protect paper and cardboard containers from moisture.

Protect pesticides from extreme temperatures during transport. Extremely hot or cold temperatures can damage pesticide containers and also may reduce the usefulness of the pesticides.

What to Do if There Is a Spill or Fire

Be prepared

Pesticide spills can be a serious threat to humans, pets, livestock, and the environment. By knowing in advance just what to do when a pesticide spill or fire occurs you may reduce the danger. While fertilizer spills are also a concern and are covered by the same state law requirements this section will focus only on pesticides.

Know your pesticides

Have available Material Safety Data Sheets (MSDS) or emergency response information for the products used so you know how to handle a specific pesticide during an emergency. These may be obtained from the manufacturer.

Report pesticide spills

According to state law, you must immediately report incidents involving pesticides, even ones that you may consider minor. This includes leaking containers, spills, exposure, poisoning, motor vehicle accidents, tornadoes, fires, and floods. Under Minnesota law all incidents (releases, spills, etc.) involving agricultural chemicals must be immediately reported by the responsible party or owner of real property to the Minnesota Department of Agriculture Incident Response Program, except for incidents which meet ALL of the following conditions:

- 1) the responsible party or owner of real property is a licensed commercial or certified private applicator; AND
 - 2) the total amount of pesticide involved in the incident at the site over the entire year is less than what can be legally applied (labeled rates) to one acre of agricultural cropland; AND
 - 3) the incident was not into or near public water or groundwater.

When you call to report a spill,
give the following information:

Your name;
Where you can be reached;
Where the spill is;
Type of pesticide;
What time the spill occurred;
The source of the spill;
How much material was spilled
(and for how long);
Whether the material is
spreading; and
Nearby surface water or wells.

The MDA will provide expert guidance on how to handle both small and large spills.

NOTE: Please remember that an agricultural chemical incident must be reported to be eligible for Agricultural Chemical Response and Reimbursement Account (ACRRA) reimbursement of cleanup costs.

Important telephone numbers to know

Local emergency response or fire	911
To report pesticide spills: The Minnesota Department of Public Safety, Division of Emergency Management (DEM) can be reached 24 hours a day. Ask the DEM to notify all appropriate state agencies for you, including the Minnesota Department of Agriculture.	Twin Cities call (612) 649-5451 Greater Minnesota call 1-800-422-0798
For spills involving large amounts of pesticide, highly toxic chemicals, or extensive contamination, additional information may be obtained by contacting the Pesticide Safety Team Network. These experts are ready 24 hours a day to give advice on how to handle emergencies.	CHEMTRAC at 1-800-424-9300
Pesticide poisoning: Call the Poison Center for your area. They can provide quick information for treating victims of pesticide poisoning.	West (Twin Cities) Metro area call (612) 347-3141. East (Twin Cities) Metro area and Greater Minnesota call (612) 221-2113 or 1-800-222-1222

If a spill occurs

Here is a list of things to do if a spill occurs.

1. **Act quickly.** If a spill occurs, it must be taken care of immediately. Any delay could cause serious contamination. It could also be very costly to pay someone to clean up a spill that was allowed to spread.
2. **Notify the authorities.** **For any kind of pesticide spill, the Minnesota Department of Agriculture (MDA) must be notified immediately.** If the spill occurs on a public road, also have someone alert state, county, or local police using 911.
3. **Protect yourself.** Do not expose yourself to the chemical. Wear protective clothing and equipment as required by the pesticide label. If someone is injured, make sure you are properly protected before you try to help them. You are not going to be able to help anyone if you become injured, too. Safety in responding to a spill is important. If you cannot safely control or contain the spill, then do not do it. Obtain expert assistance and advice on how to proceed.
4. **Control the spill.** Control the spill or leak by stopping it if it is possible to do so safely. If a small container is leaking, put it into a larger container to contain the pesticide.
5. **Contain the spill.** Prevent the spill from spreading if it can be done safely. Keep it in as small an area as possible. It is most important to keep all chemicals from getting into any body of water, including



*In handling any spill, no matter how large or small, follow the basic steps of the "Three C" program: **Control, Contain, and Clean up the spill.** Whether you are dealing with just one leaking container or with an overturned truck on a public highway, always use this basic "Three C" program.*

storm sewers and tile lines. Do not hose down the area. This will cause further spread of the chemical.

Construct a dam to prevent the pesticide from spreading. If it is a liquid, spread absorbent materials such as fine sand, vermiculite, sawdust, or clay over the entire spill. Kitty litter is very useful for containing and cleaning up small spills or minor leaks.

For dusts, wettable powders, or granular materials, a light misting with water will help to reduce spreading. Covering the spill with a plastic cover is also a good idea (the plastic cover must be properly discarded later).

6. **Guard the site.** Isolate the contaminated area to keep people away. Rope it off if possible. Do not let anyone come any closer than 30 feet. It may be necessary to evacuate people downwind from the spill. Avoid any drift or fumes that may be released. Do not use road flares if the leak may be flammable..
7. **Clean up the spill.** The Minnesota Department of Agriculture will give you guidance and assistance on cleaning up a spill and handling contaminated materials. Cleaning up some spills may be easy. Other spills may require more complex procedures. The MDA will give you recommendations on each of these steps. The procedures will vary, depending on the following factors:

- The pesticide involved in the spill;
- The extent of the spill;
- The location of nearby wells, surface waters, and other vulnerable sites;
- Soil type; and
- Materials contaminated.

There are three steps in cleaning up pesticide spills:

1. Remove the spilled pesticide.
2. Decontaminate the spill area.
3. Clean contaminated equipment.

It may be possible to reuse some of the spilled or contaminated materials. The MDA will provide information and recommendations on handling these materials. The recommendations may include applying the materials to labeled sites at or below labeled rates for that pesticide. If the materials cannot be used, then they are considered waste and come under the jurisdiction of the Minnesota Pollution Control Agency (PCA). The PCA will provide information on how to dispose of these waste materials.

Clean up all vehicles and equipment involved in an accident or cleanup. Be sure to wear protective clothing as required by the pesticide label. Use a solution of liquid bleach and alkaline detergent (dishwasher detergent) to clean equipment. Porous material and equipment such as brooms, leather shoes, and cloth hats cannot be decontaminated; they must be discarded or destroyed after cleanup.

IF A Fire Occurs

Most of the active ingredients in pesticides are not flammable; however, many of the solvents used in liquid formulations are highly flammable. All liquid pesticides and some wettable powders are potential fire hazards.

If you store large quantities of pesticides, install fire-detection devices and have fire extinguishers handy. Inform your fire department about any large quantities of stored pesticides. This is an important safety precaution to follow in case a fire breaks out when you are not available.

In the event of a fire, the main goals are:

- Protect people from smoke and fumes.
- Contain the fire.
- Prevent contamination of surrounding areas.

Immediate report the incident to the Minnesota Department of Agriculture and call the fire department. Tell them what pesticides are involved. Give specific information that may help them fight the fire and protect themselves (and others) from injury.

Remove all people from the area to a safe place upwind of smoke and fumes. Isolate the entire area. Keep spectators away.

Fighting pesticide fires require extreme caution. Firefighters should follow these guidelines:

Wear protective clothing and equipment, including liquid proof gloves, boots, full body covering, and a hat. Respirators may be necessary. If a burning structure must be entered to rescue someone, the rescuer must use a self-contained breathing apparatus to protect against toxic vapors and lack of oxygen.

Always approach the fire from the upwind side and from a safe distance.

Be aware that pesticide containers might explode. Nearby containers should be moved or kept cool.

Do not attempt to save burning chemicals.

Use foam or carbon dioxide to fight the fire whenever possible. Be especially careful about using water. Sometimes it is better to simply let the fire burn out, since the contaminated runoff created by water may create a more serious problem than the fire. If water is used, build dikes to prevent flow of contaminated runoff into lakes, streams, sewers, or other bodies of water. Also, a fog spray often works better than a straight stream of water and usually results in less contamination.

Avoid smoke, fumes, mist, and runoff as much as possible. If you suspect that someone has been poisoned by a pesticide, move the person from the fire area, call a doctor or ambulance, and give appropriate first aid as described in Chapter 5 (Protecting the Applicator).



Minnesota's Agricultural Chemical Response and Reimbursement Account

The Agricultural Chemical Response and Reimbursement Account (ACRRA) was created by the 1989 Minnesota Ground Water Protection Act. The ACRRA fund was established primarily to reimburse persons for costs incurred after July 1, 1989, in cleaning up agricultural chemical (pesticide and fertilizer) incidents.

The account is funded by annual surcharges on pesticide and fertilizer manufacturers, distributors, applicators, and dealers. The amount of surcharges levied will largely be determined by the current ACRRA fund balance. The account has a required statutory minimum balance of \$1,000,000 and a maximum balance of \$5,000,000. It is the Commissioner of Agriculture who determines if the surcharge must be increased.

The ACRRA fund can be used for reimbursement of costs resulting from cleanup of sudden incidents, such as fire or transportation accidents. Money from ACRRA can also be used to reimburse persons for cleaning up sites contaminated with agricultural chemicals.

Before any reimbursement can be made, the board must determine the following:

- The Minnesota Department of Agriculture (MDA) was given **proper notice** by reporting the incident as required under Minnesota Statues, Chapter 18D.
- The costs of investigation and cleanup were **reasonable and necessary**; and
- The eligible person complied with corrective action requests or orders issued by MDA, or the eligible person took all reasonable action necessary to minimize and abate the incident, and the corrective action was subsequently approved by MDA.

If these conditions are met, the Board may reimburse an eligible person for:

Ninety percent (90%) of the total reasonable and necessary correction action costs greater than \$1,000 and less than \$100,000; and

One hundred percent (100%) of the costs equal to or greater than \$100,000 and less than \$200,000.

The Board has authority to reduce reimbursement if the incident was caused by a violation of Minnesota Statutes, Chapters 18B, 18C, or 18D.

For further information about ACRRA, how to participate in the program, and what costs may be covered, contact:

Sharon Huber, ACRRA Administrator
Minnesota Department of Agriculture
tel. (612) 297-3490

Checklist for Preventing Agricultural Chemical Accidents

Experienced pesticide applicators may become so familiar with their pesticide equipment and materials that they take short cuts and become careless. The following checklist is based on data showing the common causes of pesticide accidents. Carefully following each step can make the difference between having a safe and routine day and one that results in a pesticide accident.

Splashes and spills

- Know what to do if you spill a pesticide while mixing it.
- Always watch the sprayer tank when filling it so it won't run over and spill on the ground.
- Have absorbent clay, sawdust, vermiculite, kitty litter, or other absorbent material on hand to soak up spills.
- Do not drain leftover spray mixtures on the ground.

Application equipment

- Equip the sprayer tank and water supply hose with air gap equipment or other devices to prevent back-siphoning into the water supply
- Maintain the equipment so it doesn't leak.
- Discard an old high-pressure hose instead of reinforcing it and hoping that nobody will be nearby if it bursts.
- Clean nozzles with a soft brush and by rinsing it.
- Keep spray equipment clean so that those touching it will not be contaminated.
- Always release pressure on the equipment so that spray guns won't be triggered accidentally.

Pesticide application

- Check wind direction and the area downwind before applying pesticide.
- Consider substituting a safer chemical if spraying near a sensitive area.
- Check for the possibility of rain showers and damaging runoff before applying pesticides.
- Plan pesticide application so it will have little or no effect on bees, birds, fish, or other wildlife.
- Remove, turn over, or cover up pet dishes, sand boxes, and plastic pools before spraying near residences.
- Make sure that children and pets are out of the area being sprayed and that they stay out for the reentry interval.

Storage

- Have a separate space to store pesticides.
- Keep the storage area locked and windows tight, barred, or boarded over.
- Keep all your pesticides in this storage area rather than in the garage, feed room, basement, porch, kitchen, or refrigerator.
- Protect pesticides from freezing or overheating.
- Place signs on the storage area so firefighters and others are warned.
- Always keep pesticides in the original containers instead of in old bottles, milk cartons, or other food containers.
- Have a label handy to remind you of precautions, antidotes, and directions when you put pesticides in unlabeled transfer containers or sprayers.
- Safely dispose of unlabeled pesticides rather than take a chance that you may forget what you've got.
- Keep spray equipment stored where children cannot play with it.

Disposal

- Limit the amount of pesticide waste material you produce.
- Follow the current federal, state, and local guidelines, laws, and regulations for proper disposal of pesticides and pesticide containers.
- Pressure-rinse or triple-rinse empty liquid containers, and dump the rinse water into the tank.
- Collect all containers for proper disposal before leaving a job instead of leaving them in the field or at your tank filling station.
- Keep used containers in your storage area until disposal.
- Puncture, break, or crush containers so they can't be reused
- Use returnable containers or recycle or recondition empty containers whenever possible.

Summary

Pesticides may be a hazard to humans, animals, and the environment. You must take special precautions when you handle pesticides or when you handle clothing or equipment that has been exposed to pesticides.

Before you handle any pesticide, read the label carefully and follow the safety recommendations.

Be especially careful when you mix and load pesticides. Always stay with a spray tank while it is being filled. Do not let a spray mixture into the water supply.

When you apply pesticides, be careful to:

- Use the correct amount;
- Avoid contaminating water;
- Avoid pesticide drift;
- Protect people and animals from exposure;
- Back-siphon clean all mixing and loading equipment after each use to remove pesticide residues;
- Store your equipment where children cannot play on it. Store pesticides in their original containers with the label intact. Keep pesticides in a separate, locked stored area. Check stored pesticide containers regularly for leaks.

Disposal of pesticides and pesticide containers must be done in accordance with federal and state regulations. Properly rinse empty plastic, glass, and metal pesticide containers. After rinsing, recycle pesticide containers or bury them at an approved landfill. Collect all pesticide container rinse water to use again. Thoroughly empty paper containers before disposing of them.

If a spill occurs, you must control, contain, and clean it up immediately. Do not let it spread to any body of water. Keep people upwind and away from the area. Immediately notify the Minnesota Department of Agriculture by contacting the Division of Emergency Management.

If a fire breaks out, inform the fire department of the type of pesticide involved. Protect people from smoke and fumes. Avoid using water to put out the fire because of the risk of contaminated runoff.

Review Questions for Safe Handling of Pesticides

1. What are two ways to properly rinse empty pesticide containers?
 - 1.
 - 2.
2. Explain what to do with excess pesticides that are still usable.
3. List the activities should occur after mixing, loading, and application of a pesticide?
4. What should be done with the rinsates from rinsing pesticide containers?
 - A. Dilute and dispose of them in an old container in the trash.
 - B. Add directly to the spray tank before application
 - C. Pour down the drain.
 - D. Add bleach or ammonia to neutralize the active ingredient.

5. Which of the following are benefits of a closed handling system?
 - A. Increase handler safety.
 - B. Allow for less personal protective equipment.
 - C. Reduce spills.
 - E. Provide more accurate measurement, which reduces overdosing or underdosing and may save money.
 - F. All of the above.
6. Water-soluble packaging may be considered a closed system for mixing and loading.
 - A. True
 - B. False
7. Describe safety features of a pesticide storage facility.
8. List the contents of a pesticide spill kit.
9. What are the "three C's" of spill management?
 - C_____.
 - C_____.
 - C_____.
10. List sources and telephone numbers of assistance for managing a spill or other pesticide incident.
11. What is the most important step in handling empty pesticide containers?
 - A. Rinsing the container
 - B. How the containers are disposed of
 - C. How the containers are stored until disposal
 - D. Putting the cap back on the container so pesticide can not drip out
12. Which of these are legal methods for disposing of pesticide containers?
 - A. Burning
 - B. Burying
 - C. Reusing the container for storing used motor oil or other chemicals
 - D. Burying at an approved landfill

References

Minnesota Extension Service. 1994. *Private Pesticide Applicator's Training Manual*. St. Paul: University of Minnesota and Minnesota Department of Agriculture.

Environmental Protection Agency. 1991. *Applying Pesticides Correctly: A Guide for Private and Commercial Applicators*. Revised.

Protecting the Environment

What's in this Chapter:

Sources of Contamination

Pesticide Movement

Airborne Causes of Pesticide Drift Problems

Factors Related to Drift

How Weather Affects Drift

How to Reduce Drift

Surface Water Contamination

Groundwater Contamination

Pesticides in Groundwater

Pesticide Leaching and Surface Runoff

Factors Affecting the Leaching and Surface Runoff of Pesticides

Processes Affecting Pesticide Stability

Pesticide Management Practices to Protect Surface and Groundwater

Keeping Pesticides Out of Surface Water and Groundwater

Protecting Nontarget Organisms

How Pesticides May Harm Wild Plants and Animals

How to Protect Nontarget Organisms from Pesticides

Endangered and Threatened Species in Minnesota

Pesticide Programs to Protect Endangered and Threatened Species

Learning Objectives

After you complete your study of this chapter, you should be able to:

- Explain the meaning of the word "environment;"
- Distinguish between point-sources and nonpoint-sources of environmental contamination by pesticides;
- List factors to consider when a pesticide is accidentally or intentionally released into the environment;
- Describe what a sensitive area may be and the considerations pesticide handlers must observe.;
- Name the routes by which pesticides can move off-site into the environment;
- Describe factors that influence whether pesticides will move off-site in the air, water, or on objects, plants, or animals;
- Identify pesticide characteristics that influence its ability to reach surface or groundwater;
- Describe factors about a given site that influence the potential for a pesticide to reach surface or groundwater;
- Identify and exercise pesticide handling practices that will help prevent surface and groundwater contamination;
- Recognize that nontarget plants and animals can be harmed by both pesticides and pesticide residues.

Terms to Know

Back-siphoning. The movement of liquid pesticide mixture back through the filling hose and into the water source.

Drift. Pesticide movement away from the application site in the air.

Groundwater. Water beneath the earth's surface in soil or rock.

Leaching. The movement of pesticides in water or another liquid downward through soil.

Organic matter. Materials and debris that originated as living plants or animals.

Predator. An organism that attacks, kills, and feeds on other organisms.

Release. When a pesticide leaves the container or the equipment, or system that is containing it and enters the environment. Release can be intentional, as in an application, or by accident, as in a spill or leak or due to fire.

Rinsate. Pesticide-containing water (or another liquid) that results from rinsing a pesticide container, pesticide equipment or other pesticide-containing materials.

Runoff. The movement of pesticide away from the target site in water or another liquid flowing across the surface.

Surface water. Water on top of the earth's surface, such as lakes, streams, rivers, irrigation ditches, or storm water drains.

Target. The site or pest toward which control measures are being directed.

Use site. The immediate environment where a pesticide is being mixed, loaded, applied, transported, stored, or disposed of, or where pesticide contaminated equipment is being cleaned.

Volatile. Evaporating rapidly; turning easily into a gas or vapor.

Introduction

This chapter describes the factors that affect the environment whenever pesticides are used. These factors include definitions of the words "environment," "point-source," and "nonpoint-source" pollution. This chapter will also explain why you need to consider the effects of pesticides on sensitive areas, plants, and animals. It is the responsibility of the pesticide applicator to be aware of and to avoid practices that can cause environmental damage. It is important for applicators to understand what happens to pesticides in the environment and how pesticides pollute water, soil, and air and may affect nontarget organisms. When pesticides move off-site, they may cause serious and long-lasting effects on humans, plants, and animals.

The environment is everything around us, whether we are indoors or outdoors. It includes the natural elements that the word "environment" most often brings to mind, as well as people and the synthetic components of our world. It is air, soil, water, plants, animals, houses, restaurants, offices, and factories and all that they contain. Anyone who uses a pesticide (indoors or outdoors, in a city or in the country) must consider how that pesticide will affect the environment.

The environment is everything around us: air, soil, water, plants, animals, people, houses, restaurants, offices, and factories.



Pesticides can harm all types of environments if used incorrectly. Responsible pesticide users know and follow good practices that achieve effective pest management with little risk of environmental damage. Labeling statements may alert you to particular environmental concerns that a pesticide product poses.

Both the public and the Environmental Protection Agency (EPA) are becoming increasingly concerned about harmful effects on the environment from the use of pesticides. Hazards to humans had been the primary reason for EPA to classify a pesticide as a restricted use product. Now, more and more pesticide labels list environmental effects, such as contamination of groundwater or toxicity to birds or aquatic invertebrate animals, as a reason for restriction.

