Private Applicator
Reference Guide
Pesticide Safety Telephone Numbers

Nonemergency Telephone Numbers

National Pesticide Information Center  
6:30 a.m. to 4:30 p.m. PT, 7 days a week  
(800) 858-7378

Chemical Referral Center (weekdays only)  
(800) 262-8200

Emergency Telephone Numbers

Nebraska Regional Poison Center  
For aid in human poisoning cases  
(800) 222-1222

Nebraska State Patrol  
To report motor vehicle accidents  
(800) 525-5555
You’ve got work to do—to plant, to nourish, to grow, to enrich, to harvest, to feed.

You’re a doer, a producer, a scientist, an entrepreneur, a teacher, a game changer.

Undergraduate programs in Agronomy, Horticulture, Plant Biology, and Turfgrass & Landscape Management provide hands-on learning in research labs and out in the field, preparing you for a future where you can influence the world in powerful ways.

Here you will get personal attention at a Big Ten university and learn from faculty who work to feed and enrich the lives of a growing global population.

Contact Anne Streich to learn more about getting your start in the UNL Department of Agronomy & Horticulture.

Grow your story here and impact the world.

CONTACT ANNE STREICH
402-472-1640 or astreich2@unl.edu
agronomy.unl.edu/undergraduate

COLLEGE OF AGRICULTURAL SCIENCES
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agronomy.unl.edu facebook.com/unagrobart
NO DRIFT ZONE

driftwatch
Pesticide Sensitive Crops and Habitats Registry

www.driftwatch.org

Sign Up!

Driftwatch is an online registry that helps Nebraska pesticide applicators, specialty crop growers, and stewards of at-risk habitats communicate more effectively to protect pesticide-sensitive areas. It is maintained by the Purdue University Department of Agricultural and Biological Engineering. The Nebraska Department of Agriculture serves as data manager.

Driftwatch is not intended to be a registry for homeowners or sites less than half an acre.

For growers and stewards
Register your site so applicators know about your sensitive area and can plan to avoid it.

For applicators
Sign-up for automated email notification of grower locations in your area. Use the handy Google Maps™ interface to locate registered sensitive crops before you spray.

As the site grows, tools and training will be added to help stewards and applicators protect sensitive areas.
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Introduction

This reference guide contains publications of interest to private pesticide applicators. Along with the Guide for Weed Management EC130 (Weed Guide), use this reference guide to learn more about topics such as pesticide laws and regulations; pesticide safety; managing risk of pesticide poisonings; environmental protection, such as preventing drift and protecting nontarget species; reading pesticide labels; safe transport, storage, and disposal of pesticides; and calibration of application equipment.

Specifically, this reference guide contains University of Nebraska–Extension NebGuides, Extension Circulars, and other publications that provide detailed information about these topics. These publications complement and/or supplement information found in the Weed Guide. Together, these two resources provide the information needed for a private applicator to make informed decisions about pest management and to effectively and safety apply pesticides.

Pesticide Laws and Regulations

Several federal and state laws and regulations control the manufacture, labeling, use, storage, and handling of pesticides. These laws enable the appropriate agencies to manage the safety and effectiveness of pesticides that are put on the market and to regulate uses in ways that minimize harmful effects to humans, animals, and other life forms. The current pesticide laws and regulations are discussed in Pesticide Laws and Regulations, NebGuide G479 (located online at http://www.ianrpubs.unl.edu). Several important points are emphasized in the following sections.

Applications Allowed with A Private Pesticide Applicator License

To quote the Nebraska Pesticide Act, a private applicator is someone who “uses or supervises the use of any pesticide which is classified for restricted use for purposes of producing any agricultural commodity on property owned or rented by him or her or his or her employer or, if applied without compensation other than trading of personal services between producers of agricultural commodities, on the property of another person.”

This means that a private pesticide applicator license allows someone to purchase and apply restricted use pesticides (RUPs) as part of their agricultural production. The Nebraska Department of Agriculture (NDA) has interpreted agricultural commodity as broadly as possible in order to accommodate most farming operations and farm commodities, including non-food commodities such as commercial tree nurseries.

Where we draw the line is for RUPs that are labeled for uses that are not associated with production of agricultural commodities. For example, a private applicator may want to renovate a farm pond for personal fishing purposes or treat a home or barn for termites. If a RUP is used, the private applicator license is not the correct license to purchase or apply these pesticides. Below are two lists for reference. The first shows the types of RUP applications where a private applicator license is appropriate; the second list shows situations where it is not. If you have any questions about specific situations or chemicals, please call the NDA Pesticide Program toll-free at (877) 800-4080.

Examples of pesticides and uses for which a private applicator license is appropriate:

- Grain or other food crop production control of insects, weeds, or diseases
- Insect control on farm animals produced for meat or milk
- Stored grain fumigation
- Field borders, fencelines, or roadside ditch weed or insect control
- Control of moles, pocket gophers or prairie dogs in pastures and rangeland
- Fly control in feedlots, sewage lagoons, and confinement operations
- Non-food crops control of insects, weeds or diseases
- Noxious weed control in fields, pastures, rangeland and rights-of-way
- Control of insects, weeds, or disease in shelter belts or around the farmstead

Examples of pesticides and uses for which a private applicator license is NOT appropriate:

- Control of fish in farm ponds for recreational purposes
- Termite control in any structure
- Mosquito control, using any pesticide, for local communities
- Residential lawn care on/around farm homes
- Weed control in aquatic sites or irrigation canals
Supervision of Unlicensed Applicators

An unlicensed applicator may make restricted use pesticide (RUP) applications on behalf of a licensed applicator (private or commercial applicator) for a once-in-a-lifetime 60-day period, IF he/she completes a NDA application within 10 days of making the first application. Contact your local Extension office to obtain a NDA application form. Complete it and send it to NDA. The unlicensed applicator agrees to work under the direct supervision of a licensed applicator, and the supervisor agrees to provide verifiable on-the-job training and supervision. The two share in the liability for applications made.

Private Applicators and Payments for Services

Private applicators cannot receive payment for a restricted use pesticide (RUP) application done for a neighbor, but they can trade services such as hauling grain, baling hay, etc. in exchange for the RUP application.

Private Recordkeeping Requirements

In Nebraska, RUP application records must be maintained for three years from the date of application. The licensed applicator should retain these records and make them available for inspection by authorized representatives.

Your records must include the following:

- Brand/product name
- EPA registration number
- Total amount of RUP applied
- Crop/site treated
- Field location
- Acres treated
- Application date
- Name of certified applicator
- Certification number

Recordbooks entitled Field Records for Restricted Use Pesticide Applications and Crop Production Recordkeeping Booklet is available at your local Extension office. It contains more information on recordkeeping requirements and provides spaces for recording RUP applications as well as field operations, fertilizer applications, and irrigation. A sample record form is provided on the following pages; please photocopy and use it as you wish.

NOTE — NDA randomly inspects private RUP records each year. This may be your year!

Pesticide Recordkeeping App (PeRK)

The app is called “PeRK”, which is short for Pesticide Recordkeeping. It is a free app and will be a useful tool for anyone that applies any type of pesticides and uses mobile devices – smartphones and tablets, Android or Apple. Records are saved within the app on the mobile device and can be easily emailed to a recipient and saved on a computer.

The free app is available from the Google Play store at bit.ly/GQ468v or Apple App store at bit.ly/1glffWz.
Recordkeeping Agreement between Commercial Applicator and Farmer

A commercial pesticide applicator may hold the records of RUP applications on behalf of a customer if an informal agreement signed by both parties is on file at the business office. It is not a formal contract. The agreement, once signed by both parties, may be kept indefinitely. The RUP records must be kept for a minimum of three years from the date of the pesticide application.

An example of an agreement follows. Please write the name of the business in the appropriate place. The agreement must be made available to a Nebraska Department of Agriculture pesticide inspector upon request.

-----------------------------------------------------------------------------------------------------------------------------------------------------------
Date _________________

As a commercial pesticide applicator, ________________________________(Custom Applicator Business) is holding records of restricted use pesticide applications applied on behalf of _____________________________________________ (Customer).

Signed___________________________________________

Signed______________________________________________

Custom Applicator Business    Customer

Date_____________________________________________

Date________________________________________________

-----------------------------------------------------------------------------------------------------------------------------------------------------------
Private Applicator Record of Restricted Use Pesticides  
(Retain record for three years after application)

**USDA REQUIREMENTS:**

If spot treatment (less than 1/10 acre) application is made, write “spot” in “Field size”.

Name of applicator ____________________________________________  Applicator certification # ________________________

Application date ____________________________________________  Crop, commodity, or site protected ______________

Pesticide brand/product name __________________________________  Pesticide EPA registration # _______________________

Total amount of restricted use pesticide applied ________________________  Field size _________________________

Restricted-entry interval (REI) ________________________

**Field location** (choose one of four below):

County/range/township/section

ASCS/SCS ID system __________________________________________

Legal property description ______________________________________

ID system using map and/or written description ______________________

Notes_______________________________________________________________
___________________________________________________________________
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Field Map

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Optional Information:

Application starting time ________________________  Temperature ______________________

Crop stage of growth ________________________  Wind direction and speed ______________________

Target pest ________________________  Soil conditions (wet, dry, cloddy, etc.) ______________________

Pest stage of growth ________________________  Relative humidity (low, med., high) ______________________

*Records of restricted use pesticide applications can be kept in any format. They may be handwritten on individual notes or forms, consist of invoices, be computerized, and/or be maintained in recordkeeping books. Certified commercial applicators must provide their record of a restricted use pesticide application within 30 days to the person for whom such an application was provided. They may provide a copy of records required by this Federal Register notice or a copy of their State/Federal record.*

*SOURCE: Pesticide Education Office, University of Nebraska–Lincoln*
Rodenticide Regulation Changes

After fully assessing human health and ecological effects, as well as benefits, EPA is announcing measures to reduce risks associated with ten rodenticides: brodifacoum, bromadiolone, bromethalin, chlorophacinone, cholecalciferol, difenacoum, difethialone, diphenacoum, warfarin, and zinc phosphide.

New safety measures announced by the U.S. Environmental Protection Agency will protect children from accidental exposure to rodent-control products. Also these measures will reduce the risk of accidental poisonings of pets and wildlife. With the EPA’s risk mitigation measures in place, rodenticide products will be safe, effective, and affordable for all consumers.

Rodenticide Safety Concerns – Rodenticides are important products for controlling mice, rats, and other rodents that pose threats to public health, critical habitats, native plants and animals, crops, and food supplies. However, these products also present human and environmental safety concerns.

Differences Among the Rodenticides – The ten rodenticide active ingredients can be divided into three categories:

- **first-generation anticoagulants**: warfarin, chlorophacinone, and diphenacoum;
- **second-generation anticoagulants**: brodifacoum, bromadiolone, difenacoum, and difethialone; and
- **non-anticoagulants**: bromethalin, cholecalciferol, and zinc phosphide.

The second-generation anticoagulants are especially hazardous for several reasons. They are highly toxic, and they persist a long time in body tissues. The second-generation anticoagulants are designed to be toxic in a single feeding, but since time-to-death is several days, rodents can feed multiple times before death, leading to carcasses containing residues that may be many times the lethal dose. Predators or scavengers that feed on those poisoned rodents may consume enough to suffer harm.

Second-Generation Anticoagulant Products for Use Around Agricultural Buildings

- Products must contain at least eight pounds of bait.
- Bait stations are required for all outdoor, above-ground placements of second-generation anticoagulant products.
- Bait stations are required indoors if exposure to children, pets, or non-target animals is possible.
- Product labels must indicate that the product is for use only in and around agricultural buildings and that use in residential use sites is prohibited.
- Distribution to and sales in “consumer” stores including grocery stores, drug stores, hardware stores, and club stores will be prohibited.

For more information about the use of non-anticoagulants, see *Prairie Dogs and Their Control*, NebGuide G1476.
Pesticide Laws and Regulations

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This NebGuide provides general information on federal and state laws and regulations regarding pesticide applicator certification, licensing, and pesticide use in Nebraska.

A succession of federal laws has addressed pesticides and their use in the United States. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was first approved in 1947 and has undergone several revisions. FIFRA and the Nebraska Pesticide Act, which was enacted in 1993, are the principal statutes governing the use of pesticides in Nebraska. Additional state laws governing the use of pesticides in irrigation water and facilities handling bulk pesticides are administered by the Nebraska Department of Environmental Quality.

FIFRA

Congress intended FIFRA to protect both people and the environment by providing for the controlled use of pesticides. The law encompasses pesticide registration, classification, labeling, distribution, use, disposal, and other topics. Those sections pertaining to pesticide users broadly address key issues: user categories, recordkeeping, certification, and penalties for violations.

General Provisions

FIFRA requires pesticide manufacturers to register each of their products with the U.S. Environmental Protection Agency (EPA) either as a general use (GUP) or restricted use (RUP) pesticide with the exception of a few minimum-risk active ingredients. In some cases, a pesticide’s active ingredient may be used in both general and restricted use pesticides.

Restricted use pesticides can be used only by certified applicators (or noncertified individuals working under the direct supervision of a certified applicator during a once-in-a-lifetime, 60-day exemption from licensing). In most cases, anyone can use general use pesticides according to the label without being certified. FIFRA defines two types of certified applicators: private applicators and commercial applicators. The Nebraska Pesticide Act further defines noncommercial applicators in order to address those individuals who do not commercially apply pesticides, and do not meet the definition of private applicator.

From a FIFRA perspective, a private applicator is defined as a certified applicator who uses or supervises the use of a restricted use pesticide to produce an agricultural commodity on property he or she owns or rents, on an employer’s property, or on the property of another person if there is no compensation other than trading personal services.

FIFRA defines a commercial applicator as any person who uses or supervises the use of restricted use pesticides for any purpose other than as provided in the definition of a private applicator.

Federally registered product labels contain sections that address personal protection; protection of others; and protection of sensitive sites, such as groundwater, surface water, and endangered species. Some pesticide labels direct an applicator to protect endangered species (plant or animal) as per an online bulletin. The online bulletin is considered a legal extension of the container label and must be followed.

Nebraska Pesticide Act and Regulations

The Nebraska Pesticide Act was enacted in 1993. It designates the Nebraska Department of Agriculture (NDA) as the lead state agency responsible for administering the Nebraska Pesticide Act under FIFRA and gives several other state agencies specific responsibilities. The Act requires registration of pesticides sold in Nebraska and state certification and licensing of those wishing to purchase and use any restricted use pesticide and, in certain situations, general use pesticides. It identifies the University of Nebraska Lincoln—Extension as responsible for providing training for private, commercial, and noncommercial applicators. People who attend these training sessions are considered competent to apply pesticides and are certified. Once certified, each must become licensed to purchase and use restricted use pesticides, and in some cases, general use pesticides.
Nebraska’s pesticide law and related regulations differ from that of FIFRA in several aspects. One difference is that in Nebraska, a pesticide license is required for applicators and mixer/loaders of all restricted use pesticides, although the NDA has allowed mixer/loaders to operate without licensing so long as they complete NDA-developed training every three years and document they took the training. The application of general use pesticides by a commercial applicator in the Ornamental and Turf, and the Structural categories requires a pesticide license, as does outdoor disease vector control in the Public Pest Control category. Under the Nebraska Pesticide Act, people wishing to be licensed as private applicators are not required to take an examination. It also stipulates that the minimum age for licensing is 16. Custom farmers are classified as commercial pesticide applicators.

Nebraska law also creates a type of pesticide applicator called noncommercial applicator. This type includes any person who applies RUPs “... only on lands owned or controlled by his or her employer or for a governmental agency or subdivision of the state.” In addition, any employee of a political subdivision of the state applying GUPs or RUPs for outdoor vector control must obtain a license in the Public Health category prior to applying such pesticides and are classified by NDA as noncommercial applicators. A pesticide applicator applying pesticides for hire on behalf of a governmental agency must be classified as a commercial applicator in the Public Health category.

All pesticide applicator licenses are good for a maximum of three years unless revoked by NDA. In order to renew a license, a state license fee must be paid to the NDA by private and commercial applicators before the license expires. Nebraska’s law and regulations set the fee for commercial applicators at $90 and $25 for private applicators. This fee is payable to the NDA and must be paid before the license is granted in order to purchase and use restricted use pesticides or general use pesticides as identified above. There is no state license fee for noncommercial applicators.

Pesticide Applicator Licensing

People seeking initial certification (a prerequisite of licensing) as commercial or noncommercial pesticide applicators in Nebraska can attend training provided through UNL Extension and/or complete self-study training materials. In either case, the candidate must successfully pass both a general standards core exam and one or more specific category examinations. These exams are proctored by the NDA, not UNL. A pesticide license is valid for three years. To become recertified and then eligible to pay the state license fee to obtain the pesticide license, the person must attend either a UNL Extension recertification training program or an equivalent training program approved by NDA. A person wishing to recertify by training must attend training before the license expires. Any applicator also may recertify by examination.

To become certified as a private applicator, individuals can:

1. Complete an approved training program provided by UNL Extension.
2. Complete a self-study workbook or an online training program provided by UNL Extension.
3. Voluntarily complete and pass an examination administered by the NDA.

Then, the private applicator is eligible to pay the state license fee to obtain the pesticide license. The same options also apply to recertification, which is required every three years.

Commercial and Noncommercial Pesticide Applicator Categories

1. Agricultural Pest Control — Plant
2. Agricultural Pest Control — Animal
3. Forest Pest Control
4. Ornamental and Turf Pest Control
5. Aquatic Pest Control
6. Seed Treatment
7. Right-of-way Pest Control
8. Structural/Health Pest Control
9. Public Health Pest Control
10. Wood Preservation
11. Fumigation
12. Aerial Pest Control (includes Ag Pest Control Plant category)
14. Wildlife Damage Control

Two subcategories (Regulatory and Demonstration/Research) expand the scope of an applicator’s primary category(ies) such as Agricultural Pest Control (1 or 2) or Ornamental and Turf Pest Control (4). The Wildlife Damage Control category (14) covers the chemical control of ver-tebrate pests such as prairie dogs in pastures or rangeland, coyotes in pastures/holding pens, moles and ground squirrels in lawns/parks/golf courses, etc., when using RUPs. The management of vertebrate pests invading structures with pesticides is covered by the Structural/Health Pest Control category (8).

Direct Supervision

In general, a person must be licensed to use a restricted use pesticide. An individual required to be licensed may use such pesticides as an unlicensed applicator for a period of up to 60 consecutive days beginning on the first date of the pesticide application. The 60-day exemption is allowed once in that applicator’s lifetime. In order to use pesticides as an unlicensed applicator, the individual or his or her employer must apply to NDA for an applicator license within 10 days of making the first pesticide use. Both the licensed and unlicensed applicator are liable for any violations. The licensed applicator, as a supervisor, must possess the correct license category for the work being done and must do the following:
8. Rate of pesticide applied per unit of measure, i.e., pounds, must be provided to the grower prior to the application.

9. Total amount of pesticide applied.

10. Area or size of treated site, i.e., acres, cubic feet, square feet, linear feet, crack and crevice, trap or bait placement, or spot treatment.

11. Method of disposal of any unused, diluted pesticide. If no unused pesticide remained, indicate such.

For the protection of the grower, his/her family, and employees, application information for any agricultural pesticide, including the restricted entry interval (REI) and personal protective equipment (PPE) required for applicators, must be provided to the grower prior to the application.

Application records of RUPs custom applied for a grower either must be provided to the grower within 30 days or held on behalf of the grower.

Licensed commercial applicators can hold the records of restricted use pesticide applications for their clients as long as the client has signed a statement stipulating who is holding the records. Commercial applicators should provide their clients with a copy of the signed statement. Commercial applicators must make these application records available to their clients upon request in a timely manner and maintain separate records for each client.

**Recordkeeping Requirements — Commercial and Noncommercial Applicators**

Nebraska Department of Agriculture regulations require commercial and noncommercial applicators of restricted use pesticides and commercial applicators applying general use pesticides for structural pest control to record the following:

1. Name and address of the person for whom the pesticide was applied.
2. Name, address, and pesticide license number of the person making the application. If an unlicensed person makes the application, information must be recorded both for that person and the supervising applicator.
3. Location of pesticide application.
4. Specific name of target pest(s), i.e., insect, weed, or disease.
5. Application site, i.e., name of crop or commodity, type of field, type of surface, etc.
6. Day, month, year, and time of application.
7. Trade name and EPA registration number of the pesticide applied.
8. Rate of pesticide applied per unit of measure, i.e., pounds per acre, ounces per 1,000 square feet, etc. For spot treatment, indicate mixture rate.
9. Total amount of pesticide applied to site.
10. Area or size of treated site, i.e., acres, cubic feet, square feet, linear feet, crack and crevice, trap or bait placement, or spot treatment.
11. Method of disposal of any unused, diluted pesticide. If no unused pesticide remained, indicate such.

NDA regulations further recommend that wind speed and direction be recorded along with ambient air temperature, and where applicable, soil, grain, and water temperature. It also is recommended that commercial applicators applying general use pesticides for lawn care purposes keep pesticide application records. Information for each commercial or noncommercial pesticide application must be recorded within 48 hours of the application and kept for a minimum of three years. They may be kept in any format.

For the protection of the grower, his/her family, and employees, application information for any agricultural pesticide, including the restricted entry interval (REI) and personal protective equipment (PPE) required for applicators, must be provided to the grower prior to the application.

Since NDA regulations do not specify a time limit for record preparation, federal standards are applied. Therefore, private applicators in Nebraska must prepare RUP application records within 14 days after the application and must maintain them for a minimum of three years. Applicators can keep required RUP records in any format.

**Recordkeeping Requirements — Private Applicators**

Private applicators shall maintain records for a period of three years of each restricted use pesticide application and must include the following:

1. Brand or product name and EPA registration number of the pesticide applied.
2. Total amount of pesticide applied.
3. Location of application; size of area treated; and the crop, commodity, stored product, or site to which a pesticide was applied. Location may be recorded using any of the following designations:
   a. County, range, township, and section.
   b. An accurate identification system using maps and/or written descriptions.
   c. An identification system established by a USDA agency such as the Farm Service Agency or the Natural Resource Conservation Service (with maps or a field numbering system).
   d. The legal property description.
4. Month, day, and year of application.
5. Name and certification number of licensed applicator who made or supervised the application.

**Spot treatments — Recordkeeping**

Restricted use pesticide applications made on the same day in a total area of less than 1/10 of an acre are considered spot treatments. For these applications, the records must include:

1. Brand or product name and EPA registration number.
2. Total amount applied.
3. Location noted as “spot application” with a concise description of location and treatment; for example, “Spot application, noxious weeds were spot sprayed throughout fields 5 and 6.”
4. Month, day, and year of the application.

Since NDA regulations do not specify a time limit for record preparation, federal standards are applied. Therefore, private applicators in Nebraska must prepare RUP application records within 14 days after the application and must maintain them for a minimum of three years. Applicators can keep required RUP records in any format.
Access to RUP Application Records

Related sections of FIFRA and the Nebraska Pesticide Act give NDA the authority to inspect private, commercial, and noncommercial applicator records and establishments. Attending licensed health care professionals or those acting under their direction, USDA representatives and state regulatory representatives with credentials have legal access to the records. Authorized people can copy the records, but the licensed pesticide applicator must retain the originals.

Recordkeeping Requirements — Distributors/Dealers

The Nebraska Department of Agriculture requires sellers of RUPs to hold a Nebraska pesticide dealer’s license and to be registered with the NDA. Dealers who distribute RUPs must keep a record of each transaction involving an RUP for three years. These records must be made available for inspection upon request by NDA or EPA. NDA regulations require that such records include:

1. Name and address (residence or principal place of business) of the person to whom the RUP was made available. No dealer may make an RUP available to an unlicensed person unless he/she can document that the distribution is to a licensed dealer or the RUP will be used by a certified/licensed applicator.
2. The name and address (residence or principal place of business) of the licensed applicator or dealer who will use the RUP, if different from Section 1 above.
3. The number on the person’s license or dealer license number, the state that issued the applicator certificate, expiration date, and the category of certification, if applicable.
4. The product name, EPA registration number, and if applicable, the state special local needs (SLN) registration number on the pesticide label.
5. The quantity of pesticide sold.
6. The transaction date.

Whenever an unlicensed person is making the purchase, EPA recommends that dealers also examine one of the following at the time of sale:

1. The original of the pesticide applicator’s license and the driver’s license or other identification of the person for whom the buyer is purchasing the RUP.
2. A photocopy or other facsimile of the applicator’s license, a signed statement from the licensed applicator authorizing the purchase, and proper identification of the buyer.

3. A photocopy or other facsimile of the applicator’s license, a copy of a signed contract or agreement between the applicator and the purchaser that provides for the proper use of the restricted pesticides, and the proper identification of the buyer.

Violations and Penalties

NDA’s pesticide regulations specify a broad range of actions for violations of the Nebraska Pesticide Act. Administrative fines imposed for violations are established using a system of base fines that are adjusted in accordance with the gravity of the offense and the business size. Base fines range from $1,000 to $2,500, depending on the nature of the violation. Base fines for subsequent violations range from $2,000 to $5,000, again depending on the violation.

Gravity adjustments are made using numerical factors that increase the seriousness of the violation. The cumulative total of the “gravity values” is used to determine the percentage of base value that will be assessed for a violation. Size of business also is considered in setting the penalty amount. The Nebraska Pesticide Act also includes civil penalties for criminal or repeat intentional violations. These penalties have a maximum of $15,000 for each violation.

Resources

University of Nebraska–Lincoln Pesticide Safety Education Program, http://pested.unl.edu
Nebraska Department of Agriculture Pesticide Program, http://www.agr.ne.gov/pesticide/

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Index: Pesticides, General Regulations
1979, 2002-2007, Revised April 2013
Worker Protection Standard for Agricultural Pesticides

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This NebGuide describes the Worker Protection Standard, helps you, the owner or operator of an agricultural operation, determine if it applies to your business, and provides information on how to comply with it.

The U.S. Environmental Protection Agency (EPA) issued the Worker Protection Standard (WPS) to protect employees working on agricultural establishments from exposure to agricultural pesticides, both general and restricted use. Similar to OSHA (Occupational Safety and Health Administration), WPS strives to provide employees with a safe workplace, with the obligation for safety falling on the employer. WPS requires employers to protect two types of agricultural employees: agricultural workers and pesticide handlers (see definitions below). WPS is part of the pesticide label and is enforceable when a pesticide with a label that references WPS is used to produce an agricultural crop or commodity.

An EPA manual, How to Comply with the Worker Protection Standard for Agricultural Pesticides—What Employers Need to Know provides detailed information about WPS. Employers will find this manual to be a valuable resource for compliance. The manual is available in paperback or CD format from the Nebraska Department of Agriculture (NDA) at no cost, or can be viewed online at www.epa.gov/agriculture/htc.html.

Understanding key terms used in the WPS is important for compliance. Here are definitions for some key terms.

- **Agricultural establishment** — any farm (including vineyard), forest, nursery, sod farm, or greenhouse.
- **Agricultural owner** — any person who possesses or has interest (fee, leasehold, rental, or other) in an agricultural establishment.
- **Agricultural plants** — crops or plants grown or maintained for commercial or research purposes. Examples include food, feed, or fiber plants; trees; turfgrass; flowers; shrubs; ornamentals; and seedlings. Horticultural plants grown for future transplant are included.
- **Agricultural workers** — those who perform tasks related to the cultivation (pruning, rouging, detasseling, etc.) and harvesting of plants or crops on agricultural establishments who may work in areas where pesticide residues are present.
- **Pesticide handlers** — those who mix, load, and apply agricultural pesticides; clean or repair pesticide application equipment; or may have direct contact with concentrated pesticides or tank mixes.
- **Crop advisors** — those who assess pest numbers or damage; pesticide distribution; or the status, condition, or requirements of agricultural plants. Crop advisors include crop consultants, crop scouts, and integrated pest management (IPM) monitors.
- **Immediate family** — includes spouse, children, step children, foster children, parents, stepparents, foster parents, brothers, and sisters. It does not include nieces and nephews.

**WPS Labeling**

All pesticide products affected by the WPS carry a statement in the Agricultural Use Requirements section on the label. This statement informs users that they must comply with all WPS provisions. If you are using a pesticide product with WPS labeling to produce an agricultural commodity, you must follow WPS requirements. WPS requirements are not in effect if an agricultural pesticide is used as labeled for a nonagricultural use.

**Who Are the Affected Employers?**

Examples of employers who may be required to follow WPS are listed below.

- Managers or owners of an agricultural establishment
- Labor contractors for an agricultural establishment
- Custom pesticide applicators
- Crop consultants hired by the owner of an agricultural establishment

Most provisions of the Worker Protection Standard are protections that employers must provide to their employees and, in some instances, to themselves. The task being performed will determine whether or not an employee is a worker or handler, and will determine the amount of protection the employer must provide. Owners of agricultural establishments and their immediate families are exempt from many, but not all, of the WPS requirements (refer to the How to Comply with the Worker Protection Standard for Agricultural Pesticides—What Employers Need to Know manual, listed in the Resources section, for details).
Requirements of Agricultural Owners, Their Families and Those Hired to Work on the Agricultural Establishment

1. Wear appropriate personal protective equipment (PPE)
   The personal protective equipment and other work attire required for each pesticide are listed on the pesticide label for the tasks being performed. The required equipment for a specific pesticide is listed under the Hazards to Humans section on the label. These requirements may be different for applicators and mixer/handlers. If an applicator is using a closed system or working in an enclosed cab, some protective equipment exceptions are allowed unless expressly prohibited by the product labeling. Required equipment must be within the cab, however, to protect the person if the rig were to break down. Always use the PPE listed on the label. Refer to the How to Comply manual for additional details.

2. Restrictions during pesticide applications
   During the application of pesticides, handlers and/or their employers must make sure that:
   - All label requirements are followed,
   - Pesticides are applied so that they do not contact anyone either directly or through drift, and
   - Everyone is kept out of treated areas during the treatment.
   In most cases, handlers who have been trained and wear the appropriate personal protective equipment are allowed to be in treated areas.

3. Restrictions during restricted entry intervals (REIs)
   WPS has established specific restricted re-entry intervals for all pesticides covered by the Standard. The restricted entry interval (REI) is the amount of time that must pass after a pesticide application before anyone may enter the treated area. The amount of time required is based on the toxicity of the compound and the tasks involved during the product’s use. In most cases, REIs are in 4-, 12-, 24-, 48-, and 72-hour intervals. When the pesticide formulation or application is a mixture of active ingredients, the REI is based on the active ingredient that has the longest restricted re-entry period. During the REI, do not enter or allow any members of your family or hired handlers or workers to enter a treated area or contact anything treated with the pesticide(s) to which the interval applies.

   Basic Duties of Employers of Pesticide Handlers and Agricultural Workers

   Some of the WPS requirements for employers are the same whether the employees are workers or handlers. The following are descriptions of some requirements.

   Information at a central location. Employers must provide current and specific information about the pesticides being applied for the benefit of their employees, whether they are handlers or workers. The following information must be displayed and made accessible at a central location on the agricultural establishment where it can be seen and read easily.
   - WPS Safety Poster
   - Name, address, and telephone number of the nearest emergency medical facility
   - Facts about each pesticide application, including:
     1) Product name
     2) EPA registration number and active ingredients,
     3) Location and description of the treated areas,
     4) Time and date of the application, and
     5) Restricted entry interval (REI) for the pesticide.

   Employers must tell workers and handlers where the information is posted and allow them access. Posted information must be kept legible and current.

   Pesticide safety training. Unless handlers and workers are state-certified pesticide applicators or possess valid EPA-approved training validation cards, the employer must provide safety training before employees begin work. Training may be conducted by a certified pesticide applicator or by someone who has completed a train-the-trainer program. The training must be conducted in a manner and language that the employees can understand, using EPA-approved training materials or the equivalent. The trainer also must be on hand and able to answer questions after the training. The NDA stocks a variety of WPS training materials for both workers and handlers that are offered at no cost to agricultural employers.

   Decontamination supplies. Employers must provide supplies so that workers and handlers can wash pesticides or their residues from their hands and bodies. Accessible decontamination supplies must be located within a quarter mile of all workers and handlers and must include:
   - Enough water for routine and emergency whole-body washing and eye flushing (about 1 gallon for each worker and 3 gallons for each handler),
   - Plenty of soap and single-use towels, and
   - A clean change of coveralls for use by each handler (this is not required for workers).

   Water for emergency eye flushes must be immediately available if the pesticide label calls for protective eyewear. Employers also must provide water that is safe and cool enough for washing, eye flushing, and drinking. Employers may not use tank-stored water that also is used for mixing or diluting pesticides.

   Employers must provide handlers with the previously mentioned supplies at each mixing site and at the place where protective equipment is removed at the end of a task. Worker decontamination supplies must not be located in areas being treated or under an REI. Supplies for handler decontamination may be in the treated area in which the handler is working, as long as the materials are stored in sealed containers.

   Nurseries and greenhouses. There are many special requirements for greenhouse and nursery owners or operators. These include special application restrictions, ventilation criteria, early entry restrictions, and additional handler protection. Consult the EPA How to Comply manual, the Worker Protection Standard in Greenhouses video on the UNL Extension PSEP YouTube channel (http://bit.ly/NnPQQM), and the pesticide label for specifics.

   Additional Duties for Employers of Workers

   Restrictions during application. Employers must prohibit worker entry into treated areas. Only handlers who have had the appropriate training and are wearing the required equipment may enter the area during application. See the EPA How to Comply manual for special restrictions for employees who work in nurseries or greenhouses.

   Restrictions after applications. Employers must notify workers about pesticide applications on the establishment and the product’s REI if workers will be on or within a quarter mile of the treated area. In most cases, employers may choose between oral warnings or posted warning signs concerning the REI. In either case, employers must tell workers which warning method is being used. Some pesticide labels may require both oral and posted sign warnings. All notifications regarding greenhouse applications must be posted.
Employers must inform them of all handling tasks, any handling tasks, EPA publication, of key elements to keep in mind. Recognize, prevent, and treat heat illness. There are a number of heat illness, especially while PPE is being worn. Train handlers to wear or take home any used personal protective equipment. Make sure respirators fit correctly. They must make sure PPE is worn and used correctly, and make sure that equipment used for mixing, loading, transferring, or applying pesticides is inspected and repaired or replaced as needed. Only appropriately trained and equipped handlers may repair, clean, or adjust pesticide-handling equipment that contains pesticides or pesticide residues.

Personal protective equipment. Employers must provide handlers with the personal protective equipment required by the pesticide labeling for each task. They also must provide handlers with a pesticide-free work area for storing personal clothing, as well as for changing into and out of personal protective equipment for each task. Employers must not allow any handler to wear or take home any used personal protective equipment. They must make sure PPE is worn and used correctly, and make sure respirators fit correctly.

Employers must take steps to avoid heat illness. Employers must take necessary steps to help employees prevent heat illness, especially while PPE is being worn. Train handlers to recognize, prevent, and treat heat illness. There are a number of key elements to keep in mind.

- Drink enough water to replace body fluid lost through sweating.
- Gradually adjust to working in the heat.
- Take periodic breaks in a shaded or air conditioned area whenever possible.
- Supervisors should monitor environmental conditions and workers.

More details about heat illness are available from the EPA publication, A Guide to Heat Stress in Agriculture (EPA 750-B-92-001).

PPE cleaning and maintenance. The employer must make sure that:

- PPE to be reused is cleaned, inspected, and repaired before each use or replaced as needed;
- PPE that is not reusable or cannot be cleaned is disposed of properly; and
- PPE should be washed, hung to dry, and stored separately from personal clothing and away from pesticide areas.

Replacing respirator purifying elements. Dust/mist filters must be replaced when breathing becomes difficult, if the filter is damaged or torn, when the respirator label or pesticide label requires it, or at the end of each day’s work period in the absence of any other instructions. Cartridges or canisters designed to remove vapors must be replaced when odor, taste, or irritation is noticed; when the respirator label or pesticide label requires it; or at the end of each day’s work period in the absence of any other instructions.

Disposal of PPE. Discard coveralls and other clothing that are heavily contaminated with an undiluted pesticide having a DANGER or WARNING signal word, according to directions on the pesticide label. Federal, state, and local laws must be followed when disposing of PPE that cannot be cleaned correctly.

Instructions for people who clean personal protective equipment. Employers must inform people who clean or launder personal protective equipment that it may be contaminated with pesticides. They must inform them of the potentially harmful effects of exposure to pesticides and show them how to protect themselves and how to clean the equipment correctly. Further information is available in the EPA How to Comply manual.

Employer/Commercial Applicator Information Exchange

To protect the agricultural owner/operator and his or her family, a commercial applicator must inform an agricultural owner/operator before a pesticide is applied on the agricultural establishment. The commercial applicator must provide the owner/operator with the following information.

- Location and description of area to be treated
- Time and date of application
- Product name, EPA registration number, active ingredients, and REI
- Whether postings at the treated area and/or oral warnings are required
- Entry restrictions and other safety requirements for workers or other people

The owner/operator is responsible to share the above information with members of his/her immediate family.

