



# 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.*

Federal laws legalize pesticides and their use in the US. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), first approved in 1947, has been amended several times. FIFRA and the Nebraska Pesticide Act are the principal statutes governing pesticide use in Nebraska. Additional state laws regarding the use of pesticides in irrigation water and facilities that handle bulk pesticides are administered by the Nebraska Department of Environmental Quality.

## FIFRA

Congress intended FIFRA to protect both people and the environment by regulating the use of pesticides. The law assures pesticide registration, classification, labeling, distribution, use, disposal, and other topics. Sections pertaining to pesticide users address user categories, recordkeeping, certification, and penalties for violations.

FIFRA requires pesticide manufacturers to register each product with the US Environmental Protection Agency (EPA). Some products are registered as restricted use pesticides (RUPs); these have the potential to harm human health and the environment if no restrictions are imposed. Other registered pesticides are grouped as general use pesticides (GUPs). In some cases, the same active ingredient may be in both GUPs and RUPs. In addition, EPA has exempted “minimum risk” pesticides from the FIFRA registration requirement; these pose little to no risk to human health or the environment. Under FIFRA, only certified applicators can use RUPs. Certification means a certifying agency recognizes that a person is competent and thus authorized to use or supervise the use of RUPs. People become certified by passing an exam or, in some cases, taking training. According to FIFRA, anyone can use GUPs according to the label without being certified. Additional legislation in Nebraska, discussed later, has exceptions to this.

FIFRA defines two types of certified applicators: private and commercial. According to FIFRA, a private applicator is certified to use or supervise the use of an RUP 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 RUPs for any purpose other than as given in the definition of a private applicator.

In addition, FIFRA covers pesticide registration and label approval. Pesticide labels are legal documents and must be followed. Federally registered product labels contain sections that address personal protection; protection of others; and protection of groundwater, surface water, endangered species, pollinators, etc. Some pesticide labels direct an applicator to online information, such as for additional required training or to protect endangered species using information from a federal online bulletin (see G1893 Resources). The online bulletin is considered a legal extension of the container label and must be followed.

## Worker Protection Standard

Under FIFRA’s authority, EPA issued the Worker Protection Standard (WPS) in 1992. Its goal is to reduce the risk of pesticide poisoning and injury to agricultural workers (detasslers, harvesters, etc.) and pesticide handlers (mixers, loaders, applicators, etc.). WPS covers agricultural workers and pesticide handlers who are employed on farms, forestry operations, nurseries, and enclosed space production areas (greenhouses, polyhouses, mushroom houses, etc.). When pesticides with product labels having an Agricultural Use Requirements section are used to produce agricultural commodities, WPS requires agricultural employers to provide certain protections. These protections include proper notification, training, personal protective equipment, transport to medical assistance if needed, etc. Under WPS, anyone under 18 years old is prohibited from being a pesticide handler (except for the owner of an agricultural establishment or immediate family member) or doing early-entry work during a restricted-entry interval (REI). WPS was last revised in 2015 with all requirements in effect in 2018. For more information on WPS, see the Resources section.

## 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 who wish to purchase and use RUPs and, in certain situations, GUPs. Training for certification and renewal must be NDA- approved

or offered by the Nebraska Extension Pesticide Safety Education Program.

Nebraska's Pesticide Act and related regulations differ from FIFRA in several aspects. One difference is that in Nebraska, a pesticide license is required for applicators and mixer/loaders of all RUPs; however, NDA has allowed mixer/loaders to operate without licensing so long as they complete NDA-approved WPS Handler training every three years and document that they took the training.

Nebraska has categories of certification in addition to those listed by FIFRA. These categories are for commercial and non-commercial applicators, defined later.

1. Agricultural Pest Control—Plant
  - 1A. Fumigation of Soil
2. Agricultural Pest Control—Animal
3. Forest Pest Control
4. Ornamental and Turf Pest Control
5. Aquatic Pest Control
- 5S. Sewer Root Control with Metam Sodium
6. Seed Treatment
7. Right-of-Way Pest Control
8. Structural/Health Pest Control
- 8W. Wood Destroying Organisms
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 vertebrate 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 GUPs and RUPs. The management of vertebrate pests invading structures with pesticides is covered by the Structural/Health Pest Control category (8).

The application of GUPs 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 Health Pest Control category if the applicator is doing it on behalf of a political subdivision of the state.

The Nebraska Pesticide Act also stipulates that the minimum age for licensing is 16. Realize that the federal minimum age of 18 applies under WPS requirements. In Nebraska, custom farmers are classified as commercial pesticide applicators. Another variation from FIFRA is that in Nebraska, noncertified individuals working under the direct supervision of a certified applicator may have a once-in-a-lifetime, 60-day exemption from licensing when applying pesticides, discussed later.

The Act defines another type of applicator, noncommercial applicators, for those who do not apply pesticides commercially, and do not meet the definition of private applicator. The non-commercial applicator 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." Any employee of a political subdivision of the state who applies GUPs or RUPs for outdoor vector control must obtain a noncommercial license in the Public Health category before applying such pesticides. 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.

### *Pesticide Applicator Certification and Licensing*

People seeking initial certification (a prerequisite of licensing) as commercial or noncommercial pesticide applicators in Nebraska must successfully pass a general standards core exam and one or more specific category examinations, proctored by NDA. Then, the person is considered competent to apply pesticides and is certified. To legally apply RUPs and in some cases, GUPs, a commercial applicator must pay a \$90 license fee. No fee is charged for a noncommercial license. Commercial and noncommercial applicator licenses are valid for up to three years, expiring April 15 of the third year. To become recertified and then eligible to pay the state license fee to become licensed, the person must attend either a Nebraska Extension recertification training program or an equivalent training program approved by NDA before the expiration date on the license. Any applicator also may recertify by examination.

To become certified as a private applicator, individuals must complete one of the following:

1. An NDA-approved training program provided by Nebraska Extension, or
2. An NDA-approved self-study training program provided by Nebraska Extension, or
3. Pass an examination administered by NDA.

People who attend these training sessions or pass the exam are considered competent to apply pesticides as private applicators and are certified. Then, the private applicator must pay a \$25 state license fee to obtain the license. The same options apply for private applicator recertification, required every three years.

### *60-Day Exemption from Licensing*

In general, a person must be licensed to use an RUP. 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 addition, applicators who have had a commercial, noncommercial, or private license at *any* time are NOT eligible for a 60-day exemption from licensing.

To legally use pesticides as an unlicensed applicator, the individual or his/her employer must apply to NDA for the 60-day exemption within 10 days of the first pesticide application. 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:

1. Determine the level of experience and knowledge of the unlicensed person using the pesticide.
2. Provide verifiable (documented) detailed guidance on how to conduct each pesticide application performed under his/her direct supervision.
3. Accompany the unlicensed person to at least one site that typifies each different pesticide use the unlicensed individual performs.
4. Be in direct two-way communication with the unlicensed applicator during the application.

5. Be able to physically be on the pesticide use, storage, or mixing/loading site, if needed, within three hours.

For more information: <http://www.nda.nebraska.gov/pesticide/60day.pdf>

### *Recordkeeping Requirements—Distributors/Dealers*

NDA requires those who sell RUPs to hold a Nebraska pesticide dealer's license and be registered with 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. 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. Number on the person's license or dealer license number, the state issuing the applicator certificate, expiration date, and the category of certification, if applicable.
4. Product name, EPA registration number, and if applicable, the state special local needs (SLN) registration number on the pesticide label.
5. Quantity of pesticide sold.
6. 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. Original pesticide applicator's license and 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 RUP, and proper identification of the buyer.

### *Recordkeeping Requirements—Commercial and Noncommercial Applicators*

NDA regulations require commercial and noncommercial applicators of RUPs, and commercial applicators of GUPs 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 applicator 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 or address of the pesticide application.
4. Specific name of target pest(s); (aphids, crabgrass, etc.)

5. Application site (name of crop or commodity, type of field, type of surface, etc.).
6. Day, month, year, and starting time of application.
7. Trade name and EPA registration number of the pesticide applied.
8. Rate of pesticide applied per unit of measure (pounds per acre, ounces per 1,000 square feet, etc.). For spot treatment, indicate mixture rate (1 ounce per gallon).
9. Total amount of pesticide applied to site.
10. Area or size of treated site (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 remains, indicate such.
12. Any other information required by the specific product label.

NDA further recommends that wind speed and direction be recorded along with ambient air temperature, and where applicable, temperatures of soil, grain, and water. NDA also recommends that commercial applicators of GUPs for lawn care 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. Application records of RUPs custom applied for a grower must be provided to the grower within 30 days or held on behalf of the grower.

### *Recordkeeping Requirements—Private Applicators*

Private applicators must maintain records of each RUP application. Federal standards apply in Nebraska: records must be completed within 14 days of the application, and maintained for three years, in any format. Records 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:
  - a. County, range, township, and section.
  - b. An accurate identification system using maps and/or written descriptions (GPS).
  - c. An identification system established by a USDA agency, e.g., Farm Service Agency or Natural Resources 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.
6. Any other information required by the product label.

See a sample form at [https://pested.unl.edu/documents/PRIVATE\\_APPLICATION\\_RECORD.pdf](https://pested.unl.edu/documents/PRIVATE_APPLICATION_RECORD.pdf)

### *Recordkeeping—Spot Applications*

RUP applications made on the same day in a total area of less than 1/10 of an acre, excluding greenhouse and nurseries, are considered spot applications or spot treatments. For private

and commercial/noncommercial spot applications, records must include:

1. Brand or product name and EPA registration number.
2. Total amount applied.
3. Location noted as “spot application” with the section, township, range, and county of the treatment.
4. Month, day, and year of the application.
5. Commercial/noncommercial spot applications must include the mixture rate.

Extension recommends that you keep detailed records, such as “Spot application: Product X, EPA Reg. XXX-XXX, 10 oz. (mixture rate of 2 oz. per gal), 5/1/2019; musk thistle sprayed on W edge of Field 5 (Section 24, T15N, R8E, Saunders Co.)”

### *Recordkeeping—Additional Information*

Both FIFRA and the Nebraska Pesticide Act state that the label must be followed when making a pesticide application. Each product label has specific information regarding use to reduce risk to the applicator, other people, nontargets, and the environment. Some products (RUP dicamba) require additional data to be collected and recorded regarding weather conditions. Some (RUP dicamba, paraquat) may require additional training. In addition, some pesticides may require you to gather additional information from online sources or through a phone call regarding protection of endangered species. Others may require that you check for sensitive crops or sites in the vicinity of planned applications, either by physically checking or through an online field registry such as FieldWatch, DriftWatch, or BeeCheck. Even if not required, it is to your benefit to document that you performed those activities. Read and follow the label *every time* you use a pesticide.

### *Access to RUP Application Records*

Related sections of FIFRA and the Nebraska Pesticide Act give NDA the authority to inspect private, commercial, and non-commercial applicator records and establishments. Attending li-

censed health care professionals or those acting under their direction, USDA representatives, and state regulatory representatives with credentials have legal access to these records. Authorized people can copy the records, but the licensed pesticide applicator must keep the originals.

### *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 are adjusted according to the seriousness of the offense and business size. Base fines range from \$1,000 to \$4,000, depending on the nature of the violation. Base fines for subsequent violations range from \$2,000 to \$5,000, depending on the violation.

Penalties are adjusted using numerical factors that increase with the gravity 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**

- Federal Insecticide, Fungicide and Rodenticide Act, as amended, <http://www.law.cornell.edu/uscode/text/7/chapter-6>.
- Hygnstrom, J.R., C.L. Ogg, and C.A. Alberts. 2016. Worker Protection Standard for Agricultural Establishments. EC3006. <http://extensionpublications.unl.edu/assets/pdf/ec3006.pdf>.
- Nebraska Department of Agriculture Pesticide Program, <http://www.nda.nebraska.gov/pesticide/>
- Nebraska Pesticide Act and Pesticide Regulations, as amended (Title 25, Chapter 2), <http://www.nda.nebraska.gov/regulations/plant/PesticideAct.pdf> for the law; <http://www.nda.nebraska.gov/regulations/plant/PesticideRegulations.pdf> for the regulations
- Nebraska Extension Pesticide Safety Education Program, <http://pested.unl.edu>
- Ogg, C.L., E.C. Bauer, J.R. Hygnstrom, E.A. Dorn, 2014. Pesticides and the Endangered Species Protection Program. G1893. <http://extensionpublications.unl.edu/assets/html/g1893/build/g1893.htm>

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# Protective Clothing and Equipment for Pesticide Applicators

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*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. Dress appropriately and use personal protective equipment (PPE) to help minimize pesticide exposure and reduce the risk of pesticide poisoning. These steps also are required and necessary for 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, nontarget animals: your family, nontarget animals, 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.

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

### 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.

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

<sup>a</sup>The lethal dose is less than those listed for a child, or a person under 150 lbs. and more for a person over 150 lbs.

<sup>b</sup>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 (PPE), 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

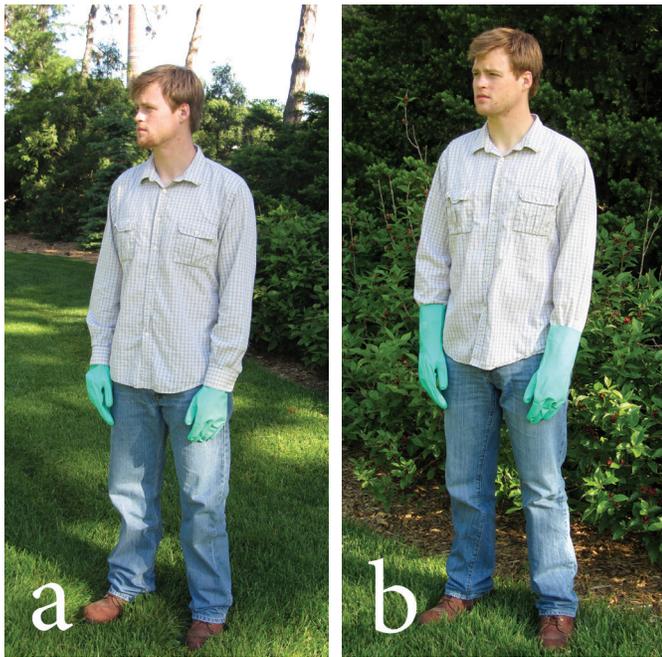


Figure 1. Wear a long-sleeved shirt, long pants, shoes plus socks, and chemical resistant gloves when applying pesticides. We recommend wearing gloves inside sleeves (1a), but wearing gloves outside sleeves may work equally well (1b).

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. To reduce pesticide penetration, select garments made of tightly woven fabrics. 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;



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



Figure 3. Different types of safety goggles and glasses.

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.

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 mixing/



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.



Figure 6. Half-face cartridge respirator with cartridges attached (6a) and cartridge detached (6b).

loading task or pesticide application. Others, such as nitrile gloves, are available in single-use disposable versions in a variety of mil weights (Figure 5).

Avoid lined gloves because the lining can absorb the pesticides and is hard to clean. Latex gloves, commonly used by medical personnel, do not provide adequate dermal protection because they are not chemical-resistant. Never wear cotton, leather, or canvas gloves unless the label specifically requires them, as with certain fumigants. Some fumigants penetrate rubber, neoprene, and leather, and if trapped inside a glove, can cause severe skin irritation or be absorbed through the skin.

In most cases, we recommend wearing gloves under your sleeves to keep the pesticide from running down the sleeves and into the gloves. When working with your hands above your head, roll glove tops into cuffs to prevent the pesticide from running down the gloves to your forearms. As an extra safety measure, you can duct tape around where the glove and sleeve meet. Remember, the most important thing is to wear gloves! For more information about types of gloves, see G1961, *Pesticide Safety: Choosing the Right Gloves*.

### 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 also is 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



Figure 7a. Full-face canister respirator, without canister. (Photo courtesy of 3M); 7b. Close-up of canister. (Photo courtesy of North by Honeywell)



Figure 8. Self-contained breathing apparatus. (Photo courtesy of MSA.)



Figure 9. Supplied-air respirator. (Photo courtesy of MSA.)

vapors. Always read the pesticide label for product-specific recommendations. In all cases, the selected respirator should bear a mark indicating it is approved by the National Institute of Occupational Safety and Health (NIOSH-approved). 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.

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 also can provide protection against dusts/mists if the appropriate filter/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.

If the oxygen supply is likely to be low or the application will result in heavy concentrations of highly toxic pesticides, such as fumigants, an atmosphere-supplying respirator such as 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 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.

## 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 perform a seal check before using a respirator to ensure 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 respirator care, see EC3021, *Respirators for Handling Pesticides* and EC3027, *Fit Testing a Respirator for Pesticide Application*.

## 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.

## Laundering Clothing Soiled With Pesticide

- Wear uncontaminated clothes during pesticide applications. Remove these clothes upon finishing the job and change into clean clothes before going home for the day. Or wear chemically resistant, disposable (non-reusable) coveralls over your clothing.
- At the end of the job or application, remove your contaminated clothing and wash immediately. If this is not possible, wash later but always separately from family laundry.
- Dispose of clothing heavily soiled with pesticide according to label instructions. This includes shoes and boots saturated with pesticides.
- Wear chemical-resistant gloves when handling contaminated clothing, even to launder.
- Wash pesticide-contaminated clothing daily.
- Wash only a few items at a time. Do not mix with regular laundry.
- Use liquid detergent, highest water level, and hot water.
- Use wash cycle for heavily soiled clothes.
- After washing, remove clothing from the machine and run the

washer through another cycle with hot water and detergent before laundering other clothing.

- Line dry if possible, or use the regular dryer setting.

## 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 Emergency Phone Numbers box) and keep them posted where pesticides are stored, mixed, or applied. If you experience any pesticide poisoning signs or symptoms (nausea, skin rashes, headaches, coughing, diarrhea, chest pain, twitching, or seizures), see a physician immediately. For more information, see EC2505, *Managing the Risk of Pesticide Poisoning and Understanding the Signs and Symptoms*.

## Disclaimer

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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

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## Cleaning Pesticide Application Equipment

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*This NebGuide describes how to properly clean pesticide application equipment, and why it is essential in protecting both you and the crops you are spraying.*

Cleaning pesticide application equipment (Figure 1) is necessary and worthwhile. The risk from **not** cleaning your spray equipment is reason enough to take the time to do it right. Even a trace of leftover chemical sprayed on a different crop can cause severe damage.

For example, suppose a sprayer with a 1,000-gallon tank is used to apply the 22-ounce rate of XtendiMax®/FeXapan™, or the 12.8-ounce rate of Engenia®. The herbicide is diluted in the tank to create a dicamba spray solution that is applied at a rate of 20 gallons per acre on a labeled site. The sprayer's next job is to spray a field of conventional soybeans with a different herbicide. It would take just **one gallon** of dicamba spray solution leftover in the sprayer system from the previous application to cause visible injury. To put it another way, one drop (456 drops per fluid ounce) of dicamba is enough to cause significant visible crop response on nearly 3 acres of conventional soybeans.

The last thing any applicator wants to do is increase costs because the job was done incorrectly. To reduce the risk that pesticide residues could harm a crop, it is crucial to clean every nook and cranny (of a sprayer system) that might hold spray solution.

When cleaning spray equipment, it is just as important to protect yourself from pesticide exposure as it is to protect the crops you are spraying. Determining what personal protective equipment (PPE) to wear when cleaning equipment is simple. Read the PPE statement on the label of the product you are cleaning out. At the very least, wear the



Fig. 1. Agricultural field sprayer for pesticide applications.

PPE required by the label. In addition, wear a chemical-resistant apron, eye protection, pesticide-resistant gloves, and any other appropriate PPE.

### Places Where Residues Hide

Because sprayer systems are complex, pesticide residues can accumulate in many places. Places in a system that tend to collect the most residues include:

- spray tanks
- sumps and pumps
- around baffles
- hoses
- valves
- booms

- screens
- end caps
- nozzles

## Cleaning Procedures

The following is a general set of guidelines to clean a sprayer system. If this contradicts label instructions for a given pesticide, always follow the label's instructions instead. The label is the law.

### *Step 1. Clean booms after each use.*

Some pesticide formulations can settle inside spray equipment very quickly, which can make cleaning much more difficult. To avoid cleaning difficulties, it is important for handlers to clean out sprayer booms every single day the sprayer is used. This prevents chemicals from penetrating plastic or getting cemented to the inner surfaces of equipment. Never allow the spray solution to remain in the boom lines overnight prior to flushing. Hoses can become contaminated. Use oil-resistant hoses on sprayers. Remove end caps after the nozzles and screens have been flushed to further help clean out the spray booms.

### *Step 2. Rinse sprayer the first time in the field.*

Because of the high concentration of residue still in the system during the first rinse, it is wise to perform this first rinse at the original application site. Use 10 percent of the tank's water capacity to rinse. Agitating the rinse water is helpful in freeing any residue. A pressure washer can make this rinsing more effective. Be sure to open all valves to ensure every part of the system is rinsed on the first flush. Run water through the system for at least five minutes. Doing this by boom section makes it easier to check for plugged nozzles.

Apply the contaminated rinse water to the outer rows of the field you treated. Check to make sure that these outer rows are not near susceptible vegetation. It is up to the handler's judgment as to where to clean other parts of the system and dispose of that rinse water. Alternate the places to spread rinse water and avoid having pesticide residues concentrated in one spot. Avoid contaminating other water sources such as lakes and streams.

Rinsate can also be used as a diluent for future pesticide mixtures if:

- the pesticide in the rinsate is labeled for use on the target site where the new mixture is to be applied,
- the rinsate is used to dilute a mixture containing the same or a compatible pesticide, and

- the amount of pesticide in the rinsate, plus the amount of pesticide product in the new mixture, does not exceed the label rate for the target site.

The rinsate cannot be added to a future pesticide mixture if:

- the rinsate contains strong cleaning agents, such as bleach or ammonia, that might harm the plant, animal, or surface where the rinsate will be applied, or
- the rinsate would alter the pesticide mixture and make it unusable.

### *Step 3. Clean all screens.*

The screens in a sprayer system collect solids and semisolids (e.g., gooey pesticide residue), so clean them to prevent clogs in the line. Dirty screens can negatively affect sprayer performance. Removing **and** cleaning these screens is a very important step in cleaning the system. Dirty screens can continually recontaminate the rest of the system. Clean with a brush and hot soapy water. Rinse. It is also important to clean the filter housings, where residues can also build up. After cleaning, put screens back in the system, except nozzle screens; these should be left off until the end.

### *Step 4. Clean the end caps and rinse a second time.*

The space between the last nozzle and the very end of the boom is called an end cap. This is yet another essential part of a sprayer to thoroughly clean. There are two end caps on each section of the boom sprayer. If the sprayer does not have end caps, you need to install them in order to adequately clean the booms. Remove the end caps and scrape the residue (*Figure 2*) off with a brush, using tank cleaner and water. Put one end cap back on each section of the boom to prepare for the second rinse cycle. The rings on end caps break easily, so watch for rings that need replacing.

Circulate water through the system a second time. With one end cap in place on each boom section, flush each section, one at a time, so there is enough water pressure and volume to properly rinse the boom. Once a section is rinsed, put the missing end caps back on and move to the next section. Remove the end caps that were attached previously. Rinse again. After all sections have been rinsed, put all end caps back in place.

### *Step 5. Add tank cleaner.*

Commercial tank cleaners neutralize and loosen chemicals that remain in spray equipment; use them only after the first two thorough rinses. Tank cleaners should not be expected to do the bulk of the cleaning, but rather



Fig. 2. Pesticide residue accumulation at an end cap.

to manage remaining traces of pesticide. Cleaners typically have a high pH level, which counteracts the acidity of many pesticides. There is some doubt about the effectiveness of ammonia or bleach as tank cleaners. However, some pesticide labels may specify using ammonia or bleach to clean a tank. If so, do **not** use both at the same time. When bleach and ammonia mix, they generate toxic chloramine vapor. Many pesticide labels offer suggestions on what commercial tank cleaners to use. For more information about specific cleaners to use with specific herbicides, see the “Recommended Cleaning Agents for Selected Herbicides” table in the *Guide for Weed, Disease, and Insect Management in Nebraska*, EC130.

Put water in the tank first. Add the cleaner next. The rate of cleaner to be used is usually expressed as pints or quarts per 100 gallons of water and can be found on its label. Once this mixture is in the tank, turn on the agitation and circulate the cleaning solution throughout the system.

Most tank cleaner labels will list an amount of time that the cleaner needs to successfully neutralize the chemicals. The longer the solution is in the system, the better. In fact, letting it sit overnight is perfectly acceptable. Once you decide the cleaner has had ample time to do its job, proceed with Step 6.

#### *Step 6. Perform final system flush.*

Thoroughly flush out the system with clean water. You can also use a tank mix surfactant or a fertilizer additive to remove residues that commercial cleaners can miss.

#### *Step 7. Wash up.*

After you are completely finished with the process of cleaning your spray equipment, do not come into contact with other people. Do not eat, drink, chew gum, use tobacco, or use the bathroom until you and your clothing are properly cleaned. Wash gloves thoroughly before removing them. Remove outer clothing outdoors, then immediately shower. Wash the clothes you wore separately from any other clothing. After removing the clothes, run the empty machine with the hottest water available and detergent, on the longest cycle to completely cleanse it. Safely discard any clothing that is heavily contaminated.

### **Cleaning Backpack Sprayers**

Cleaning backpack sprayers is much different from cleaning a field rig. Backpack sprayers are far smaller in size with a lot less plumbing to hide pesticide residues. Thus, they are much easier to clean. In fact, cleaning a backpack sprayer is a lot like rinsing a pesticide container. Rinse out the tank thoroughly and then spray the rinsate from the sprayer onto the site of application. When applying the rinsate, do not exceed the legal amount of pesticide that may be applied to a given area. Repeat this procedure for a total of three rinses. For the second rinse, consider using a commercial tank cleaner to make a solution that will more effectively remove residues. See the pesticide label for recommended cleaning agents. Another source is the *Guide for Weed, Disease, and Insect Management in Nebraska*, EC130. Allow the solution to sit for the amount of time listed on the label of the cleaning product. Rinse a third time with only water. After the third rinse, the sprayer should be sufficiently cleansed to be used with a different product.

### **Winterizing Sprayers**

**Tank and Pumps:** To begin the process of winterizing the sprayer, add a solution of 50 percent automotive antifreeze and 50 percent water to the empty tank. RV antifreeze is nontoxic but is harder on pumps and seals. If you choose to use RV antifreeze, do not add water. Turn off all the boom sections, turning on the pump and master spray switch. If the sprayer is a backpack sprayer, pump the solution through the system and collect it after it comes out of the nozzle. Likewise, with a field sprayer, run the solution through the entire system for at least five minutes. Do not allow the antifreeze solution to fall on the ground. Drain any and all accessory tanks and lines. Keep in mind that the solution can usually be reused for two years after the first use, a total of three uses. Make sure the antifreeze does not become diluted. Using compressed air, blow any

remaining liquid from the sprayer lines. Open, drain, and clean the mixing chambers. Some pumping systems have a drain plug within the pump housing that can be used to drain the pump.

**Spray Boom:** Begin by taking the boom feed hoses off of the boom section valves. Thoroughly flush all the boom sections with compressed air through the feeder hose and out the nozzles until dried. Take off the nozzle tube end plugs and blow out any water left in the boom. Once dry, clean out any and all boom section filters. Remove screens and nozzles and store them in a lightweight oil such as vegetable oil, kerosene, or diesel fuel during the winter. Plug any open assemblies. Check to see if the boom is dry. Apply vegetable oil to O-rings and reinstall. All gauges should be removed and stored indoors upright so they do not freeze. Plug these open assemblies also. This will help the remaining antifreeze prevent any freezing/cracking of boom lines. The stainless steel plungers in solenoid valves come in contact with the spray solution. Apply lithium grease on solenoid switches and relays. This will prevent rust and sticky valves during the winter months. Always store spray equipment indoors when possible.

### Equipment Storage

If leaving equipment in the field or a different off-site location, be sure to disable it. Do not leave pesticides or mixtures in the spray tanks, as they can break down and become ineffective, or could be difficult to clean out of the equipment. Take the keys with you. Whenever possible, lock pesticide application equipment indoors and keep the facility locked when not in use. If an airplane must be left outside, use practical alternatives to locking it inside, such as propeller chains or blocking equipment.

It is a good idea to install an electronic security system where equipment is stored to keep it safe from intruders (and keep intruders safely away!).

### Standard Operating Procedure (SOP) Checklists

One way to help consistently clean spray equipment is to develop a checklist called a Standard Operating Procedure (SOP). List every step that you take to properly clean a specific sprayer. Each sprayer differs slightly in how to clean it, so each should have its own SOP. This means that operators don't have to worry about memorizing a procedure because it is already written out for them. A written procedure also makes it less likely that a step in the process will be overlooked. A separate SOP needs to be developed for every unique model and type of sprayer.

### Final Thoughts

Cleaning pesticide equipment is a vital step in the process of applying pesticides. Each and every component of a sprayer system must be thoroughly cleaned to avoid crop injury in the next field sprayed. Following the general procedure laid out here and developing rig-specific SOPs will ensure that pesticide applications go as planned and that the treated crops will yield to their full potential.

#### ADDITIONAL RESOURCES

*Guide for Weed, Disease, and Insect Management in Nebraska*, EC130, Nebraska Extension  
Procedures for specific herbicides. See: <http://extension.missouri.edu/explorepdf/agguides/crops/g04852.pdf>

#### ACKNOWLEDGMENTS

Purdue University Extension  
University of Missouri Extension  
Penn State Extension  
TechLine Invasive Plant News (Dow AgroSciences)  
Montana State University Extension

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# Rinsing Pesticide Containers

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*It is estimated that every year 1 million plastic agricultural pesticide containers are used in Nebraska. Effective rinsing of these containers saves money, protects the environment, and meets federal and state regulations for pesticide use.*

Proper rinsing of pesticide containers is easy, saves money, and contributes to good environmental stewardship. Rinsing containers when preparing spray solutions prevents potential problems with unrinsed containers, storing rinse solution (rinsate), and generating hazardous waste. Even during a busy season, the few extra minutes it takes to properly rinse empty pesticide containers is time well spent. For example:

- Rinsing pesticide containers efficiently and economically uses all the pesticide that you purchased. When the rinsate is added immediately to the load and sprayed on a labeled site, you eliminate the need to store and later dispose of it.
- Rinsing pesticide containers immediately after emptying easily removes leftover concentrate. If the container is not rinsed immediately, remaining pesticide mixtures may dry inside the container and be difficult to remove.
- Rinsing containers removes potential pesticide exposures to people, wildlife, and the environment.
- Proper rinsing is required by federal regulations and is a sound management and environmental practice.

### Rinsing Saves Money

It is very easy to leave 6 ounces or more of pesticide product in a 2.5-gallon container. That is about 2 percent of the container's capacity. If you do not rinse, you either apply 2 percent less product, which can affect performance

of the pesticide, or incur 2 percent more cost for the application. Neither option is good.

Delayed rinsing of used pesticide containers means more difficulty removing product from the containers. More difficulty means more time is required, and time is money. Removing pesticide product from containers that were not rinsed immediately may also require additional cleaning agents. These added chemicals are costly and some may even cause injury if applied to the target site.