Sources of Contamination

When environmental contamination occurs, it is the result of either point-source or nonpoint-source pollution. Point-source pollution comes from a specific, identifiable place (point). A pesticide spill that moves into a ditch or storm sewer is an example of point-source pollution. Contamination point-sources include:

- Washwater and spills produced at equipment cleanup sites;
- Improper disposal of containers, water from rinsing containers, and excess pesticides;
- Pesticide storage sites where leaks and spills are not correctly cleaned up; and
- Spills that occur while mixing concentrates or loading pesticides into application equipment.

Nonpoint-source pollution comes from a number of sources spread over a broad area, such as a watershed. One example of nonpoint-source pollution is the movement of pesticides into streams after broadcast applications. Nonpoint-source pollution from pesticide applications is what has most commonly been blamed for pesticide contamination in the outdoor environment. Some studies are revealing that this may not be where the bulk of the blame should go.

As a pesticide handler, especially if you use and supervise the use of restricted use pesticides, you must be aware of the potential for environmental contamination during every phase of your pesticide operation.

Whenever a pesticide is released into the environment, whether intentionally or accidentally, consider:

- Whether there are sensitive areas at or nearby the pesticide use site that might be harmed by the pesticide;
- Whether conditions may cause the pesticide to move off-site; and
- Whether you need to change any factors in your application or in the target site to reduce the risk of environmental contamination.

Sensitive areas

Sensitive areas are sites or living things that are easily injured by a pesticide.

Sensitive areas *outdoors* include:

- Areas where groundwater is near the surface or easily accessed (wells, sinkholes, porous soil, etc.);
- Areas in or near surface water;
- Areas near schools, playgrounds, hospitals, and other institutions;
- Areas near the habitats of endangered or threatened species;
- Areas near apiaries (honeybee sites), wildlife refuges, or parks; and
- Areas near ornamental gardens, food or feed crops, or other sensitive plantings.

Sensitive areas *indoors* include:

- Areas where people (especially children, pregnant women, the elderly or the sick) live, work, or are cared for;
- Areas where food or feed is processed, prepared, stored, or served; and
- Areas where domestic or confined animals live, eat, or are otherwise cared for.

Sensitive areas may be part of a larger target site. Take special measures to avoid direct pesticide contact with sensitive areas. For example, leaving an untreated buffer zone around sensitive areas is often a practical way to avoid contaminating them.

Pesticide Movement

Pesticides can move away from application sites whether indoors or outdoors and may cause harm in both environments. Pesticides move in several ways, including:

- In air, through wind or through air currents generated by ventilation systems;
- In water, through runoff or leaching;
- In or on objects, plants, or animals (including humans) that move or are moved off-site.

Airborne Causes of Pesticide Drift Problems

Pesticide drift is the movement by air of pesticides to areas other than the target area of application. Drift can be in the form of a spray, dust, or vapor. Drift of spray or dust occurs at the time the pesticide is applied. Small spray droplets or dust particles can be carried by wind

to sites beyond the application area. Lower pressure and coarse nozzles produce larger droplets with less drift potential.

Vapor drift occurs when the pesticide evaporates and the vapors are carried by air movement. Some pesticides may re-volatilize, or evaporate off surfaces after they are applied, and then drift to other sites. Volatilization occurs when a solid or liquid turns into a gas. A pesticide in a gaseous state can be carried away from a treated area by air currents; movement of pesticide vapors is called vapor drift. Unlike the drift of sprays and dusts that can sometimes be seen during an application, vapor drift is invisible.

Volatilization of pesticides increases with higher air temperature and air movement, higher temperature at the treated surface (soil, plant, etc.), low relative humidity, and when spray droplets are small. Pesticides also volatilize more readily from coarse-texture soils and from medium- to fine-texture soils with high moisture content.

Avoid applying volatile pesticides when conditions favor volatilization. The vapor pressure rating of the pesticide may help indicate the volatility of the material. The higher the vapor pressure, the more volatile the pesticide. Volatilization can be reduced through the use of low-volatile formulations and incorporation of the pesticide.

The likelihood that pesticides will drift off-site depends partly on the way they are applied. Pesticides released close to the ground are not as likely to be caught up in air currents as those released from a greater height. Pesticides applied in an upward direction or from an aircraft are the most likely to be carried away on air currents.

Heed all warning statements on the labeling of volatile pesticides. Any time you use a volatile pesticide in an enclosed area, consider the hazards not only to yourself and fellow workers, but also to people, animals, and plants that are in or near the site or that may enter the area soon after the application.

Pesticide drift can lead to a number of problems. Drift can:

- Harm sensitive crops, ornamentals, gardens, livestock, wildlife, or people;
- Contaminate water, soil, or buildings;
- Settle on crops, leaving a residue.

Factors Related to Drift

The type of pesticide, the application equipment, and the weather all have an effect on pesticide drift and the damage it causes. It is easier to control drift if you understand how these factors are related.

Formulation

A volatile formulation is one that changes from a solid or liquid into a gas or vapor. Volatile formulations and pesticides applied as dust are likely to drift. Dusts drift more readily than liquid sprays. Vapors can drift farther than spray droplets and may form after the pesticide is applied. You can avoid vapor drift by using relatively nonvolatile formulations.

Droplet size

Large droplets are less likely to drift than small droplets. Droplets with diameters smaller than 50 microns are likely to drift under normal conditions. The following table shows how drift varies with droplet size.

Distance water droplets drift while falling 10 feet in a 3 mph wind

Droplet diameter (in microns*)	Classification	Drift (in feet)
30	Cloud	500
100	Mist	50
200	Drizzle	16
500	Light Rain	7

* 1 micron = 1/25,000 inch

Evaporation rate

Spray droplets get smaller as they evaporate. Smaller-sized droplets tend to stay airborne longer. Water evaporates more rapidly than oils, as much as 35 times as fast as diesel fuel. The water in small droplets may completely evaporate before the droplets reach the ground.

Height Of release

Droplets that are released closer to the ground are less likely to drift, since they are in the air for less time. Spraying close to the plants or soil surface will give good coverage. Using drop nozzles to release the spray below the crop canopy will also help to reduce drift.

How Weather Affects Drift

Three aspects of weather affect drift: air movement, temperature, and relative humidity.

Air movement

Air movement, both vertical and horizontal, affects the potential for drift. Good times to apply pesticides in order to avoid drift are just before sunrise and again just after sunset and throughout the night. The air is generally the least turbulent during these times. Avoid application on windy days. Winds usually pick up as cold or warm fronts approach. Before applying pesticides, check the product label for directions regarding wind speed.

Temperature

Besides affecting air movement, temperature also has other effects on pesticides. Volatile herbicides turn to vapor more rapidly at temperatures above 80°F. High temperatures also increase the rate of evaporation from spray droplets, which means the droplets stay airborne longer.

Relative humidity

Relative humidity affects the rate of evaporation from spray droplets. The rate is faster at low relative humidities.

How to Reduce Drift

Whenever you apply pesticides, think about how you can control drift. Pay attention to each of the factors affecting pesticide drift listed above. Try to use the following practices:

- Use low-volatility formulations;
- Use the proper size nozzle for the job, preferably the largest practical nozzle;
- Operate at the lower end of the rated pressure range of the nozzle;
- Release spray near the crop or soil surface;
- Avoid spraying at high temperatures;
- Spray when the wind is low and blowing away from sensitive crops or sensitive areas.

Surface Water Contamination

Pesticides in surface water have not received as much media attention as pesticides in groundwater but are of equal concern. Pesticides can reach surface water in runoff, from drift, through storm sewers, from point-source discharges, or in groundwater that is discharging into surface water. Some also reach surface waters in rainfall. Some of the pesticides found in rainfall were probably in the atmosphere because they are very volatile, while other nonvolatile compounds were probably transported into the atmosphere through wind erosion or drift.

A 1989 study by the US Geological Survey reported that 55 percent of streams tested in ten Midwestern states had measurable levels of pesticides prior to spring agricultural field applications and 90 percent had measurable levels shortly after the applications. Although most detections were of very small quantities, numerous samples exceeded the health advisory limits for atrazine and alachlor. Efforts must be taken to reduce the potential of pesticides moving into surface water.

Pesticides can most easily reach surface water when applied to areas adjacent to lakes, streams, wetlands, and fields containing natural drainage ways. Vegetation buffer strips planted along waterways help filter contaminants before they reach the water. The agricultural community can use conservation tillage and contouring in their management programs to help protect surface water. All pesticide applicators can:

- Implement nonchemical pest management strategies when practical;
- Select pesticides with low runoff and leaching potentials;
- Reduce pesticide use as much as possible;
- Use the lowest effective rates and frequency;
- Use set-backs to keep safe distances from water bodies when making applications;

- Apply pesticides with calibrated, well-functioning equipment; and
- Properly store and dispose of pesticides, rinsates, and containers.

Many of the proactive efforts used to prevent groundwater contamination described in the next section also help protect surface water quality.

Groundwater Contamination

Groundwater is water contained in the cracks and pores of rocks and the space between sand grains, minerals, and other soil particles underground. Because it can not be seen it is difficult to visualize groundwater and its interactions with the rest of the environment. Groundwater is part of the water cycle. Rain hits the ground and either soaks in or runs off the land surface into lakes, wetlands, or rivers. Water filtering through the soil moves into the *unsaturated zone* where pores contain both air and water. Some of this water is taken up by plants. The rest continues downward to the groundwater or *saturated zone*, where pores are completely filled with water. The top of the saturated zone is called the *water table*. Layers of rock, sand, gravel, silt, or clay that contain groundwater are called *aquifers*.

Pesticides in Groundwater

It was once thought that soils and subsurface clay layers protected groundwater from contamination. Then in the 1970s a soil fumigant was detected in several California wells. By 1986 twenty different pesticides

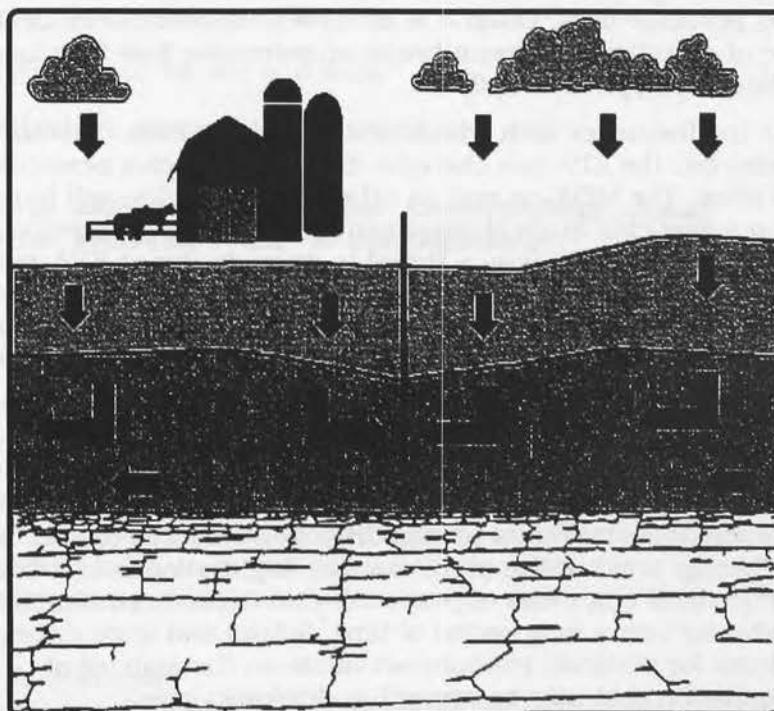


Figure 1. Arrows indicate the direction of water flow. Water from rainfall and snowmelt seeps down into the ground until it reaches a point where all of the cracks between the grains of sand and gravel are filled with water. This is the water table. Below the water table, the groundwater is moving slowly toward a stream. The pumping well in the diagram is causing water in the vicinity of the well to flow towards it.

had been detected in the groundwater of twenty-four states and by 1990 the EPA had documented the contamination of groundwater by forty-six different pesticides. In some cases, pesticide contamination of groundwater appears to be due to spills and leaky storage containers, but field application also appears to be a source.

Water movement

Groundwater is always moving and sooner or later it surfaces at low spots such as springs, lakes, or wetlands, or is pumped to the surface from wells. Groundwater is replenished by rain and snow that has seeped into the soil and moved through unsaturated sediments and cracks down to the water table (see Figure 1)..

Areas where water is seeping down to the water table are called recharge areas. Areas where groundwater flows to the surface are called discharge areas. In humid climates such as Minnesota, streams, lakes, and wetlands are usually fed by groundwater. Groundwater flows toward the streams, often at nearly right angles.

Groundwater moves relatively slowly through most aquifers, flowing at rates from a few inches per year through shale or rock with few fractures to a few inches per day through some sands. In areas with highly fractured rock and in areas with lots of caves and sinkholes, water can flow very quickly through the cracks and caves just as if they were pipes.

Sources of pesticides in groundwater

In many cases, pesticide contamination of groundwater in a particular area has been traced to a point-source; that is, a place where a spill or mishap has allowed abnormally large amounts of chemical to reach the water table. Other instances of contamination in an aquifer are known to be from nonpoint-sources: regular field applications. For example, some wells have been contaminated because of spills or mishandling at mixing/loading sites, while others became contaminated as a result of labeled pesticide uses. Often it is difficult or impossible to identify the source of a pesticide in groundwater or determine how long ago the pesticide was applied or spilled.

Due to the frequency with which pesticides have been detected in groundwater, the EPA has changed the way it handles pesticide registration. The MDA, as well as other state agencies, will have to develop a Pesticide State Management Plan (PSMP) for specific pesticide active ingredients that pose a threat to groundwater or EPA will prohibit the use of the pesticide in that state. The Minnesota Department of Health has also set state "Health Risk Limits": groundwater standards for many chemicals including some pesticides. See Chapter 5 (Protecting the Applicator) for more information.

Health effects of pesticides in groundwater

The impact of pesticide-contaminated groundwater on human health depends on the chemical present, the amount that is in the water, and the amount of water that a person drinks or comes in contact with over time. To help avoid health problems that might arise from drinking the relatively small quantities of pesticides that occur in contaminated groundwater over a long period of time, federal and state drinking water guidelines for pesticide residues set limits on the amount of contamination that may be present in drinking water.

*For a listing of pesticides, their properties, and their potential for leaching or surface runoff see the Minnesota Extension Service publication AG-BU-3911 **Pesticides: Surface Runoff, Leaching and Exposure Concerns.** R. L. Becker, et al.*

*For more information on Minnesota soils properties and their affect on pesticide leaching and surface runoff, see this Minnesota Extension Service publication: AG-TO-5755 **Minnesota Rating Guide for Potential Leaching and Surface Runoff of Pesticides.** 1992.*

The process by which maximum allowable contamination levels (MCLs) are set for each pesticide uses the toxicity research that must be completed for each active ingredient before a pesticide is registered. Uncertainties arise because it is difficult to predict long-term effects on humans living in complex environments using short-term studies with laboratory animals. To adjust for these uncertainties, safety factors are built into the equations that federal and state agencies use to set allowable contamination levels from the research data.

Economic costs of groundwater contamination

The costs to society of pesticide-contaminated groundwater are difficult to quantify. Losses of pesticide chemicals through leaching represent lost investments by the applicator. Contaminated groundwater can be very costly to the communities and families that rely on it for drinking water. Once groundwater has become contaminated it is difficult, if not impossible, to do anything about it. The best solution is to prevent the contamination in the first place.

Pesticide Leaching and Surface Runoff

Pesticides and soils each have certain characteristics that affect the leaching and surface runoff of pesticides. It is no single characteristic but their combination that determines whether a particular pesticide will leach or runoff on a particular soil.

The factors that influence whether a pesticide will reach groundwater (through leaching) or surface water (through runoff from "normal" use) can be divided into three categories:

1. Characteristics of the pesticide;
2. Characteristics of the site and soils;
3. The applicator's management practices.

Factors Affecting the Leaching and Surface Runoff of Pesticides

Depth to groundwater

If groundwater is within a few feet of the soil surface, pesticides are more likely to reach it and to reach it quickly.

Amount of water applied

The goal of good irrigation management is to make sure there is enough moisture to assure plant growth and pesticide uptake. Some pesticides need water in the form of rain or irrigation in order to work. But if too much water is applied during irrigation there is a greater chance for the excess water to leach or run off the soil surface. Pesticides applied shortly before heavy rains or irrigation are more likely to leach or run off.

Geologic formations

Some areas are recharge areas where water from the surface enters groundwater. Recharge areas tend to be more vulnerable to

groundwater pollution than other areas. Rocky geological formations that are tight force water to run off rather than move through the ground. Limestone areas or karst areas, as in southeastern Minnesota, often have many cracks in the rocks that let pesticides move quickly to groundwater.

Tillage systems

Pesticides applied to a full crop canopy will have much less chance of leaching the soil surface than pesticides applied to bare ground. This reduces the chance of water pollution. Large amounts of crop residues on a field may reduce surface runoff but increase the chance of leaching. Tillage systems may affect soil structure, either increasing or decreasing leaching or surface runoff. Tile drains may also contribute to both surface and groundwater contamination.

Processes Affecting Pesticide Stability

When a pesticide is released into the environment it is affected or broken down by various processes. Above we discussed the *movement* of pesticides. In this section we will examine the *processes* that affect pesticide stability and persistence following an application, disposal, or spill.

Adsorption

Adsorption is the binding of chemicals to soil particles. (This term is sometimes confused with absorption. See the next section.) The amount and persistence of pesticide adsorption varies with pesticide properties, soil moisture content, soil acidity, and soil texture. Soils high in organic matter or clay are the most adsorptive; coarse, sandy soils that lack organic matter or clay are much less adsorptive.

Pesticides vary in their degree of binding or *adsorption* to soil particles. Those which are strongly adsorbed (bound) are less likely to be carried from the treated area by surface water or to leach through the soil; they may, however, be moved readily by soil erosion. Pesticides vary in their degree of water *solubility*. Those with greater solubility have a greater potential for both movement and water contamination.

Absorption

Absorption is the process by which chemicals are taken up by plants and other organisms. It is another process that can transfer pesticides in the environment. Once absorbed, most pesticides are metabolized or degraded within organisms.

Microbial degradation

Microbial degradation occurs when microorganisms such as fungi and bacteria break down pesticides and use them as a food source.

Microbial degradation can be rapid and thorough under soil conditions favoring microbial growth. Those conditions include warm temperatures, favorable pH levels, adequate soil moisture, aeration (oxygen), and fertility. The amount of adsorption also influences microbial degradation. Adsorbed pesticides are more slowly degraded because they are less available to the microorganisms.

Microbial populations that easily degrade certain pesticides can build up in the soil. If similar pesticides are repeatedly applied to an area, the pesticide may be consumed and broken down by the microbes so rapidly that it will not provide the desired pest control. This *enhanced microbial degradation* has occurred with many soil insecticides and

some herbicides. This can be avoided or delayed by alternating types of pesticides used, spot-treating, and applying pesticides only when needed.

Solubility

The solubility of a pesticide in water (how readily it dissolves in water) affects whether it will be flushed from the soil and carried away by runoff or leaching water.

Chemical degradation

Chemical degradation of a pesticide involves reactions that change its chemical bonds, reducing the pesticide's original structure into less complex components. The rate and type of chemical reactions that occur are influenced by the adsorption of pesticides to soil, pH levels, temperature, and moisture. Many pesticides, especially the organophosphate insecticides, are susceptible to degradation by hydrolysis (a chemical reaction that splits bonds and adds the elements of water) in high pH (alkaline) soils or spray mixes. The addition of buffers to the spray mix can help slow hydrolysis reactions.

Photodegradation

Photodegradation is the breakdown of pesticides by the action of sunlight. Pesticides applied to foliage, the soil surface, or structures, vary considerably in their stability when exposed to natural light. Similar to other degradation processes, photodegradation reduces the amount of chemical present, which can subsequently reduce the level of pest control. Soil incorporation by mechanical methods during or after application, or by irrigation water or rainfall following application, can reduce pesticide exposure to sunlight.

Solubility

Solubility is the ability of a pesticide to dissolve in water. The more soluble a pesticide is in water the more likely it is to move with water. Water can carry soluble pesticides by leaching through soils or by runoff over the soil surface.

Persistence

Breakdown rate is the time it takes a pesticide to degrade or break down into other chemicals. The rate of breakdown varies greatly among pesticides and depends on whether the pesticide is on the soil surface, in the soil, or in water. Temperature, moisture conditions, soil type, organic matter, application method, soil pH, and other factors can also greatly affect the rate at which a pesticide will break down. The slower the breakdown rate of a pesticide the more likely it is to reach surface or groundwater.