If owners of agricultural establishments hire people to perform worker or handler activities, such as commercial applicators, or hire a contract employer, such as a detasseling company, the agricultural owner/operator must inform hires of any treated areas under an REI if they will be at or walk within a quarter mile of that area. The agricultural owner/operator is responsible for providing all WPS protections for his/her employees. If the operator of an agricultural establishment hires a contract employer, that contract employer is responsible for providing all WPS protections to his/her employees.

Emergency medical assistance. When there is a possibility that a handler or worker has been poisoned or injured by a pesticide, an employer must promptly provide transportation to an appropriate medical facility. Information about the medical facility must be posted at a central location. In addition, the employer must provide the victim and medical personnel with the following information.

- The product name, EPA registration number, and active ingredients (listed on the label and posted at the central location)
- All first aid and medical information from the label
- A description of how the pesticide was used
- Information about the victim’s exposure
Exemptions

The WPS does not cover pesticides applied:
• On pastures, rangeland, or livestock;
• On the harvested portions of plants or on harvested timber;
• For control of vertebrate pests, such as rodents;
• On plants grown in home gardens and home greenhouses;
• On plants that are in golf courses (except those areas set aside for plant production) or right-of-way areas;
• On public or private lawns, although sod farms are covered by the WPS;
• On plants intended only for decorative or ornamental use, such as trees and shrubs in lawns;
• For mosquito abatement, or similar wide area public pest control;
• For structural pest control, such as termite control; or
• For research uses of unregistered pesticides.

Agricultural Owner Exemptions

Owners of agricultural establishments and members of their immediate family are exempt from some of the WPS requirements while performing tasks related to the production of agricultural plants on their own establishment. The following WPS requirements do not need to be met by owners or members of their immediate family but must be provided to any worker or handler they may hire.
• Pesticide information at a central location
• Pesticide safety training
• Decontamination sites
• Emergency assistance
• Notice about pesticide applications
• Monitoring of handler’s actions and health
• Specific handling instructions
• Duties related to early entry: training and instructions and decontamination sites
• All the specific duties related to the need, use, management, and inspection of personal protective equipment

Exceptions to REIs

In general, you, your family members, hired handlers, and hired workers must stay out of a treated area during the restricted entry interval. This restriction has two exceptions:
• Early entry with no pesticide contact; or
• Early entry with contact for short-term, emergency, or specially exempted tasks.

No contact early entry means just that: no contact! You, your family members, hired handlers, or hired workers may enter a treated area during an REI if no one will touch or be touched by any pesticide residues, and if the required early entry personal protective equipment is worn. There must not be any exposure to pesticides or residue, even if PPE is worn.

Early entry with contact allows you, members of your family, hired handlers, or hired workers to enter a treated area during a restricted entry interval in only three work situations.

1. Short-term tasks that last less than one hour per 24-hour period and do not involve hand labor
2. Emergency tasks that take place because of an agricultural emergency recognized by the Nebraska Department of Agriculture
3. Specific tasks approved by EPA through a formal exception process.

For early entry short term tasks with no hand labor, one must:
• Wait at least four hours after the pesticide application is completed before entering,
• Enter and work for only one hour during a 24-hour period,
• Wear the personal protective equipment specified on the pesticide label for early entry tasks, and
• Follow any other restrictions specified on the pesticide label or in any special exception under which the early entry takes place.

Crop Advisor Exemptions

Crop advisors are exempt from many WPS provisions in Nebraska if they have met the pesticide safety training requirements. To meet the training requirement, they must either be state-certified pesticide applicators or receive approved WPS pesticide handler training.

As pesticide handlers under the WPS, crop advisors or those under their direct supervision may enter treated areas during pesticide application and the REI if they follow the product labeling PPE requirements. Crop advisors with approved safety training can determine the appropriate protection to be used while performing crop advising tasks in treated areas after the pesticide has been applied.

Individuals under the direct supervision of a crop advisor are exempt from WPS provisions except for the pesticide safety training requirements (see pesticide safety training). These people must be trained as agricultural workers under WPS provisions. The exemption applies only after the pesticide application is completed and while performing crop advising tasks.

The crop advisor must provide people under their direct supervision with information on the pesticide product and active ingredient(s) applied, method and time of application, and the REI. Also, advisors must provide individuals under their supervision with information regarding the tasks to undertake and how to contact the crop advisor.

Resources

Nebraska Department of Agriculture. For WPS regulatory interpretation and compliance guidance, call 402-471-2394.

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Index: Pesticides, General Regulations
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Nebraska Pesticide Container and Secondary Containment Rules

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This NebGuide examines the rules and regulations required in Nebraska for pesticide containers and secondary containment of liquid pesticides and fertilizers.

The Environmental Protection Agency (EPA) Pesticide Container and Containment (PCC) Rule is intended to ensure that containers are strong and durable and that cross-contamination or other problems do not occur. The PCC Rule’s purpose is to minimize human pesticide exposure while handling containers, facilitate pesticide container disposal and recycling, and protect the environment from pesticide spills, leaks, or other accidents at bulk storage sites during the pesticide refilling or dispensing process. The PCC Rule may apply to you if you are a pesticide registrant, distributor, retailer, commercial applicator, custom blender, or end user.

Pesticide Containers

EPA pesticide container rules apply to nonrefillable containers, refillable containers, and the re-use of refillable containers (repackaging). The PCC Rule also addresses labeling on pesticide containers, including requirements for cleaning and disposing of empty containers.

Nonrefillable Containers

Registrants, formulators, distributors, and dealers are responsible for ensuring that their nonrefillables meet standards (Figure 1). EPA’s publication A Snapshot of the EPA Container and Containment Rule (2009) explains that for products that are not restricted use and are in Toxicity Categories III and IV, containers must:

- Meet basic Department of Transportation (DOT) requirements in the Code of Federal Regulations (49 CFR 173.24).
- Meet certain requirements for DOT construction, design, and marking (for example, five-gallon or smaller containers should be capable of 99.99 percent residue removal; three-gallon or smaller containers require special lids).
- Be vented so product does not surge and pours in a continuous stream (for example, not “glug”); there also should be minimal dripping outside the container.
- Labels for nonrefillables identify them as nonrefillable containers with a “Do not use” statement. The label also contains cleaning/rinsing and disposal instructions, recycling instructions, and a lot number identifying the batch.

Refillable Containers

Both registrants and independent refillers (repackage but are not the product registrant) must comply with re-
STORAGE AND DISPOSAL

Container Disposal
Refillable Container: Refill this container with pesticide only. DO NOT reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller.

Figure 2. Example of label language on a refillable container

Requirements for stationary tanks, repackaging, and portable refillable containers (Figure 2).

Requirements for refillable containers are discussed below.

1) Stationary tanks are containers that are fixed in place for 30 or more days at the facilities of independent refillers and hold 500 gallons (liquid) or 4,000 pounds (dry) pesticides. The tanks require:
   • A serial number or other identifying code
   • Sufficient strength and durability
   • Vents that limit evaporation
   • No external sight gauges
   • A lockable inlet/outlet valve
   • Secondary containment if holding an agricultural pesticide
   • Anchorage or elevation to prevent flotation if holding an agricultural pesticide

2) Registrants are responsible for making sure portable refillable containers (mini bulks, shuttles, totes, etc.) meet DOT standards and bear a DOT transport marking and serial number. They also must be tamper resistant or have one-way valves. These changes will result in many older containers being recycled. Tri-Rinse, Inc. and many other agro chemical manufacturers or distributors offer programs to properly collect and destroy old mini-bulk containers that can no longer be used under the PCC Rule. Many of these programs will continue for years as old containers are being taken out of circulation and replaced by new, compliant containers. In Nebraska, Tri-Rinse will collect containers annually, bi-annually, or as requested. For more information, see www.tri-rinse.com/.

3) Repackaging requirements for any refiller or registrant include:
   • A written contract between the independent refiller and the registrant
   • Responsibility for product integrity
   • No regulatory limits on size of refillable containers, although in their contract, registrants might establish a specific size limitation
   • Acquiring from the registrant 1) procedures to clean refillables 2) descriptions of acceptable containers that meet stationary tank and portable refillable requirements. Refillers must have these documents on file.

4) Important requirements that refillers need to implement during the repackaging process include:
   • Identifying the previous pesticide that was in the refillable container and visually inspecting the container to ensure it is safe and has the required marks and openings
   • Cleaning containers unless the tamper resistant or one-way valve is intact and the container is being refilled with the same product (or if a new product meets other limited circumstances)
   • Ensuring that the container is included in the registrant’s description of acceptable containers
   • Properly labeling the product, including the EPA establishment number and net contents
   • Recording product repackaging information, such as date of repackaging and container serial number

Examples of label language for refillables include a “refillable container” statement and instructions for cleaning the container before recycling or disposal (not before being refilled).

Secondary Containment/Load-out Facilities

Large containers of bulk liquid fertilizers or pesticides pose some unique challenges, such as the potential for spillage or leakage into groundwater or surface water. To address these issues, there are secondary containment and load-out facility standards covered by the EPA containment rules and Title 198, Rules and Regulations Pertaining to Agricultural Chemical Containment. According to Title 198, secondary containment is “a device or structure designed, constructed, and maintained to hold or confine a release of a liquid pesticide or liquid fertilizer from a storage facility.” Simply stated, this means using a larger container to hold a smaller container in order to prevent leakage (Figure 3).
Also, a load-out facility (Figure 4) is defined as “a location, other than the field of application, used for the loading, unloading, handling, or mixing of pesticides or fertilizers or a location used for the rinsing or washing of delivery or application equipment which is designed, constructed, and maintained to hold or confine a release of a liquid pesticide or liquid fertilizer.” For more detailed information about rules pertaining to size, capacity, enclosed or not enclosed, and other aspects of secondary containment and load-out facilities, see the full Title 198 rule at http://www.deq.state.ne.us/RuleAndR.nsf/Pages/198-TOC.

The Nebraska Department of Environmental Quality (NDEQ) also makes appropriate minor adjustments to Title 198 to comply with new EPA standards from the PCC Rule. If you are responsible for bulk quantities of liquid pesticides and fertilizers, you may be required to use secondary containment and/or load-out facilities.

According to the NDEQ, secondary containment and/or load-out facilities are required if the storage capacity of a liquid pesticide exceeds 500 gallons. Also, custom applicators must be aware that load-out facilities are required if using liquid pesticides in original containers greater than 3 gallons or if using mixtures of liquid fertilizers or pesticides in containers greater than 100 gallons.

Liquid fertilizer storage requirements differ from liquid pesticide storage requirements in that liquid fertilizers require secondary containment if:

- One container exceeds 2,000 gallons
- Two or more containers have a combined capacity greater than 3,000 gallons, or
- Liquid fertilizers are stored anytime between Nov. 1 and March 15 in quantities that occupy over 25 percent of the container capacity for containers larger than 500 gallons.

Secondary containment is not required if the contents of one or more containers (up to 6,000 gallons total) are stored at the application site between March 15 and Oct. 1 for no more than 21 consecutive days. Note that this exception is specific to application sites, and some containers, such as those used in chemigation, do not qualify for this exemption. Containers must also follow other rules including maintaining a minimum distance from wells and surface water. For more information about containment rules and/or exceptions, consult the NDEQ publications Are Environmental Regulations becoming a Pest? or Fertilizer and Pesticide Containment in Nebraska (see Resources).

While Title 198 does not require either registration or a permit, you must have a construction plan and management program for secondary containment and load-out facilities. The construction plans must be certified by a Nebraska registered professional engineer. These plans remain with the owner and must be made available to NDEQ upon request.

Containment standards follow existing NDEQ regulations. For guidance contact the NDEQ at (402) 471-2186 or visit them at http://www.deq.state.ne.us/.
Resources

Are Environmental Regulations becoming a Pest?, Nebraska Department of Environmental Quality. http://www.agr.state.ne.us/division/bpi/pes/ndeq_title198.pdf


Title 198: Rules And Regulations Pertaining To Agricultural Chemical Containment, Nebraska Department of Environmental Quality. http://www.deq.state.ne.us/RuleAndR.nsf/Pages/198-TOC


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Fumigating Farm-stored Grain
with Aluminum Phosphide

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Fumigants kill all insect life stages. They control pests by diffusing through the air spaces between grain kernels and into the kernel itself. Fumigants are able to penetrate into places that are inaccessible to insecticide sprays or dusts.

Regardless of formulation, all fumigants are poisonous to humans, other animals, insects, and other pests. Because fumigant chemicals are highly toxic and hazardous to use, they are Restricted Use Pesticides (RUP). Only certified applicators can purchase and use them.

Aluminum phosphide is formulated in tablets, pellets, paper sachets, plates, and blister strips. The tablet or pellet formulations are most suitable for farm applications. Solid aluminum phosphide formulations release hydrogen phosphide (phosphine) gas when exposed to moisture and heat. Warm, humid air accelerates the reaction while cool, dry air slows it down. The reaction starts slowly, gradually accelerates, and then tapers off.

Federal regulations require a Fumigation Management Plan (FMP) be developed prior to the application. The basics of an FMP will be discussed in this publication and a fill-in-the-blank fumigation management plan is included as well. Details of requirements for the FMP can be found in the applicator’s manual.

In most cases, the authors recommend farmers hire a trained, licensed professional to fumigate grain. However, a producer with a valid private pesticide applicator license and the necessary air monitoring equipment can legally fumigate his or her own grain provided an FMP is completed prior to the fumigation event. This publication is designed to help provide direction to farmers who have private pesticide applicator licenses and who decide to do the fumigation themselves.

Fumigation Management Plan

All phosphine-type fumigant labels require the development of a Fumigation Management Plan (FMP) for each fumigated storage site. An FMP is a written document, required by the U.S. Environmental Protection Agency (EPA), which describes the grain storage site and details each step of the proposed fumigation. The purpose of the FMP is to ensure the safety of all workers, the community, and the environment. It also is designed to ensure an effective fumigation and to assist in meeting label requirements.

The FMP provides a uniformly organized process that will help grain managers at each grain storage site to document their fumigation procedures, and thus “characterize” their fumigation. The FMP should include a facility diagram showing the primary structures and technical features (such as main electrical power, gas, and water shut-off points) of the storage facility, grain storage structures in relation to other buildings, and equipment at the site.

The FMP has a standard data form that is to be completed by the person responsible for the fumigation each time a fumigation application is made. It covers important items like the volume of grain fumigated, the type and dosage level of the fumigant, starting and ending times of the fumigant application, and the overall fumigation time from dosage to structure ventilation. During the fumigation, gas levels must be monitored.
and documented at specific locations around the storage structure where people work, as well as at specified locations on the property, such as property boundaries downwind from fumigated structures. A fill-in-the-blank example of a Fumigation Management Plan is provided at the end of this publication.

The Plan

The FMP must address characterization of the site and include appropriate monitoring and notification requirements consistent with but not limited to the following:

1. Inspect the site to determine its suitability for fumigation.

2. When sealing, consult previous records for any changes to the structure, seal leaks, and monitor any occupied adjacent buildings to ensure safety.

3. Prior to each fumigation, review any existing FMP, material safety data sheets (MSDS), fumigant label, applicator’s manual, and other relevant safety procedures.

4. Develop procedures and appropriate safety measures for all workers in and around the area during the application and subsequent aeration.

5. Develop an appropriate monitoring plan to confirm that nearby workers and bystanders are not exposed to levels above the allowed limits during the application/aeration. This plan also must demonstrate that nearby residents will not be exposed to concentrations above the allowable limits.

6. Develop procedures for local authorities to notify nearby residents in the event of an emergency.

7. Confirm the placement of placards to restrict entrance into any area under fumigation.

8. Confirm that the required safety equipment is in place and the necessary manpower is available to complete a safe, effective fumigation.

These factors must be considered in developing an FMP. It is important to note that some plans will be more comprehensive than others. All plans should reflect the experience and expertise of the applicator and circumstances at and around the site.

In addition to the plan, the applicator must read the entire label and applicator manual, then follow the directions carefully. If the applicator has any questions about the development of an FMP, contact the product registrant for further assistance.

The FMP and related documentation, including monitoring records, must be maintained for a minimum of three years for fumigations made in Nebraska.

Application and Distribution of Aluminum Phosphide

Aluminum phosphide tablets and pellets may be applied to the grain mass by probing them below the grain surface, adding them as the grain is turned, or placing them in the aeration ducts below the grain mass. Treatment during turning of the grain generally is not feasible in on-farm storage and often alternative methods must be used to treat the grain in place. In shallow bins, tablets may be probed into the grain using a 5- to 7-foot-long hollow tube designed for this purpose. These tubes can be made from 1½-inch PVC pipe or other similar material.

In metal farm bins, air currents form within the grain mass even if the visible leaks have been sealed. When cold grain is fumigated during warm weather, the dominant currents will carry the fumigant downward, so most of the fumigant should be probed into the top 5 to 8 feet of the grain mass. When warm grain is fumigated during cool weather, chimney-effect air currents carry fumigant toward the surface. Therefore, much of the fumigant should be applied beneath the grain mass, in the aeration ducts. Consult the label for instructions about the maximum portion that can be applied in the aeration ducts or drying floor. Never apply the fumigant to a wet floor or duct as dangerous fumes are released when exposed to moisture.

The following is a step-by-step description of a typical probe application of aluminum phosphide to grain in a circular steel bin.

Equipment Needed

- **Man-in-Bin** sign placed near the control panel or auger power control.
- 2- or 3-inch tape, spray adhesive, and adhesive for polyethylene sheets.
- Applicator’s manual and current label.
- Sufficient fumigant for the volume of the bin.
- Tape measure to calculate volume of grain to be treated.
- 2- to 6-mils polyethylene film large enough to cover the grain surface. Attach a rope to the polyethylene film for easy removal after fumigation.
• Cotton gloves for handling phosphine-type fumigant — do not handle tablets with bare hands or wet gloves.

• All fumigations should be done by at least two people, each equipped with a full set of safety equipment, including chemical-resistant gloves, protective clothing, etc. If entrance into the structure is required for fumigating the grain, two licensed people MUST be present.

• Proper respiratory protection for all personnel involved in the fumigation. Check the fumigant label for specific requirements.

• Probes for applying aluminum phosphide tablets.

• Safety rope to attach anyone climbing into a bin, and long enough to extend through the bin access point and strong enough so rescue personnel can drag a victim to the exit if necessary.

• Shovels to level grain mass prior to treatment.

• Grain thermometer to measure grain temperature prior to treatment at locations throughout the grain mass.

• Fumigation placards.

• A lock to keep unauthorized personnel out of the building. Be sure everyone is out before attaching the lock.

• Monitoring equipment to check gas concentration available from the vendors listed at the end of this guide.

Level the grain

Level the grain surface and break up any crusted areas prior to fumigant application.

Seal the bin

Sealing the bin is the single most important step in achieving good fumigation results. The bin must be made as airtight as possible to achieve and maintain the proper gas concentration and exposure time necessary to kill grain pests.

Metal storage bins are not gas-tight. Many were originally designed to hold and aerate grain, but can be used for fumigation with proper sealing. It is important to recognize that bins will vary in tightness depending upon how well they were built. If the corrugated sections were caulked when put together, and then bolted, they will be more gas-tight. Loosely constructed wooden bins may have to be totally covered with a gas-tight plastic sheet or coated tarpaulin to retain enough fumigant to be effective.

Grain in flat storage buildings must be covered with a tarpaulin for maximum effectiveness. Remember, the goal is to confine the gas in the grain mass long enough at the proper concentration to be lethal to the target pests. Sealing is extremely important and demands study and work. There are several places in a bin where gas can escape. The roof-wall junction may look tight from the outside, but most grain bins have a gap between the roof and wall so water that may condense on the underside of the roof can run down and drip outside the bin. This gap is difficult to seal because it is usually dusty and may be damp. Cracks wider than 1 inch are even harder to seal.

To begin the sealing process, clean the dust from the surfaces before applying tape or other sealing material. Professionals often clean the surface first and then spray it with an adhesive dispensed from a pressurized can. The gap is then sealed with tape. Use at least 2-inch and preferably 3-inch wide tape when sealing these cracks.

A pressurized can of spray adhesive is a useful tool. It is available from the fumigant distributor or sometimes from hardware or hobby stores. This adhesive can help attach plastic sheets and make the tape’s sticky surface stickier and improve the holding quality.

Polyurethane foams can be used to seal gaps, but they are expensive and difficult to remove. Roof vents must not be obstructed during grain aeration.

Another key area to seal is the gap between the bottom of the wall and the concrete floor. Some manufacturers design the wall base to accept a special sealant that can give a long-term seal. Various sealing materials have been used, including one made with polyurethane impregnated with asphalt. Roofing asphalt also has been used on the outside as a sealant but does not have as much elasticity.

Roof ventilators must be covered with plastic at least 3 mils thick. The plastic is less likely to tear against sharp edges if a burlap bag is placed over the ventilator first. The plastic must be taped in place and removed before aeration.

Bin doors are not gas-tight. Seal them with plastic and tape.

Aeration ducts must be sealed to avoid gas loss. Remove the fan and heater, and seal the opening with plastic 3 mils thick, and tape.

Determine dosage

Determine the number of tablets required to treat the volume of grain in the bin and the head space.

Since hydrogen phosphide is a gas and will penetrate to all parts of the storage structure, dosage must be based
upon the total volume of the space being fumigated and not on just the amount of grain, unless the grain surface is covered with a plastic tarpaulin.

Follow label instructions for dosage determinations.

**Calculate dosage**

All fumigant labels provide information on the recommended dosages required to effectively treat stored grain. Using less fumigant than recommended can result in a concentration of gas too low to be effective. Using more fumigant than recommended is illegal, adds unnecessary cost, and may not increase efficacy.

Dosages recommended for the various phosphine-producing fumigant formulations are fairly similar. However, the actual amount of phosphine involved in specific fumigations will vary depending on the type of structure to be treated. Because phosphine distribution is not affected by being taken up by the grain, application rates are based primarily on the gas tightness of the structure, the size and shape of the structure, and the method of application.

Dosages for aluminum phosphide formulations are expressed in terms of tablets per 1,000 bushels storage capacity or 1,000 cubic feet of space.

**Calculating Total Bin Volume — Cubic Feet**

To calculate the total volume in a bin follow the steps outlined here. The total volume is determined by combining the volume of the bin from the floor, typically a concrete pad, to the eave with the volume of the bin above the eave.

**Step 1**

Volume of space from concrete pad to the eave (ft$^3$)  
= $0.785 \times \text{diameter}^2 \times \text{height to eave}$

**Example:** A bin has a diameter of 30 feet and is 18 feet from the concrete pad to the eave.

The volume (ft$^3$) = $0.785 \times 30 \times 30 \times 18$ ft  
= 12,723 ft$^3$

**Step 2**

Volume of the head space under the roof (ft$^3$) =  
$0.2618 \times \text{diameter}^2 \times \text{height (from eave to peak)}$

**Example:** The head space in the bin is 5 feet higher at the peak than at the eave.

The head space volume (ft$^3$) = $0.2618 \times 30 \times 30 \times 5$ ft  
= 1,178 ft$^3$

**Step 3**

Total volume of the bin = volume to eave + volume above the eave = 12,723 ft$^3$ + 1,178 ft$^3$ = 13,901 ft$^3$

**Post warning placards**

The applicator must post warning signs at all entrances to the fumigated area. These signs must contain:

1. The words “DANGER/PELIGRO.”
2. The SKULL AND CROSSBONES symbol in red.
3. The words “Area and/or commodity under fumigation, DO NOT ENTER/NO ENTRE.”
4. The words “This sign may only be removed after the commodity is completely aerated (contains 0.3 ppm or less phosphine gas).” If incompletely aerated commodity is transferred to a new site, the new site must also be placarded and workers must not be exposed to more than 0.3 ppm phosphine.
5. The date and time fumigation begins and is completed, name of fumigant used, and the name, address, and telephone number of the applicator.

**Apply the aluminum phosphide tablets**

Divide the total number of tablets needed by four so they may be placed in each pie-shaped quarter of the bin. Typically, the number would then be divided by five (the number of tablets per probe) to determine the number of probes needed per quarter. For example, if the total number of tablets required for the bin is 280, the number for each quarter is 280 divided by four, which equals 70 tablets per quarter section. Each section would be probed 70 divided by 5, or 14 times with five tablets in each probe.

When placing the tablets in the probe, place the first one when the probe is down 5 feet, then raise the probe 1 foot, and place the next tablet in the probe. Continue until five tablets are placed. The last tablet should be placed about 6 inches from the surface.

Applicators must work in pairs, be properly fitted with respiratory devices and other personal protective equipment required by the label, and must monitor the atmosphere.

**Provide respiratory protection**

If the fumigator enters the fumigated structure for any reason, such as to apply the fumigant or reopen the structure, a National Institute for Occupational Safety and Health (NIOSH)-approved gas mask must be used.
A NIOSH-approved self-contained breathing apparatus (SCBA) also must be available if needed. The gas mask must be a full-face type with the appropriate filter canister. The SCBA gear may be present at a nearby emergency responder, but the applicator must have written proof of availability.

The gas level must be monitored, and workers must not be exposed to more than 0.3 ppm on a time-weighted average basis unless wearing gas masks. The SCBA would be used only if it were necessary to enter a fumigated structure containing an unknown concentration or a concentration greater than 15 ppm phosphine.

The permissible gas concentration ranges (based on eight hours, time-weighted average) for various types of respiratory protection devices are:

<table>
<thead>
<tr>
<th>Gas Concentration</th>
<th>Respiratory Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.3 ppm</td>
<td>None required</td>
</tr>
<tr>
<td>0.3 - 15 ppm</td>
<td>NIOSH/MSHA-approved full face gas mask-hydrogen phosphide canister combination</td>
</tr>
<tr>
<td>More than 15 ppm</td>
<td>NIOSH/MSHA-approved self-contained breathing apparatus (SCBA)</td>
</tr>
</tbody>
</table>

If monitoring equipment is not available and the gas concentration is unknown, a NIOSH/MSHA-approved self-contained breathing apparatus is required.

If monitoring equipment is not available and the application cannot be done from outside the structure, an approved canister respirator must be worn during application within the enclosed indoor area.

Seal the doors

After all sections of the bin have been probed, close the bin and seal the access point with tape or plastic glued into place. This seal prevents fumigant vapors from venting to the outside and prevents the wind from drawing the fumigant out of the grain.

Determine length of fumigation

The exposure time of the phosphine gas in the grain must be long enough to provide for adequate control. Lengthen the time at lower temperatures because insects are more difficult to kill under these conditions (Table 1).

<table>
<thead>
<tr>
<th>Temperature to which fumigant and/or insects are exposed</th>
<th>Pellets</th>
<th>Tablets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 40°F</td>
<td>Do not fumigate</td>
<td>Do not fumigate</td>
</tr>
<tr>
<td>40°F - 53°F</td>
<td>8 days</td>
<td>10 days</td>
</tr>
<tr>
<td>54°F - 59°F</td>
<td>4 days</td>
<td>5 days</td>
</tr>
<tr>
<td>60°F - 68°F</td>
<td>3 days</td>
<td>4 days</td>
</tr>
<tr>
<td>Above 68°F</td>
<td>2 days</td>
<td>3 days</td>
</tr>
</tbody>
</table>

As a rule of thumb, add at least one day to the exposure time listed above for each 10 feet the gas must penetrate downward. It is preferable to add two days for each 10 feet.

Aeration and re-entry

If the area is to be entered after fumigation, it must be aerated until the level of hydrogen phosphide gas is 0.3 ppm or below. Remove the plastic covering the grain surface immediately after fumigation even if the bin is not to be aerated. The area or site must be monitored to ensure that liberation of gas from the treated grain does not result in the development of unacceptable levels of hydrogen phosphide. Do not allow anyone to enter treated areas before this time unless protected by an approved respirator.

After the bin is aired out, treat the grain surface with an approved grain protectant to reduce insect reinfestation and to kill any flying insects in the space above the grain.

At the end of a phosphine fumigation, the powdery residue of tablets or pellets will still contain a small amount of aluminum phosphide for several days. Under normal circumstances of grain handling, these residues do not present a hazard, but avoid inhaling the powder.

Determining concentrations. After the fumigation is over, it is important to determine that the gas has been reduced to a level below the eight-hour time-weighted average (0.3 ppm) to ensure worker safety upon re-entry.

There is no single device that can economically and efficiently measure all fumigants at all normal levels. Various devices can be used depending on the gas being measured and whether a high reading during the fumigation or a low-range reading for compliance with the time-weighted average after the fumigation is needed. Follow instructions for the particular device you use.

Detection tubes (Figure 1) are probably the most versatile tools available for measuring gas concentrations. They are available for many industrial gases as well as for phosphine. The matching pumps (Figure 2) used with...
the tubes are well built, durable, and manufactured by a number of suppliers. The initial equipment cost for the pumps is moderate and can be amortized over hundreds of uses and many years. For most gases, they are sufficiently accurate.

The disadvantage to using the detection tubes is that they are designed for a single use on a single type of fumigant. Their cost can be burdensome when many readings are needed. And, they are not available for both high and low readings so separate tubes of different capacities must be used. The tubes have a limited shelf life and are not reliable after the expiration date. In addition, they have limited accuracy on some gases.

Cautions

- All fumigants are dangerous if improperly used. Follow the cautions listed on the container label and use only in strict accordance with label directions.

- Never place aluminum phosphide on a wet surface or in standing water since it would evolve the gas too fast and could possibly ignite or explode.

- Wear respiratory protection approved by NIOSH/MSHA (Mine Safety and Health Administration) for the level of hydrogen phosphide gas to which you will be exposed.

- The effective life of a gas mask canister is limited. Keep an accurate record of the time that a canister is used and replace it when it has reached its hours-of-time limit, if you smell fumigant, or the canister is outdated.

- A self-contained breathing apparatus requires a refilling source. Your local fire station or rescue squad may be a refill source.

- Never fumigate a bin by yourself. Have one or more people on site to help if you get into trouble. The helper(s) must be properly fitted with approved respiratory protective devices. Devise a code so that you can communicate with one another. Make sure gas and electrical connections are turned off. Have the telephone numbers of the police and fire departments, hospital, physician, and rescue squad.

- Do not drink alcoholic beverages for a day before, during, or after exposure to grain fumigants.

- Perhaps you did not take precautions during past fumigations and had no problems or emergencies. Ignoring safety procedures may have serious consequences. Fumigants demand respect if you want to avoid injury or death, so protect yourself and others when working with these products.

- If there are differences between information provided here and on the aluminum phosphide label, follow the label instructions.
Fumigation Supply, Safety, and Gas Detection Vendors

AFC International, Inc.
P.O. Box 894
715C S.W. Almond St.
DeMotte, IN 46310
1-800-952-3293
http://www.afcintl.com/index.html
Email: sales@afcintl.com

Draeger Safety Inc.
101 Technology Drive
Pittsburgh, PA 15275-1057
1-800-858-1737

DEGESCH America, Inc.
P.O. Box 116
153 Triangle Drive
Weyers Cave, VA 24486
1-800-330-2525
http://degeschamerica.com
Email: info@degeschamerica.com

Fumigation Service and Supply, Inc.
16950 Westfield Park Road
Westfield, IN 46074
1-317-896-9300
http://www.fumigationzone.com/
Email: info@fumigationzone.com

Grainger
100 Oak Creek Drive
Lincoln, NE 68528
1-800-476-9014
http://www.grainger.com/
Email: w4north@grainger.com

Matheson Gas, Inc.
166 Keystone Drive
Montgomeryville, PA 18936
1-800-416-2505
http://www.mathesongas.com/
Email: info@mathesongas.com

Mine Safety Appliances Company
P.O. Box 426
Pittsburgh, PA 15230
1-800-672-2222
http://us.msasafety.com
Email: info@msasafety.com

Pest Fog Sales
3049 Cabaniss Parkway
P.O. Box 270959
Corpus Christi, TX 78427
1-800-395-2345
http://www.pestfogsales.com/
Email: pestfog@aol.com

Sensidyne, Inc.
1000 112th Circle North, Suite 100
St. Petersburg, FL 33716
1-800-451-9444
http://www.sensidyne.com/
Email: info@Sensidyne.com

SKC, Inc.
Eighty Four, PA 15330
1-800-752-8472
http://www.skcshopping.com/
Email: skcorder@skcinc.com
Fumigation Management Plan

The purpose of this Fumigation Management Plan is to assist (Your name or Enterprise name) in (City), Nebraska, to ensure the safety of the workers, the community, and the environment. It is also designed to ensure an effective fumigation and to assist in meeting phosphine label requirements.

Owner/Manager

Name: 

Address: 

Day Telephone Number: 

Night Telephone Number 

Email 

Certified Applicator(s) in Charge

Name: 

Address: 

Day Telephone Number(s): 

Night Telephone Number(s): 

Email(s): 

Certification Number(s): 

Year of Expiration(s): 

Emergency Telephone Numbers

Local Police: 

Local Fire Department: 

Local Hospital: 

Sheriff’s Office: 

Poison Control:  1-800-222-1222 

Fumigant Company:
Date of site inspection: ____________________________________________________________

or previous FMP date: ____________________________________________________________

Date of developing FMP & worker safety plan: __________________________________________

Date of developing a monitoring plan: ________________________________________________

Date of developing procedures for notifying local authorities and to notify nearby residents in the event of an emergency: _________________________________________________________________

Date of confirming the placement of placards: _________________________________________

Date of confirming the presence of the required safety equipment: _______________________

Target pest(s): ______________________________________________________________________

Commodity fumigated: ________________________________________________________________

Date of application: _____________________ Start time: ________________________________

Fumigant trade name: __________________________ EPA registration number: ______________

Location of nearest telephone: ______________________________________________________
(May refer to facility diagram with telephone marked)

Emergency electrical, gas, and water shut-off stations:
(May refer to facility diagram with telephone marked)
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________

Reason for Fumigation — pest(s), buyer requirements, etc.

Type of Fumigation: steel bin, corrugated steel, etc.

Previous fumigation history:

<table>
<thead>
<tr>
<th>Site(s) to be fumigated:</th>
<th>Treated Area</th>
<th>Commodity</th>
<th>Commodity</th>
<th>Dosage</th>
<th>Fumigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Indicate below or refer to attached diagram of facility)</td>
<td>Volume</td>
<td>Temperature</td>
<td>Moisture</td>
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<td>Time</td>
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</table>
Sites to placard:
(List below or indicate on attached diagram)

<table>
<thead>
<tr>
<th>Site</th>
<th>Date</th>
<th>Phosphine reading</th>
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Sites to be monitored:
(List below or indicate on attached diagram)

<table>
<thead>
<tr>
<th>Site</th>
<th>Wind speed</th>
<th>Wind direction</th>
<th>Date</th>
<th>Phosphine reading</th>
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</table>

Site, wind speed and direction, date, and reading for samples taken at property line.

<table>
<thead>
<tr>
<th>Site</th>
<th>Wind speed</th>
<th>Wind direction</th>
<th>Date</th>
<th>Phosphine reading</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
Site(s) and date cleared of phosphine:
(List below or indicate on attached diagram)

<table>
<thead>
<tr>
<th>Site</th>
<th>Date cleared</th>
<th>Phosphine reading</th>
</tr>
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</table>

Method of disposal of unused pesticide: _______________________________________________________________
_______________________________________________________________________________________________

Names of Fumigators:
Example:

<table>
<thead>
<tr>
<th>Person fumigating</th>
<th>License number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abraham Lincoln</td>
<td>NEB 000000</td>
</tr>
<tr>
<td>Jefferson Davy</td>
<td>NEB 000000</td>
</tr>
</tbody>
</table>

Attach a facility diagram showing structures to be fumigated in relation to other structures; electrical, gas, and water shut-off controls; telephones, equipment; etc.
Pesticides and the Endangered Species Protection Program

Clyde L. Ogg, Extension Pesticide Safety Educator; Erin C. Bauer, Extension Associate; Jan R. Hygstrom, Extension Project Manager; and Emilie A. Dorn, Extension Assistant

This NebGuide discusses the Endangered Species Protection Program and its role in the use of pesticides.

Background

The Endangered Species Act (ESA) is designed to protect animal and plant species in danger of becoming extinct, as well as the ecosystems in which they live. According to the ESA, federal agencies are required to "use their legal authorities to promote the conservation purposes of the ESA and to consult with the U.S. Fish and Wildlife Service and National Marine Fisheries Service, as appropriate, to ensure that effects of actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of listed species" (U.S. Fish & Wildlife Service, 2013). The overall goal of the ESA is to help populations of species recover so they no longer are threatened or endangered. An endangered species is one in danger of becoming extinct in all or most of its range. Threatened species have a high probability of becoming endangered in the near future if assistance is not given.

The U.S. Environmental Protection Agency (EPA) requires and is responsible for registration of pesticides. The EPA reviews information and data and determines whether a pesticide product may be registered for a particular use. Because some pesticides may harm certain threatened or endangered species, the EPA requires a review of potential impacts.

The Endangered Species Protection Program (ESPP) is one of the ways that the EPA meets the requirements of the ESA. A primary goal of the ESPP is to manage federally registered pesticides to avoid jeopardizing protected species while avoiding any unnecessary limitations on the use of many pesticides important to American agriculture for the production of food, fiber, wood, and other commodities.

Pesticide Labeling

A key component of the ESPP is directing pesticide users, through labeling on applicable pesticide products, to follow use limitations found in Endangered Species Protection Bulletins. When referenced on a pesticide label, the limitations on pesticide use given in the bulletins are mandatory and enforceable.