### Rinsing Helps Protect the Environment

Properly rinsing pesticide containers reduces the risk of contaminating soil, surface water, and groundwater. Contamination harms plants and animals and affects water supplies. Preventing environmental contamination is always better and less expensive than cleanup.

### Rinsing is NOT Optional

Federal regulations require the rinsing of liquid pesticide containers. Violation of these regulations is punishable by criminal and/or civil penalties. When an empty container is recycled, or disposed of according to label directions, **it must be properly rinsed**. Approved pesticide container recyclers can accept only properly rinsed containers. Some landfill operations may not accept any pesticide containers, rinsed or unrinsed.

### Types of Pesticide Containers

The most common agricultural pesticide containers are plastic drums in 15-, 30-, and 55-gallon sizes, and portable refillable containers (minibulks, shuttles, totes, etc.), which are usually larger than drums. The 2.5-gallon plastic containers also remain popular. Portable refillable containers

are intended to be returned and reused by the supplier. Applicators returning these containers are not required to rinse them. Instead, it is the supplier's responsibility to rinse the containers. If the supplier intends to refill the container with the exact same formulation as it held previously, they may choose not to rinse. Granular and dust insecticides are sold in waxed-paper bags or other water-resistant containers. Nearly all pesticide products used on animals and in households are sold in plastic containers.

Plastic drums and 2.5-gallon containers may be recycled after the pesticide materials have been removed by rinsing. Properly rinsing plastic pesticide drums and containers removes more than 99 percent of any pesticide residue after they have been emptied. Two commonly used procedures are effective for rinsing pesticide containers: triple-rinsing and pressure-rinsing.

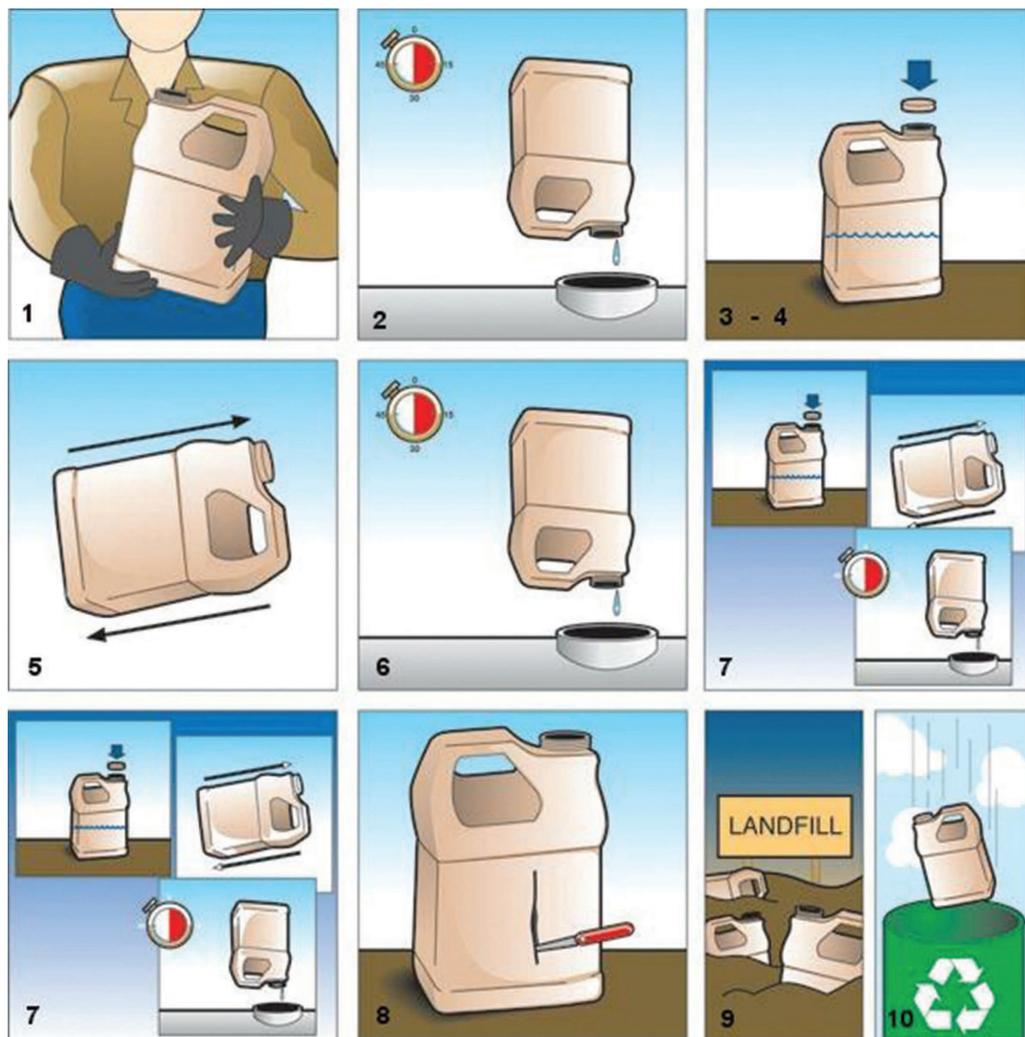


Figure 1. Triple-rinsing procedure for plastic pesticide containers. Used with permission from Fred Whitford, Purdue University. Scott Dallas and John Metzinger, illustrators.

### Triple-Rinsing

Triple-rinsing means rinsing the container three times. This method can be used with all plastic containers.

#### How to Triple-Rinse 2.5-Gallon Containers (Figure 1)

1. Wear the same personal protective equipment (PPE) while rinsing containers as the pesticide label requires for handling and mixing.
2. Remove the cap from the pesticide container. Empty all pesticide into the spray tank, allowing the container to drain for 30 seconds. Begin rinsing immediately

or the product may be difficult to remove. If you are unable to rinse the container immediately, replace the cap until you can.

3. Fill the container 10 percent to 20 percent full of water or rinse solution (i.e., fertilizer solution).
4. Replace the cap on the container.
5. Swirl the liquid within the container to rinse all inside surfaces.
6. Remove the cap from the container. Pour the rinsate from the pesticide container into the spray tank and allow it to drain for 30 seconds or more.
7. Repeat steps 3 through 6 **two more times**.
8. Puncture or crush the container so it cannot be reused. Keep any puncturing or crushing tools with the pesti-

cides. Never use these tools anywhere else, especially in the kitchen or household.

9. Replace the cap and dispose of the pesticide container according to label directions.
10. If recycling, remember that caps and containers are made from different materials; therefore, caps cannot be recycled. Ensure that caps are clean before disposal as regular solid waste.

### How to Triple-Rinse Drums

First, reread the procedures for triple-rinsing containers because they contain important information not listed here. Triple-rinsing a drum may require two people.

1. Empty the drum as much as possible.
2. Fill the drum with water to 25 percent of capacity. Replace and tighten bungs (plugs) to seal the drum.
3. Tip the drum on its side. Roll it back and forth for 30 seconds, ensuring at least one complete revolution.
4. Stand the drum on end and tip it back and forth several times to rinse the inner edging.
5. Turn the drum over, onto its other end, and repeat this procedure.
6. Carefully empty the rinsate into the spray tank.
7. Repeat steps 2 through 6 **two more times**.
8. Carefully rinse the bung(s) over the spray tank opening and then dispose of as regular solid waste.
9. Puncture the base of the drum with a drill so that it cannot be reused. Keep a drill bit with the pesticides for this purpose and this purpose only.
10. Store rinsed drums under cover where they will be protected from rain.

### Pressure-Rinsing

Use a pressure rinser with an anti-siphon device to flush the remaining pesticide from the container. Use a special nozzle with a spear-point generally available from your pesticide supplier or other sources. Attach it to the end of a water hose and force water under pressure into the pesticide container. Pressure-rinsing is faster and easier than triple-rinsing and can be used most effectively with plastic 2.5-gallon pesticide containers.

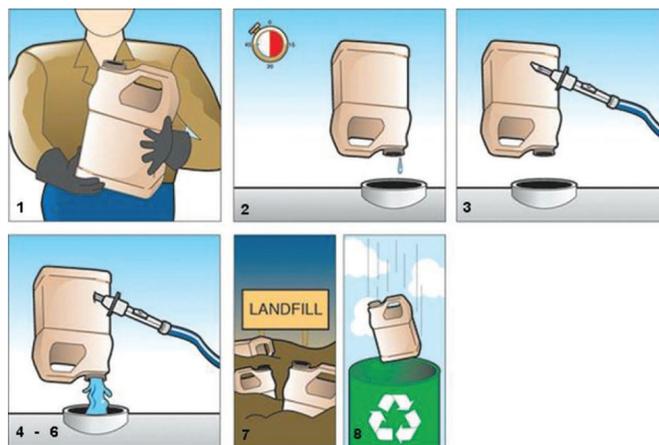


Figure 2. Pressure-rinsing procedure for plastic pesticide containers. Used with permission from Fred Whitford, Purdue University. Scott Dallas and John Metzger, illustrators.

### How to Pressure-Rinse 2.5-Gallon Containers (Figure 2)

1. Wear the same PPE while rinsing containers as required on the pesticide label for handling and mixing.
2. Remove the cap from the pesticide container. Empty all pesticide into the spray tank. Turn the container so that any product in the handle flows out. Allow the container to drain for 30 seconds. Begin the rinsing procedure immediately or the product may be difficult to remove. If you are unable to rinse the container immediately, replace the cap until you are able to rinse the container.
3. Insert the pressure-rinsing nozzle, which should be equipped with a flow control, by puncturing a hole through the lower side of the pesticide container.
4. Hold the pesticide container upside down over the spray tank opening, turn on the flow of water, and allow the rinsate to run into the spray tank.
5. Rinse for the length of time recommended by the manufacturer (usually 30 seconds or more). Rotate or rock the nozzle to rinse all inside surfaces.
6. Rinse the cap separately in a bucket of water and pour this rinse water into the spray tank.
7. Replace the cap and dispose of the pesticide container according to label directions.
8. If recycling, remember that caps and containers are made from different materials; therefore, caps cannot

be recycled. Dispose of cleaned caps as regular solid waste.

### Storing Empty Pesticide Containers

- Unrinsed empty pesticide containers should be stored in the same way as containers with pesticides still in them. Replace the cap and store unrinsed containers upright in a roofed or covered and secure (locked) structure over an impervious surface.
- Pressure-rinsing creates a hole in the container. Store pressure-rinsed containers indoors to prevent water, rain, or snow from entering the containers. Remove the caps to allow the containers to completely dry out during storage.
- Triple-rinsed containers should be stored outside only if you replace the cap. Triple-rinsed and capped containers do not need to be stored on impervious surfaces.
- When you are ready to offer rinsed, empty pesticide containers for recycling, remove the caps (they cannot be recycled) and any labels, plastic sleeves, or wrappers attached to the container. Dispose of these materials in an approved landfill.

### Container Recycling

Recycling clean agricultural pesticide containers protects Nebraska's environment. Several locations in Nebraska accept rinsed plastic agricultural pesticide containers for recycling. All containers are thoroughly inspected before acceptance.

Any pesticide container with pesticide residue that can be rubbed off with a neoprene- or nitrile-gloved hand will be rejected. Properly rinsed containers that are stained will be accepted. Do not include pesticide containers in household or curbside recycling programs. Check with your Nebraska Extension educator, other local officials, or <http://pested.unl.edu/recycling> to determine the locations and availability of plastic pesticide container recycling sites in Nebraska.

### Remember

- Read and follow all pesticide label directions. Federal regulations require rinsing of liquid pesticide containers.
- **Never** dispose of rinsate on a site the pesticide product label doesn't allow. Instead, use the rinsate generated by triple- or pressure-rinsing pesticide containers as part of your spray mixture. Do not exceed labeled application rates.
- Store pesticides only in their original, labeled containers. Never reuse a pesticide container for any purpose. Never use other containers (e.g., soda bottles) to store pesticides. Children, as well as adults, have died from drinking these, thinking they were food beverages.
- Wear appropriate PPE as required by the label.
- Always use an anti-siphon or backflow prevention device when filling spray tanks or rinsing pesticide containers.
- Mixing and loading sites should be at least 150 feet away from all wells. Review pesticide labels. Be aware of requirements for specific setbacks from wells regardless of whether the well is active or not.

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# Worker Protection Standard for Agricultural Establishments

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*This publication describes the federal Worker Protection Standard (revised 2015), to help owners or operators of agricultural operations determine if it applies to their businesses, and provide information on how to comply. Some changes take effect Jan. 2, 2017, with the remainder effective as of Jan. 2, 2018.*

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 the goal of the Occupational Safety and Health Administration (OSHA), WPS was put in place to provide employees with a safe workplace; the obligation for safety falls on the employer. WPS requires employers to protect two types of agricultural employees: agricultural workers and pesticide handlers (see definitions below), as well as others who may be in the vicinity of a pesticide application. WPS is part of the pesticide label; it is enforceable when a pesticide with a label referencing WPS is used to produce an agricultural crop or commodity. Any farm or community garden that produces agricultural plants for sale, trade, or use in another location meets the definition of an agricultural establishment under the rule, and is subject to WPS.

The 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. Access information is listed in the Resources section at the end of this publication.

## Key Terms

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

### General terms

**Agricultural employer:** any person who is an owner of, or is responsible for the management or condition of, an agricultural establishment, and who employs any worker or handler.

**Agricultural establishment:** any farm (including a vineyard, sod farm, etc.), forest operation, or nursery engaged in the outdoor or enclosed space production (greenhouse, polyhouse, mushroom house, hoop house, high tunnel, etc.) of agricultural plants.

**Agricultural owner:** any person who possesses or has interest (fee, leasehold, rental, or other) in an agricultural establishment.

**Agricultural plants:** plants grown or maintained for commercial or research purposes. Examples include plants for food, feed, or fiber; trees; turfgrass; flowers; shrubs; ornamentals; and seedlings. Horticultural plants grown for future transplant are included. Pasture or rangeland used for grazing is not included.

**Workers:** those who perform tasks related to the production (pruning, roguing, detasseling, etc.) and harvesting of plants on agricultural establishments who may work in areas where pesticide residues are present. Crop advisors are considered workers if they perform crop advising tasks after the restricted entry interval (REI).

**Handlers:** those who mix, load, transfer, and apply agricultural pesticides; clean or repair pesticide application equipment; dispose of pesticides or containers; act as flaggers; perform crop advising tasks during a pesticide application or during the REI; or may have direct contact with concentrated pesticides or tank mixes.

**Commercial pesticide handling establishment:** any enterprise, other than an agricultural establishment, that provides pesticide handler or crop advising services to agricultural establishments.

**Crop advisors:** those who assess pest numbers or damage; pesticide distribution (the performance of a pesticide on a crop after application such as the spray pattern or coverage and/or its effectiveness); or the status, condition, or requirements of agricultural plants. Crop advisors include crop consultants, crop scouts, and integrated pest management (IPM) monitors.

**Labor contractor:** person other than a commercial pesticide handler employer who employs workers or handlers to perform tasks on an agricultural establishment for an agricultural employer or a commercial pesticide handler employer.

**Employ:** to obtain, directly or through a labor contractor, the services of a person in exchange for a salary or wages, including piece-rate wages, without regard to who may pay or who may receive the salary or wages. It includes obtaining the services of a self-employed person, an independent contractor, or a person compensated by a third party. The exception is an agricultural employer obtaining the services of a handler through a commercial pesticide handler employer or a commercial pesticide handling establishment.

**Immediate family:** the agricultural owner's spouse, parents, stepparents, foster parents, father-in-law, mother-in-law, children, stepchildren, foster children, sons-in-law, daughters-in-law, grandparents, grandchildren, brothers, sisters, brothers-in-law, sisters-in-law, aunts, uncles, nieces, nephews, and first cousins.

**First cousin:** the child of a parent's sibling (the child of an aunt or uncle).

#### *Terms regarding personal protective equipment (PPE):*

**Chemical-resistant:** made of material that prevents any measurable movement of the pesticide being used through the material during use.

**Waterproof:** made of material that prevents any measurable movement of water or water-based solutions through the material during use.

**Chemical-resistant suit:** a loose-fitting, one- or two-piece chemical-resistant garment that covers, at a minimum, the entire body except head, hands, and feet.

**Coveralls:** a loose-fitting, one- or two-piece garment that covers, at a minimum, the entire body except head, hands, and feet.

**Protective eyewear:** goggles; a face shield; safety glasses with front, brow, and temple protection; or a full-face respirator.

**Chemical-resistant apron:** an apron that covers the front of the body from mid-chest to the knees, made of material that prevents any measurable movement of the pesticide being used through the material.

**Chemical-resistant headgear:** a chemical-resistant hood or chemical-resistant hat with a wide brim.

#### *Terms regarding application*

**Closed system:** an engineering control used to protect handlers from pesticide exposure hazards when mixing and loading pesticides.

**Enclosed cab:** a cab with a nonporous barrier that totally surrounds the occupant(s) of the cab and prevents dermal contact with pesticides that are being applied outside of the cab.

**Enclosed space production:** production of an agricultural plant indoors or in a structure or space that is covered in whole or in part by any nonporous covering and that is large enough for a person to enter, such as a greenhouse, polyhouse, mushroom house, hoop house, high tunnel, and similar structure.

**Outdoor production:** production of an agricultural plant in an outside area that is not enclosed or covered in any way that would obstruct the natural air flow.

**Application Exclusion Zone (AEZ):** the area surrounding the pesticide application equipment that must be free of all people other than appropriately trained and equipped handlers during pesticide applications.

## **WPS Labeling**

All pesticide products affected by the WPS carry a statement in the Agricultural Use Requirements section on the label (Figure 1). 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 plant, you must follow WPS requirements. WPS requirements are not in effect if an agricultural pesticide is used for a nonagricultural use as allowed by the label.

## 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 (REI). 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 REI of **24 hours**.

PPE required for early entry into 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 worn over short-sleeved shirt and short pants
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant footwear plus socks
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

WPS requirements (refer to the EPA manual *How to Comply*). The owners of agricultural establishments still must provide all of the applicable protections for any employees or other persons on the establishment who are not members of their immediate family.

### Exceptions

The WPS does not cover pesticides applied on an agricultural establishment in the following circumstances:

- on pastures or rangeland unless forage is harvested for hay;
- on livestock;
- for control of vertebrate pests, such as rodents, unless directly related to the production of agricultural plants;
- 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 WPS;
- on plants already planted (not grown for distribution) 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;
- for research uses of unregistered pesticides; or
- on harvested portions of plants or on harvested timber.

Regarding the last bullet, pesticide applications to harvested portions of agricultural plants or to harvested timber are outside the scope of WPS. Once a crop is harvested, WPS does not apply to workers performing activities related only to the harvested portion of the agricultural plant. Harvesting includes packing produce into containers in the field. For purposes of WPS, an agricultural plant is considered harvested when:

- a desirable portion of the agricultural plant (seed, fruit, flower, stem, foliage, or roots) is detached from its parent; or

Figure 1. The pesticide label contains information regarding WPS requirements when a product is used to produce agricultural plants on farms, forests, nurseries, or enclosed spaces, such as greenhouses.

### Who Is Affected by WPS?

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

- Managers or owners of an agricultural establishment
- Labor contractors (crop advisors, detasslers, etc.)
- Commercial pesticide handling establishments, including self-employed applicators

Most provisions of the WPS 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

- a whole agricultural plant is separated from its growth media (soil, water, or other media).

Pesticide applications on an agricultural establishment that are within the scope of the WPS include:

- applications to the “parent” portion of the agricultural plant that remains after the crop has been harvested, if the application is made to continue production of the parent plant or eliminate the parent plant;
- applications to the growth media that remains behind after the crop has been harvested, if the application is made to
  - continue production of the parent plant, or
  - eliminate the parent plant, or
  - prepare the media for replanting or reseeding of an agricultural plant;
- applications to agricultural plants (including transplants) that are in growth media;
- applications to agricultural plants or plant portions (seeds, roots, bulbs, cuttings, etc.) on an agricultural establishment immediately prior to or during planting, transplanting, or grafting.

### Requirements of Agricultural Owners and Those Hired to Work on the Agricultural Establishment

The WPS covers a great deal of information, more than can be addressed in this publication. This section will cover some requirements that everyone who owns or works on an agricultural establishment must follow regarding personal protective equipment, restrictions during and after pesticide applications, and minimum age requirements. Some exemptions exist for immediate family members of the agricultural owners. These will be covered later in this publication.

#### 1. Wear appropriate personal protective equipment (PPE)

The PPE 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 (Figure 2). 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 enclosed cab, howev-

## PRECAUTIONARY STATEMENTS

### HAZARDS TO HUMANS AND DOMESTIC ANIMALS WARNING

Causes substantial but temporary eye injury. Do not get in eyes or on clothing. Wear protective eyewear (goggles or face shield). Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse. May be fatal if swallowed. Harmful if inhaled or absorbed through skin. Do not breathe vapors or spray mist. Prolonged or frequently repeated skin contact may cause allergic skin reactions in some individuals.

#### Personal Protective Equipment (PPE)

##### Applicators and other handlers must wear:

Long-sleeved shirt and long pants

Barrier laminate or Viton® gloves.

Shoes plus socks

Protective eyewear

**Mixer/loaders supporting aerial applications and chemigation applications must wear also** (except when using closed mixing/loading systems): a dust/mist filtering respirator (MSHA/NIOSH approval number prefix TC-21C), or a NIOSH approved respirator with any R, P, or HE filter.

Figure 2. The Hazards to Humans section lists the required PPE for the pesticide product.

er, 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 a pesticide application, handlers and/or their employers must make sure to:

- follow all label requirements,
- apply pesticides so that they do not contact anyone either directly or through drift, and
- ensure no one enters treated areas and the Application Exclusion Zone (AEZ) that is within the boundaries of the establishment.

In most cases, handlers who have been trained, wear the appropriate PPE, and are involved in the application are allowed to be in treated areas. Agricultural employers must keep workers and other people out of the treated area and the Application Exclusion Zone (AEZ) that are WITHIN the boundary of the establishment owner's property. The EPA realizes that handlers and employers cannot keep people out of an AEZ that extends beyond the boundaries of the establishment; however, the AEZ still applies beyond the boundary.

The AEZ is measured from the application equipment; it moves with the application equipment like a halo around the application equipment (Figure 3).



Figure 3. The AEZ is the white area around the application equipment shown above; it moves with the equipment. The AEZ generally is within the treated area, except when the application equipment is near the edges of the treated area.

The size of an AEZ depends on the type of application and other factors, including droplet size and height of nozzles above the planting medium. The AEZ is 100 feet for aerial, air blast, fumigant, smoke, mist, and fog applications. It also is 100 feet for spray applications using extremely fine, very fine, or fine droplet sizes. An AEZ of 25 feet is required when the pesticide is sprayed using medium or larger droplet sizes and from more than 12 inches above the plants. An application that does not fall into one of these categories does not require an AEZ.

After Jan. 1, 2018, the handler must suspend the application if a person is in the AEZ for farms, forests, and nurseries. The requirement to suspend application is NOT limited by the boundary of the establishment owner's property. For example, if a person is walking next to the field that is being treated and is within the AEZ, the pesticide application must temporarily stop (be suspended). Application may resume when the applicator can ensure that the pesticide will not contact any people in the AEZ that extends beyond the boundary of the establishment. The applicator can take measures to ensure that people are not contacted by the pesticides by:

- assessing wind and other weather conditions to confirm that people will not be contacted directly or through drift;
- adjusting the application method or using drift reduction measures;
- asking people to move out of the AEZ until the application is completed; or
- adjusting the treated area or path of the application equipment so that people will not be in the AEZ.

The above are required when the AEZ extends beyond the boundaries of the establishment. An applicator cannot resume application while workers or others on the establishment are within the AEZ.

### 3. Restrictions during restricted-entry intervals (REIs)

WPS has established specific restricted-entry intervals for all pesticides covered by the WPS. The restricted-entry interval (REI) is the amount of time that must pass after a pesticide application before anyone other than a trained and equipped handler involved with the application may enter the treated area. The REI is listed on the pesticide label under Agricultural Use Requirements (Figure 4). It is based on the toxicity of the active ingredient and the worker tasks involved during the production of the agricultural plant. In most cases, REIs range from 4 to 72 hours. When the pesticide formulation or application is a mixture of active ingredients, base the REI on the active ingredient that has the longest REI.

During the REI, do not enter or allow workers, including members of the immediate family, to enter a treated area or contact anything treated with the pesticide(s) to which the interval applies.

**Exceptions to REIs.** In general, an agricultural owner/operator, family members, hired handlers, and hired workers must stay out of a treated area during the REI. This restriction has four exceptions: no contact, short-term activities, an agricultural emergency, and limited contact and irrigation activities. Each early-entry exception has certain conditions that must be met. For all of the early-entry exceptions, the agricultural employer must provide the worker with certain information, the required PPE, and decontamination supplies. Consult the EPA *How to Comply* manual for specifics.

### 4. Minimum age requirements.

Any handler and any early-entry worker must be at least 18 years old. This minimum age does not apply to an adolescent working on an establishment owned by an immediate family member.

## 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 (REI). 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 REI of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

Coveralls

Barrier laminate or Viton® gloves

Shoes plus socks

Protective eyewear

selers, for example. Some information must be displayed and accessible after Jan. 1, 2018. The time delay allows for development of revised posters and displays. The current pesticide safety poster should be displayed in 2017. The following information is required after Jan. 1, 2018.

- Seven concepts about preventing pesticides from entering a person's body:
  1. Follow directions/signs about keeping out of the AEZ and treated areas
  2. Avoid getting on skin or body
  3. Wash before eating, drinking, chewing gum or tobacco, or using the toilet
  4. Wear protective clothing
  5. Wash/shower with soap, water, shampoo
  6. Wash work clothes separately
  7. Wash immediately if spilled/sprayed on body
- Name, address, and telephone number of the Nebraska Department of Agriculture (NDA) or Tribal pesticide regulatory agency
- Name, address, and telephone number of a nearby emergency medical facility
- Instructions for employees to seek medical attention as soon as possible if they are poisoned, injured, or made ill by pesticides

The following information must be displayed and accessible by Jan. 2, 2017. The agricultural employer already knows or has access to this information.

- Facts about each pesticide application, displayed within 24 hours of the end of the application and before workers enter that treated area, including:
  1. product name;
  2. EPA registration number and active ingredients;
  3. Safety Data Sheet (SDS);
  4. crop or site treated, and location and description of the treated areas;
  5. date and times the application started and ended; and
  6. REI for the pesticide.

Employers must tell workers and handlers where the information is displayed and allow them access. Safety information must be kept legible and current. Information about an application and the associated SDS must remain displayed for 30 days after the REI expires. This information must be kept for two years after the REI expires.

Figure 4. Information about the restricted-entry interval (REI) is in the Agricultural Use section of the pesticide label.

### Basic Duties of Employers of Pesticide Handlers and Agricultural Workers

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

**Safety Information.** For the benefit and safety of their employees, employers must provide basic safety information plus current and specific information about the pesticides being applied. All of the information must be displayed and made accessible at a central location on the agricultural establishment where it can be seen and read easily. The pesticide safety information (poster) also must be displayed and accessible at any permanent site with decontamination supplies, and at any location when 11 or more workers are present. The latter may be a bus or gathering area for detas-

**Pesticide safety training.** Prior to Jan. 2, 2017, workers and handlers had to receive training every five years. After that date, the employer must provide WPS safety training each year before employees begin work, unless handlers and workers are owners/immediate family members; state-certified pesticide applicators; or crop advisors certified or licensed as a crop advisor by a program acknowledged in writing by EPA, NDA, or a Tribal agency. After Jan. 2, 2017, handlers must be trained before they perform any handling task on the establishment unless they have been trained within the past 12 months. After Jan. 2, 2017, workers will have to be trained before they perform any worker task in an area that has been treated with a pesticide or an REI has been in effect within the last 30 days, unless they have been trained as a worker or handler within the last 12 months. Training may be conducted by a certified pesticide applicator or by someone who has completed an EPA-approved train-the-trainer program. The training must be conducted in a manner and language that the employees can understand, using EPA-approved training materials. The trainer also must be on hand and able to answer questions after the training, especially if a video or other media is used.

A list of content required for worker and handler training as of Jan. 2, 2018 is in the EPA *How to Comply* manual. Until Jan. 2, 2018, WPS safety training content remains the same as under the existing rule and will not change **although all training materials used after Jan. 2, 2017, must be approved by EPA.** By using EPA-approved training materials, the employer is assured that all required content is covered.

Training records must be kept for two years, and a copy provided to the worker or handler upon request. The records must include the trained worker or handler's name and signature, the date of training, the trainer's name, evidence of the trainer's qualification to train, the employer's name, and which EPA-approved training materials were used.

**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  $\frac{1}{4}$  mile of all workers and handlers. One exception is that if worker or handler activity is more than  $\frac{1}{4}$  mile from the nearest place of vehicular access or more than  $\frac{1}{4}$  mile from any non-treated area, the decontamination supplies may be at the nearest place of vehicular access outside any treated area or area subject to a REI. For more details, refer to the EPA *How to Comply* manual. Decontamination supplies must include the following:

- 1 gallon of water for each worker and 3 gallons for each handler and each early-entry worker; measured at the beginning of the worker's or handler's work period;

- if a handler is mixing/loading a product that requires eye protection or using a closed system under pressure, eyeflush water (Figure 5) must be immediately available at the mix/load site for handler eye flushing; the system must be capable of delivering 0.4 gallons per minute for 15 minutes, or 6 gallons of water at a gentle flow for about 15 minutes at a mix/load site;
- if a handler is applying a product that requires eye protection, 1 pint of water must be immediately available to each applicator;
- plenty of soap and single-use towels; and
- a clean change of coveralls for use by each handler (not required for workers).

Water must be safe and cool enough for washing and eye flushing. Employers may not use tank-stored water that also is used for mixing or diluting pesticides unless there are safeguards to prevent contamination, such as anti-backflow devices.

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

**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 a nearby medical facility. Information about the



Figure 5. Water for eye flushing must be available for handlers when using a pesticide that requires eye protection. Haws Corporation photo.

medical facility must be displayed at a central location and, if applicable, at permanent decontamination supply sites and locations where 11 or more workers are present. In addition, the employer must give medical personnel who provide treatment the following information:

- the product name, EPA registration number, and active ingredients;
- the SDS;
- a description of how the pesticide was used; and
- information about the employee's exposure.

**Enclosed space production.** Owners and operators of greenhouses, polyhouses, mushroom houses, hoop houses, high tunnels, and other enclosed spaces have additional requirements. These include special application restrictions, ventilation criteria, early-entry restrictions, and additional handler protection. Consult the EPA *How to Comply* manual and the pesticide label for specifics.

### Additional Duties for Employers of Workers

**Notification regarding application.** The employer must notify all workers on the establishment of any areas being treated with pesticides or that may be under an 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 (Figure 6) 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. Notification must be provided before the application begins or at the start of the workers' work period if they will be coming on to the establishment when applications are ongoing or an REI is already in effect. For outdoor production, notifications must be posted for applications of a pesticide with an REI of more than 48 hours. All notifications regarding enclosed space applications of a pesticide with an REI of more than four hours must be posted. The exception is that if no worker will enter the enclosed space area from the start of the application until the end of any REI.