Soil properties

Some pesticides stick very tightly to soil while others are easily dislodged. Pesticides that bind more tightly with soil particles will remain in the surface soil longer and are less likely to leach down into the groundwater. The more organic matter in the soil, the better the soil can adsorb the pesticide, hold water, and promote the breakdown of the pesticide.

Soil

Deep soils which have high organic matter contents, a medium-to-fine texture (silty or clayey) with good structure and drainage are relatively good at "capturing" pesticides until they are taken up by plants or broken down by microbial activity. Pesticides are more likely to leach

through soils which are very coarse (sandy or gravelly), shallow (less than 20 inches), poorly drained, or drought-prone. Pesticides are more likely to be lost in runoff from areas with crusted or compacted soils, which do not allow rainfall to soak in, particularly on sloping sites. Other soil conditions that affect runoff include:

Soil structure is how soil is held together. Highly compacted soil tends to reduce leaching and increase surface runoff. Macropores, large openings in the soil created by animals and plant roots, may allow more rapid movement of pesticides through the soils than normal leaching.

Soil texture is the size of the particles in the soil. Water and pesticides move quickly through large particles such as sand, increasing the chance of groundwater pollution, but reducing the amount of surface runoff. Silt or clay soils have smaller particles that are more effective in adsorbing pesticides. This decreases the downward movement of water and pesticides, but may increase surface runoff.

Soil slope is the angle a field lies from the horizontal. The steeper the slope the greater the runoff and the less water is available for leaching through the soil. Applicators should be aware that researchers have found cases where pesticides have moved comparatively quickly downward through fields with soils that are known to be good at preventing leaching. It is thought that in these cases, chemicals have moved along with rainwater flowing through cracks and holes (such as root and worm holes) in the soil.

Subsoil

Pesticides that leach through the soil may also be “captured” by the sediments below the soil (subsoil) before reaching the water table. This is more likely to occur if the water table is not close to the surface and if the materials below the soil do not allow rapid water movement. Sand, gravel, and bedrock with large fractures allow leaching contaminants to move downward with little chance for further filtering.

Other site factors

The shallower the depth to groundwater, the less the filtering action of the soil and the fewer the opportunities for degradation or adsorption of pesticides. Spring and fall generally are the times of greatest groundwater recharge and therefore, also of highest water table elevations. In areas with very shallow water tables and permeable soils, heavy rains may carry dissolved pesticides to groundwater in only a few days.

Under certain conditions, pesticides may easily reach groundwater even if the water table is far below the surface. If there is any conduit from the surface to the water table at or near the site of application, such as a sinkhole or a well that is not completely sealed, pesticides can be washed directly into the groundwater without any filtering at all.

A heavy rainfall soon after application can result in much of the pesticide being lost through leaching or runoff.

Pesticide Management Practices to Protect Surface and Groundwater

Proper transporting, storing, mixing, loading, applying, and disposal of pesticides can greatly minimize water pollution. Usually, when a very high level of a pesticide is found in groundwater it is due to improper pesticide handling rather than to normal field application. However, excessive irrigation can cause runoff or leaching by applying more water than the soil can absorb or the plants can use. Repeated spills on the same spot, even if each spill is very small, or pesticides running down active or abandoned wells may create large contamination problems. Fire prevention is also important because extensive water contamination may result from fighting fires involving pesticides.

Keeping Pesticides Out of Surface Water and Groundwater

To lower the risk of groundwater contamination and pesticides being lost through leaching or runoff, applicators must be concerned with all three of the categories of factors described above (pesticide and site characteristics, and management practices). For example, an application of a pesticide with a low potential for leaching or runoff applied to an area with a "good" soil for preventing chemical movement can still cause contamination if it is applied haphazardly.

First and foremost, the applicator has a responsibility to follow label directions and all Minnesota regulations for handling and applying pesticides.

Here are some more ways to protect water quality:

- Use Integrated Pest Management Practices to avoid unnecessary pesticide use. An integrated pest management program using "scouting" techniques allows a pest manager to apply control methods only when pests reach economically damaging levels.
- Choose pesticides that have less potential for leaching or for surface runoff, particularly in vulnerable areas.
- Use the lowest effective rate of a pesticide for the type of soil and pest conditions.
- Spot spray or band pesticides when possible.
- Keep all pesticide preparation areas, supply tanks, and storage areas at least 150 feet from any water well.
- Design storage areas, supply tanks, and pesticide preparation areas to minimize pesticide runoff.
- Use a rinse pad facility or mix, load, and clean application equipment in the field.
- Prevent back-siphoning into wells by installing backflow prevention devices. The end of the fill hose should remain above the water level in the spray tank at all times to prevent back-siphoning of chemical

into the water supply. This practice also reduces the likelihood of the hose becoming contaminated with pesticides. When diluting any chemical use a backflow prevention device when obtaining water directly from a well, public water supply, pond, or stream.

- If pesticides are applied near sinkholes or in areas draining directly into rivers, streams, or lakes, leave an untreated buffer space surrounding the treated area.
- Plant vegetative covers as buffer zones around surface water.
- Control the amount and timing of irrigation to minimize pesticide leaching and surface runoff.
- Control erosion to prevent runoff water from carrying pesticides attached to soil particles.
- Properly rinse containers and dispose of waste and rinse water as described in the section of this manual on Safe Handling of Pesticides.
- Minimize pesticide waste by using less pesticide, practicing careful pesticide management, using bulk containers, etc.
- Report all spills or back-siphonages to the Minnesota Department of Agriculture and to local authorities.
- Use fire prevention practices to avoid fires involving pesticides.
- Fire control tactics may create potentially large water contamination problems.
- When selecting a pesticide product, take into account its chemical characteristics (adsorptivity, solubility, persistence) and whether it has a high potential to leach or run off the site where you will apply it.
- Determine the soil characteristics at the application site. Soil texture and organic matter content influence chemical movement. The Natural Resources Conservation Service offices have soil survey maps that will provide much of this information. Compare the soils at your application site with the leaching and runoff potentials of the pesticide to select the safest product for use at the site.
- Consider the geology at the application site. When planning pesticide applications, be aware of the water table depth and the permeability of the geologic layers between the surface soil and groundwater. Some of this information may be obtained from well drillers' records on file at the Public Health Department.
- Use only what is needed to get the job done. Use the lowest effective rate of a pesticide product. Follow label directions. Calibrate sprayers to ensure that you are applying at the correct rate.
- Avoid Spills/Clean Up Spills. When spills do occur, contain and clean them up quickly. Chemicals spilled near wells and sinkholes can move directly and rapidly into groundwater. See Chapter 6 (Safe Handling of Pesticides).

- Schedule irrigation applications so you apply only the amount of water required by the crop. Some computer models are available to assist with water use decisions.
- Avoid pesticide applications if heavy rain is forecast.
- Maintain records of where and when you have applied pesticides.
- Dispose of wastes properly. All pesticide wastes must be disposed of in accordance with local, state, and federal laws. Never pour unused pesticides or rinse water into drains, sewers, streams, or other places that will contaminate the water.
- Store pesticides away from water sources. Pesticide storage facilities should be situated away from wells, cisterns, springs, and other water sources.
- Properly close non-functioning wells. Old wells can be a direct pipeline for contaminants to groundwater. Many properties still have open, but unused, wells scattered across them.

American Bald Eagle

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Protecting Nontarget Organisms

How Pesticides May Harm Wild Plants and Animals

Rare species of plants and animals face many threats to survival. These may include: alteration or destruction of their required or preferred habitat; illegal harvest or over-collection; and exposure to certain pesticides.

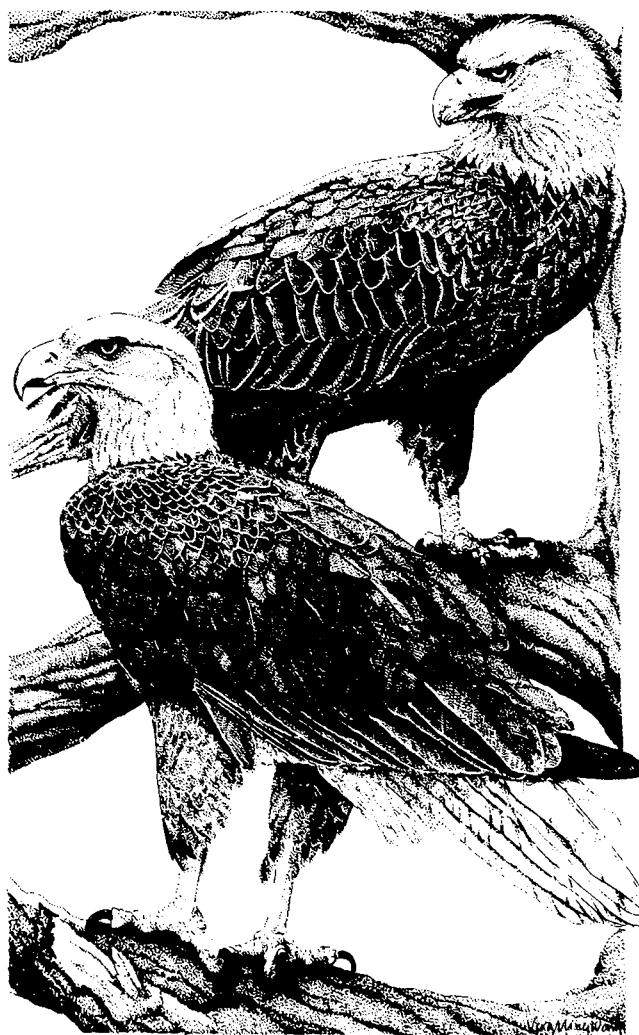
Pesticides can harm wild plants and animals in two ways: acute (or lethal) effects and chronic (or sublethal) effects.

Acute or lethal effects

When plants or animals are killed as a direct result of pesticide exposure, the effect is "acute" or "lethal." An endangered plant may die after being exposed to an herbicide, or a frog may die after feeding on pesticide-contaminated insects; both are examples of acute or lethal effects.

Chronic or sublethal effects

Normal physiological processes such as reproduction or digestion can be harmed by long-term exposure to one or more pesticides. Reproductive failures in birds of prey (raptors) after prolonged exposure to chlorinated hydrocarbons, such as DDT, are one example of chronic effects. Decreased resistance to



disease or increased risk of predatory behavior for ducks that feed in pesticide-treated wetlands is another.

Pesticides have the potential to poison large numbers of nontarget organisms. For example, the US EPA estimates that the use of a single pesticide, carbofuran, is responsible for between one and two million bird deaths each year. Some endangered or threatened species have been among the casualties. Many of these bird die-offs could be avoided if the pesticide used were less toxic. For example, fenvalerate, a pyrethrin insecticide, has low toxicity to birds and mammals, but is highly toxic to fish. Therefore, it is very important to evaluate the area to be treated and to determine in advance which nontarget organisms may be susceptible.

An example of a chronic pesticide effect is the dramatic decline in the bald eagle and peregrine falcon numbers in the late 1960s and early 1970s. These birds of prey were exposed to a class of persistent pesticides known as chlorinated hydrocarbons. One chlorinated hydrocarbon is DDT. DDT, and compounds like it, have a tendency to bioaccumulate in the fat of animals that feed at or near the top of the food chain. Because of this exposure, female birds were unable to produce eggs sturdy enough to support their own weight during incubation. The result was a high percentage of nest failures. Eagle and falcon populations fell dramatically. DDT was banned in the United States in 1973. Since then the trend in the US chemical industry has been toward compounds that break down more rapidly in the environment. Because of this and many other factors, including better wildlife management, many eagle and falcon populations are once again increasing. However, migratory birds may still be exposed to chlorinated hydrocarbons in the US, in areas such as the Great Lakes where these compounds persist, or in countries where their use is still legal.

How to Protect Nontarget Organisms from Pesticides

Here are some ways for conservation-minded pesticide applicators to avoid harming nontarget organisms:

- Do not apply pesticides directly to surface waters.
- Use buffer zones (untreated crop areas, grassy or wooded filter strips) to help protect sensitive areas such as wetlands or rare plant and animal habitats.
- Avoid applying pesticides when weather conditions are wrong (wind speeds greater than 5 mph, temperatures over 85° F, and/or low relative humidity).
- Avoid ultra-low-volume (ULV) applications by ground or air equipment, since they can increase off-target pesticide movement by as much as 30 percent.
- Choose chemicals that are less toxic to plants and animals in the treatment area. For example, avoid pyrethroids around water because they are highly toxic to fish and other aquatic species. But, choose pyrethroids in upland areas where bird and mammal species are likely to predominate.

Use these recommendations with an integrated pest management program that includes scouting and multiyear crop rotations. In this way you may be able to limit or even omit pesticide application in areas where damage to nontarget species is a concern or where pesticides may provide only marginal economic benefits. Extra caution should be used when a pesticide is being applied on or near water or adjacent to a sensitive area. Sensitive areas include endangered species habitats (for example, a native prairie which harbors a population of threatened orchids) and land which is highly susceptible to groundwater contamination (for example, fractured limestone or karst topography).

State contacts

Questions regarding pesticide use as it pertains to endangered or threatened species in Minnesota should go to the Endangered Species Protection Program, Agronomy Services Division, Minnesota Department of Agriculture, 90 W. Plato Boulevard, St. Paul, MN 55107; (612) 297-7279.

Questions about the use of aquatic pesticides should be directed to the Minnesota Department of Natural Resources (MNDNR), 500 Lafayette Road, St. Paul, MN 55155; 1-800-652-9747.

Questions regarding endangered or threatened species in Minnesota should go to the Minnesota Natural Heritage Program, Section of Wildlife, Minnesota Department of Natural Resources, Box 7, Lafayette Road, St. Paul, MN 55155; (612) 296-3344.

Federal contact

Questions about the Federal Endangered Species Act, federally listed species, or the endangered species listing process should be directed to the Office of Endangered Species, US Fish and Wildlife Service, Bishop Henry Whipple Federal Building, One Federal Drive, Fort Snelling, MN 55111; 612-725-3276.

Endangered and Threatened Species in Minnesota

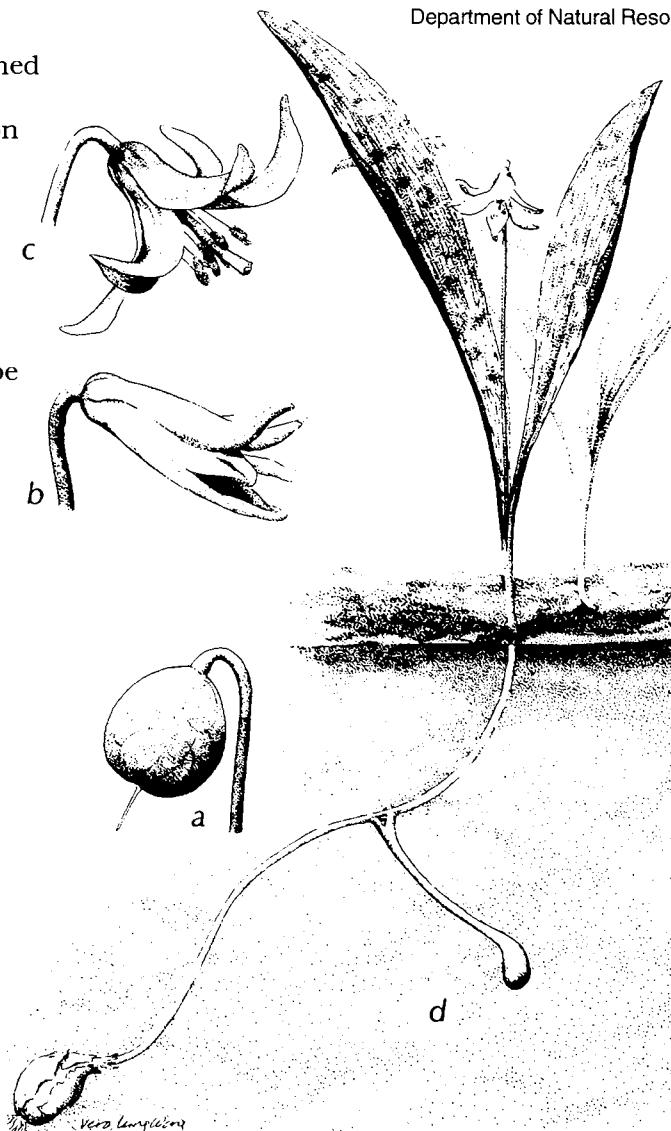
An endangered species is a plant or animal which is in danger of extinction throughout all or a portion of its historic range. A threatened species is one which is likely to become endangered within the foreseeable future.

Federally listed plants and animals

As of June 1994, eleven federally listed (threatened or endangered) species are known to live in Minnesota. The list includes four plants, two freshwater mussels, three migratory birds, one mammal, and one insect.

Minnesota Dwarf Trout Lily

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Minnesota Dwarf Trout Lily (*Erythronium propullans*)

This tiny plant is known from only three counties in the world: Rice, Goodhue, and Steele counties in southeastern Minnesota. It is found primarily on north-facing slopes within the Big Woods maple-basswood forests on moist to saturated floodplain soils. Flowering period: late April and early May. Member of the lily family.

Leedy's Roseroot (*Sedum integrifolium* ssp. *leedyi*)

This close relative of the common jade plant is restricted to limestone cliffs within the Root and Whitewater river drainages in Olmsted and Fillmore counties. Within these watersheds, roseroot plants occupy cool, moist, north-facing cliffs that are fed by a combination of cool air and groundwater. Flowering period: mid-June. Member of the stonecrop family.

Prairie Bush Clover (*Lespedeza leptostachya*)

The pale pink flowers of this delicate plant can be seen from mid-July through early August, but its silvery green foliage and pods make it especially noticeable in late summer and early fall. Prairie bush clover prefers slightly moist shallow depressions and north-facing exposures on hill prairies in the southern part of the state. In Minnesota, it is known from eight counties: Goodhue, Rice, Renville, Redwood, Brown, Cottonwood, Jackson, and Houston. Flowering period: mid-August. Member of the pea family.

Western Prairie Fringed Orchid (*Platanthera praecocula*)

This showy orchid prefers moderately wet to wet, shallow depressions in native prairie habitats in the western and southeastern parts of the

Below Left:
Western Fringed Orchid
Below Right:
Prairie Bush Clover
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state. The most significant populations are found within the former glacial Lake Agassiz interbeach areas in Polk County, but populations are also known from Kittson, Norman, Pennington, Clay, Pipestone, Rock, Freeborn, Mower, and Dodge counties. Flowering period: early July. Member of the orchid family.

Higgins' Eye Pearly Mussel (*Lampsilis higginsi*) and Winged Mapleleaf Mussel (*Quadrula fragosa*)

Both species are known from only a few locations in the St. Croix and Upper Mississippi Rivers. The system of locks and dams that was installed in the early 1900s to enhance river navigation has proven to be one of the greatest obstacles to the survival of freshwater mussels. Dams produce widely fluctuating water levels and alter both current speed and duration of flow in the rivers. Consequently, the texture of the river bottom above and below the dams has changed and water clarity has decreased. Dams also affect the concentration and variety of suspended food particles available to the filter-feeding mussels and create a barrier for migrating larval mussels and their host fish. Other threats to freshwater mussels include: general water quality degradation, due partly to agricultural and urban runoff; physical destruction of mussel beds as a result of bridge construction; illegal collecting or overharvesting; and the presence of the newly introduced exotic zebra mussel, which can colonize the shells of native mussels and suffocate them. Large infestations of zebra mussels may also deplete the food resources available to native mussels.

Bald Eagle (*Haliaeetus leucocephalus*)

In Minnesota the breeding range for bald eagles includes most of the northern half of the state and the counties that border Wisconsin along the Mississippi River. Nesting pairs also occur in Chippewa County. Bald eagles winter in the state along the Mississippi and in both Lac qui Parle and Chippewa counties. The federal recovery goal for the bald eagle has been exceeded in Minnesota, largely because of the successful implementation of the Federal Endangered Species Act and the 1973 ban on the use of DDT and other persistent pesticides.

Peregrine Falcon (*Falco peregrinus*)

An aggressive restoration effort has returned the peregrine falcon to Minnesota after a more than 20-year absence. Active peregrine nests are known from the north shore of Lake Superior and from some of the steep Mississippi River bluffs in the southeastern part of the state, as well as from several of Minnesota's metropolitan areas.