Bulletins are available through EPA's "Bulletins Live!" (Figure 1) database program at http://www.epa.gov/espp/bulletins.htm, which is searchable by state and county. Click the "Bulletins Live!" link and select the state and county where the pesticide application will take place. You also may click

Bulletin Live! on the map, and choose the county where the application will take place from the pull-down menu. Then, select the month of the pesticide application and follow the steps given in the bulletin. Bulletins also are available by calling the toll-free Endangered Species Hotline at 1-800-447-3813. Those applying pesticides can check for information in a bulletin up to six months prior to making a pesticide application.

Bulletins contain a description of the endangered or threatened species to be protected, the name of the pesticide's active ingredient that could cause harm, use limitations of the pesticide that ensure the species' protection, county maps where the bulletin applies, and the valid month(s) in which the bulletin is applicable.

Species-Based Approach

A pesticide is included in the ESPP if it poses a potential threat to a federally listed plant or animal species. The EPA consults with the U.S. Fish and Wildlife Service to make this determination. Discussed here are examples of Endangered and Threatened (E&T) animal or plant species that may appear in Endangered Species Protection Bulletins for Nebraska. While all E&T species require special attention, this publication covers only 10 of Nebraska's species, to explain how pesticides may affect plants, insects, fish, and birds. For a complete listing of all Nebraska E&T species, visit the Nebraska Game and Parks Commission's (NGPC) Rare Species website at http://rarespecies.nebraska.gov.
Endangered and Threatened Plants

Herbicide applications, drift, and overspray may weaken or kill fragile populations of plants. In addition, pollinators such as bees, butterflies, moths, and flies are important to the survival of many plants. Be careful when applying pesticides that could affect pollinators.

Hayden's blow-out penstemon (Penstemon haydenii, Figure 2, federal and state endangered) is unique to the Sandhills region of Nebraska and Carbon County, Wyoming. Blowout penstemon is a "pioneer" plant that begins growth in a sand blow-out site before most other plant species, anchoring the sandy soil and reducing wind erosion. In 1968, about 7,000 plants grew on less than 25 total acres scattered throughout the Sandhills. Since then, seeds have been collected and raised in greenhouses, with seedlings introduced to blowouts. About 20,000 plants existed in 2008 due to recovery efforts, primarily in Box Butte, Cherry, Garden, Hooker, and Thomas counties, with populations in Grant and Morrill counties, as well. In 2013, 32 blowout penstemon populations were found in the Sandhills region of Nebraska (10 native sites and 22 introduced populations). Most of the known plants are on private land. To sustain the populations, continual transplanting and maintenance of blowout sites may be necessary.

Western prairie fringed orchid (Platanthera praecox, Figure 3, federal and state threatened) requires a relatively high and constant level of soil moisture, maintained by groundwater that is near the surface. Known populations are in 64 sites in wet prairies and meadows in the eastern two-thirds of Nebraska. According to the Nebraska Natural Legacy Project, the western prairie fringed orchid is one of Nebraska's rarest plants, with estimates of 2,000 to 5,000 plants in the state. It relies on the sphinx moth for pollination and seed production, so insecticides and other threats to these insects threaten the orchid as well. Loss of these native pollinators may be impacting pollination and genetic diversity in the western prairie fringed orchid. Other threats include invasive species, annual mid-summer haying, loss of habitat, and herbicide sprays.

Colorado butterfly plant (Gaussia neomexicana ssp. coloradensis, Figure 4, federal and state threatened) is found in moist areas of floodplains within a small area of southeastern Wyoming, north-central Colorado, and western Nebraska. The only known populations in Nebraska are located in the floodplain of Lodgepole Creek in Kimball County and the Oliver Reservoir State Recreation Area. The U.S. Fish and Wildlife Service estimates fewer than 50,000 reproducing individuals in its entire range, with only 10 of the 14 current populations considered stable or increasing in numbers. In 2008, Nebraska populations were estimated at less than 200 plants; a field survey of the two areas of Nebraska counted 12 plants. Threats to this species include invasion of habitat by Canada thistle and herbicide spraying.

Ute ladies'-tresses (Spiranthas diluviales, Figure 5, federal threatened, state endangered) is a perennial terrestrial orchid. It grows in scattered sites in Colorado, Wyoming, Utah, Montana, Washington, Idaho, and Nevada. Nebraska is at the eastern edge of the species' known range. In Nebraska, they have been found only in Sioux County on private land in a two-mile stretch of the Niobrara River Valley, in subirrigated wet meadows. Ute ladies'-tresses could occur in other river and stream valleys in western Nebraska, but have not been found during surveys. Only about 60,000 individual plants remain in the U.S. A 2010 survey in Nebraska found 831 flowering plants.

Small white lady's slipper (Cypripedium candidum, Figure 6, state threatened) is a perennial orchid of the northeastern U.S. Historically, the orchid probably was found throughout eastern Nebraska and much of central Nebraska. Historic collection records account for the orchid in 17 Nebraska counties. The present range consists of the eastern Sandhills and the Loup River Valley. All known Nebraska populations have less than 200 plants each, with total population estimates of 1,000 to 2,000 plants in the state. Nebraska's known populations occur primarily in native, subirrigated wet meadows, which are commonly hayed. Populations of orchids also can occur in road ditches adjacent to native wet meadows. Threats include invasive species, annual mid-summer haying, loss of habitat, and herbicide sprays.
Endangered and Threatened Insects

Applications of insecticides in areas occupied by E&T insects could result in the loss of local populations. Direct contact with the spray or insecticide carried by particle drift, vapor drift, or runoff could affect these insects.

Salt Creek tiger beetle (*Cicindela nevadica lincolniana*, Figure 7, federal and state endangered) is a predatory insect, about ½ inch long, that captures smaller or similar-sized insects by grasping prey with its mouthparts. The beetle spends two years as a larva in an underground burrow, capturing insects that wander by the opening. The adult beetle lives on the surface for only about six weeks, from mid-June through July.

Found only in Lancaster and Saunders counties of Nebraska, Salt Creek tiger beetles live in the moist, muddy areas of saline wetlands and stream edges associated with Salt Creek, Little Salt Creek, and Rock Creek. In 2012, researchers counted 374 beetles during an intensive field survey.

Applications of insecticides in areas occupied by Salt Creek tiger beetle could result in the loss of local populations or the entire subspecies. Both the adult and larvae are susceptible to insecticides. They may be killed through direct contact with insecticides, or they could die from secondary poisoning — eating insects that had been sprayed with an insecticide. Insecticides may reduce the numbers of insects that serve as food for this beetle, as well.

American burying beetle (*Nicrophorus americanus*, Figure 8, federal and state endangered) feeds on carrion — dead birds, fish, mammals, and other organisms. It is now found only in six states, including Nebraska. This beetle is the largest North American carrion beetle and may reach up to 2 inches in length. This species is nocturnal, seeking out and burying carrion to feed its young.

Availability of carrion and soil moisture, rather than vegetation type, appears to determine the habitat of the American burying beetle. This insect seems to require a soil type that allows for burial of carrion. The species occurs in areas least disturbed by human influence, including the Sandhills and an area southeast of North Platte. Locations include grassland prairie, forest edges, and wet meadows.

Perhaps fewer than 1,000 American burying beetles live east of the Mississippi River. In Nebraska, an estimated 3,000 beetles live in Lincoln County, with the population extending into Gosper, Frontier, and Dawson counties. A northern population of perhaps 30,000 is in the Sandhills of Nebraska, extending into South Dakota. Factors that may play a role in the population decline include habitat fragmentation that lowers the availability of preferred carrion, competition for carrion by other predators, and artificial lighting that decreases the populations of nocturnal insects. Contact with insecticides can cause direct mortality or lower reproduction rates. Applications of pesticides to control grasshoppers may affect populations.

Endangered and Threatened Fish

Pesticide applications or runoff could enter streams, ponds, or rivers and harm fish populations. Fish are particularly susceptible to pesticides during their larval development. In addition, most small native fish depend on aquatic insects for survival. Applications of insecticides could affect the fish populations indirectly due to the loss of insects as a food source. Reduce the risk of having pesticides enter surface water by establishing adequate buffer strips and using sound agricultural practices to reduce erosion and runoff.

Topeka shiner (*Notropis topeka*, Figure 9, federal and state endangered) is a small minnow, less than 3 inches long. Food consists of insects, algae, and other plant material, and fish eggs. The Topeka shiner is known to occur in portions of South Dakota, Minnesota, Kansas, Iowa, Missouri, and Nebraska. It is found in small prairie (or former prairie) streams in pools containing clear, clean water in areas of Cherry County, and the North Loup River. It also is found in Taylor Creek and its tributaries in Madison County. Most streams with Topeka shiner flow year-round, but some are small enough to stop flowing during dry summer months. When this happens, water levels must be maintained by groundwater seepage for the fish to survive. The estimated population in Nebraska is less than 200 fish.

Endangered and Threatened Birds

Pesticides in stormwater runoff could enter streams, ponds, or rivers and harm or kill fish and invertebrates such as aquatic insects, crustaceans, and mollusks upon which some shorebirds feed. Fish and invertebrates can accumulate toxins in their bodies; a bird that eats them may have a buildup of toxins as well.

Interior least tern (*Sternula albifrons*, Figure 10, federal and state endangered) is 8 to 9 inches long with a 20-inch wingspread. Males and females are similar in appearance. Immature birds also look similar but have considerably browner upperparts and the black on the head is more diffuse.

Interior least terns leave their wintering grounds in Central and South America and arrive in Nebraska from mid-May to early June. This tern nests on midstream river sandbars, sand and gravel mines, and lakeshore housing developments across the state (primarily along the Platte, Missouri, Elkhorn, Loup, and Niobrara River drainages). Nests are inconspicuous, consisting of a small depression on sand or similar substrate.
Interior least terns typically lay two or three brown spotted eggs. Adult interior least terns eat small fish. Water quality must be high enough to support a reproducing fish population. During the breeding season, least terns may feed within a few hundred yards of, or miles from the nesting area. Typically, all interior least terns have migrated out of Nebraska by the end of August.

The decline of interior least terns is principally attributed to habitat loss, but human disturbance at nesting sites, pollution, and disease also negatively affect this species in Nebraska and elsewhere.

**Piping plover** (*Charadrius melodus, Figure 11*, federal and state threatened) is a robin-sized shorebird. A common relative, the killdeer, is larger, more darkly colored, and has two dark breast bands.

Piping plovers breed in Nebraska from early April through August. Nesting habitat includes extensive, sparsely vegetated areas of sand adjacent to water, including sandbars, sand and gravel beaches, reservoir shorelines, and sand and gravel mines along rivers. Nests are shallow, typically lined with small pebbles, shells, or other material. Females lay a clutch of four eggs. Piping plovers feed on small insects, worms, and other invertebrates they collect from the surface of wet sand along the shoreline of rivers, ponds, and lakes. Reduced availability of food due to pollution or other variables can affect survival and reproductive success. The piping plover commonly is found in the same breeding areas as the interior least tern, and has been negatively affected by many of the same variables as the interior least tern.

**National Pollutant Discharge Elimination System Permits**

When making pesticide applications to, over, or near waters of the state for nonagricultural uses (rights-of-way, mosquito control, algae control, etc.), a National Pollutant Discharge Elimination System (NPDES) permit may be required. In these cases, you must consider if state-listed E&T species could be adversely affected. The NGPC has developed a document with standard procedures to follow, *E&T Species Standard Procedures for NPDES Pesticide Permit*. If you cannot follow these procedures, you must consult with the NGPC Planning and Programming Division prior to the pesticide application. Paperwork must be submitted, and at least 30 days are required for the review. Information on a consultation with NGPC is available at [http://outdoorenbrat.wi.gov/wildlife/programs/nongame/consultation.asp](http://outdoorenbrat.wi.gov/wildlife/programs/nongame/consultation.asp).

**Summary**

Endangered and threatened species require special attention due to their vulnerability. Always read pesticide labels carefully. If directed to do so by the label, follow use limitations found in Endangered Species Protection Bulletins, accessed either online or through the toll-free telephone number. When applying nonagricultural pesticides to, over, or near waters of the state, a National Pollutant Discharge Elimination System may be required. If so, Nebraska Game and Parks Commission has additional standards that must be followed.

**Resources**

Contact the following individuals, offices, or websites for additional information.

**Nebraska Department of Agriculture**
Craig Romery, Nebraska Department of Agriculture, Lincoln, NE (402) 471-2394

**Nebraska Department of Environmental Quality**

**Nebraska Game and Parks Commission**


**NGPC Environmental Analyst, Supervisor, Michelle Koch, Lincoln, NE (402) 471-5438**


**USDA Natural Resource Conservation Service (NRCS)**

**U.S. Environmental Protection Agency**
Dick Wiedman, Environmental Protection Agency Region 7, Nebraska Field Office, Lincoln, NE (402) 437-5080

**EPA endangered species hotline (800) 447-3813**

**Endangered Species Protection Program, U.S. Environmental Protection Agency** [http://www.epa.gov/epa](http://www.epa.gov/)

**U.S. Fish & Wildlife Service**
U.S. Fish & Wildlife Service, Grand Island, NE (308) 382-6468


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**Index: Environmental & Natural Resources Conservation**

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Bee Aware: Protecting Pollinators from Pesticides

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Honey bees (Apis mellifera) and other bee species such as bumblebees, orchard mason bees, and leafcutter bees are very important to the pollination of flowers and crops, and can be found foraging on numerous plants in the spring through late summer and early fall. In addition to bees, butterflies, moths, flies, hummingbirds, and some bats can be important pollinators.

Approximately 3,500 species of bees live in North America. Bees are valuable pollinators of 95 crops grown in the United States. Crops pollinated by bees have a farm value of well over $10 billion annually in the U.S. Honey bee colonies also contribute to our agricultural economy by producing over $200 million of honey annually.

This Extension Circular focuses on the honey bee, the most important pollinator in the Midwest, because it can:

- be managed by beekeepers,
- be transported,
- be managed for income from both honey production and pollination,
- be maintained in large populations throughout the growing season, and
- visit and pollinate many plant species.

Honey bees (Figure 1) are hairy, yellow, and black or brown banded social insects that are about ½-inch long on average and live in hives. Each individual has distinct duties, either

Figure 1. Honey bee
as a worker (serving as a nursemaid, housekeeper, or forager) or a reproductive bee (drone or queen).

Maintenance of the hive relies on the distributed work within the colony. For example, foragers (usually older worker bees) search for food resources (pollen and nectar) and communicate this to the colony. Because the health of the hive and successful crop pollination relies on the foraging activities of worker honey bees, it is essential to protect these important insects from potentially harmful pesticide exposure.

Protecting pollinators is an important consideration when applying pesticides to control crop pests. Pesticides such as insecticides, fungicides, and miticides may be toxic to bees. Insecticides are formulated to kill insects, fungicides kill fungi that cause some plant diseases, and miticides kill mites. Pesticide labels may carry specific statements to protect bees and should be read carefully prior to pesticide application. The loss of native pollinators due to habitat reduction, and the decline in honey bee colonies due to parasitic bee mites and other factors, reinforces the need to protect these insects through good pesticide stewardship. While this Extension Circular focuses on protecting honey bees, many of the recommendations serve to protect other bee and pollinator species as well.

**Considerations for Pollinator Protection**

**Plant Growth Stage**

Most honey bee poisonings happen when pesticides are applied to flowering crops (e.g., apples, melons, soybeans) or are allowed to drift onto flowering plants (e.g., weeds and wildflowers) during periods when the bees are actively foraging. If applications are permitted by the label, growers and applicators need to communicate with beekeepers and exercise all reasonable measures to minimize the risks to bees.

**Relative Toxicity of the Chemical**

Pesticides vary in their toxicity to honey bees. Most fungicides and herbicides (pesticides that kill weeds) have relatively low toxicities to honey bees and can be used without endangering them. In addition, certain insecticides and miticides are not hazardous to bees and can be applied with little risk of bee injury. For example, *Bacillus thuringiensis* (*Bt*), a biological insecticide derived from a soil-dwelling bacterium, is not toxic to bees. However, insecticides such as pyrethroids that are more toxic to bees can only be applied when bees are not actively foraging because bees that are exposed during the application may be killed. Pesticides that are highly toxic to honey bees cannot be applied to flowering crops when bees are present without causing serious injury or death. Bee toxicity data for selected pesticides are listed in Table I. Lethal dose (LD$_{50}$) and relative toxicity ratings are provided for each active ingredient (AI) included. Use the table to compare toxicities within and between broad pesticide types (i.e., fungicides, insecticides, herbicides, miticides), but understand that these pesticide types can vary in their toxicity to bees. Also, recognize that toxicity does not indicate the exposure a bee is likely to receive, but rather how much of an AI it takes to kill a bee. Realize that toxicity is only one factor when considering hazards to bees. Exposure time and dosage, application rate, and formulation all contribute toward overall risk or hazard of using an active ingredient. A good way to think about risk is with the risk formula:

\[
RISK = TOXICITY \times EXPOSURE
\]

Always read and follow the label for the product you are using. It will provide guidance about toxicity to bees and how you can reduce the risk of exposure during application.

**Choice of Formulation**

Different formulations of the same pesticide often vary considerably in their toxicity to bees. Granular (G) pesticides are generally less hazardous to honey bees than other formulations. Dust (D) formulations, though uncommon, are usually more hazardous than emulsifiable concentrates (EC) because they adhere to the bee’s body hairs and are carried back to the hive. Wettable powder (WP) and flowable (F) formulations dry after application to a dust-like material that can be transferred to foraging pollinators. Likewise, microencapsulated (M) formulations also can be transferred to bees along with pollen and brought back to the colony. Since bees are highly social and hives can be crowded, substances picked up in the field can be spread within a hive. Exposure to pesticide formulations can cause significant losses of both foraging bees and bees in the hive. In severe cases, pesticides may remain active in the hive for several months and prevent colonies from recovering.

**Using Treated Seed**

Pesticides added as a protective coating to seeds can become dislodged during handling and/or planting. Graphite and talc used to lubricate seeds during planting can carry these residues to non-target locations. Before handling or planting treated seed, take precautions to reduce the risk of pesticide residues or planter talcs drifting or moving offsite onto flowering plants where bees may be foraging. For example, if you intend to plant treated corn seed with a pneumatic planter, a burndown herbicide should be used to eliminate henbit from the site prior to planting. This will prevent planter talc from settling on the henbit, which is usually blooming at corn planting time and may be visited by bees.
<table>
<thead>
<tr>
<th>Representative Trade Names</th>
<th>Pesticide Active Ingredient (AI)</th>
<th>Bee Toxicity (LD$_{50}$ as μg/bee)</th>
<th>Toxicity Rating</th>
<th>Pesticide type</th>
</tr>
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<tbody>
<tr>
<td>Gaucho</td>
<td>Imidacloprid</td>
<td>0.0039</td>
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<tr>
<td>Cruise Platinum</td>
<td>Thiamethoxam</td>
<td>0.005</td>
<td>Highly toxic</td>
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<td>Lorsban Vulcan Nufos 4E</td>
<td>Chlorpyrifos</td>
<td>0.01</td>
<td>Highly toxic</td>
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<tr>
<td>Brigade Capture</td>
<td>Bifenthrin</td>
<td>0.0146</td>
<td>Highly toxic</td>
<td>I</td>
</tr>
<tr>
<td>Ambush Pounce</td>
<td>Permethrin</td>
<td>0.024</td>
<td>Highly toxic</td>
<td>I</td>
</tr>
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<td>Aztec</td>
<td>Cyfluthrin</td>
<td>0.037</td>
<td>Highly toxic</td>
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<td>Dimethoate</td>
<td>Dimethoate</td>
<td>0.056</td>
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<td>Methyl parathion</td>
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<td>Avid Zoro</td>
<td>Abamectin</td>
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<tr>
<td>Acramite</td>
<td>Bifentanate</td>
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<td>Moderately toxic</td>
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<tr>
<td>Captan</td>
<td>Captan</td>
<td>10</td>
<td>Moderately toxic</td>
<td>F</td>
</tr>
<tr>
<td>Javelin Dipel</td>
<td>Bacillus thuringiensis</td>
<td>23.2</td>
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<td>Tilt Bumper Fitness</td>
<td>Propiconazole</td>
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<td>Relatively nontoxic</td>
<td>F</td>
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<tr>
<td>Quilt</td>
<td>Propiconazole + Azoxyostrobin</td>
<td>25</td>
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</tr>
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<td>Atrazine AAtrix</td>
<td>Atrazine</td>
<td>97</td>
<td>Relatively nontoxic</td>
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<td>2,4-D Ester</td>
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<td>Triflumuron + Propiconazole</td>
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<tr>
<td>Quadris Dynasty</td>
<td>Azoxyostrobin</td>
<td>200</td>
<td>Relatively nontoxic</td>
<td>F</td>
</tr>
</tbody>
</table>

1The USDA Windows Pesticide Screening Tool (Win-PST) is an environmental risk screening tool that includes bee toxicity data available for each active ingredient in the database. The tool is available for download from [http://go.usa.gov/Kok](http://go.usa.gov/Kok).

2*Bacillus thuringiensis* (Bt) Reregistration Eligibility Decision (RED), U.S. EPA. Data can be found at [http://www.epa.gov/oppsrrrl1/REDs/0247.pdf](http://www.epa.gov/oppsrrrl1/REDs/0247.pdf)
Residual Action

Residual activity of a pesticide is an important factor in determining its safety to pollinators. Pesticides that degrade within a few hours usually can be applied with minimal risk during times when bees are not actively foraging. Applying pesticides with extended residual activity (more than eight hours), even when bees are not actively foraging, may still result in bee injury if bees visit the crop during the period of residual activity. Pesticides with extended residual activity require extra precaution to prevent bee exposure. Look for clues about the residual activity of an individual pesticide on the pesticide label. For example, restricted entry intervals greater than 12 hours indicate extended residual activity.

Drift

Bees may forage in areas adjacent to the target crop. Pesticides that drift from the target crop onto nearby flowering plants can cause significant bee poisoning. In general, sprays should not be applied if wind speed exceeds 10 mph or is blowing toward adjacent flowering plants. While pesticides should never be applied near beehives, drift alone rarely causes extensive bee poisoning. When evaluating potential drift hazards, focus on reducing the risk of drift moving to nearby flowering plants.

Temperature

Because temperature plays such an important role in the activity of cold-blooded animals, such as bees, as well as having an effect on pesticides, it can affect when or how bees are exposed to pesticides. Bees are most actively foraging during periods of high temperature and sunlight. Also realize that some pesticides vaporize during these times, thereby increasing potential for bee injury. Making pesticide applications during periods of cooler temperatures and low light or overcast conditions will minimize exposure to bees. Always be aware of temperature fluctuations and use common sense before applying pesticides that are toxic to bees.

Distance from Treated Areas

Honey bee mortality due to pesticides usually decreases the farther away colonies are from treated areas (i.e., crops, turf, etc.). Most foraging activity occurs within one to two miles of the hive. However, during periods of nectar or pollen shortage, honey bees forage at greater distances, and colonies up to five miles from the treated area can be injured.

Time of Application

Application timing is related to all the previously mentioned factors, but the most critical one is to control pests either prior to crop flowering or after flowering is complete. This will greatly reduce the risk of pollinators being exposed to pesticides. If pesticides must be applied to flowering plants, use pesticides with short residuals in the evening when the temperatures are below 60 degrees. This can greatly reduce the potential for honey bee injury.

Communication and Cooperation

Reducing pesticide injury to honey bees requires communication and cooperation among beekeepers, growers, and pesticide applicators. Beekeepers should understand the cropping and pest management practices used by growers near their apiaries. Likewise, pesticide applicators should be aware of apiary locations, have a basic understanding of honey bee behavior, and know which materials and application practices are the most hazardous to bees. It is unlikely that all bee poisonings can be avoided, but in most cases, bee losses can be reduced by understanding the hazards and maintaining effective communication.

How Growers and Applicators Can Reduce Risks of Honey Bee Injury

Understand the risks. Many crop pests can be controlled without endangering bees. Attend crop pest management training sessions to learn the latest about crop pests and control measures used by growers and applicators.

Do not treat flowering plants. Be especially careful when treating crops such as alfalfa, sunflowers, and canola, which are highly attractive to bees. Pesticide labels carry warning statements and sometimes prohibit application during bloom. Always read and follow the label.

Examine fields before spraying to determine if bees are foraging on flowering weeds. Milkweed, smartweed, henbit, and dandelion are examples of weeds that are highly attractive to honey bees. Where feasible, eliminate these flowering weeds in fields by mowing or cultivating prior to pesticide application or planting. While bright and colorful flowers are highly attractive to bees, some plants with inconspicuous blossoms such as dock, lambsquarter, and ragweed are also visited. Therefore, when you examine areas for flowering plants, consider all plants that have flowers. Be aware that many plants only produce pollen and nectar for a few hours each day. Fields should be scouted for honey bees at the same time of day as the anticipated pesticide application.

Maintain forage areas for bees. Intensive agriculture often increases bee dependence on cultivated crops for forage. Establishing plants in wild or uncultivated areas for honey bees to forage will reduce bee dependence on crop plants that may require pesticide treatments. Plants recommended for uncultivated areas include sweet clover, white Dutch clover, alfalfa, purple vetch, birdsfoot trefoil, and partridge...
pea (Figure 2). Many trees and shrubs are beneficial to bees as well. The most attractive species include linden, black locust, honey locust, Russian olive, wild plums, elderberries, red maples, willows, and honeysuckle. However, when establishing foraging areas with trees and shrubs, avoid planting honey locust, Russian olive, or honeysuckle. Although attractive to honey bees, these species can become invasive and outcompete native plant species. Soil conservation, natural resource, and game managers usually are eager to help establish plantings that benefit honey bees because these areas also conserve soil and provide valuable habitat for plant and wildlife conservation programs. These individuals can be a good resource for selecting trees that are both attractive to bees and healthy for the environment.

Avoid spray drift. Give careful attention to the location of flowering crops and weeds relative to wind speed and direction. Changing spray nozzles or reducing pressure as allowed by the label can increase droplet size and reduce spray drift.

Apply pesticides when bees are not foraging. In general, bees are foraging more actively during the sunniest and warmest times of the day. Therefore, some pesticides can be applied in late evening or early morning (i.e. from 8 p.m. to 6 a.m.) with relative safety. For example, with the partridge pea plant, bees work heavily on it in the morning, but by early afternoon the field will go quiet because the nectar stops flowing about that time of day.

Although bees don’t prefer corn pollen and it has limited nutritive value, they may collect pollen from tassels in the early morning but are not present in the afternoon or evening. Short-residual materials applied from late afternoon until midnight pose less bee hazard in corn fields if flowering weeds are not present.

Adjust spray programs in relation to weather conditions. Reconsider the timing of a pesticide application if unusually low temperatures are expected. Cool temperatures can delay pesticide degradation and cause residues to remain toxic to bees the following day. Stop applications when temperatures rise and when bees re-enter the area in early morning. Similarly, do not apply during evening hours if temperatures are unusually high and bees are still foraging.

Contact local beekeepers and obtain locations of beehives. If colonies are present in an area where you will be applying a product that is toxic to bees, you should contact beekeepers (Figure 3) within 48 hours so they have time to protect or move the colonies. Many pesticide applications pose minimal risk to bees, and beekeepers may choose to accept some risk rather than move colonies. Notify beekeepers as far in advance as possible.
information on DriftWatch, making personal communication much easier. If bees are present, pesticide application procedures, including timing and/or application methods, should be adjusted accordingly.

Beekeepers, crop producers, and applicators are encouraged to access DriftWatch and document known beehive locations in application records, or print a map from the website and incorporate it into application records. It is also a good practice to scout the area prior to a planned pesticide application to become familiar with the landscape. Because listings on DriftWatch are voluntary, not all apiary locations may be included. DriftWatch is only as effective as the information provided by beekeepers and the action taken by applicators. New or updated information should be submitted as soon as possible. Good communication is the key to avoiding pesticide injury to honey bees. To view video segments about DriftWatch and bees/pollinators, visit the UNL Extension PSEP YouTube channel, listed in the Resources section of this Extension Circular.

Read the pesticide label. Carefully follow listed restrictions and/or precautions with regard to bee safety.

**Steps Beekeepers Can Take to Protect Their Colonies**

Choose low hazard apiary locations. Do not place beehives adjacent to crops likely to be sprayed with a pesticide (Figure 5).

Know the risks. Many crop pests can be controlled without endangering bees. Attend crop pest management training sessions to learn the latest about crop pests and control measures used by growers and applicators. These sessions also provide an opportunity to establish communication links with growers and pesticide applicators.
Maintain positive working relationships with applicators. Risk management decisions can best be made when both parties understand each other’s needs. Establish a communication link prior to the spray season rather than during peak activity periods when all parties are busy.

Use DriftWatch. As mentioned earlier, register the location of your hives on DriftWatch.

Applicators will be able to search for such locations and communicate with you before applying pesticides near your beehives.

Be prepared to protect colonies if necessary. If pest control measures that carry unacceptable risks are necessary, know the options for protecting your colonies and be prepared to implement them. Options for protecting bees include:

1. When products with short residual activity are to be applied, briefly confine bees to their hive with wet burlap. This measure is only feasible if a small number of colonies are involved and if the confinement period is brief and early in the morning. Caution! This measure can result in the colony overheating and should be used with care. Fine mesh moving nets are also available and can be purchased by beekeepers if the need arises.

2. Temporarily disrupt foraging activity by removing colony covers and offsetting boxes. This will result in a temporary reduction in foraging. Most honey bees will remain in the hive to protect their stores and to maintain temperature and humidity in the exposed hive. After a few hours to one day, colonies will adjust to the change and resume foraging. This approach is safer than confining colonies but is not recommended if bees are located in or adjacent to areas that will be treated.

3. When highly toxic products with extended residual activity are applied to flowering crops, move honey bees to another location at least four miles from the treated area. Moving populous colonies during hot weather can result in considerable bee mortality and should be avoided if possible. Moves should be made early in the morning or evening when temperatures are cool and the bees are the least active. In general, moving colonies isn’t practical for most beekeepers. It requires that hives be kept on pallets and moved using a forklift. Migratory beekeepers may be some of the few with such equipment.

Report colony injury. Beekeepers are often reluctant to report bee injury incidents for a number of reasons, one of which is because they may be relying on the landowner/applicator to provide a place to put their hives. However, EPA is unable to adequately evaluate product use and risk.
assessment without bee injury incident information. The best way for EPA to collect this necessary information is through an incident reporting form, available at http://pi.ace.orst.edu/erep/.

Final Thoughts

There are many ways to reduce bee poisoning. Often, severe losses can be avoided by relatively simple modifications of pest control programs. Talk with other growers and applicators about how to reduce bee injury and consult reference materials, such as this Extension Circular, on protecting honey bees.

With good environmental stewardship, you can help protect the bees that are essential pollinators for Nebraska crops. Applicators and beekeepers should work together to ensure successful pest control while reducing the risks to honey bees. This includes registering beehives on DriftWatch, having a good communication network, using pesticides that are least toxic to bees, and timing applications when bees are not actively foraging. Bees are a valuable agricultural resource that are worthy of our respect and protection.

Resources

- DriftWatch: http://www.driftwatch.org
- UNL Extension PSEP YouTube Channel: http://www.youtube.com/user/UNLExtensionPSEP

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Prairie Dogs and Their Control

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Prairie dogs are an important part of the prairie landscape, but the damage they cause can be extensive. The control methods described can prevent or reduce damage.

Black-tailed prairie dogs (Figure 1) are stocky, burrowing rodents that are members of the squirrel family. They are the only species of prairie dog native to Nebraska and they inhabit the western two-thirds of the state. Prairie dogs live in colonies called “dog towns.” They are interesting creatures to watch and are an important part of the prairie environment. They cause problems, however, when they conflict with livestock ranching and other land uses, or threaten human health and safety.

Black-tailed prairie dogs have tawny fur, large eyes, short legs, inconspicuous ears, and a characteristic black-tipped tail. Adults weigh 2 to 3 pounds and are 10 to 12 inches long.

Prairie dogs live in burrows that usually are about 6 to 9 feet deep and 20 feet long. Most burrows have one or two entrances and the associated mound serves as a sentinel post for the vigilant occupant (Figure 2). Prairie dog towns usually contain 30 to 75 burrows per acre, and numbers of prairie dogs vary from 1 to 50 or more per acre depending on location, food availability, and time of year. Prairie dog towns in Nebraska range from one to several hundred acres and may contain from a few to thousands of individuals.

Prairie dogs inhabit most soil types but are less likely to occur in sandy or heavy clay soils. Prairie dogs do not thrive in eastern tallgrass prairie unless it has been heavily grazed. Colonies in the more western mixed and short-grass prairie usually begin and remain near where concentrated grazing by livestock occurs.

Prairie dog towns consist of social groups called “coterie” that typically contain 1 or 2 adult males, up to 6 adult females, and several yearlings and juveniles. Almost all mating occurs among unrelated individuals within a coterie. Black-tailed prairie dogs mature in 1 year, but most don’t breed until they are over 1½ years old. One breeding season occurs per year in February and March, and litters of 3 to 6 pups are born in March or April. The pups first emerge from their burrows at about 6 weeks of age during May, just before weaning.

Males usually leave the coterie as yearlings in the early summer of the following year. Prairie dogs often travel several miles to establish new colonies or burrows at the edges of other existing colonies. Prairie dogs readily adapt to areas close to humans and livestock. They are active during the day and remain somewhat active during the winter.

Prairie dogs are opportunistic feeders, eating many different kinds of grasses, sedges, and broad-leaved plants. They switch their diet to include more seeds and roots during fall and winter. Prairie dogs have the ability to go without food for long periods of time and fulfill their need for water entirely through plants in their diet. Prairie dogs use several forms of communication including a “kiss” of recognition, where two touch their front teeth. Either amicable grooming or chasing and fighting may ensue, depending on whether the animals are competing for mates or nest sites or protecting their young. Prairie dogs often sit upright at the openings of their burrows, with heads held high to watch and listen for threats of danger from predators. If spotted, a series of barks by the sentinels can send the occupants of the whole colony underground.

Ecological Importance

Immense colonies of prairie dogs were present on the Great Plains before settlement. Although significantly reduced, these colonies still create unique patches of habitat in extensive grasslands. These patches are used by an abundance of wild creatures, such as burrowing owls, ferruginous hawks, mountain plovers, and horned larks. Over 200 species of wildlife have been associated with prairie dog towns. Prairie dogs are prey for a variety of predators such as hawks, eagles, badgers, coyotes, foxes, and weasels.
One special animal that is dependent on prairie dogs is the black-footed ferret. It is a member of the weasel family, lives in prairie dog towns, and feeds almost exclusively on prairie dogs. Because of habitat loss (prairie dog towns), black-footed ferrets are very rare and are included on the federal list of endangered species. Before beginning any type of control, inspect prairie dog towns for signs of black-footed ferrets. The U.S. Fish and Wildlife Service (308-382-6468) can provide information on conducting surveys for black-footed ferrets. If a ferret or ferret sign are observed, contact your local extension office, a Nebraska Game and Parks Commission conservation officer, or the U.S. Fish and Wildlife Service.

**Economic Importance**

Surveys indicate that black-tailed prairie dogs have occupied 30,000 to 80,000 acres of rangeland in Nebraska during the past 3 decades. Most of this land is privately owned. The economic impact of prairie dogs on rangeland is difficult to determine. From a rancher’s perspective, prairie dogs can severely reduce annual production of forage and, if present for many years, can reduce the capacity of the land to produce desired grass species. Prairie dogs typically graze and clip plants to less than 1 inch high, which is shorter than most livestock will graze. Prairie dogs also graze year-round, whereas most livestock are rotated among pastures. Most grass species lose vigor under continuous grazing pressure. Impacts of prairie dogs on rangeland depend on the range site, range condition, historic grazing use, and demographics and distribution of the prairie dog colony. From 3 to 80 percent of the total annual forage production may be lost to prairie dogs where they occur. On the other hand, reduced availability of forage may be partially offset by the improved nutrition of newly growing grasses and forbs.

Land uses other than livestock grazing may be affected by prairie dog colonies. Some colonies exist near new home sites or subdivisions, where wildlife disease or animals common to prairie dog towns, such as rattlesnakes and black widow spiders, may threaten human health and safety. Be aware that removal of burrows may force rattlesnakes to seek suitable hibernacula in areas closer to human habitation. Other colonies may exist near row crops, where prairie dogs consume sprouting corn and soybeans. Prairie dogs may burrow near roadways or water impoundments, where erosion and structural integrity may be an issue.

Conversely, colonies may be seen as favorable to wildlife viewing, photography, ecotourism, shooting, and associated revenue generation. Large and remote colonies of black-tailed prairie dogs enhance wildlife diversity and may be viewed as potential sites for reintroducing black-footed ferrets. For more information on improving the environment and/or generating revenue from prairie dogs, contact Nebraska Master Naturalists at 402-472-8689 or naturalist.unl.edu.

**Legal Status of the Black-tailed Prairie Dog**

Petitions to the U.S. Fish and Wildlife Service to list the black-tailed prairie dog as a federally “threatened” species resulted in the designation of the species as “warranted but precluded” in January 2000. The black-tailed prairie dog currently is considered an unprotected nongame species in Nebraska and has relatively little protection under the law.