**Restrictions during application.** Employers must prohibit entry by workers or other persons into areas being treated. Only handlers who have had the appropriate training, are wearing the required equipment, and are involved in the application may enter the area during application. See the EPA *How to Comply* manual for special restrictions for employees who work in enclosed spaces.

**Restrictions after applications.** See information previously given in **Restrictions during restricted-entry intervals (REIs)**.

**Warning signs.** The warning sign must have a white background with the words "DANGER" and "PELIGRO," plus "PESTICIDES" and "PESTICIDAS," at the top of the sign, and the words "KEEP OUT" and "NO ENTRE" at the bottom of the sign (Figure 6). The sign may have a language other than Spanish if that language is read by the majority of workers who do not read English. A circle containing an upraised hand on the left and a stern face on the right must be near the center of the sign. The inside of the circle must be red, except that the hand and a large portion of the face must be in white. The length of the hand must be at least twice the height of the smallest letters. The length of the face must be only slightly smaller than the hand. Additional information, such as the name of the pesticide and the date of application, may appear on the warning sign if it does not detract from the size and appearance of the sign or change the meaning of the required information.



Figure 6. The EPA has specifications for warning signs. EPA photo.

Warning signs must be posted:

- if the REI is greater than 48 hours for an outdoor application or four hours for an enclosed space (e.g., greenhouse) or the label requires oral and posted notification;
- no more than 24 hours before the application and removed within three days after the end of the REI;
- where they can be seen at all normal entrances, paths, and trails to treated areas;

- at borders where worker housing areas are within 100 feet of the treated area; or
- if employees will come within ¼ mile of the treated site.

**Oral warnings.** Oral warnings must be delivered in a manner understood by workers, using an interpreter if necessary. For outdoor production, the agricultural employer must notify workers either orally or by posting signs if a product is used with an REI of 48 hours or less. For enclosed spaces, such as a greenhouse, the agricultural employer must notify workers either orally or by posting signs if a product is used with an REI of four hours or less. Oral warnings must contain the following information:

- the location and description of the treated area,
- the date and time that the REI is in effect, and
- specific directions indicating that workers must not enter the treated area or AEZ during the application and must stay out of the treated area during the REI.

### Additional Duties for Employers of Handlers

**Specific training for handlers.** Before handlers perform any handling tasks, employers must inform them of all instructions on the pesticide labeling about safe use (Figure 7). In addition, employers must keep pesticide labels accessible to each handler during the entire handling task and inform handlers of how to use any assigned handling equipment safely before they use it.

**Safeguarding handlers.** Before commercial handlers come to an agricultural establishment, inform them of areas on the establishment where pesticides will be applied or where an REI will be in effect, and the restrictions for entering those areas.

**Equipment safety.** Employers of handlers must 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 PPE 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 PPE for each task. Employers must not allow any handler to wear or take home any used PPE. They must make sure PPE is worn and used correctly. If the labeling requires any handler to wear a respirator, the employer must provide respirator fit testing, training, and medical evaluation that conforms to OSHA standards.

Employers must keep records of the completion of the fit test, training, and medical evaluation.

**Cleaning and maintenance of PPE.** 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 storage, treatment, or application areas.

**Replacing respirator purifying elements.** Particulate filtering facepiece respirators (known as 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 eight hours of cumulative use 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; when breathing becomes difficult; or at the end of eight hours of cumulative use 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. If PPE cannot or will not be cleaned properly, make it unusable as apparel or unavailable for further use. Federal, state, and local laws must be followed when disposing of PPE that cannot be cleaned correctly.



Figure 7. Because handlers have more risk of exposure, including working with concentrated pesticides, their training has additional topics. UNL photo.

**Instructions for those who clean PPE.** Employers must inform people who clean or launder PPE that it may be contaminated with pesticides. Employers must inform them of the potentially harmful effects of exposure to pesticides, how to protect themselves, how to clean the equipment correctly, and proper decontamination procedures after handling contaminated PPE. More information is available in EPA's *How to Comply* manual.

**PPE regarding closed systems.** The WPS has some exceptions to PPE requirements when a closed system (Figure 8) is used. The closed system is one that removes the pesticide from its original container and transfers the pesticide product through connecting hoses, pipes, and couplings that are tight enough to prevent exposure of handlers to the pesticide product, except for the negligible escape associated with normal operation of the system. Another exception to PPE requirements is allowed when loading intact, sealed, water-soluble packaging into a mixing tank or system. However, if the integrity of a water soluble packaging is compromised (dissolved, broken, punctured, torn, or allows its contents to escape), it is no longer a closed system and the labeling-specified PPE must be worn.

In addition, the handler employer must satisfy *all* of the following:

- Each closed system must have clearly written, legible operating instructions. These must include operating procedures for use, including the safe removal of a probe; maintenance, cleaning and repair; known restrictions or limitations relating to the system, such as incompatible pesticides, sizes (or types) of containers or closures that cannot be handled by the system; any limits on the ability to measure a pesticide; and special procedures or limitations regarding partially filled containers.
- The written operating instructions for the closed system must be available at the mixing or loading site to any handlers who use the system.
- Any handler operating the closed system must be trained in its use and operate the closed system according to its written operating instructions.
- The closed system must be cleaned and maintained as specified in the written operating instructions and as needed to ensure the system works properly.
- All PPE specified in the pesticide product labeling must be immediately available to the handler in case of an emergency.
- Protective eyewear must be worn when using closed systems operating under pressure.



Figure 8. Because an enclosed system reduces the risk of pesticide exposure, the PPE requirements may be reduced. GoatThroat Pumps photo.

Once all of the above are met, the exceptions to wearing the PPE as required by labeling are:

- Handlers using a closed system to mix or load pesticides with a signal word of “DANGER” or “WARNING” may substitute a long-sleeved shirt, long pants, shoes and socks, chemical-resistant apron, protective eyewear, and any protective gloves specified on the labeling for handlers for the labeling-specified PPE.
- Handlers using a closed system to mix or load pesticides other than those with a signal word of “DANGER” or “WARNING” may substitute protective eyewear, long-sleeved shirt, long pants, and shoes and socks for the labeling-specified PPE. Although the mixer/loader does not have to wear label-required gloves, those gloves must be available in case there is a problem with the closed system.

**PPE regarding enclosed cabs.** Handlers in enclosed cabs (Figure 9) may substitute a long-sleeved shirt, long pants, shoes, and socks for PPE for skin and eye protection specified by the labeling under certain conditions. These are:

- All of the PPE required by the pesticide product labeling

for applicators must be immediately available to handlers in an enclosed cab, and stored in a sealed container to prevent contamination.

- Handlers must wear the applicator PPE specified by the labeling if they exit the cab within a treated area during application or when an REI is in effect.
- Once PPE has been worn in a treated area, the handler must remove it before reentering the cab to prevent contaminating the cab.

If the enclosed cab has a properly functioning air ventilation system that is used and maintained according to the manufacturer's written operating instructions, a handler in an enclosed cab does not have to wear a filtering facepiece respirator (NIOSH approval number prefix TC-84A, formerly called dust/mist respirator) if one is required by the labeling. A handler in an enclosed cab must wear any other type of respirator required by the labeling.

**PPE regarding aerial application.** Wearing chemical-resistant gloves when entering or leaving an aircraft used to apply pesticides is optional, unless those gloves are required on the pesticide product labeling. Gloves that have been used to apply pesticides must be kept in an enclosed container if brought into the cockpit, to prevent contaminating the inside of the cockpit.

*Open cockpit.* Handlers applying pesticides from an open cockpit aircraft must use the PPE specified in the pesticide product labeling for use during application, except that chemical-resistant footwear need not be worn. A helmet may be substituted for chemical-resistant headgear, and a helmet with a face shield lowered to cover the face may be substituted for protective eyewear.

*Enclosed cockpit.* A person in an enclosed cockpit may substitute a long-sleeved shirt, long pants, shoes, and socks for labeling-specified PPE.

**Heat illness.** Employers must take necessary steps to help employees prevent heat illness, especially while wearing PPE. Train handlers to recognize, prevent, and treat heat illness. A number of key elements to keep in mind are listed.

- Make sure that employees drink enough water to replace fluids lost through sweating. Thirst is not a good indicator of how much water a person needs to drink; usually a person needs water more often.
- Monitor temperature and humidity, and workers' responses at least hourly in hot temperatures.
- Schedule heavy work and tasks that require PPE for the cooler hours of the day.



Figure 9. In some situations, PPE requirements may be reduced when a handler is in an enclosed cab. UNL photo.

- Help workers gradually adjust to hot temperatures.
- Shorten the length of work periods and increase the length of rest periods.
- Provide workers shade or cooling during breaks.
- Stop work altogether under extreme conditions.

OSHA has relevant resources at <https://www.osha.gov/SLTC/heatstress/>.

### Information Exchange between Employer and Commercial Applicator

To ensure the agricultural owner/operator has the information to protect employees and comply with WPS, 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;
- date, and start and estimated end times of the application;
- product name, EPA registration number, active ingredients, and REI;
- whether postings at the treated area and/or oral warnings are required; and
- any restrictions or use directions on the pesticide product labeling that must be followed to protect workers, handlers, or other persons during or after application.

In addition, the agricultural employer must obtain and display the SDS for any WPS-covered pesticides used on the establishment if the agricultural establishment employs workers or handlers. Although the commercial applicator isn't required to provide a copy of the SDS to the agricultural employer, the EPA encourages this since the commercial applicator should have received copies of the SDS from the distributor.

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

### **Exemptions for Agricultural Owners and Immediate Family**

On any agricultural establishment where a majority of the establishment is owned by one or more members of the same immediate family, the owner(s) of the establishment are not required to provide some of the WPS requirements to themselves or members of their immediate family while performing handling activities and 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 hire.

- Minimum age of 18 years for handlers and early-entry workers
- Information at a central location and certain decontamination sites
- Pesticide safety training for workers and handlers
- Decontamination and eyeflush supplies
- Emergency medical assistance
- Notification of pesticide applications
- Monitoring of handler's actions and health
- Specific handling instructions
- Duties related to early entry: training and instructions and decontamination sites
- Inspecting, cleaning, and maintaining PPE

Owners of agricultural establishments and their immediate family members are required to comply with all of the following WPS requirements when using WPS-labeled products:

- Wear the PPE and any other work attire required by the pesticide labeling
- Keep out of the treated area until the REI expires
- Ensure the pesticide is applied so it does not contact any persons, including members of the immediate family
- Ensure that all persons, including immediate family members, are kept out of the treated area and the AEZ during the application of the pesticide
- Ensure that the pesticide applied is used in a manner consistent with the product's labeling
- Provide a medical evaluation, fit test, and respirator training to any handler, including an immediate family member, before the handler uses a pesticide whose labeling requires a respirator
- Beginning Jan. 2, 2018, a handler must suspend a pesticide application if a worker or other person is in the AEZ during the application.

### **Exemptions for Crop Advisors**

Certified crop advisors are exempt from some WPS provisions in Nebraska if they have met pesticide safety training requirements. To meet the training requirement, the crop advisor must be certified or licensed as a crop advisor by a program acknowledged as appropriate in writing by EPA, the NDA, or Tribal agency responsible for pesticide enforcement.

When performing crop advisor tasks in a treated area during the REI, certified crop advisors who meet this description may determine the appropriate PPE to wear and do not have to comply with the requirements for emergency assistance, understanding the label, and decontamination for themselves. However, certified crop advisors must provide these protections for their employees.

As pesticide handlers under the WPS, a crop advisor (i.e., anyone who does a crop advisor task) other than a certified crop advisor may enter treated areas during the REI if the application has been complete for at least four hours, they only perform crop-advising tasks, and they:

- wear the PPE required for handling activities as required by the label, OR
- follow the PPE requirements on the product label for early-entry activities, OR

- wear a standard set of PPE (coveralls, shoes, socks, waterproof gloves, and eye protection if the product labeling requires protective eyewear for handlers).

## Resources

Nebraska Department of Agriculture. For WPS regulatory interpretation and compliance guidance, call 402-471-2351 or 877-800-4080 (toll free).

Ogg, C.L., Bauer, E.C., Hygnstrom, J.R., Hansen, P.J. (2012) Protective Clothing and Equipment for Pesticide Applicators, NebGuide G758. US Code of Federal Regulations. 2016. Title 40, Chapter I, Subchapter E Part 170 Worker Protection Standard available online at [http://www.ecfr.gov/cgi-bin/text-idx?SID=e3b0693d1b8ccd5e04ed42ced2a268c8&mc=true&tpl=/ecfrbrowse/Title40/40cfr170\\_main\\_02.tpl](http://www.ecfr.gov/cgi-bin/text-idx?SID=e3b0693d1b8ccd5e04ed42ced2a268c8&mc=true&tpl=/ecfrbrowse/Title40/40cfr170_main_02.tpl).

*How to Comply with the 2015 Revised Worker Protection Standard For Agricultural Pesticides: What Owners and Employers Need To Know*, US Environmental Protection Agency, <https://www.epa.gov/pesticide-worker-safety/pesticide-worker-protection-standard-how-comply-manual>.

“Safety and Health Topics: Occupational Heat Exposure,” US Occupational Health and Safety Administration, <https://www.osha.gov/SLTC/heat-stress/>.

## Acknowledgment

The authors gratefully acknowledge Trevor Johnson, Nebraska Department of Agriculture, and Nancy Fitz, US EPA, for extensive reviews.



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# Spray Drift of Pesticides

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*Conditions that cause particle drift, and methods that private and commercial applicators can adopt to reduce drift potential from pesticide spray applications, are discussed in this publication.*

Spray drift of pesticides away from the target is an important and costly problem facing both commercial and private applicators. Drift problems include:

1. damage to susceptible off-target sites;
2. a lower pesticide rate than intended on targets, which can reduce efficacy and waste pesticide and money; and
3. environmental contamination, such as water pollution, exposure to threatened and endangered species, and illegal pesticide residues.

Drift occurs by two methods: vapor drift and particle drift. This publication focuses on conditions that cause particle drift, and methods to reduce drift potential when spraying pesticides. **Potential off-target movement needs to be a primary consideration for all pesticide applications.**

### Drift Dynamics

A solution sprayed through a nozzle atomizes into droplets that are spherical or nearly spherical in shape.

Table 1. Effect of droplet size on drift potential (Grisso, et al., 2013).

Droplet Diameter (microns)	Droplet Size *	Time Required to Fall 10 Feet	Lateral Movement in a 3-mph Wind
20	Very fine (VF)	4.2 minutes	1,100 feet
100	Very fine (VF)	10 seconds	44 feet
240	Medium (M)	6 seconds	28 feet
400	Coarse (C)	2 seconds	8.5 feet
1,000	Extremely coarse (XC)	1 second	4.7 feet

\*Droplet size categories in parentheses are based on the American Society of Agricultural and Biological Engineers (ASABE) droplet size classification as described by ASABE S572.1.

Particle drift is the actual movement of spray particles away from the target area at or near the time of application. Many factors affect this type of drift, but the most important is initial droplet size. Small droplets decelerate quicker than large droplets and fall through the air slowly, making them more likely to be carried farther by air movement.

Droplet size is measured in microns. Droplets with diameters smaller than 100 microns, about the diameter of a human hair, are considered highly driftable. These small droplets cannot be readily seen unless in high concentrations, such as fog. As a result of the small size, drift is more dependent on the irregular movement of turbulent air than on gravity.

Table 1 shows how droplet size affects the rate of fall. The longer the droplet is airborne, the greater the potential for drift.

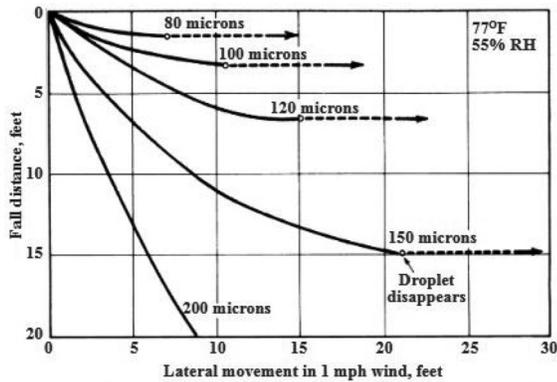


Figure 1. Lateral movement of water droplets (Hofman and Solseg, 2004).

When exiting the nozzle, a solution may have a velocity of 60 feet per second (41 mph) or more. Unless spray particles are electrostatically charged, there are two forces acting upon the emerging droplets. These forces, gravity and air resistance, greatly influence the deceleration and movement of spray droplets. Air resistance is affected by the direction of the nozzle. There is less air resistance with nozzles aimed away from the direction of travel and wind direction. After their initial speed slows, droplets are more influenced by gravitational pull.

With lower boom heights, the initial speed may be great enough that droplets reach the target before drifting, and prevent off-target movement. Large droplets maintain a downward velocity for a longer time than smaller ones, and are more likely to be deposited on the intended target. Small droplets evaporate quicker than large droplets because of the greater surface area to mass ratio, leaving minute quantities of pesticide in the air (Figure 1). In addition to realizing that spray droplet size is an important factor in reducing drift, an applicator should be aware that nozzles will produce many different sizes of droplets.

### Droplet Size Categories

Volume median diameter (VMD), a common term used when describing a spray characteristic distribution, is the droplet diameter at which half the spray volume consists of droplets of greater diameter and half consists of droplets of lesser diameter.

The American Society of Agricultural and Biological Engineers (ASABE) developed a droplet size classification system with categories ranging from extremely fine to ultra-coarse, based on the droplet size distribution measured in microns (Table 2). Nozzle catalogs and guides often refer to

these droplet size categories, known as spray classification, and color code descriptions to reduce confusion.

An applicator can select the nozzle and pressure based on the spray classification charts. In addition, the pesticide label may list the required or recommended droplet size classification to use with a particular product. For example, the label statement might read: “Apply with 12+ gallons per acre using a nozzle producing a coarse droplet.” The label includes these spray classification recommendations to make sure that the droplet size is suitable for pesticide efficacy. Typically, low-drift nozzles produce spray droplets in the medium (M) to ultra-coarse (UC) range, while reducing the fine droplets—those most likely to drift.

### Altering Droplet Size

Some sprayer components can be adjusted to alter droplet size. Initial selection of the proper nozzle type has the most impact on the resulting droplet size produced (Table 3). For more information on droplet sizes created under various conditions, download Nebraska Extension’s smartphone app “Ground Spray” from the Apple App Store or the Google Play Store.

The following can be altered to modify the applied droplet size.

#### Nozzle Type

Different nozzle types produce different spray droplet sizes and patterns.

- A *flat-fan nozzle* forces liquid under pressure through an elliptical orifice spreading it out into a thin sheet that breaks up into different-sized droplets. This nozzle type includes the venturi-type nozzles that rely on a pressure-against-orifice effect to atomize the spray.
- A *flood nozzle* deflects a liquid stream off a plate that causes droplets to form.
- A *whirl-chamber nozzle* swirls the liquid out an orifice with a circular motion and aids the droplet formation with a spinning force.
- An *air-inclusion nozzle* has one orifice to meter liquid flow and another, larger orifice to form the pattern. Between these two orifices is a venturi, or jet, that draws air into the nozzle body. Air mixes with the liquid and forms a spray pattern at a lower pressure. The coarse spray can contain large, air-filled droplets and usually has fewer drift-susceptible droplets.

Table 2. Spray classifications with color codes, based on ASABE standards.

<i>Spray quality*</i>	<i>Size of droplets</i>	<i>Color code</i>	<i>Retention on leaves difficult to wet</i>	<i>Used for</i>	<i>Drift potential</i>
Extremely Fine (XF)		Purple	Excellent	Exceptions	
Very Fine (VF)		Red	Excellent	Exceptions	
Fine (F)		Orange	Very good	Fung. & insect.	
Medium (M)		Yellow	Good	Fung., insect., contact herb.	
Coarse (C)		Blue	Moderate	Systemic herbicides	
Very Coarse (VC)		Green	Poor	Soil herbicides**	
Extremely Coarse (XC)		White	Very poor	Liquid fertilizer**	
Ultra Coarse (UC)		Black	Very poor	Liquid fertilizer**	

\*Always check the pesticide label to determine which spray classification is required.

\*\*Systemic herbicides for which there is concern with spray particle drift usually require higher carrier rates for good coverage with the larger size spray quality.

### Spray Pressure

Spray pressure impacts droplet size with increased pressure reducing overall droplet size. The spray solution emerges from the nozzle in a thin sheet with droplets forming at the edge of the sheet. Higher pressures create a thinner sheet that breaks up into smaller droplets. These smaller droplet sizes created at higher pressure are potentially carried farther downwind than the larger droplet sizes produced at lower pressures (*Figure 1*). *Table 3* shows the mean droplet size for nozzles when spraying at three pressures. **Higher pressures decrease droplet size, allowing for more drift potential. Nozzle manufacturers provide specific recommendations for optimum pressure range for different nozzle types.**

### Nozzle Flow Rate and Carrier Volume

Large flow rate nozzles with higher carrier volumes produce larger droplet sizes than do smaller orifices. The relationship between flow rate (gallons per minute or GPM) and pressure (pounds per square inch or PSI) is not linear. In order to double the flow rate from a given nozzle, a four times pressure increase is required. This pressure increase consequently reduces droplet size increasing drift potential and is an undesirable method to increase carrier volume. Rather, it is better to select a larger orifice size that meets the rate requirements at a lower spray pressure. Air inclusion nozzles have two orifices, one to meter the liquid flow and a larger orifice to form the spray pattern. Spray particle sizes depend on the relationship between the orifice sizes and the air inclusion. A lower flow rate nozzle may have a larger particle size when the difference between the two orifice sizes is larger. Consult the pesticide label and EC141, *Nozzles—Selection and Sizing*, for proper selection.

Table 3. Effect of spray angle and pressure on droplet size (\*adapted from Spraying Systems Co., 1990).

<i>Nozzle spray angle (Degrees)</i>	<i>Volume Median Diameter (VMD), microns</i>		
	15 PSI	40 PSI	60 PSI
40	900 (UC)	810 (UC)	780 (UC)
65	600 (XC)	550 (XC)	530 (XC)
80	540 (XC)	470 (XC)	450 (XC)
110	410 (VC)	380 (VC)	360 (VC)

\*Droplet size categories in italics were added based on ASABE droplet size classification now in use.

### Nozzle Spray Angle

The spray angle of a nozzle is the distance between the outer edges of the spray pattern, expressed as a number of arc degrees (a full circle is 360°). Wider angles cover a wider spray path and produce a thinner sheet of spray solution and smaller droplets at the same pressure (*Table 3*). However, wide-angle nozzles can be placed closer to the target, and the benefits of lower nozzle placement may outweigh the disadvantage of slightly smaller droplets. Lower pressures can be used to reduce the amount of fine droplets. For lower pressures with flat-fan nozzles, low pressure or extended range nozzles must be used.

### Spray Volume

The size or capacity of the nozzle also influences droplet size. A higher flow rate nozzle increases droplet size at a common pressure. Since a higher flow rate nozzle uses more spray volume, it also increases the number of refills; however, the increased volume of carrier solution improves coverage, and in some cases increases pesticide effectiveness. *Table 4* shows the influence of increasing flow rate on droplet size at a constant pressure. With some pesticides,

Table 4. Effect of flow rate on droplet size at 40 PSI (\*adapted from Spraying Systems Co., 2007).

Nozzle type	Volume Median Diameter (VMD), microns		
	0.3 GPM	0.4 GPM	0.5 GPM
Extended Range Flat-Fan	270 (C)	300 (C)	330 (C)
Drift Guard	400 (VC)	425 (XC)	450 (XC)
Turbo TeeJet	450 (XC)	480 (XC)	510 (XC)

\*Droplet size categories in italics were added based on ASABE droplet size classification now in use.

such as glyphosate, performance is better at lower carrier volumes.

## Other Drift Factors

### *Boom Height*

Operating the boom as close to the sprayed surface as possible, while staying within the manufacturer’s recommendation, reduces drift potential. A wider spray angle allows the boom to be placed closer to the target (*Table 5*). Booms that bounce cause uneven coverage and drift. Wheel-carried booms stabilize boom height, reduce drift hazard, provide more uniform coverage, and permit lower boom height. Boom height controllers are now optional on most sprayers. The nozzle height suggestions in *Table 5* are based on the minimum overlap required for uniform spray distribution. In many cases, however, height adjustments are based on a 1-to-1 nozzle spacing-to-height ratio. For example, 110° flat spray tips with 20-inch spacing usually are set 20 inches above the target.

### *Nozzle Spacing*

Nozzle spacing is the distance between individual nozzles on the spray boom and is critical to achieving adequate spray coverage. Spray angle and boom height also are key in the resulting coverage achieved. At a given spray volume, as the spacing between nozzles increases, nozzle flow rate must also be increased to maintain the volume applied. This typically means increasing the boom height to get the proper overlap. However, increasing droplet size is more important than reducing boom height.

It is important to follow the equipment and nozzle manufacturer’s recommendations for appropriate nozzle configuration. As a general guideline, do not exceed a 30-inch nozzle spacing as the spray pattern will be less uniform. A configuration of nozzle spacing, height, and

direction that gives proper spray overlap is preferred for broadcast applications. The best nozzle spacing for most sprayers is 15 inches. Specifically for high volumes, use a 15-inch nozzle spacing and for low volumes, cap off every other nozzle and use a 30-inch nozzle spacing.

### *Wind Speed*

Both the amount of pesticide lost from the target area, and the distance it moves downwind, increase as wind speed increases (*Table 6*). Severe drift injury can occur with low wind velocities as well, especially under temperature inversions. Inversions can also lead to pesticide movement in any direction following subsequent winds when the inversion starts to lift. Most recommendations are to stop spraying if wind speeds are less than 3 mph or exceed 10 mph. Some product labels have application restrictions when winds are higher than 8 mph, some have 15 mph cut-offs, and others do not specify. Therefore it is important to consult the product label for exact restrictions of the product being applied. The wind effect can be minimized by using larger droplet sizes, shielded booms, and lower boom heights.

### *Wind Direction*

Pesticides should not be applied when the wind is blowing toward a nearby susceptible crop, a crop in a vulnerable stage of growth, or sensitive areas such as beehives. Select a time when there is little wind or the wind blows gently away from sensitive areas. If these conditions do not exist, consider another method of control or time of application.

### *Air Stability*

Air movement largely determines the distribution of spray droplets. Often wind is recognized as the most important factor, but vertical air movement is often overlooked. Temperature inversions occur when cool air near the soil surface is trapped under a layer of warmer air. A strong inversion potential occurs when ground air is 2–5°F cooler than the air above it and there is no wind.

Under inversion conditions spray drift can be severe. Small spray droplets may fall slowly or be suspended and move several miles to susceptible areas, carried by a gentle breeze. Do not apply pesticides near susceptible crops or other sensitive areas during temperature inversion conditions. Inversions can be identified by observing smoke

Table 5. Suggested minimum spray height above spray contact surface. (Most nozzle manufacturers have nozzles similar to the TeeJet nozzles listed below).

Nozzle	Spray angle degrees	Spray height, inches		
		20-inch nozzle spacing	30-inch nozzle spacing	40-inch nozzle spacing
TP, TJ	65°	22–24"	30–35"	NR*
TP, XR, TX, DG, TJ, AI, XRC	80°	17–19"	26–28"	NR*
TP, XR, DG, TT, TTI, TJ, DGTJ, AI, AIXR, AIC, XRC, TTJ, AITJ	110°	16–18"	20–22"	NR*
FullJet*	120°	10–18" <sup>**</sup>	14–18" <sup>**</sup>	14–18" <sup>**</sup>
FloodJet*TK, TF, K, QCK, QCTE, 1/4TTJ	120°	14–16" <sup>***</sup>	15–17" <sup>***</sup>	18–20" <sup>***</sup>

\*Not recommended.

\*\*Nozzle height based on 30° to 45° angle of orientation.

\*\*\*Wide angle spray tip height is influenced by nozzle direction. The critical factor is to achieve a double spray pattern overlap.

Source: TeeJet Technologies Catalog 51A.

Table 6. Effect of wind speed on drift in a 10-foot fall (\*adapted from Ross and Lembi, 1985)

Droplet diameter (microns)	Drift (feet)	
	1 mph winds	5 mph winds
100 ( <i>VF</i> )	15	77
400 ( <i>VC</i> )	3	15

\*Droplet size categories in italics were added based on ASABE droplet size classification now in use.

from a smoke bomb or a fire (Figure 2). Smoke moving horizontally close to the ground is indicative of a temperature inversion.

### Relative Humidity and Temperature

Low relative humidity and/or high temperature conditions cause faster evaporation of spray droplets and a higher potential for drift. During evaporation, the spray solution generally loses more water than pesticide, creating smaller droplets with a greater concentration of pesticide. The quantity of spray that evaporates from the target surface is related to the quantity of spray deposited on that surface. Smaller droplets, being more prone to drift and evaporation, have less chance of actually being deposited on the target surface than do large droplets. Therefore, hot and dry weather conditions lead to less spray deposition and more drift, due to evaporation of the spray carrier solution.

Evaporation increases the potential for drift, so it is recommended to spray during lower temperature and higher humidity conditions. Pesticides differ in their evaporation rate. Use formulations and adjuvants that reduce evaporation when possible. Some pesticide labels specify relative humidity and temperature conditions for product

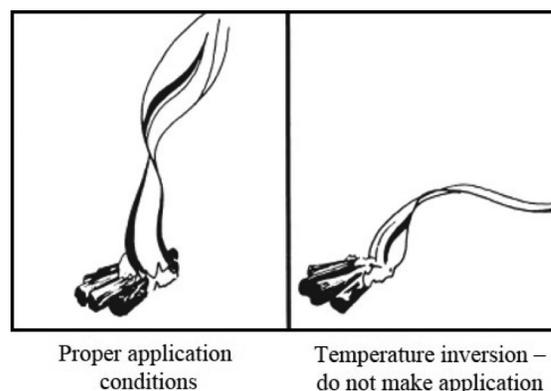


Figure 2. Smoke movement indicates temperature inversion conditions.

use. Generally, if the relative humidity is above 70%, conditions are ideal for spraying. A relative humidity below 50 percent is low enough to warrant additional caution.

### Spray Thickeners

Some spray adjuvants and formulations act as spray thickeners or drift retardants when added to a spray tank. These materials increase the number of larger droplets and decrease the number of fine droplets. They tend to give water-based sprays a “stringy” quality and reduce drift potential.