Piping Plover (*Charadrius melodus*)

The piping plover is a small shorebird that prefers sandy to gravelly undisturbed beaches for nesting. Since piping plovers are very sensitive to human disturbance, they face a great challenge in attempting to compete with recreational, industrial, agricultural, and other conflicting

Leedy's Roseroot

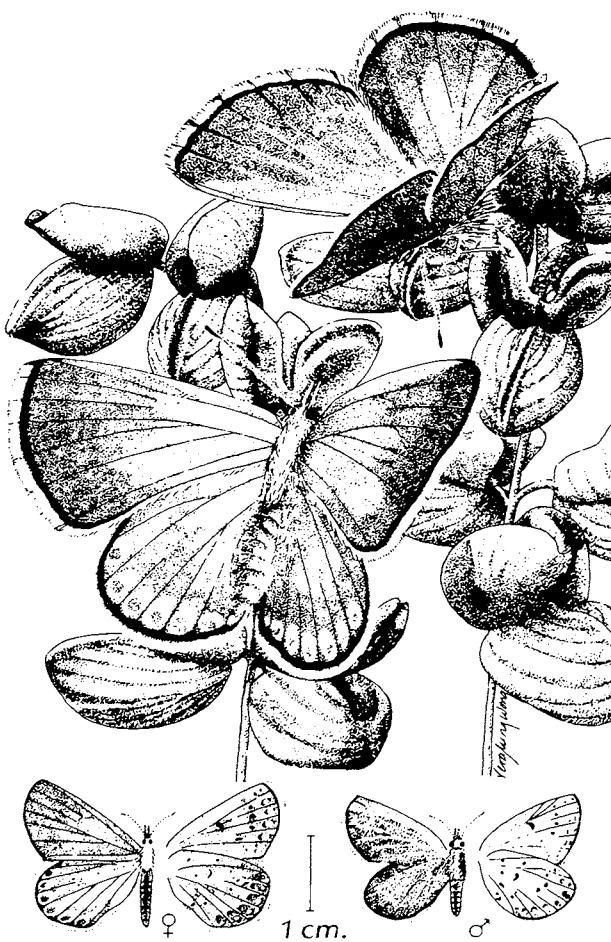
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human uses of shoreline. In 1993 only nine adult piping plovers were documented in Lake of the Woods County by the Minnesota DNR. They are the only remaining breeding piping plovers in the state.

Grey Wolf (*Canis lupus*)

Minnesota is fortunate to have a wolf population that is second only to Alaska in numbers and widespread distribution. Current estimates put wolf numbers in Minnesota at between 1,550 to 1,750 individuals. Predation on livestock by wolves can, admittedly, pose a problem in certain areas of Minnesota. However, federal and state programs designed to remove the offending animal(s) and to compensate landowners for livestock losses should minimize human/wolf conflicts. The Minnesota Department of Agriculture administers the wolf-reimbursement program statewide.



Karner Blue Butterfly (*Lycaides melissa samuelis*)

This tiny, but showy, butterfly is known in Minnesota from only a single Winona County location. Male karner blues are bright violet-blue with a narrow black band, tinged white around the wing margin. The females are mostly dark brown on the upper wings with a crescent-shaped band of orange spots on the hind wings. Both males and females are approximately one inch in long. Karner blue butterfly larvae feed exclusively on wild blue lupine (*Lupinus perennis*). Consequently, the range of this species is restricted to the sandy oak-savanna plant community type that will support wild blue lupine.

In addition to Minnesota's eleven federally listed species, the Minnesota Department of Natural Resources maintains a list of state endangered, threatened, and special concern species. These plants and animals are protected by Minnesota Statute 84.0895. For further information, contact the Minnesota DNR at the address listed on page 7-19..

Pesticide Programs to Protect Endangered and Threatened Species

US Environmental Protection Agency's pesticide program

The Federal Endangered Species Act of 1973 requires all federal agencies to ensure that their actions do not pose a risk to any of the more than 825 plants and animals that are federally listed as threatened or endangered. The EPA's pesticide registration process is one way to do this. Therefore, the EPA is developing a pesticide labeling system that will refer users to an endangered species bulletin prepared specifically

for the county where the pesticide is to be applied. These county bulletins contain a brief overview of the EPA's Endangered Species Protection Program. A table lists pesticide active ingredients that have been shown to pose a risk to the species in question and a map shows the range of that species in the county. Usually these bulletins recommend a buffer zone around endangered species, habitats. The size of the buffers, or pesticide restriction zones, is based on several factors including: the life history requirements of the species; the consistency of the pesticide; the rate of application; and the method of application (for example, aerial vs. ground).

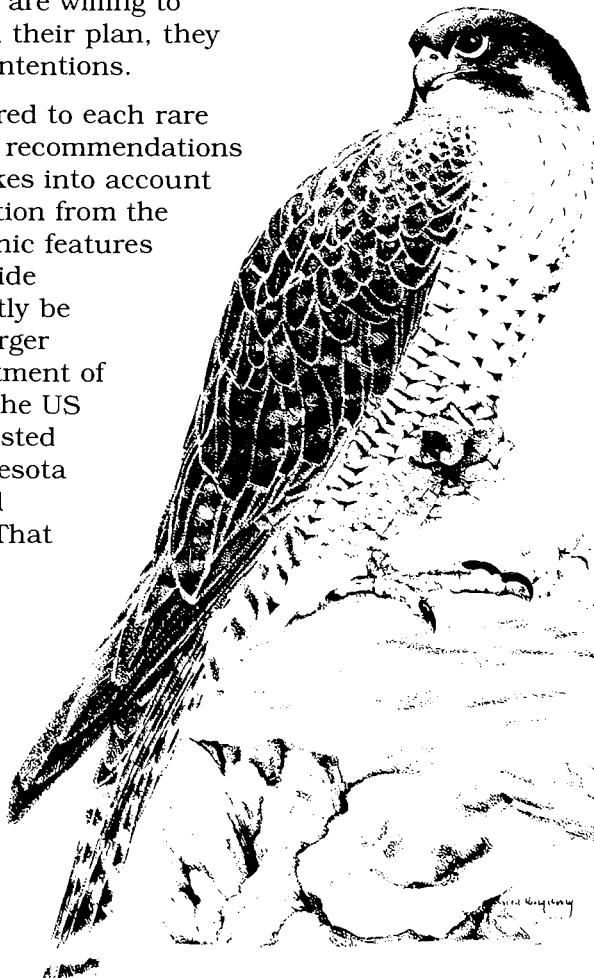
Minnesota's Endangered Species Protection Program

The EPA's proposed program has been difficult to put into action and the implementation date has been delayed several times. Because of this, the Minnesota Department of Agriculture (MDA) accepted the EPA's offer to develop an alternative Endangered Species Protection Program. The goal of the MDA program is to be responsive to the needs of the agricultural community while ensuring that federally listed endangered species are protected from harmful pesticide exposure. The MDA meets individually with private landowners and public land managers who own or manage federally listed plant populations in the state. These people are given detailed information about the rare species on their land. The site is surveyed by an MDA staff person to find out if pesticide use will harm the species. After the survey and a discussion about pesticide use at the site, a personalized Pesticide Management Plan is drafted. If owners and managers are willing to follow the pesticide use recommendations outlined in their plan, they sign a Voluntary Protection Agreement stating their intentions.

Since the MDA Pesticide Management Plans are tailored to each rare species site, they provide more specific pesticide use recommendations than the EPA program could allow. The MDA plan takes into account the actual distance of the rare plant or insect population from the nearest pesticide application site as well as topographic features that may serve as natural barriers to off-target pesticide movement. Because of this, buffer zones can frequently be reduced to segments of fields, instead of the much larger acreage required by the EPA. If the Minnesota Department of Agriculture is successful in convincing the EPA and the US Fish and Wildlife Service that Minnesota's federally listed species are well protected from pesticide harm, Minnesota pesticide applicators will not be subject to the federal labeling/county bulletin approach discussed above. That is why the cooperation of all pesticide applicators is needed in helping to minimize off-target pesticide impacts on Minnesota's rarest plants and animals.

Peregrine Falcon

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Summary

Pesticides may cause damage to the environment if they move out of the target area into the surrounding environment. This can happen if the pesticides drift in the air, get into surface water or groundwater, or contaminate the soil. Pesticide drift occurs when dust, droplets, or vapors are carried in the air away from the application site. Small droplets or pesticides that vaporize easily are more likely to drift. To reduce drift, select nozzles properly and use lower pressure when spraying. Spray close to the ground. Avoid spraying when it is windy or when temperatures are high. Use low-volatility formulations and spray thickeners where appropriate. Because groundwater is the source of much of the drinking and irrigation water in Minnesota, it is essential to prevent contamination of this valuable resource. Pesticides may contaminate groundwater and surface water through accidental spills or, under certain conditions, during normal application. Protect ground and surface water by using Integrated Pest Management techniques to avoid all unnecessary pesticide use. Do not spray plants or animals that are not pests (that is, learn the difference between weeds and native plants or animals that are not harmful or invasive). Use pesticides that are less likely to leach or run off the soil surface. Use the lowest effective application rate on sandy soils or where groundwater is near the surface. Prevent spills and accidents by using good pesticide management practices. Keep pesticides away from wells, sinkholes, or surface water. It is illegal to harm or harass an endangered or threatened species. Since pesticides can affect nontarget organisms, the EPA and MDA are working together to develop a plan to protect Minnesota's federally listed species from pesticides. Check with the Minnesota Department of Agriculture's Endangered Species Program Manager, the US EPA, the US Fish and Wildlife Service, or your local extension educator for more information about pesticide restrictions in your county.

Review Questions for Protecting the Environment

1. What is the "environment"?
 2. Explain the difference between point-source and nonpoint-source contamination.
 3. List the factors that influence whether a pesticide will move off-site in the air.
 - 1)
 - 2)
 - 3)
 - 4)
 - 5)
 - 6)
 - 7)
 4. Pesticides with a high degree of water solubility have a greater potential water contamination.
 - A. True
 - B. False
 5. Which federally listed endangered species is found only in Minnesota and nowhere else in the world?
 - A. American bald eagle
 - B. Piping Plover
 - C. Minnesota dwarf trout lily
 - D. Karner blue butterfly
 6. Pesticides that are strongly adsorbed to soils:
 - A. Are less likely to be carried from the treated area by surface water.
 - B. Are more likely to be leached.
 - C. Are not likely to be moved with soil erosion.
 - D. Stay in the soil longer giving microbes more opportunity to degrade them.
 7. Which soil type is best at adsorbing pesticides.
 - A. Sandy soils
 - B. Clay soils low in organic matter.
 - C. Clay soils high in organic matter.
 8. What is the term used for the tendency of a persistent pesticide to concentrate in the bodies of wildlife that feed near or at the top of the food chain?
 - A. Adsorption
 - B. Absorption
 - C. Microbial
 - D. Poisoning
 - E. Bioaccumulation
 9. What conditions enhance microbial degradation of pesticides?
 - A. Pesticide adsorption to soil surfaces.
 - B. Pesticides leaching deep into the soil profile.
 - C. Warm, moist, fertile soils.
 - D. Limited amount of oxygen to volatilize the pesticide.
 - E. Soil fertility is low and microbes must obtain energy from the pesticide.
 10. Pesticides can reach surface water from drift, rainfall, or groundwater that is discharging into surface water.
 - A. True
 - B. False
 11. List three possible effects of "chronic" or "sublethal" pesticide exposure to nontarget animals:
 - 1)
 - 2)
 - 3)
-

12. List four ways pesticides can enter surface waters:

- 1)
 - 2)
 - 3)
 - 4)
-

13. What is vapor drift?

- A. Movement of fog
 - B. The movement of a pesticide from evaporation or volatilization during or after application.
 - C. Direct movement of pesticide spray off-site during application
 - D. Inhalation of a pesticide by an applicator
-

14. List at least four outdoor "sensitive areas" for pesticide contamination:

- 1)
 - 2)
 - 3)
 - 4)
-

15. List three indoor "sensitive areas" for pesticide contamination:

- 1)
 - 2)
 - 3)
-

16. List seven factors or processes that effect the leaching and surface runoff of pesticides:

- 1)
 - 2)
 - 3)
 - 4)
 - 5)
 - 6)
 - 7)
-

References

Stachecki, J. 1995. *Pesticide Applicator Core Training Manual: Certification, Recertification and Registered Technician Training*. East Lansing: Michigan State University Extension.

Minnesota Extension Service. 1994. *Private Pesticide Applicator's Training Manual*. St. Paul: University of Minnesota.

Chemigation

What's in this Chapter:

What is Chemigation?

Advantages, Limitations, and Risks

To Chemigate or Not to Chemigate?

Irrigation Systems

Chemigation Equipment

Injection Equipment

Required Antipollution Devices and Measures

Calibration

Summary of Chemigation Management Practices

Learning Objectives

After you complete your study of this chapter, you should be able to:

- Define the term "chemigation;"
- Identify the advantages and risks of chemigating in a given situation;
- Describe the different types of chemigation processes possible with different kinds of irrigation systems;
- Identify the various pieces of chemigation equipment and how they are used;
- Explain what the required antipollution devices are in the state of Minnesota;
- Explain the necessary steps to calculate the proper chemigation injection rate for a center pivot in a given situation.

Terms to Know

Calibration. Adjusting the control mechanisms of the chemigation system to ensure an accurate application of pesticides.

Chemical injection system. Consists of an injection meter/pump, chemical supply hose, supply tank, calibration equipment, and antipollution and safety devices.

Chemigation. The process of applying an agricultural chemical (fertilizer or pesticide) to the soil or plant surface with an irrigation system by injecting the chemical into the irrigation water.

Diaphragm pumps. Metering devices for chemigation.

Introduction

This chapter provides information for producers who irrigate and are considering chemigation as a way to apply pesticides. The chapter will help you decide if a given irrigated field and irrigation system can use chemigation and, if so, what practices to follow. While irrigation systems may also be used to apply fertilizers, this chapter will discuss only chemigation of pesticides.

General chemigation safety measures and management practices are discussed. These practices can help minimize the possibility of creating a public health problem. They help in reducing the risk of accidentally allowing any injected chemical to flow back into the irrigation well or surface water sources, or discharge onto the land where not intended. *Owners/operators of any chemigation system must have a Minnesota Department of Agriculture chemigation system user permit. Owners/*

operators must also: install several safety antipollution and safeguard devices; comply with Minnesota Department of Health's well separation distance rules; and implement several management measures. Details about specific chemigation systems must be obtained from their respective manufacturers.

This chapter does not discuss every protection requirement for chemigation systems connected to a potable well or public water supply system. For specific details on required safety devices and measures for systems connected to public water supplies contact the Minnesota Department of Health.

The discussion on chemigation in this chapter can also be partially reviewed via three video tapes: "Chemigation Management," "Chemigation Equipment," and "Chemigation Calibration." Video tapes can be rented from the MES Distribution Center (612-625-8173) at 3 Coffey Hall, University of Minnesota, 1420 Eckles Avenue, St. Paul, MN 55108. These video tapes do not discuss requirements under Minnesota laws and regulations.

What is Chemigation?

Chemigation is the process of applying an agricultural chemical (fertilizer or pesticide) to the soil or plant surface with an irrigation system by injecting the chemical into the irrigation water. Depending on the type of agricultural chemical being applied, chemigation may be referred to as fertigation, herbigation, insectigation, fungigation, etc. Only pesticides labeled for chemigation and certain fertilizer solutions can be applied by injecting them into an irrigation system. It is estimated that less than 1 percent of the conventionally irrigated land in Minnesota has the proper equipment to apply a pesticide (usually insecticides or fungicides) by chemigation. However, more than two-thirds of the sprinkler irrigation systems in Minnesota have been used to apply liquid nitrogen at one time or other.

In 1987 the Minnesota legislature determined that chemigation regulations and a permit program be developed for pesticide application. In 1989 chemigation regulations were expanded to include fertilizers. The MDA put the pesticide chemigation regulations in effect in January 1989, and adopted fertilizer regulations in the fall of 1992. The Minnesota Department of Health (MDH) also has adopted rules for the chemical storage tanks, chemigation systems, and water wells (irrigation, potable, and public water systems) referred to in the MDA regulations.

Advantages, Limitations, and Risks

Chemigation, like other methods of application, has advantages, limitations, and risks that a producer must consider when deciding the best way to apply the desired pesticide. Chemigation can be an effective way of applying certain agricultural chemicals to some irrigated crops if the irrigation system can apply the pesticide/water mixture uniformly and at the proper amount. The greatest risk of chemigation is the potential for accidental backflow of chemical into the irrigation water source. To minimize this risk to the water source, you must use all of the required antipollution safety devices and the chemigation system must be properly set up, operated, and maintained.

Advantages and Benefits:

- Provides uniform distribution of chemicals when the irrigation system's nozzleing package is properly selected and maintained.
- Offers more flexibility in timing the chemical application, especially when the field is too wet for a tractor or an aircraft is unavailable.
- May increase pesticide activity and effectiveness for some compounds.
- May reduce the application cost in some situations.
- May reduce mechanical damage to plants caused by ground sprayer wheels.
- May reduce the risk of soil compaction caused by ground application methods.

Limitations and Risks

- Uniform chemical application depends on uniform water distribution from the irrigation system.
- Application time is longer than most other chemical application methods.
- Most pesticide compounds are not approved for application with irrigation water.
- Potential risk exists for all or a part of the chemical to flow back into the irrigation water source (ground or surface) if two or more of the required safety devices malfunction while chemigating. Farm managers/operators must take time to learn about chemigation safety devices, calibration, and management practices.
- Extra investment must be made for chemigation system and for safety equipment.
- A chemigation permit from the MDA is required.

To Chemigate or Not to Chemigate?

Consider at least the following factors before deciding to chemigate.

Pesticides

Some, but not all, pesticides can be applied through an irrigation system. Check the pesticide label. In April 1988, the EPA required all pesticide labels to state if they are allowed to be applied through an irrigation system. The label also lists minimum safety devices needed for the irrigation system (for states that do not have their own regulations).

First decide which pesticide product is best to use to protect the crop from a potential problem, regardless of application method. Chemigation then can be considered if the label of the chosen pesticide allows for chemigation. If you only consider those products that are labeled for chemigation, you may limit your options for the most effective, economical, or safest control. Chemigation is an application option for only some irrigated fields and situations and will not be right for all situations. Effectiveness of any chemigated pesticide depends on the ability of the irrigation system to apply the recommended amount of water uniformly throughout the field. For example, a preemergence herbicide may work with 0.4 to 0.75 inch of water, while some fungicides will only work best with 0.15 inches of water.

Regulations

Regulations governing pesticide applications sometimes change. Before you do any chemigation, check with the Minnesota Department of Agriculture (612-297-2614) or with the Minnesota Extension Service.

Minnesota pesticide and fertilizer chemigation regulations require the owner/operator of any irrigation system who intends to chemigate to:

- Obtain an MDA chemigation system user permit;
- Pay a fee;
- Install several safety antipollution and safeguard devices;
- Comply with the MDH's well separation distance rules;
- Implement several management measures.

The MDA staff will help identify the proper equipment and will inspect chemigation systems on both a routine and a complaint basis.

Field Posting

Minnesota chemigation rules require that the treated field be posted at all times during the chemigation and for the specified reentry time on the label. See page 9 - 14 in this chapter for more information on posting chemigated fields.

Site Location

Do not chemigate with pesticides if the irrigation system will cause off-target spray or drift on adjacent homes or occupied buildings, surface water sources, wetlands, neighboring crops, or roadways.

Land and Soil Characteristics

Certain soils and topographies are not suitable for chemigation. For example, if the land is very hilly with a lot of variation in elevation, the irrigation system may not distribute the chemical-water mixture uniformly on the plant or soil surfaces.

Hilly land may also cause the chemical-water mixture to run down the sloping areas and cause injury to the crop where it ponds. This situation may also cause some chemical either to leach into the groundwater in the areas where the water ponds or to run off the field into surface water.

Type of Irrigation System

Pesticide application with irrigation water should only be done with systems that can apply water uniformly over the entire field at an application rate that does not exceed the intake rate of the soil. Distribution of an injected pesticide through an irrigation system is no better than the same system's water distribution.

An irrigation system that causes water to flow down plant rows is exceeding the intake rate of the soil and will not provide an adequate distribution of soil-applied pesticides. This may cause some chemical to either leach into groundwater in the areas where the water ponds or to run off into adjacent surface waters.

An irrigation system should be able to apply water at various application depths. Some pesticides only work when applied with a very light application depth of water (0.15 to 0.25 inches). If an irrigation system is three or more years old, evaluate the water distribution pattern with an in-field catch can test before using chemigation. Specific characteristics of different types of irrigation systems are discussed later in this chapter.