**Prevention and Control of Damage**

**Integrated Pest Management**

As in most situations involving wildlife damage, a combination of methods typically will be more effective than relying on any 1 method of control. Proper livestock grazing rates, rotation of livestock, and deferred or intensive grazing can be used along with proper timing and use of toxic baits, fumigants, and shooting. Prairie dogs are beneficial in many respects; consider their importance to the environment and the wildlife that are associated with them. Elimination of prairie dogs alone may not result in improved rangeland. In most situations, range improvement is a gradual process that requires a combination of prairie dog reduction and proper grazing management.

**Grazing Management**

Prairie dogs are not as abundant in areas dominated by tall vegetation. Therefore, management of livestock grazing can be useful in preventing colonization of an area or reducing recolonization by prairie dogs.

**Stocking Rates**

Overgrazed pastures often are favorable sites for establishment, continuance, or expansion of prairie dog towns. Stocking rates should fit the local range site conditions and recent weather patterns. Managers should include prairie dogs in the calculations for stocking rates or they may contribute to overgrazing. Consumption rates of prairie dogs during summer range from about 30 to 100 grams of green forage per prairie dog per day.

**Grazing Distribution**

Prairie dogs often establish towns in areas where livestock congregate, such as at wells and mineral licks. Grazing pressure by livestock can be distributed more evenly by placing salt and minerals on areas that are used less by livestock.

**Grazing Strategies**

In some situations, the vigor and productivity of plants will improve if livestock grazing is deferred for part or all of the growing season. Improved grazing management includes practices such as intensive rotational grazing and 3- or 4-pasture grazing systems instead of season-long continuous grazing. Livestock can be excluded from vacant prairie dog towns with temporary fencing to help vegetation regain vigor and productivity.

Managers that choose to graze livestock on prairie dog towns should do so during early spring through early summer when plant nutrients are relatively high on towns compared to other areas. Such a strategy should be examined carefully each year to ensure the seasonal needs for nutrients by both range plants and livestock are in balance. Any livestock grazing strategy should provide for the health and productivity of the mid- to tall-grass species where they are a part of the natural vegetation. Benefits associated with grazing strategies alone will be minimal if no remnants of these species exist in a pasture or if moisture is too limited for vegetation to respond to a reduction in livestock grazing.

**Toxicants**

**Toxic Baits**

Two active ingredients, zinc phosphide (ZP) and chloraphacinone, currently are registered in toxic baits for controlling prairie dogs in Nebraska. Both are Restricted Use Pesticides and are available only to certified pesticide applicators. Baits can be applied by hand or mechanical applicators mounted on all-terrain vehicles. Toxic baits are most effective when prairie dogs have no fresh green feed available. They are the most economical methods for controlling large numbers of prairie dogs. If you plan to control prairie dogs with toxic baits, prohibit shooting 1 to 2 months before bait application. Without shooting, prairie dogs will return to their natural activities and bait acceptance will increase.

**Zinc phosphide-treated baits.** ZP is a relatively fast-acting non-anticoagulant toxicant formulated as a loose grain or small pellet bait (2%). The use of ZP for controlling prairie dogs is effective and relatively safe to other wildlife when used properly. Research at UNL indicates that it costs about $15 per acre (2010 prices) for materials and labor to apply ZP-treated baits. When applied according to label and in favorable conditions, a 75 percent reduction of prairie dogs in a treated colony can be expected. ZP baits must be applied from July through February and should be applied in late summer or fall after local vegetation has died and...

**Prebaiting.** Before applying ZP baits, you must first “pre-bait” burrows with untreated, clean, and fresh rolled or crimped oats. Prebaiting will habituate prairie dogs to grain and will make the ZP-treated bait much more effective when it is applied. Drop a heaping teaspoon (4 grams) of oats on the edge of each prairie dog mound or in an adjacent feeding area. The bait should scatter, forming a 6-inch circle (Figure 3). Do not place ZP baits in piles or inside burrows, on top of mounds, in piles of droppings, or in vegetation away from the mound. Following this advice increases the likelihood of prairie dogs taking the bait and decreases hazards to other animals.

About ½ pound of untreated oats will be needed per acre to prebait an established prairie dog colony. Do not apply ZP-treated baits until the prebait has been consumed by prairie dogs, which should take 1 to 2 days. Another application of untreated oats may be necessary if prairie dogs do not accept the prebait immediately.

**Bait Application.** Apply ZP-treated bait in the same way the untreated prebait was applied. Apply 1 heaping teaspoon (4 grams) of grain bait per burrow. Excess bait will not be eaten by prairie dogs and can present a hazard to nontarget wildlife or livestock. Apply about ½ pound of ZP bait per acre.

Follow all label directions and observe all warnings regarding the handling of bait. Wear cloth gloves when handling ZP-treated baits. Cattle can stay on pastures that are treated with ZP baits, but we recommend removing all livestock, especially horses, sheep, and goats from pastures before ZP baits are applied. Baits should be applied when clear, calm weather is expected for the following 5-day period. Bait that is dampened by rain is poorly accepted and the toxicity likely will be reduced. Avoid baiting on windy days since wind may reduce the activity of prairie dogs and also can scatter baits.

Inspect treated dog towns 2 to 3 days after applying ZP baits. Bury any dead prairie dogs found above ground deeply in unused burrows. Though most prairie dogs that succumb to the toxic effects of ZP die below-ground, they still may contain toxic baits within their stomachs and pose a hazard to other animals that may consume the carcasses. Look for evidence of prairie dog activity and plug burrows with soil to aid in identifying burrows that remain occupied. Active burrows will be re-opened by surviving prairie dogs. Prairie dogs that survive the initial bait treatment may be “bait shy” and much less likely to succumb to a second treatment of ZP bait. Wait at least 1 year before applying ZP baits to the same prairie dog town. Removal of survivors by fumigation or shooting reduces the need to conduct yearly treatments with toxic baits.

**Chlorophacinone-treated baits (Rozol®).** Chlorophacinone is a relatively slow-acting, multiple feed anticoagulant formulated as a small pellet (0.005 percent). The use of Rozol for controlling prairie dogs is effective and relatively safe to other wildlife when used properly. Research at UNL and Kansas State University indicates that it costs about $20 per acre (2010 prices) for materials and labor to apply chlorophacinone-treated baits. When applied according to the label and in favorable conditions, you can expect a 90 percent reduction of prairie dogs in a treated colony. Rozol must be applied from October through March 15 and should be applied early before cold and snow makes application more difficult. Rozol is available through various retail agricultural suppliers in Nebraska. Prebaiting is not required, which saves a step in application.

**Bait Application.** Apply ¼ cup (53 grams) of Rozol bait at least 6 inches down each active burrow. Do not apply the bait aboveground, and remove any spilled bait because it can present a direct hazard to nontarget wildlife. About 4 pounds of Rozol bait will be needed per acre. Follow all label directions and observe all warnings regarding the handling of bait. Wear gloves when handling Rozol. Do not allow livestock to graze on treated areas within 14 days of application.

**Post-application surveys.** Prairie dogs will begin to die 4 to 5 days after ingesting a lethal dose. Applicators must survey the treated site within 4 days of application and at 1- to 2-day intervals for at least 2 weeks to collect and dispose of any bait and dead or dying prairie dogs found aboveground. Dispose of them on-site by deep burial, at least 18 inches belowground. Almost all prairie dogs that succumb to the toxic effects of chlorophacinone die below-ground. Dead and intoxicated prairie dogs pose a hazard of secondary poisoning to other animals that consume carcasses. Prairie dogs that survive the initial Rozol treatment likely will not be “bait shy” and can be re-treated in the same manner several weeks later.

**Fumigation.** Fumigants, including aluminum phosphide (AP) tablets and gas cartridges, can provide satisfactory control of prairie dogs. Research at UNL indicates that it costs about $50 per acre (2010 prices) for materials and labor to apply aluminum phosphide and gas cartridges. When applied according to label, you can expect a 95 percent reduction of prairie dogs in a treated colony. Fumigation is costly and labor intensive, so it is not recommended as the primary means of control for large numbers of prairie dogs. It also is more hazardous to nontarget wildlife than toxic baits. Fumigation is best used as a follow up to treatment with toxic baits. Read labels of pesticide products carefully and comply with all recommendations and requirements. Seek assistance from your local extension educator or USDA-APHIS-WS biologist if needed.

Do not use fumigants in burrows where nontarget species are thought to be present. Black-footed ferrets, burrowing owls, cottontail rabbits, and other desirable wildlife may inhabit prairie dog burrows and can be killed unintentionally by fumigation. Ferret surveys can be conducted during the day or at night with spotlights. Check with the U.S. Fish and Wildlife Service (308-382-6468) for details on conducting surveys. Avoid applying fumigants between April and October to protect burrowing owls that nest and roost in prairie dog burrows. Be familiar with the signs of nests, especially whitewash and finely shredded cow manure at burrow entrances.

**Aluminum phosphide.** AP is a Restricted Use Pesticide that is available only to certified pesticide applicators. Before using AP, read the product label and applicators manual, and develop a Fumigation Management Plan to help assure safe, legal, and effective fumigations. Pre-control surveys for black-footed ferrets may be required if your colony is greater than 80 acres or is a part of a 1,000-acre complex. Surveys typically are conducted at night with spotlights during July through October and less than 30 days before application. Contact the U.S. Fish and Wildlife Service in Grand Island (308-382-6468) for details.
AP tablets should be rolled deep down into prairie dog burrows, where they will react with moisture in the air and release phosphine gas (Figure 4). Place crumpled newspaper, a dry cowpie, or slice of sod in the burrow entrance (to prevent soil from smothering the tablets), then shovel loose soil over the burrow entrance to contain the fumigant in the burrow. AP activates more quickly with high soil moisture and temperature, so it is most effective when used in early spring as a follow-up to toxic baits. Wear cotton gloves and long sleeves when applying AP. Avoid breathing the fumes. Keep the container closed as much as possible and work into the wind to avoid exposure to the gas. Symptoms of exposure include tightness in the chest, dizziness, nausea, and stupor. Exposed individuals should be placed in fresh air and receive medical attention immediately.

Gas cartridges. Gas cartridges are another type of fumigant that burn and produce carbon monoxide, carbon dioxide, and other gases when ignited. To use a gas cartridge, stir the contents with a screwdriver or metal rod, insert a fuse, light it, and place the cartridge, burning end down, deep into a burrow. Plug burrows in the same way as above to seal the smoke in the burrow. Minimize contact after the cartridge has ignited to avoid severe burns. For additional information, refer to NebGuide G1477, Fumigation of Burrowing Rodents with Aluminum Phosphide or Gas Cartridges.

Shooting

Shooting is a very selective control method that causes little hazard to nontarget wildlife when done responsibly. Use small-caliber rifles (.17 to .25 caliber) and copper bullets to minimize exposure of scavengers (especially hawks and eagles) to lead poisoning. Populations of prairie dogs and the areal expansion of colonies can be reduced but generally not eliminated through shooting alone. The shooting of prairie dogs is most effective in late winter through early summer because it can disrupt their breeding and pup rearing activities. Propane cannons and small gas engines with the timing off-set to promote backfire can be used to habituate prairie dogs to the sound of gunfire.

Landowners can encourage shooters on their property. Local UNL Extension and Nebraska Game and Parks Commission offices may maintain lists of landowners who allow the shooting of prairie dogs in the area.

Evaluating Effectiveness of Control Methods

To estimate the effectiveness of your control methods, plug several treated burrows and mark them with flagging. After 24 hours, count the number of burrows that have been reopened and calculate the percent reduction in activity. For example, (100 burrows plugged – 25 plugged burrows opened)/100 burrows plugged x 100 = 75 percent reduction in burrow activity. The behavior of prairie dogs can affect the accuracy of estimates. Some burrows that are treated may not be occupied, thus exaggerating the effect. On the other hand, some prairie dogs may emerge from burrows and dig out other plugged burrows, thus reducing the calculated effect.

Other Techniques

Several other approaches have been used to control prairie dogs — most of which are expensive, ineffective, illegal, or hazardous.

Prairie dogs can be captured with cage-traps and either flooded or vacuumed out of their burrows, but the costs of such activities are prohibitive on anything but small prairie dog towns. In addition, it is not legal to translocate prairie dogs over 100 yards in Nebraska.

Barriers that inhibit the view of prairie dogs have been constructed out of snow fence, ditch liner, and windrowed trees. Again, these practices are expensive and their effectiveness is highly variable.

Prairie dogs have been subjected to vehicle exhaust, anhydrous ammonia, and propane-oxygen explosions with minimal effectiveness and great hazard to the applicator. The use of propane-oxygen exploding devices is illegal in Nebraska.

Burrows can be leveled with a disk to prevent reuse, but cultivation will not exclude prairie dogs from an area.

Assistance

UNL Extension provides a wide range of information on prevention and control of wildlife damage, especially through the Internet Center for Wildlife Damage website (icwdm.org) and the book Prevention and Control of Wildlife Damage (icwdm.org/handbook/index.asp). Landowners can receive information on controlling prairie dogs from their local UNL Extension office.

The USDA-APHIS-WS has a program that offers toxic baits, fumigants, and on-site assistance for landowners who request help in controlling prairie dogs. Eligibility and costs for assistance may vary. Contact the USDA-APHIS-WS (402-434-2340) for details.

In addition, Nebraska Natural Resources Districts (NRDs) also may provide materials or share costs for the application of toxic baits and fumigants to control prairie dogs. Check your local telephone directory for the NRD office nearest you.

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SAFE

Transport, Storage, and Disposal of Pesticides

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Most accidental pesticide poisonings occur when pesticides are mishandled. Young children are often the victims. Pesticide accidents can be prevented by careful planning, using a secure storage location, adopting safe handling methods during transport, and following proper disposal guidelines for both products and containers.

The first step in preventing accidental poisonings and environmental contamination is to use good judgment when buying pesticides.

• Buy only the amount that can be used in a reasonable length of time.
• Don’t be tempted by “sale prices.”
• Buy pesticides in quantities that you will use in the near future. Some pesticides should not be stored for long periods of time, allowed to freeze, or be stored in direct sunlight because they may become less effective.

Always keep pesticides in their original containers. Using any other container is illegal and could cause an accidental pesticide poisoning. Also, using another container could make it very difficult to retrieve the pesticide label information in the case of pesticide poisoning or environmental contamination.
Certain precautions should be taken when transporting pesticides. Traffic accidents can happen even when you travel only a short distance, and improperly loaded pesticide containers can fall off your vehicle or become punctured or torn. Because pesticides are transported on public roads, the potential damage from such accidents is great.

Never transport pesticides with food, livestock/poultry feed, or minerals. Also, transport pesticides separately from seed, grain, or consumer goods.

Keep a pesticide spill kit in your vehicle at all times. A spill kit commonly contains chemical-resistant gloves, coveralls, and goggles; sorbent pads and absorbent material (such as kitty litter); shovel; and a plastic temporary storage bag or container.

In case of a pesticide spill follow the three “C’s”: control, contain, and cleanup. Control the spill immediately to prevent further spillage. Turn off or close the valve on a leaky hose or upright a container that has tipped over. Contain the spill. Dike the spill with absorbent material or sorbent pads to keep it out of water and prevent environmental contamination. Clean up the spill. Use absorbent material to soak up the spill, then shovel contaminated material into a plastic storage container for disposal. Additional information may be found in the shipping papers or the label.

What Vehicle to Use

The safest way to transport pesticides is in the back of a truck or pickup. Never carry pesticides in the passenger compartment of a vehicle. If you use a flatbed truck, it should have side and tail racks. If the truck has a wooden bed, insert an impervious liner such as plastic or a truck bed liner before loading pesticides. Nonporous beds are preferred because they can be easily decontaminated in case of an accidental spill. Make sure your truck is in good operating condition to help reduce the chance of an accident (see Vehicle Maintenance Checklist, page 12).

Loading Pesticides

Wear work clothing and chemical-resistant gloves even when handling unopened pesticide containers, in case the container should leak. Also, carry protective clothing and equipment in the passenger compartment of the vehicle. You will need protective equipment if a spill or other pesticide-related accident should occur.

Thoroughly inspect all containers at the time of purchase, before loading. Accept them only if the labels are legible and firmly attached. Check all caps, plugs, or bungs and tighten them if necessary. If leakage has occurred, do not accept the container. Request another container.

When loading containers, handle them carefully; don’t toss or drop them. Avoid sliding containers over rough surfaces that could rip bags or puncture rigid containers. Know safe handling procedures when using forklifts. Secure all containers to the truck to prevent load shifts and potential container damage. Protect containers made of paper, cardboard, or similar materials from rain or moisture.

Unloading Pesticides

Never leave pesticides unattended. You are legally responsible if people are accidentally poisoned from pesticides left unattended in your vehicle. Move the pesticides into your storage facility as soon as possible. Inspect the vehicle thoroughly after unloading to determine if any containers were damaged or any pesticide leaked or spilled.
Transporting Hazardous Pesticides

The U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration has designated many chemical compounds, including some pesticides, as hazardous materials (hazmat). If you transport any of these materials on public roads in commerce, you are required to comply with DOT Hazmat Regulation 49 Code of Federal Regulations (CFR) parts 100-185. To determine which pesticides are classified as hazardous, refer to Hazmat Tables (HMT) I and II (49 CFR part 172.101). To be in compliance, you may be required to:

- Carry shipping papers in your vehicle including an emergency response phone number and Material Safety Data Sheets (MSDS) for the pesticides in transport,
- Receive training concerning DOT Hazmat regulatory requirements,
- Be sure that packages are properly labeled and/or marked,
- Placard your vehicle if transporting a bulk container or 1,000 pounds or more of a pesticide from HMT II or any amount of a pesticide from HMT I, and
- Obtain a Commercial Driver’s License (CDL) when required.

Shipping Papers. When you transport any hazardous pesticide, carry the proper shipping papers in the passenger compartment of the vehicle. While you are driving (belted and operating the vehicle), the papers must be within your reach or placed in a door pouch and readily recognizable by emergency personnel. These papers provide information about the chemical that can be used to prevent further damage or injury in case of an accident. Your pesticide dealer will help you obtain the proper papers. Also, carry the Material Safety Data Sheet (MSDS) for each hazardous pesticide or an emergency response guidance manual that cross-references a chemical’s shipping name with emergency response information.

Hazardous Materials (Hazmat) Training. The DOT Hazmat training increases your awareness of safety considerations involved in loading, unloading, handling, storing, shipping-paper preparation, marking, labeling, placarding, and transporting of hazardous pesticides. It also improves emergency preparedness for responding to transportation accidents. Hazmat training includes general awareness training, function-specific training, and safety training.

DOT Training Is Available. The DOT Office of Hazardous Materials Safety has prepared training modules that meet the requirements for general awareness Hazmat training. These modules are available online (http://phmsa.dot.gov/hazmat/training/publications/modules) or on an interactive CD-ROM. (For more information, phone: 202-366-4900 or email: phmsa.hm-training@dot.gov.) A list of training opportunities for the function-specific and safety training sections is available online (http://www.phmsa.dot.gov/hazmat/training-outreach) or can be obtained by contacting the DOT Office of Hazardous Materials Initiatives and Training (Phone: 202-366-4900 or email: phmsa.hm-training@dot.gov). Specialized training is available from the DOT Transportation Safety Institute as well (405-954-5000).

Labeling and Marking. Always check each package (e.g., cardboard box, plastic or metal drum) to be sure it is properly labeled and/or marked. Labeling means a prescribed hazard warning notice (usually diamond-shaped) on the outer package. Marking means the required words are written on the side of the outer package, including shipping name, identification number, specifications or UN marks, plus other required information, instructions, or cautions.
Placarding. For most hazardous pesticides (HMT II) in non-bulk, you will need to placard your vehicle when you transport as little as 1,000 pounds of the chemical. When transporting hazardous pesticides (HMT II) in bulk (over 119 gallons) or any amount from HMT I, placarding is required at all times. Place placards, which are available from your pesticide dealer, on all four sides of your vehicle.

Commercial Driver's License. Contact the hazardous materials coordinator at the Nebraska State Patrol (402-471-0105) for more information on training, shipping papers, labeling, marking, and placarding. For more information on the CDL, contact the Nebraska Department of Motor Vehicles office (402-471-2281) or your local driver’s license examiner.

Farmer Exception

Farmers have been granted exceptions from the DOT Hazmat regulations if they are private motor carriers transporting pesticides within the state of Nebraska. Farmers can transport DOT-defined hazardous pesticides (other than compressed gases) between fields of the same farm over any roadway EXCEPT the interstate highway system. Farmers also have had emergency response information and Hazmat employee training requirements waived when they were transporting agricultural pesticides to or from their farm (within 150 miles of the farm).

Transporting Hazardous Pesticide Waste

Certain pesticide wastes are listed as hazardous under the Resource Conservation and Recovery Act (RCRA). RCRA defines “hazardous wastes” (40 CFR parts 240-299) as either:

- “Characteristic” wastes. These are waste materials with one or more of these characteristics: ignitable, corrosive, reactive, TCLP toxic. These are considered “hazardous wastes” even though they may not be “listed,” or,
- “Listed” substances. See the Code of Federal Regulations 40, parts 261.3 and 261.32 for those pesticides that have been declared to be “hazardous waste.”

Except for those taking their own pesticides to an approved excess pesticide waste collection/disposal site, only a permitted hazardous waste hauler can transport such waste. For more information, contact the hazardous waste specialist at the Nebraska Department of Environmental Quality at 402-471-2186.
A s soon as pesticides arrive at their destination, they should be properly stored and the area immediately secured. This not only helps discourage theft, but also prevents access to the materials by pets, children, and others not trained to use pesticides. Always keep personal protective equipment (PPE) and a pesticide spill kit (chemical-resistant gloves, coveralls, and goggles; sorbent pads and absorbent material such as kitty litter; and a plastic temporary storage bag or container) readily available in or near the pesticide storage area.

When storing pesticides on shelving, place liquid formulations on lower shelves and dry formulations above them. If a liquid formulation container leaks, the dry formulations will not be contaminated. Keeping the liquid containers on lower shelving also helps reduce the risk of accidental spills if the container is knocked off the shelf.

To prevent contamination or accidental use of the wrong chemical, store herbicides, insecticides, and fungicides in separate areas within the storage unit. Dry formulations of insecticides or fungicides can become contaminated if stored with certain volatile herbicides and may cause plant injury when used. Treated baits (for rodents, insects, and birds) should not be stored near other chemicals because they can absorb odors and may repel the pest.

Always store a pesticide in the original container with the label intact. Once a container is opened, the shelf life is considerably reduced. Never store a pesticide, for even a short time, in any container other than the original. **Doing so is a violation of the law.** Pesticides in soft drink bottles, fruit jars, milk cartons, margarine tubs, or glassware are a common cause of accidental poisonings. Store pesticides away from food, pet food, animal feed, seed, fertilizers, veterinary supplies, and plants.

Check all stored pesticide containers (see Pesticide Storage Checklist, page 13) for any existing or potential problems, including leaks or spills. Transfer the contents of any leaking container into a container with exactly the same original formulation and label. When this is not possible, put the leaking container with the pesticide into a liquid-proof container and dispose of it as discussed under Disposal of Excess Pesticide Waste. If necessary, contact the pesticide manufacturer for specific directions.

The pesticide storage location should be a cool, dry, well-ventilated area away from sources of heat or flame. See the pesticide label for specific storage recommendations. Some pesticides may not be as effective if they are or have been frozen or overheated. Expansion of pesticides caused by freezing or heating can cause containers to crack or break, resulting in potentially dangerous leaks or spills. Heat expansion of a liquid pesticide also may result in contents that are under pressure. When the container is opened, the pressure may cause an overflow and/or contamination of the user or storage site. Excessively high temperatures (120°F or higher) also can change the effectiveness of a pesticide and may produce dangerous fumes, making the storage area unsafe.

To prepare for pesticide applications, remove the pesticide containers from storage and take them to an open area. Always measure and mix pesticides in a well-lit, well-ventilated location. Regardless of whether they are partially or completely emptied, never leave pesticide containers open or unattended while the pesticide is being applied. Return all containers to storage prior to application to prevent accidental spills, ingestion, or exposure to people, pets, livestock, or wildlife.

Mixing and applying pesticides requires detailed attention to label instructions, along with common sense and good judgment. So, too, does pesticide storage. **Being careless or using improper storage procedures is an open invitation to disaster.** While all pesticide labels have a section on storage and disposal, the guidelines do not answer every question. If you have questions about pesticide storage, contact the Nebraska Department of Agriculture (402-471-2394).

**Be Prepared for Pesticide Spills**

Despite all safety precautions, accidents can happen. If a pesticide spills in a storage area, quick action is imperative. **Have a pesticide spill kit on hand.** If a pesticide spill occurs on a public right-of-way, contact the Nebraska State Patrol at 800-525-5555 for assistance.

If a pesticide is spilled on a person’s body or clothing, the person should leave the area immediately. All contaminated clothing should be removed as quickly as possible — this is no time for modesty! Wash affected areas of the body thoroughly with detergent or soap and water. In any pesticide...
contamination incident, follow the instructions given in the label’s first aid treatment guidelines. If the label is not available or if there are further questions, seek medical attention. If necessary, contact The Poison Center in Omaha (800-222-1222).

If toxic fumes are present at the spill site, evacuate people and animals from the immediate area. In addition, secure the area until qualified rescue personnel, with proper protective equipment, arrive at the scene. Except for a small, properly equipped cleanup crew, don’t allow anyone to enter the area until it is thoroughly decontaminated.

**Spilled pesticides must be contained.** If the pesticide starts to spread, contain it by diking with soil or sorbent materials, if this can be done safely without contacting the pesticide or breathing the fumes. Never hose down a contaminated area. This will cause the pesticide to spread and infiltrate into the soil, possibly reaching groundwater. If the spill is liquid, use activated charcoal, absorptive clay, vermiculite, pet litter, or sawdust to cover the entire spill area. Use enough absorbing materials to completely soak up the liquid. Then sweep or shovel the material into a leak-proof drum. Dispose of this material according to the label of the pesticide involved.

Always refer to the product label and, if necessary, contact the chemical manufacturer for information about the appropriate neutralizing materials to be used following a pesticide spill. As a precaution, it is wise to read all product labels thoroughly at the time of purchase and/or delivery to be able to deal quickly and safely with any pesticide emergency.

### Pesticide Storage and Spill Reporting Requirements

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) requires that spills or releases of reportable quantities (RQ) of hazardous substances must be reported immediately to the National Response Center (800-424-8802). The reportable quantity for some chemicals can be as low as 1 pound; however, the majority are 100-5,000 pounds. Definitions of hazardous substances and specific reportable quantities can be found in 40 CFR 302. General information is available by calling 800-424-9346.

The Superfund Amendments and Reauthorization Act (SARA) amended CERCLA. One part of the provisions, the Community Right-to-Know Act (Title III), established new lists of “Extremely Hazardous Substances” (EHS) and “Toxic Chemicals” for additional notification and reporting requirements. It also added new reporting requirements for the CERCLA list of “hazardous substances.”

SARA Title III established threshold planning quantities (TPQ). Any facility that produces, uses, or stores these Extremely Hazardous Substances (EHS), in amounts equal to or in excess of the threshold planning quantities, has reporting and notification obligations under section 302 of SARA Title III (40 CFR Part 355). If the facility produces, uses, or stores hazardous chemicals or Extremely Hazardous Substances exceeding the designated amounts (10,000 pounds for hazardous chemicals and either 500 pounds or the threshold planning quantities, whichever is lower, for Extremely Hazardous Substances), specific information must be submitted to state and local officials as defined in sections 311 and 312 of the Act (40 CFR 370).

In addition, owners and operators of most business facilities must report spills or releases of CERCLA hazardous substances and Extremely Hazardous Substances to state and local authorities (section 304, 40 CFR 355). If the spill occurs while in transport, the notification can be made either by the owner or the operator of the motor vehicle. Report spills and releases to the Nebraska State Patrol (800-525-5555) or to the 911 emergency operator.

### Selecting a Site for Pesticide Storage

Several points must be considered when selecting the site for pesticide storage. One of these factors is prevailing wind direction. The best site is downwind and downhill from sensitive areas, such as houses, play areas, feedlots or animal shelters, gardens, and ponds. Locating storage facilities away from dwellings and livestock facilities will minimize possible contamination.

The site also should be in an area where flooding is unlikely. It should be located where runoff can be diverted and drainage from the site cannot contaminate surface or groundwater.
Ideally, a drainage system should be built to collect any runoff water from the storage area. Pesticides that may be present in tank rinsate, spills, seepage from storage, and heavy runoff in the event of fire or flooding must be controlled. Dikes, collecting pools, and washing slabs with sumps provide a proper drainage system. All of the collected runoff water should be treated as a surplus pesticide and disposed of properly.

Storage Area

Depending on inventory size, a separate building, room, or enclosure may be best for pesticide storage. If the inventory is not large enough to warrant a separate facility, enclose the storage area on the first floor of an existing building. In either case, store pesticides and pesticide containers in a fire-resistant structure having good ventilation and a sealed, concrete floor that slopes toward drainage and secondary containment.

Post weatherproof signs, stating “Danger – Pesticides – Keep Out!” or a similar warning on each door and in any windows of the facility. In some cases, it may be advisable to post the warning signs in one or more languages in addition to English. Post the name, address, and phone number of a contact person at the primary entrance to the storage area.

Regardless of whether it is a cabinet, room, or an entire building, the pesticide storage area should be lockable to prevent unauthorized entry and should be used only for pesticides and pesticide equipment.

An electrically shielded exhaust fan may be needed in a confined storage area to reduce the temperature and/or concentrations of toxic fumes. The fan should be installed so that fumes can be vented outdoors without endangering people, animals, or plants in the area.

Whenever large quantities of pesticides must be stored, it is strongly recommended that fire detection sensors and fire-fighting equipment be provided. A floor plan, records related to the storage location, and an annual inventory of the pesticides and containers in storage must be provided to the local emergency response coordinator as well.

Wooden pallets or metal shelves must be provided for storing granular and dry formulations packaged in sacks, fiber drums, boxes, or other water-permeable containers. If metal pesticide containers are stored for a prolonged period, they should be placed on pallets, rather than directly on the floor, to help reduce potential corrosion and leakage.
Disposing of Excess Pesticides and Pesticide Containers

Despite one’s best efforts to avoid accumulating excess pesticides, it is sometimes necessary to dispose of leftover chemicals. And, occasionally it may be necessary to dispose of pesticide wastes, such as materials collected while cleaning up a spill. Pesticide wastes are as hazardous as the pesticide itself. These guidelines should be followed in handling both excess pesticides and pesticide wastes.

In addition, empty pesticide containers must be disposed of properly. Empty containers that have been properly rinsed may be disposed of in a sanitary landfill if allowed by state and local laws/regulations. Some plastic containers may be recycled after they have been rinsed properly. Refillable containers, described later, may be returned to the supplier unrinsed.

Types of Pesticide Containers

There are several types of pesticide containers. A common agricultural pesticide container is the 2.5-gallon plastic jug. Many liquid agricultural pesticides also are sold in bulk containers (mini-bulks, shuttles, shuttle juniors, etc.), which are intended to be returned and reused by the supplier. Liquid, dry, and granular pesticides often are sold in various sizes of plastic containers and some granular pesticides are sold in bags. Another type of pesticide container is the pressurized can, which is commonly used for indoor pesticides.

Some containers are designed to be returned to the supplier upon emptying without rinsing. These containers commonly are referred to as “refillables.” Refillable containers must not have the seal broken or the container opened. They should never be rinsed. NebGuide G2033, Nebraska Pesticide Container and Secondary Containment Rules, has information about rules for refillable and nonrefillable containers.

Removing Pesticide Residues from Nonrefillable Liquid Containers

Proper rinsing of nonrefillable liquid pesticide containers is easy to do, saves money, is required by state and federal regulations, and is a good, sound management practice that helps protect the environment. Even during a busy season, the few extra minutes it takes to properly rinse empty pesticide containers is time well spent. Here are some rinsing guidelines:

- Rinse the container immediately, as otherwise the remaining residue may dry and become difficult to remove. Typically, an unrinsed pesticide container is considered hazardous waste, but once rinsed, the same container usually is considered solid waste. Rinsing containers also removes a potential source of pesticide exposure to people, pets, livestock, wildlife, and the environment.
- The rinse solution (rinsate) should be added directly into the sprayer tank. This action eliminates the need to store and later dispose of the rinsate.

Proper Rinsing

Two commonly used procedures are effective for properly rinsing nonrefillable liquid pesticide containers: pressure-rinsing and triple-rinsing.

Pressure-rinsing a pesticide container.
Pressure-rinsing

Usually, pressure-rinsing is faster and easier than triple-rinsing. A special nozzle, generally available from your pesticide supplier, is attached to the end of a pressure hose and used to flush the remaining pesticide from the container. The hydrant or water source should have an anti-siphon valve or a back-flow protection device attached.

1. Remove the cap from the pesticide container. Empty pesticide into the spray tank and allow the container to drain for 30 seconds.
2. Insert the pressure-rinser nozzle by puncturing through the lower side (not the bottom) of the pesticide container.
3. Hold the pesticide container upside down over the spray tank opening so rinsate will run into the spray tank.
4. Rinse for the length of time recommended by the manufacturer (usually 30 seconds or more). Rotate the nozzle to rinse all inside surfaces.
5. Rinse caps in a bucket of water for at least one minute and pour this rinse water into the spray tank.
6. Return the container to the supplier or pesticide container recycling site or dispose of the pesticide container according to label directions.

Plastic caps and containers usually are made from different materials, and often are recycled separately. For more information on pesticide container recycling sites, contact your local Extension office.

Triple-rinsing

Triple-rinsing can be done as follows:

1. Remove the cap from the pesticide container. Empty all remaining pesticide into the spray tank, allowing the container to drain for 30 seconds.
2. Fill the container 20 percent full of water or rinse solution (i.e., fertilizer solution).
3. Secure the pesticide container cap.
4. Swirl the liquid within the container to rinse all inside surfaces.
5. Remove the cap from the container. Pour the rinsate from the pesticide container to the spray tank and drain for 30 seconds or more.
6. Repeat steps 2 through 5 two more times.
7. Puncture the container so that it cannot be reused.
8. Return the container to the supplier or pesticide container recycling site or dispose of the pesticide container according to label directions.

Usually, plastic caps and containers are made from different materials and typically are recycled separately. For more information on pesticide container recycling sites, contact your local Extension office.
When Rinsing Is Not Possible

In certain situations it is not possible to triple-
or pressure-rinse pesticide containers. Thorough removal of the pesticide material packaged in bags or pressurized cans may be done as follows:

**Bags**

1. Empty contents of the bag into the spray tank.
2. Shake the bag to remove as much product as possible.
3. Cut the sides and folds to fully open the bag; add the remaining product to the tank.
4. Dispose of the empty bag in a sanitary landfill, if allowed by state and local laws/regulations. Some labels may allow alternate disposal methods.

**Pressurized cans**

1. Spray any remaining contents according to label instructions. Be sure to use it on the proper site and to use it at the correct rate, as listed on the label.
2. Dispose of the empty can according to label directions in a sanitary landfill if allowed by state and local laws/regulations.

Disposal of Excess Pesticide Waste

The best way to dispose of small amounts of pesticide is to apply it to a labeled site (specific plant, animal, or structure) for which the product is registered. Always double check the product label to be certain that the site is listed and that the maximum application rate will not be exceeded.

Large quantities of stored excess pesticides may be hazardous. When disposing of large quantities of such materials, contact the Nebraska Department of Environmental Quality (402-471-2186) or the Nebraska Department of Agriculture (402-471-2394) for specific disposal instructions.

The Nebraska Department of Agriculture occasionally sponsors disposal programs for excess or unwanted pesticides.

Preventing accidental poisonings and damage to the environment requires pesticides to be transported, stored, and disposed of in a safe manner. Read and follow the label carefully. It tells you how to use pesticides, provides information about special hazards, and gives proper storage and disposal methods.
Vehicle Maintenance Checklist

**Cab Interior**
- Clean cab — no food wrappers or trash
- Extra change of clothes
- Post emergency phone numbers: 911 for help involving spills, leaks, and fires
  - Poison Center 800-222-1222
  - For aid in human poisonings
  - NE State Patrol 800-525-5555
  - To report chemical spills or vehicle accidents
- Record of on-board pesticides
- Label and MSDS available
- First aid kit
- Pesticides NOT stored in cab
- Pesticide application equipment NOT present

**On-board Pesticide Containers**
- Lockable pesticide storage compartment
- Containers properly sealed and secured
- Legible labels on all containers
- Pesticides in original containers
- Adequate amount of pesticides for day’s use
- Empty containers properly rinsed and positioned for removal at end of day. **Never reuse pesticide containers!**

**Spill Control**
- Absorbent materials and rags on board
- Shovel, broom, plastic bags on board
- Pesticide spill kit with chemical-resistant gloves, coveralls, goggles, absorbent material, shovel, disposal bag or container

**Equipment Check**
- Sprayers NOT pressurized
- Supplies in moisture-proof containers
- Lids fit securely on pesticide tanks
- Spray hoses and fittings in good condition
- Pressure gauges operable
- All application equipment cleaned
- Water containers labeled

**Personal Protective Equipment**
- Goggles or other eye protection
- Chemical-resistant gloves
- Boots, apron, hat — if required by label
- Respirator — stored in sealed plastic bag
- Other — as directed by the label

**Tires**
- Proper pressure
- Tread wear acceptable
- No cuts or cracks
- Spare tire inflated properly

**Lights**
- High beam headlights
- Low beam headlights
- Turn signals
- Running lights
- Emergency flashers
- Tail lights
- Brake lights
- Backup lights

**Wipers**
- Wiper blades in good condition
- Washer fluid dispenser filled
- Washer fluid pump in working order

**General Vehicle Maintenance**
- Horn in good working order
- Seat belts in good working order
- Brakes in good working order
- Windshield free of obstructions
- Truck bed free of debris

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Vehicle ID __________________________ Notes_________________________
Inspected by ________________________ _______________________________
Date ________________________________ _______________________________
**Pesticide Storage Checklist**

Safety is the key in proper pesticide storage. If you answer “no” to any of the statements below, you should correct your storage facility immediately.