### Best Management Practices to Avoid Pesticide Drift

All nozzles produce a range of droplet sizes. The small, drift-prone particles cannot be eliminated but can be reduced and kept within reasonable limits. Here are some tips:

1. Select low or nonvolatile pesticides.
2. Read and follow the pesticide label. Instructions on the pesticide label are given to ensure the safe and effective use of pesticides with minimal risk to the environment. Each pesticide is registered for use on specific sites or locations. Many drift complaints involve application procedures in violation of the label.
3. Use spray additives within label guidelines. This will result in better pesticide effectiveness and usually less potential for drift.
4. Use nozzles with higher flow rates, producing larger droplets with less potential for drift.
5. Avoid high spray boom pressures, as high spray pressures create finer droplets.
6. Use drift-reduction nozzles that produce larger droplets when operated at low pressures. When using venturi nozzles, higher pressures will be required to maintain an effective pattern. As the pressure is increased with these nozzles, the drift potential will increase, but usually not as much as with other types of nozzles.
7. Use wide-angle nozzles coupled with low boom heights, and keep the boom stable. Drive perpendicular to terraces rather than parallel to avoid moving the boom ends high above the target surface or dropping it into the ground.
8. Drift is reduced when wind velocity is between 3 mph and 10 mph. Do not spray when temperature inversions are likely or when wind is high or blowing toward sensitive crops, gardens, dwellings, livestock, water sources, or other sensitive areas.

9. Use shielded booms. When banding, use shroud covers.
10. When possible, use lower application speeds. As application speed increases, unintended effects on other application parameters may increase drift.

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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 Nebraska Extension is implied for those mentioned.

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## Pesticides and the Endangered Species Protection Program

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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

**Bulletins Live!**

Protecting Endangered Species



Figure 1. Bulletins Live! map on U.S. EPA website.

“NE” on the map, and choose the county where the application will take place from the pull-down menu. Next, 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://rarspecies.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



Figure 2. Blowout penstemon (photo credit: James Stubbendieck, UNL).

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 praeclara*, 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



Figure 3. Western prairie fringed orchid (photo credit: NGPC).

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** (*Gaura 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** (*Spiranthes diluvialis*, 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 far 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.

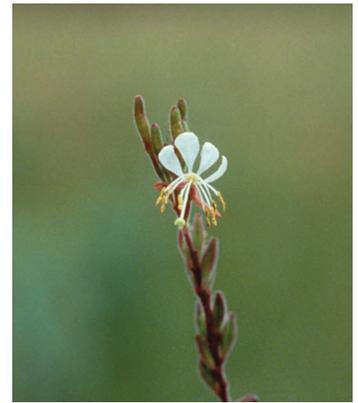


Figure 4. Colorado butterfly plant (photo credit: NGPC).



Figure 5. Ute ladies'-tresses (photo credit: Bekee Hotze, U.S. Fish and Wildlife Service).



Figure 6. Small white lady's slipper (photo credit: Tom Barnes, University of Kentucky).

## 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



Figure 7. Salt Creek tiger beetle (photo credit: UNL Department of Entomology Image Library).

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 beetles 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 now is found only in six states, including Nebraska. This beetle is the largest North American carrion beetle and may



Figure 8. American burying beetle (photo credit: NGPC).

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.



Figure 9. Topeka shiner (photo credit: Konrad Schmidt, Minnesota Department of Natural Resources).

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

(*Sterna antillarum athalassos*, 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.



Figure 10. Interior least tern (photo credit: NGPC).

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, to 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.



Figure 11. Piping Plover (photo credit: NGPC).

### 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://outdoornebraska.ne.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 Romary, Nebraska Department of Agriculture, Lincoln, NE (402) 471-2394

Nebraska Department of Agriculture List of Threatened and Endangered Species <http://www.nda.nebraska.gov/pesticide/endangered.html>

#### Nebraska Department of Environmental Quality

NPDES Press Release <http://www.deq.state.ne.us/Press.nsf/pages/PR111011> or <http://pested.unl.edu/NPDES>

#### Nebraska Game and Parks Commission

Nebraska Game and Parks Commission, Lincoln, NE (402) 471-0641 <http://rarspecies.nebraska.gov/>

NGPC Endangered and Threatened Species Consultation Information <http://outdoornebraska.ne.gov/wildlife/programs/nongame/consultation.asp>.

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

NGPC E&T Species Standard Procedures for NPDES Pesticide Permit [http://outdoornebraska.ne.gov/wildlife/programs/nongame/pdf/E&T%20Species%20Standard%20Procedures%20for%20Pesticide%20Permit\\_04112012.pdf](http://outdoornebraska.ne.gov/wildlife/programs/nongame/pdf/E&T%20Species%20Standard%20Procedures%20for%20Pesticide%20Permit_04112012.pdf)

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

Field Office Technical Guide listing of Nebraska Endangered and Threatened Species with descriptions and locations (2011). [http://efotg.sc.egov.usda.gov/references/public/NE/Subsection\\_II\\_TOC\\_ENDANGERED\\_AND\\_THREATENED\\_SPECIES\\_LISTS.pdf](http://efotg.sc.egov.usda.gov/references/public/NE/Subsection_II_TOC_ENDANGERED_AND_THREATENED_SPECIES_LISTS.pdf)

#### U.S. Environmental Protection Agency

Dick Wiechman, 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/espp>

#### U.S. Fish & Wildlife Service

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

U.S. Fish & Wildlife Service. 2013. ESA Basics at [http://www.fws.gov/endangered/esa-library/pdf/ESA\\_basics.pdf](http://www.fws.gov/endangered/esa-library/pdf/ESA_basics.pdf)

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### Index: Environmental & Natural Resources Conservation

2008, Revised October 2014

Extension 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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Revised May 2015

## Understanding the Pesticide Label

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 Ben W. Beckman, 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 and use a product. (For more information see NebGuide G479, *Pesticide Laws and Regulations*).

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, and have different label types. 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 provide certain information on the label. The information includes:

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

Other required parts of the label are:

- the registration and establishment numbers;
- statement of practical treatment;
- environmental hazard statement;
- classification statement;
- directions for use;
- re-entry statement, if necessary;
- harvesting and/or grazing restrictions; and
- storage and disposal statements.

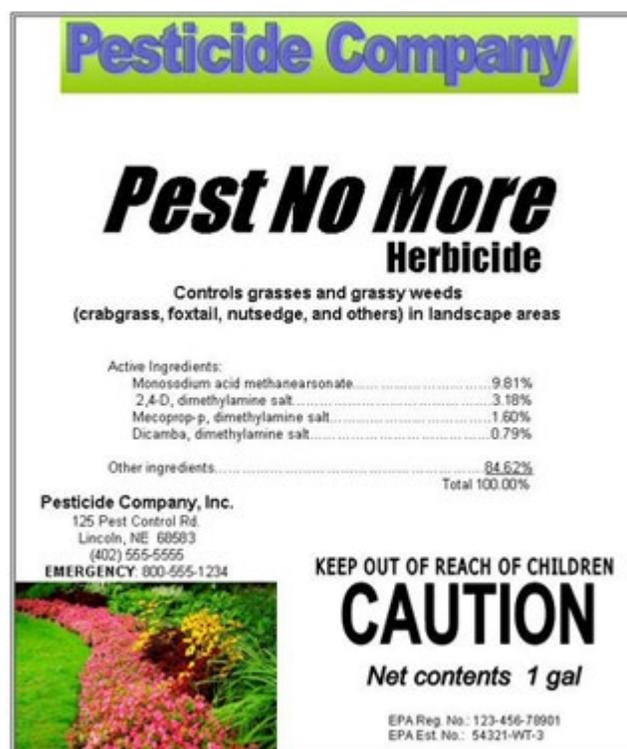


Figure 1. An example of pesticide label.

## Brand, Trade, or Product Name

Brand, trade, or product name is used to identify and market the product (e.g., Pest No More in *Figure 1*). Different companies use different brand names to market products 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 show the 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*).

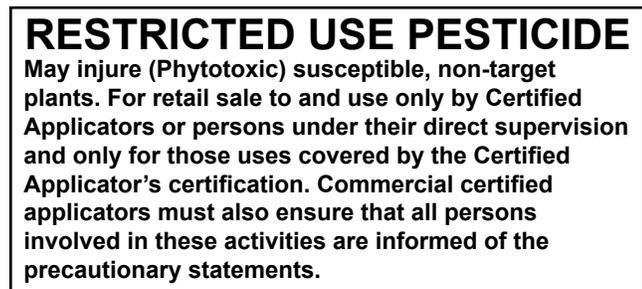


Figure 2. An example of a Restricted Use Pesticide statement.

## 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, etc.). 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.

## 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, Danger, and Danger-Poison. (*Table I*).

Table I. Signal words that may appear on the label.

Signal Word	Category	Toxicity*
Danger or Danger-Poison	Class I — highly toxic	Corrosive or irritant properties, a few drops to 1 teaspoon
Warning	Class II — moderately toxic	1 teaspoon to 1 ounce
Caution	Class III — slightly toxic	1 ounce to 1 pint/ 1 pound
Caution or none	Class IV — very slight hazard	Over 1 pint or 1 pound

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

## 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 *Personal Protective 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 *Personal Protective Equipment Statement* outlines the equipment requirements that protect the applicator from exposure to the pesticide (see NebGuide G758, *Protective Clothing and Equipment for Applicators*). Nebraska Extension recommends applicators wear at a minimum long-sleeved shirt, long pants, chemical-resistant shoes plus socks, and chemical-resistant gloves in order to be adequately protected, other necessary protective clothing and equipment will be provided on the label.

### Statement of Practical Treatment

Also called *First Aid* on many consumer labels, the *Statement of Practical Treatment* tells what to do in case of exposure to the product. 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 “seek medical attention” are two examples of information found in the *Statement of Practical Treatment* section.

### Environmental Hazard Statement

*Environmental Hazard Statement* details possible hazards to the environment including soil, water, air, wildlife, fish, and nontarget 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

The *Physical or Chemical Hazards* section of the label describes any possible fire, chemical, or explosion hazards specific to the product. 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 gas 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 this section of the label.

### Agricultural Use Requirements

Information about use in agricultural settings (*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 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
- 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.

### Storage and Disposal Statement

Each pesticide label has general storage and disposal instructions. 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

*Directions For Use* instruct the applicator how to properly apply the pesticide and achieve the best results. This section provides information such as the rate of application, the sites the product is intended to protect (e.g., aquatic, non-crop sites, wildlife habitat areas, crop 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, which indicates how much time must pass between the application and harvest to avoid pesticide residues so that the crop will not exceed the maximum tolerance level for pesticide residues. The consequences of not following the PHI can vary, but toxicity to livestock or inability to sell harvested grain are two possible results. On some labels, the *Re-entry Statement* may also be listed under this section.

A product with the potential to harm pollinators will have restrictions to the application, indicated by a *Bee Hazard Icon* (Bee Box) on the label (*Figure 4*) in the directions for use section.

**PROTECTION OF POLLINATORS**



**APPLICATION RESTRICTIONS** EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.



Look for the bee hazard icon  in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

**This product can kill bees and other insect pollinators.**

Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- o Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- o Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- o Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- o Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives or off-site to pollinator attractive habitat can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at <http://pesticidestewardship.org/PollinatorProtection/Pages/default.aspx>.

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state, go to [www.aapco.org/officials.html](http://www.aapco.org/officials.html). Pesticide incidents should also be reported to the National Pesticide Information Center at [www.npic.orst.edu](http://www.npic.orst.edu) or directly to EPA at [beekill@epa.gov](mailto:beekill@epa.gov)

**Figure 4. Explanation of the bee hazard icon.**

Read and follow all label directions for effective, safe, and legal use of pesticides. Reading the pesticide label will help ensure proper and legal pesticide use.

### 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.

**This publication has been peer reviewed.**

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**Index: Pesticides  
General Safety**  
2009, Revised May 2015

Extension 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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## Pesticide Safety: Choosing the Right Gloves

Erin C. Bauer, Extension Associate; Clyde L. Ogg, Extension Educator; Jan R. Hygnstrom, Project Coordinator; Emilee A. Dorn, Extension Assistant; and Ben W. Beckman, Extension Assistant

This NebGuide explains how to choose and properly use gloves when mixing, loading, or applying pesticides; how to maintain such gloves; and how these procedures can help reduce exposure to chemicals and protect human health.

Properly protecting yourself when using pesticides can decrease the risk a pesticide has on your health and safety. Handling pesticides can include mixing, loading, or applying pesticides, all of which could expose your hands to chemicals. Using the right gloves is 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 chemical-resistant gloves, we recommend that you wear them when handling any pesticide.

### Types of Gloves

Choosing gloves depends on the type of pesticide and the application. In general, unlined, liquid-proof neoprene, butyl, or nitrile gloves (*Figure 1*) with tops that extend well up on the forearm are best. These materials provide good protection under most conditions, are durable, and are reasonably priced. Most of these gloves are available in reusable pairs that can be cleaned after each mixing/loading task or pesticide application. Others, such as nitrile gloves, are available as single-use disposables.

The barrier laminate glove (*Figure 2*) offers the most protection. It consists of two or more different materials that are laminated or blended together. Viton® is another good choice, but is more expensive than most other chemical-resistant gloves. When making decisions about which gloves to purchase, you must consider your risk—the length of time you will be exposed to the pesticide along with the type of pesticide you’ll be using ( $\text{Risk} = \text{Exposure} \times \text{Toxicity}$ )—and weigh this against the cost of gloves.



Figure 1. Examples of recommended gloves: nitrile (reusable and disposable), neoprene, and butyl rubber. Photo: University of Nebraska–Lincoln.



Figure 2. Example of EPA's highest rated protective glove material, barrier laminate. Photo: University of Nebraska–Lincoln.

**Table I. Types and Characteristics of Personal Protective Material.**  
(for use when PPE section on pesticide label lists a chemical resistance category)

Selection Category Listed on Pesticide Label	Types of Personal Protective Material							
	Barrier Laminate	Butyl Rubber ≥ 14 mils	Nitrile Rubber ≥ 14 mils	Neoprene Rubber ≥ 14 mils	Natural Rubber* ≥ 14 mils	Polyethylene	Polyvinyl Chloride (PVC) ≥ 14 mils	Viton ≥ 14 mils
<b>A</b> (dry and water- based formulation)	NA	NA	NA	NA	high	NA	NA	NA
<b>B</b> (acetate)	high	high	slight	slight	none	slight	slight	slight
<b>C</b> (alcohol)	high	high	high	high	moderate	moderate	high	high
<b>D</b> (halogenated hydrocarbons)	high	high	moderate	moderate	none	none	none	slight
<b>E</b> (ketones, such as acetone)	high	slight	high	high	slight	none	moderate	high
<b>F</b> (ketone and aromatic petroleum distillates mixture)	high	high	high	moderate	slight	none	slight	high
<b>G</b> (aliphatic petroleum distillates, such as kerosene, petroleum oil, or mineral oil)	high	slight	slight	slight	none	none	none	high
<b>H</b> (aromatic petroleum distillates, such as xylene)	high	slight	slight	slight	none	none	none	high

\*includes natural rubber blends and laminates

**High:** Highly chemical resistant. Clean or replace PPE at end of each day’s work period. Rinse off pesticides at rest breaks.

**Moderate:** Moderately chemical resistant. Clean or replace PPE within an hour or two of contact.

**Slight:** Slightly chemical resistant. Clean or replace PPE within ten 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.

**Reference:** Environmental Protection Agency, “Labeling Review Manual-Chapter 10: Worker Protection Labeling, EPA Chemical Resistance Category Selection Chart,” <http://www.epa.gov/oppfead1/labeling/lrm/chap-10.htm#VIA>

Waterproof gloves will not provide adequate protection from pesticides, so be sure your gloves are rated as chemical-resistant. You should avoid latex gloves, as they do not provide adequate skin protection; they disintegrate rapidly; and they are not recommended by the Environmental Protection Agency (EPA). Canvas (such as gardening) or leather gloves, gloves worn by medical personnel, or household cleaning gloves are all inadequate for working with pesticides.

You may wear lightweight, single-use cotton liners inside chemical-resistant gloves. These liners improve the comfort and ease of putting on and taking off your gloves. Never reuse these liners, however; they must be discarded after each use to avoid potential exposure to pesticides that may have been absorbed by the cotton material. In addition, you 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 developed a rating chart defining chemical resistance of various materials used for gloves. These ratings range 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 pesticide label and is based on the solvents used in pesticides rather than the pesticides themselves. These categories refer to how long you can safely wear gloves of a certain material and thickness while handling a specific pesticide. This also depends on the

formulation of a pesticide. For example, the amount of time you can wear a certain glove material when using a dry formulation may be different from the same pesticide in a liquid formulation.

Table I, a reproduction of the EPA’s rating chart, gives the types of personal protective material and their characteristics to help determine the appropriate type of gloves to use when mixing and loading or applying a pesticide. The first column of Table I has the selection categories (A through H) that may be found on some pesticide labels, as well as the solvents (listed in parentheses) that are associated with pesticides in those categories.

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 when mixing and loading, or a diluted pesticide, used during application. Glove lifespan is much longer when using a diluted pesticide than when using a concentrated one. Regardless of whether you are mixing and loading or applying pesticides, the amount of contact time you have with pesticides also will be a factor. For example, someone mixing and loading a concentrated pesticide all day will need to change gloves that are labeled as having “slight” or “moderate” chemical resistance more often than someone who mixes and loads for one hour or someone who spends half a day applying diluted pesticide. Always follow label instructions about which gloves to wear for the activity you will be doing.

## 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 any other protective equipment, however, the number of times you can reuse these gloves is determined by the hours of use. For example, gloves would have to be replaced after eight hours of continuous use, but if used for shorter intervals they could be reused several times. Other factors include the age and condition of the material. After enough use or lengthy storage, glove material can become brittle and less impervious to chemicals. Also, any glove, no matter its thickness, should be discarded if it becomes torn or damaged. Do not reuse gloves from one season to the next.

Gloves with less than 14-mil thickness (often referred to as disposable) have a shorter usable life than those gloves indicated in the EPA chart. These disposable gloves are available in a variety of thicknesses (e.g., 4, 8, or 12 mil), sizes, and cuff lengths.

Cost often varies with thickness; thicker gloves usually are more expensive. Keep in mind, however, that thicker gloves offer better protection than thinner ones.

In general, disposable gloves may be preferable over reusable because they can be discarded after one use and thus do not require as much maintenance as reusable gloves. 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 greater may be a better choice in some circumstances.

Reusable gloves must be washed and carefully removed after use to prevent contaminating your skin or other areas, such as the interior of tractor cabs. In addition, reusable gloves must be stored properly and checked for leaks before using again; you can throw away disposable gloves according to directions on the label upon completion of your 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 for you by measuring the circumference around the palm of your hand. For example, if it measures 8 inches, a medium would probably be the best choice.

Table II lists available glove sizes:

Proper glove fit is essential. Poorly fitting gloves can complicate your ability to apply pesticides correctly. A glove

**Table II. Glove size in relation to circumference of the hand at the palm.**

Glove size	Circumference of palm (in inches)
Extra small	6-7
Small	7-8
Medium	8-9
Large	9-10
Extra large	10-11
2XL	11-12
Jumbo	12-13

that is too tight will be uncomfortable and may split, allowing the pesticide to penetrate your skin. Gloves that are too large can slide on your hands and allow the pesticide to run down into the gloves and onto your skin. Handling equipment also becomes more difficult when you can't grip it sufficiently, increasing the chance for mistakes. Always try on your gloves and ensure they fit properly before handling pesticides.

## Glove Thickness

The thickness of the material used in chemical-resistant gloves can affect their lifespan and their susceptibility to tears, abrasions, and general wear. Both disposables and reusables are available in various thicknesses. Manufacturers sell gloves with thickness ranges falling between 4-22 mils (Figure 3). Other thicknesses also may be available. Note that breakthrough time (the length of time for the pesticide to permeate the glove) is generally greater the thicker the material.

As mentioned earlier, the lifespan of a pair of gloves also depends on whether you are using concentrated or diluted pesticides. Concentrated pesticide will wear out gloves much faster and decrease lifespan much more quickly than diluted pesticides. Keep this in mind when choosing a glove thickness.

## Proper Use

In most cases, we recommend wearing gloves under your sleeves to keep pesticide from running down the sleeves and into the gloves (Figure 4). When working with your hands above your head, roll glove tops into cuffs over your sleeves to prevent the pesticide from running down the gloves to your forearms. As an extra safety measure, you can apply duct tape where the glove and sleeve meet. Remember, the most important thing is to wear gloves!



**Figure 3. Disposable nitrile gloves in 4-, 8- and 12-mil weights. Photo: University of Nebraska–Lincoln.**



**Figure 4. Wear gloves under long sleeves to protect yourself from pesticide exposure. Photo: University of Nebraska–Lincoln.**

If applying fumigants, be especially careful to follow label directions regarding gloves. Some fumigants can penetrate materials such as rubber and neoprene, and may cause 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 airflow so that fumigant gasses won't be trapped against and burn skin.

### Proper Cleaning and Removal

After finishing a pesticide application, remove and discard disposable gloves and then wash your hands with soap and warm water. It is especially important to do so before eating, smoking, or using the toilet. Wash reusable gloves with soap and warm water while still wearing them, and then remove them.

If you are using a concentrated pesticide for mixing and loading and it gets on your gloves, you should rinse them immediately before continuing the activity. Then, after finishing the job, thoroughly wash and remove the gloves, as outlined below. By following these guidelines, you can prolong the life of your gloves as well as protect yourself from exposure.

To remove disposable gloves properly:

1. Grasp the outside cuff of one glove with the other gloved hand and pull it inside out and off the hand. Be careful not to touch your skin. Then, ball up the removed glove in your gloved hand as you take off the remaining glove by grasping the inside of the cuff and pulling it off. You can pull it so the first glove ends up inside the glove you just removed.
2. Finally, dispose of gloves according to label directions, being careful at all times not to contaminate clothes and skin.

To remove reusable gloves properly:

1. Wash the outsides of your gloves with soap and warm water. Use a sink if one is available nearby, otherwise bring a bucket and water onsite with you.
2. Next, with one gloved hand, grasp the fingers of the other glove and slowly work back and forth alternately between the gloves until you have pulled off both gloves.
3. Finally, hang the reusable gloves out to dry. Do not put gloves in the washing machine!

After removal of either disposable or reusable gloves, always wash your hands with warm water and soap before going about 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 expose you, your family, or other nontargets to pesticides.

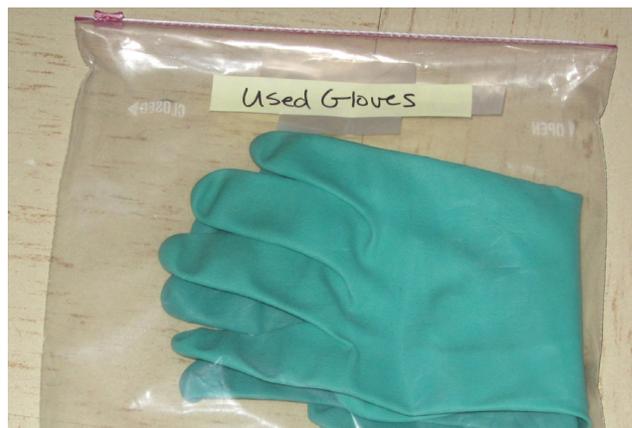


Figure 5. Properly store used gloves in a plastic bag or bucket labeled as such. Photo: University of Nebraska–Lincoln.

### Storage and Disposal

Proper maintenance of chemical-resistant gloves includes not only cleaning and removal, but also safe storage and disposal practices.

1. Store unused disposable or reusable gloves in their original bag or other container with a lid, such as a plastic bucket. Mark the container with the name of its contents.
2. After using disposable gloves, discard them according to label directions.
3. Store reusable gloves in a bucket or plastic bag marked as such once they are dry (Figure 5). Never place contaminated gloves directly onto the seat of your vehicle or other surfaces you may come in contact with.
4. Check reusable gloves before each pesticide application for leaks or wear. A good practice is to fill the gloves with water and look for any holes or tears, or put the gloves on and put your hands in a bucket or sink of clean water. Dispose of any glove according to the pesticide label if it is defective or has significant wear and replace with a new one.
5. Store gloves in a different location from pesticides to prevent them from accidental contamination during storage. Gloves should be stored in a clean environment, away from direct sunlight or temperature extremes. Do not store used gloves in your home where they might be accessible to children or pets.

By following the label, using recommended chemical-resistant gloves when applying pesticides, and properly maintaining gloves when not in use, you will reduce your risk of pesticide exposure.

#### 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.

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**Index: Pesticides  
General Safety**  
2009, Revised April 2015

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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 reuse 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. 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).

Packaging for all other products (Restricted Use Products (RUP) and/or toxicity categories I or II) must meet the nonrefillable container requirements. Nonrefillables must:

- 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"); dripping outside the container should be minimal.

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 (Figure 1), and a lot number identifying the batch.

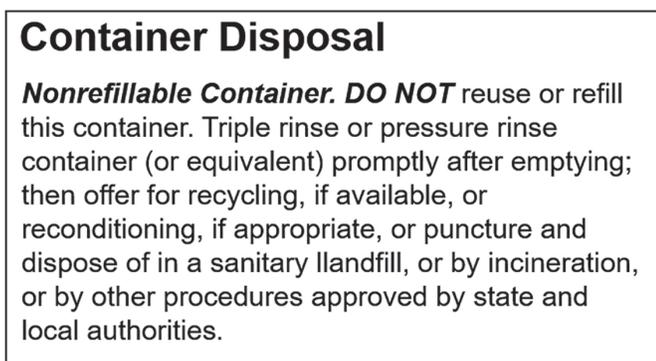


Figure 1. Example of label language on a nonrefillable container.

### Refillable Containers

Both registrants and independent refillers (those who repackage but do not register the product) must comply with requirements for stationary tanks, repackaging, and portable refillable containers (Figure 2).

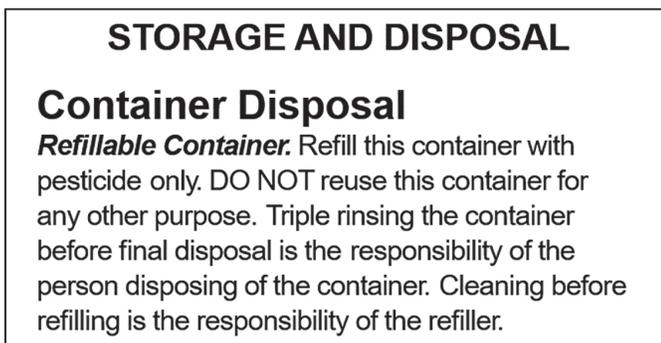


Figure 2. Example of label language on a refillable container.

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, biannually, or as requested. For more information, see [www.tri-rinse.com/](http://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

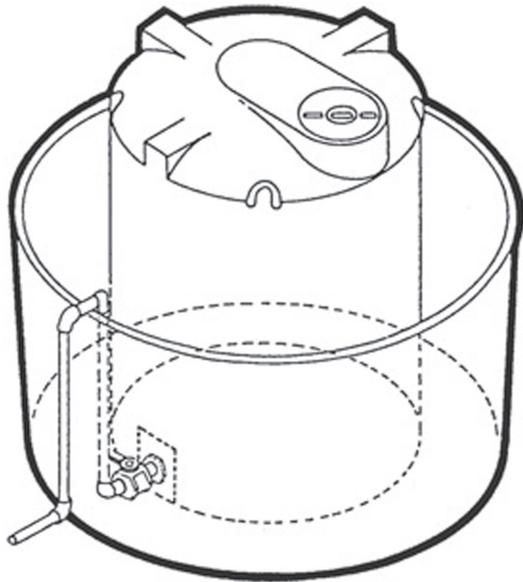


Figure 3. Secondary containment.

- 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 Nebraska 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://deq.ne.gov/RuleAndR.nsf/Title\\_198.xsp](http://deq.ne.gov/RuleAndR.nsf/Title_198.xsp).

The Nebraska Department of Environmental Quality (NDEQ) administers Title 198. According to the NDEQ,

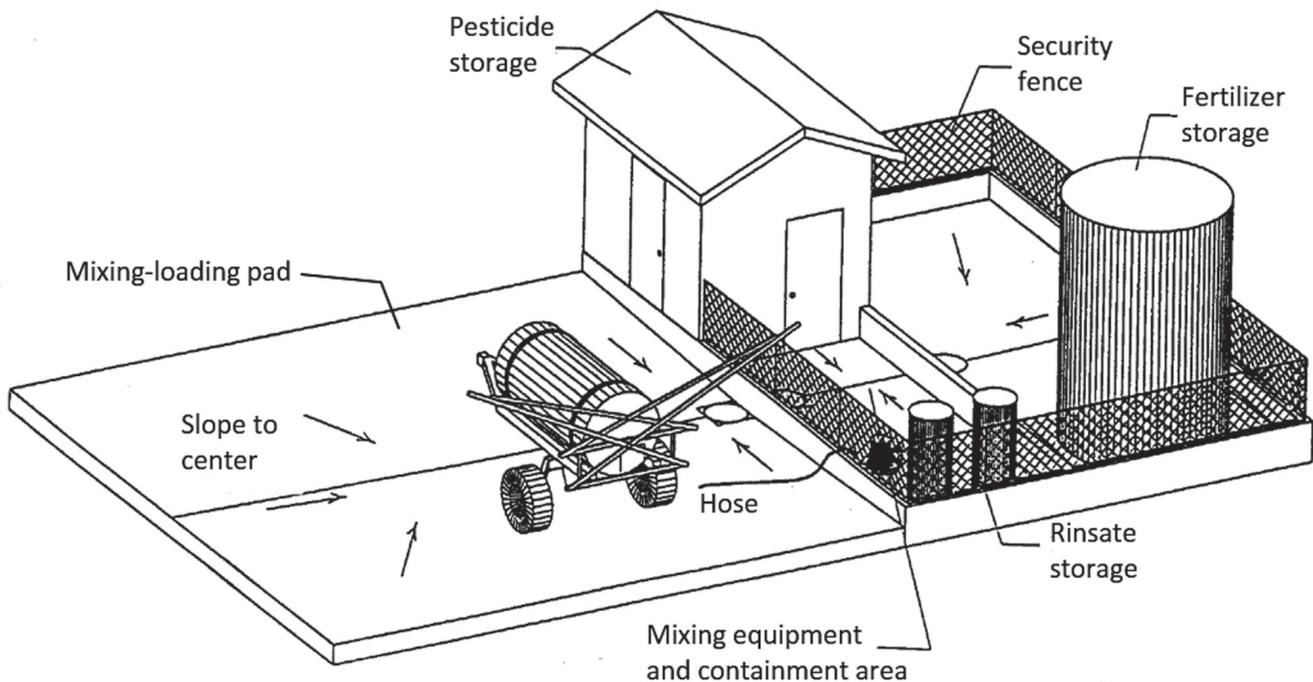


Figure 4. A load-out pad.

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 November 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 October 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://deq.ne.gov/>.

## Resources

*Are Environmental Regulations becoming a Pest?* Nebraska Department of Environmental Quality. [http://www.nda.nebraska.gov/pesticide/ndeq\\_title198.pdf](http://www.nda.nebraska.gov/pesticide/ndeq_title198.pdf).

*Fertilizer and Pesticide Containment in Nebraska*, 2004, Nebraska Department of Environmental Quality. <http://www.deq.state.ne.us/>. Search for publication title.

*Title 198: Rules And Regulations Pertaining To Agricultural Chemical Containment*, Nebraska Department of Environmental Quality. [http://deq.ne.gov/RuleAndR.nsf/Title\\_198.xsp](http://deq.ne.gov/RuleAndR.nsf/Title_198.xsp).