Injection and Antipollution Equipment

Special equipment is needed for injecting chemicals into the irrigation system to prevent accidental backflow of pesticides into the water supply. The MDA's chemigation regulations require that anyone who intends to chemigate must install several safety (antipollution and safeguard) devices, comply with MDH's well separation distance rules, and implement several management measures. Specific safety equipment is described later in this chapter.

Calibration

The chemigation operator must be able to calibrate the irrigation and chemigation systems to achieve an accurate application of pesticide. The injection pump must be easy to calibrate and adjust during application. An in-line calibration tube should be used to assist in calibration. Details on how to calibrate are given later in this chapter.

Weather

Winds can cause irrigation water droplets to drift. Strong winds will also cause uneven application of water and chemicals. Do not chemigate if winds are strong enough to cause drift onto nontarget areas.

Irrigation Systems

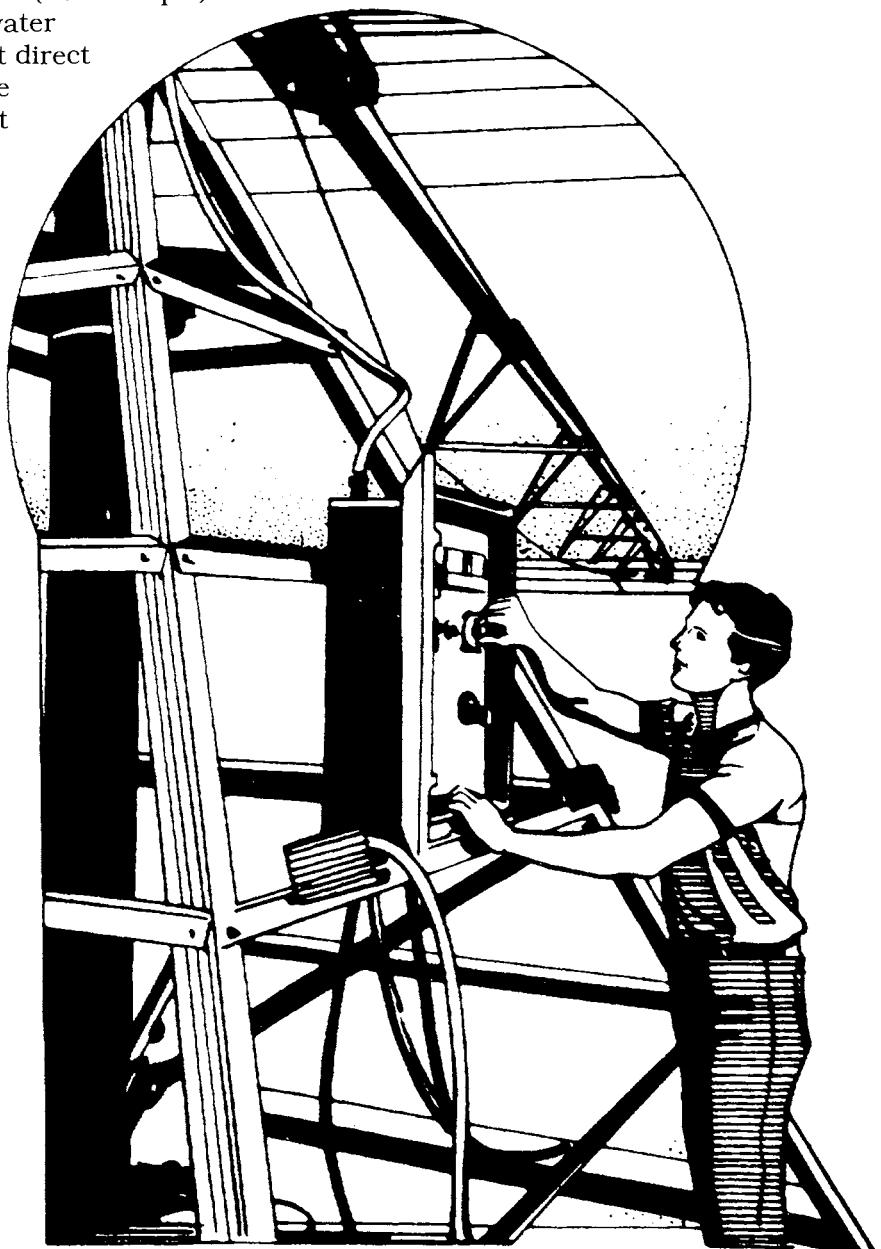
Sprinkler systems like the center pivot (electric or oil drive) and the linear move can provide a very even distribution of water and chemical if the sprinkler package is properly selected and maintained. Water-driven center pivots, however, should not be used because the rate of application around each drive tower is usually much higher than between the towers. Center pivots and linears can be equipped with several types of sprinkler packages (10 to 60 psi) and both can provide adequate water distribution. Spray packages that direct the flow of water downward to the plant or soil surface give the least risk of wind drift.

The end gun on a center pivot should be operated during chemigation only if it can provide uniform application of water and can be controlled to spray within the field boundaries.

Traveling guns and set move sprinkler systems (sidewheel roll, hand move lateral) produce overlapping water patterns between moves and therefore do not distribute water over the whole field as evenly as center pivots. These systems should not be used to apply pesticide, but may be used to apply fertilizer when the wind is very low and no other method is available.

Trickle systems can provide adequate distribution of water when properly designed and operated, but can only be used to apply soil contact pesticides.

NOTE: Always check the pesticide label to see if a particular type of irrigation system can be used to chemigate.



Chemigation Equipment

For safe and effective chemigation, the irrigation system must be equipped with the correct chemical injection system and MDA-approved antipollution devices and safeguards. The system must also be able to apply the pesticide uniformly to the targeted field only and be easily calibrated.

Chemigation can potentially pollute the irrigation water source if not protected with the proper functioning safety devices. Three main ways pollution could occur are:

- The chemical in the supply tank and in the irrigation pipeline could flow or be siphoned back into the water source when the irrigation system shuts down (see Figures 1 and 4).
- The chemigation system could continue to inject chemical into the irrigation pipe line when the irrigation system shuts down. This causes the chemical solution to flow back into the water source or spill onto ground (Figure 2).
- The chemigation system could shut down while the irrigation system continues to operate and force water back into the chemical supply tank. This would cause the tank to overflow and spill onto the ground (Figure 3).

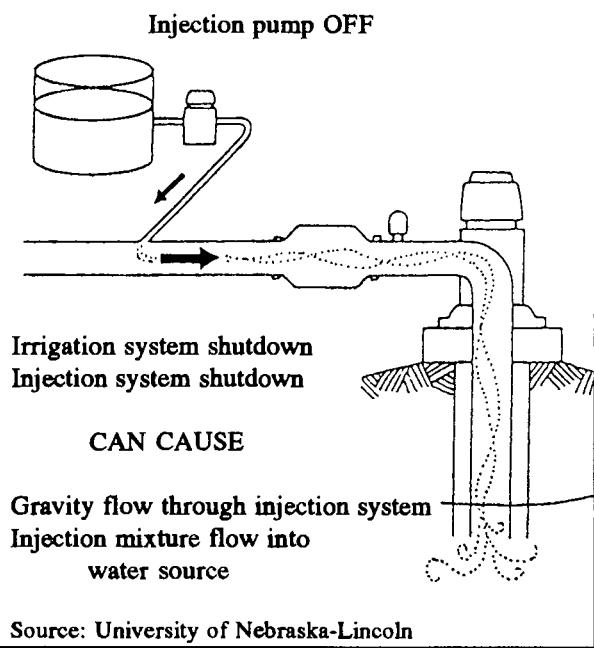
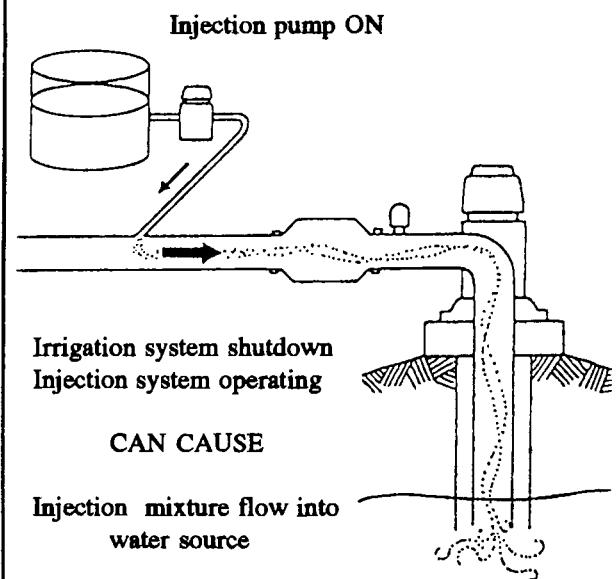
Injection Equipment

A chemical injection system consists of an injection meter/pump, chemical supply hose, supply tank, calibration equipment, and antipollution and safety devices. Any equipment that comes in contact with chemicals, including hoses, seals, and gaskets, must be resistant to all formulations being applied. This includes emulsifiers, solvents, and other carriers as well as the active ingredient.

Injection Meter/Pump

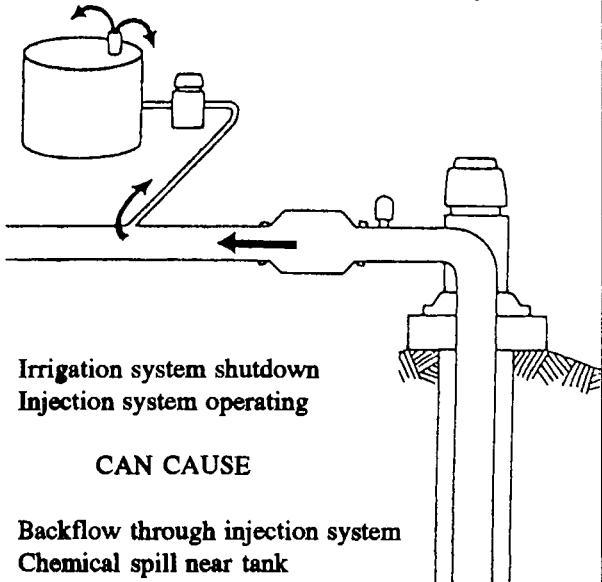
The chemical injection meter or pump should be easy to adjust for different injection rates. It should be sized to meet the injection rates of the specific system and chemical. No single pump can do all jobs, since application rates may range from pints to several gallons an hour. Do not operate a pump at its maximum or minimum setting. This may result in inaccurate injection rates. A strainer should be always be located on the inlet side of the suction line to prevent the pump and injection hose check valves from clogging.

The main types of metering devices are diaphragm pumps, piston pumps, and venturi injectors. *Diaphragm pumps* are the best all-round metering devices for chemigation, even though they are more expensive than piston or venturi units. They have fewer moving parts, are less subject to corrosion and leaks, and are easily adjusted during chemigation. *Piston pumps* can not be easily recalibrated during a chemigation event and the piston parts are more likely to wear faster where they come in contact with the chemical. The system must be

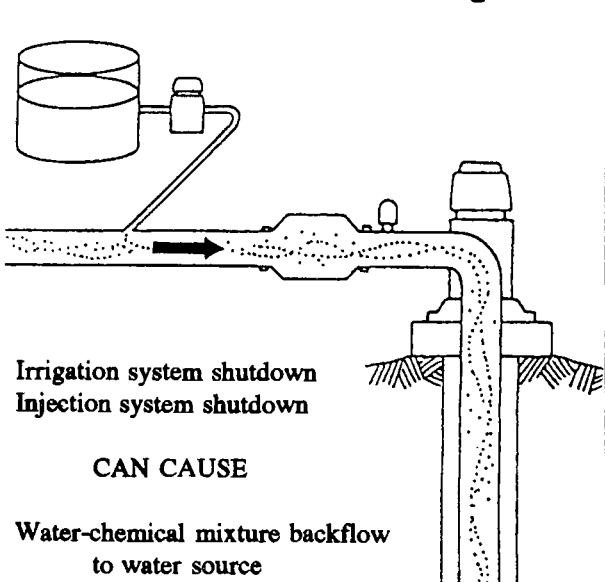
Figure 1***Figure 2***

Source: University of Nebraska-Lincoln

Source: University of Nebraska-Lincoln

Figure 3*

Source: University of Nebraska-Lincoln

Figure 4*

Source: University of Nebraska-Lincoln

stopped to make a calibration adjustment. Venturi injection units are usually lower in cost, but it may be harder to maintain an accurate or consistent injection rate with this type of pump.

Supply Tank

The chemigation supply tank should be made of noncorroding materials such as stainless steel, fiberglass, nylon, or polyethylene. Avoid materials (like iron, steel, copper, aluminum, or brass) that can corrode. Depending on the pesticide formulation used, the tank may need mechanical or hydraulic agitation to keep the chemicals mixed. The outlet of the tank should contain a manual control valve.

Injection Line Strainer

A chemical-resistant strainer should be located on the chemical suction line/hose to remove foreign materials that could plug or damage the injection meter/pump or chemical injection line check valve.

Hoses, Clamps, and Fittings

All components that come in contact with the chemical mixtures should be constructed of materials that are resistant to chemicals and to sunlight degradation. The pressure rating of all components should be adequate to withstand all operating pressures. Hoses and fittings should be protected from mechanical damage.

Calibration Equipment

A calibration tube or in-line flow meter installed on the chemigation injection hose line provides an easy way to measure the rate of flow of the chemical being injected into the irrigation system. The tube, with the necessary valves and fittings, should be placed on the suction side of the injection device so the injection rate can be checked during a chemigation. A calibration tube is typically a clear tube with markings

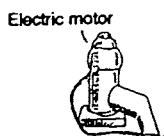
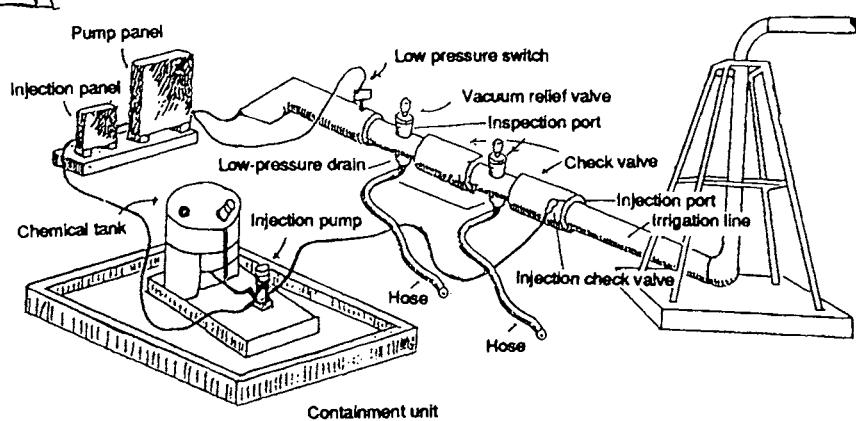


Figure 5 .

Chemigation safety equipment arrangement when applying a pesticide with an irrigation system connected to an irrigation well. (Diagram adapted from South Dakota Cooperative Extension Service Fact Sheet 860).T



in milliliters or fluid ounces. It is used with a stopwatch to measure the flow rate.

An in-line flow meter can be used on either the suction or discharge side of the injection device. It is typically marked in flow units of volume per time.

Required Antipollution Devices and Measures

MDA Required Devices and Safeguards

The Minnesota pesticide and fertilizer chemigation regulations of 1992 require that the owner/operator of any irrigation system who intends to chemigate (pesticide or fertilizer) obtain a MDA chemigation system user permit, install several safety (antipollution and safeguard) devices, comply with MDH's well separation distance rules, and implement several management measures. The safety devices are necessary to prevent pollution of the water supply via the ways described in Figures 1-4 on page 8-9.

Figure 5 shows a typical arrangement of the basic safety devices. Some installations will have different requirements depending on the kind of water supply system and the location of the water source. Alternative safety devices can only be used if approved in advance by MDA staff. The actual MDA chemigation regulations can be found in Minnesota Rules, parts 1505.2100 1505.2800. MDH regulations relating to well separation distances from potential contamination sources are listed in Minnesota Rules, part 4725.4450.

Basic Safety Devices and Measures

Basic safety devices and measures outlined in the MDA chemigation regulations to protect the irrigation water source from pollution are described below.

Irrigation main pipeline check valve

An MDA-approved reduced pressure zone (RPZ) backflow preventor, or two check valves in series, must be installed in the main irrigation water supply pipeline of any system that will be injecting pesticide that is directly connected to an irrigation water well or a surface water source. A single MDA-approved check valve may be used in the main pipeline only if you intend to inject fertilizer solely.

The check valve(s) or RPZ assembly must be located between the point of chemical injection and the irrigation water supply pump. Their main purpose is to keep the water and chemical mixture from flowing back or being siphoned back into the water source. Check valves should be installed with fittings that allow you to easily remove them for maintenance or repair. The check valve(s) assembly may be installed as a portable unit and moved to other irrigation systems where permitted by MDA.

Each *check valve assembly* must contain an air vacuum relief valve and an automatic low pressure release drain immediately upstream of the

check valve flapper. The check valve assembly must also have an inspection port that is easy to open to inspect the check valve flapper and the low pressure drain when the irrigation system is shut down.

The *vacuum relief valve* allows air to enter the pipeline when the water stops flowing. This prevents the creation of a vacuum that could cause siphoning of the water-chemical mixture downstream of the check valve back into the water supply.

The *low pressure drain* must be located on the bottom of the pipeline on the supply side of the check valve and have a fully functioning drain opening at least 3/4-inch in diameter. It must open automatically whenever the irrigation water flow stops. This provides a secondary safety backup to prevent any chemical and water mixture from entering the water source if the check valve should leak. The drain outlet must be positioned, or the drainage directed to flow, away from the well or surface water source during shutdown. A hose, pipe, or open conduit can be used to direct the drain discharge.

Approved check valve assemblies must meet MDA design and operating standards and be certified by an independent testing laboratory. *A list of currently approved check valve models can be obtained from the MDA.* Check valve assemblies must be quick-closing by spring action and must provide a watertight seal. They must be constructed of material resistant to corrosion, or be protected to resist corrosion, and be easy to maintain and repair.

System interlock

The chemigation injection system must be interlocked with the irrigation system's power or water supply so it will shut down any time the irrigation system or pumping plant stops operating or the water flow is disrupted. In all cases this measure must prevent chemical from the supply tank being injected into the main irrigation pipeline after the water supply stops flowing.

If electric motors are used for both the irrigation and chemigation systems, the control panels for the two systems must be interlocked. This interlock must be set up so the injection pump motor stops whenever the irrigation system or pump stops.

Irrigation pumps driven by an internal combustion engine can be interlocked with an injection pump by being belted to the drive shaft or an accessory pulley on the engine. If the injection pump is electrically powered, it should be connected to the engine's generator or electrical control system.

Some chemigation systems use flowing water or water pressure to power the injection meter or pump. In most cases these systems will stop injecting a chemical when the irrigation water supply stops flowing.

If chemical flow from the supply tank could possibly continue after shutdown, a normally closed solenoid valve should be installed in the chemical injection line, preferably on the suction side of the injection meter. The solenoid valve must be interlocked with and powered by the irrigation system control panel, water supply pressure, or the injector power supply.

Chemical injection line check valve

The chemical injector's discharge line/hose must contain a positive-closing check valve that will not allow flow either way when the injection system is not operating. The check valve must be located

between the injection meter and the point of the chemical injection into the irrigation pipeline.

This valve should: 1) stop flow of water from the irrigation system into the chemical supply tank if the injection system stops; and 2) prevent gravity flow from the chemical tank into the irrigation pipeline following an unexpected shutdown. To provide two-way protection the valve must have a watertight sealing check valve with a minimum opening (cracking) pressure of 10 pounds per square inch. It should also be constructed of an agricultural chemical-resistant and corrosive-resistant material.

If irrigation water is allowed to flow back into the chemical supply tank it could overflow the tank causing chemical to spill onto the ground. If chemical in the supply tank is allowed to flow into the irrigation pipeline by gravity or be siphoned when the irrigation system is not operating, it could damage the crop or leak on the ground, possibly getting into a surface water or groundwater source.

Low pressure shutdown switch

The irrigation system must contain a low pressure shutdown switch or device with similar operating characteristics on the main pipeline. This will shut down the irrigation system and the chemigation system if the operating pressure drops to an unsatisfactory level for proper agricultural chemical distribution.

Chemical supply tank

The chemigation supply tank must not be located closer to an irrigation well than the distance specified in the MDH Rules chapter 4725, and must be safeguarded according to the MDA specifications described in the following paragraphs. All preparation or filling of a chemical tank must be done at least 150 feet from a wellhead unless properly safeguarded.