Enter date of each inspection: __________  __________  __________

| General Information |  |  |  |  |  |
|---------------------|---|---|---|---|
| Clean, neat pesticide storage site | Yes | Yes | Yes | Yes |
| Current, on-site pesticide inventory | Yes | Yes | Yes | Yes |
| Emergency phone numbers posted | Yes | Yes | Yes | Yes |
| Labels and MSDS available | Yes | Yes | Yes | Yes |
| Accurate storage inspection log maintained | Yes | Yes | Yes | Yes |

| Pesticide Containers |  |  |  |  |  |
|----------------------|---|---|---|---|
| Containers marked with purchase date | Yes | Yes | Yes | Yes |
| Insecticides, herbicides, and fungicides segregated | Yes | Yes | Yes | Yes |
| Pesticides stored in original containers | Yes | Yes | Yes | Yes |
| Dry formulations stored on pallets | Yes | Yes | Yes | Yes |
| Feeds stored separately from pesticides | Yes | Yes | Yes | Yes |
| Used containers rinsed and drained | Yes | Yes | Yes | Yes |
| Rinsed and unrinsed containers separated | Yes | Yes | Yes | Yes |
| Liquid formulations stored below dry formulations | Yes | Yes | Yes | Yes |

| Spills and Disposal |  |  |  |  |  |
|---------------------|---|---|---|---|
| Storage area free of spills or leaks | Yes | Yes | Yes | Yes |
| Shovel and absorbent materials available | Yes | Yes | Yes | Yes |
| Sealed floors | Yes | Yes | Yes | Yes |
| Floor drains closed off (if present) | Yes | Yes | Yes | Yes |

| Safety Information |  |  |  |  |  |
|-------------------|---|---|---|---|
| No smoking signs posted | Yes | Yes | Yes | Yes |
| Personal protective equipment available | Yes | Yes | Yes | Yes |
| Fire extinguisher in good working order | Yes | Yes | Yes | Yes |
| Storage room locked, limited access to keys | Yes | Yes | Yes | Yes |
| Storage room posted: **Pesticides — Keep Out!** | Yes | Yes | Yes | Yes |
| Storage site well lit and ventilated | Yes | Yes | Yes | Yes |

Adapted from Pesticides and Commercial Vehicle Maintenance, Purdue University.
Managing Pesticide Spills

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This NebGuide describes the steps to follow after a pesticide spill to promote safe and effective management and to avoid human toxicity or environmental contamination.

No one expects to have a pesticide spill, but being prepared to manage one is part of practicing good pesticide safety. Protecting human health and the environment is essential. Pesticides are toxic to humans and other living organisms as well as to the pests they control. Exposure to pesticides, whether during the mixing and application process or during a spill, poses a risk to human health. Pesticide spills also can be a direct threat to the environment by leaching into groundwater, contaminating surface water, persisting in the soil, or harming nontarget plants and animals.

There are three common ways pesticide spills occur: during storage or transportation, when mixing the spray solution, or during application. Pesticide spills during storage or transportation can be due to damaged containers or a vehicle accident (see Safe Transport, Storage, and Disposal of Pesticides (EC2507) for more on safe transport of pesticides). Spills during the mixing process often can be attributed to human error, while spills during application often are caused by equipment malfunction. Pesticide spills can range from very minor, like a single leaking pesticide container, to a major spill, such as a tanker truck accident. No matter the cause or size of the spill, being prepared to manage it is important.

Spill Management

Proper training in handling pesticides is the number one way to prevent spills. It is important that all those involved in the use of pesticides be trained on how to correctly transport, store, mix and apply, and dispose of pesticides, as well as how to properly respond to and manage a pesticide spill. See the Resources at the end of this NebGuide for more information on preventing pesticide spills.

If a spill occurs, protecting the environment and human health is the primary goal. Following guidelines like the Three C’s, referring to the pesticide label, and contacting the appropriate agencies to report the spill will help achieve this goal.

The Three C’s

The Three C’s — Control, Contain, Clean Up — provide guidelines for managing a pesticide spill. The Three C’s provide a way to quickly organize after a pesticide spill, whether it occurred during transport, storage, mixing and loading, or application. Also consider where the spill has occurred when preparing to manage it. Managing a pesticide spill on soil may be different than a spill that occurs on a concrete loading pad.

Control: Control is the first step of the Three C’s because the goal is to stop the release of the pesticide. For example, if a five-gallon jug leaks liquid pesticide from a crack in the bottom, place the jug inside a larger container to catch the pesticide. If it is a larger container (e.g., 55-gallon drum), try to stop the leak by plugging it. If a hose or spray tip on application equipment is leaking, relieve the pressure and use a container to catch the solution.

Planning ahead will ensure that the necessary emergency materials are on hand to control a larger leak. Make sure to wear the proper protective clothing to prevent chemical exposure when controlling a pesticide spill.

Contain: When controlling the spill, it is also equally important to contain it to keep the pesticide from spreading. When a spill occurs in the field, the pesticide can be prevented from spreading by creating a dam using soil and a shovel. When the spill is on a hard surface, use an absorbent material like cat litter or an absorbent pillow designed to contain the spill. If the spill occurs with a dry pesticide formulation, prevent spreading by lightly misting with water (do not over-apply water or runoff may occur), or covering the spill with a plastic tarp. The important thing is not to let the spilled material get into any body of water, including storm sewers or drains.

Clean Up: After the spill has been contained, the absorbent material and pesticide need to be properly disposed, and the area cleaned. For spills on concrete or similar materials, the absorbent material should be swept up and placed in a fiber or steel drum lined with a heavy-duty plastic bag. The area can then be cleaned using a commercial cleaning product made for this purpose (e.g., ammonia and water,
commercial tank cleaner and water, or as recommended on the product label. Use more absorbent material to soak up the cleaning solution and dispose of it in the heavy-duty plastic bag. When the spill occurs on soil, the only effective way to decontaminate the area is to remove the top 2-3 inches of soil. In either of these situations, the next step is to follow state guidelines for disposing of the pesticide waste material, now considered hazardous waste. Contact the Nebraska Department of Environmental Quality, (402) 471-2186, for guidance on disposal of cleanup material following a spill. Since each spill will be different, the Nebraska Department of Environmental Quality will determine the proper steps for each situation.

In addition to cleaning the area where the spill occurred, be sure to clean any equipment used in the cleanup process. Be sure that hands, clothing, and any other exposed skin are washed as soon as possible with soap and water. If only water is available, be sure to rinse repeatedly and then wash with soap and water as soon as possible.

Remember the PPE

In the chaos of an emergency, it can be easy to forget personal safety. Personal protective equipment (PPE) is necessary when dealing with a pesticide spill. Wearing chemical-resistant gloves, a long-sleeved shirt, long pants, shoes plus socks, and a chemical-resistant apron or coveralls (if concentrated pesticide is involved) is a must. Even if there is an injury, PPE should be put on before attending to the victim to prevent exposure to toxic chemicals.

Spill Kit

A spill kit is essential when working with pesticides because it contains all the items needed when a spill occurs. With all the items in one place, response to a pesticide spill can occur quickly. The following items should be included in a plastic container labeled “Spill Kit”:

- Emergency telephone numbers (see next page)
- Copies of all labels and Material Safety Data Sheets (MSDS) for pesticides in storage, under transport, or being applied
- Chemical-resistant gloves, footwear, apron/coveralls
- Long-sleeved shirt
- Protective eyewear
- Respirator (if working in a confined space or required by the product label)

- Absorbent material (e.g., cat litter, sawdust, spill pillow)
- Shovel, broom, dustpan
- Heavy-duty detergent for cleaning (e.g., commercial cleaner, ammonia, detergent as recommended by pesticide product manufacturer)
- Decontamination kit (used to clean hard surfaces; can include sponges, paper towels, scrub brush, and cleaning solution appropriate for the chemicals being used)
- Fire extinguisher rated for chemical fires
- Other items specified on labels of the products in use
- Heavy-duty plastic bags for disposing of hazardous waste

Figure 1. Example of a spill kit.

Read the Label

Product labels and MSDS contain emergency information and procedures that may be specific to each product. Read labels carefully and make sure they are easily accessible for quick reference in an emergency.

Resources


Pesticide Environmental Stewardship, Pesticide Spills, http://pesticidestewardship.org

When and How to Report a Pesticide Spill

Evaluating which spill situations require reporting is the first step in proper response. The following statement helps assess when to report a spill: “Report a spill if there is any potential harm to human health or the environment ... a spill is not reportable when it does not result in pesticide lost to the environment ... such as when it occurs on a concrete floor or in an enclosed area.”

Follow these steps when a spill occurs:

1. Call First Responders/EMT for human injuries, and medical or fire emergencies (911), OR The Poison Center for aid in human poisoning cases, (800) 222-1222.
2. Control the spill.
3. Contain the spill.
4. Call CHEMTREC (Pesticide Accident Hotline) or the local fire department for help involving spills, leaks, fires; be prepared to report the actual amount of concentrated chemical/fertilizer spilled, (800) 424-9300.
5. Call the Nebraska State Patrol to report chemical spills or releases and motor vehicle accidents on state/public roadways, (800) 525-5555; OR the Nebraska Department of Environmental Quality to report all other spills, (402) 471-2186 and receive guidance.
6. Clean up the spill according to recommendations from appropriate agencies.

It is imperative to contact the appropriate state agencies when a spill occurs. Refer to the numbers listed below in nonemergency situations.

Nonemergency Telephone Numbers

- National Pesticide Information Center for questions about pesticides and safety, (800) 858-7378.
- Chemical Referral Center (weekdays only) for referrals to manufacturers on health and safety related to chemicals, (800) 262-8200.
- Individual chemical manufacturer numbers on the pesticide label.
Protecting Pesticide Sensitive Crops

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This NebGuide examines how to protect sensitive crops, such as those found on organic and traditional commercial farms or in vineyards, from pesticide injury.

Pesticide sensitive crops, such as grapes in vineyards or fruit, vegetable, and ornamental crops grown on organic or traditional commercial farms, are becoming more common in the landscape. Consumer demand has created markets for these products, and sales of these crops have contributed to the state’s agricultural economic diversity. Even though any agricultural crop can be damaged by pesticide drift, these crops are especially sensitive to injury by pesticides; the potential for economic loss is significant. For example, grapes have an annual fruit value of $4,000 to $5,000 per acre and the processed value can be up to 10 times higher (Figure 1).

Use Pesticides Carefully

Pesticides include herbicides, insecticides, and fungicides. When applying pesticides, take extra precautions to avoid damaging sensitive crops. Many plants and animals are sensitive to pesticides and may be harmed by particle spray drift, vapor drift, or pesticides that run off the target area. This NebGuide focuses on herbicides that are especially prone to drift, and have high risk of causing damage when they move off-target. Reducing the potential for off-site movement onto sensitive sites is particularly important when applying these herbicides.

Since the introduction of Roundup Ready™ crops in 1996, glyphosate has been used extensively for weed management in the Midwest. Glyphosate drift can damage many different crops. Plants including grapes, tomatoes, potatoes, soybeans, and fruit and nut trees, are very sensitive to spray drift from hormonal-type herbicides such as dicamba, picloram, MCPA, triclopyr, fluoroxypr, mecoprop, and 2,4-D. These herbicides can affect plants, especially sensitive crops, near the application site.

Be Proactive

The Nebraska Department of Agriculture (NDA) and Purdue University have arranged for a Web-based locator for sensitive commercial crops and bee hives called Driftwatch™ (Figure 2). Commercial growers of sensitive crops and bee keepers

Figure 1. Fruit crops such as grapes contribute to Nebraska’s agricultural economic diversity (Jeanne Fox, Kansas Department of Agriculture).

Figure 2. Nebraska Driftwatch encourages commercial producers to register locations of sensitive crops and bee hives.
are encouraged to register locations of their crops and hives. Pesticide applicators are encouraged to use this website to determine if any sensitive crops are near a planned pesticide application site. If a sensitive crop site is identified, applicators should adjust pesticide application procedures, including timing and/or application methods, accordingly.

Applicators are encouraged to use Driftwatch and document known locations in application records, or print a map from the website and incorporate it into application records. It is also good practice to scout the area before the planned pesticide application to become familiar with the landscape. Because listings on Driftwatch are voluntary, not all sensitive crop locations may be included. Pesticide applicators and dealers should visit with neighbors who may have sensitive crops or bee hives to let them know of intended pesticide applications, and assure them that all applications will be made so as to avoid injury.

Driftwatch allows applicators the ability to sign up for email notifications when new locations are entered in their “business area.” Simply register for this service then choose a business area by selecting statewide or individual counties, or use the online mapping tool to draw a geographic area.

Driftwatch is only as effective as the information provided by growers and the action taken by applicators. New or updated information should be submitted as soon as possible. In addition, those with sensitive crops should contact their neighbors and/or local pesticide dealers, co-ops, and other pesticide applicators in the area to alert them to the potential for pesticide damage. Good communication is the key to avoiding pesticide injury problems.

The Nebraska Driftwatch can be found at http://nebraska.agriculture.purdue.edu/.

### Strategies to Protect Sensitive Crops

**Use Integrated Pest Management (IPM).** Before each application, review and consider using a variety of IPM methods, including pest prevention, scouting to monitor pest populations, economic threshold levels, and pesticide alternatives such as mechanical controls, sanitation, crop rotation, biological controls, and selection of resistant varieties.

**Select an appropriate pesticide product.** If using a chemical control, read product labels to find one suitable for the pest you want to control. Consider the toxicity and potential hazard of the product, and select one with the lowest risk of harming sensitive crops. Make sure the target site or crop is listed on the label.

**Read the label.** Follow all label directions. It is illegal to apply more than the label allows. For more details about the pesticide label see Understanding the Pesticide Label (NebGuide G1955).

- Remember that the pesticide label is the law. Read and follow all directions and precautions. Only apply pesticides on sites (crops, pastures, or other areas) that are listed on the label. Application of a pesticide to a site that is not listed on the label is illegal. Do not exceed the rate specified on the pesticide label; the use of a rate higher than that given on the label is illegal. The risk of off-target injury to people, livestock, pets, wildlife, and plants will be greatly reduced by following label instructions.
- Many labels, especially new ones, have instructions on avoiding drift. Some new labels include set-back zones to protect sensitive areas. Additionally, there could be information ranging from droplet size, nozzle selection, and maximum wind speeds in which applications can be made to avoid drift.

**Follow all precautions and plan your application.** The pesticide label will list environmental hazards and restrictions on the use of the product. Become familiar with the application site and ask yourself these questions:

- Are there any sensitive or desirable plants nearby?
- Is there a stream, pond, ditch, drainage area, or other open-water site close by?
- Does the weather forecast predict suitable conditions for application?
- Could the wind carry the pesticide to a neighboring property?
- Is my chosen pesticide product likely to volatilize due to high temperatures either on the day of application or the next day?
- Are there any children, pets, or other animals in the area?
- Do I know the amount of pesticide needed to complete the job so I don’t mix more than necessary?

**Watch for drift or runoff during the pesticide application.** It’s good practice to adjust pesticide applications for conditions that may increase drift or runoff. One factor to consider is wind speed and direction. Stop applying if the weather becomes too windy or if the product starts to run off the target area. You can also reduce injury by reducing your field speed when navigating difficult areas and if near sensitive crops. This will prevent uneven treatment patterns and wind eddies that can form behind a fast-moving tractor, and decrease unwanted movement of the boom.

Wind and boom height are two of the biggest problems when it comes to drift. By using a rate controller that changes output pressure, and lowering boom height, you can effectively help reduce drift. For more details about pesticide drift and how to prevent it, see *Spray Drift of Pesticides* (NebGuide G1773).

**Clean equipment thoroughly after applying any herbicide.** Herbicide residues in spray equipment can damage crops during future pesticide applications. Always clean tanks, nozzles, and other equipment thoroughly after applying herbicides by adding one-half tank of water, then flushing all parts of the tank for five minutes through agitation and spraying. Always spray rinseate on an appropriate site.

If several pieces of spray application equipment are available, dedicate one to phenoxy herbicides or one to the specific crop to be treated. If not, extra careful cleaning following each application of a phenoxy herbicide is necessary to avoid subsequent crop damage. Mixing two quarts of ammonia and letting it stand in the sprayer overnight is especially effective for cleaning residue from growth regulator herbicides such as 2,4-D (phenoxy) or dicamba. Certain herbicides, such as glyphosate, if left in the tank, will absorb growth regulator herbicides that are added later and result in crop injury when applied. For more details about cleaning pesticide application equipment see *Cleaning Pesticide Equipment* (NebGuide G1770).

**Follow directions for storing and disposing of unused pesticides and empty containers.** Off-site movement of rinse water or unused pesticides can harm sensitive sites, including sensitive crops. Plan your application carefully so that only the amount of pesticides needed will be mixed, and no extra mixed product will be left over. However, if extra product remains after an application is completed, dispose of the remainder by applying to a site mentioned on the label. Nebraska does not have a statewide pesticide disposal program. There are companies that can help you dispose of unused or outdated
pesticide for a fee, but it is better to plan ahead and avoid
having leftover pesticide. 

Empty containers should be triple or pressure rinsed and
either disposed of at a landfill according to label directions, or
recycled. See the resources listed under “Additional Informa-
tion” in this publication for more information about disposal and
recycling programs. 

Always store pesticides in a cool, dry, locked storage
facility away from food, feed, and other supplies. Be sure the
structure where you store pesticides is not located near water
resources or sensitive sites. Store liquid pesticides on lower
shelves in case of spills, and always have a spill kit available.
Keep pesticides in their original containers, and when ready
to do an application, use the oldest pesticides first. 

For more details about storage and disposal of pesticides see Safe Transport, Storage, and Disposal of Pesticides (EC2507). 

Pesticides Can Move Off the Application Site 

Particle Drift. Small spray droplets are susceptible to
drift during a pesticide application and may potentially travel
long distances to damage non-target plants or animals. To help
prevent drift, use larger spray droplets and lower pressures;
select nozzles designed to reduce drift, and apply the pesticides
using the appropriate boom height. Make sure the wind speed
is low and blowing away from sensitive areas. 

Vapor Drift. After a pesticide is applied, the product may
volatilize off the application site and move in an unpredict-
able manner, affecting off-site plants. The volatility of some
pesticide products increases as the temperature rises into the
upper 80s and 90s. The product label will warn you not to
apply the product if a certain temperature is expected in the
next few days. Ester formulations of phenoxy herbicides, for
example, are more likely to volatilize and damage sensitive
crops than amine formulations. 

Spray drift can be reduced by doing the following: 

• Spray when wind speeds are less than 10 mph. 

• Avoid applying pesticides when there is a temperature
inversion. An inversion occurs when there is cool,
calm air near the surface with warmer air above. The
inversion reduces air circulation and results in spray
particles concentrating at the cool/warm air boundary
and then moving off-site in an unpredictable manner. 

• Select a nozzle that produces coarser (larger) spray
droplets. 

Use the lower end of the suggested pressure range for
a given spray nozzle. 

• Adjust the height of the boom so it is at the appropriate
application height. 

• Use an additive to control drift on windy days. 

Volatilization can be reduced by doing the following: 

• Switch to a less volatile formulation. For example,
switch from the ester form of 2,4-D to the less volatile
amine form. 

• The companies that manufacture growth regulator
herbicides are currently working to design,
manufacture and market low drift and low volatility
compounds. These new formulations in combination
with practices such as low drift nozzles, drift reduc-
ing adjuvants, and reduction in pressure will reduce
both drift and volatility. 

  - Dow AgroSciences has a low volatile 2,4-D choline
salt. 

  - BASF has a low volatile dicamba BAPMA. 

• Spray only when temperatures will remain less than
90°F for several days. 

Runoff. A pesticide product applied to a steep slope, bare
ground, or even level ground immediately before a rain can
run off and enter streams, rivers, and lakes, or severely
damage other plants. Runoff can kill fish or aquatic invertebrates
and/or make the water unsuitable for recreation or human
consumption. Select a chemical weed control and application
method that will not violate the label or cause damage. For
more details about pesticide runoff and runoff prevention see
Protecting Surface Water Quality (EC730). 

Growth Regulator Herbicides 

Growth regulator herbicides, despite being the oldest
herbicide mode-of-action on the market, are not completely
known. Growth regulator herbicides are known to mimic indole
acetic acid in plants. The mimicry of auxin in the plant leads to
malformed growth and epinasty (downward bending of plant
parts such as leaves due to increased growth of upper leaf
tissue) in broadleaf plants when exposed to growth regulator
herbicides. While growth regulators are not any more prone
to drift than other herbicides, they are often thought to be
because injury from growth regulator herbicides are distinct
and are caused by much lower doses than many of the other
herbicides currently on the market.
Symptoms of Phenoxy (2,4-D) Injury

Phenoxy (phenoxyacetic acid) herbicides, such as 2,4-D, are a subset of growth regulator herbicides that cause abnormal plant growth by disrupting the hormone balance within the plant. Broadleaf plants are more susceptible to this type of injury. Sensitive plants that receive small amounts of a phenoxy herbicide may develop abnormal leaves and multiple or enlarged lower plant parts (Figure 3). Higher concentrations of the herbicide can cause stunting and cupping of leaves, twisted growth of soft shoots, clearing and enlargement of major leaf veins (Figure 4), and severe distortion of flowering or fruiting plant parts.

When phenoxy injury is present, the youngest growth is most severely affected. Plant growth may stop after exposure to a phenoxy herbicide and may be restricted for several weeks. Vines (i.e. grapes) showing symptoms of 2,4-D injury usually do not produce new growth with normal features for the rest of the season. Severely injured vines may not recover for two or more years.

Additional Information

University of Nebraska Extension Publications
http://www.ianrpubs.unl.edu/epublic/pages/index.jsp
- Spray Drift of Pesticides, G1773
- Nozzles - Selection and Sizing, G955
- How to Spray a Field to Prevent Overlap and Reduce Drift Injury, G1570
- Cleaning Pesticide Equipment, G1770
- Guide for Weed Management, EC130
- Protecting Surface Water Quality, EC730
- Safe Transport, Storage, and Disposal of Pesticides, EC2507
- Understanding the Pesticide Label, G1955

University of Nebraska–Lincoln Extension Pesticide Safety Education Program
- Pesticide Container Recycling: http://pested.unl.edu/recycling
- Pesticide Disposal: http://pested.unl.edu/Hazardous

NDA’s Pesticide Program: http://www.agr.ne.gov/pesticide/
- Nebraska Driftwatch
- Integrated Pest Management
- Applicator Certification and Training
- Nebraska Pesticide Act and Enforcement

National Pesticide Information Center, for objective, science-based information about pesticides and pesticide-related topics: (800) 858-7378, www.npic.orst.edu

The U.S. Environmental Protection Agency Office of Pesticide Programs www.epa.gov/pesticides/

This publication has been peer reviewed.

Disclaimer

Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement by University of Nebraska–Lincoln Extension is implied for those mentioned.

UNL Extension publications are available online at http://extension.unl.edu/publications.

Index: Pesticides, General
Herbicides
Issued October 2012
Label Questions

Answer the questions using the label for Milestone herbicide included in this exercise. These herbicide label questions are not specific to the Milestone herbicide label and can be applied to any label of your choosing. So, for further practice reading pesticide labels, choose another label and answer the questions.

1. What is the signal word on this label and what does it indicate?

2. What should you do if the concentrated product comes in contact with your skin or clothing?

3. List the Personal Protective Equipment (PPE) that must be worn when applying and/or handling this product.

4. What potential hazards to the environment exist when using this pesticide?

5. What are the storage requirements for this product?

6. If a restricted-entry interval (REI) is present, what is the REI?

7. How do the empty pesticide containers need to be cleaned and disposed?

8. List the different methods of application that can be used.

9. What pest(s) does this product aim to control? If possible list at least three pests controlled.

10. Describe the sites where this pesticide can be used. List two sites that are allowed by this label and one site that is not allowed.

11. What problems may arise from feeding cattle hay that has been treated with Milestone?

See Educator for Answer Key.
**Specimen Label**

**Specialty Herbicide**

- For control of susceptible weeds and certain woody plants, including invasive and noxious weeds, on rangeland, permanent grass pastures, Conservation Reserve Program (CRP) acres, non-cropland areas (such as roadsides), non-irrigation ditch banks, natural areas (such as wildlife management areas, wildlife openings, wildlife habitats, recreation areas, campgrounds, trailheads and trails), and grazed areas in and around these sites.

**IMPORTANT ADVISORY TO PREVENT INJURY TO DESIRABLE PLANTS**

- It is mandatory to follow the “Use Precautions and Restrictions” section of this product label.
- Carefully read the section “Plant Residues or Manure.”
- Manure and urine from animals consuming treated grass or hay may contain enough aminopyralid to cause injury to sensitive broadleaf plants.
- Inform the recipient of hay or manure from animals grazing pastures or feeding on hay from areas treated with aminopyralid of the label use precautions and restrictions.
- Consult with a Dow AgroSciences representative if you do not understand the “Use Precautions and Restrictions”. Call [1-(800) 263-1196] Customer Information Group.

**Hay and Manure Management**

- Rangeland, Pasture, Hayfield, CRP
- Manure, Compost, Hay, Bedding
- Potato, Lettuce, Beans, Tomato
- Rangeland, Pasture, Wheat
Not For Sale, Distribution, or Use in New York State.

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<tr>
<th>GROUP</th>
<th>4</th>
<th>HERBICIDE</th>
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Active Ingredient:
Trisopropanolammonium salt of 2-pyridine carboxylic acid, 4-amino-3,6-dichloro—............................................ 40.6%  
Other Ingredients .............................................. 59.4%  
Total ................................................................. 100.0%

Acid Equivalent: aminopyralid (2-pyridine carboxylic acid, 4-amino-3,6-dichloro) - 21.1% - 2 lb/gal

EPA Reg. No. 62719-519

Keep Out of Reach of Children

CAUTION

Agricultural Use Requirements
Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. Refer to label booklet under “Agricultural Use Requirements” in the “Directions for Use” section for information about this standard.

Refer to inside of label booklet for Directions for Use.

Notice: Read the entire label. Use only according to label directions. Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies at end of label booklet. If terms are unacceptable, return at once unopened.

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Container Use Directions
1. Tip
   - Tilt container at an angle as shown and til head to desired amount—use vertical scale for measuring. Container should be sealed.
2. Level
   - Hold container upright and check the amount for accuracy. Add or subtract as needed, using pound-back scale or guide.
3. Dispense
   - Remove cap on head and pour into sprayer or other devices. No need to pour from the main container. Replace cap for storage in sealed condition.

Precautionary Statements

Hazards to Humans and Domestic Animals

CAUTION

Causes Moderate Eye Irritation

Avoid contact with eyes or clothing.

Personal Protective Equipment (PPE)
Applicators and other handlers must wear:
- Long-sleeved shirt and long pants
- Shoes plus socks

Follow manufacturer’s instructions for cleaning/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.

First Aid
If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Environmental Hazards
Do not apply directly to water, 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 washerwater or rinsate.

Directions for Use
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

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.

Not For Sale, Distribution, or Use in New York State.

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 48 hours.

REI 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
- Chemical-resistant gloves made of any waterproof material as polyethylene or polyvinyl chloride
- Shoes plus socks

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for Agricultural Pesticides (40 CFR Part 170). The WPS does not pertain to non-agricultural use on sites, such as, rangeland, permanent grass pastures, or non-cropland. If the WPS applies, see the Agricultural Use Requirements section below for information where the WPS applies.

Entry Restrictions for Non-WPS Uses: For applications on rangeland and permanent grass pastures (not harvested for hay) and non-cropland areas, do not enter or allow worker entry into treated areas until sprays have dried.

Storage and Disposal
Do not contaminate water, food, feed or fertilizer by storage or disposal. Open dumping is prohibited.

Pesticide Storage: If this product is exposed to subfreezing temperatures, the active ingredient may crystallize and settle out of solution. Under these conditions the product should be warmed to at least 40°F and agitated well to dissolve any crystallized active ingredient prior to use.

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

Nonrefillable containers 5 gallons or less:
Container Handling: Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Triple rinse or pressure rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal.

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Maximum Application Rate: On all labeled use sites do not broadcast apply more than 7 fl oz per acre of Milestone per year. The total amount of Milestone applied broadcast, as a re-treatment, and/or spot treatment cannot exceed 7 fl oz per acre per year. Spot treatments may be applied at an equivalent broadcast rate of up to 0.22 lb acid equivalent (4 fl oz of Milestone) per acre per annual growing season; however, not more than 50% of an acre may be treated at that rate. Do not apply more than a total of 0.11 lb acid equivalent (7 fl oz per acre of Milestone per annual growing season) as a result of broadcast, spot or repeat applications.

Avoiding Injury to Non-Target Plants: Do not apply Milestone within 50 feet of a border downwind (in the direction of wind movement), or allow spray drift to come in contact with any broadleaf crop or other desirable broadleaf plants, including, but not limited to, alfalfa, cotton, dry beans, flowers, grapes, lettuce, potatoes, radishes, soybeans, sugar beets, sunflowers, tobacco, tomatoes or other broadleaf or vegetable crop, fruit trees, ornamental plants, or soil where sensitive crops are growing or will be planted. Application under conditions that may allow spray drift because of very small quantities of spray may seriously injure susceptible crops. Read and consider the “Precautions for Avoiding Spray Drift and Spray Drift Advisory” at the end of this label to help minimize the potential for spray drift.

Milestone is highly active against many broadleaf plant species. Do not use this product on areas where loss of broadleaf plants, including legumes, cannot be tolerated.

Do not use on grasses grown for hay intended for export.

Chemigation: Do not apply this product through any type of irrigation system.

Do not contaminate water intended for irrigation or domestic purposes. Do not treat inside banks or bottoms of irrigation ditches, either dry or containing water, or other channels that carry water that may be used for irrigation or domestic purposes.

Do not apply this product on residential or commercial lawns or ornamental plantings.

Seeding grasses:
- Preemergence: Milestone may be applied in the spring or early summer, depending on the target weed species, and grass planted in the fall when conditions are favorable for grass establishment.
- Postemergence: During the season of establishment, Milestone should be applied only after perennial grasses are well established (have developed a good secondary root system and show good vigor). Most perennial grasses are tolerant to Milestone at this stage of development. Milestone may suppress certain established grasses, such as smooth bromegrass (Bromus inermis), especially when plants are stressed by adverse environmental conditions. Grasses should recover from this transient suppression with the onset of environmental conditions favorable to grass growth and upon release from weed competition.

Seeding Legumes: Do not plant forage legumes until a soil bioassay has been conducted to determine if aminopyralid concentration remaining in the soil will adversely affect the legume establishment.

Grazing and Haying Restrictions: There are no restrictions on grazing or hay harvest following application of Milestone at labeled rates. Cutting hay too soon after spraying weeds will reduce weed control. Wait 14 days after herbicide application to cut grass hay to allow herbicide to work. Do not transfer grazing animals from areas treated with Milestone to areas where sensitive broadleaf crops occur without first allowing 3 days of growth of the untreated pasture. Otherwise, urine and manure may contain enough aminopyralid to cause injury to sensitive broadleaf plants.

Grazing Poisonous Plants: Herbicide application may increase palatability of certain poisonous plants. Do not graze treated areas until poisonous plants are dry and no longer palatable to livestock.

Plant Residues or Manure:
- Do not use aminopyralid-treated plant residues, including hay or straw from treated areas, or manure from animals that have grazed forage or eaten hay harvested from treated areas within the previous 3 days, in compost or mulch that will be applied to areas where commercially grown mushrooms or susceptible broadleaf plants may be grown.
- Do not spread manure from animals that have grazed or consumed forage or eaten hay from treated areas within the previous 3 days on land used for growing susceptible broadleaf crops.

Storage and Disposal (Cont.)

disposal. Insert pressure rinsing nozzle in the side of the container, and rinse container at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

Refillable containers larger than 5 gallons:
Container Handling: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or a mix tank. Fill the container about 10% full with water. Agitate vigorously or recirculate water with the pump for two minutes. Pour or pump rinse into application equipment or rinse collection system. Repeat this rinsing procedure two more times.

Nonrefillable containers larger than 5 gallons:
Container Handling: Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Triple rinse or pressure rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto another end and tip it back and forth several times. Empty the rinse into application equipment or a mix tank or store rinse for later use or disposal. Repeat this procedure two more times. Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinse for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

Milestone specialty herbicide may be applied by aerial or ground equipment to control susceptible broadleaf weeds and certain woody plants, including invasive and noxious weeds on rangeland, permanent grass pastures, CRP acres, non-CRP areas (such as roadsides), non-irrigation ditch banks, natural areas (such as wildlife management areas, wildlife openings, wildlife habitats, recreation areas, campgrounds, trailheads and trails), and grazed areas in and around these sites without injury to most grasses.

It is permissible to treat non-irrigation ditch banks, seasonally dry wetlands (such as flood plains, deltas, marshes, swamps, or bogs) and transitional areas between upland and lowland sites. Milestone can be used to the waters edge. Do not apply directly to water and take precautions to minimize spray drift onto water.

Resistance Management Guidelines
- Development of plant populations resistant to this herbicide mode of action is usually not a problem on rangeland, permanent grass pastures, Conservation Reserve Program (CRP), or non-CROP sites since these sites receive infrequent pesticide applications.
- In croplands, use an effective integrated pest management (IPM) program, integrating tillage or other mechanical methods, crop rotation or other cultural control methods into weed control programs whenever practical.
- Similar looking biotypes of a given weed species occurring in a treated area may vary in their susceptibility to a herbicide. Application of a herbicide below the treated area may remove tolerant weeds to survive and a shift to more tolerant biotypes within the treated area.
- Where identified, spreading of resistant weeds to other fields may be prevented by cleaning harvesting and tillage equipment before moving to other fields and by planting weed-free seed.
- Contact your extension specialist, certified crop consultant, or Dow AgroSciences representative for the latest resistance management information.

Use Precautions and Restrictions
Consult with a Dow AgroSciences representative if you do not understand the “Use Precautions and Restrictions.” Call (1-800-263-1196) for more information.
Table 1: Amount of Milestone (in mL) to mix in 1 gallon of water

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<thead>
<tr>
<th>Gallons per acre</th>
<th>Milestone amount (in mL) to mix with various application rates</th>
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<td>5 fl oz</td>
</tr>
<tr>
<td>GPA</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>7.5</td>
</tr>
<tr>
<td>30</td>
<td>5.0</td>
</tr>
<tr>
<td>40</td>
<td>3.8</td>
</tr>
<tr>
<td>50</td>
<td>3.0</td>
</tr>
<tr>
<td>60</td>
<td>2.5</td>
</tr>
<tr>
<td>70</td>
<td>2.1</td>
</tr>
<tr>
<td>80</td>
<td>1.9</td>
</tr>
<tr>
<td>90</td>
<td>1.7</td>
</tr>
<tr>
<td>100</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Conversions:
1 tsp = 5 mL
3 tsp = 1 Tbsp
1 cc = 1 mL
30 mL = 1 fluid ounce
2 Tbsp = 1 fluid ounce

Table 2: Amount of Milestone per 1000 sq ft to Equal Broadcast Rate

<table>
<thead>
<tr>
<th>Broadcast Rate (fl oz/acre)</th>
<th>Amount of Milestone per 1000 sq ft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(fl oz)</td>
</tr>
<tr>
<td></td>
<td>(Milliliters)</td>
</tr>
<tr>
<td>3</td>
<td>0.069</td>
</tr>
<tr>
<td>5</td>
<td>0.115</td>
</tr>
<tr>
<td>7</td>
<td>0.161</td>
</tr>
</tbody>
</table>

Note: 1 fluid ounce (fl oz) = 29.6 milliliters (mL) = 2 tablespoons = 6 teaspoons
To calculate the amount of Milestone for areas larger than 1000 sq ft:
Multiply the table value (fl oz or milliliters) by the area to be treated in "thousands" of square feet. For example, if the area to be treated is 3500 sq ft, multiply the table value by 3.5 (3500 sq ft divided by 1000 sq ft = 3.5).

Mixing Instructions

Mixing with Water: To prepare the spray, add about half the required amount of water in the spray tank. Then, with agitation, add the specified amount of Milestone and other registered tank mix herbicides. Finally, with continued agitation, add the rest of the water and additives such as surfactants or drift control and deposition aids.