*A snapshot of the EPA Pesticide Container and Containment Rule*, Environmental Protection Agency, 2009. <https://www.epa.gov/pesticide-worker-safety/snapshot-epa-pesticide-container-and-containment-rule>.

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## 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 clean-up 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” (Figure 1).

- Emergency telephone numbers (see next page)
- Copies of all labels and Safety Data Sheets (SDS) 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 SDS 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

Nebraska Pesticide Applicator Certification Core Manual, 2015.  
Pesticide Environmental Stewardship, *Pesticide Spills*, <http://pesticidestewardship.org>.  
*Safe Transport, Storage, and Disposal of Pesticides*, EC2507, <http://extensionpubs.unl.edu/publication/9000016363802/safe-transport-storage-and-disposal-of-pesticides/>

### 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, and contact them when a spill occurs. Refer to the following numbers 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.

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# Respirators for Handling Pesticides

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This publication examines the types of respirators used during pesticide applications, and how to safely use, maintain, and store them.

## Why Use a Respirator?

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 a pesticide. Respirators, a type of PPE, are required when a pesticide can be harmful if inhaled.

A pesticide label may have information about Agricultural Use Requirements, indicating that the product must be used in accordance with its labeling and the Worker Protection Standard (WPS). The purpose of WPS is to reduce risks of illness or injury due to occupational exposures to pesticides. Through WPS, agricultural employers must ensure that their employees will be informed about exposure to pesticides; ensure that they will be protected from exposure to pesticides; and that employers will address pesticide exposures that employees may experience.

Under the 2015 revisions to WPS, agricultural owners/employers, their employees, and family members who use a pesticide that falls under WPS and requires the use of a respirator must follow some Occupational Safety and Health Administration (OSHA) respirator requirements, as well. Although at the time of writing this publication, the implementation date has yet to be determined, we recommend you follow these (future) WPS requirements now. You will be ready when implementation is required. In general, even those to whom WPS does not apply should consider following those requirements of having a medical evaluation, fit test, and training prior to using a respirator. These WPS

requirements address the main reasons that respirators don't provide protection: People don't use them; the respirators leak because they don't fit properly; or filters, cartridges, and canisters aren't replaced when needed. For more information, see <http://www.osha.gov> and search for "respirator."

## Types of Respirators

The product label lists the minimum type of respiratory protection required. Among other factors, this is determined by the type and toxicity of the pesticide and the application site. Respirators that provide more protection than the type listed on the label may be used. The label of the respirator will indicate that the National Institute for Occupational Safety and Health (NIOSH) has certified a particular model to meet specific standards.

Two main categories of respirators are air-purifying and atmosphere-supplying. Air-purifying respirators are more commonly used when handling pesticides. They filter the ambient (surrounding) air using filters to protect against particulates, or cartridges and canisters to protect against gases. Atmosphere-supplying respirators provide clean air to the user from a tank or compressor, and are more expensive.

Under WPS, respirators must be approved by NIOSH. This means they have had significant testing, and their safety can be ensured if used and maintained according to directions. Nuisance dust masks, such as the one-strap dust mask, are **not** considered respirators; they are **not** approved by NIOSH. One size fits all, but usually not very well and air can easily leak under the sides of the mask. They may be appropriate for use by someone while sweeping a floor. The nuisance dust mask is not suitable nor is it approved for use with pesticides, even granular or dust formulations.

## Air-purifying Respirators

OSHA states these “have filters, cartridges, or canisters that remove contaminants from the air by passing ambient (surrounding) air through the air-purifying element before it reaches the user.” Most have negative pressure; the user pulls air through the filter when he or she inhales. Air-purifying respirators have particulate filters, chemical cartridges, canisters, or a combination of these. The powered air-purifying respirator (PAPR) has positive pressure where air is filtered and supplied via a battery-operated blower. These will be discussed in more detail.

### Particulate Filtering Respirator

This type of respirator is approved for protection against dust and mists. Older pesticide labels may refer to the particulate filter mask (*Figure 1*) as a NIOSH TC-84A respirator.



Figure 1. Two models of NIOSH-approved (TC-84A) particulate filter mask respirators. Both have a metal band at the nose area for adjustment. The mask on the left has straps that are not adjustable; its shape and construction may make it difficult to form the tight seal needed for protection. The mask on the right has adjustable straps and an exhalation valve. 3M photo, © 3M 2016. All rights reserved.

NIOSH has three classes of particulate filters:

- **N**, not resistant to oil;
- **R**, resistant to oil for up to 8 hours; and
- **P**, oil-proof.

As oil is present in some pesticide products, this is an important rating for those in agriculture.

In addition, a particulate filter has an efficiency rating based on how well it protects against particles at least 0.3 microns in diameter. (A human hair has a diameter of about 50 to 70 microns, household dust is 10 microns, and a smoke particle is 2.5 microns, *Figure 2*.) Protection is needed because particles can be inhaled, and even dust particles can cause long-term (chronic) lung conditions. Filters have minimum efficiencies of 95 percent, 99 percent, and 99.97 per-

cent, listed as 95, 99, and 100 for the respirator (*Table 1*). For example, an N95 particulate mask is **not** resistant to oil (N), and will filter 95 percent of particulates 0.3 microns or larger (95). In addition to N, R, and P, some filters may be rated HE for high efficiency. This is similar to the 100 efficiency rating. The 95 filters should be appropriate for most pesticides, as most pesticide spray particles are larger than 2 microns. Always refer to the pesticide label for specific requirements.

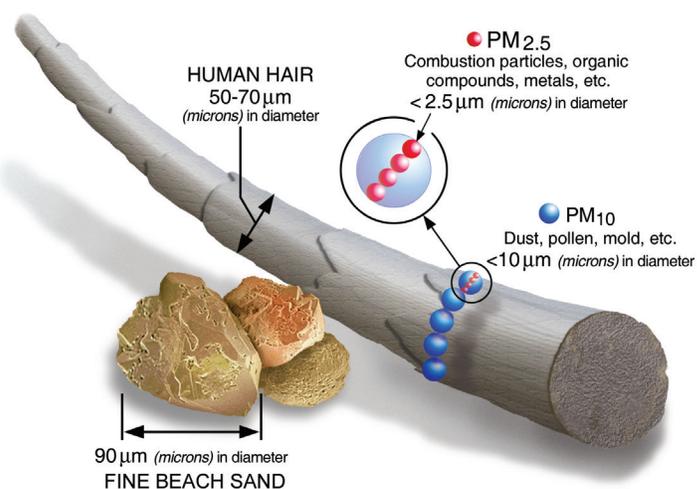


Figure 2. This chart, by the U.S. Environmental Protection Agency, shows the size of various materials in terms of microns.

**Table 1. System for naming particulate filters based on resistance to oil and efficiency at removing particulates.**

Filter class	Number and minimum efficiency		
N (Not resistant to oil)	95 (Removes 95% of 0.3 microns or larger).	99 (Removes 99% of 0.3 microns or larger)	100 (Removes 99.97% of 0.3 microns or larger)
R (Resistant to oil for up to 8 hours)	95 (Removes 95% . . .)	99 (Removes 99% . . .)	100 (Removes 99.97% . . .)
P (Oil-proof)	95 (Removes 95% . . .)	99 (Removes 99% . . .)	100 (Removes 99.97% . . .)

Several types of respirators that filter particulates are available. Particulate filtering facepiece respirators (masks) usually are made of a cloth-like filter material. An example is the two-strap particulate filter respirator (two examples shown in *Figure 1*). It can be adjusted for a better fit to protect against dust and other particulates. To increase comfort, some respirators have an exhalation valve that helps minimize the buildup of heat and humidity within the mask.

Particulate filters also are available for half-mask and full-facepiece respirators (*Figure 3*). These respirators are meant to be reused many times, and have particulate filters



Figure 3. This full-face mask respirator with pink filters provides protection against dusts, as well as eye protection. UNL photo.

Table 2. Some of the color codes for cartridges.

Color*	Offers protection against:
Pink	Dusts, welding fumes
Yellow	Organic vapors, acid gases (chlorine and other disinfectants)
Green	Ammonia (anhydrous, livestock confinement)
Black	Organic vapors (pesticides; not fumigants unless allowed on fumigant label)

\*Base choice on text on cartridge label; colors may vary with printer or computer monitor.



Figure 4. This half-mask respirator with replaceable black cartridges offers protection against organic vapors (pesticides). UNL photo.

that snap into place, are sometimes used alone, or are sometimes used with chemical cartridges.

The particulate filter respirator is appropriate to wear when applying fertilizer or lime, working with hay, harvesting, tilling dusty fields, grinding feed, or sweeping. Some granular or dust-formulated pesticides may require the use of a particulate filter respirator during mixing and application. Do **not** use a particulate filter mask when mixing or applying a liquid pesticide; a particulate filter does **not** provide protection against vapors. In addition, the mask may absorb splashes or vapors. While wearing the particulate filter respirator, if breathing becomes difficult or you taste or smell the substance, the filter is no longer effective. Typically, filters for reusable particulate filter masks are meant to be replaced when they have reached the service life listed by the manufacturer or when breathing becomes difficult—whichever comes first. Although the half-mask and full-facepiece masks are reusable, replace them if the mask loses its shape and you cannot adjust it to form a tight seal around your face.

### Chemical Cartridge Respirator

This type of respirator can be half-mask or full-face mask. They have replaceable cartridges to remove chemicals from the air; different types of cartridges protect against different materials. Cartridges are color-coded, based on the protection they offer (*Table 2*). For example, cartridges that protect against organic vapors such as pesticide vapors are black, with “organic vapors” written on the label. (Pesticides are organic compounds; they consist of carbon molecules.) A pink and black cartridge removes pesticide dusts, mists, and fine particles along with organic vapors (such as pesticides).

The half-mask respirator (*Figure 4*) covers the nose and mouth. If the pesticide label requires eye protection,

you must wear goggles or another type of eye protection in addition to the half-mask respirator. A full-face respirator protects the eyes, nose, and face.

The chemical cartridge respirator is meant to protect against light concentrations of chemicals, such as when mixing pesticides outdoors or applying a pesticide product diluted with water or another carrier. A pink pre-filter cartridge also provides protection from particulate matter. The pesticide label will state if the chemical cartridge respirator is appropriate, and the type of cartridge required. The cartridge respirator should **not** be used if the pesticide product does not have good warning properties, meaning the pesticide cannot be tasted or smelled. This is because one of the warning signs that a cartridge is spent or the respirator is not working correctly is tasting or smelling the chemical while wearing the respirator. **Do not** wear a chemical cartridge respirator in an area considered immediately dangerous to life or health. This is an area where dangerous gases can build up, creating a deadly atmosphere that can kill in seconds. Examples are a manure pit or silo with gases; a chemical cartridge respirator will **not** provide adequate protection in these situations.

### Canister Filter Respirator

Also called gas masks, these respirators are more effective for a longer time than cartridge respirators. Only full-face

canister respirators are available (Figure 5). The canister is screwed into the mask or worn on the user's belt, back, or chest. A hose or tube connects the canister to the facepiece. Canister filter respirators are **not** to be used in areas considered immediately dangerous to life or health, such as a manure pit or silo with gases.



Figure 5. Canister filter respirator with an olive cartridge, effective against organic vapors, ammonia, and acid gases. Photo courtesy of HoneywellSafety.com.

### Powered Air-purifying Respirator (PAPR)

The PAPR uses a battery-powered fan to pull ambient air through filters or cartridges, and circulates it over the user's face within a full-face mask, protective helmet, or hood (Figure 6). PAPRs may be suitable for particulate dusts and mists, or chemical gases and vapors, depending on the particulate filters or chemical cartridges used. A breathing hose connects the cartridge/filter to the mask, hood, or helmet. While the respirators discussed previously are negative pressure respirators (the user inhales, drawing in air), the PAPR is considered a positive pressure respirator because air is delivered to the wearer. The battery pack to power the fan is strapped to the user's waist or back. Batteries for PAPR range from rechargeable batteries to adapters for using 12V or 24V DC.

With the PAPR, filtered air surrounds the head area within the hood, full-face mask, or helmet. If there is a leak in the respirator, filtered air is forced out through the leak; contaminated air is not drawn in. People with health conditions that prohibit them from wearing a restrictive air mask such as a half- or full-facepiece respirator may be able to use this type. The PAPR is **not** to be worn in areas considered immediately dangerous to life or health.



Figure 6. These PAPRs with a hood (left) and full-face mask (right) have a battery pack worn at the waist. UNL, Honeywell Safety photos.

### Atmosphere-supplying Respirators

The air-purifying respirators just discussed are more commonly used when handling pesticides. The other category of respirator, atmosphere-supplying, supplies clean air directly to the user from a tank or compressor. An atmosphere-supplying respirator has positive pressure, because air is delivered to the breather. The tank may be stationary with an air hose to the respirator (supplied-air respirator), or portable and worn on the user's back, called a self-contained breathing apparatus or SCBA (Figure 7). SCBA respirators are appropriate for areas considered immediately dangerous to life or health. They are used when there is very little oxygen, such as in fire-fighting or in high concentrations of a very toxic pesticide in an enclosed area, such as during a fumigation.



Figure 7. Self-contained breathing apparatus with facemask. Photos by HoneywellSafety.com.

### Tight-fitting and Loose-fitting Respirators

Another way to classify respirators is by whether they require a seal between the respirator, face, and/or neck to provide protection. Respirators can be classified as tight-fitting or loose-fitting.

Tight-fitting respirators must have a tight seal between the respirator facemask and user's face and/or neck. Examples of tight-fitting respirators are particulate filter masks, full-face masks, and half-masks. If the seal leaks, contaminated air is pulled into the facepiece and inhaled. Facial hair such as a beard or stubble that could interfere with the respirator seal

is not permitted. Piercings, stray hair, and clothing may also interfere with the seal. For WPS, a fit test must be performed for any tight-fitting respirator at least every 12 months to make sure that the facepiece makes a tight seal. Situations such as weight gain, weight loss, or dental work that might affect the seal trigger the need for another fit test.

A loose-fitting respirator, such as a hood or helmet, does not depend on a tight seal with the face to provide protection. These are options for those who have facial hair, or those who cannot find a respirator that provides a tight seal. Loose-fitting respirators do not need to be fit tested.

## Selecting the Correct Type of Respirator

Pesticide labels state the types of respirators and cartridges/filters that are required (Figure 8). For your safety, you must use the appropriate respirator and the appropriate filter, cartridge, or canister for the product you will be handling. In some cases, one face mask will work with particulate filters and organic vapor (pesticide) cartridges. Many suppliers have detailed catalogs to help in your selection.

**PRECAUTIONARY STATEMENTS**  
 All mixers, loaders, applicators, and other handlers must wear a NIOSH-approved dust/mist filtering respirator with any R, P, or HE filter or a NIOSH-approved number prefix TC-84A.

Figure 8. This label requires a NIOSH-approved dust/mist filtering respirator with particulate filters (R, P, or HE) to be worn. A NIOSH-approved respirator with any R, P, or HE filter includes the R95 filter mask, which is a TC-84A respirator, or any half-mask or full facepiece respirator with an R, P, or HE particulate filter. The N filter (not resistant to oil) is not suitable.

## Using a Respirator

Under the WPS revisions, if WPS applies to you, before using a respirator when handling pesticides you must have a medical evaluation and then a fit test. The medical evaluation is important, because people with some medical conditions may be at risk if they work while wearing a respirator. Your employer or the owner/operator will keep a copy of the medical determination (**not** a copy of the confidential medical evaluation) for two years, stating whether you are medically able to use the respirator. The fit test ensures that the respirator is properly sized and shaped for the wearer to prevent pesticide exposure. It is to be conducted at least annually by someone properly trained. After completing the fit test, you will receive training on:

1. Why a respirator is necessary.
2. How to properly fit, use, and maintain it.
3. Known limitations and capabilities of the respirator.
4. How to use it in emergency situations.
5. How to inspect, put on, remove, check seals, and use.
6. Procedures for maintenance and storage.
7. Medical signs and symptoms that may limit or prevent effective use.

In addition to the medical determination, your employer or the owner/operator will keep records that fit testing and training were conducted annually, as well as fit test results, all for two years. Read all documentation provided with your respirator. It explains how to properly assemble, fit, maintain, and store the respirator. Rubber or plastic parts can break down, so before each use, check the respirator for cracks, abrasions, and deterioration. Check that the facepiece, valves, connecting tubes or hoses, fittings, and filters are in good condition. An inspection checklist may be helpful (Figure 9).

Respirator Inspection Checklist	
<b>Facepiece</b>	<input type="checkbox"/> No cracks, tears, or holes <input type="checkbox"/> No facemask distortion <input type="checkbox"/> No cracked or loose lenses or face shields
<b>Head straps</b>	<input type="checkbox"/> No breaks or tears <input type="checkbox"/> No broken buckles
<b>Valves</b>	<input type="checkbox"/> No residue or dirt, cracks, or tears in valve material
<b>Filters and cartridges</b>	<input type="checkbox"/> NIOSH approved <input type="checkbox"/> Gaskets seat properly <input type="checkbox"/> No cracks or dents in housing <input type="checkbox"/> Proper cartridge for hazards
<b>Air supply systems</b>	<input type="checkbox"/> Breathing-quality air is used <input type="checkbox"/> Supply hoses are in good condition <input type="checkbox"/> Hoses are properly connected <input type="checkbox"/> Settings on regulators and valves are correct

\*This checklist represents a general overview of respirator inspection requirements. Always refer to the manufacturer's user manual for more detailed information.

Figure 9. Checklist for inspecting respirators by Oregon Occupational Safety and Health Administration.

## Seal Check

Performing a seal check tells if the facepiece is positioned properly to protect you from inhalation exposure. Between removal, cleaning, and storage, the respirator may change shape and not fit the same. A good common practice is to check the seal every time you put on the respirator. Facial hair, for example, interferes with the seal. OSHA states employers “shall not permit respirators with tight-fitting facepieces to be worn by employees who have facial hair that comes between the sealing surface of the facepiece and the face.” This is a good policy to follow, even if WPS and OSHA don't apply, as it helps assure the respirator will provide protection.

Two common ways to check the seal are the positive seal check and the negative seal check. For a half-mask cartridge

respirator, 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 the seal seems tight, perform the seal check.

#### Positive Seal Check (*Figure 10, left*)

Cover the exhalation valve on the front of the respirator and gently exhale. If you can do this without feeling a rush of air around the faceplate, the seal is good. If you feel air leaking under the facepiece, reposition and repeat the check until the seal is effective.

#### Negative Seal Check (*Figure 10, right*)

Cover the inlet opening of each of the cartridges with your hands and inhale gently so the facepiece collapses. Hold your breath for about 10 seconds; if the facepiece stays collapsed, the seal is effective. If you can do this without feeling a rush of air around the faceplate, the seal is good. If the facepiece expands or air leaks under the facepiece, reposition and repeat the check until the seal is effective.



Figure 10. Positive (left) and negative (right) seal check. UNL photo.

For a disposable particulate filter mask, put on (don) the mask. Some have a piece of metal along the nose bridge. With both hands, press your fingertips on the metal band at the nosepiece. Press down while moving your fingers along the mask from your nose outward. This will mold the mask to fit your face. To check the seal (*Figure 11*), put both hands over the respirator completely and inhale sharply. You should feel the mask tighten against your face (negative pressure). If air leaks under the mask, adjust the nosepiece or straps. If you can't get a proper seal after repositioning the mask, try another style of respirator.

If the facemask has breaks or damaged portions that would prevent a good seal, replace the respirator. If you cannot get a good seal with any other respirator, use a loose-

fitting respirator or choose an alternative pesticide that does not require a respirator.



Figure 11. Seal check of a disposable particulate filter mask. UNL photo.

### Signs that a Respirator Is Not Working

The respirator is not protecting you from exposure if you:

- smell or taste contaminants;
- have eye, nose, or throat irritation;
- have difficulty breathing; or
- are nauseated or dizzy.

If the respirator is not working, get to fresh air **immediately**. Check the faceplate for breaks. You may need to replace the faceplate and/or the cartridges.

### Maintaining Your Respirator

A respirator is not meant to be shared with others. After each use, clean and store the respirator properly so it's in good condition for your next use. Follow all directions that came with your respirator regarding cleaning and maintenance. In general, the following directions will apply.

After taking off the respirator, remove the filters, cartridges, or canisters. They generally unthread, bend, or snap out of the faceplate. If the seating is damaged during removal, replace the filter. Set undamaged filters, cartridges, or canisters in the resealable plastic container where the respirator will be stored.

Next, disassemble the facepiece by removing speaking diaphragms, valve assemblies, hoses, or any components recommended by the manufacturer. Replace any defective parts.

Wash components in warm water with a mild detergent or with a cleaner recommended by the manufacturer. Use a stiff bristle (not wire) brush to help remove dirt. Then, rinse the components thoroughly in clean, warm (running) water and allow them to drain. Inspect the cleaned respirator components for any holes, damage, or wear.

When using a cleaner that does not have a disinfecting agent, immerse respirator components for 2 minutes in a solution of 2 tablespoons of laundry bleach to 1 gallon of warm water. Otherwise, you may use a commercial cleanser of equivalent disinfectant quality as directed, if recommended or approved by the manufacturer of the respirator.

After disinfecting, again rinse the components thoroughly in clean, warm, running water and drain. Thorough rinsing is extremely important, as dried detergents or disinfectants on a facepiece may irritate skin. Also, some disinfectant residues may cause rubber to deteriorate or metal parts to corrode.

Hand dry components with a clean lint-free cloth (*Figure 12*) or hang out of direct sunlight to air dry. When dry, reassemble the facepiece, replacing filters, cartridges, or canisters where necessary. Test the respirator to ensure that all components work properly.



Figure 12. Dry with a lint-free cloth.

Store the respirator in a way that preserves its shape and integrity, and protects it from contamination and extreme temperatures. Store filters, cartridges, or canisters and the respirator in the original respirator packaging (*Figure 13*) or a resealable zipper storage bag, away from pesticides. The best type of storage container has an airtight seal, as filters, cartridges, or canisters can absorb pesticides and other organic vapors when exposed to air. Mark the storage container with the purchase date of the filters, cartridges, or canisters and a running tally of the total number of hours used or keep a separate log, discussed later.



Figure 13. Store the respirator in packaging that can be sealed tightly. UNL photo.

## Replacing Your Respirator or Its Components

Proper storage helps preserve filters, cartridges, or canisters, but eventually they need to be replaced. They have a limited service life and must be replaced at proper intervals, as listed by the manufacturer. Their service life is greatly affected by:

- temperature,
- humidity,
- work of the user,
- chemical concentration,
- types of chemicals to which they are exposed, and
- extensive exposure to organic vapors over a short time span.

Many respirator manufacturers have online calculators where you can enter this information to determine service life; consult the manufacturer's website. Keep a log of respirator usage to track how long filters, cartridges, or canisters have been used. For more information and a sample log, see the university's Safe Operating Procedure "Respiratory Protection—Air Purifying Respirators Cartridge Change Schedule" at [http://ehs.unl.edu/sop/RPP\\_SOP\\_Cartridge\\_Change\\_Log.pdf](http://ehs.unl.edu/sop/RPP_SOP_Cartridge_Change_Log.pdf)

When using a respirator that filters out dusts and mists, change the filter and/or particulate filter mask when breathing becomes difficult, or if the filter is torn, damaged, or wet. In addition, replace chemical cartridges or canisters immediately if you can smell pesticide odors when using the respirator. If no time limitation is given by the manufacturer, replace the filter, cartridge, or canister after it has had 8 hours of use, even if you cannot smell or taste pesticide odors and the

filter seems in good condition. If you are unsure when a filter, cartridge, or canister was last used or if the total hours of use have not been recorded, replace it; **when in doubt, replace.** Begin and maintain a log for the new filters, cartridges, or canisters.

## Summary

Always read the pesticide label to see what type of respiratory protection is required for the product you'll be using. Have a medical evaluation to determine if you can safely wear a respirator. Use a respirator approved by the National Institute of Occupational Safety and Health (NIOSH) and have a fit test. Read and follow the manufacturer's instructions for its use and care. Filters, cartridges, and canisters must be designed for the type of contaminant expected. Conduct a seal check and inspect the respirator before every use. Clean the respirator before storing it in a sealed package, away from pesticides and direct sunlight.

## ACKNOWLEDGMENTS

The authors gratefully acknowledge Trevor Johnson, Nebraska Department of Agriculture; and Carolyn Sheridan, AgriSafe Network, for extensive reviews.

## 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 Nebraska Extension is implied for those mentioned.

## RESOURCES

3M Centers of Expertise: Worker Health and Safety Respiratory Protection at [http://www.3m.com/3M/en\\_US/safety-centers-of-expertise-us/respiratory-protection/](http://www.3m.com/3M/en_US/safety-centers-of-expertise-us/respiratory-protection/)  
AgriSafe Network. Information about WPS and respirator use at <http://www.agrisafe.org/epa-worker-protection-standard>  
Centers for Disease Control and Prevention (CDC) links to NIOSH publications and other resources at <https://www.cdc.gov/niosh/topics/respirators/>  
Occupational Safety and Health Administration (OSHA) training videos, and other resources at <https://www.osha.gov/SLTC/respiratoryprotection/>



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# Fit Testing a Respirator for Pesticide Applications

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This publication covers how to conduct a fit test for respirators used when applying pesticides. A person who performs a fit test does not need to be certified, but must know how to conduct a fit test. Practice giving a fit test until you feel comfortable with the process before conducting an actual fit test.

## Use of a Respirator

Anyone working with a pesticide must follow all personal protective equipment (PPE) requirements listed on the label. This is for safety, and also is a legal requirement for using pesticides. Pesticides that carry a risk of inhalation exposure require the use of a respirator. This may be a particulate filtering facepiece respirator (formerly known as dust/mist respirator), full- or half-face cartridge (air purifying) respirator with chemical cartridges and/or particulate filters, or self-contained breathing apparatus (SCBA).

The United States Occupational Safety and Health Administration (OSHA) is responsible for ensuring a safe workplace for employees. Related to agriculture, OSHA can conduct enforcement activities on any person engaged in a farming operation with more than 10 non-family employees, or has maintained a temporary labor camp within the preceding 12 months. These farms must follow OSHA requirements regarding the use of respirators. See the OSHA *Small Entity Compliance Guide for the Respiratory Protection Standard* (2011) at <https://www.osha.gov/Publications/3384small-entity-for-respiratory-protection-standard-rev.pdf>. This publication does not address those farms that must follow all OSHA requirements for respirators.

A pesticide label may have information about Agricul-

tural Use Requirements, indicating that the product must be used in accordance with its labeling and the Worker Protection Standard (WPS). The purpose of WPS is to reduce risks of illness or injury due to occupational exposures to pesticides. Through WPS, employers are required to ensure that their employees will be informed about exposure to pesticides, ensure that they will be protected from exposure to pesticides, and that employers will address pesticide exposures that they may experience. Under the 2015 revisions to WPS, ag owners/employers, their employees, and family members who use a pesticide that falls under WPS and requires the use of a respirator must follow some OSHA respirator requirements, as well. Although at the time of writing this publication, the implementation date has yet to be determined, we recommend you follow these (future) WPS requirements now. You will be ready when implementation is required. In general, even those to whom WPS does not apply should consider following the requirements that employees have a medical evaluation, fit test, and training prior to using a respirator. For information, see <http://www.osha.gov> and search for *respirator*.

Under the 2015 revisions to WPS, if the pesticide product label requires the handler (applicator, mixer/loader, etc.) to use a respirator, the employer must ensure the handler has:

- a medical evaluation to determine whether the handler is medically able to use a respirator;
- a follow-up visit with a physician, if deemed necessary;
- all respiratory equipment required by label for the product(s) the handler will use;

- annual training on the proper use, seal checking, care, and maintenance of the respiratory equipment; and
- annual fit testing with each respirator the handler will use.

Although the agricultural owner and immediate family members are exempt from some WPS requirements, they must follow requirements regarding the use of respirators. We recommend that anyone who uses a pesticide that requires respiratory protection have a medical evaluation, fit test, and training before using a respirator.

### What Is a Fit Test?

A respirator must form an adequate seal with the wearer's face to protect against inhaling materials that could cause harm; the fit test determines whether the respirator fits properly to form that seal. OSHA recognizes two main types of fit testing, quantitative and qualitative. The quantitative fit test measures the amount or quantity of solution that penetrates the face mask. This type of fit test requires specialized equipment (*Figure 1*) for analysis, and will not be covered in this publication.



Figure 1. Equipment used for a quantitative fit test. UNL Photo.

The qualitative fit test determines if the respirator fits properly by testing if the person wearing the respirator can detect a taste or an odor. This publication will focus on a qualitative fit test for a person (called the subject) wearing a respirator.

### Why Have a Fit Test?

Fit tests are not required for loose-fitting respirators, such as hoods, helmets, and loose-fitting facepieces because a tight seal is not needed for the equipment to protect the user. Fit tests are required for respirators with tight-fitting facepieces.

These include disposable particulate filter masks, half-masks, and full-face masks. These also include face masks used with a powered or air-fed respirator. As discussed earlier, a fit test may be required by WPS. Even if not required, we recommend that a fit test be performed when a tight-fitting respirator is used to ensure that a proper seal can be formed. We also recommend that even if not required, the subject have a medical evaluation prior to the fit test, to ensure that the person is physically able to use a respirator. A person with certain health problems or medical conditions could be injured due to the stress a respirator can cause. The person giving the fit test must be knowledgeable about fit tests.

### When Should a Fit Test Be Conducted?

A fit test should be done before using a respirator, and whenever the person uses a different size, style, model or make. According to the revised WPS, a fit test must be conducted annually for each type of respirator used. Also, it must be conducted when the wearer loses or gains weight, or has a change that would affect how the respirator fits. Examples of such changes include facial surgery, facial scarring, or extensive dental work. Even if not required, this is a good strategy to follow.

### Equipment Needed for Qualitative Fit Test

The fit test must be conducted with the model of the respirator that the subject will use. Refer to the pesticide labels of all products the subject will use to find out the type of respirator(s) required, and information that comes with the respirator(s) for appropriate uses. A number of models are available to fit the many shapes of heads and faces.

Equipment required to perform a fit test includes the following (those in *italics* can be purchased as a kit):

- a hood;
- at least 3 hand-operated *nebulizers* (*Figure 2*), labeled for the sensitivity test, the fit test, and a spare if any become clogged;
- *solutions (see below) for the sensitivity and fit tests;*
- equipment for mixing and measuring ml, (volume) and mg (weight) if preparing solutions;
- a table to place the equipment;
- the respirator(s) to be tested;
- a mirror so the subject can see and adjust the respirator;
- a fit test record form (sample provided on page 10);



Figure 2. A nebulizer converts solution from liquid to a mist as it is sprayed into a hood. UNL photo.



Figure 3. This full-face mask respirator has a particulate filter, suitable for the qualitative fit test using Bitrex or saccharin. UNL Photo.

- a pen;
- a watch or device that shows seconds;
- disposable wipes;
- a prompting list of exercises the subject must perform while wearing the respirator and hood;
- the Rainbow Passage (bottom of page 10); and
- a closeable jug of water and drinking glasses.