The separation distance from a surface water source must likewise be no less than that specified for an irrigation well unless other state/federal regulations are more applicable. The supply tank should be placed away from the water source in such a way that, if a spill occurs, the chemical will not move directly to the source.

According to MDA chemigation rules, a chemigation supply tank must be housed in a secondary containment unit if the tank storage meets at least two of the following conditions: 1) the supply tank has a rated capacity of more than 1,500 gallons; 2) the tank is located within 100 feet of a water supply; and 3) the supply tank storage is located at the site for more than 30 consecutive days.

The minimum required capacity for a secondary containment unit is 125 percent of the tank capacity (110 percent if it is under a roof). Its walls and base may be made of ferrous metal, reinforced concrete, solid reinforced masonry, synthetic lined earth, prefabricated metal, or synthetic materials. Synthetic liners must have a minimum thickness of 30 mils.

The unit must be leakproof and built to withstand the hydrostatic pressure from the release of a full tank. The walls or base must not contain a drain. Design specifications for some types of units are described in Midwest Plan Service Bulletin #37 *Designing Facilities for Pesticide and Fertilizer Containment*. This bulletin is available at county extension offices.

The chemical supply tank must be constructed from material such as fiberglass, polyethylene, or stainless steel that is resistant to the chemical being stored and resistant to degradation by sunlight. If not contained in a secondary unit, the tank should be located and landscaped so if a leak develops it will direct any leakage away from entering the water source. The tank should also be protected from damage from farm machinery and livestock.

Posting of field

All sites being treated with a pesticide through the irrigation water must be posted with signs during the entire chemigation treatment. Signs must contain the signal word from the pesticide label, name of the pesticide, date of treatment, and reentry date as described by the pesticide label. An example of a sign can be obtained from the MDA.

Signs must be posted at usual points of entry and at property corners immediately adjacent to public transportation routes or other public or private property. Signs must be placed no farther than 100 feet apart for a field that is located adjacent to a public area such as a park, school, or residential area. If more restrictive instructions for posting are described on the label, those restrictions must be followed.

The new federal Worker Protection Standards sometimes require posting as well as notifying any agricultural employees of the pesticide application. See "Worker Protection Standard" in Chapter 3 (Pesticide Laws and Regulations) and check with your local county extension office or the MDA for more information.

Additional Protection Measures

There are several other devices and measures that make management of the chemigation operation easier and also reduce the potential risks to the environment. These include:

Portable chemigation system and chemical supply tank

Install the chemigation injection meter/pump and chemical supply tank on a portable trailer or truck. Construct a secondary containment unit of appropriate size on the bed of the trailer or truck.

Injection meter/pump

Place the injection meter or pump within the chemical supply tank containment unit when possible.

Chemigation system location

When developing a new irrigation system always try to locate the irrigation water supply at least 150 feet from the chemigation system, chemical supply tank, injection port, and power interlock controls.

Bleed valve

Locate a bleed valve upstream from and next to the injection line check valve to assist in relieving any locked-in pressure in the chemical injection line when the injection line is disconnected. This will prevent the operator from being sprayed with the chemical in the line during line removal.

Injection port location

When possible, locate the port for chemical injection higher than the chemical supply tank but lower than the lowest sprinkler outlet to prevent siphoning from the tank. In all cases the injection port must be located downstream from the main pipeline check valve.

Injection line flow sensor

An injection line flow sensor installed just upstream from the chemical injection line check valve and interlocked with the injection device can be used to shut down the injection system if flow in the injection line ceases. This safety measure will prevent continuous operation if the injection device loses prime or fails, the supply tank is emptied, the injection port becomes plugged, or the lines or hoses rupture or become disconnected. The flow sensor could also be interlocked with the irrigation system to shut down the whole system if injection line flow stops.

Two-way interlock

A two-way interlock arrangement between the irrigation system and the injection system will stop either system if the other system also stops. This eliminates untreated areas in the field because it stops the irrigation pump and sprinkler system if the injection system stops or malfunctions. The interlock can be done electrically or by using a flow sensor on the discharge side of the chemical injection device. When there is no flow in the injection line, the irrigation system and pumping plants shut down.

Solenoid valve

A normally closed solenoid valve installed on the suction side of the injection device can provide a good backup. It acts as an automatic shut-off valve on the injection line when the injection pump is not in use. The solenoid valve must be interlocked with injection device power supply to open or close properly.

Calibration

Proper calibration of the irrigation system and chemigation injection pump is essential for an effective, safe, and economical application. Minor differences in calibration and application rate over a period of time can cause the pesticide application rate to be too high or too low. A rate that is too high can be potentially damaging to the crop or the environment. An application rate that is too low may make the pesticide treatment ineffective.

It is important to have accurate in-field measurement of the field size, travel time to cover the field at the desired water depth, and amount of chemical required per acre for accurate calibration of the equipment and the whole system.

The following table shows the typical steps to take to calculate the proper chemigation injection rate for a center pivot with a given situation. Examples are given for fertilizer and pesticide.

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Steps	Example		Yours
	Nitrogen	Pesticide	
1. Number of acres under center pivot*	128 acres	128 acres	_____
2. Amount of chemical/acre (example: 30 lb of 28% N per acre = 10.0 gal and pesticide of 2 pt + 2 pt of oil = 2 qt per acre)	10.0 gal (30 lb.)	2 qt	_____
3. Multiply step 1 by 2	1,280 gal	256 qt	_____
4. If chemical needs some dilution with water, enter total amount of solution.	--	175 gal	_____
5. Select water application depth per product recommendation.	0.75 inch	0.2 inch	_____
6. Determine travel time of center pivot for one revolution to apply water depth in Step 5.**	72 hr	1,153 min (19.2 hrs)	_____
7. Determine injection rate by dividing step 3 or 4 by step 6 (1 gal = 3,785 ml)	12.7 gal/hr	(575 ml/min)*** or (100 ml in 10.4 sec) ****	_____
8. Select injection pump dial per Manufacturer's curve for step 7 and check delivery rate of the injector with calibration tube to make certain it is injecting at the proper rate. Adjust rate dial as needed to obtain calculated injection rate.	7.5	90%	_____

*If acreage of field is not known, the area should be calculated. For example, for a center pivot that runs a full circle, the area covered in acres can be found by the following formula.

$$\text{Area covered} = \frac{\text{Wetted radius (ft)} \times \text{Wetted radius (ft)} \times 3.14}{43,560 \text{ ft per acre}} = \text{Acres}$$

Where the area covered is only part of a circle, multiply the full circle area by the percentage of the coverage. If an end gun or corner system is used, calculate the area of both wetted radii and estimate the percentage of each operation. For example, assume 2/3 of the circle with normal sprinklers and 1/3 with end gun.

If further assistance is needed in calculating the area, contact your equipment dealer, local extension office, or SWCD office.

**Knowing the correct travel time to cover the field is very important in making an accurate calibration. There are two methods that can be used to time the application of a center pivot.

First method: Operate the system wet at the same travel speed (% timer setting) that is planned for chemigation and measure the time to make one revolution or to cover the desired part of the field.

Second method: Measure the distance from the pivot point to the outer tower wheel tracks. Then operate the system wet at the desired travel speed (% timer setting) that is planned for chemigation and measure the time it takes the outer tower to travel a preset distance. The following example is for a preset distance of 100 feet. To calculate the time to cover a circle, use the following formulas:

Wheel track circumference (ft) = $3.14 \times 2 \times \text{distance from pivot to outer wheel track}$.

$$\text{Rotation time} = \frac{\text{Wheel track circumference (ft)} \times \text{time (min) between stakes}}{\text{Distance traveled between stakes (ft)}}$$

Example: A center pivot with a 1250 ft length to the outer track takes 14.69 minutes to travel 100 feet. Wheel track circumference = $3.14 \times 1250 \times 2 = 7,850 \text{ ft}$.

$$\text{Rotation time} = \frac{7850 \times 14.69 \text{ min}}{100 \text{ ft}} = 1,153 \text{ minutes OR } \frac{1153}{60 \text{ min/hr}} = 19.2 \text{ hours}$$

$$*** \text{ ml per min: } \frac{9.11 \text{ gal/hr} \times 3,785 \text{ ml/gal}}{60 \text{ min/hr}} = 575 \text{ ml/min}$$

$$**** \text{ sec per 100 ml: } \frac{100 \times 60 \text{ seconds/min}}{575 \text{ ml/min}} = 10.4 \text{ sec per 100 ml (100 ml in 10.4 sec)}$$

Summary of Chemigation Management Practices

A chemigation system requires regular maintenance and supervision to apply a pesticide safely and effectively. The owner or operator is responsible for making sure that all equipment and components function properly and the pesticide application is done according to label directions. Listed below are several management tips that should be reviewed each time a chemigation system is used to apply a pesticide.

Review Operation of Irrigation System

Periodically observe the irrigation system's water distribution pattern and conduct a water distribution test of the spray pattern. Remember that the uniformity of the chemical distribution will be no better than the distribution of the water.

Adjust the irrigation system (such as the end gun) to prevent spray going beyond the boundaries of the target field. Shut down the irrigation system if wind will carry chemical drift off target. Manage the irrigation system so runoff or deep percolation of the water/chemical mixture does not occur.

Do not chemigate in areas containing wetlands and other surface bodies of water. Do not apply any pesticide that is not labeled for use in an irrigation system. Such applications are illegal and may adversely affect wildlife, nontarget plants, and water quality.

Inspect Safety and Antipollution Equipment Before Each Use

Inspect all components of the chemigation and irrigation system before each use. Components not working at the time of inspection should be repaired or replaced before chemigating. Routine inspections should minimize the potential for failure of any component during chemigation.

To inspect the irrigation pipeline check valve, low pressure drain, injection line check valve, low pressure switch and the power interlock follow the procedures listed below. RPZ backflow preventors and some other types of check valves will require a different approach to inspection. Contact MDA staff for directions on inspecting if assistance is needed.

- Connect the chemigation system to the irrigation system, but leave the chemical injection line/hose disconnected from the injection port check valve.
- Start the irrigation pump and pressurize the irrigation system to its normal operating pressure.
- Observe the injection line check valve to see if any water is leaking back out the inlet side of the check valve. There should be no leakage observed when the irrigation system is operating or when shut down.
- Connect the chemical injection hose to the injection check valve and start up the chemigation system. *The chemigation system should only be operated with clean water.*

- Close the main pipeline control valve (reducing the operating pressure) until the low pressure switch shuts down the irrigation system. The pressure switch should be set to cause the irrigation pump and system to shut down when the normal operating pressure has been reduced by 15 to 25 percent. If no flow control valve is present, shut power off to the pump and/or irrigation system and go to the next step.
- Immediately after shutdown, observe if any water is flowing from the low pressure drain(s). Some drainage for a short period of time after shutdown is normal, but then drainage should stop.
- Check to see if the chemigation injection device has stopped operating. This device should stop when the irrigation system and pump shut down. If the chemigation system has an agitation system, this unit does not have to shut down when the injection device stops.
- Open the inspection port at the main pipeline check valve assembly after the low pressure drain has stopped flowing. Inspect for any leakage from the check valve flapper. There should be no leakage from the downstream flapper. Also check for proper functioning of the flapper valve assembly.

Filling of supply tank/mixture of agricultural chemicals

Chemigation supply tanks should be located at least 150 feet from any water well during filling unless housed in the appropriate safeguard unit defined by the MDA and. The supply tank condition and plumbing fixtures should be inspected closely each time before it is filled. Fill supply tank no more than 95 percent of capacity. Monitor the supply tank during chemigation for development of any leaking.

Triple-rinse pesticide containers at time of use and add the rinse water into the supply tank to minimize risk of spilling on the ground.

Keep the Chemigation Site Uncontaminated

To make monitoring the chemigation operation safe and easy, do not allow the irrigation system to spray water and chemical into the chemigation equipment area. This may mean plugging a few nozzles on the irrigation system near the chemigation site.

Calibration

Accurate calibration of the chemical injection device is essential for proper application. Recheck the calibration setting of the injection device periodically. Follow calibration procedures described by the chemical label, chemigation equipment manufacturer, or the Minnesota Extension Service. Minor differences in injection rate over an extended period can cause too high or too low a chemical application rate. This may produce unsatisfactory results when too low; it can also cause potential pollution or crop damage when too high.

Empty chemigation supply tank

Leftover pesticide mixtures should be removed from the supply tank and stored in an appropriate place for later use or immediately applied to another crop or site listed on the label. The empty tank should be rinsed out, and the rinsing water should be applied to the irrigated crop or to another labeled site.

Flush injection equipment

Flush the chemigation injection device, hoses, and check valve with clean water after each use. Flush cleaning water into the irrigation system while it is operating so the cleaning water will be applied to the field. Clean strainer after each chemigation.

Flush irrigation system

After chemigation is completed and the chemigation system is cleaned and flushed, operate the irrigation pump as long as necessary to flush the irrigation system free of any remaining chemical. This may take 10 to 15 minutes for most systems.

Report accidental spills

If an accident occurs, regardless of size, avoid personal contamination. Take action to keep the spill to a minimum, and report the incident to the MDA immediately.

In case of an accidental spill, phone the MDA at 1-800-422-0798 for assistance.

Summary

Understanding the processes in chemigating help applicators make responsible choices in a given chemigation situation. Minimizing the risk of accidental backflow into water supplies is important to maintaining safe environments. In deciding whether or not chemigation is necessary in a given situation, remember to use only those products that are recommended for chemigation. You need to know what the current MDA regulations are for proper chemigation. You will also need to know which injection and antipollution equipment is necessary. Review the recommended chemigation practices described in this chapter each time you chemigate.

Review Questions for Chemigation

1. What is 'chemigation'?
 - A. Applying pesticides and fertilizers through irrigation systems
 - B. Applying pesticides with a water carrier
 - C. Using a pesticide sprayer to apply chemicals other than pesticides
 2. Which state government agency has adopted rules for chemical storage tanks, chemigation systems, and water wells?
 - A. Minnesota Department of Agriculture
 - B. Minnesota Department of Natural Resources
 - C. Minnesota Department of Health
 - D. Minnesota Environmental Quality Board
 3. What is the greatest risk of chemigation?
 - A. Poor distribution of pesticide to target area
 - B. Accidental backflow of chemical into the irrigation water source
 - C. Protecting the applicator from pesticide exposure
 4. Which state agency issues chemigation permits?
 - A. Minnesota Department of Agriculture
 - B. Minnesota Department of Natural Resources
 - C. Minnesota Department of Health
 - D. Minnesota Environmental Quality Board
 5. Most pesticides are labeled for chemigation.
 - A. True
 - B. False
 6. A Minnesota Department of Agriculture approved RPZ backflow preventor or two check valves in series must be installed in the main irrigation water supply line of all systems directly connected to a well or surface water source.
 - A. True
 - B. False
 7. When should chemigated fields be posted in Minnesota?
 - A. Only when required by the Worker Protection Standard
 - B. Only for those products with a Danger/Poison signal word
 - C. No posting is required when chemigating pesticides
 - D. For all pesticides during the entire chemigation treatment
-

For More Information

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Appendices

What's in this Chapter:

Appendix A - Examples of Restricted Use Pesticides (RUPs)

Restricted Use Pesticides

Chemicals Deleted from the Restricted Use List Because of Product Cancellation

Appendix B - Effects of Pesticides on the Human Body

Pesticide Effects Table

Index for Pesticide Effects Table

Appendix C - Answers to Chapter Review Questions

Appendix A - Examples of Restricted Use Pesticides (RUPs)

This is not a complete list of restricted use pesticides. It merely shows examples of different kinds of pesticides that are restricted and the reasons for their classification as RUPs.*

Restricted Use Pesticides (RUPs)** are those designated by the EPA that may cause adverse effects to the environment or injury to the applicator. The EPA may use a RUP classification as an alternative to severely limiting the pesticide's use or banning it all together.

A pesticide may be classified as an RUP because of these potential or documented risks:

- Applicator injury through acute or chronic exposure;
- Ground or surface water contamination;
- Harm to endangered species and other nontarget organisms;
- A history of pesticide incidents.

Some pesticide with an RUP classification may not be classified as an RUP in different formulations due to specific traits or ways of using that formulation. Generally, if a package contains one active ingredient classified as an RUP, the package mixture is also designated as an RUP.

NOTE: Herbicides containing atrazine are now RUP.

* Always read and follow all pesticide label directions. Data presented in this appendix will require updating periodically.

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Common Name	Trade Name	Pesticide Type	Formulations Restricted	Use Pattern
Acetamide	Guardsman	Herbicide	Dimethenamide 25.0%, atrazine 28.8%	For weed control in field corn, seed corn, and popcorn /or forage
Acetochlor	Hamess Plus, Surpass, Doubleplay	Herbicide	Emulsifiable concentrate	Field corn, popcorn, forage/fodder corn
Acrolein	Magnacide H and B Aqualin	Herbicide	As sole active ingredient	All uses
Alachlor	Lasso, Lasso II, Lasso Micro-Tech, Partner, Cannon, Bullet, Bronco, Freedom, Ala-Scept, others	Herbicide	All formulations	All uses
Aldicarb	Temik	Nematicide, Insecticide	As sole active ingredient and in combination with other actives. All granular formulations.	All uses
Aluminum phosphide	Detia, Phos-Kill, L-Fume, Phostoxin, Quick-Phos, Gastoxin, Quik-Fume, Detta Fumex, others	Fumigant	As sole active ingredient	All uses
Amitraz	Mitac, Taktic	Insecticide, Miticide	All formulations	Pears
Amitrole	Amizol, Amitrol T	Herbicide	All formulations	All uses except homeowner
Arsenic acid	Desiccant L-10, Hy-Yield H-10, Poly Brand, Desiccant, CCA Type C, Chemonite Part A	Herbicide, wood preservative	All formulations except brush-on	All dessicant uses, all preservative uses
Arsenic pentoxide	Osmose K-33, Chromated Copper Arsenate, CCA, Wolmanac Concentrate	Wood preservative	All formulations	Wood preservative uses
Atrazine	Atrazine, AAtrex, Bicep, Extrazine, Bullet, Colonel, Atratol, Atraol, Laddok, Sutazine, Marksman, Gladezine, others.	Herbicide	All manufacturing and end use formulations	Agricultural and/or Industrial herbicide. Home use exempted from restrictions.
Avermectin	Zephyr, Agri-Mek	Insecticide	Emulsifiable concentrate	Cotton, citrus
Avitrol	Avitrol	Bird Control	All formulations	All uses

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Common Name	Trade Name	Pesticide Type	Formulations Restricted	Use Pattern
Azinphos-methyl	Guthion, Beetle Buster, Ketokil No. 52, others	Insecticide	All liquids with a concentration greater than 13.5%. All other formulations on a case-by-case basis.	All uses
Bendiocarb	Turcam	Insecticide	Granular and wettable powder	Turf
Biphenothrin	Capture 2	Insecticide	Emulsifiable concentrate	Cotton
Bis(tributyltin) oxide	Interlux Micron, Interswift BKA007, SuperSea Jacket, SigmaPlane7284, Navicote 2000, AF-SeafloZ-100	Biocide	Solution - ready to use	Antifouling paint
Carbofuran	Furadan	Nematicide, Insecticide	All formulations, except pellets/tablets	All uses
Chlorophacinone	Rozol Tracking Powder, Rozol Blue Tracking Powder	Rodenticide	Tracking powder, dust and ready-to-use formulations 0.2%.	Inside buildings
Chloropicrin	Timberfume, Chlor-O-Pic, Tri-Con, Brom-O-Gas, Terr-O-Gas, Pic-Brom, Bro-Mean, Pic-Chlor, Telone, Dowfume, others	Fumigant, fungicide, rodenticide	All formulations greater than 2% and all formulations for rodent control	All uses
Chlorothalonil	Consynt, Dacobre, Echo 75	Fungicide	Water dispersible granules	Cranberries, strawberries, almonds, walnuts, crabapples, pears, quinces, apricots, cherries and nectarines
Chlorpyrifos	Lorsban 4E-SG	Insecticide	EC	Wheat
Chromic acid	CCA (Chromated Copper Arsenate), Osmose K-33, others.	Wood preservative	All formulations except brush-on	All wood preservative uses
Clofentezine	Apollo SC	Miticide	Apollo SC	All uses
Coal tar	60/40 Creosote Coal Tar Solution	Wood preservative	Solution - ready to use	Wood preserving compounds
Coal tar creosote	Creosote Oil, Creosote Coal Tar, Smoplastic-F, Osmoplastic-D	Wood preservative	All formulations	Wood preservative uses