Addition of Surfactants or Adjuvants on All Labeled Use Sites: The addition of a high quality non-ionic surfactant (of at least 80% active ingredient) at 0.25 to 0.5 % volume per volume (1 to 2 quarts per 100 gallons of spray) is recommended to enhance herbicide activity under adverse environmental conditions (such as, high temperature, low relative humidity, drought conditions, dusty plant surfaces) or when weeds are heavily pubescent or more mature.

Tank Mixing with Other Herbicides: Milestone at rates of up to 7 fl oz per acre may be mixed with labeled rates of other herbicides registered for application on all labeled use sites. Milestone may be applied in tank mix combination with labeled rates of other herbicides provided: (1) the tank mix product is labeled for the timing and method of application for the use site to be treated and (2) mixing is not prohibited by the label of the registered tank mixed products, and (3) that the tank mix combination is physically compatible (see tank mix compatibility testing below). When tank mixing, use only in accordance with the restrictions, precautions and limitations on the respective product labels.

- Read carefully and follow all applicable use directions, precautions, and limitations on the respective product labels.
- Do not exceed specified application rates. If products containing the same active ingredient are mixed, do not exceed the maximum allowable active ingredient use rates.
- For direct injection or other spray equipment where the product formulations will be mixed in undiluted form, special care should be taken to ensure tank mix compatibility.
- Always perform a jar test to ensure the compatibility of products to be used in tank mixture.

Tank Mix Compatibility Testing: Perform a jar test prior to mixing in a spray tank to ensure compatibility of Milestone and other pesticides or carriers. Use a clear glass jar with lid and mix ingredients in the same order and proportions as will be used in the spray tank. The mixture is compatible if the materials mix readily when the jar is inverted several times. The mixture should remain stable after standing for 1/2 hour or, if separation occurs, should readily remix if agitated. An incompatible mixture is indicated by separation into distinct layers that do not readily remix when agitated and/or the presence of flakes, precipitates, gels, or heavy oily film in the jar. Use of an appropriate compatibility aid may resolve mix incompatibility. If the mixture is incompatible do not use that tank mix partner in tank mixtures.

Mixing with Sprayable Liquid Fertilizer Solutions: Milestone is usually compatible with the liquid fertilizer solutions. It is anticipated that Milestone will not require a compatibility agent for mixing with fertilizers; however, a compatibility test (jar test) should be made prior to mixing. Jar tests are particularly important when a new batch of fertilizer or pesticide is used, when water sources change, or when tank mixture ingredients or concentrations are changed. Compatibility may be determined by mixing the spray components in the desired order and proportions in a clear glass jar before large scale mixing of spray components in the spray tank.

Note: The lower the temperature of the liquid fertilizer, the greater the likelihood of mixing problems. Use of a compatibility aid may be required if Milestone is mixed with a 2.4-D-containing product. Mixing Milestone and 2,4-D in N-P or N-P-K liquid fertilizer solutions is more difficult than mixing with straight nitrogen fertilizer and should not be attempted without first conducting a successful compatibility jar test. Agitation in the spray tank must be vigorous to be comparable with jar test agitation. Apply the spray mixture the same day it is prepared while maintaining continuous agitation. Rinse the spray tank thoroughly after use.

Note: Foliar-applied liquid fertilizers themselves can cause yellowing of the foliage of forage grasses and other vegetation.

Use Rates and Timing

Milestone may be applied post emergence as a broadcast spray or as a spot application to control weeds including, but not limited to, those listed on this label. When a rate range is given use the higher rate to control weeds at advanced growth stages, or under less than favorable growing conditions, or for longer residual control. Best results are obtained when spray volume is sufficient to provide uniform coverage of treated weeds.

For optimum uptake and translocation of Milestone, avoid mowing, haying, shredding, burning or soil disturbance in treated areas for at least 14 days following application.

Milestone also provides preemergence control of emerging seedlings of susceptible weeds, and re-growth of certain perennial weeds following application. Preventing establishment of weeds will depend upon application rate, season of application, and environmental conditions after application.

Milestone can provide long-term control of susceptible weeds. The length of control is dependent upon the application rate, condition and growth stage of target weeds, environmental conditions at and following application, and the density and vigor of competing desirable vegetation.

Long-term weed control is most effective where grass vegetation is allowed to recover from overgrazing, drought, etc., and compete with weeds. Milestone can be an important component of integrated vegetation management programs designed to renovate or restore desired plant communities. To maximize and extend the benefits of weed control provided by Milestone, it is important that other vegetation management practices and development of integrated vegetation management programs.

Weeds Controlled

The following weeds will be controlled with the rates of Milestone indicated below (Table 3). For best results, most weeds should be treated when they are actively growing and under conditions favorable for growth. Use a higher rate in the rate range when growing conditions are less than favorable or when weed foliage is tall and dense, or when residual control is desired.

Milestone also provides preemergence control of germinating seeds or seedlings of susceptible weeds following application.

Table 3: Weeds Controlled

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Rate Range (fl oz/ac)</th>
<th>Life Cycle</th>
<th>Plant Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranth, spiny</td>
<td>Amaranthus spinosus</td>
<td>4 to 7</td>
<td>annual</td>
<td>Amaranthaceae</td>
</tr>
<tr>
<td>Bedstraw</td>
<td>Galium spp.</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Rubiaceae</td>
</tr>
<tr>
<td>Beggarticks</td>
<td>Bidentis spp.</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Broomweed, annual</td>
<td>Amphiachyris dracunculoides</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Burdock, common</td>
<td>Arctium minus</td>
<td>4 to 7</td>
<td>biennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Buttercup, hairy</td>
<td>Ranunculus sardous</td>
<td>4 to 7</td>
<td>annual</td>
<td>Ranunculaceae</td>
</tr>
<tr>
<td>Buttercup, tall</td>
<td>Ranunculus acris</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Ranunculaceae</td>
</tr>
<tr>
<td>Camelthorn</td>
<td>Alhagi pseudalhagi</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Chamomile, scentless</td>
<td>Matricaria inodora</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Chicory</td>
<td>Cichorium intybus</td>
<td>4 to 6</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Chickweed</td>
<td>Stellaria media</td>
<td>7</td>
<td>annual</td>
<td>Caryophyllaceae</td>
</tr>
<tr>
<td>Cinquefoil, sulfur</td>
<td>Potentilla recta</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Rosaceae</td>
</tr>
<tr>
<td>Cocklebur</td>
<td>Xanthium strumarium</td>
<td>3 to 5</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Rate Range (fl oz/acre)</th>
<th>Life Cycle</th>
<th>Plant Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trifolium spp.</td>
<td>clover</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Croton glandulosus</td>
<td>croton, tropic</td>
<td>3 to 5</td>
<td>annual</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Securigera varia</td>
<td>crownvetch</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Gamochaeta purpurea</td>
<td>cudweed, purple</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Leucanthemum vulgare</td>
<td>daisy, oxeye (1)</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Onagraceae</td>
</tr>
<tr>
<td>Rumex crispus</td>
<td>dock, curly</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Polygonaceae</td>
</tr>
<tr>
<td>Oenothera laciniata</td>
<td>evening primrose, cutleaf</td>
<td>4 to 7</td>
<td>annual</td>
<td>Onagraceae</td>
</tr>
<tr>
<td>Arminskia intermedia</td>
<td>fiddleneck, common</td>
<td>7</td>
<td>annual</td>
<td>Boraginaceae</td>
</tr>
<tr>
<td>Epilobium angustifolium</td>
<td>fireweed</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Onagraceae</td>
</tr>
<tr>
<td>Conyza bonariensis</td>
<td>fleabane, flax-leaf</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Hieracium aurantiacum</td>
<td>hawkweed, orange (2)</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Hieracium caespitosum</td>
<td>hawkweed, yellow (2)</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Lamium amplexicaule</td>
<td>henbit</td>
<td>5 to 7</td>
<td>annual/biennial</td>
<td>Lamiaeae</td>
</tr>
<tr>
<td>Conyza canadensis</td>
<td>horseweed, Carolina</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Solanaceae</td>
</tr>
<tr>
<td>Conyza canadensis</td>
<td>horseweed (marestail)</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Verronia gigantea</td>
<td>ironweed, tall</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Verronia baldwinii</td>
<td>ironweed, western</td>
<td>7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Centaurea diffusa</td>
<td>knapweed, diffuse (3)</td>
<td>5 to 7</td>
<td>biennial/perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Acroptilon repens</td>
<td>knapweed, Russian (4)</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Centaurea stoebc</td>
<td>knapweed, spotted (3)</td>
<td>5 to 7</td>
<td>biennial/perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Centaurea spp.</td>
<td>knapweeds</td>
<td>5 to 7</td>
<td>biennial/perennial</td>
<td>Asteraceae</td>
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<tr>
<td>Pueraria montana</td>
<td>kudzu</td>
<td>7</td>
<td>perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Polygonum persicaria</td>
<td>lady's thumb</td>
<td>3 to 5</td>
<td>annual</td>
<td>Polygonaceae</td>
</tr>
<tr>
<td>Chenopodium album</td>
<td>lambsquarters</td>
<td>5 to 7</td>
<td>annual</td>
<td>Chenopodiaceae</td>
</tr>
<tr>
<td>Robinia pseudoacacia</td>
<td>locust, black</td>
<td>7</td>
<td>woody perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Gleditsia triacanthos</td>
<td>locust, honey</td>
<td>7</td>
<td>woody perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Tripleurospernum perforata</td>
<td>mayweed, scentless</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Anthermis cotula</td>
<td>mayweed, stinking</td>
<td>7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Medicago lupulina</td>
<td>medic, black</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Albizia julibrissin</td>
<td>mimosa</td>
<td>7</td>
<td>woody perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Verbascum spp.</td>
<td>mullein (5)</td>
<td>7</td>
<td>biennial</td>
<td>Scrophulariaceae</td>
</tr>
<tr>
<td>Picris echioiodes</td>
<td>oxtongue, bristy</td>
<td>5 to 7</td>
<td>biennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Ambrosia artemisifolia</td>
<td>ragweed, common</td>
<td>3 to 5</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Ambrosia psilostachya</td>
<td>ragweed, western</td>
<td>4 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Senecio jacobaea</td>
<td>ragwort, tansy</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Cercis Canadensis</td>
<td>redbud</td>
<td>7</td>
<td>woody perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Chondrilla juncea</td>
<td>rush skeletonweed</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Polygonum pensylvanicum</td>
<td>smartweed, Pennsylvania</td>
<td>3 to 5</td>
<td>annual</td>
<td>Polygonaceae</td>
</tr>
<tr>
<td>Helianthus amarum</td>
<td>sneezeweed, bitter</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Solanum viarum</td>
<td>soda apple, tropical (6)</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Solanaceae</td>
</tr>
<tr>
<td>Sonchus arvensis</td>
<td>sowthistle, perennial</td>
<td>3 to 5</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Bidens bipinnata</td>
<td>spanishneedles</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Hypericum perforatum</td>
<td>St. Johnswort, common</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Clusiaceae</td>
</tr>
<tr>
<td>Centaurea melitensis</td>
<td>star-thistle, Malta (7)</td>
<td>3 to 5</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Centaurea calctrpa</td>
<td>starthirstle, purple (7)</td>
<td>3 to 5</td>
<td>biennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Centaurea solstitialis</td>
<td>star thistle, yellow (7)</td>
<td>3 to 5</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Helianthus annuus</td>
<td>sunflower, common</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Dipsacus spp.</td>
<td>teasel</td>
<td>4 to 7</td>
<td>biennial</td>
<td>Dipsacaceae</td>
</tr>
<tr>
<td>Cynara cardunculus</td>
<td>thistle, artichoke</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Cirsium vulgare</td>
<td>thistle, bull (8)</td>
<td>3 to 5</td>
<td>biennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Cirsium arvense</td>
<td>thistle, Canada (9)</td>
<td>5 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Carthamus lanatus</td>
<td>thistle, woolly distaff</td>
<td>4 to 7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Carduus pycnocephalus</td>
<td>thistle, Italian</td>
<td>7</td>
<td>annual</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Carduus nutans</td>
<td>thistle, musk (8)</td>
<td>3 to 5</td>
<td>biennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Carduus acanthoides</td>
<td>thistle, plumless (8)</td>
<td>3 to 5</td>
<td>biennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>Onopordum acanthium</td>
<td>thistle, Scotch</td>
<td>5 to 7</td>
<td>biennial</td>
<td>Asteraceae</td>
</tr>
</tbody>
</table>
Invasive plants are introduced species that are indicated to be invasive in the USDA-NRCS, PLANTS Database [http://plants.usda.gov/index.html]. Plants designated as noxious weeds in at least one state (PLANTS Database, USDA-NRCS, http://plants.usda.gov/index.html).

### Table 3: Weeds Controlled (Cont.)

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Rate Range (fl oz/acre)</th>
<th>Life Cycle</th>
<th>Plant Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>vetch</td>
<td>Vicia spp.</td>
<td>3 to 7</td>
<td>perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>wisteria</td>
<td>Wisteria brachybotris</td>
<td>7</td>
<td>woody perennial</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>wormwood, absinth (10)</td>
<td>Artemisia absinthium</td>
<td>6 to 7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
<tr>
<td>yarrow, common</td>
<td>Achillea millefolium</td>
<td>7</td>
<td>perennial</td>
<td>Asteraceae</td>
</tr>
</tbody>
</table>

State regulations must be followed. The applicator should be familiar with and take into account the information covered in the following Aerial Drift Reduction Advisory. This information is advisory in nature and does not supersede mandatory label requirements.

### Aerial Drift Reduction Advisory

#### Information on Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversions).

#### Controlling Droplet Size:
- **Volume**: Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure**: Do not exceed the nozzle manufacturer’s specified pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of Nozzles**: Use the minimum number of nozzles that will provide uniform coverage.
- **Nozzle Orientation**: Orient nozzles so that the spray is released parallel to the airstream to produce larger droplets than other orientations. Significant deflection from horizontal will reduce droplet size and increase drift potential.
- **Nozzle Type**: Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

#### Boom Length: The distance of the outer most operating nozzles on the boom must not exceed 75% of wingspan or 85% of rotor diameter.

#### Application Height: Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

#### Swath Adjustment: When applications are made with a crosswind, the spray will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

#### Wind: Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **Note**: Local terrain such as valleys and ravines can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

#### Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

#### Temperature Inversions: Applications should not occur during a local, low level temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the formation of a smoke plume from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.
Understanding the Pesticide Label

Leah L. Sandall, Extension Assistant
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Erin C. Bauer, Extension Assistant

This NebGuide describes the parts of a pesticide label to aid understanding and promote safe and effective use of pesticide products.

The pesticide label is more than just a piece of paper. It is a legal document recognized by courts of law. Pesticide applicators assume certain responsibilities when they purchase a product. (For more information see NebGuide G479, Pesticide Laws and Regulations).

Not all labels are the same. The format of labels differs between manufacturers, as well as between consumer and commercial product labels. The U.S. Environmental Protection Agency’s (EPA) Consumer Labeling Initiative (CLI) details the main differences between consumer and commercial product labels. (See more on CLI at http://www.epa.gov/pesticides/regulating/labels/consumer-labeling.htm).

Pesticide products are further differentiated based on type and registration. There are many different types of pesticides but some examples include herbicides, insecticides, fungicides, termiticides and rodenticides. All pesticide products must be registered with the EPA. The four main pesticide registrations are:

- **Section 3** — product has standard registration;
- **Section 25(b)** — minimal risk, product has been exempted from registration;
- **Section 24(c)** — pesticide has been registered based on a special local need; and
- **Section 18** — product has been given an emergency exemption.

Pesticide manufacturers are required by law to furnish certain information on the label. The information includes:

- the brand name or trade name of the product;
- the ingredient statement;
- the percentage or amount of active ingredient(s) by weight;
- the net contents of the container; and
- the name and address of the manufacturer.

Other required parts of the label are:

- the registration and establishment numbers;
- statement of practical treatment;

Figure 1. An example of what a pesticide label might look like.

- environmental hazard statement;
- classification statement;
- directions for use;
- re-entry statement, if necessary;
- harvesting and/or grazing restrictions; and
- storage and disposal statements.

The following information details the parts of the label and discusses the importance of each.

**Brand, Trade, or Product Name**

This is the name used to identify and market the product (e.g. Pest No More in Figure 1). Different companies will use different brand names to market their product even when the same active ingredient is used.
Ingredient Statement

Every pesticide label must include the product’s active and inert ingredients with the percentage of each by weight. Only the active ingredients must be listed out by name (chemical and/or common name). Inert ingredients, also referred to as “Other ingredients” on consumer pesticide labels, don’t have to be listed out by name but must also show their percentage by weight. Net contents are listed on the front of the product and indicate the total amount of product in the container (fluid ounces, pints, quarts, ounces, pounds, etc.).

Use Classification Statement

Each pesticide is categorized as either a General Use Pesticide (GUP) or a Restricted Use Pesticide (RUP). In general, GUPs are less toxic than RUPs. Thus, to purchase, apply, or supervise the use of RUPs, the applicator must be trained and certified (Figure 2).

RESTRICTED USE PESTICIDE
May injure (Phytotoxic) susceptible, non-target plants. For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator’s certification. Commercial certified applicators must also ensure that all persons involved in these activities are informed of the precautionary statements.

Figure 2. An example of a restricted-use pesticide statement.

Type of Pesticide

Most labels state the type of pesticide on the front. For example, the label may say Herbicide, indicating it controls weeds or Insecticide, indicating it will control insects.

Manufacturer

The name and address of the manufacturer, formulator, or registrant (e.g. Pesticide Company, Inc. in Figure 1) of the product is required to be on the label. If the registrant is not the manufacturer, then contact information will be preceded by statements like, “packed for,” “distributed by,” or “sold by.”

Emergency Telephone Number

Often the label will show a telephone number to use in case of emergencies (poisoning, spill, fire). This is especially common on consumer labels.

Registration and Establishment Numbers

The Registration Number (EPA Reg. No.) is proof that the product and the label was approved by the EPA. The Establishment Number (EPA Est. No.) identifies the specific facility that manufactured the product. This allows an individual product to be traced back to the manufacturing facility.

Table 1. Signal-level words.

<table>
<thead>
<tr>
<th>Signal Word</th>
<th>Category</th>
<th>Toxicity*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danger or</td>
<td>Class I — highly</td>
<td>Corrosive or irritant</td>
</tr>
<tr>
<td>Poison</td>
<td>toxic</td>
<td>properties, a few</td>
</tr>
<tr>
<td></td>
<td></td>
<td>drops to 1 teaspoon</td>
</tr>
<tr>
<td>Warning</td>
<td>Class II —</td>
<td>1 teaspoon to 1 ounce</td>
</tr>
<tr>
<td></td>
<td>moderately toxic</td>
<td></td>
</tr>
<tr>
<td>Caution</td>
<td>Class III —</td>
<td>1 ounce to 1 pint/</td>
</tr>
<tr>
<td></td>
<td>slightly toxic</td>
<td>1 pound</td>
</tr>
<tr>
<td>Caution or none</td>
<td>Class IV —</td>
<td>Over 1 pint or 1 pound</td>
</tr>
<tr>
<td></td>
<td>very sligh hazard</td>
<td></td>
</tr>
</tbody>
</table>

*The lethal dose is less than those listed for a child or person under 150 lbs. and more for a person over 150 lbs.

Signal Words

Pesticide labels must include a signal word prominently displayed on the front unless they have a Class IV toxicity level. Signal words identify the relative toxicity of a particular product. The signal words, in order of increasing toxicity, are Caution, Warning and Danger (Table 1).

Precautionary Statements

These statements guide the applicator to take proper precautions to protect humans or animals that could be exposed. Sometimes these statements are listed under the heading Hazards to Humans and Domestic Animals. Every pesticide label must include the statement: “Keep Out of Reach of Children.” Some example Precautionary Statements include: “Harmful if inhaled.” and “Remove contaminated clothing and wash before reuse.”

Often the Route of Entry and Protective Clothing and Equipment (PPE) Statements are located under the Precautionary Statement on a label. The Route of Entry Statement identifies the way(s) in which a particular pesticide may enter the body and gives specific actions to prevent exposure. The main routes of exposure are dermal (skin and eyes), oral, and respiratory.

The Protective Clothing and Equipment Statement outlines the equipment requirements which protect the applicator from exposure to the pesticide. (See NebGuide G758, Protective Clothing and Equipment for Applicators) Even though it may not be required by the label, UNL Extension recommends applicants wear a long-sleeved shirt, long pants, chemical-resistant shoes plus socks, and chemical-resistant gloves in order to be adequately protected.

Statement of Practical Treatment

Also called First Aid on many consumer labels, the Statement of Practical Treatment tells what to do in case of product exposure. This information should be read before using the product, again in the event of an emergency, and be available for all emergencies in order to reference specific information. Statements like, “Move individual to fresh air” and “Get medical attention” are two examples of information found in the Statement of Practical Treatment section.

Environmental Hazards Statement

This statement details possible hazards to the environment including soil, water, air, wildlife, fish, and non-target
plants. There may be special warning statements like “This product is highly toxic to bees.” “Do not contaminate water when disposing of equipment washwaters,” and “Do not allow drift to contact nontarget plants or trees.”

Physical or Chemical Hazards

Descriptions of any possible fire, chemical, or explosion hazards specific to the product are listed in this section of the label. For example, “Spray solutions of this product should be mixed, stored, and applied, using only stainless steel, aluminum, fiberglass, plastic, or plastic-lined steel containers” and “This gaseous mixture could flash or explode causing serious personal injury if ignited by open flame, spark, welder’s torch, lighted cigarette, or other ignition source” are both statements that can be found under the Physical and Chemical Hazards section of the label.

Agricultural Use Requirements

This section (Figure 3) will only be on pesticide labels where the Worker Protection Standard (WPS) must be followed. The WPS includes specific safety measures for agriculture workers and handlers of agricultural pesticides.

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 4 hours.

PPE required for 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
- Chemical resistant gloves made of any waterproof material
- Shoes plus socks

Figure 3. An example of an “agricultural use” label section.

The Re-entry Statement or Restricted Entry Interval (REI) is often contained in the information pertaining to WPS. The REI indicates how much time must pass after the application before workers are allowed back in to the treated area with no personal protective equipment (PPE). (See NebGuide G1219, Worker Protection Standard for Agricultural Pesticides.)

Some pesticide applications fall under Non-agricultural Use Requirements (lawns, golf courses, aquatic areas, rights-of-way, etc.) and no specific re-entry time is indicated. Often the label on these products advises people and pets to not enter the area until the application has dried or dust has settled (Figure 3).

Storage and Disposal Statement

Each pesticide label has general storage and disposal instructions. Proper storage of any pesticide is important. Keep pesticides stored in a secure location, away from food and feed supplies, and in the original containers. When disposing of pesticide containers, triple- or pressure-rinse and puncture containers to avoid re-use. State and local laws may include additional requirements, especially for proper pesticide disposal procedures. (See Extension Circular EC2507, Safe Transport, Storage, and Disposal of Pesticides.) Two very common statements found on the label under this section are: “Do not contaminate water, food, or feed by storage or disposal,” and “Store in original containers only.”

Directions for Use

These directions instruct the applicator how to properly apply the pesticide and achieve the best results. The Directions for Use provide information for things such as the rate of application, the site the product is intended to protect (e.g. aquatic, non-crop sites, wildlife habitat areas, crops sites, greenhouses, etc.), which pests it controls, mixing directions, and other specific directions related to applying the pesticide.

In cases where the product is intended for use on crops or vegetables, the Pre-harvest Interval (PHI) will be listed that indicates how much time must pass between the application and harvest to avoid pesticide residues. The consequences of not following the PHI can vary, but toxicity to livestock or in ability to sell harvested grain are two possible results. In some labels, the Re-entry Statement may also be listed under this section.

Everyone should read and follow all label directions for effective, safe, and legal use of pesticides. Reading the pesticide label before purchasing, transporting, mixing, applying, and before storing or disposing of excess pesticide or empty containers will help ensure proper and legal pesticide use.

This publication has been peer reviewed.

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Index: Pesticides
General Safety
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Protective Clothing and Equipment for Pesticide Applicators

Clyde L. Ogg, Extension Educator; Erin C. Bauer, Extension Associate; Jan R. Hygnstrom, Project Coordinator; and Pierce J. Hansen, Extension Assistant, all in the Pesticide Safety Education Program

This NebGuide explains how to choose and properly use personal protective equipment (PPE) when mixing, loading, and applying pesticides to help reduce exposure to pesticides and protect human health.

Pesticides are valuable pest management tools and, like any tool, must be used carefully and responsibly. Dressing appropriately and using personal protective equipment (PPE) can help minimize pesticide exposure and reduce the risk of pesticide poisoning. These steps also are important signals of appropriate and legal pesticide use. Use all pesticides safely. Read the pesticide product label and comply with all directions. Failure to do so may subject you to state and/or federal penalties, and place you, your family, and the environment at a greater risk of pesticide exposure.

Manage Your Risk

Wearing protective clothing and equipment when handling or applying pesticides can reduce your risk of exposure, and thus your risk of pesticide poisoning. Understanding the toxicity of a product and the potential for personal exposure allows you to lower your risk. This idea is expressed by the Risk Formula: Risk = Toxicity x Exposure

No matter how toxic a substance is, if the amount of exposure is kept low, risk can be held to an acceptably low level. The toxicity of a substance can’t be changed, but risk can be managed, and the applicator is the manager.

What is Toxicity?

All pesticides are toxic, differing only in the degree of toxicity, and are potentially dangerous to people if exposure is high. Pesticide product labels have signal words that clearly indicate the degree of toxicity associated with a given product (Table I). The signal words — “Danger,” “Warning,” and “Caution” — indicate the degree of potential risk to a user, not the expected level of pest control.

Pesticides can enter the human body in three ways:

1) through the mouth (orally),
2) by breathing into the lungs (inhalation), and, most commonly,
3) by absorption through the skin or eyes (dermally).

Along with the signal words, pesticide product labels also include route of entry statements and specific actions a user must take to avoid exposure.

Table I. Pesticide product label signal words and relative toxicities.

<table>
<thead>
<tr>
<th>Group</th>
<th>Signal Word</th>
<th>Toxicity Rating</th>
<th>Lethal Dose for a 150 lb Human*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Danger</td>
<td>Highly toxic</td>
<td>Few drops to 1 teaspoon</td>
</tr>
<tr>
<td>II</td>
<td>Warning</td>
<td>Moderately toxic</td>
<td>1 teaspoon to 1 tablespoon</td>
</tr>
<tr>
<td>III</td>
<td>Caution</td>
<td>Slightly toxic</td>
<td>1 tablespoon to 1 pint</td>
</tr>
<tr>
<td>IV</td>
<td>Caution (signal word not always required)</td>
<td>Relatively non-toxic</td>
<td>More than a pint</td>
</tr>
</tbody>
</table>

*The lethal dose is less than those listed for a child, or a person under 150 lb and more for a person over 150 lb.

The skull and crossbones symbol and the word “Poison” are sometimes printed with the “Danger” signal word.

Read the Pesticide Product Label

Route of entry statements on the pesticide product label indicate the outcome that can be expected from different kinds of exposure. For example, a pesticide label might read, “Poisonous if swallowed, inhaled, or absorbed through the skin. Rapidly absorbed through the skin and eyes.” This tells the user that this pesticide is a potential hazard through all three routes of entry, and that skin and eye contact are particularly hazardous. The specific action statements normally follow the route of entry statements and indicate what must be done to prevent accidental poisoning. Using the previous example, the specific action statement might read, “Do not get in eyes, on skin, or on clothing. Do not breathe spray mist.”

Before handling, mixing, loading, or applying any pesticide, read the product label directions completely. If the label calls for the use of personal protective equipment, comply fully with those directions. The label will define the minimal protective equipment required for various tasks. Note that the PPE required for mixing and loading may be more extensive than the PPE required during application because of the potential for contact with a concentrated pesticide product.
Use Personal Protective Equipment

The type of PPE needed depends both on the toxicity of the pesticide being used and the formulation (liquid, granular, wettable powder, etc.). Some labels, especially for agricultural pesticides, are affected by the Worker Protection Standard and specifically state that certain items of clothing, equipment, eyewear, footgear, and gloves must be used. Others do not include such a statement. Some of the PPE required are specific to early entry while others are specific to handling and applying. In general, the more toxic the pesticide, the greater the need for PPE.

Choose the Right PPE

If a pesticide label does not have specific PPE requirements, always take reasonable precautions and use common sense. Use the route of entry and specific action statements from the product label to determine the type and degree of protection needed to handle the pesticide safely. For example, if you’ll be handling pesticides or pesticide equipment, consider wearing chemical-resistant gloves even if the label doesn’t specifically call for them.

Liquid pesticides often are more hazardous to use than dry formulations, and extra protection is warranted while mixing and/or loading pesticides. Recognize that in cases where there will be prolonged exposure to the spray or where the application is being made in an enclosed area, you must use extra protection.

Use Protective Clothing

Whenever you are using pesticides, at the very least you should wear a long-sleeved shirt, long pants, shoes, socks, and chemical-resistant gloves (Figure 1). Many labels will require you to wear more than this, depending on the product’s toxicity and use. Select garments made of tightly woven fabrics to reduce pesticide penetration. Disposable coveralls, such as those made of Tyvek®, provide adequate protection to a pesticide applicator under most conditions. Protective suits made of or coated with butyl rubber, neoprene, PVC, or one of the newer coated and laminated polyethylene fabrics may be needed for certain applications.

Shoes and socks also should be worn. Avoid sandals, flip-flops, and cloth or canvas shoes to minimize exposing your feet to liquid pesticides. Leather shoes are suitable while using most pesticides; however, leather will absorb liquids. Therefore, wear chemical-resistant boots while working with highly toxic liquid pesticides (signal word: DANGER) and when there may be prolonged exposure to any pesticide spray. Applicators who mix and load liquid concentrates, especially highly toxic ones, also should wear chemical-resistant aprons.

Protect Your Head, Eyes, and Hands

Protection for your head also is advisable and in some cases is specifically required. In general, a wide-brimmed, easily cleaned hat that will keep pesticides away from the neck, eyes, mouth, and face is adequate (Figure 2). Avoid hats with cloth or leather sweatbands as these will absorb pesticides. Baseball-style caps have headbands that readily absorb and retain pesticides. Labels that specify the use of headgear are generally found on highly toxic liquid concentrates. When working with these pesticides, wear a chemical-resistant hood or a plastic hard hat with a plastic sweatband and a rain-trough edge to keep drips off your neck and back.

Whenever you are using pesticides, at the very least you should wear a long-sleeved shirt, long pants, shoes, socks, and chemical-resistant gloves (Figure 1). Many labels will require you to wear more than this, depending on the product’s toxicity and use. Select garments made of tightly woven fabrics to reduce pesticide penetration. Disposable coveralls, such as those made of Tyvek®, provide adequate protection to a pesticide applicator under most conditions. Protective suits made of or coated with butyl rubber, neoprene, PVC, or one of the newer coated and laminated polyethylene fabrics may be needed for certain applications.

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Figure 1. Wear a long-sleeved shirt, long pants, shoes plus socks, and chemical resistant gloves when applying pesticides. We recommend wearing gloves inside sleeves (1a), but wearing gloves outside sleeves may also work equally well (1b).

Figure 2. Example of protective hat that can be worn when applying pesticides.

Pesticides are readily absorbed through the eyes and can cause eye injury. When the labels for liquid pesticides include precautionary statements with the signal words “Warning” or “Danger,” it generally indicates the need for eye protection. Use goggles or safety glasses when the label requires it. (See Figure 3 for examples.) Some goggles have a wider bridge over the nose to be compatible with respirators. Goggles will provide adequate protection if they have the right type of venting. Safety goggles have three types of venting:

- open vents for impact protection only; not recommended for use with pesticides;
- indirect vents for protection from pesticide and other chemical splashes; and
- non-vented for protection from gases, mists, and fumes.

Other labels may require a full face shield.

Chemical-resistant gloves (Figure 4) often are needed for mixing, loading, and applying pesticides. Unlined, liquid-proof neoprene, butyl, PVC, Viton®, barrier laminate, or nitrile gloves with tops that extend well up on the forearm are best. Most of these gloves are available in reusable pairs that can be cleaned after each use.

Figure 3. Different types of safety goggles and glasses.

Figure 4. Chemical resistant gloves (top row, left to right): natural rubber, disposable nitrile, reusable nitrile and (bottom row, left to right) neoprene, butyl rubber, Viton, and barrier laminate.

Figure 5. Disposable nitrile gloves in 4, 8, and 12 mil weights.
Use and Care of a Respirator

Always read and follow the label guidelines to see what type of respiratory protection is required for the pesticide you’ll be using. OSHA (Occupational Safety and Health Administration) requires that when using a respirator, you must have a medical evaluation prior to fit testing. In addition, you will need to be properly trained in respirator use.

• Use respirators approved by the National Institute of Occupational Safety and Health (NIOSH).
• Read and follow the manufacturer’s instructions for use and care of the respirator. Filters, cartridges, and canisters must be designed for the type of contaminant expected. For example, a particulate filter is appropriate for dusts and mists. An organic vapor cartridge is necessary for protection against organic vapors, such as pesticides. Other examples include mercury vapor cartridges or acid gas cartridges. Manufacturers also offer combination cartridges when protection against multiple types of contaminants is needed.

• Cartridges and canisters have a limited useful life and must be replaced at proper intervals.
• Inspect and fit test respirators before use to ensure a snug seal against the face. Users with facial hair may not be able to obtain an adequate seal; a clean shave along the seal line is usually necessary.
• Exposed respirator parts must be cleaned after each use, and cartridges should be stored in an airtight container in a clean location. For more information about fit testing and cleaning respirators, see NebGuide 2083, Maintaining and Fit Testing Cartridge Respirators for Pesticide Applications at [http://www.ianrpubs.unl.edu/live/g2083/](http://www.ianrpubs.unl.edu/live/g2083/).

Most air purifying respirators consist of a tight-fitting mask with disposable cartridges or canisters (Figures 6 and 7). The respirator design may be a half-mask (covers the nose, mouth, and chin) or full-face (covers the entire face). An air-purifying respirator equipped with suitable cartridges/canisters is needed for protection against vapors. An air-purifying respirator can provide protection against dusts/mists if the appropriate cartridge/canister is selected. Canisters typically have a longer use life than cartridges because they have more absorption capacity. A full-face respirator provides greater protection than a half-mask and also protects the eyes.

Protect Your Lungs

Your lungs and the lining of your respiratory system readily absorb pesticide dusts and vapors from the air. Respiratory protection, therefore, is essential whenever the label calls for it and is recommended during mixing and loading, even if not required by the label. Respiratory protection is also recommended whenever an applicator will be exposed to intensive concentrations of pesticide dusts, fumes, or vapors. The type of respirator an applicator uses will be determined by the type and toxicity of the pesticide, application site, and other factors.

Particulate respirators (dust masks) are acceptable when applying pesticide dusts and granules, and for protection against large droplets suspended in air. They are not recommended for protection against vapors. Always read the pesticide label for product-specific recommendations. In all cases, the selected respirator should bear a mark indicating it is “NIOSH approved.” (NIOSH refers to the National Institute of Occupational Safety and Health.) One-strap dust masks typically available at hardware stores generally are not NIOSH approved and will not provide adequate respiratory protection. Discard particulate respirators after each use and do not attempt to reuse a disposable respirator.

If the oxygen supply is likely to be low or the application will result in heavy concentrations of highly toxic pesticides, such as fumigants, a self-contained breathing apparatus (SCBA) (Figure 8) or supplied-air respirator (Figure 9) will be needed. The air pack is an SCBA commonly used for applications.
fumigation. Air packs typically supply 25-30 minutes of air and consist of a full-face mask attached to a tank of air carried on the applicator’s back. The supply time may be considerably shorter if the respiration rate increases due to overexertion. A warning bell can be set to signal depletion of the air supply.

Air-supplied respirators provide air from an outside source that is pumped to the applicator through an airline. A major advantage of an airline is that the air supply does not expire in a short time. However, the airline must be towed throughout the facility being treated; air pump failure or a constriction of the airline can shut off the air supply. Also, the air pump must be located in a fumigant-free area. In combination with an SCBA, an air-supplied respirator offers an unlimited work period with backup respiratory protection provided by the SCBA if the outside air supply is cut off for any reason.

Caring for Protective Clothing

Applicators who routinely work with pesticides should wear clean clothing daily, and reserve at least one set of clothing for pesticide work if possible. Launder pesticide-contaminated clothing and store work clothing separately.

Clothing that has become wet from pesticides should be removed immediately. Fast action will reduce your exposure to the pesticide. Discard clothing (including shoes and boots) saturated with any concentrate or any diluted spray of highly toxic pesticides (signal word: “Danger”). Waterproof and chemical-resistant hats, gloves, boots, and goggles should be washed daily and hung to dry. Test reusable gloves for leaks by filling them with water and gently squeezing the top. If water comes out, replace the gloves.

Laundry is a Division of the Institute of Agriculture and Natural Resources at the University of Nebraska–Lincoln cooperating with the Counties and the United States Department of Agriculture.