Choices of solution include saccharin (sweet), Bitrex® (bitter), or isoamyl acetate (IAA, banana oil). Fit tests using Bitrex or saccharin use a hood; tests using IAA require a chamber, such as a 55-gallon drum liner. Because of the chamber, and because IAA breaks down quickly so solutions must be replaced frequently, most people use the sweet and bitter fit test methods. The IAA method will not be described in this publication. Another fit test method uses irritant smoke. The Safety Data Sheet for this testing material says, “The smoke can be irritating to the eyes, lungs, and nasal passages. The test conductor shall take precautions to minimize the test subject’s exposure to irritant smoke. Sensitivity varies, and certain individuals may respond to a greater degree to irritant smoke.” Because of the potential for a reaction, and the need for good ventilation in the test area, the irritant smoke method is not described in this publication. For more information on fit tests using IAA or irritant smoke, see <http://www.OSHA.gov> and enter *fit test* in the search box.

All qualitative fit tests using Bitrex or saccharin solutions must be conducted with particulate filters (or cartridges with particulate filters, *Figure 3*) on the respirator. Once the test is over, use the appropriate filter for the protection needed—particulate filter, organic cartridge, etc. The IAA solution is not effective with particulate filters; it is used only to test respirators with organic vapor cartridges.

Make a card with the Rainbow Passage for the subject to read, as the fit test includes speaking while wearing the respirator. Fit test kits with the hood, nebulizers, and pre-mixed solutions are available from companies such as 3M, Honeywell Safety, Grainger, Gemplers, and others. The pre-mixed solutions save time because you don’t have to measure ingredients to make the correct concentrations. Find these kits through an online search for *Respirator Fit Test Kit*.

Conduct the fit test in a room with good ventilation, and have a separate room or area for people waiting to be tested. Allow about 30 minutes for each fit test. In reality, each test will take from 20 to 40 minutes; the longer time is needed if the respirator doesn’t fit properly and another has to be selected and tested. Subjects should not eat or drink anything other than water for 15 minutes before the taste sensitivity screening and fit test. Otherwise, they may not be able to taste the solution, or tastes in the mouth could be confused with the testing solution.

### General Overview of Fit Testing

1. Give the subject an overview of what will happen during the fit test using a saccharin or Bitrex solution. Explain that the fit test is to make sure the respirator is the right size and shape for the subject. If it doesn’t fit correctly, it will not protect the subject from inhaling pesticides while on the job.
2. Determine that the subject can detect the solution (saccharin or Bitrex) with a sensitivity test. If the subject can’t detect a particular solution, the fit test would be a waste of time. The subject will wear the hood without a respirator during the sensitivity test. You will be squeezing a sensitivity test solution spray into the hood to see if/when the subject can taste it.

3. After the sensitivity test determines that the subject can detect the solution, the subject will don (put on) the respirator with the particulate filter(s), adjust so it is comfortable, don any other PPE, such as eye protection, that will be worn that might affect use, and perform a seal check. This is a simple initial check to see that the respirator is positioned correctly. It is not a substitute for a fit test. If the subject cannot get a good seal, even after adjusting the respirator, have him/her select another respirator and conduct the seal check.
4. After the seal check shows that the subject has positioned the face mask properly, you will perform the fit test. The subject will don the fit test hood while wearing the respirator and any other PPE. Using the nebulizer, you will squeeze the fit test solution into the hood through the hole, and ask the subject to do some specific movements similar to what might occur during work (normal breathing, deep breathing, turning head from side to side, bending over, etc.), and read a paragraph. The subject will tell if/when s/he can taste the solution.
5. If the subject can taste the solution, choose another respirator and conduct the seal check and fit test again.
6. If the subject does not detect the solution, the test is over and the respirator is suitable. The fit test must be performed for each respirator the subject will be using.

### Procedure for Sensitivity Test

First, find out if the subject can detect saccharin or Bitrex, and at what level (taste threshold) with a sensitivity test. Do this without the respirator. Subjects should not eat or drink anything besides water for 15 minutes prior to the test, as they may be unable to taste the solution, or tastes in the mouth could be confused with the testing solution.

We recommend doing sensitivity and fit tests with premixed solutions that are ready to use (Figure 4). Some kits may have the chemicals, but require you to make the solutions. The sensitivity test solution is much weaker than the fit test solution. Test kits with premixed solutions will have one marked as “Sensitivity Solution.” If yours aren’t marked, do so by marking the sensitivity solution and one nebulizer as “Sensitivity” to distinguish them from the fit test solution and the fit test nebulizer. Fill the sensitivity nebulizer with the sensitivity test solution. About 1 teaspoon of solution will be enough to test 10 people.

During a taste sensitivity test, as well as during fit testing, the subject wears an enclosure such as a hood (Figure 5) over the head and shoulders. It is about 12 inches in diameter and 14 inches tall, with at least the front portion clear. The hood must allow the subject to freely move his/her head while



Figure 4. Solutions are available that require no measuring for sensitivity or fit testing. UNL Photo.

wearing a respirator. The hood has a 3/4-inch hole that will be in front of the subject’s nose and mouth area. The nebulizer nozzle is inserted through the hole to spray solution into the hood.



Figure 5. A hood used for a fit test. UNL photo.

The following procedure uses saccharin to detect a sweet taste. As another option, use Bitrex to detect a bitter taste. The subject dons the hood without wearing the respirator. Throughout the sensitivity test, the subject breathes through his/her slightly open mouth with an extended tongue. Tell the subject to report when he/she detects a sweet taste. When the subject reports tasting the solution, ask the subject to remember that taste as a reference during the fit test.

Use the sensitivity nebulizer to spray the sensitivity solution into the hood, with about 1 ml of the liquid in the nebulizer body at a time. Direct the nozzle away from the nose and mouth of the subject. To produce fine droplets (the aerosol), firmly squeeze the nebulizer bulb so that it collapses completely, then release and allow it to fully expand.

Repeat 10 squeezes rapidly and then ask the subject whether s/he can taste the saccharin. If the subject reports tasting sweetness during those 10 squeezes, the screening test is completed. Circle 10 squeezes on the Fit Test Record; the taste threshold is 10 regardless of the number of squeezes actually completed.

If the subject doesn't detect a sweet taste, squeeze the nebulizer rapidly 10 more times and again ask if the subject tastes the saccharin. If the subject reports tasting sweetness during the second set of 10 squeezes, the screening test is completed. Circle 20 squeezes on the Fit Test Record; the taste threshold is 20 regardless of the number of squeezes actually completed.

If the subject still doesn't detect a sweet taste, squeeze the nebulizer rapidly 10 more times. Ask the subject for a third time if the saccharin is tasted. If the subject reports tasting sweetness during the third set of 10 squeezes, the sensitivity test is completed. Circle 30 squeezes on the Fit Test Record; the taste threshold is 30 regardless of the number of squeezes actually completed.

If the saccharin is not tasted after 30 squeezes, the subject cannot taste saccharin and may not perform the saccharin fit test. Use another solution, such as Bitrex.

Keep the nebulizer clean; thoroughly rinse it with water, and shake dry prior to refilling with solution at least each morning and afternoon, or every 4 hours.

## Selecting a Respirator

Provide enough respirators so subjects can choose an acceptable model that fits correctly. Another option is to have subjects bring respirator(s) to be tested. Be sure they understand that they must be tested with the type of respirator(s) required by the pesticide label(s). In addition, they should understand that the particular size, model, or style of respirator(s) they brought with them may fail the fit test, and would not provide protection.

Once they choose a respirator, show them how to don it, position it on their face, set the strap tension, and make sure the fit is acceptable. This process is considered a review, *not* the required formal training. If subjects are not familiar with using a particular respirator, have them put it on and take it off several times so they can make the needed adjustments for a good fit.

Have a mirror for subjects to use when evaluating the position and fit (*Figure 6*). Have the subject look in the mirror as you check the following. They will be able to do this on their own in the future.

- Proper chin placement
- Adequate strap tension, not too tight
- Good fit across nose bridge
- Respirator of proper size to span distance from nose to chin
- Tendency of respirator to slip
- Room for eye protection, if needed
- Ability to talk



Figure 6. Have a mirror so the subject can see and learn about proper placement of the respirator. UNL photo.

Have the subject seat the mask by moving his/her head from side to side and up and down slowly while taking a few deep breaths. The subject should wear the respirator for at least 5 minutes to ensure it is comfortable. Then, have the subject do a seal check (see next section).

## Perform a Seal Check with a Respirator

Whenever a respirator is to be worn, including for the fit test, the wearer should perform a seal check. This helps determine if the respirator has a tight seal or needs some adjustment. The subject should don any other equipment that is required, such as safety goggles or other eye protection. The wearer should put on prescription eyeglasses if needed, as some frames may prevent a good seal. The wearer must be clean shaven so the seal is not compromised. A beard, beard stubble, mustache, stray hairs, or even a low hairline could prevent the mask from making tight contact with the skin. This would allow unfiltered air to be inhaled. Do not conduct the fit test if the subject has any hair, including facial hair, between the skin and respirator (*Figure 7*). They must alter or remove any clothing or items that interfere with the seal.



Figure 7. Hair between the face mask and skin will prevent a proper seal. UNL photo.

The subject should place the respirator on his/her face, then pull the top (halo-shaped in some models) plastic strap and adjust it over and on top of the head. Next, connect the straps that go behind the neck, and pull the loose ends of the straps to adjust for comfort and fit. When the subject feels s/he has a tight seal, perform a seal check. Although only one is required, performing both the positive and negative seal check may be valuable training for the subject. The manufacturer of the respirator may have a recommended check method; this is also acceptable.

### *Positive Seal Check*

To perform the positive seal check (*Figure 8*), the subject should cover the exhalation valve in front of the respirator and gently exhale. If the subject can do this without feeling a rush of air around the faceplate (sometimes called the face seal), s/he has a good seal.



Figure 8. Positive seal check. UNL photo.

### *Negative Seal Check*

To perform the negative seal check (*Figure 9*), the subject covers the intake portion of each of the two cartridges with his/her hands and inhales gently. The subject can do this test without cartridges by simply covering the intake holes. If the seal is good, the subject should not be able to pull any air through the faceplate against his/her face.



Figure 9. Negative seal check. UNL photo.

If either the positive or negative check shows the seal is not good, check carefully around the faceplate for damages or obstructions. If the faceplate has breaks or damaged portions, replace the respirator. If the subject can clear obstructions and make additional adjustments to strengthen the faceplate, simply recheck the unit. In some cases, replace the respirator faceplate or the entire unit.

For a disposable particulate filter mask, don the mask. Some have a piece of metal along the nose bridge. Check the manufacturer's instructions for correct donning of a specific mask. In general, with both hands, press your fingertips on the metal band at the nosepiece. Press down while moving your fingers along the mask from your nose outward (*Figure 10*). This will mold the mask to fit your face.



Figure 10. Even disposable filter masks must be adjusted for a proper seal. UNL photo.

To check the seal (*Figure 11*), put both hands over the respirator completely and inhale sharply. You should feel the mask tighten against your face (negative pressure). If air leaks under the mask, adjust the nosepiece or straps. If you can't get a proper seal after repositioning the mask, try another style of respirator.



Figure 11. Seal check of a disposable particulate filter mask. UNL photo.

## Procedure for the Saccharin Solution Fit Test

The subject must wear the selected respirator and whatever s/he would normally wear with the respirator that could interfere with the fit, such as eye protection or eyeglasses, for 5 minutes before the fit test. This is to make sure the respirator is comfortable. If the respirator is adjusted at any time during the fit test, you must start over. If you have to stop to unplug and wash a nebulizer, you must start over (that's why we suggest having a spare ready). If the fit test was paused, the concentration of the test solution in the hood might decrease, giving inaccurate results.

Some kits have the fit test solution already prepared. If you wish to mix your own saccharin sensitivity and fit test solutions, directions are available at <http://www.OSHA.gov>; search for *saccharin solution*. Look at the records to determine the number of squeezes used for the sensitivity test. The numbers will be 10, 20, or 30.

After successfully performing a seal check with the respirator and particulate filter(s) and wearing the respirator for at least 5 minutes, the subject dons the hood. Instruct the subject as before, to breathe through the slightly open mouth with tongue extended, and report if he/she tastes the sweet taste of saccharin.

Insert the nebulizer into the hole in the front of the hood and spray the saccharin fit test solution into the hood. Use the same number of squeezes (10, 20, or 30) that caused a taste response in the sensitivity test. This was circled on the Fit Test Record.

After spraying the solution, instruct the subject to perform the following exercises, each for 1 minute. Tell the subject to report if she/he tastes saccharin.

Every 30 seconds, you must replenish the aerosol concentration using one-half the original number of squeezes used initially (e.g., 5, 10, or 15).

1. Normal breathing. Ask the subject to stand in a normal standing position, and breathe normally without talking.
2. Deep breathing. Ask the subject to breathe slowly and deeply while still in a normal standing position, being careful not to hyperventilate.
3. Turn head side to side. Ask the subject to stand in place, and slowly turn his/her head from side to side and pause to inhale at each side.
4. Move head up and down. Ask the subject to stand in place and slowly move his/her head up and down. Inhale when looking toward the ceiling.
5. Talk. Ask the subject to speak slowly and loud enough so you can hear clearly. The subject can read from a prepared text such as the Rainbow Passage (below),

count backward from 100, or recite a memorized poem or song for 1 minute (Figure 12). Some people may have to be prompted to continue to talk.



Figure 12. The subject reads a passage while wearing the respirator and hood. In a work setting, the applicator may have to speak to someone while making an application, so it is important that the respirator has a tight seal when the applicator's mouth is moving. UNL photo.

**Rainbow Passage:** When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

6. Bend over. Ask the subject to bend at the waist as if he/she were going to touch his/her toes (Figure 13).



Figure 13. The subject should hold the bottom of the hood against his/her body while bending. UNL photo.

7. Normal breathing. End with normal breathing in standing position.

During the fit test: every 30 seconds, replenish the aerosol concentration with one-half the original number of squeezes used initially (e.g., 5, 10 or 15).

If the subject does not report tasting the saccharin after these seven exercises, the respirator fits and the test is completed.

If the subject tastes saccharin, the fit is unsatisfactory and the test failed. Select a different respirator, then go through the sensitivity test and fit testing again. At least 5 minutes must pass between taste screenings and fit testing so that odor sensitivity returns (the subject can detect the saccharin taste).

The nebulizer could clog during use, so make periodic checks of the nebulizer to ensure that it is working. If clogging is found at the end of the test session, the test is invalid. If you have to stop to unclog and wash the nebulizer, you will have to start the fit test over. Have another nebulizer handy in case of clogs.

After each fit test, clean the inside of the hood with a disposable wipe.

### Procedure for the Bitrex Aerosol Fit Test

Bitrex is a taste aversion agent—it has a very bitter taste. Manufacturers add it to household liquids that children should not drink. Bitrex is endorsed by the American Medical Association, the National Safety Council, and the American Association of Poison Control Centers. Follow the same procedure as for the Saccharin Aerosol Fit Test, except use Bitrex. You can purchase a kit with the solutions premixed and ready to use. If you wish to mix your own Bitrex sensitivity and fit test solutions, directions are available at <http://www.OSHA.gov>; search for *Bitrex solution*.

Follow the same procedures as for saccharin sensitivity and fit testing, using the appropriate Bitrex solutions.

### When the Subject/Respirator Passes the Fit Test

Once all required respirators have been selected and passed the fit test, the subject must have training that covers:

1. Why the respirator is necessary;
2. How improper fit, usage, or maintenance can compromise the respirator;
3. The limitations and capabilities of the respirator;
4. How to use the respirator effectively in emergency situations, such as when the respirator malfunctions;

5. How to inspect, don, remove, use, and check the seals of the respirator;
6. How to maintain and store the respirator; and
7. Medical signs and symptoms of the wearer that may limit or prevent the effective use of respirators.

The subject should always conduct a seal test after donning a respirator. Training and the fit test must be conducted once a year; fit testing is required more often if the subject has a change in weight, dental work, or anything that might affect the seal; and if there is a change in the make, model, style, or size of the respirator facepiece. The fit test record must be kept on file for 2 years from the date it was conducted.

### After the Fit Test

After each fit test, wipe the hood with a disposable wipe. Clean the equipment properly at the end of a session of fit tests. Thoroughly clean and rinse the nebulizers after use. Dry them with a fabric or paper towel. Clean the hood with a cloth dampened with mild soapy water, and rinse with clean water. You also may use a cloth dampened with water containing a small amount of mild disinfectant, but make sure to rinse thoroughly. Use a fabric or paper towel to dry the inside of the hood.

Discard unused solution; do not pour it back into bottles of stock solution. Make sure that caps on the bottles are tight, to prevent leaks. Saccharin crystals may form on the neck of the bottle if the cap is not tight.

## Summary

Respirators provide protection only if they are in good condition, appropriate for the work, and fit the subject. The fit test is important to determine whether the respirator can provide protection. It may be required by the Worker Protection Standard, but is recommended for anyone who wears a respirator.

### 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 Nebraska Extension is implied for those mentioned.

### ACKNOWLEDGMENT

The authors gratefully acknowledge Robin Tutor, North Carolina Agromedicine Institute; and Carolyn Sheridan, Founder of Ag Health and Safety Alliance, for reviewing this publication.

### RESOURCES

Centers for Disease Control and Prevention (CDC) links to NIOSH publications and other resources at <https://www.cdc.gov/niosh/topics/respirators/>

Environmental Protection Agency (EPA), *How to Comply with the 2015 Revised Worker Protection Standard for Agricultural Pesticides. What Owners and Employers Need to Know* at <https://www.epa.gov/sites/production/files/2016-10/documents/htcmanual-oct16.pdf>

Occupational Safety and Health Administration (OSHA) training videos, and other resources at <https://www.osha.gov/SLTC/respiratoryprotection/>



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## Fit Test Record

Date:

Employee name:

Job/Classification:

Farm/Company:

Fit test method (*Circle one*):

Qualitative saccharin

Qualitative Bitrex

Qualitative IAA

(for either of these, the respirator  
must have particulate filters)

(respirator must have  
organic vapor cartridges)

Sensitivity Test Results to Determine Taste Threshold (*Circle one*):

10 squeezes

20 squeezes

30 squeezes

½ to be administered every 30 seconds during Fit Test Exercises (*Circle one*):

5 squeezes

10 squeezes

15 squeezes

Type of respirator	Make/model/size (Must include all three)	Fit factor/results (Circle one)	
		Pass	Fail

Person conducting the fit test:

Problems the employee encountered with respirator:

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### Fit Test Exercises

- (1) Normal breathing. Stand and breathe normally without talking for 1 minute.
  - (2) Deep breathing. In a normal standing position, breathe slowly and deeply 1 minute, being careful not to hyperventilate.
  - (3) Turn head side to side for 1 minute. Stand in place, and slowly turn your head from side to side and pause to inhale at each side.
  - (4) Move head up and down for 1 minute. Stand in place and slowly move your head up and down. Inhale in the up position (when looking toward the ceiling).
  - (5) Talk. Speak slowly and loud enough so the test person can hear you. Read the following:  
**Rainbow Passage:** When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.
  - (6) Bend over for 1 minute. Bend at the waist as if you were going to touch your toes.
  - (7) Normal breathing. End with normal breathing in standing position for 1 minute.
- If you ever taste the sweetness or bitterness, signal the test person.



## Protecting Pesticide Sensitive Crops

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*Sensitive crops are becoming more common in the landscape. Examples include grapes in vineyards, and fruits, vegetables, and ornamental crops grown on organic or traditional commercial farms. Consumer demand has created markets for these products, and sales of these crops have contributed to Nebraska's agricultural economic diversity. Any agricultural crop can be damaged by pesticide drift. However, these crops are especially sensitive to injury by pesticides, and 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. Because of the high value and sensitivity of these crops, it is essential for pesticide applicators to be aware of their surroundings and use any and all appropriate safety measures before, during, and after each application.*

### Use Pesticides Carefully

When applying pesticides, take extra precautions to avoid damaging nearby sensitive crops. Many plants are sensitive to pesticides and may be harmed by particle drift, vapor drift, or pesticides that run off targeted areas.

Crops with glyphosate- and dicamba-resistant

technologies continue to pervade the market, with other herbicide-resistant crop technologies on the horizon. As this occurs, these herbicides are increasingly relied upon for weed control. Hormonal-type herbicides like 2,4-D and dicamba can cause significant damage to nontarget plants including grapes, organics, nondicamba-resistant soybeans, and trees. Product-specific label requirements such as buffer zones, specific weather conditions at time of application, and equipment settings are good indications that a pesticide is susceptible to drift or runoff. However, it's important to realize that **any** pesticide has the potential to move off-site and cause injury.

### Be Proactive

The nonprofit company FieldWatch, Inc., cooperates with the Nebraska Department of Agriculture (NDA) to maintain three online registries that enable improved communication and stewardship among commercial sensitive crop growers, beekeepers, and pesticide applicators. Commercial growers of sensitive crops are encouraged to register locations of their crops on **DriftWatch™**; beekeepers are encouraged to register locations of their hives

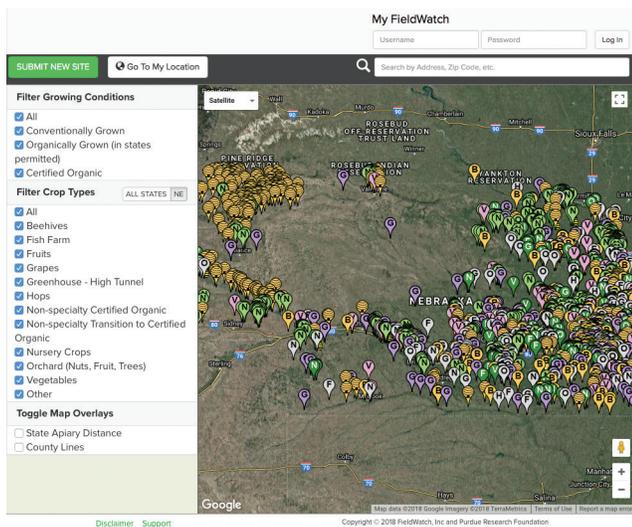


Figure 1. FieldWatch, DriftWatch, and BeeCheck allow for increased communication between pesticide applicators and commercial specialty crop growers and beekeepers.

on **BeeCheck™**; pesticide applicators are encouraged to register on **FieldWatch®** and use it to determine if sensitive crops or beehives 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 FieldWatch and document known 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 before the planned pesticide application to become familiar with the landscape. **Listings on DriftWatch and BeeCheck are voluntary, so the registries may not list all sensitive crop or hive locations.** Pesticide applicators and dealers should visit with neighbors who may have sensitive crops or beehives to let them know of intended pesticide applications and assure them that every effort will be made to avoid off-target injury. This NebGuide focuses on protecting sensitive crops. For more details about protecting bees from pesticides, see *Bee Aware: Protecting Pollinators from Pesticides* (EC301).

FieldWatch allows applicators 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 outline a geographic area.

These registries rely on proactive growers and applicators to be effective. Growers should update or submit new information 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 avoid pesticide injury problems.

All three registries can be found at <http://www.fieldwatch.com>

## 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, and biological controls. Prior to the field season, consider crop rotation and selecting herbicide- and/or insect-resistant varieties. By incorporating a variety of management techniques, you reduce your reliance on chemical controls (pesticides). This, in turn, reduces the risk of injuring off-target plants.

**Select an appropriate pesticide product.** If using a chemical, read product labels to find one suitable for the pest you want to control. Consider the toxicity and potential hazard of the product; 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.** Remember that the pesticide label is the law. Read and follow all directions and precautions. Apply pesticides only on sites (crops, pastures, or other areas) listed on the label. Applying a pesticide to a site not listed on the label is illegal. Do not exceed the rate specified on the pesticide label; using 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 have instructions to avoid drift. Some labels include buffer or set-back zones to protect specialty crops and sensitive areas. Additionally, there may be information regarding droplet size, nozzle selection, and maximum wind speeds to avoid drift. Restrictions or requirements are often added to labels over time as new information becomes available. Read the label when planning every application. For more details about the pesticide label, see *Understanding the Pesticide Label* (NebGuide G1955).

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

- Are any sensitive or desirable plants nearby?

- Are any streams, ponds, ditches, drainage areas, or other open-water sites 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 several days?
- Are 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 when conditions may increase drift or runoff. Factors to consider include wind speed and direction, and soil type and saturation. Stop applying if the weather becomes too windy or if the product starts to run off the target area. You can also reduce off-target 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.

**Clean equipment thoroughly after applying any herbicide.** Herbicide residue in spray equipment can damage sensitive crops during future pesticide applications. Always clean tanks, nozzles, and other equipment thoroughly after applying herbicides. In the case of some herbicides, this may be done by adding one-half tank of water, then flushing all parts of the tank for five minutes through both agitation and spraying. Other herbicides may require more exhaustive cleaning procedures, such as triple-rinsing. Always check the label for product-specific sprayer cleanout directions. Always spray rinsate on an appropriate site.

If several pieces of spray application equipment are available, dedicate one to growth regulator herbicides or one to the specific crop to be treated. If not, extra careful cleaning following each application of a growth regulator is necessary to avoid subsequent crop damage. Mixing two quarts of ammonia for every 50 gallons of water 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. For more details about cleaning pesticide application equipment, see *Cleaning Pesticide Application 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 pesticide 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. Some companies can help 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 Information" at the end of 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 storage structure 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-Target

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

Spray drift can be reduced by doing the following:

- Spray when wind speeds are between 3 and 10 mph.
- Avoid applying pesticides when there is a temperature inversion. An inversion occurs when cool, calm air is 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 the largest label-recommended droplet size for the product being applied.
- Use a rate controller to spray at the lower end of the suggested pressure range for a given spray nozzle.

- Adjust the height of the boom so it is as close to the target as possible while maintaining effective spray coverage.
- Use a drift-reducing adjuvant approved for use with the product being applied.

For more details about pesticide drift and how to prevent it, see *Spray Drift of Pesticides* (NebGuide G1773).

**Vapor Drift.** After a pesticide is applied, the product may volatilize from the application site and move in an unpredictable manner, affecting off-site plants or animals. 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.

Volatilization can be reduced by doing the following:

- Switch to a less volatile formulation. For example, 2,4-D *amine* is less volatile than 2,4-D *ester*; 2,4-D *choline* is less volatile than both the *amine* and *ester* forms.
  - Some newer, less volatile formulations are on the market. Pesticide manufacturers continue to develop other low-volatility formulations.
- 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 pesticide 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).

### Herbicide Injury

Any herbicide has the potential to injure unintended plants through particle drift, vapor drift, or runoff. In general, the amount and type of injury is dependent on the amount of drift/runoff that occurs as well as the species of crop in the area affected by off-target movement.

Off-target damage can lead to strained relationships between neighbors and/or result in significant financial losses for those whose sensitive crops are affected. In some cases, the full extent of these losses may not be known for several years. Communication is key. As Nebraska's agricultural economy continues to diversify, it becomes more important to recognize specialty crops as a key source of income for many growers.

**Non-GMO Soybeans.** Despite the continued influx of soybeans equipped with herbicide-resistant technology, producers should be mindful of conventional soybean varieties grown in their area. Drift damage on non-GMO soybeans can be devastating. When planning applications, never make assumptions about which bean varieties neighbors have chosen to plant.



Figure 2. Soybean leaves showing signs of dicamba injury (Amit Jhala, University of Nebraska-Lincoln).

**Organic Crops.** Organic producers adhere to stringent USDA standards in order for their crops to be labeled “Certified Organic.” This requires careful, long-term planning and alternative inputs, offset by increased market value of their certified product. By regulation, crops grown organically cannot be equipped with genetic engineering, such as herbicide-resistance traits. In addition, land used for organic production must be free of prohibited material (including synthetic pesticides and fertilizers) for at least 3 years prior to harvest. Pesticide drift can not only damage these vulnerable crops, it can cause a grower to lose their organic certification, which can cost them years of income from the organic market. (Personal communication: Gary Lesoing, Nebraska Extension Educator)



Figure 3. The USDA Organic Seal may be used only for certified organic agricultural products.

**Trees.** Trees are valued for many reasons in Nebraska. They form windbreaks, produce fruit and nuts, and serve as ornamentals, to name a few. There are well over 3 million acres of trees in the state. Trees sold as nursery stock can take several years to reach saleable sizes, and, in Nebraska, hold an average value of more than \$100 per tree (USDA National Agricultural Statistics Service). Many hold a value much higher. A significant number of trees are inadvertently exposed to herbicides due to drift and root uptake. While injury may sometimes seem minor or superficial, it can easily render nursery stock unsuitable for sale. Repeated exposure over several years can take a heavy toll on the life of a tree. For more information from the Nebraska Forest Service, visit <https://nfs.unl.edu/publications/herbicide-damage-trees>.



Figure 4. A bur oak tree in a nursery with abnormal growth after suspected herbicide drift injury. Note the branch (center, upper left) that has dramatically altered its growing angle. The tree is likely unsaleable (UNL photo).

**Grapes.** Grape production has flourished in Nebraska since the 1990s and the state has developed a reputation for its viticulture and high-quality wine production. Grapes have an annual fruit value of \$4,000 to \$5,000 per acre. When a vineyard's grapes are processed, that value can be up to 10 times higher. Acreage continues to be converted for commercial grape production across the state. Grapevines are sensitive to many herbicides, most notably growth regulators, which can injure vines at a small fraction of labeled rates. (Personal communication: Stephen Gamet, Nebraska Viticulture Research Technologist)

**Hops.** The craft beer industry has experienced dramatic growth in the past decade. With this growth has come increased interest among Nebraska brewers in using locally sourced ingredients, such as hops, in their beers. Depending on the variety and post-harvest processing, hops have an annual value of \$15,000 to \$22,000 per acre. Acreage devoted to hop production in Nebraska has steadily increased



Figure 5. A young grape shoot injured by 2,4-D (Bruce Bordelon, Purdue University).

in recent years. Hops are sensitive to a variety of herbicides including glyphosate and growth regulators; they are made even more vulnerable to drift by their 18-foot growing height. (Personal communication: Katie Kreuser, Nebraska Hops Program Coordinator)

### Reporting Pesticide Violations or Incidents

Applicators and producers alike should be prepared to report pesticide violations or incidents. If you are aware of a pesticide violation, or are concerned about a possible violation, contact NDA as soon as possible at 402-471-2351. NDA can help you determine what actions to take, such as photographing perceived damage and carefully keeping records of your observations. Depending on the circumstances, you may wish to submit a formal complaint.

Not all pesticide incidents necessarily result in violations of local, state, or federal pesticide laws. It is possible for pesticides to adversely affect humans, animals, plants, and the environment, even when the label is followed to the letter. In any case, consider reporting incidents to the product's manufacturer. The manufacturer is required by law to submit reports of adverse effects to the EPA.

### Summary

Making effective pesticide applications with low drift potential takes careful planning. This is extremely important for protecting sensitive crops and beehives. Follow pesticide labels, check application equipment, and be aware of environmental conditions to make sure the products are applied where they are intended and have maximum effectiveness.