Common Name	Trade Name	Pesticide Type	Formulations Restricted	Use Pattern
Coumaphos	CO-RAL	Insecticide	Flowable concentrate	Indoor
Creosote oil	Original Carbolineum	Wood preservative	All formulations	Wood preservative
Cyanazine	Bladex, Extrazine, Cycle	Herbicide	All formulations	All uses
Cyfluthrin	Baythroid 2	Insecticide	25% EC	Agricultural
Cyhalothrin	Karate C50	Insecticide	Emulsifiable concentrate	Cotton
Cypermethrin	Ammo	Insecticide	All formulations	All ag crop uses
Diazinon	Diazinon	Insecticide	14G, AG 500, 50W, 4EC, 4AG	Small fruits
Dichloropropene	Telone Soil Fumigant, Tri-Form, Pic Clor, Brom 70/30	Fumigant	All formulations (94% liquid concentrate is the only formulation)	All uses
Diclofop methyl	Hoelon 3 EC or 3 EW, Brestan H 47.5	Herbicide	All formulations	All uses
Dicrotophos	Penetrex, Chiles' Go-Better, Mauget Inject-A-Cide B	Insecticide	All liquid formulations 8% and greater	All uses
Diflubenzuron	Dimilin	Insecticide	Wettable powders	All uses
Dioxathion	Cooper Del-Tox Delnav	Insecticide, Miticide	All concentrate solutions or emulsifiable concentrates greater than 30%. All solutions 3% & greater for uses.	All uses
Disulfoton	Di-Syston, Root-X, Dot-Son Brand Stand-Aid, Rigo Insyst-D, Terraclor Super-X	Insecticide	All ECs 65% and greater. All ECs & concentrate solutions 21% and greater with fensulfothion 43% and greater. All ECs 32% and greater in combination with 32% fensulfothion and greater.	All uses. Commercial seed treatment (non-aqueous solution 95% and greater).
Dodemorph	Milban	Fungicide	All formulations	All uses
Endrin	Endrin 1.6 EC	Insecticide	9.4% liquid	Bird perch use
EPTC	Doubleplay	Herbicide	Emulsifiable concentrate	Grapes, citrus, grapefruit, lemons, oranges, tangerines, almonds, walnuts, tomatoes, potatoes, sweet potato
Ethion	Ethion 8	Insecticide	Emulsifiable concentrate	All uses

Common Name	Trade Name	Pesticide Type	Formulations Restricted	Use Pattern
Ethoprop	Mocap, Holdem	Insecticide	Emulsifiable concentrates 40% and greater (aquatic). All granular and fertilizer formulations.	Aquatic uses. All uses.
Fenamiphos	Nemacur	Nematicide	Emulsifiable concentrates 35% and greater	All uses
Fenitrothion	Sumithion	Insecticide	Emulsifiable concentrate, 93% soluble concentrate/ liquid	Only forestry uses
Fenpropathrin	Danitol	Insecticide, miticide	2.4 EC spray	Cotton
Fenthion	Mosquitocide 700, Baytex, Rid-a-Bird, BX-1, BX-2	Insecticide	Emulsifiable concentrate	Mosquitocide
Fenvalerate	Asana XL, Fury 1.5	Insecticide	Emulsifiable concentrates (30%)	Outdoor uses
Fonofos	Dyfonate	Insecticide	Emulsifiable concentrates 44% and greater Granulars 20% and greater.	All uses
Hydrogen cyanamide	Dormex	Herbicide	50% active ingredient	Desert grown grapes
Isazofos	Triumph 4E	Insecticide	All formulations	All uses
Isofenphos	Pryfon 6	Insecticide	65% liquid formulation	Termiticide
Lambda cyhalothrin	Karate, Scimitar	Insecticide	All formulations	All uses
Lindane	Lindane, Borer Spray, many trade names	Insecticide	All formulations for various uses	Avocados, pecans, livestock sprays, forestry, Christmas trees, commercial ornamentals, structural treatments, dog dusts/shampoos.
Magnesium phosphide	Magtoxin, Phostoxin, Fumi-Cel Plate, Magnaphos	Insecticide, fumigant	All formulations	All uses
Methamidophos	Monitor 4	Insecticide	Liquid formulation 40% and greater, dust formulations 2.5% and greater	All uses

Common Name	Trade Name	Pesticide Type	Formulations Restricted	Use Pattern
Methidathion	Supracide	Insecticide	All formulations	All uses except nursery stock, safflower and sunflower.
Methiocarb	Mesurol, Slug & Snail Bait, Slug'm	Acaricide, insecticide, bird repellent	All formulations	Outdoor commercial and ag uses
Methomyl	Lannate, Methomyl 5G, Lannabait	Insecticide	As sole active ingredient in 1% to 2.5% baits (except 1% fly bait). All concentrated solution formulations and 90% WP formulations (not in water soluble bags)	Non-domestic outdoor ag crops, ornamentals and turf; all other registered uses.
Methyl bromide	Meth-O-Gas, Terr-O-Gas, Brom-O-Gas, Bro-Mean, Pic-Brom, Metabrom, Tri-Con, Tri-Brom, others	Fumigant	All formulations	All uses
Methyl isothiocyanate	Degussa methyl isothiocyanate	Wood preservative	Solution - ready to use	Fungicide for wood, wood preservative
Mevinphos	Phosdrin, Duraphos, others	Insecticide	Emulsifiable concentrates, 2% dust	None
Niclosamide	Bayluscide	Molluscicide, larvicide	70% WP and greater	All uses
Nicotine	Nicotine, others	Insecticide, Fumigant	Liquid and dry formulations 14% and above for indoor use, all formulations to cranberries	Indoor (greenhouse) applications to cranberries
Nitrogen, liquid	Liquid nitrogen	Insecticide	Solution - ready to use	Termiticide
Oxamyl	Vydate	Nematicide, Insecticide	Liquid formulations, granular on a case by case basis	All uses
Oxydemeton methyl	Metasystox-R, Dylox/MSR, Inject-A-Cide, Harpoon	Insecticide	All products	All uses
Paraquat	Paraquat, Gramoxone, Prelude, Surefire	Herbicide	All formulations and concentrates except for certain mixtures. See label	All uses

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Common Name	Trade Name	Pesticide Type	Formulations Restricted	Use Pattern
Parathion, ethyl	Parathion, Phos Kil, Parawet, Durathion, Dithion, Thionspray No.84, others	Insecticide	All formulations	All uses
Parathion, methyl	Methyl parathion, Penncap-M, Terrazole 5%, Dithon 63, Mal Methyl, Ketokil No. 52, Seis-Ties 6-3, Metaspay, Paraspray 6-3, others	Insecticide	All formulations	All uses
Pentachlorophenol	Penta, PCP, Pol-NU, Oz-88, Pentacon, Osmoplastic, Forepen-50, Dura-Treat, Penwar, others	Wood preservative	All formulations	Wood preservative uses
Pentachlorophenol, Sodium S	Mitrol G-ST, Dura Treat	Wood preservative	All formulations	Wood preservative uses
Permethrin	Pounce, Ambush, Ketokil, Biomist	Insecticide	All formulations	Ag crop uses (broadcast spray)
Phorate	Thimet, Rampart, Phorate, Holdem, Milo Bait, others	Insecticide	Liquid formulations 65% and greater. All granular formulations on rice	All uses
Phosphamidon	Phosphamidon 8	Insecticide	Liquid formulations 75% and greater, dust formulations 1.5% and greater	All uses
Picloram	Tordon 101/22KK, Access, Grazon	Herbicide	All formulations and concentrations except Tordon 101R and Tordon RTU	All uses
Piperonyl butoxide	Vex, Oblique	Insecticide	Emulsifiable concentrate	Small fruits, certain berries
Profenophos	Curacron	Insecticide	Emulsifiable concentrate 59.4%	Cotton
Pronamide	Kerb	Herbicide	All 50% wettable powders	All uses
Propanoic acid	Bugle	Herbicide	Emulsifiable concentrate	Wheat, cotton, rice clover, alfalfa, wheatgrass, sideoats grama, little bluestem, edible chrysanthemum
Propetamphos	Safrotin, Zoecon	Insecticide	Emulsifiable concentrates 50%	Indoor domestic use
Resmethrin	Kill-Ko-Permgard, Ind-Sol, Vex, Oblique, Bonide	Insecticide	All formulations	Mosquito abatement and pest control treatments at non-ag sites

Common Name	Trade Name	Pesticide Type	Formulations Restricted	Use Pattern
Rotenone	Rotenone, Synpren, Prenfish, Fish-Tox, Chem Fish, NUSYN	Fish control	2.5/5.0 EC, 5.0% & 20.0% wettable powder	Fish kill - lakes, ponds, and streams immediately above lakes and ponds
Simazine	Lilly Miller 4G, Printrex, Simazat	Herbicide	Emulsifiable concentrate	Berries (cane, black, blue, logan, cran., rasp., straw.), grapes
Sodium cyanide	M-44, cyanide,	Rodenticide	All capsules and bait formulations	All uses
Sodium fluoracetate	Compound 1080 Livestock Protection Collar,	Rodenticide	All solutions and dry baits	All uses
Sodium hydroxide	Augus Hot Rod	Herbicide	Ready to use	Control tree roots in sewage systems
Sodium methyldithiocarbamate	Metam, Vapam, Metam-Sodium	Fumigant	32.7% anhydrous	Soil fumigant - control soilborne pests to ornamentals, food and fiber crops
Starlicide	Gull Toxicant 98%	Bird repellent	98% concentrates	Bird repellent
Strychnine	Strychnine, Gopher Bait, Gopher Getter, Gopher-Rodent Killer, others	Rodenticide	Dry baits, pellets and powder formulations. See label for specifics.	Various uses
Sulfotepp	Dithio Insecticidal Smoke	Insecticide	Sprays and smoke generators	All uses
Sulfuric acid	Sulfuric acid	Desiccant	Solution - ready to use	Desiccant for potato vines
Sulfuryl fluoride	Sulfuryl Fluoride Fumigant, Vikane	Fumigant	All formulations	All uses
Sulprofos	Bolstar 6	Insecticide	All formulations	All uses
Tefluthrin	Force	Insecticide	Granular product	Corn grown for seed
Terbufos	Counter	Insecticide	Granular formulations 15% and greater	All uses
Tergitol	Compound PA-14	Bird control	Solution - ready to use	Single dose poison, avian control, limited to USDA approved and supervised situations
TFM	Sea Lamprey Larvicide, TFM Bar	Biocide	Impregnated material	Aquatic pest control

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Common Name	Trade Name	Pesticide Type	Formulations Restricted	Use Pattern
Toxaphene	Toxaphene Methyl Parathion	Insecticide	All formulations	All uses
Tralomethrin	Scout	Insecticide	All formulations	All ag crop uses
Tributyltin fluoride	Polyflo, KL-990, Amercoat 635, Pro-Line 1077, Sea Hawk Biotin, Vin Clad Super Vinge	Biocide	Solution - Ready to use	Antifouling paint
Tributyltin methacrylate	Interlux Micron, Interswift BKA007, Intersmooth Hisol, M&T Polyflo, Amercoat Biocop, AF-SeafloZ-100, Classic Yacht 625, Hempel's.	Biocide	Solution - ready to use	Antifouling paint
Triphenyltin hydroxide	Super Tin Man, Du-Ter, Supertin, Brestan H/R, Photon	Fungicide	All formulations	All uses
Zinc phosphide	Ridall-Zinc Rodent Field/Ag Bait, ZP Tracking Powder, ZP Rodent Bait, Zincphos, others	Rodenticide	All dry formulations 60% and greater; all bait formulations; all dry formulations 10% and greater.	All uses; non-domestic outdoor uses (other than 1-2% formulation in/around bldg.); domestic uses

Appendix B - Effects of Pesticide on the Human Body*

Chemicals in pesticides can injure humans in a variety of ways. You should know the kinds of injury most likely to be caused by the pesticides you use. Knowing how pesticides affect the body will make you more aware of the need for safe handling. Knowing what the symptoms of poisoning are can help prevent serious injury.

The chart on the following pages lists the ways pesticides can harm human beings. The column headings of the chart are defined below.

Chemical family. The active ingredients in pesticides

Action on human system. The injuries that the chemical can cause.

Acute systemic effects. The symptoms and signs that can occur if you have been exposed to the chemical over a period of time.

Irritation effects. The symptoms that can occur when the skin or membranes have been irritated by pesticides.

Delayed/allergic effects. The symptoms and signs that can occur if you have been exposed to low levels of the chemical over a long period of time.

Type of pesticide. The kinds of pesticide that the chemical is found in, such as insecticides, acaricides (for spiders), herbicides, fungicides, rodenticides, avicides (for birds), miticides (for mites), and germicides (for bacteria).

An alphabetic index to pesticides, keyed to the chart, begins on page A-22.

* Taken from *Applying Pesticides Correctly: A Guide for Private and Commercial Applicators*. Published by the United States Environmental Protection Agency and the Extension Service, United States Department of Agriculture. 1991. Revised.

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Exposure
1. Organophosphates	Inhibits acetylcholinesterase enzyme in the tissues	Headache, dizziness, weakness, shaking, nausea, stomach cramps, diarrhea, sweating	Minimal rashes but readily absorbed through the skin	Loss of appetite, weakness, weight loss, and general feeling of sickness. Occasionally permanent harm to brain and nervous system	Insecticides, acaricides
2. N-Methyl Carbamates	Reversible changes in acetylcholinesterase enzyme of tissues	Headache, dizziness, weakness, shaking, nausea, stomach cramps, diarrhea, sweating	Minimal rashes but readily absorbed through the skin	Loss of appetite, weakness, weight loss, and general feeling of sickness	Insecticides, acaricides
3. Organochlorines (Chlorinated Hydrocarbons)	Disrupts function of nervous system, mainly the brain	Headache, dizziness, weakness, shaking, nausea, excitability, disorientation	Minimal rashes but readily absorbed through the skin	Some buildup in the fat tissues. May cause nervousness, weakness, and shaking. Some buildup in glands and may damage cells and hormone production	Insecticides, acaricides
4. Pyrethrum and Pyrethrins	Allergen	Slight toxic reaction	Minimal	Skin and respiratory tract allergic effects	Insecticides, acaricides
5. Nicotine	Harms nervous system	Nausea, headache, diarrhea, dizziness, shaking, abdominal pain, lack of coordination, sweating, salivation	Minimal but readily absorbed through the skin		Insecticides
6. Rotenone	Irritant	Minimal	Irritates skin, eyes, and respiratory tract		Insecticides, acaricides
7. Bacillus Thuringiensis	None known				Insecticide
8. Gibberellic Acid	None known				Growth regulator
9. Pyrethroids	Irritant	Minimal	Stinging, burning, itching, tingling, numbness of skin		Insecticides

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Exposure
10. Fluorides	Harms brain and stomach	Thirst, abdominal pain, vomiting, diarrhea, headache, weakness, salivation, dilated pupils, lethargy			Insecticides
11. Boric Acid	Irritant; harms stomach, intestines, blood system, and brain	Nausea, vomiting, abdominal pain, diarrhea, blood in vomit and feces, headache, weakness, tremors, restlessness	Irritates and burns skin and respiratory tract		Insecticides
12. Chlordimeform	Harms bladder; sometimes harms skin	Blood in urine, frequent and painful urination, abdominal and back pain, hot sensation, sleepiness	Skin rash, sweet taste		Insecticides, miticides
13. Propargite	Irritant; low systemic toxicity	Minimal	Severe skin and eye irritant	Probable skin sensitizer	Acaricide
14. Diflubenzuron, Teflubenzuron	Low systemic toxicity	Minimal			Insecticide
15. Chlorbenzilate	Irritant; low systemic toxicity	Minimal	Skin and eye irritant	Tumors observed in laboratory animals	Acaricide
16. Cyhexatin	Irritant; probable harm to nervous system	Probable headache, nausea, vomiting, dizziness, avoidance of light	Mild skin irritant		Insecticide
17. Methoprene	Very low systemic toxicity	Minimal			Insecticide
18. Sulfur	Irritant; low systemic toxicity	Minimal	Irritates eyes, skin, and respiratory tract		Acaricide, fungicide

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Pesticide
19. Diethyltoluamide	Irritant; low systemic toxicity except to children	Headache, restlessness, crying spells, stupor, tremors	Very irritating to eyes, mild skin irritation and peeling, except severe skin irritation in tropical conditions		Insect repellent
20. Alkyl Phthalates	Irritant; low systemic toxicity	Stomach- and intestine-lining irritation	Severely irritating to eyes and mucous membranes; not irritating to skin		Insect repellent
21. Benzyl Benzoate	Irritant; low systemic toxicity	Minimal	Occasionally irritating to skin		Acaricide
22. Arsenicals	Irritant; harms liver, kidney, brain, bone marrow, and nervous system	Headache, burning stomach pain, vomiting, diarrhea, dizziness, garlic odor on breath and feces	Swelling of mouth and throat; irritating to eyes, nose, and throat	Accumulates in body: chronic headaches, dizziness, stomach-aches, salivation, low fever, garlic breath; skin, liver, kidney, and blood system disorders; possible skin and lung cancer	Rodenticides, insecticides, acaricides, marine antifouling compounds, desiccants, herbicides, fungicides.
23. Chlorophenoxy compounds	Irritant; harms liver, kidney and nervous system. May cause skin to discolor	Does not remain in body; passed out within hours or days	Irritating to eyes, skin, lungs, mucous membranes	Severe disfiguring skin condition (chloracne) in manufacturing workers	Fungicides
24. Nitrophenolic and Nitrocresolic pesticides	Harms liver, kidneys, and nervous system	Headache, weakness, thirst, excessive sweating, feeling of overall illness. Characteristic yellow stain on skin, hair, and urine	Moderately irritating sensations to skin, eyes, nose, and throat	Weight loss, cataracts, glaucoma	Herbicides
25. Pentachlorophenol	Irritant; harms liver, kidneys and nervous system	Headache, weakness, nausea, excessive sweating, dizziness, rever, rapid breathing, intense thirst, vomiting, restlessness	Highly irritating to skin, eyes, nose, and throat	Weight loss, weakness, anemia; severe disfiguring skin disorder in manufacturing workers	Herbicides, defoliants, molluscicides, germicides, fungicides, wood preservatives

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Pesticide
26. Paraquat and Diquat	Irritant; harms skin, nails, cornea, liver, kidney, linings of stomach and intestine, and heart. Severe delayed harm to lungs.	Burning pain in mouth, throat, stomach, and intestine; nausea, vomiting, diarrhea, giddiness, fever	Irritates and harms skin, nails, nose and eyes		Herbicides
27. Acetamides	Irritant	Minimal	Moderately irritating to skin and eyes		Herbicides
28. Anilides	Irritant	Minimal	Irritates skin, eyes, and respiratory tract	Skin sensitizer	Herbicides
29. Aliphatic Acids	Irritant	Minimal	Irritates skin, eyes, and respiratory tract		Herbicides
30. Benzamide	Irritant; low systemic toxicity	Minimal	Occasionally irritating to skin		Herbicides
31. Benzoic Acid and Anisic Acid derivatives	Irritant	Minimal	Irritates skin and respiratory tract		Herbicides
32. Benzonitriles	Irritant	Minimal	Moderately irritating to skin and respiratory tract	Skin sensitizer	Herbicides, fungicides
33. Benzothiadiazinone Dioxide	Irritant	Minimal	Irritates eyes and respiratory tract		Herbicides
34. Dithio and Thio Carbamates	Irritant; very weak or no inhibition of cholinesterase enzyme in tissues	Nausea, vomiting, diarrhea, weakness	Irritates skin, eyes, mucous membranes, and respiratory tract	Skin sensitizer	Herbicides, fungicides
35. Carbanilate	Irritant; very weak or no inhibition of cholinesterase enzyme in tissues	Minimal	Irritates skin, eyes, mucous membranes, and respiratory tract	Skin sensitizer	Herbicides
36. Chloropyridinyl	Irritant	Minimal	Irritates skin and eyes		Herbicides
37. Cyclohexenone derivative	Irritant	Minimal	Irritant		Herbicides