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Emergency Phone Numbers

The Poison Control Center
For aid in human poisoning cases
(800) 222-1222

Nebraska Department of Environmental Quality
To report chemical spills 8 a.m. to 5 p.m. M-F
(402) 471-2186; (877) 253-2603

Nebraska State Patrol (after hours)
To report chemicals spills after hours
(800) 525-5555; (402) 471-4545

Washing Up

Good personal hygiene is essential to keeping yourself pesticide-free. Soap and water are cheap insurance against pesticide contamination.

• Wash your hands and face often and keep soap and water nearby when working.
• If you’ve handled pesticides, always wash your hands with soap before smoking, eating, drinking, or using the toilet.
• Shower immediately after using pesticides and before changing into clean clothes.
• Remove and leave shoes at the door so you don’t track pesticides into the house.

Be Prepared for an Emergency

Take the pesticide label with you when seeking medical care. Have emergency telephone numbers handy (see above box) and keep them posted where pesticides are stored, mixed, or applied. If you experience any pesticide poisoning symptoms (nausea, skin rashes, headaches, coughing, diarrhea, chest pain, twitching, or seizures), see a physician immediately. For more information, see Extension Circular 2505, Signs and Symptoms of Pesticide Poisoning.

This publication has been peer reviewed.

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Index: Pesticides, General Safety
Pesticide Safety: Choosing the Right Gloves

Erin C. Bauer, Extension Assistant
Clyde L. Ogg, Extension Pesticide Education Coordinator
Leah L. Sandall, Extension Assistant

This NebGuide explains how to choose and properly use gloves when mixing, loading, and applying pesticides to help reduce exposure to chemicals and protect human health.

Properly protecting yourself when applying pesticides can decrease the potential risk of pesticides to your health and safety. Handling pesticides can include mixing, loading, and applying, all of which can potentially expose your hands to chemicals. The right gloves are essential since the highest percentage of pesticide exposure occurs through the skin. Chemical-resistant gloves are one of the most important pieces of personal protective equipment (PPE). Most pesticide labels have minimum requirements for personal protective clothing and equipment. Even when the label does not require their use, chemical-resistant gloves should be worn when handling pesticides.

Types of Gloves

Glove selection depends on the type of pesticide and the application. In general, unlined, chemical-resistant gloves made of neoprene, butyl, or nitrile rubber are best. These materials provide good protection under most conditions, are durable, and are reasonably priced (Figure 1). The most protective glove is a barrier laminate glove consisting of two or more materials laminated or blended together (Figure 2).

Some gloves are waterproof, but do not provide adequate protection. Be sure you use gloves specified as “chemical resistant.” Avoid latex gloves. They do not provide adequate skin protection, disintegrate rapidly, and are not recommended by the EPA for use with pesticides. Garden gloves, medical gloves, and household cleaning gloves are inadequate for pesticide applications.

Lightweight, single-use cotton liners may be worn inside chemical-resistant gloves. Liners improve the comfort and ease of putting on and taking off gloves. However, these...
Table 1. Types and characteristics of personal protective material.
(for use when the personal protective equipment section on pesticide label lists a chemical resistance category)

<table>
<thead>
<tr>
<th>Selection Category Listed on Pesticide Label</th>
<th>Types of Personal Protective Material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Barrier</td>
</tr>
<tr>
<td></td>
<td>Laminate</td>
</tr>
<tr>
<td>A (dry and water-based formulation)</td>
<td>NA</td>
</tr>
<tr>
<td>B (acetate)</td>
<td>high</td>
</tr>
<tr>
<td>C (alcohol)</td>
<td>high</td>
</tr>
<tr>
<td>D (halogenated hydrocarbons)</td>
<td>high</td>
</tr>
<tr>
<td>E (ketones, such as acetone)</td>
<td>high</td>
</tr>
<tr>
<td>F (ketone and aromatic petroleum distillates mixture)</td>
<td>high</td>
</tr>
<tr>
<td>G (aliphatic petroleum distillates, such as kerosene, petroleum oil, or mineral oil)</td>
<td>high</td>
</tr>
<tr>
<td>H (aromatic petroleum distillates, such as xylene)</td>
<td>high</td>
</tr>
</tbody>
</table>

*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 or 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.

**NA:** Not Applicable. Provides high resistance but exceeds level of protection required for these formulations.


liners must be discarded after each use to avoid potential exposure to pesticides that may have been absorbed into the cotton material. You also should avoid gloves with integrated linings or gloves made entirely of cotton. These materials absorb pesticides, are hard to clean, and increase your chance of pesticide exposure.

The EPA has developed a rating chart defining chemical resistance of various materials used in glove construction. These ratings vary from no chemical resistance — materials that should never be used during pesticide applications — to highly chemical-resistant materials that with proper care and cleaning can be reused and still provide good protection. A chemical resistance category (designated with letters A-H) may be listed on the label. It is based on the solvents within pesticides rather than the pesticides themselves. The category refers to how long a glove of a certain material and thickness can be worn while handling a specific pesticide. This is also dependent upon the pesticide’s formulation. For example, the amount of time you can wear a certain glove when using a dry formulation may differ from the same pesticide in a liquid formulation.

**Table 1,** a reproduction of the EPA’s ratings chart, contains a list of the types of personal protective material and their characteristics. It can be very helpful when determining the appropriate type of gloves for pesticide mixing, loading, and application. In addition, the solvents in pesticides assigned to each chemical resistance category are listed next to the corresponding category letter (A-H).

The guidelines in this chart provide basic information about protective materials used in gloves. Glove longevity is determined by whether you are using a concentrated pesticide, such as in mixing and loading, or a diluted pesticide, used during application. Glove lifespan is much longer when using a diluted pesticide than a concentrated one. Whether you are mixing, loading, or applying pesticides, the amount of contact time you have with pesticides also will be a factor. Depending on the amount of chemical resistance in the material, someone mixing and loading a concentrated pesticide all day will need to exchange gloves that are labeled as “Slight” or “Moderate” chemical resistance more often than someone who does mixing and loading for one hour or someone who spends half a day applying diluted pesticide. Always follow label instructions about proper glove wear.

**Disposable vs. Reusable**

The majority of information in this guide addresses gloves that have 14 mil (mil = 0.001 inch) or greater thickness (often referred to as reusable). These gloves are available in
a variety of sizes, cuff lengths, and thicknesses. Like other protective equipment, the number of times these gloves can be reused depends on the age and condition of the material and hours of use. Gloves have to be replaced after eight hours of continuous use, for example, but could be used several times if used in shorter intervals. After sufficient use or extended storage, glove material can become brittle and less impervious to chemicals. Also, any glove, regardless of thickness, should be discarded if it becomes torn or damaged. Do not use gloves more than one season.

Gloves with less than 14 mil thickness (often referred to as disposable) have a shorter lifespan than those indicated in the EPA chart. These disposable gloves also feature thickness (less than 14 mil), size, and cuff length choices.

Cost often varies with thickness; thicker gloves usually are more expensive. However, thicker gloves offer better protection.

In general, disposable gloves may be preferable to reusable because they can be discarded after use and require much less maintenance. However, because reusable gloves are thicker, always consider the type of pesticide being used and the length of time needed to make the application. Thicknesses of 14 mil or more may be a better choice in some circumstances.

Reusable gloves must be washed and carefully removed after use to prevent contamination of your skin or areas such as a tractor cab interior. Reusable gloves must be stored properly and checked for leaks before using again, but disposable gloves can be thrown away — according to the label — after completing a pesticide application.

Glove Size

Depending upon the manufacturer and material, disposable and reusable gloves are available in standard or long-cuff lengths. Determine the best glove size by measuring the circumference around the palm of your hand. For example, if the circumference is 8 inches, a medium probably would be the best choice.

Available glove sizes are found in the table below:

<table>
<thead>
<tr>
<th>Glove size</th>
<th>Circumference of palm (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra small</td>
<td>6-7</td>
</tr>
<tr>
<td>Small</td>
<td>7-8</td>
</tr>
<tr>
<td>Medium</td>
<td>8-9</td>
</tr>
<tr>
<td>Large</td>
<td>9-10</td>
</tr>
<tr>
<td>Extra large</td>
<td>10-12</td>
</tr>
<tr>
<td>2XL</td>
<td>11-12</td>
</tr>
<tr>
<td>Jumbo</td>
<td>12-13</td>
</tr>
</tbody>
</table>

Proper glove fit is essential. Poorly fitting gloves can complicate your ability to apply pesticides correctly. Gloves that are too tight will be uncomfortable and may result in breakage, allowing pesticides to penetrate. Gloves that are too large can slide on the hands and potentially allow pesticide to run down into the gloves and onto your skin. Handling equip-

ment also becomes more difficult when you can't sufficiently grip it, increasing the chance for mistakes. Always try on your gloves and ensure they fit properly before beginning a pesticide application.

Glove Thickness

The thickness of the material in chemical-resistant gloves can affect their lifespan, susceptibility to tears, abrasions, and general wear. Both disposable and reusable gloves are available in various thicknesses. Manufacturers sell gloves with thickness ranges falling between 4 and 22 mil. Other thicknesses also may be available. The breakthrough time generally increases with the material's thickness.

Concentrated pesticide will wear out gloves much faster and decrease their lifespan much more quickly than diluted pesticides. Keep this in mind when choosing a glove thickness.

Proper Use

Under normal circumstances, gloves should be worn over long sleeves to prevent pesticides from running under the gloves (Figure 3). If working above your head, roll the glove tops into a cuff to prevent pesticides from running down the gloves and onto your forearms.

If applying fumigants, be especially cautious; read the label directions for gloves. Some fumigants can penetrate materials such as rubber and neoprene, and may result in severe skin irritation if trapped and absorbed by the skin. Many labels for pelletized fumigants, such as aluminum phosphide, may require dry cotton gloves. These gloves allow air flow so that fumigant gasses won't get trapped against and burn skin.

Proper Cleaning and Removal

After finishing a pesticide application, remove and discard disposable gloves. Wash your hands with soap and warm water, particularly before eating, smoking, or using the toilet. Reusable gloves should be washed with soap and warm water while still wearing them.
If a concentrated pesticide for mixing and loading gets on your gloves, rinse them immediately before continuing. Thorough washing and removal, as outlined below, can then be done after finishing the job. By implementing these guidelines, you can prolong the life of your gloves as well as protect yourself from exposure.

To properly remove disposable gloves:

1. Grasp the cuff of one glove with the other gloved hand; pull it inside out and off the hand. Deposit the glove into a plastic bag for later disposal. Do the same with the other glove by grasping the inside of the cuff and pulling the glove off with the uncontaminated side up. Don’t let the contaminated glove touch your clothing or skin.

2. Dispose of the plastic bag containing the gloves according to label directions.

To properly remove reusable gloves:

1. Wash the outside of your gloves with soap and warm water. Then with a gloved hand, either grasp the fingers of the other glove and slowly pull both gloves off, or turn back the cuffs of each glove and proceed to remove the gloves inside out.

2. Hang the reusable gloves until dry. Do not put them in the washing machine!

After removal of either disposable or reusable gloves, always wash your hands with warm water and soap before resuming daily activities. This will ensure that you do not transfer pesticide residue from your hands into your home, vehicle, or other areas where it could potentially expose you, your family, or other people or animals to pesticides.

Storage and Disposal

1. Store unused disposable or reusable gloves in their original bag or other container with a lid, such as a plastic bucket. After disposable gloves have been used, they can be discarded according to label directions. Reusable gloves can be stored in a bucket or plastic bag once they are dry (Figure 4). Never put contaminated gloves directly on the seat of your vehicle. Reusable gloves should be checked before each pesticide application for leaks and wear. Filling the gloves with water and looking for any holes or tears is recommended. Dispose of gloves according to the pesticide label if they are defective or have significant wear. Replace with new ones.

Figure 4. Properly store gloves in a plastic bag or bucket.

Gloves, as well as other PPE, should be stored separately from pesticides to prevent accidental contamination. Gloves should be stored in a clean environment away from direct sunlight or temperature extremes. Do not store used gloves where they could be accessed by children or pets.

By following the label and properly using chemical-resistant gloves when applying pesticides, you will be able to control pests safely and effectively while protecting yourself, your family, other people, animals, and the environment.

This publication has been peer reviewed.

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Maintaining and Fit Testing Cartridge Respirators for Pesticide Applications

Erin C. Bauer, Extension Associate; Clyde L. Ogg, Extension Educator; Pierce J. Hansen, Extension Assistant; and Jan R. Hygnstrom, Project Coordinator

When working with any pesticide, you must follow all personal protective equipment (PPE) requirements listed on the label. This is for your safety, and also is a legal requirement for using pesticides. Some pesticides carry a risk of inhalation exposure and require the use of a respirator, such as a dust respirator, full or half face cartridge (air purifying) respirator, or self-contained breathing apparatus (SCBA). This NebGuide will focus on the half face cartridge respirator, which is one of the most common respirators used when applying pesticides.

Like other PPE, it is vital to properly maintain your respirator to ensure that it offers adequate protection when you apply pesticides. This includes testing the respirator before each use to make sure that it has a tight seal, as well as proper cleaning and storage of the respirator after each use.

Your New Respirator

Some pesticide labels clearly state specific types of respirators/cartridges/filters that are required. Be sure to follow these directions carefully; purchase and use the appropriate type for the product you will be applying.

When you buy a new respirator, it will come in a package with several components. These include an instruction manual, faceplate with straps, two cartridges, and extra accessories to attach for dust or particulate protection (Figure 1). Check the labels on the cartridges to ensure they provide the protection you need, whether it is against organic vapors or other particulates.

It is important to read the instruction manual thoroughly before using the respirator. The manual explains how to properly assemble, fit, maintain, and store the respirator. The most important thing to remember when using a respirator is to get a good seal. Without a good seal, the respirator will not effectively protect you from pesticide inhalation exposure.

Fit Testing

Fit testing is mandatory under Occupational Safety and Health Administration (OSHA) regulations. Fit testing must be done to determine the size of the respirator for a particular user. Pesticide applicators need to meet certain health requirements before conducting a fit test or doing work that requires a respirator. OSHA requires that an employee who will be using a respirator have a medical evaluation prior to fit testing. The employee also needs to be properly trained in respirator use. For more information about OSHA’s medical evaluation questionnaire, mandatory fit test procedures, and

Figure 1. Examples of respirator packaging and instruction manual.

OSHA lists minimum requirements for respirator fit testing and initial use. For example, a new fit test may be required if there is a change in size, make, or model of the respirator you are using, or a change in user characteristics such as dental work, body weight, etc. You should always follow these guidelines.

The most important part of a fit test is obtaining a good seal. It is good common practice to test the seal on your respirator every time you put it on. Between removal, cleaning, and storage, the respirator may not fit the same, so you’ll have to readjust it before using it again. Prior to each use, check the face seal for cracks and abrasions. Check respirator assembly (components, valves, O-rings) to ensure they are intact, present, and appropriate.

To accomplish a seal check, the faceplate has to fit tightly against your face. Facial hair may prevent you from being able to get a tight seal, so you may need to shave before using a half face respirator, or choose an alternative pesticide that does not require a respirator.

There are three common ways to test the seal. Before testing, adjust the respirator so you think you have a good fit. To begin, place the respirator on your face, then pull the top (halo-shaped in some models) plastic strap and adjust it over and on top of your head. Next, connect the straps that go behind your neck, and pull the loose ends of the straps to adjust for comfort and fit. When you feel you have a tight seal, test to ensure your respirator is fitted properly (Figure 2).

**Positive Seal Check**

To perform the positive seal check (Figure 3), cover the exhalation valve in front of the respirator and gently exhale. If you can do this without feeling a rush of air around the faceplate, you have a good seal.

**Negative Seal Check**

To perform the negative seal check (Figure 4), cover the intake portion of each of the two cartridges with your hands and inhale gently. Note that you also can do this test without...
the cartridges by simply covering the inlet holes and testing the seal. If you have a good seal, you should not be able to pull any air through the seal against your face. If you can pull air, check carefully around the seal for damages or obstructions. If you find breaks or damaged portions of the seal, replace the respirator. If you are able to clear obstructions and make additional adjustments to strengthen the seal, simply retest the unit. In some cases, if you can’t find a solution, you will need to replace the respirator seal or the entire unit.

Ampule Test

An ampule is a small, sealed vial that can be purchased from many online suppliers. Ampule testing for respirator fit is one example of several procedures that may be required by OSHA. In the ampule test (Figure 5), you break an ampule designed for this purpose and see if you can detect an odor (often smelling like concentrated banana) through the respirator. If you detect an odor, you know that your seal isn’t adequate and you’ll have to make additional adjustments. Make sure to test the ampule across all portions of the respirator seal. You also should consider simulating common working motions such as moving your head up and down and side to side to test field operability.

Maintaining Your Respirator

When finished with your respirator, clean and store it properly after each use so that it’s in good condition for the next use.

After removing your respirator, remove the cartridges. They generally unthread, bend, or snap out of the faceplate. If the cartridge seating is damaged during removal, do not attempt to repair or bend it back in place — simply replace the cartridge. Store cartridges in either the original respirator packaging or a resealable zipper storage bag when not in use. The best type of storage container is one with an airtight seal. Cartridges absorb pesticides and other organic vapors when exposed to air. You can extend their life span by storing them properly whenever they are not in use. The respirator package or resealable zipper storage bag provides ideal storage because it offers an airtight seal that will help preserve the cartridges by keeping organic vapors out. It is also a good idea to mark the storage container with the purchase date of the cartridges and a running tally of the total number of hours used (Figure 6).

After removing and storing the cartridges, wash the faceplate with soapy water and either air or towel dry before storing it in a clean, dry container with a good seal such as a resealable zipper storage bag or a tight-sealing plastic storage container until the next use. Store the respirator in a way that preserves the shape and integrity of the respirator, protecting it from distortion, contamination, and extreme temperatures.
Figure 6. Store your respirator in its original packaging or a resealable zipper storage bag or plastic storage container.

Figure 7. After each use and before storing your respirator, the faceplate should be washed with soapy water, hung to dry, and checked for wear or damage.

Also, be sure to inspect the respirator for any holes, damage, or wear, and replace it if necessary (Figure 7).

Replacing Your Cartridges

A respirator cartridge has a limited life span, which is greatly affected by the conditions of use, such as the temperature, humidity, work efforts of the user, and the chemical concentration and type of chemicals for which the cartridge is used. Many respirator manufacturers have online calculators in which you can enter this information to determine cartridge life. Consult the manufacturer’s website for such software. Keep a log of respirator usage to know how long the cartridges have been used. For more information and a sample log, see the UNL Safe Operating Procedure “Respiratory Protection — Air Purifying Respirators: Cartridge Change Schedules” at http://ehs.unl.edu/sop/RPP_SOP_Cartridge_Change_Log.pdf.

Proper storage will help preserve cartridges for as long as possible, but eventually you will need to replace them. Pay attention to when a cartridge’s life is spent and be sure to replace as necessary. Cartridge life may be reduced if exposure to organic vapors is extensive and occurs over a short time span. Always replace cartridges immediately if you can smell pesticide odors when using the respirator. If you are unsure of the last time a cartridge was used or if the total hours of use have not been recorded, replace it; when in doubt, replace.

Your new cartridges should be the same type as those you are replacing. Cartridges are color coded depending on what particulates they filter. For example, organic vapor cartridges are black and have “organic vapors” written on the label (Figure 8). A cartridge that filters organic vapors as well as pesticide dusts, mists, and fine particles (using a P100 filter) will be magenta and black.

To learn more about maintenance and fit testing of your respirator, refer to the user’s manual that came with your respirator, or view the University of Nebraska–Lincoln Extension video, “Cartridge Respirator Use” at http://www.youtube.com/user/UNLExtensionPSEP.

This publication has been peer reviewed.

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Index: Pesticides, General Safety
Issued June 2011
Managing

the Risk of Pesticide Poisoning

and Understanding the Signs and Symptoms

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Pierce J. Hansen, Extension Assistant
Managing Pesticide Poisoning Risk and Understanding the Signs and Symptoms

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The potential for accidents with pesticides is real. Accidental exposure or overexposure to pesticides can have serious consequences. While most pesticides can be used with relatively little risk when label directions are followed, some are extremely toxic and require special precautions.

In 2010, the Poison Control Centers received 91,940 calls (3.3 percent of all human exposures) related to pesticide exposures. That year, pesticides were responsible for about 3 percent of all accidental exposures to children 5 years and younger and almost 6 percent for adults. In addition, pesticides were the cause of about 4 percent of children's deaths reported to the Poison Control Centers.

Routes of Exposure

Pesticides can enter the human body three ways: 1) dermal exposure, by absorption through the skin or eyes; 2) oral exposure, through the mouth; and 3) through inhalation or respiratory exposure, by breathing into the lungs.

Dermal exposure results in absorption immediately after a pesticide contacts the skin or eyes. Absorption will continue as long as the pesticide remains in contact with the skin or eyes. The rate at which dermal absorption occurs is different for each part of the body (Figure 1). The relative absorption rates are determined by comparing each respective absorption rate with the forearm absorption rate, given a rate of 1.

It is easy to transfer pesticide residues from one part of the body to another. For example, residues can be inadvertently moved from the palm of a hand that has an absorption rate of 1.3, to a sweaty forehead (4.2) or to the genital area (11.8). When this occurs, the applicator increases the potential for pesticide poisoning.

Oral exposure may result in serious illness, severe injury, or even death. Pesticides can be ingested by accident, through carelessness, or intentionally. The most common accidental oral exposure occurs when a pesticide is taken from its original container and put into an unlabeled bottle, jar, or food container. A pesticide stored in a food container can be especially inviting to a child. When pesticides are managed and stored properly, children should not be able to touch them.

Inhalation or respiratory exposure is particularly hazardous because the lungs can rapidly absorb pesticides into the bloodstream. Some pesticides can cause serious damage to the nose, throat, and lung tissue if inhaled in sufficient amounts. Vapors and very small particles pose the most serious risks.

Lungs can be exposed to pesticides by inhalation of powders, airborne droplets, or vapors. Concentrated wettable powders can pose a hazard if inhaled during mixing. The hazard from inhaling pesticide spray droplets usually is fairly low when dilute sprays are applied with low-pressure application equipment, because most
droplets are too large to remain airborne long enough to be inhaled. The potential for respiratory exposure increases, however, when high pressure, ultra low volume (ULV), or fogging equipment is used. Droplets produced during these operations are fog-sized (less than 10 microns) or mist-sized (10 to 100 microns) and can be carried on air currents for a considerable distance.

Follow these guidelines to reduce the risk of pesticide exposure:

- Always store pesticides in their original labeled containers.
- Never use your mouth to clear a spray hose or nozzle, or to begin siphoning a pesticide.
- Always leave the work area and wash thoroughly before eating, drinking, using tobacco, or using the toilet.
- Read the pesticide label and wear appropriate clothing and personal protective equipment (PPE). The label has precautionary statements listing hazards to humans, indicating whether risks are due to oral, dermal, and/or respiratory exposure.

### Pesticide Toxicity

The toxicity of a pesticide can be measured several ways. Determining the toxicity of a pesticide to humans is not easy, since humans cannot be used as test subjects. Because of this, other animals, such as rats, are used. If a pesticide is poisonous to rats, however, it is not necessarily poisonous to dogs, cows, wildlife, or people. Toxicity studies are only guidelines: they are used to estimate how poisonous one pesticide is compared with another. Some pesticides are dangerous in one large dose or exposure, which is known as acute toxicity. Others can be dangerous after small, repeated doses, called chronic toxicity.

#### Measuring toxicity

The LD50 (lethal dose, 50 percent) describes the dose of a pesticide that will kill half of a group of test animals (rats, mice, or rabbits) from a single exposure or dose by a dermal, oral, or inhalation route. The LD50 is the dose per unit of body weight, such as milligrams per kilogram (mg/kg). A pesticide with a lower LD50 is more toxic than a pesticide with a higher number because it takes less of the pesticide to kill half of the test animals. For example, a pesticide with an LD50 of 10 mg/kg is much more toxic than a pesticide with an LD50 of 1,000 mg/kg.

The toxicity of fumigant pesticides is described in terms of the concentration of the pesticide in the air, LC50 (lethal concentration, 50 percent). Researchers use a similar system to test the potential effects of pesticides on aquatic organisms in water.

**Acute toxicity** of a pesticide refers to the effects from a single exposure or repeated exposures over a short time, such as an accident when mixing or applying pesticides. Various signs and symptoms are associated with acute poisonings. A pesticide with a high acute toxicity can be deadly even if a small amount is absorbed. Acute toxicity can be measured in terms of acute oral, dermal, or inhalation toxicity.

**Chronic toxicity** refers to the effects of long-term or repeated low-level exposures to a toxic substance. The effects of chronic exposure do not appear immediately after first exposure: years may pass before signs and symptoms develop. Possible effects of long-term exposure to some pesticides include:

- cancer, either alone or by assisting other chemicals;
- genetic changes;
- birth defects in offspring following exposure of the pregnant female;
- tumors, not necessarily cancerous;
- liver damage;
- reproductive disorders;
- nerve damage;
- interfering with the endocrine system (hormones and glands that regulate many body functions); and
- sensitivity or allergic reactions such as irritation of the skin and/or respiratory tract.

The effects of chronic toxicity, as with acute toxicity, are dose-related. Low-level exposure to chemicals that have the potential to cause long-term effects may not cause immediate injury, but repeated exposures through careless handling or misuse can greatly increase the risk of chronic adverse effects.

### Table I. Signal words and relative toxicities used on labels of pesticide products.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>SIGNAL WORD</th>
<th>TOXICITY RATING</th>
<th>ORAL LETHAL DOSE for a 150-pound Human*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Dangera</td>
<td>Highly toxic</td>
<td>Few drops to 1 tsp</td>
</tr>
<tr>
<td>II</td>
<td>Warning</td>
<td>Moderately toxic</td>
<td>1 tsp to 1 Tbsp</td>
</tr>
<tr>
<td>III</td>
<td>Caution</td>
<td>Slightly toxic</td>
<td>1 Tbsp to a pint</td>
</tr>
<tr>
<td>IV</td>
<td>Caution (signal word not always required)</td>
<td>Relatively nontoxic</td>
<td>More than a pint</td>
</tr>
</tbody>
</table>

*aThe lethal dose is less than those listed for a child or for a person under 150 lb, and more for a person over 150 lb.

bThe skull and crossbones symbol and the word “Poison” sometimes are printed with the signal word “Danger.”
Signal Words

Nearly all pesticides are toxic at some dose. They differ only in the degree of toxicity. All pesticides are potentially dangerous to people who have had excessive exposure. Every label of a pesticide product will have one of three signal words that clearly indicates the degree of toxicity associated with that product (Table I). The signal word indicates the degree of risk to a user, not the effectiveness of the product in controlling the target pest.

Read the Pesticide Label

Pesticide labels also include statements about route of entry and specific actions that must be taken to avoid exposure. Route of entry statements indicate the outcome that can be expected from exposure. For example, a pesticide label might read, “Poisonous if swallowed, inhaled, or absorbed through the skin. Rapidly absorbed through skin and eyes.” This indicates that the pesticide is a potential hazard through all three routes of entry, and that skin and eye contact are particularly hazardous. Specific action statements normally follow the route of entry statement and indicate what must be done to prevent poisoning accidents. In the case of the pesticide discussed above, the statement might read, “Do not get in eyes, on skin, or on clothing. Do not breathe spray mist.”

The route of entry and specific action statements usually are followed by first aid instructions (see Table II). Read this section of the label carefully prior to using the pesticide so you know what to do if an accidental exposure occurs. By following the instructions carefully, you will help limit the amount of exposure you or the victim will receive, even after initial contact with the pesticide.

<table>
<thead>
<tr>
<th>Table II. Example of a first aid section from a pesticide label.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRST AID:</strong></td>
</tr>
<tr>
<td><strong>IF IN EYES:</strong></td>
</tr>
<tr>
<td><strong>IF INHALED:</strong></td>
</tr>
<tr>
<td><strong>IF SWALLOWED:</strong></td>
</tr>
</tbody>
</table>

Another important section on a pesticide label provides instructions for pesticide applicators and other handlers on the use of personal protective equipment (PPE) to help them limit pesticide exposure. It lists specific protective clothing and equipment requirements. For example, the label for a moderately toxic pesticide might read, “Applicators and other handlers must wear long-sleeved shirts and long pants, shoes plus socks, protective eyewear, and chemical-resistant gloves.”

Manage Your Risk

Wear PPE required by the label when handling or applying pesticides to reduce the risk of exposure to pesticides. If none are listed, wear appropriate clothing, including a long-sleeved shirt, long pants, shoes, socks, and chemical-resistant gloves. Risk of pesticide poisoning is directly related to the toxicity of a pesticide and the level of exposure, which is reflected in the Risk Formula:

\[ \text{Risk} = \text{Toxicity} \times \text{Exposure}. \]

Understanding the toxicity of a product and the potential for personal exposure will help you to lower your risk. No matter how toxic a pesticide is, if the amount of exposure is kept low, risk can be held at an acceptably low level. The toxicity of a pesticide can’t be changed, but an applicator can manage and reduce risk by selecting less toxic pesticides, carefully following the label instructions, and wearing the required PPE.

Recognizing Signs and Symptoms of Poisoning

Anyone who may be exposed to pesticides or is working with someone who may be exposed should be aware of the signs and symptoms of pesticide poisoning. Signs can be seen by others. Vomiting, sweating, and pinpoint pupils are signs of pesticide poisoning. Symptoms are any changes in normal condition that can be described by the victim of poisoning, including nausea, headache, weakness, dizziness, and others. Knowledge of these signs and symptoms will allow for prompt treatment and help prevent serious injury. People who are frequently involved with pesticides should become familiar with the following important steps.

1. Recognize the signs and symptoms of pesticide poisoning for those pesticides commonly used or to which people may be exposed. Often, pesticide poisoning resembles flu symptoms.
2. If you suspect poisoning due to a pesticide, get immediate help from a local hospital, physician, or the nearest Poison Control Center (800-222-1222).
3. Identify the pesticide to which the victim was exposed, giving the chemical name and the EPA registration number found on the label, if possible. Provide this information to medical authorities.
4. Have a copy of the pesticide label available when medical attention begins. The label provides information that will be useful to those assisting a victim of pesticide poisoning.
5. Know emergency measures you can undertake until help arrives or the victim can be taken to the hospital. Both first aid and medical treatment procedures are listed on the product label.

Recognizing Common Pesticide Poisonings

All pesticides in a given chemical group generally affect the human body in the same way. Severity of the effects, however, varies depending on the formulation, concentration, toxicity, and route of exposure of the pesticide. Therefore, it is important to know both the type of pesticide being used and the signs and symptoms associated with poisoning from it.

Pesticides that present the greatest potential health risks and those in which the mode of action is better understood are covered in the following sections. Categories of pesticides with similar signs and symptoms are covered together.

The listings of pesticides in Tables III, IV, and V are not necessarily complete, nor do they guarantee that the product is currently registered. They do, however, represent products that have or have been used in Nebraska. The Environmental Protection Agency (EPA) and Nebraska Department of Agriculture (NDA) maintain registrations for pesticide products. The EPA attempts to discontinue use of the most toxic products and replace them with less toxic products. Pesticides mentioned in this publication may not currently be registered for use in Nebraska, but still may be found on the shelves of applicators. Therefore, they still present risk, so signs and symptoms are included. Mention of a trade name does not constitute endorsement of a product, nor does omission constitute criticism.

### Insecticides

Insecticides have many different modes of action. Some act on the nervous system of the insect. Others slow the production of energy that an insect needs to survive. Another type slows or stops the production of chitin, a major component of an insect exoskeleton, so the insect can’t molt. Insect growth regulators, another type, also may prevent an insect from molting or keep it from maturing and reproducing. Some insecticides disrupt the water balance in an insect, causing rapid water loss and eventual death. The modes of action involving the nervous system and energy production may affect not only insects, but other animals as well. Insecticides such as the insect growth regulators typically are specific to insects. The following is a list of insecticides grouped by their chemical makeup.

### Organophosphate and Carbamate Insecticides

Most cases of pesticide poisoning involve either organophosphate or carbamate insecticides. Both chemical groups affect humans by inhibiting acetyl cholinesterase, an enzyme essential for proper function of the nervous system. Without acetyl cholinesterase, nerve impulses continue and the victim has uncontrolled twitching. Examples of organophosphate and carbamate insecticides used in Nebraska are listed in Table III. Some are being phased out or are not used as much as other insecticides.

<table>
<thead>
<tr>
<th>Organophosphates</th>
<th>Carbamates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acephate (Orthene®)</td>
<td>Dimethoate (Cygon) Phorate (Thimet®) *Aldicarb (Temik®)</td>
</tr>
<tr>
<td>Azinphos-methyl (Guthion®)</td>
<td>Dimethoate (Cygon) Phorate (Thimet®)</td>
</tr>
<tr>
<td>Chlorpyrifos (Lorsban®)</td>
<td>Ethoprop (Mocap®) Pirimiphos-methyl (Actellic) **Carbofuran (Furadan®)</td>
</tr>
<tr>
<td>Coumaphos (Co-Ral®)</td>
<td>Malathion Terbufos (Counter®) Methomyl (Lannate®)</td>
</tr>
<tr>
<td>Diazinon</td>
<td>Methyl Parathion (Penncap-M®) Trichlorfon (Dylox®) Propoxur (Baygon®)</td>
</tr>
<tr>
<td>Dichlorvos (Vapona®, DDVP®)</td>
<td>Naled (Dibrom®, Trumpet®)</td>
</tr>
</tbody>
</table>

*Registrations for italicized products have been discontinued or will be soon after this publication is printed. The product still may be in an applicator’s storage, so names are listed in the tables.

**Registration of this product has been discontinued, and it must not be used after December 31, 2013.
The effects of these materials, particularly organophosphate insecticides, are rapid. Signs and symptoms begin shortly after exposure, and in cases of acute poisonings, during exposure. Exposure to either of these insecticide classes may pose special risks to people with reduced lung function, seizures, or other conditions. In some cases, consumption of alcoholic beverages may worsen the effects of the pesticide.

The onset of symptoms in milder exposures usually occurs within 4 hours, but can occur up to 12 hours after exposure. Diagnosis of a suspected poisoning must be rapid. Signs and symptoms associated with mild exposures to organophosphate and carbamate insecticides include headache; fatigue; dizziness; loss of appetite with nausea, stomach cramps, and diarrhea; blurred vision associated with excessive tearing; contracted pupils; excessive sweating and salivation; slowed heart-beat, often less than 50 beats per minute; and rippling of surface muscles just under the skin. Some of these symptoms may be mistaken for those of flu, heat stroke, heat exhaustion, or an upset stomach.

Moderately severe organophosphate and carbamate insecticide poisoning cases exhibit all the signs and symptoms found in mild poisonings listed above. In addition, a victim may be unable to walk, complain of chest discomfort and tightness, have marked pinpoint pupils, exhibit muscle twitching, and have involuntary urination and bowel movement. Signs of severe poisonings include incontinence, unconsciousness, and seizures.

The order in which these symptoms appear may vary, depending on how contact is made with the pesticide. If the product is swallowed, stomach and other abdominal manifestations commonly appear first; if it is absorbed through the skin, gastric and respiratory symptoms tend to appear at the same time.

Fortunately, good antidotes are available for victims of organophosphate or carbamate poisoning at emergency treatment centers, hospitals, and many physicians’ offices. As with all pesticide poisonings, prompt assistance is critical. If a pesticide is swallowed, obtain prompt medical treatment. If dermal exposure has occurred, remove contaminated clothing, wash exposed skin, and seek medical care.

Organochlorine Insecticides

The U.S. EPA has sharply curtailed the availability of many organochlorines because they persist in the environment. Organochlorines are formed from carbon and chlorine; examples include DDT, chlordane, dieldrin, aldrin, and lindane. Although few are available for purchase or registered for use, some organochlorine insecticides still may be present in storage areas. In addition, organochlorines, such as pesticides, dioxins, and polychlorinated biphenyls (PCBs), are in the environment due to drift from application, spills, leaks, and improper disposal of industrial wastes. Because of the persistence of organochlorines, traces of them still can be found in sediment, water, and living organisms, even though most use was banned in the U.S. decades ago. Some areas have advisories limiting the consumption of fish and shellfish due to the presence of these materials in their tissue. When fish and shellfish such as crabs and mollusks eat, they accumulate pollutants such as organochlorines and heavy metals present in their food, in tainted sediment, or water they filter to get food. The process called bioaccumulation or bioconcentration describes how pollutants accumulate or concentrate in living tissue. The potential for bioaccumulation increases as you go up the food chain, from tiny fish with organochlorines, eaten by larger fish, eaten by larger fish, eaten by humans.

Organochlorines affect the nervous system as stimulants or convulsants. Nausea and vomiting commonly occur soon after ingesting organochlorines. Other early signs and symptoms include apprehension (feelings of suspicion or fear of the future), excitability, dizziness, headache, disorientation, weakness, a tingling or prickling sensation on the skin, and twitching muscles. Loss of coordination, convulsions similar to epileptic seizures, and unconsciousness often follow. When chemicals are absorbed through the skin, apprehension, twitching, tremors, confusion, and convulsions may be the first symptoms. Chronic exposure may lead to cancer, birth defects, and mutations of genes.