## Additional Information

### Nebraska Extension Publications

<http://extensionpubs.unl.edu/>

- *Spray Drift of Pesticides*, G1773
- *Nozzles-Selection and Sizing*, EC141
- *How to Spray a Field to Prevent Overlap and Reduce Drift Injury*, G1570
- *Cleaning Pesticide Application Equipment*, G1770
- *Guide for Weed, Disease, and Insect Management in Nebraska*, EC130
- *Protecting Surface Water Quality*, EC730
- *Bee Aware: Protecting Pollinators from Pesticides*, EC301
- *Safe Transport, Storage, and Disposal of Pesticides*, EC2507
- *Understanding the Pesticide Label*, G1955

### Nebraska Extension Pesticide Safety Education Program

- Pesticide Container Recycling: <https://pested.unl.edu/recycling>
- Pesticide Disposal: <https://pested.unl.edu/disposal>

### NDA's Pesticide Program:

<https://www.nda.nebraska.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, <http://www.npic.orst.edu/>

**U.S. Environmental Protection Agency Office of Pesticide Programs** [www.epa.gov/pesticides/](http://www.epa.gov/pesticides/)

## 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 Nebraska Extension is implied for those mentioned.

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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, important pollinators can include butterflies, moths, flies, hummingbirds, and some bats.

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 nearly \$20 billion annually in the U.S. Honey bee colonies also contribute to our agricultural economy by producing over \$200 million in honey annually.

This publication 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 1/2 inch long on average and live in hives. Each individual has distinct duties, either as a worker (serving as a nursemaid, housekeeper, or forager) or a reproductive bee (drone or queen).



Figure 1. Honeybee

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 rely on the foraging activities of worker honey bees, it is essential to protect these 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. In 2013, the Environmental Protection Agency

(EPA) introduced the Bee Advisory Box (Figure 2) on labels of pesticides, such as neonicotinoids, that pose a high risk to bees. The goal is to provide clearer and more precise directions to protect bees. The loss of native pollinators due to habitat reduction, and the decline in honey bee colonies due to parasitic bee mites, diseases, and other factors reinforce the need to protect these insects through good pesticide stewardship. While this publication focuses on protecting honey bees, many of the recommendations serve to protect other bee and pollinator species as well.

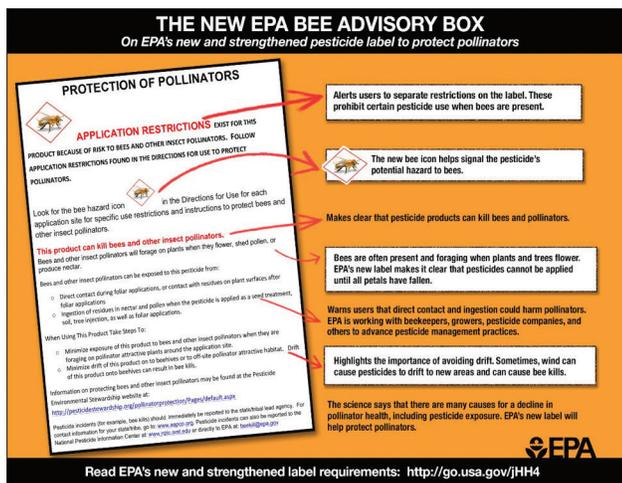


Figure 2. EPA developed the Bee Advisory Box for pesticide labels with a high risk to pollinators to provide clearer information on safer applications.

## 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 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; bees 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 1. Lethal dose (LD<sub>50</sub>, the amount of a substance that will kill 50% of a population) and relative toxicity ratings are provided for each active ingredient (AI). 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:

$$\text{RISK} = \text{TOXICITY} \times \text{EXPOSURE}$$

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 beehive. Wettable powder (WP) and flowable (F) formulations dry after application to a dustlike material that can be transferred to foraging pollinators. Likewise, micro-encapsulated (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 nontarget locations. Before handling or planting treated seed, take precautions to reduce the risk of pesticide residues or planter talcs drifting or moving offsite

Table 1. Selected representative trade names, pesticide AIs, bee toxicities, toxicity ratings, and pesticide types.<sup>1</sup>

Representative Trade Names	Pesticide Active Ingredient (AI)	Bee Toxicity (LD <sub>50</sub> as µg/bee)	Toxicity Rating	Pesticide Type
<b>Gaucho</b>	Imidacloprid	0.0039	Highly toxic	I
<b>Cruiser Platinum</b>	Thiamethoxam	0.005	Highly toxic	F
<b>Lorsban Vulcan Nufos 4E</b>	Chlorpyrifos	0.01	Highly toxic	I
<b>Brigade Capture</b>	Bifenthrin	0.0146	Highly toxic	I
<b>Ambush Pounce</b>	Permethrin	0.024	Highly toxic	I
<b>Aztec</b>	Cyfluthrin	0.037	Highly toxic	I
<b>Dimethoate</b>	Dimethoate	0.056	Highly toxic	I
<b>Avid Zoro</b>	Abamectin	0.41	Highly toxic	M
<b>Carbaryl Sevin</b>	Carbaryl	1	Highly toxic	I
<b>Acramite</b>	Bifenazate	7.8	Moderately toxic	M
<b>Captan</b>	Captan	10	Moderately toxic	F
<b>Javelin Dipel</b>	<i>Bacillus thuringiensis</i>	23.2	Relatively nontoxic	I
<b>Tilt Bumper Fitness</b>	Propiconazole	25	Relatively nontoxic	F
<b>Quilt</b>	Propiconazole + Azoxystrobin	25 200	Relatively nontoxic	F
<b>Atrazine AAtrex</b>	Atrazine	97	Relatively nontoxic	H
<b>Headline</b>	Pyraclostrobin	100	Relatively nontoxic	F
<b>Kanemite Shuttle</b>	Acequinocyl	100	Relatively nontoxic	M
<b>2,4-D Ester</b>	2,4D 2EHE	100	Relatively nontoxic	H
<b>Roundup</b>	Glyphosate	100	Relatively nontoxic	H
<b>Parallel Stalwart</b>	Metolachlor	110	Relatively nontoxic	H
<b>Stratego</b>	Trifloxystrobin + Propiconazole	200 25	Relatively nontoxic	F
<b>Quadris Dynasty</b>	Azoxystrobin	200	Relatively nontoxic	F

<sup>1</sup>The 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>.

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.

### *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. Some pesticides have extended residual activity, longer than eight hours after application. So, even if bees aren't actively foraging, they still may be injured if they 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 product 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. When evaluating potential drift hazards, focus on reducing the risk of drift to nearby flowering plants.

### *Temperature*

Temperature affects the activity of cold-blooded animals, such as bees; it also has an effect on pesticides, and 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°F. 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 that growers use 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. Milkweed is the only food source for monarch butterfly larvae, which are declining in numbers. Consider leaving milkweed alone. For other flowering weeds and where feasible, consider eliminating them 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 3). Many trees and shrubs are beneficial to bees as well. The most attractive species include linden, black locust, honey locust, Russian olive, wild plum, elderberry, red maple, willow, 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 resources, and game managers usually are eager to help establish plantings



Figure 3. Partridge pea planted in an uncultivated area serves as bee forage.

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. Be aware that temperature inversions may occur during these times, however. In addition, the species of plant that is blooming may guide you in the best time to apply pesticides. For example, with the partridge pea, 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 4) 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.

**Use DriftWatch.** The Nebraska Department of Agriculture (NDA) subscribes to a web-based locator for sensitive commercial crops and beehives (Figure 5). The site consists of three programs: DriftWatch, for those who raise sensitive crops (organic, grapes, bees, etc.); BeeCheck, where beekeepers can register just hives; and FieldWatch, where pesticide applicators register to receive notification of new crops as they are registered in BeeCheck and DriftWatch. These three programs all fall under the name of DriftWatch,



Figure 4. Notify beekeepers when you will be applying a product that is toxic to bees.

the original program. The site is not intended for homeowners or sites less than 1/2 acre. This site can be accessed at <http://www.driftwatch.org>. Beekeepers are encouraged to register the locations of their hives, and pesticide applicators are encouraged to use this website to determine if any beehives are located near a planned pesticide application site (Figure 6). Many beekeepers have provided their contact information on DriftWatch, making personal communication much easier. If beehives are present, pesticide application procedures, including timing and/or application methods, should be adjusted accordingly.

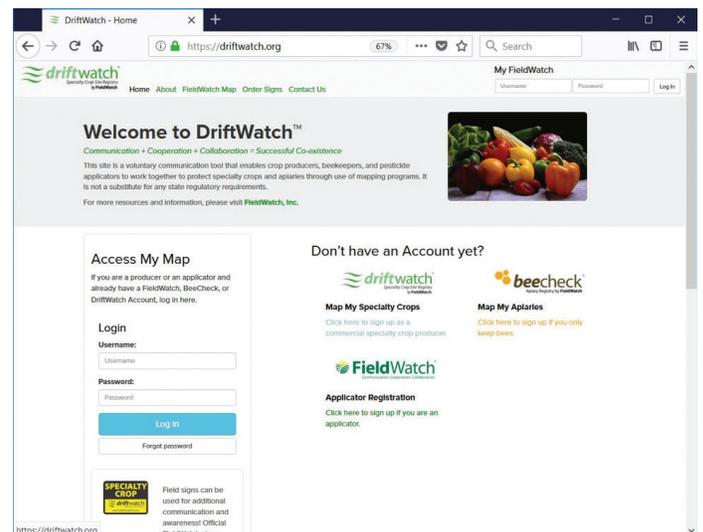


Figure 5. DriftWatch and BeeCheck encourage commercial producers to register locations of beehives.

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 good

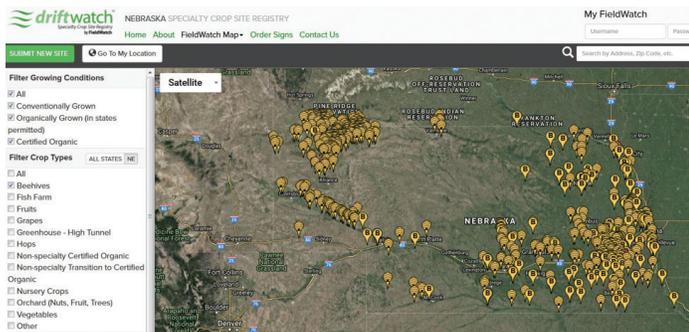


Figure 6. Locations of registered hives along with contact information are available through DriftWatch.

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 Nebraska Extension PSEP YouTube channel, listed in the Resources section of this publication.

**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 7).



Figure 7. Hives shouldn't be placed near crops likely to be sprayed with pesticides.

**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 or BeeCheck. 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 reduce forage activity by removing colony covers and offsetting boxes. Most honey bees will remain in the hive to protect their supply 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 cannot 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

Many ways are available 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 publication, 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 or BeeCheck, 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>

Nebraska Extension PSEP YouTube Channel:

<http://www.youtube.com/user/UNLExtensionPSEP>

### 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 Nebraska Extension is implied for those mentioned.



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# 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.

The Poison Control Centers receive about 90,000 calls each year related to pesticide exposures. Pesticides are responsible for about 3 percent of all accidental exposures to children 5 years and younger and about 4 percent for adults. In addition, pesticides are the cause of about 3 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 inhaling into the lungs. Some classify exposure through the eyes as **ocular exposure**.

**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*). Maiback and Feldman (1974) measured the amount of the pesticide parathion absorbed by different parts of the human body over 24 hours. The relative absorption rates were determined by comparing each respective absorption rate with the forearm absorption rate, given a rate of 1. An area that absorbed twice as much of the pesticide parathion had a rate of 2, three times as much had a rate of 3, etc.

It is easy to transfer pesticide residues from one part of the body to another. For example, residues can be inadver-

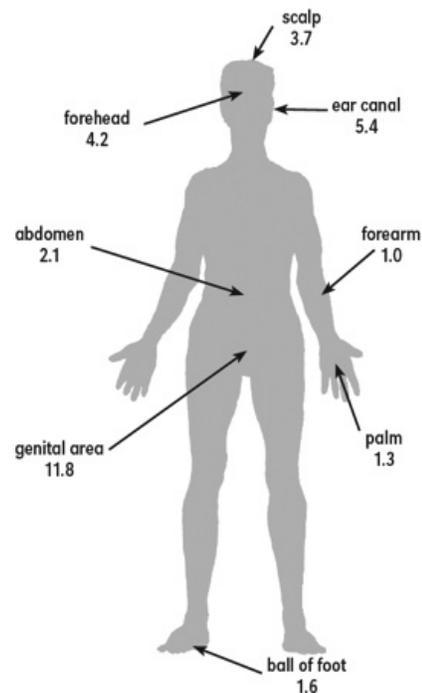


Figure 1. Absorption rates of different parts of the body based on the absorption of parathion into the forearm over 24 hours.

tently 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 or beverage 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 inhaling 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. That's because most droplets are too large to remain airborne long enough to be inhaled. The potential for respiratory exposure increases, however, when using high-pressure, ultra-low volume (ULV), or fogging equipment. 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 and indicating whether risks are due to oral, dermal, and/or respiratory exposure.

## Pesticide Toxicity

Pesticide toxicity to people can be measured several ways, although it 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 LD<sub>50</sub> (lethal dose, 50 percent) describes the dose of 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 LD<sub>50</sub> is the dose per unit of body weight, such as milligrams per kilogram (mg/kg). A pesticide with a lower LD<sub>50</sub> 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 LD<sub>50</sub> of 10 mg/kg is much more toxic than a pesticide with an LD<sub>50</sub> of 1,000 mg/kg.

The toxicity of fumigant pesticides is described in terms of the concentration of the pesticide in the air, LC<sub>50</sub> (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 oral, dermal, or inhalation.

**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 the first exposure: years may pass before signs and symptoms develop. Possible effects of long-term exposure to some pesticides include:

- cancer, either alone or in combination with 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 both chronic and acute toxicity are dose-related. Low-level exposure to chemicals that have the potential to cause long-term effects may not cause immediate injury. However, 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.

Group	Signal Word	Toxicity Rating	Oral Lethal Dose (for a 150-Pound Human <sup>a</sup> )
I	Danger <sup>b</sup>	Highly toxic	Few drops to 1 tsp
II	Warning	Moderately toxic	1 tsp to 1 Tbsp
III	Caution	Slightly toxic	1 Tbsp to a pint
IV	Caution (signal word not always required)	Relatively nontoxic	More than a pint

<sup>a</sup>The 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.

<sup>b</sup>The 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. The 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. The signal word “Caution” is not required to appear on the label of a relatively nontoxic pesticide, but is required for slightly toxic pesticides.

### 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 (Table II). Read this section of the label carefully before using the pesticide so you know what to do if accidental exposure occurs. By following instructions carefully, you will help limit the amount of exposure you or the victim will receive, even after initial pesticide contact.

Table II. Example of a first aid section from a pesticide label.

<b>First Aid:</b>	Call a poison control center or doctor for treatment advice.
<b>If in Eyes:</b>	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 eye.
<b>If Inhaled:</b>	Move the victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.
<b>If Swallowed:</b>	This product will cause gastrointestinal tract irritation. Immediately dilute by having the victim swallow water or milk. Get medical attention. Never give anything by mouth to an unconscious person.

Another important section on a pesticide label provides instructions for pesticide applicators and other handlers on the use of 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 pesticide exposure. 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:

$$\text{Risk} = \text{Toxicity} \times \text{Exposure.}$$

Many people focus their concerns on the immediate effects of a pesticide exposure (acute toxicity). While this is important, realize that we might not understand or see chronic effects of some pesticides for years, if not decades. Since you cannot go back in time to reduce exposure and the chronic effects that could result, the most powerful action an applicator can take is to prevent chronic effects by acting **today**. Go overboard in protecting yourself from exposure, not just because the label tells you to, but because you can't predict which pesticide will result in a chronic disease in the future. It is precisely because you cannot foresee this that you should act today to protect yourself from all pesticide exposures.

Understanding pesticide product toxicity and potential for personal exposure will help 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. Pesticide toxicity 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, such as vomiting, sweating, and pinpoint pupils, can be observed by others. Symptoms are any changes in normal condition that can be described by the victim of poisoning, including nausea, headache, weakness, dizziness, and others. Knowing 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 Environmental Protection Agency (EPA) registration number found on the label, if possible. Provide this information to medical professionals.
4. Have a copy of the pesticide label available when medical attention begins. The label provides useful information to those assisting a victim of pesticide poisoning. The Safety Data Sheet (SDS) has helpful information as well; supplying the SDS to medical professionals is required when the Worker Protection Standard applies.
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, how-

ever, 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 presenting 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 are or have been used in Nebraska. EPA and Nebraska Department of Agriculture maintain registrations for pesticide products. 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 some storage shelves. 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.

Included are some findings from the Agricultural Health Study (AHS), involving 90,000 applicators and spouses from Iowa and North Carolina. The AHS states that the study "began in 1993 with the goal of answering important questions about how agricultural, lifestyle and genetic factors affect the health of farming populations. The study is a collaborative effort involving investigators from the National Cancer Institute, the National Institute of Environmental Health Sciences, the Environmental Protection Agency, and the National Institute for Occupational Safety and Health." The AHS relies mainly on participant memory to determine dose-related exposures. Also, keep in mind that an association does not automatically mean there is a cause-and-effect relationship. An association shows that more research is needed.

Some general findings of the AHS are listed below.

- Farmers have lower rates of many diseases compared with the rest of the population, perhaps because they are less likely to smoke and are more physically active.
- Farmers have a higher risk for developing some cancers, including prostate cancer.
- Gloves matter. Use of chemical-resistant gloves can reduce pesticide exposure 50 to 80 percent.
- Accidental high pesticide exposure events may affect health later in life.

## Insecticides

Insecticides have many different modes of action. Some act on the insect's nervous system. Others slow the production

of energy that an insect needs to survive. Another type slows or stops 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. Modes of action involving the nervous system and energy production may affect not only insects, but other animals as well. Insecticides such as insect growth regulators typically are specific to insects. The following is a list of insecticides grouped by their chemical makeup.

### *Organophosphate and Carbamate Insecticides*

Many cases of pesticide poisoning involve 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. The AHS shows that allergic asthma in men and women may be associated with poisoning caused by these insecticides. Examples of organophosphate and carbamate insecticides used in Nebraska are listed in *Table III*. EPA registration has been cancelled for some; others are being phased out or are not used as much as other insecticides.

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, consuming alcoholic beverages may worsen pesticide effects.

The onset of symptoms in milder exposures usually occurs within four 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 heartbeat, often less than 50 beats per minute; and rippling of surface muscles just under the skin. Some symptoms may be mistaken for those of flu, heat stroke, heat exhaustion, or upset stomach.

Moderately severe organophosphate and carbamate insecticide poisoning cases exhibit all the signs and symptoms found in mild poisonings listed previously. 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 movements. 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, 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*

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 dioxins and polychlorinated biphenyls (PCBs) are in the environment

**Table III. Organophosphate and carbamate insecticides that have been or currently are used in Nebraska. Examples of trade names are in parentheses. Registrations for italicized products have been discontinued. Those products still may be in an applicator's storage, so names are listed in the table.**

<b>Organophosphates</b>		<b>Carbamates</b>	
Acephate (Orthene®)	Dimethoate ( <i>Cygon</i> , Dimethoate)	Phorate (Thimet®)	<i>Aldicarb (Temik®)</i>
<i>Azinphos-methyl (Guthion®)</i>	<i>Disulfoton (Di-Syston®)</i>	Phosmet (Imidan®)	Carbaryl (Sevin®)
Chlorpyrifos (Lorsban®)	Ethoprop (Mocap®)	Pirimiphos-methyl (Actellic)	<i>Carbofuran (Furadan®)</i>
Coumaphos (Co-Ral®)	Malathion	Terbufos (Counter®)	Methomyl (Lannate®)
Diazinon	<i>Methyl Parathion (Penncap-M®)</i>	Trichlorfon (Dylox®)	Propoxur ( <i>Baygon®</i> )
Dichlorvos (Vapona®, DDVP®)	Naled (Dibrom®, Trumpet®)		

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 still larger fish, and finally 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 pricking sensation on the skin, and twitching muscles. Loss of coordination, convulsions (violent seizures with involuntary jerky movements that cause the victim to stop breathing) similar to epileptic seizures, and unconsciousness often follow. When chemicals are absorbed through the skin, the first symptoms may include apprehension, twitching, tremors, confusion, and convulsions. Chronic exposure may lead to cancer, birth defects, and genetic mutations. AHS states that the risk of developing diabetes and thyroid disease may increase for those who use some organochlorine chemicals.

No specific antidotes are available for organochlorine poisoning. People assisting a victim should wear chemical-resistant gloves and be careful to avoid being exposed to the pesticide. Remove contaminated clothing immediately and bathe and shampoo the person vigorously with soap and water to remove pesticides 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. Pyrethroid insecticides, with trade names for some products in parentheses.**

Bifenthrin (Sniper®)	Fenvalerate (Evercide® EC)
Cyfluthrin (Decathlon®, Tempo®)	Fluvalinate (Mavrik® Perimeter)
Cypermethrin (Cyper TC, Barricade, Demon® Max)	Permethrin (Pounce®, Ambush®)
Deltamethrin (Suspend SC, Delta Technical®)	Phenothrin or Sumithrin (Enforcer® Flea Spray)
Esfenvalerate (Asana® XL)	Tetramethrin Assault Wasp and Hornet Killer)

In the U.S., pyrethroids have widespread usage as they have replaced many organophosphates. Of all pesticides used, pyrethroid exposures are the most often reported. Risk of pyrethroid poisoning through inhalation and dermal absorption is low. Few poisonings of humans by pyrethroids have been documented, although exposures associated with Total Release Foggers, discussed later in this publication, have caused problems. Dermal contact may result in skin irritation such as stinging, burning, itching, and tingling progressing to numbness. Some people experience a range of allergic reactions from pyrethroids. Repeated exposures may increase the intensity of the reaction.

Although some pyrethroids may be toxic orally, ingesting this type of insecticide usually presents relatively little risk. Occasionally, a large dose may cause loss of coordination, tremors, salivation, vomiting, diarrhea, and irritability to sound and touch. Most pyrethroids are promptly excreted by the kidneys.

### *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 is used as both an insect attractant and insecticide. In humans, exposure to skin or eyes can cause irritation and burns. Ingestion of 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 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 AHS 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. Rotenone manufacturers have voluntarily stopped producing the pesticide for all uses except to manage undesirable fish species. Rotenone is now a restricted use pesticide.

**Antibiotics** include abamectin, *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, especially by children. Avoid inhaling the dust during application. The label may indicate that respiratory protection is required. Inhaled borax dust irritates the respiratory tract and causes shortness of breath. Borax dust is moderately irritating to skin. Infants have developed a red skin rash that most often affects 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 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 of crystalline silica, known to cause a respiratory disease called silicosis, and cancer. The cancer risk 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*

**Neonicotinoids** were introduced in the 1990s. Chemically similar to nicotine, they have a lower toxicity to humans than do organophosphates and carbamates. Imidacloprid and thiamethoxam are used to control termites, turf insects, and some crop insects. Neonicotinoids are being studied for their risk to honeybees and other pollinators.

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<sup>®</sup>, Taurus<sup>™</sup>), cockroaches (Combat<sup>®</sup>, Maxforce<sup>®</sup>), certain insect pests of corn, and fleas and ticks of cats and dogs (Frontline<sup>®</sup>, Effipro<sup>®</sup>, PetArmor<sup>™</sup>). 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 headache, nausea, dizziness, and weakness. Symptoms developed two hours after spraying and then disappeared. The National Pesticide Information Center reports that signs and symptoms from a brief exposure to fipronil generally improve and clear up without treatment (<http://npic.orst.edu/factsheets/fipronil.pdf>).

**Pyrrroles.** Chlorfenapyr (Phantom<sup>®</sup>, Pylon<sup>®</sup>) is the only active ingredient 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 contacts skin, and can moderately irritate eyes and skin.

**Tetronic acids.** Spiromesifen is the sole active ingredient 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.**

Diflubenzuron (Adept®, Clarify®)	Methoprene (Bio Spot®)
Hexaflumuron (Shatter™)	Noviflumuron (Recruit®)
Hydroprene (Gentrol®)	Pyriproxyfen (First Shield™)

## Mosquito Repellents

**Diethyltoluamide (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 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, immediately discontinue using DEET. 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. Widely used as an insect repellent in Europe and Australia, picaridin has been available in the U.S. 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 with adults, no data suggest that children have increased sensitivity specifically to picaridin.

**Oil of Citronella** was registered in 1948 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 insects and other pests. Fumigants are among the most hazardous pesticide products to use, due to danger of inhalation.

Various fumigants produce differing physiological ef-

fects. Headache, dizziness, nausea, and vomiting are common early signs and symptoms of excessive exposure.

Prompt medical treatment is critical with fumigant poisoning. After donning appropriate PPE, 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 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. Chloropicrin can cause eye irritation and tearing in concentrations as low as 0.15 ppm. Some fumigant formulations include small amounts as a warning agent to clear people from an area.

**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 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. Methyl bromide is corrosive to eyes; damage may have a delayed onset after exposure. Some liquid fumigants cause skin injuries

such as redness or blisters that rupture, leaving raw skin or deep ulcers.

**Acrolein** (Magnacide H®) is an extremely irritating gas used as an aquatic herbicide. Inhaling vapors causes irritation in the upper respiratory tract, which may lead to a buildup of fluids in and narrowing of the air passages. Acrolein is corrosive to the eyes. 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. Exposure to the eyes can cause irreversible eye damage. 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 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 lungs. Although limited data for humans exist, animals have experienced liver, kidney, and cardiac damage. 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 bait is a risk. The active ingredients of rodenticides fall into three categories:

- First-generation anticoagulants,
- Second-generation anticoagulants, and
- Non-anticoagulants.

Anticoagulants slow the blood's ability to clot. Death can result from excessive bleeding. First-generation antico-

agulants were developed during World War II, with others appearing before 1970. Rodents die after eating a number of doses, and death usually occurs within five to seven days.

Second-generation anticoagulants were initially developed in the 1970s. They are more hazardous—more likely to kill after a single feeding. Their increased toxicity increases the risk to humans. Also, second-generation anticoagulants remain in body tissues longer than first-generation anticoagulants. Second-generation anticoagulants are designed to poison the rodent as soon as it feeds (one dose), but death may occur after several days. During that time, the rodent can feed many times, meaning that when the rodent finally dies, the residues in its carcass might be much higher than the lethal dose. Predators or scavengers that eat the carcass might consume enough of the poison to suffer harm. This is called secondary poisoning.

Non-anticoagulants affect the nervous system or other body organs. They do not have an effect on clotting of blood. The first non-anticoagulant rodenticides were developed for use against rodents that were resistant to anticoagulants.

### *First-generation Anticoagulants*

**Coumarins** are anticoagulants: they slow blood's ability to clot, and disrupt capillary and liver function. Examples include warfarin (Kaput® Mole Gel Bait and Mouse Blocks). 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** include chlorophacinone (Rozol®) and diphacinone (Ditrac®, d-CON® IX and XI, Kaput Pocket Gopher Bait and Prairie Dog Bait, 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 human poisonings. Vitamin K is an antidote.

### *Second-generation Anticoagulants*

**Coumarins** also may be second-generation anticoagulants, developed with increased toxicity. Examples include brodifacoum (Jaguar®, Talon®, WeatherBlok®), and bromadiolone (Contrac®, Maki®). 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.

## *Non-anticoagulants*

**Benzenamines.** Bromethalin (Tomcat® Mouse Killer), the only chemical in this class of rodenticide, 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, abdominal swelling or bloating.

**Cholecalciferols.** (Terad 3 Blox®, d-CON XVI and XVII). This rodenticide is an activated form of vitamin D, and affects the liver and kidneys. It causes elevated levels of calcium in the blood; rodents die due to problems such as blockages in the circulatory system. For humans, signs and symptoms include fatigue, headache, weakness, and nausea. This rodenticide has poisoned dogs and cats. A high dosage may cause death in humans. Labels caution against direct contact with skin; gloves are required when handling bait or retrieving carcasses.

**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 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 phosphine gas, which enters the bloodstream and affects lungs, liver, kidneys, heart, and central nervous system. Zinc phosphide can be absorbed through 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, coldness, loss of consciousness, coma, and death can occur from fluid buildup in 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. They reduce or prevent 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; prolonged exposure may lead to inflamed skin. Creosote vapors and fumes 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, Penta), typically used on utility poles or fence posts, irritates 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 inhaling 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 twitching, difficulty breathing, a sense of tightness in the chest, abdominal pain and vomiting, restlessness, 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 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 concentrates in cells in the lungs. AHS states the use of paraquat is linked to an increased risk of developing Parkinson's disease.

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 examples of arsenical herbicides. Acute arsenic poisoning usually appears within one hour of ingestion. Breath and feces that smell of garlic may help 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 yellowing of the skin. Injury to tissues that form blood may reduce numbers of red and white blood cells and blood platelets. Death usually occurs one to three days after the onset of symptoms, 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, ingesting 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 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 to cause adverse effects in humans. According to the EPA manual, *Recognition and Management of Pesticide Poisoning* (Roberts and Reigart, 2013), “. . . 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 irritant injuries to skin and mucous membranes, as well as some skin sensitization.

AHS scientists found that applicators with retinal degeneration were twice as likely to have used fungicides. The risk of retinal degeneration increased as the days of fungicide use increased. This trend was noted for five specific fungicides: benomyl, captan, chlorothalonil, maneb, and metalaxyl. In addition, researchers found that applicators reporting retinal degeneration were more likely to raise orchard fruit, where fungicides are commonly used. Those with retinal degeneration were more likely to use hand spray guns, backpack sprayers, and mist blower/foggers. These application methods result in higher exposure to pesticides.

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. Ingesting a toxic dose often is followed by nausea and vomiting, then fever, seizures, and changes in mental status that sometimes leads 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 as either MGK 264 or n-octyl bicycloheptene dicarboximide.

### Application Method

In some cases, the application method itself is the root cause of increased risk. Using hand spray guns, backpack sprayers, and mist blower/foggers may result in higher pesticide exposure. Another example is the Total Release Fogger (TRF). Also known as a bug bomb, TRF is a pesticide product that uses an aerosol propellant to release an insecticide in an enclosed area. They often are used to control fleas, cockroaches, and flying insects in homes, offices, etc. Pyrethrins or pyrethroids are common active ingredients found in TRFs.

A 2018 study by the Centers for Disease Control and Prevention (CDC) reported 3,222 exposures to TRFs in 10 states between 2007 and 2015. According to this study, the most commonly reported cause of exposure was failure to leave the treated premises during the application. The 2018 study stated, “Moderate or high severity illness was more common among males, persons over 60 years of age, those with preexisting asthma, and those who failed to vacate premises during application, or who were exposed to excessive TRFs.”

A 2008 CDC study reporting 466 exposures in eight states from 2001–2006 said many exposures resulted from not leaving the enclosed space before the fogger discharged, re-entering the site too soon after the discharge, using too many foggers, or failing to notify others that foggers had been used. According to the 2008 study, the most often reported symptoms involved respiratory problems. Other symptoms dealt with gastrointestinal, neurological, cardiovascular, eye, and skin problems. Although one death was reported, most exposures were not considered severe.