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Pesticide
38. Dinitroaminobenzene derivatives	Irritant	Minimal	Moderately irritating		Herbicides
39. Fluorodinitrotoluidine compounds	Irritant	Minimal	Mildly irritating		Herbicides
40. Isoxazolidinone	Irritant	Minimal	Moderately irritating		Herbicides
41. Nicotinic Acid Isopropylamine derivative	Irritant	Minimal	Irritating to eyes and skin		Herbicides
42. Oxadiazolinone	Low systemic toxicity				Herbicides
43. Phosphonates	Irritant	Minimal	Irritates eyes, skin, and respiratory tract		Herbicides
44. Phthalates (except endothall)	Irritant	Minimal	Moderately irritating to eyes		Herbicides
45. Endothall	Harms heart, blood vessels, nervous system, and stomach and intestinal linings	Convulsions, shock, lack of coordination, severe burning of stomach and intestine	Irritates eyes, skin, and mucous membranes		Herbicides, algicides
46. Picolinic Acid compounds	Irritant	Minimal	Irritates skin, eyes, and respiratory tract		Herbicides
47. Triazines	Irritant; low systemic toxicity	Minimal	Moderately irritating to skin, eyes, and respiratory tract		Herbicides
48. Tiazole	Minimal	Minimal	Slight irritant effect		Herbicides
49. Uracils	Irritant	Minimal	Irritates eyes, skin, and respiratory tract		Herbicides
50. Urea derivatives	Irritant	Minimal	Irritates eyes, skin and mucous membranes		Herbicides

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Pesticide
51. Thiophthalimides	Irritant; low systemic toxicity	Minimal	Irritates skin, eyes, and respiratory tract	Skin sensitizer	Fungicides
52. Copper	Irritant; harms stomach and intestinal lining, brain, liver, kidneys, and blood system	Prompt vomiting, burning pain in chest, diarrhea, headache, sweating	Irritates skin, respiratory tract, and particularly the eyes. Corrosive to eyes		Fungicides
53. Organomercuric compounds	Harms nervous system and kidneys	Delirium, muscle weakness, lack of coordination, numbness in fingers and face, slurred speech, hearing loss	Minimal	Weakness and lack of coordination in arms and legs; difficulty talking and swallowing; permanent nerve and brain damage	Fungicides
54. Organotin	Irritant; harms brain, stomach, and intestines	Headache, vomiting, dizziness, convulsions, stomach pain	Irritates eyes, skin, and respiratory tract		Fungicides, antifouling paints
55. Cadmium	Irritant; harms lungs, kidneys, blood system, liver, and stomach and intestinal linings	Headache, cough, labored breathing, chest pain, nausea, vomiting, diarrhea, abdominal pain	Very irritating to respiratory tract	Harm to kidneys, liver, blood system, bone structure	Fungicides
56. Anilazine	Irritant; low systemic toxicity	Minimal	Irritates skin.		Fungicides
57. Cycloheximide	Low systemic toxicity				Fungicides
58. Dodine	Irritant; low systemic toxicity	Nausea, vomiting, diarrhea, harm to stomach and intestinal lining	Irritates skin and eyes		Fungicides
59. Iprodione, Metalaxyl, Terrazole, Thiabendazole, Triadimefon, Triforine	Slight irritants; low systemic toxicity	Minimal	Slightly irritating to eyes and skin		Fungicides
60. Coumarine, Indandiones, and other anticoagulants	Prevents blood from clotting	Minimal; blood in urine	Bleeding gums and nose		Rodenticides

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Pesticide
61. Yellow Phosphorous	Corrosive; highly toxic; harms heart, blood system, liver, brain, and kidneys	Breath has garlic odor; feces may glow and smoke; vomiting, diarrhea, lethargy, restlessness, irritability, burning pain in throat, stomach, and intestines.	Corrosive to skin, eyes, and mucous membranes		Rodenticides
62. Zinc Phosphide	Highly toxic; harms liver, kidneys, nervous system, heart. Severe respiratory and intestinal irritation	Intense nausea, stomach pain, excitement, chills, cough	Irritates skin and mucous membranes; very irritating to respiratory tract		Rodenticides
63. Thallium Sulfate	Harms nervous system, lungs, heart, blood vessels, kidney, liver, and lining of stomach and intestines	Stomach pain, nausea, diarrhea, salivation, headache, lethargy, tremors, muscle weakness	Minimal	Confusion, damage to nervous system, partial paralysis, damage to sight	Rodenticides
64. Sodium Fluoroacetate	Extremely toxic; harms heart and brain	Stomach pain, vomiting, hallucination, nervousness	Minimal		Rodenticides
65. Strychnine and Crimidine	Acts directly on cells in the brain and spinal cord	Blue skin color, violent convulsions	Minimal		Rodenticides
66. ANTU and Norbormide	Low systemic toxicity, except in huge doses				Rodenticides
67. Red Squill	Low systemic toxicity	Prompt vomiting and nausea			Rodenticides
68. Pyriminil	Very toxic; harms nervous system, brain, and area around the heart	Nausea, vomiting, diarrhea, stomach cramps, chills, confusion, weakness, chest pains	Minimal		Rodenticides

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Pesticide
69. Cholecalciferol	Harms liver, kidney, and heart tissue	Weakness, headache, nausea, excess thirst and urine			Rodenticides
70. Naphthalene	Irritant; harms kidneys and blood system	Headache, dizziness, nausea, vomiting	Irritates eyes and respiratory tract	Skin sensitizer	Rodenticides
71. Methylene Chloride	Harms stomach, intestines, liver, and kidneys	Fatigue, weakness			Fumigants
72. Methyl Bromide	Irritant; serious harm to lungs; harms nervous system	Coughing of frothy fluid; severe shortness of breath; drowsiness, shaking, weakness	Severe burns, itching, and blisters on skin	Lack of coordination, muscle weakness, confusion	Fumigants
73. Chloroform, Carbon Tetrachloride, Ethylene Dichloride	Irritant; harms liver and kidneys	Dizziness, loss of sensation and motor power, unconsciousness	Irritates respiratory tract		Fumigants
74. Ethylene Dibromide	Severe irritant; harms lungs, kidneys, and lining of stomach and intestine	Dizziness, headache, fatigue, cough, abdominal pain	Severely irritates respiratory tract. Corrosive to eyes and skin	Damage to male reproductive organs	Fumigants
75. Dibromochloropropane	Severe irritant; harms liver and kidneys	Headache, nausea, vomiting, slurred speech, confusion	Irritates skin, eyes, and respiratory tract	Sterility, eye damage	Fumigants

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Pesticide
76. Dichloropropene, Dichloropropane	Strong irritant; harms liver, kidneys, and heart tissue	Breathing spasms	Severely irritating to skin, eyes, and respiratory tract		Fumigants
77. Paradichlorobenzene	Irritant; low systemic toxicity	Minimal	Mildly irritating to nose and eyes		Fumigants
78. Ethylene oxide, Propylene Oxide	Irritant; harms lungs and heart	Headache, nausea, vomiting, weakness, cough of frothy, bloody fluid	Blistering and erosion to skin	Skin sensitizer	Fumigants
79. Formaldehyde, Paraformaldehyde	Irritant; harms kidneys, blood system, and lining of stomach and intestine	Asthma, abdominal pain	Irritates eyes and respiratory tract; hardens and roughens skin	Systemic sensitizer	Fumigants
80. Acrolein	Irritant; harms lungs, kidneys, blood system, and lining of stomach and intestine	Asthma, abdominal pain	Severely irritating to eyes and respiratory tract; blisters on skin		Fumigants
81. Sulfur Dioxide	Strong irritant to lungs and throat	Respiratory distress	Severely irritating to eyes, skin, and respiratory tract		Fumigants
82. Chloropicrin	Irritant	Vomiting, abdominal pain	Severely irritating to eyes, skin and respiratory tract		Fumigants
83. Sulfuryl Fluoride	Harms lungs and kidneys	Weakness, nausea, vomiting, cough, muscle twitch, convulsions	Irritates eyes, nose and throat	Harm to lungs and kidneys	Fumigants
84. Carbon Disulfide	Irritant; harms nervous system. Delayed harm to kidneys and liver	Dizziness, headache, nausea, and disorientation.	Irritates eyes, nose, and throat	Painful tingling and weakness in arms and legs; loss of mental functions; blindness, deafness, paralysis	Fumigants
85. Phosphine	Irritant; harms lungs, liver, kidneys, heart, and nervous system	Nausea, vomiting, dizziness, weakness, shaking, cough, difficulty in breathing, intense thirst	Mildly irritating to respiratory tract		Fumigants

Chemical Family	Action on Human System	Acute Systemic Effects	Irritation Effects	Delayed/Allergic Effects	Type of Pesticide
86. Hydrogen Cyanide, Acrylonitrile	Irritant; harms brain and heart tissues	Headache, nausea, constriction of throat, dizziness, nervousness, sudden unconsciousness			Fumigants, rodenticides
87. Methaldhyde	Harms stomach lining, kidneys, and liver.	Salivation, cramps, vomiting, tremors			Molluscicides
88. Aminopyridine	Disrupts nervous system functions	Thirst, nausea, dizziness, weakness, excessive sweating			Avicides
89. Calcium Cyanamide	Irritant	Flushing, headache, low blood pressure, difficulty breathing	Irritates skin; may be caustic to skin and severely irritating to mucous membranes		Fungicides, herbicides
90. Sodium Chlorate	Irritant; harms intestinal lining, nervous system, and kidneys	Swelling of mouth and throat; pain in esophagus, stomach and intestine; restlessness, nausea, vomiting, diarrhea	Irritates skin, eyes, and respiratory tract		Herbicides, defoliants
91. Creosote	Irritant; harms brain tissue, lining of stomach and intestine	Salivation, vomiting, abdominal pain, headache, dizziness, chills, convulsions	Severely irritates skin, eyes, and mucous membranes	Skin irritation, skin discoloration. Rarely gangrene and skin cancer	Wood preservatives, insecticides, disinfectants
92. Hexachlorobenzene	Irritant; low systemic toxicity; chronic systemic effects		Minimal	Injures liver and blood system	Fungicides
93. Pentachloronitrobenzene	Minimal			Possible skin sensitizer	Fungicides
94. Dichloran	Minimal				Fungicides
95. Chlorothalonil	Irritant		Irritates eyes, mucous membranes, and respiratory tract	Skin sensitizer	Fungicides
96. Chloroneb	Irritant		Moderately irritating to skin and mucous membranes		Fungicides
97. Benomyl	Low systemic toxicity			Skin sensitizer	Fungicides

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Appendix C - Answers to Chapter

Review Questions

Integrated Pest Management

1. Identify the pest to be sure you know exactly what the problem is.
2. Identification of the pest allows you to determine basic information about it, including its life cycle and the time that it is most susceptible to being controlled.
3. Prevention is keeping a pest from becoming a problem; suppression is reducing pest numbers or damage to an acceptable level; eradication is destroying an entire pest population.
4. B
5. Use of threshold information can improve your pest control strategy by helping you make a decision about when to begin management strategies.
6. C
7. Monitoring is important to many pest control strategies, because it helps determine if the threshold has been reached and whether control measures have been effective.
8. Integrated pest management utilizes all appropriate, economical strategies to manage pests and their damage to an acceptable level with the least disruption to the environment.
9. Pest management tactics may include: host resistance, biological control, cultural control, mechanical control, sanitation, and chemical (pesticide) control.
10. The failure of the pesticide to control the pest might have been caused by: pest resistance; choosing the wrong pesticide; misidentifying the pest; applying the wrong amount; or applying the pesticide incorrectly, including applying at the wrong time.
11. Pest resistance can be reduced by using integrated pest management and rotating the types of pesticides used.

Pesticides and Pesticide Formulations

1. B
2. Type of pests managed—examples: insecticides control insects, herbicides control weeds, fungicides control fungi.

Chemistry: inorganic or organic—examples: botanicals and microbials

Mode of action—examples: stomach poison, root inhibitor

Formulation—examples: emulsifiable concentrate, fumigant, dust,

3. The presence or absence of carbon. Organic pesticides contain carbon. Inorganic pesticides do not contain carbon.

4. False
5. E
6. C
7. To reduce the development of pest resistance to pesticides
8. D
9. You should think about the characteristics of each formulation, and you should consider which of the formulation's advantages and disadvantages are important in your application situation. Also, consider if you have the right application equipment, if the formulation can be safely applied, and if the formulation can reach the target pest and remain active long enough for effective control.
10. C
11. Finely ground active ingredients mixed with a liquid, along with inert ingredients, to form a suspension.
12. To increase their effectiveness or safety.
13. E

Laws and Regulations

1. B
2. D
3. C.
4. D.
5. True
6. Minnesota State Emergency Response Commission
7. True
8. B
9. 1) Private Applicators
2) Noncommercial Applicators
3) Commercial Applicators
4) Aquatic Applicators and Structural Pest Control Applicators
5) Structural Pest Control Applicators
10. A
11. True
12. True
13. A
14. C

The Pesticide Label

1. The label is the printed material attached to or on the product container. Labeling includes the label plus all other information you receive from the manufacturer about the product when you buy.

2. True

3. On the top of the first page of the label.

4. On the first page of the label in large letters.

5. CAUTION 4

WARNING 3

DANGER 2

POISON

and the

skull and

crossbones

[symbol] 1

6. True

7. 1) "Keep Out of Reach of Children"

2) Signal words

3) Routes of entry

4) Protective clothing and equipment

5) Safe handling precautions

6) First aid

7) Environmental hazards

8) Physical and chemical hazards

9) Reentry and restricted entry intervals

8. The time interval required between a pesticide's application and harvest.

9. Right after the signal words section.

10. CAUTION! 3

Imazethapyr 2

Pursuit 1

77.13.0% 4

11. False

12. C

13. A

14. False

15. D

16. 1) Long-sleeve shirt & long pants

2) Waterproof gloves

3) Shoes plus socks

Protecting the Applicator

1. Toxicity measures the capacity of a pesticides to cause injury. Hazard is the potential for injury.
2. True
3. False
4. Oral, Dermal, Eye, and Inhalation
5. D
6. D
7. 1 - A
2 - C
3 - D
4 - B
8. D

Safe Handling of Pesticides

1. Triple-rinse
Pressure-rinse
2. Collected and use again for use on a crop, plant, or site listed on the label or stored for mixing with future solutions of the same pesticide
3. 1) Record information relating to the pesticide application.
2) Wash yourself.
3) Clean all equipment used during the activities.
4) Return equipment to its designated place.
5) Safely store or dispose of all pesticide materials.
6) Be sure the work site presents no hazards to people or the environment.
4. B
5. F
6. True
7. 1) Locked
2) Separate building or area in a building
3) Located to avoid contamination of sensitive areas
4) Impermeable flooring
5) Fire-resistant
6) Well lit, well ventilated, and well insulated against extremes of temperatures
7) Use pallets or metal shelving
8) Have storage supplies on hand

8. 1) Detergent
2) Hand cleaner
3) Absorbent material to soak up spills
4) Shovel
5) Broom and dust pan
6) Fire extinguisher rated for ABC fires
9. Control the spill
Contain the spill
Clean up the spill
10. Minnesota Department of Public Safety, Division of Emergency Response In the Twin Cities: (612) 649-5451; In Greater Minnesota: 1-800-422-0798

Poison Control Center: West Metro area: (612)-347-3141; East Metro area and Greater Minnesota: (612) 221-2113 or 1-800-222-1222

Local emergency response: 911

Pesticide Safety Team Network (Chemtrek): 1-800-424-9300

11. A

12. D

Protecting the Environment

1. Environment is everything that surrounds us indoors and outdoors including natural elements, man-made objects, people, and other living organisms.
2. Point-source contamination comes from specific identifiable sources. Nonpoint-sources of contamination come from many, generally small sources over broad areas.
3. 1) Pesticide formulation
2) Droplet size
3) Evaporation rate
4) Temperature
5) Relative humidity
6) Height of pesticide application above the ground
7) Air movement
4. True
5. C
6. A
7. C
8. E
9. C
10. True

- 11.1) Impaired reproduction
 - 2) Impaired digestion
 - 3) Decreased resistance to disease
12. 1) Water runoff from pesticide treated fields or sites
 - 2) Through agricultural tile lines
 - 3) Soil erosion by wind or water
 - 4) Drift during application
13. B
14. 1) Sinkholes
 - 2) Where groundwater is close to the surface
 - 3) In or near surface water
 - 4) Near schools, playgrounds, and hospitals
 - 5) Near habitats of endangered species
 - 6) Near apiaries
 - 7) Near ornamental gardens, vegetable gardens, food or feed crops or other sensitive plantings
15. 1) Where people, especially children and pregnant women, the elderly or the sick live, work, or are cared for.
 - 2) Where food or feed is processed, prepared, stored or served
 - 3) Where domestic or confined animals live, eat, or are otherwise cared for.
16. 1) Depth to groundwater
 - 2) Amount of irrigation water or rainfall
 - 3) Geologic formations
 - 4) Tillage systems used
 - 5) Pesticide adsorption to soil
 - 6) Pesticide absorption to soil
 - 7) Microbial degradation
 - 8) Chemical degradation
 - 9) Photodegradation
 - 10) Pesticide water solubility
 - 11) Pesticide persistence
 - 12) Soil type

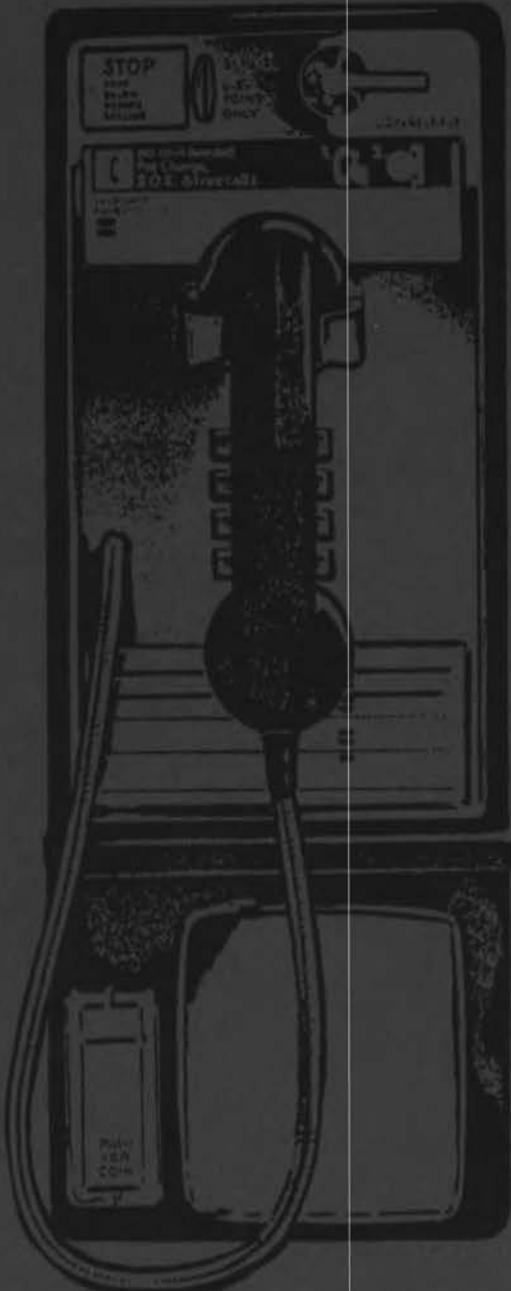
Chemigation

1. A
2. C
3. B
4. A
5. False
6. True
7. D



3 1951 D01 951 648 5

For
Emergency
Response or
Fire Call
911



**Pesticide Emergency
Telephone Numbers:**

To report pesticide spills:

The Minnesota Department of Public Safety, Division of Emergency Management (DEM), can be reached 24 hours a day. Ask the DEM to notify all appropriate state agencies for you, including the Minnesota Department of Agriculture.

Twin Cities call (612) 649-5451

Greater Minnesota call 1-800-422-0798

When you call to report a spill,
give the following information:

Your name;

Where you can be reached;

Where the spill is;

Type of pesticide;

What time the spill occurred;

The source of the spill;

How much material was spilled
(and for how long);

Whether the material is spreading; and

Nearby surface water or wells.

For spills involving large amounts of pesticide, highly toxic chemicals, or extensive contamination, additional information may be obtained by contacting the Pesticide Safety Team Network.

These experts are ready 24 hours a day to give advice on how to handle emergencies.

CHEMTRAC at 1-800-424-9300

Pesticide poisoning: Call the Poison Control Center for your area. They can provide quick information for treating victims of pesticide poisoning.

West (Twin Cities) Metro area
call (612) 347-3141.

East (Twin Cities) Metro area and
Greater Minnesota call (612) 221-2113
or 1-800-222-1222