No specific antidotes are available for organochlorine poisoning. People assisting a victim should wear chemical-resistant gloves and be careful to avoid contamination by the pesticide. Remove contaminated clothing immediately and bathe and shampoo the person vigorously with soap and water to remove pesticide from the skin and hair. If the pesticide has been swallowed, empty the stomach as soon as possible by giving the conscious patient syrup of ipecac and water or by inserting a clean finger into the throat while the victim is turned to one side, facing the floor. Never induce vomiting when a victim is unconscious: inhaling vomit may cause suffocation.

Pyrethroid Insecticides

Pyrethroids are synthetically produced compounds that mimic the chemical structure of naturally occurring pyrethrins found in a specific type of chrysanthemum plant. As with organophosphates and carbamates, pyrethroids affect the insect’s nervous system, but in a different way: They are not cholinesterase inhibitors. Some examples of pyrethroids are listed in Table IV.

Table IV
### Biological Insecticides

Insecticides produced from plant materials or bacteria are called biological insecticides.

**Azadirachtin.** Derived from the Neem tree, is an insect growth regulator that interferes with the insect molting process. For humans, exposure to azadirachtin causes slight skin and gastrointestinal irritation. Stimulation and depression of the central nervous system also have been reported.

**Eugenol** is derived from clove oil and used both as an insect attractant and insecticide. In humans, large doses can cause skin burns. Extremely large doses may result in liver problems and coma.

**Pyrethrum and pyrethrins.** Pyrethrum is found in the flowers of *Chrysanthemum cinerariaefolium*. Crude pyrethrum is a dermal and respiratory allergen for people. Skin irritation and asthma have occurred following exposures. Refined pyrethrins are less allergenic, but appear to retain some irritant and/or sensitizing properties.

In cases of human exposure to commercial pyrethrum products, realize that other toxicants may be present and will be listed on the label. Synergists may be added to insecticide products to enhance the killing power of the active ingredient. Synergists such as piperonyl butoxide, discussed later, have low toxic potential in humans, but organophosphates or carbamates included in the product may have significant toxicity. Pyrethrins themselves do not inhibit the cholinesterase enzyme.

**Rotenone** is a naturally occurring substance found in several tropical plants. Until 2011, it was formulated as dusts, powders, and sprays for use in gardens and on food crops. The Agriculture Health Study, involving 90,000 applicators and spouses from Iowa and North Carolina, showed a relationship between exposure to rotenone and the incidence of Parkinson’s disease. More research is needed to reach any conclusions on the specifics of that relationship. Manufacturers of rotenone have voluntarily stopped producing the pesticide for all uses except the management of undesirable fish species. Rotenone is now a restricted use pesticide.

**Antibiotics** include abamectin, ivermectin, *Bacillus thuringiensis* (Bt), spinosad, and streptomycin. These compounds are practically nontoxic to humans. In studies involving deliberate ingestion by human subjects, slight inflammation of the gut occurred. Antibiotic insecticides in the form of emulsifiable concentrates may cause slight to moderate eye irritation and mild skin irritation due to the solvent carriers. Antibiotic pesticides are different from antibiotics taken by people to cure bacterial infections.

### Inorganic Insecticides

**Boric acid and borates.** Boric acid, derived from borax and usually combined with an anti-caking agent, is commonly used to kill cockroaches. It can be harmful to humans if accidentally ingested. Avoid inhaling the dust during application. Inhaled borax dust causes irritation of the respiratory tract and shortness of breath. Borax dust is moderately irritating to skin. Infants have developed a red skin rash that most often affects the palms, soles of the feet, buttocks, and scrotum in severe poisonings. The skin developed a “boiled lobster appearance” followed by extensive skin peeling.

**Diatomaceous earth** (DE) is mined from the fossilized silica shell remains of diatoms, which are microscopic sea animals. Labels may refer to this ingredient as silicon dioxide, or “silicon dioxide from diatomaceous earth.” DE is used commercially to control crawling insects, such as cockroaches, ants, and insects that infest grain. It is virtually nontoxic to humans. Avoid inhaling diatomaceous earth, however, as it can irritate the eyes and lungs.

**Silica gel** is a nonabrasive, chemically inert substance used as a dehydrating agent because the small particles absorb moisture and oils. Avoid inhaling the dust. Some grades of diatomaceous earth contain small amounts

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| Table IV. Pyrethroid insecticides, with trade names for some products in parentheses. |
|---------------------------------|---------------------------------|
| Allethrin (Sniper<sup>®</sup>) | Fenvalerate (Evercide<sup>®</sup>) |
| Baythroid (Baythroid<sup>®</sup>, Discus<sup>®</sup>) | Fluvalinate (Mavrik<sup>®</sup>, Perimeter) |
| Cylthurin (Tempo<sup>®</sup>) | Permethrin (Pounce<sup>®</sup>, Ambush<sup>®</sup>) |
| Cypermethrin (Barricade<sup>®</sup>) | Resmethrin (Rid<sup>®</sup>, Mosquito Beater<sup>®</sup>) |
| Deltamethrin (Battalion<sup>®</sup>) | Tetramethrin (aero<sup>®</sup> Assault) |
| Esfenvalerate (Asana<sup>®</sup> XL) | Tralomethrin (Dead-Fast<sup>®</sup> Insecticide Chalk) |
of crystalline silica, which is known to cause a respiratory disease called silicosis and cancer. The risk of cancer depends on the duration and level of exposure. Pesticide-quality diatomaceous earth and silica gel are amorphous (non-crystalline), and do not cause silicosis or cancer.

**Sulfur** is moderately irritating to skin and has been associated with skin inflammation. Dust is irritating to the eyes and respiratory tract. If swallowed, it acts like a strong laxative.

**Other Insecticides**

**Fluorines.** Sulfluramid (Spectracide terminate® and Firstline®) is formulated as an ant, roach, or termite bait and is slightly irritating to the skin. Sulfluramid has low toxicity in lab tests. However, with repeated exposure, it has caused developmental abnormalities in young laboratory animals and affected the reproductive systems of male laboratory animals.

**Nicotinoids,** sometimes called **neonicotinoids,** were introduced in the 1990s. They are chemically similar to nicotine. They have a lower toxicity to humans than organophosphates and carbamates. Imidacloprid and thiamethoxam are used to control termites, turf insects, and some crop insects.

Farm workers reported skin or eye irritation, dizziness, breathlessness, confusion, or vomiting after they were exposed to pesticides containing imidacloprid. Similar symptoms, along with increased heart and breathing rates, also were noted after a victim ingested a product containing imidacloprid; the victim suffered severe cardiac toxicity and death 12 hours after oral exposure.

**Pyrazoles.** Fipronil is a moderately toxic pyrazole that may cause mild irritation to the eyes and skin. It is used to control termites (Termidor®, Taurus®), cockroaches (Combat®, Maxforce®), certain insect pests of corn, and fleas and ticks of cats and dogs (Frontline®, Effipro®, PetArmor®). Lab animals exhibited reduced feeding, reduced urination, increased excitability, and seizures following a toxic oral dose. After ingesting fipronil, humans have reported sweating, nausea, vomiting, headaches, abdominal pain, dizziness, agitation, and weakness. Direct, short-term contact with skin can result in slight skin irritation. Inhalation or dermal contact while spraying fipronil for five hours may have caused a person to have a headache, nausea, dizziness, and weakness. Symptoms developed two hours after spraying and then disappeared. According to the National Pesticide Information Center, signs and symptoms from a brief exposure to fipronil generally improve and clear up without treatment (http://npic.orst.edu/factsheets/fipronil.pdf).

**Pyroles.** Chlorfenapyr (Phantom®, Pylon®) is the only product in this group. It is formulated to control ants, cockroaches, termites, and some insect and mite pests on fruits and vegetables. It is slightly toxic if swallowed or if it contacts the skin, and can be moderately irritating to eyes and skin.

**Tetronic acids.** Spiromesifen is the sole insecticide in this group. It is used to control mites and whiteflies on some vegetable crops (Oberon®) and ornamental trees (Forbid™, Judo™, Oberon®). No indication of eye irritation has been reported.

**Tetramic acids.** Spirotetramat (Kontos®, Movento®) is a systemic insecticide that controls a number of major sucking insects and mites that are pests of trees, vegetables, potatoes, and other plants. Some products with tetramic acids may cause moderate eye irritation. Prolonged or repeated skin contact may cause allergic reactions in some individuals.

**Insect Growth Regulators**

Insect growth regulators (IGR) act on insects in different ways. Those that mimic juvenile hormones keep insects in immature stages and prevent insect reproduction. Chitin synthesis inhibitors prevent insects from molting and growing into adults. In general, IGRs are very low in toxicity and cause mild skin irritation with limited exposure. No human poisonings or adverse reactions in exposed workers have been reported. Some examples of insect growth regulators are listed in Table V.

**Table V. Common insect growth regulators. Examples of trade names are in parenthesis.**

<table>
<thead>
<tr>
<th>Insect Growth Regulator</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diflubenzuron (Adept®, Clarify®)</td>
<td>Methoprene (Bio Spot®)</td>
</tr>
<tr>
<td>Hexaflumuron (Shatter™)</td>
<td>Noviflumuron (Recruit®)</td>
</tr>
<tr>
<td>Hydroyprone (Gentrol®)</td>
<td>Pyriproxyfen (First Shield™)</td>
</tr>
</tbody>
</table>

**Mosquito Repellents**

**Dietyltoluamide (DEET)** was developed by the U.S. Army in 1946 as an insect repellent and has been available to the general public since 1957. Products containing DEET (Detamide®, OFF®) have been effective and generally well tolerated when applied to human skin. If left on skin for an extended period, some people have experienced irritation, redness, a rash, and swelling. Tingling and mild irritation have occurred following repeated application. In some cases, DEET has caused skin irritation and worsened preexisting skin disease. It is very irritating to the eyes but not corrosive. When swallowed, it has caused nausea and vomiting.

Serious adverse effects have occurred when DEET was used under hot, humid conditions and not washed off before going to sleep. The skin became red and tender, then blistered and formed ulcers, leaving painful
weeping bare areas that were slow to heal. Permanent scarring resulted from most of these severe reactions. Very rarely, seizures in people have been associated with exposure to DEET. Most have occurred after drinking products with DEET or using the products in ways that do not follow label directions.

Exercise great caution when using DEET on children: only use products containing lower concentrations. The American Academy of Pediatrics (AAP) recommends against using any repellent on infants 2 months of age or younger. The AAP cautions parents not to use DEET on the hands of a child and to avoid applying it to areas around a child’s eyes and mouth. Consider applying DEET only to clothing, using as little repellent as possible. If a child experiences a headache or any kind of emotional or behavioral change, discontinue the use of DEET immediately. Limited information is available on childhood responses to DEET from research or Poison Control Center reports. Most adverse responses were the result of improper use or accidents.

**Picaridin**, a synthetic compound first made in the 1980s, resembles a natural compound found in the group of plants used to produce black pepper. Although widely used as an insect repellent in Europe and Australia, picaridin has been available in the United States only since 2005. Although uncommon, some people have experienced skin irritation. Picaridin also may cause irritation if it gets into a person’s eyes. Rats lost weight and their kidneys were affected when fed large doses of picaridin. The material is considered practically nontoxic if inhaled. While children may be especially sensitive to pesticides compared to adults, no data suggest that children have increased sensitivity specifically to picaridin.

**Oil of Citronella** has been used for over 50 years as an insect and animal repellent. It is found in many familiar insect repellent products, including candles, lotions, gels, sprays, and towelette wipes. These products vary in effectiveness and may repel various insects, such as mosquitoes, biting flies, and fleas. When used according to the label, citronella products are not expected to harm humans, pets, or the environment. The only concern in studies involving laboratory animals is skin irritation. The EPA requires precautionary labeling because some citronella products are applied to human skin. Citronella is not expected to pose health risks to people, including children and other sensitive populations, if used according to label instructions.

**Fumigants**

Fumigants deliver the active ingredient to the target site in the form of a gas. Fumigants can completely fill a space, and many have tremendous penetrating power. They can be used to treat objects such as furniture, structures, grain, and soil for insect pests and other vermin. Fumigants are among the most hazardous pesticide products to use due to danger of inhalation.

Various fumigants produce differing physiological effects. Headache, dizziness, nausea, and vomiting are common early signs and symptoms of excessive exposure.

Prompt medical treatment is critical with fumigant poisoning. Immediately move a victim of fumigant inhalation to fresh air. Keep the individual quiet in a semi-reclining position even if initial signs and symptoms are mild. If breathing has stopped, give mouth-to-mouth or mouth-to-nose resuscitation. If the victim has no pulse, immediately give cardiopulmonary resuscitation (CPR) using chest compression. Some fumigant products, along with signs and symptoms of poisoning, are listed below.

**Chloropicrin** causes severe irritation of the upper respiratory tract, eyes, and mucous membranes. Symptoms of exposure to chloropicrin include burning eyes, tearing, coughing, difficulty breathing, headaches, nausea, and vomiting. Chloropicrin may be a stand-alone fumigant or may be combined with other fumigants to increase their potency. When present in low percentages, it serves as a warning agent.

**Sulfuryl fluoride** (Vikane®) poisoning symptoms include depression, slowed walking pattern, slurred speech, nausea, vomiting, stomach pain, stupor, itching, numbness, twitching, and seizures. Inhalation of high concentrations may irritate the respiratory tract and may be fatal due to respiratory failure. Sulfuryl fluoride almost always is applied with chloropicrin, so the first signs of poisoning are often associated with severe irritation of the eyes and mucous membranes. Skin contact with gaseous sulfuryl fluoride normally poses no hazard, but contact with liquid sulfuryl fluoride can cause pain and frostbite due to cold temperatures from rapid evaporation.

**Phosphine** fumigants, such as aluminum and magnesium phosphide (Phostoxin®, PhosFume®, Fumitoxin®, and Fumi-Cel®) affect cell function in the liver and lungs. Mild exposure is signaled by a sensation of cold, chest pains, diarrhea, and vomiting. Exposures that are somewhat more serious will be evidenced by cough, tightness in the chest, difficulty in breathing, weakness, thirst, and anxiety. Signs and symptoms of severe exposure include stomach pain, loss of coordination, blue skin color, pain in limbs, enlarged pupils, choking, fluid in the lungs, and stupor. Severe poisonings can lead to seizures, coma, and death.

**Methyl bromide** (Metabron, Meth-O-Gas®) affects the central nervous system, lungs, heart, and liver. People poisoned by methyl bromide experience the common
signs and symptoms of fumigant poisoning along with abdominal pain, weakness, slurred speech, mental confusion, muscle twitching, and convulsions similar to epileptic seizures. Some liquid fumigants cause skin injuries indicated by areas of redness or blisters that rupture, leaving raw skin or deep ulcers. There are few registered uses of methyl bromide: those remaining are on a conditional year-by-year basis.

**Acrolein** (Magnacide H®) is an extremely irritating gas used as an aquatic herbicide. Inhalation of the vapor causes irritation in the upper respiratory tract, which may lead to a buildup of fluids in and narrowing of the air passages. If ingested, it attacks the stomach lining, resulting in open sores and cell death. Contact with skin may cause blistering.

**Dazomet** (Basamid®, G) is a granular soil fumigant. It is used to sterilize soil to eliminate weeds, nematodes, and soilborne diseases. Dazomet is highly toxic if swallowed and can be fatal. Frequent or prolonged exposure to skin can result in irritation or more serious skin problems for some individuals. Inhalation can cause a variety of acute and chronic lung conditions, including local irritation, inflammation, fluid buildup, and lung disease.

**Metam sodium** (Vapam®) is a soil fumigant used to kill fungi, bacteria, weed seeds, nematodes, and insects. When combined with water, it produces a gas that is very irritating to respiratory mucous membranes, eyes, and lungs. Inhalation can cause severe respiratory distress, including coughing of blood and frothy sputum. It can only be used outdoors, and precautions must be taken to avoid inhaling the gas.

**Dichloropropene** (Telone®) is very irritating to skin, eyes, and the respiratory tract. Inhalation may cause spasms of the bronchi, where air passes into the lungs. Although limited data for humans exist, animals have experienced liver, kidney, and cardiac toxicity. Most dichloropropene products contain chloropicrin; severe irritation of the eyes and mucous membranes is an early sign of exposure. Apparently, risk for oral toxicity is low for humans unless large quantities of dichloropropene are ingested.

**Rodenticides**

Pesticides designed to kill rodents pose particular risks to humans. Since they are designed to kill mammals, their mode of action is toxic to humans as well. In addition, rodents often live near humans and other mammals, so accidental exposure to baits is a risk. In the effort to make more effective rodenticides, more toxic materials have been developed, increasing the risk to humans. Symptoms from ingestion of rodenticides can be delayed for days — up to four days for bromethalin, and up to seven days for anticoagulants.

**Benzenamines**. Bromethalin (Tomcat®), the only chemical in this class of rodenticide, is not an anticoagulant (substance that slows clotting of blood). Instead, it acts on the central nervous system. Possible signs and symptoms of exposure to this compound include skin and eye irritation, headache, confusion, muscle twitching, convulsive seizures, and difficulty breathing. Bromethalin poisoning in dogs usually results in paralysis or convulsions and sometimes swelling or bloating of the abdomen.

**Coumarins** are anticoagulants: they slow the ability of blood to clot and disrupt capillary and liver function. Examples include brodifacoum (Jaguar®, Talon®, WeatherBlok®, now d-CON®), bromadiolone (ContraC®, Maki®), and warfarin (Kaput®, formerly d-CON®). The main signs and symptoms are nosebleeds, bleeding gums, blood in the urine, tar-colored feces, and large irregular blue-black to greenish-brown spots on the skin. Vitamin K is an antidote.

**Indandiones** also are anticoagulants. Examples are chlorophacinone (Rozol®) and diphacinone (Ditrac®, Ramik®). Main signs and symptoms are similar to coumarin compounds, but some indandiones cause nerve, heart, and blood system damage in laboratory rats, leading to death before hemorrhage occurs. None of these signs and symptoms have been reported in poisonings of humans. Vitamin K is an antidote.

**Strychnine** is not easily absorbed through the skin nor does it accumulate in the human body. When ingested, however, it acts on the central nervous system within 10 to 30 minutes. Convulsions — violent seizures with involuntary jerky movements that cause the victim to stop breathing — also can occur. Treatment of strychnine poisoning is geared toward eliminating outside stimuli. If strychnine poisoning occurs, place the victim in a warm, dark room to reduce outside stimuli that trigger convulsions. Consequently, in the case of strychnine poisoning, bring medical help to the victim rather than transporting the victim to a medical center, because movement will trigger the convulsions.

**Zinc phosphide** causes severe irritation if ingested. It reacts with water and stomach juices to release phos- phine gas, which enters the blood stream and affects the lungs, liver, kidneys, heart, and central nervous system. Zinc phosphide can be absorbed through the skin and inhaled from fumes. With repeated exposure, it accumulates in the body to dangerous levels. Signs and symptoms of mild zinc phosphide poisoning include diarrhea and stomach pains. In more severe cases, nausea, vomiting, chest tightness, excitement, coldness, loss of consciousness, coma, and death can occur from fluid buildup in the lungs and liver damage. No antidote...
for zinc phosphide poisoning exists. It is a slow-acting material, which allows time to get the victim medical assistance.

**Wood Preservatives**

Pesticides registered as wood preservatives extend the life of wood by reducing or preventing the establishment of populations of organisms such as fungi that cause rot or insects that degrade the wood. Some preservatives can leach slowly into the surrounding soil or water. Sometimes, touching treated wood can leave residue on exposed skin.

**Creosote** (coal tar) typically is found on railroad ties that sometimes are used for landscaping. Exposure can cause skin irritation and prolonged exposure may lead to inflamed skin. Vapors and fumes of creosote are irritating to the eyes and respiratory tract. Ingested creosote may result in severe liver damage. Creosote is considered a probable human carcinogen. Creosote-treated wood cannot be used in residential settings; it may only be used in commercial applications.

**Pentachlorophenol** (PCP, Penchlorol, Penta, Dura-treat®), typically used on utility poles or fence posts, is irritating to the eyes, skin, and respiratory tract. It can cause a stuffy nose, scratchy throat, and tearing eyes. Prolonged exposure sometimes leads to an acne-like skin condition. Ingestion of PCP solutions, excessive skin contact, or inhalation of concentrated vapors may cause fever, headache, weakness, dizziness, nausea, and profuse sweating. Extreme cases of exposure can lead to a loss of coordination and seizures, high fever, muscle spasms and muscle twitching, difficulty breathing, a sense of tightness in the chest, abdominal pain and vomiting, restlessness, excitement, and mental confusion. Intense thirst also is a characteristic. Pentachlorophenol poisoning can be fatal.

**Arsenical** wood preservatives such as chromated copper arsenate (CCA) and ammoniacal copper arsenate (ACA) were used extensively in the past to treat construction lumber for decks, play sets, and fence posts. CCA is not well absorbed through the skin, but hand-to-mouth contact can result in exposures. If swallowed, arsenicals can cause nausea, headache, diarrhea, and abdominal pain. Extreme signs and symptoms can progress to dizziness, muscle spasms, violent mental agitation, and seizures. Prolonged exposure to arsenical wood preservatives can result in persistent headaches, abdominal distress, salivation, low-grade fever, and upper respiratory irritation.

**Herbicides**

Herbicides kill weeds by affecting metabolic processes in plants. Therefore, risk to humans and other mammals is relatively low. Some herbicides, however, can pose a risk of poisoning if not handled according to label directions. Regardless of their chemical structure, the vast majority of herbicides often affect the human body in a similar way. In general, they can irritate the skin, eyes, and respiratory tract. Always read and follow label recommendations carefully to avoid any of these health risks. Herbicides that present the greatest potential health risks are covered in the next four sections.

**Bipyridyl Herbicides**

**Diquat** and **paraquat** are the most common bipyridyl herbicides. Paraquat is more toxic than diquat and produces chronic abnormal cell growth in the lungs, cornea and lens of the eyes, nasal mucous membranes, skin, and fingernails. Diquat affects the eye lens and intestinal tract lining but usually does not produce the frequently fatal lung changes characteristic of paraquat.

Ingesting diquat or paraquat causes severe irritation to the mucous membranes of the mouth, esophagus, and stomach. Repeated vomiting generally follows. Large doses of diquat also produce restlessness and reduced sensitivity to stimulation. Large doses, and sometimes even small doses, of paraquat initially can affect the kidneys, liver, adrenal glands, and lungs: potentially fatal fluid accumulation in the lungs can occur in 24 to 72 hours.

Lesser amounts of paraquat will cause decreased urine output because of kidney failure. Yellowing of the skin due to liver damage is sometimes observed. This initial phase is followed by an inactive period lasting up to two weeks, during which the victim appears to improve. The victim, however, may have permanent and gradually advancing lung damage caused by rapid growth of connective tissue. This prevents proper lung function and eventually leads to death through respiratory failure. Paraquat selectively concentrates in cells in the lungs.

Skin exposure to paraquat and diquat concentrates may cause severe skin irritation and burning. Contact with dilute liquids and diquat dusts may cause slight to moderate irritation. Skin absorption of paraquat apparently is slight. Diquat, however, is absorbed and after repeated contact will produce symptoms similar to those following ingestion.

Exposure to paraquat and diquat spray mist may produce skin irritation, nasal bleeding, irritation and inflammation of the mouth and upper respiratory tract, coughing, and chest pain. Exposure to paraquat concentrates may cause nails to blacken and grow abnormally.

No specific antidotes are available to counteract the effects of paraquat, diquat, and other bipyridyl...
herbicides once significant exposure and absorption has occurred. Seek medical attention promptly. If ingested, and the victim is conscious, induce vomiting immediately unless a physician advises not to. Flush affected eyes with water, and wash skin with soap and water.

**Chlorophenoxy Herbicides**

2,4-D and MCPA are examples of chlorophenoxy herbicides. These compounds are moderately irritating to skin and mucous membranes. Inhalation may cause a burning sensation in the nose, sinuses, and chest, which may result in coughing. Prolonged inhalation sometimes causes dizziness.

Stomach irritation usually leads to vomiting soon after ingestion. Victims may experience chest and abdominal pain and diarrhea. Headache, mental confusion, and bizarre behavior are early signs and symptoms of severe poisoning, which may progress to unconsciousness.

**Arsenical Herbicides**

Ansar®, Montar®, MSMA, and cacodylic acid are some examples of arsenical herbicides. Acute arsenic poisoning usually appears within one hour of ingestion. Garlic odor of the breath and feces may help to identify the responsible toxicant in severe cases. Effects on the digestive tract include inflammation of the mouth and esophagus, burning abdominal pain, thirst, vomiting, and bloody diarrhea.

Arsenic may affect the central nervous system as well. Effects include headache, dizziness, muscle weakness and spasms, low body temperature, sluggishness, delirium, seizures, and coma. Liver damage may lead to yellowness of the skin. Injury to tissues that form blood platelets. Death usually occurs one to three days after the onset of symptoms and is usually the result of circulatory failure.

Chronic arsenic poisoning through skin exposure usually is more of a problem than acute poisoning, characterized by effects in the intestinal tract. Chronic arsenic poisoning may result in cancer. Symptoms of chronic exposure include overgrowth of the eye’s cornea; scaling off of dead skin; excessive fluids under the skin of the face, eyelids, and ankles; white streaks across the nails; loss of nails or hair; and brick red coloration of visible mucus membranes.

**Other Herbicides**

Endothall (Aquathol®) is commonly used as an aquatic herbicide or algaecide. It is irritating to skin, eyes, and mucous membranes. In one case, a man died after ingesting endothall. In this case, bleeding and swelling were noted in the gut and the lungs.

Sodium chlorate (Drexel®, Defol®) is used as a defoliant, nonselective herbicide, and soil sterilant. It is irritating to skin, eyes, and stomach. Even though sodium chlorate is poorly absorbed in the digestive tract, ingestion of a large dose will cause severe poisoning. Irritation to the gut causes nausea, vomiting, and abdominal pain. Bluish skin sometimes is the only visible sign of poisoning. Dark brown staining of the blood and urine can indicate sodium chlorate poisoning.

**Fungicides**

Fungicides are used extensively in industry, agriculture, and the home and garden. Fungicides vary in their potential for causing adverse effects in humans. According to the EPA manual, Recognition and Management of Pesticide Poisoning (Morgan, 1999), “...most fungicides currently in use are unlikely to cause frequent or severe systemic poisonings for several reasons. First, many have low inherent toxicity in mammals and are inefficiently absorbed. Second, many fungicides are formulated as suspensions of wettable powders or granules, from which rapid, efficient absorption is unlikely. And third, methods of application are such that relatively few individuals are intensively exposed.” Fungicides probably have caused a large number of irritant injuries to skin and mucous membranes, as well as some skin sensitization. As with any pesticide, always read and follow label recommendations carefully to avoid any health risks that a specific fungicide may pose.

**Other Pesticides and Synergists**

The three chemicals listed in this section are among the many pesticides and synergists that have not been discussed. These are listed because they have a relatively high potential for harming humans and nontarget animals.

4-aminopyridine (Avitrol®) is a highly toxic powder used as a bird repellent, often mixed with whole or cracked corn. It is toxic to all vertebrates. No human poisonings have occurred when used according to label directions. However, intentional ingestion has resulted in immediate abdominal discomfort, nausea and vomiting, weakness, dizziness, profuse sweating, and, sometimes, death.

Metaldehyde (Deadline®) has been used to control slugs and snails for many years. Poisoning of animals (particularly dogs) and children occurs occasionally when metaldehyde is swallowed. Ingestion of a toxic dose often is followed by nausea and vomiting, then fever, seizures, and changes in mental status, sometimes leading to coma. Other signs and symptoms that can occur...
are excessive salivation, facial flushing, dizziness, rapid breathing, and high acidity in the blood. While most poisonings are dramatic, they are rarely fatal. Deaths of dogs are common, however, when they eat enough of the product.

Piperonyl butoxide (PBO) is not a pesticide but one of the most common synergists in use. Synergists typically are added to insecticide products to enhance the effectiveness of the active ingredient. For example, PBO slows the ability of an insect to break down a pesticide. If PBO was not added to a particular insecticide, the insect could break down the pesticide before it could have an effect. As a synergist, PBO reduces the amount of a pesticide that is needed to be effective. Toxicity of PBO in mammals is low, although based on limited evidence of cancer in laboratory animals, it was considered a possible human carcinogen. PBO may trigger allergic responses in some people. Another common synergist that works the same way is known by either MGK 264 or n-octyl bicycloheptene dicarboximide.

What if a Pesticide Poisoning Occurs?

The key to surviving and recovering from a pesticide poisoning is rapid treatment. Take emergency action immediately when you suspect a pesticide poisoning has occurred. As time elapses after exposure, the toxic effects are heightened, and the victim may need more time to recover.

Immediately dial 911 whenever you suspect a pesticide poisoning. An advanced life support team will be dispatched to provide assistance. In addition, you may wish to contact the following:

1. **The Poison Control Center (800-222-1222)** will provide specific directions on procedures to follow until a life support team arrives.
2. The nearest hospital or a physician. These can benefit by having preliminary information before the patient arrives.
3. Another source of medical and consumer information related to pesticides during non-emergencies is the National Pesticide Information Center (800-858-7378 or online at [http://npic.orst.edu](http://npic.orst.edu)).

What a victim might think is a cold or the flu could be a fatal pesticide poisoning. Whenever possible, get answers to the following questions.

1. Has the victim been exposed to a pesticide?
2. If so, which one and how did the exposure occur?
3. What emergency actions are given on the pesticide label?

Many pesticide labels direct that vomiting be induced. You can do this by giving the patient syrup of ipecac and water or by inserting a clean finger into the throat of the victim. **Do not induce vomiting when:**

- the label says not to,
- the victim is having or has had seizures accompanied by involuntary jerking movements,
- the victim is unconscious, or
- the pesticide contains petroleum products such as xylene.

**Caution:** Inhaling vomit can be life-threatening. Timely emergency treatment is vital to survival.

After exposure to a pesticide, always wash the victim’s exposed skin with soap or detergent and plenty of water, then obtain medical treatment. Skin irritation can result from continuous exposure if not treated. If the victim’s clothing has been contaminated by a pesticide that is readily absorbed by the skin, remove the clothing and wash or rinse the victim’s skin.

Remember to protect yourself as you help the victim. Wear chemical-resistant gloves. If a pesticide spill is involved, move the victim away from the spill. Assist the victim first; take action to clean up the spill after all first aid has been completed.

Even though most people are careful when working with pesticides, accidents can happen. Be prepared. Keep the telephone number for the Poison Control Center readily available either in your telephone directory or near your telephone. Do not hesitate to contact medical authorities if any symptoms of pesticide poisoning occur. It is better to be safe than sorry.

Most pesticides used by Nebraska farmers, ranchers, and people with lawns and gardens have lower toxicity levels than many of the pesticides discussed in this publication. When applied properly, with the required protective clothing and equipment, they are unlikely to cause problems for the user. However, any pesticide can cause problems due to exposure or overexposure. **Use all pesticides safely. Federal and state laws require that you read the pesticide label completely and comply with all directions. Failure to do so may subject you to federal and/or state sanctions or penalties.**
References


Pesticide Safety Telephone Numbers

**Emergency Telephone Numbers**

- **Poison Control Center**
  - 800-222-1222
  - For aid in human poisoning cases

- **Nebraska Department of Environmental Quality**
  - 402-471-2186 or 877-253-2603
  - 8 a.m. to 5 p.m. Central Time, Monday through Friday
  - To report chemical spills or releases after hours and holidays, contact the Nebraska State Patrol Dispatch.

- **Nebraska State Patrol Dispatch**
  - 402-471-4545 or 800-525-5555

**Nonemergency Telephone Number**

- **National Pesticide Information Center**
  - 800-858-7378
  - 8:30 – 4:30 Mountain time, 9:30 – 5:30 Central time, Monday through Friday

This publication has been peer reviewed.

**Disclaimer**

Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement by University of Nebraska–Lincoln Extension is implied for those mentioned.

UNL Extension publications are available online at [http://extension.unl.edu/publications](http://extension.unl.edu/publications).
# Pesticide Toxicities

The following tables can be used to compare the toxicities of some pesticides and other substances commonly found around the farm, ranch and home. Remember that a low LD<sub>50</sub> means high toxicity.

<table>
<thead>
<tr>
<th>Pesticide Name</th>
<th>Oral LD&lt;sub&gt;50&lt;/sub&gt; (mg/kg rat)</th>
<th>Dermal LD&lt;sub&gt;50&lt;/sub&gt; (mg/kg rabbit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D</td>
<td>500-949</td>
<td>—</td>
</tr>
<tr>
<td>Accent (nicosulfuron)</td>
<td>&gt;5,000</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Ally (metsulfuron-methyl)</td>
<td>&gt;5,000</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Atrazine 4L</td>
<td>1,886</td>
<td>&gt;5,000</td>
</tr>
<tr>
<td>Banvel (dicamba)</td>
<td>2,629</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Bacillus thuringiensis (BT) spp. israelensis</td>
<td>&gt;5,000</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Basagran (bentazone)</td>
<td>1,000-2,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Beacon (primisulfuron)</td>
<td>&gt;5,050</td>
<td>&gt;2,010</td>
</tr>
<tr>
<td>Benlate (Benomyl)</td>
<td>&gt;10,000</td>
<td>&gt;10,000</td>
</tr>
<tr>
<td>Boric Acid</td>
<td>3,500</td>
<td>&gt;10,000</td>
</tr>
<tr>
<td>Buctril (bromoxynil)</td>
<td>779</td>
<td>—</td>
</tr>
<tr>
<td>Captan</td>
<td>9,000</td>
<td>—</td>
</tr>
<tr>
<td>Command (clomazone)</td>
<td>2,077</td>
<td>2,000</td>
</tr>
<tr>
<td>Counter (terbufos)</td>
<td>29</td>
<td>182</td>
</tr>
<tr>
<td>Daethal (DCPA)</td>
<td>&gt;10,000</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Diazinon (technical)</td>
<td>1,250</td>
<td>2,020</td>
</tr>
<tr>
<td>Dual (technical metolachlor)</td>
<td>2,780</td>
<td>&gt;10,000</td>
</tr>
<tr>
<td>Eptam (EPTC)</td>
<td>1,325 - 1,500</td>
<td>2750</td>
</tr>
<tr>
<td>Furadan (carbofuran)</td>
<td>8</td>
<td>&gt;3,000</td>
</tr>
<tr>
<td>Pesticide Name</td>
<td>Oral LD&lt;sub&gt;50&lt;/sub&gt; (mg/kg rat)</td>
<td>Dermal LD&lt;sub&gt;50&lt;/sub&gt; (mg/kg rabbit)</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Gramoxone Extra (paraquat)</td>
<td>150</td>
<td>—</td>
</tr>
<tr>
<td>Lasso (tech alachlor)</td>
<td>930 - 1,350</td>
<td>—</td>
</tr>
<tr>
<td>Lorsban (chlorpyrifos)</td>
<td>96 - 270</td>
<td>2,000</td>
</tr>
<tr>
<td>Malathion (technical)</td>
<td>5,500</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Nicotine (pesticide grade)</td>
<td>50 - 60</td>
<td>—</td>
</tr>
<tr>
<td>Poast (sethoxydim)</td>
<td>3,200-3,500</td>
<td>&gt;5,000</td>
</tr>
<tr>
<td>Ro-Neet (technical cycloate)</td>
<td>2,275-3,200</td>
<td>&gt;2,000</td>
</tr>
<tr>
<td>Rotenone</td>
<td>132 - 1,500</td>
<td>—</td>
</tr>
<tr>
<td>Roundup (glyphosate)</td>
<td>&gt;5,000</td>
<td>&gt;5,000</td>
</tr>
<tr>
<td>Sevin 80S (technical carbaryl)</td>
<td>246-283</td>
<td>—</td>
</tr>
<tr>
<td>Strychnine</td>
<td>30 - 60</td>
<td>—</td>
</tr>
<tr>
<td>Tordon (picloram)</td>
<td>8,200</td>
<td>—</td>
</tr>
<tr>
<td>Treflan (trifluralin)</td>
<td>&gt;10,000</td>
<td>—</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Other Common Examples</th>
<th>Oral LD&lt;sub&gt;50&lt;/sub&gt; (mg/kg rat)</th>
<th>Dermal LD&lt;sub&gt;50&lt;/sub&gt; (mg/kg rabbit)</th>
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</thead>
<tbody>
<tr>
<td>Absolute alcohol (200 proof)</td>
<td>10,600</td>
<td>—</td>
</tr>
<tr>
<td>Antifreeze (ethylene glycol)</td>
<td>8,540</td>
<td>—</td>
</tr>
<tr>
<td>Aspirin</td>
<td>1,000</td>
<td>—</td>
</tr>
<tr>
<td>Caffeine (coffee, cola drinks)</td>
<td>192</td>
<td>—</td>
</tr>
<tr>
<td>Fingernail polish remover</td>
<td>10.7</td>
<td>—</td>
</tr>
<tr>
<td>Gasoline</td>
<td>50 - 100</td>
<td>—</td>
</tr>
<tr>
<td>Ibuprofen (Advil)</td>
<td>626</td>
<td>—</td>
</tr>
<tr>
<td>Salt</td>
<td>3,750</td>
<td>—</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>7,910</td>
<td>—</td>
</tr>
</tbody>
</table>