For TRF exposures, recommendations are to get the victim(s) to fresh air or administer oxygen if necessary.

Flush the skin and/or eyes with water to wash out chemicals. Because of limited effectiveness and the risks associated with their use, Extension generally does not recommend the use of TRFs.

### 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>).

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 or near your phone, or in your telephone directory. 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.**

### 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 Nebraska Extension is implied for those mentioned.

### Resources

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This publication has been peer reviewed.

Nebraska Extension publications are available online at <http://extension.unl.edu/publications>.

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## Pesticide Safety Telephone Numbers

### *Emergency Telephone Numbers*

<b>Any Emergencies</b>	911
<b>Poison Control Center</b> For aid in human poisoning cases	800-222-1222
<b>Chemical Transportation Emergency Center (CHEMTREC)</b> Available 24/7 for technical assistance for pesticide incidents dealing with fires, spills, leaks, exposures, and accidents.	800-424-7930
<b>Nebraska Department of Environmental Quality</b> 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.	402-471-2186 or 877-253-2603
<b>Nebraska State Patrol Dispatch</b>	402-471-4545 or 800-525-5555

### *Nonemergency Telephone Numbers*

<b>National Pesticide Information Center</b> 9:00 AM-1:00 PM Mountain time, 10:00 AM-2:00 PM Central time, Monday through Friday	800-858-7378
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<b>S</b>	<b>Transport, Storage, and Disposal of Pesticides</b>
<b>A</b>	
<b>F</b>	
<b>E</b>	

**Clyde L. Ogg, Extension Educator  
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**M**ost 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.

# T ransporting Pesticides

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 become dislodged and damaged. 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 protec-

tive 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.



Always carry a pesticide spill kit and carefully secure all pesticide containers.

## 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 Safety Data Sheets (SDS) 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 per-

sonnel. 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 Safety Data Sheet (SDS) 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 (<https://www.phmsa.dot.gov/training/hazmat/training-modules>) or on an interactive CD-ROM. (For more information, phone: 202-366-4900 or email: [phmsa.hm-training@dot.gov](mailto:phmsa.hm-training@dot.gov).) A list of training opportunities for the function-specific and safety training sections is available online (<https://www.phmsa.dot.gov/training/hazmat/hazardous-materials-outreach-engagement>) 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](mailto:phmsa.hm-training@dot.gov)). Specialized training is available from the DOT Transportation Safety Institute as well (405-954-3153).

**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.

## Accessing the Regulations

Hazardous materials regulations are available online and in print versions.

The U.S. Code of Federal Regulations is available online by searching for US Code of Federal Regulations.

The print version can be ordered through: <http://bookstore.gpo.gov/catalog/laws-regulations>

It is published by the Office of the Federal Register National Archives and Records Administration as a Special Edition of the Federal Register.

**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.

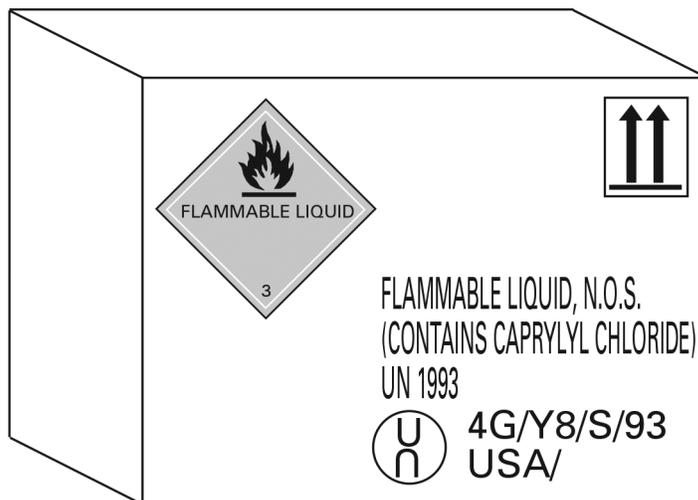
**Commercial Driver's License.** Contact the hazardous materials coordinator at the Nebraska State Patrol (402-471-0105) for more information on training, shipping papers, labeling, marking, and placarding. For more information on the CDL, contact the Nebraska Department of Motor Vehicles office (402-471-2281)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



Check all shipping containers for proper DOT labeling and marking.

- "Characteristic" wastes. These are waste materials with one or more of these characteristics: ignitable, corrosive, reactive, TCLP toxic1. 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 Environment and Energy at 402-471-2186.

# Storing Pesticides

**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.

Store pesticides in their original containers with the label attached whenever possible. 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. If the container is leaking and the pesticide needs to be transferred to another container, use a container capable of holding the product; some pesticides have solvents that cannot be held by some plastics. Make sure a copy of the complete label is attached to the receiving container. The repackaged pesticide cannot be sold to another user, and the receiving container must be marked "Service Container, Not for Sale." 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.



Danger! Pesticide storage sign.

# 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 Environment and Energy (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 SDS 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

Vehicle ID _____	Notes _____
Inspected by _____	_____
Date _____	_____

Adapted from Pesticides and Commercial Vehicle Maintenance, Purdue University.

# 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.

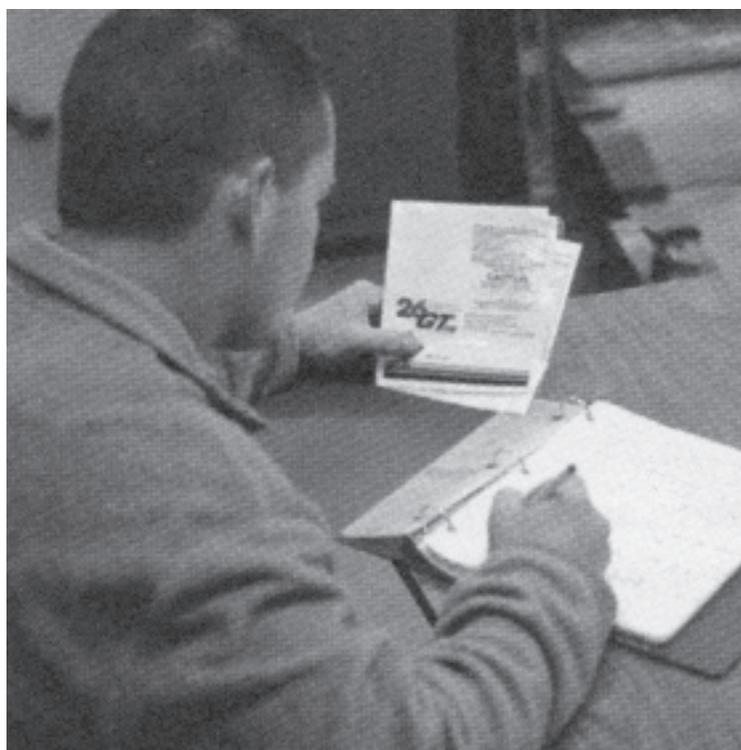
Enter date of each inspection: \_\_\_\_\_

	Yes	No	Yes	No	Yes	No
<b>General Information</b>						
Clean, neat pesticide storage site	_____	_____	_____	_____	_____	_____
Current, on-site pesticide inventory	_____	_____	_____	_____	_____	_____
Emergency phone numbers posted	_____	_____	_____	_____	_____	_____
Labels and SDS available	_____	_____	_____	_____	_____	_____
Accurate storage inspection log maintained	_____	_____	_____	_____	_____	_____
<b>Pesticide Containers</b>						
Containers marked with purchase date	_____	_____	_____	_____	_____	_____
Insecticides, herbicides, and fungicides segregated	_____	_____	_____	_____	_____	_____
Pesticides stored in original containers	_____	_____	_____	_____	_____	_____
Dry formulations stored on pallets	_____	_____	_____	_____	_____	_____
Feeds stored separately from pesticides	_____	_____	_____	_____	_____	_____
Used containers rinsed and drained	_____	_____	_____	_____	_____	_____
Rinsed and unrinsed containers separated	_____	_____	_____	_____	_____	_____
Liquid formulations stored below dry formulations	_____	_____	_____	_____	_____	_____
<b>Spills and Disposal</b>						
Storage area free of spills or leaks	_____	_____	_____	_____	_____	_____
Shovel and absorbent materials available	_____	_____	_____	_____	_____	_____
Sealed floors	_____	_____	_____	_____	_____	_____
Floor drains closed off (if present)	_____	_____	_____	_____	_____	_____
<b>Safety Information</b>						
<i>No smoking</i> signs posted	_____	_____	_____	_____	_____	_____
Personal protective equipment available	_____	_____	_____	_____	_____	_____
Fire extinguisher in good working order	_____	_____	_____	_____	_____	_____
Storage room locked, limited access to keys	_____	_____	_____	_____	_____	_____
Storage room posted: <b>Pesticides — Keep Out!</b>	_____	_____	_____	_____	_____	_____
Storage site well lit and ventilated	_____	_____	_____	_____	_____	_____

Adapted from Pesticides and Commercial Vehicle Maintenance, Purdue University.

# Pesticide Label Exercise

## A Supplement for Pesticide Applicators



Extension 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.

University of Nebraska–Lincoln Extension educational programs abide with the nondiscrimination policies of the University of Nebraska–Lincoln and the United States Department of Agriculture.

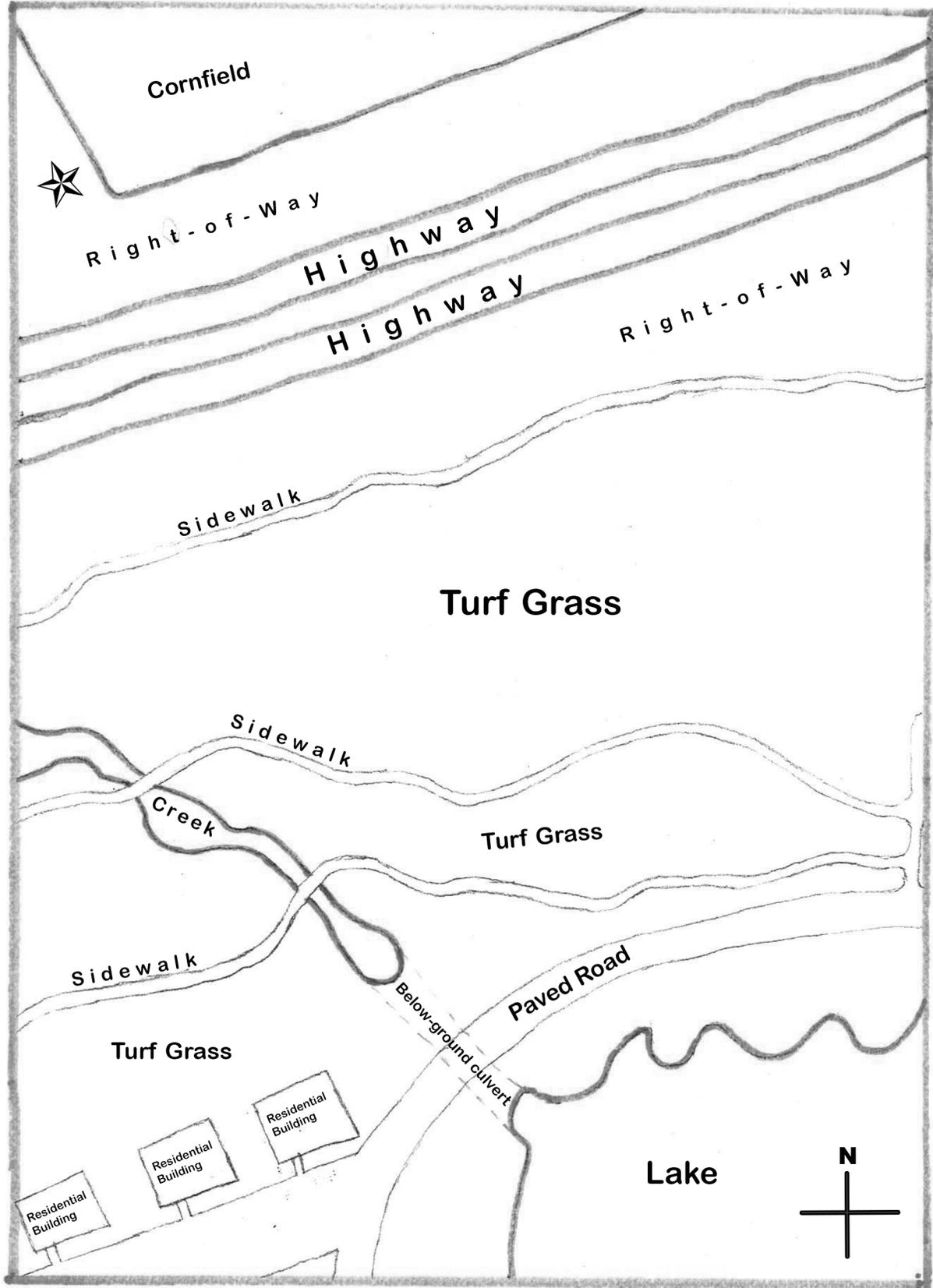
## Understanding The Details

### **Aloft® LC SC Scenario**

The park's turf is infested with white grubs. You know this because of monitoring in past years, surveying done this year, and anticipation of a particularly heavy grub year regionwide. An application of Aloft® LC SC is planned to control these pests. Ornamental trees are scattered throughout the park's turf areas. A commercial beehive is located north of the highway (marked by a star).

1. The features of the landscape in the target site and surrounding it present a number of challenges and/or concerns for the applicator. Before you even consult the label, which features and surroundings on the map are concerning to you? Why?
2. How many active ingredients are in Aloft? What are their common names? Which mode of action group(s) do they belong to? Why is having 2 different groups important?
3. What are two ways that insect pollinators can be exposed to Aloft?
  - a. How long is Aloft toxic to bees following application?
  - b. Though not included on the label, how might you determine that a commercial beehive is in the vicinity of the application site?
  - c. According to the label, what steps should be taken to protect pollinators?
  - d. Can you think of other steps to take to avoid injuring the nearby hive?
4. Could Aloft be applied to the trees in the park if necessary? Are there any exceptions?
5. Why should you be concerned about the presence of fish or other aquatic organisms while planning the application?
6. How did you determine the need for an application of Aloft to control white grubs?
7. Describe an ideal weather forecast for applying Aloft to the turf in this park for grub control.
8. After the application, when can turf be mown again?
9. After the application, how long must children and pets be barred from treated surfaces?
10. What is the maximum amount of clothianidin which can be applied to turfgrass per acre per year? How much Aloft concentrate is this? If the maximum amount of Aloft is applied, can a product containing *only* bifenthrin still be applied within the same year? How much?

Aloft Scenario Map



<b>GROUP</b>	<b>4A</b>	<b>INSECTICIDE</b>
<b>GROUP</b>	<b>3</b>	<b>INSECTICIDE</b>



# Aloft<sup>®</sup> LC SC

## INSECTICIDE



**FOR CONTACT AND SYSTEMIC INSECT PEST CONTROL IN LAWNS, LANDSCAPE ORNAMENTAL**

**TREES (INCLUDING NON-BEARING FRUIT TREES), AROUND RESIDENTIAL, INSTITUTIONAL, PUBLIC, COMMERCIAL AND INDUSTRIAL BUILDINGS, PARKS, RECREATIONAL AREAS, AND ATHLETIC FIELDS. NOT FOR USE ON GOLF COURSES AND SOD FARMS.**

Active Ingredients	By Wt
Clothianidin*	24.70%
Bifenthrin**	12.30%
Other Ingredients	63.00%
<b>Total</b>	<b>100.00%</b>

\* (E)-1-(2-chloro-1,3-thiazol-5-ylmethyl)-3-methyl-2-nitroguanidine  
 \*\* (2-methyl[1,1'-biphenyl]-3-yl)methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl-cyclopropanecarboxylate

Contains 2.22 lb of Clothianidin and 1.10 lb of Bifenthrin per gallon.

EPA Reg. No. 59639-213      EPA Est. 70815-GA-001

### KEEP OUT OF REACH OF CHILDREN WARNING – AVISO

**SEE BELOW FOR ADDITIONAL PRECAUTIONARY STATEMENTS.**

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

**FIRST AID**

**If swallowed:** Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to by the poison control center or doctor. Do not give anything by mouth to an unconscious person. (continued)

**FIRST AID (continued)**

**If inhaled:** Move person to fresh air. If person is not breathing, call 911 or ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

**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 eye. Call a poison control center or doctor for treatment advice.

**If on skin or clothing:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

**NOTE TO PHYSICIAN**

This pesticide contains a pyrethroid. If significant quantities have been swallowed, promptly eliminate the ingested quantities from the stomach and intestines. Treatment is symptomatic and supportive. Alcohol, milk, cream, and other digestible fats and oils should NOT be administered as they may increase absorption.

**HOTLINE NUMBER**

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact **800-892-0099** for emergency medical treatment information.

### PRECAUTIONARY STATEMENTS

#### HAZARDS TO HUMANS AND DOMESTIC ANIMALS WARNING

May be fatal if swallowed. Harmful if inhaled. Harmful if absorbed through skin. Causes moderate eye irritation. Avoid breathing spray mist or vapor. Avoid contact with skin, eyes, or clothing.

#### PERSONAL PROTECTIVE EQUIPMENT (PPE):

Some materials that are chemical-resistant to this product are barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinyl chloride or Viton. If you want more options, follow the instructions for category A on an EPA chemical-resistance category selection chart.

**Applicators and other handlers must wear:** long-sleeved shirt, long pants, shoes plus socks and chemical-resistant gloves.

Follow the manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, 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/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

### ENVIRONMENTAL HAZARDS

This product is extremely toxic to fish and aquatic invertebrates. To protect the environment, do not allow pesticide to enter or run off into storm drains, drainage ditches, gutters or surface waters. Applying this product in calm weather when rain is not predicted for the next 24 hours will help to ensure that wind or rain does not blow or wash pesticide off the treatment area. Rinsing application equipment over the treated area will help avoid runoff to water bodies or drainage systems. Drift and runoff may be hazardous to aquatic organisms in neighboring areas. Do not apply where runoff is likely to occur.

This product is toxic to bees exposed to treatment and for more than 5 days following treatment. Do not apply this product to blooming, pollen-shedding or nectar-producing parts of plants if bees may forage on the plants during this time period, unless the application is made in response to a public health emergency declared by appropriate State or Federal authorities.

**PROTECTION OF POLLINATORS APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.**



Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

**This product can kill bees and other insect pollinators.**

Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications.

(continued)

### PROTECTION OF POLLINATORS (continued)

- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives or off-site to pollinator attractive habitat can result in bee kills.
- Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at: <http://pesticidestewardship.org/pollinatorprotection/pages/default.aspx>.

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your State, go to: [www.aapco.org](http://www.aapco.org). Pesticide incidents should also be reported to the National Pesticide Information Center at: [www.npic.orst.edu](http://www.npic.orst.edu) or directly to EPA at: [beekill@epa.gov](mailto:beekill@epa.gov).

### DIRECTIONS FOR USE

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

**READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH PRECAUTIONARY STATEMENTS AND DIRECTIONS, AND WITH APPLICABLE STATE AND FEDERAL REGULATIONS.**

Do not apply this product in any 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.



Do not apply Aloft® LC SC Insecticide while bees are foraging. Do not apply *Aloft* LC SC Insecticide to plants that are flowering. Only apply after all flower petals have fallen off.

All outdoor applications must be limited to spot or crack-and-crevice treatments only, except for the following permitted uses:

1. Treatment to soil or vegetation around structures;
2. Applications to lawns, turf, and other vegetation;
3. Applications to building foundations, up to a maximum height of 3 feet.

Other than applications to building foundations, all outdoor applications to impervious surfaces such as sidewalks, driveways, patios, porches and structural surfaces (such as windows, doors, and eaves) are limited to spot and crack-and-crevice applications, only.

## RESTRICTIONS

- Do not apply by air.
- Do not water the treated area to the point of runoff.
- Do not make applications during rain.
- Do not mow until after irrigation or rainfall has occurred.
- Application is prohibited directly into sewers or drains, or to any area like a gutter where drainage to sewers, storm drains, water bodies, or aquatic habitat can occur. Do not allow the product to enter any drain during or after application.
- Do not apply through any type of irrigation system.
- Do not apply on the following: Commercial nurseries, commercial greenhouses, grass grown for seed, golf courses and sod farms.
- Do not allow children or pets on treated surfaces until the spray has dried.
- Do not apply this product, by any application method, to linden, basswood or other *Tilia* species.

## USE INFORMATION

*Aloft* LC SC Insecticide is a long lasting contact and systemic insecticide for control of listed insects infesting lawns and ornamentals in landscapes and surrounding areas. *Aloft* LC SC Insecticide can be used around residences, business complexes, industrial complexes, airports, playgrounds, school yards, parks and recreation areas, athletic fields, cemeteries and arboretums.

## PREPARATION OF SPRAY MIXTURES AND APPLICATION

Begin with clean equipment. Add sufficient clean water to the spray tank for one-half of the mix load. Start tank agitation. Add the necessary amount of *Aloft* LC SC Insecticide before adding any other products. Agitate to ensure thorough mixing while adding the remaining water. Maintain agitation during mixing and application. Apply with properly calibrated spray equipment. If agitation is stopped for any reason the spray solution must be thoroughly remixed prior to any further use.

Use sufficient water volume to provide uniform coverage of the lawn and ornamental plants. For control of listed surface insects, do not water in until at least 48 hours after the application. If the target insects are in the thatch, either apply *Aloft* LC SC Insecticide in enough spray volume to wet the thatch or lightly water in after application with enough water to wet the thatch zone.

For control of existing grub populations, water in after application with enough water to move the insecticide into the root zone where the grubs are feeding.

## RESISTANCE MANAGEMENT

*Aloft* LC SC Insecticide contains two active ingredients with different modes of action and provides a recognized built in insecticide resistance management strategy to minimize the development of insecticide resistance in insect pests. The active ingredients in *Aloft* LC SC Insecticide are clothianidin, a Group 4A insecticide, and bifenthrin, a Group 3

insecticide. Insect biotypes with acquired resistance to Group 4A or Group 3 insecticides may eventually dominate the insect population if Group 4A or Group 3 insecticides are used alone or repeatedly in the same site or in successive years as the primary method of control for targeted species.

To delay insecticide resistance in insects that are at risk of developing resistance to insecticides consider:

- Avoid the consecutive use of insecticides on the same insect species.
- Use tank mixtures or premixes of insecticides from a different target site of action.
- Base insecticide use on a comprehensive IPM program.
- Monitor treated insect populations for loss of field efficacy.
- Contact your local extension specialist, certified crop advisors and/or manufacturer for insecticide resistance management or IPM recommendations for the specific site and resistant pest problems.
- For further information or to report suspected resistance, you may contact Valent U.S.A. Corporation at 800-898-2536.

## APPLICATION INSTRUCTIONS – TURFGRASS AND LAWNS.

*Aloft* LC SC Insecticide can be used for control of listed insects in lawns. *Aloft* LC SC Insecticide can be used around residences, business complexes, industrial complexes, airports, playgrounds, school yards, parks and recreation areas, athletic fields, cemeteries and arboretums.

*Aloft* LC SC Insecticide has sufficient contact and residual activity to provide high levels of control. The need for an application can be based on historical monitoring of the presence of or anticipated occurrence of individual or multiple insect pest species, the site, previous records or experiences, current season adult trapping or other methods. Optimum control of white grubs will be achieved when applications are made just prior to egg laying or to early instar larvae of target pests, followed by sufficient irrigation or rainfall to move the active ingredient into the zone where the insect pests are active. Multiple applications can be made each growing season but do not use more than 23.3 fl oz of product (0.4 lb of clothianidin active ingredient, 0.2 lb bifenthrin) per acre per year. Note: You may also use additional products containing bifenthrin as long as the maximum amount of bifenthrin does not exceed 0.4 lb active ingredient per acre per year.

Apply *Aloft* LC SC Insecticide to lawns and perimeters at 11.65 - 23.3 fl oz per acre per year (0.27 - 0.54 fl oz/1,000 sq ft). The rate is dependent on the target pest(s), their stage of development and the desired level of control. Optimum control of white grubs (larvae) will be achieved when applications are made just prior to or just after peak egg laying. Use the higher rates within the rate range when long residual control is desired for control of multiple insect pests or late season applications are made to lawns

already showing grub damage or damage by scavenging animals. Multiple applications can be made but do not exceed the maximum amount per year (23.3 fl oz/A or 0.54 fl oz/1,000 sq ft). Consult your local State Agricultural Experiment Station, State Extension Turf Specialists or other lawn experts for specific information concerning the timing of applications.

For early season control of listed insect pests (such as annual bluegrass weevil) and for full season control of white grubs, make the first application of *Aloft* LC SC Insecticide at peak adult activity or when other insect pests reach a damaging population in the spring at a rate of 11.65 - 23.3 fl oz per acre (0.27 - 0.54 fl oz/1,000 sq ft). For control of white grubs at standard application timing, apply 11.65 - 23.3 fl oz/A (0.27 - 0.54 fl oz/1,000 sq ft) just prior to peak adult activity or to early instar larvae.

For control of listed surface insects, do not water in until at least 24 hours after the application. For control of the target insects in the thatch, use enough carrier volume to move the insecticide into the thatch or lightly water in after application with enough water to wet the thatch zone. For control of armyworms, cutworms and other surface feeders, apply 11.65-23.3 fl oz/A (0.27-0.54 fl oz/1,000 sq ft) at the first sign of insects or insect damage. Repeat applications up to a total of 23.3 fl oz/A per year (0.54 fl oz/1,000 sq ft) to control additional flushes of insects. Up to a total of 23.3 fl oz/A per year (0.54 fl oz/1,000 sq ft) can be applied.

For control of existing grub populations, irrigate after application with enough water to move the insecticide into the zone where the grubs are feeding.

Do not mow until after irrigation or rainfall has occurred.

## TURFGRASS AND LAWNS

APPLICATION RATE	INSECT PEST
0.27 - 0.54 fl oz per 1,000 sq ft (11.65 - 23.3 fl oz/A)	Annual Bluegrass Weevil/ Hyperodes (Adults) <sup>1</sup> Annual Bluegrass Weevil/ Hyperodes (Larvae) <sup>1</sup> Ants <sup>2</sup> , Nuisance (Excluding Fire, Harvester, Pharaoh, and Carpenter Ants) Armyworms Billbugs <sup>3</sup> Black Turfgrass Ataenius <sup>4</sup> Chiggers Chinch Bugs Cutworms European Crane Fly Grasshoppers Leafhoppers Mole Crickets <sup>5</sup> Pillbugs Sod Webworms Sowbugs Spittlebug Sugarcane Grub Ticks <sup>6</sup> White grubs <sup>7</sup> (Asiatic Garden Beetle, European Chafer, Green June Beetle, Japanese Beetle, Northern Masked Chafer, <i>Phyllophaga</i> spp. (May or June Beetle), Oriental Beetle, Southern Masked Chafer)
APPLICATION RATE	INSECT PEST
<b>Control</b> 0.46 fl oz per 1,000 sq ft (20 fl oz/A) <b>Suppression</b> 0.33 fl oz per 1,000 sq ft (14.4 fl oz/A)	Fire Ants, Red Imported <sup>8</sup> *
<p><sup>1</sup> <b>Annual Bluegrass Weevil:</b> Application can be timed for adult weevils as they move from their over-wintering sites into turf. This movement usually begins shortly before or when Forsythia is in full bloom and continues to full bloom of dogwoods. Larvae from adult weevils that escape the application will be controlled with the application directed at adult weevils. Applications made after adult weevil activity will control larvae. Consult your State Cooperative Extension Service for more specific information regarding timing of application. Full season control of white grubs will be obtained with an application of 14 fl oz/A targeted towards Annual Bluegrass Weevil/Hyperodes.</p>	

(continued)

## TURFGRASS AND LAWNS (continued)

- <sup>2</sup> Applications of *Aloft* LC SC Insecticide in the late fall or early spring will reduce populations of nuisance ants on residential lawns. Make an application in the fall before ants stop foraging or after they become active in the spring. Make a broadcast application and lightly water in to wet the turf and thatch area where nuisance ants are foraging.
- <sup>3</sup> **Billbugs:** Application can be made when adult Billbugs are first observed, usually in April and May in temperate regions. A spring application will also control Billbug larvae. Consult your State Cooperative Extension Service for more specific information regarding timing of application. White grubs will be controlled with an application targeted towards Billbugs.
- <sup>4</sup> **Black Turfgrass Ataenius:** Application can be timed to coincide with the first generation of Black Turfgrass Ataenius that usually appears during May. White grubs will be controlled with an application targeted towards Black Turfgrass Ataenius.
- <sup>5</sup> **Mole Crickets:** Apply during peak adult flight and egg lay. If the soil is dry, irrigate before application to stimulate insect activity and water in lightly after application to move the insecticide into the zone where the mole crickets are active.
- <sup>6</sup> **Ticks (including ticks that may transmit Lyme Disease and Rocky Mountain Spotted Fever):** Treat the entire area where exposure to ticks may occur. Use higher spray volumes when treating areas with dense groundcover or heavy leaf litter. Ticks may be reintroduced from surrounding areas on host animals.
- Deer Ticks (*Ixodes* sp.):** Apply in late fall and/or early spring to control adult ticks that are usually located on brush or grass above the soil surface and in mid- to late-spring to control larvae and nymphs that reside in the soil and leaf litter.
- American Dog Ticks (*Dermacentor* sp.):** These ticks commonly congregate along paths or roadways where humans are likely to be encountered. Apply from mid-spring to early fall to control American dog tick larvae, nymphs and adults.
- <sup>7</sup> *Aloft* LC SC Insecticide will control White Grubs anytime applications are made when they are active from early spring to late fall. The residual activity of *Aloft* LC SC Insecticide is long enough to provide season long control of White Grubs when applied for control of listed early season insects such as Annual Bluegrass Weevil, Billbugs, Nuisance Ants, or overwintering White Grubs.

(continued)

## TURFGRASS AND LAWNS (continued)

- <sup>8</sup> **Red Imported Fire Ants\*:** If the soil is not moist, irrigate before application or use a high volume application. For mound treatments, use one teaspoon *Aloft* LC SC Insecticide per gallon of water (this is equivalent to 14.4 fl oz *Aloft* LC SC Insecticide per acre applied in 87 gallons of water) and apply 1 - 2 gallons of finished spray per mound. The solution should be applied in such a manner to allow the solution to move into the mound. Also treat a four foot diameter circle around the mound. Apply in cool weather (65 - 80° F) or in early morning or late evening hours when most of the foraging workers are in the colony.

### RESTRICTIONS

- Do not apply more than a total of 23.3 fl oz of *Aloft* LC SC Insecticide (0.4 lb of clothianidin active ingredient, 0.2 lb bifenthrin) per acre per year.
- If the maximum season limit of *Aloft* LC SC Insecticide has been applied and pest populations require additional treatments, use another registered pesticide labeled for control of the targeted insects that does not contain clothianidin. You may use additional products containing bifenthrin as long as the maximum amount of bifenthrin does not exceed 0.4 lb active ingredient per acre per year.
- Do not allow this product to contact plants in bloom if bees are foraging the treatment area.
- Do not allow children and pets to enter the treated area until sprays have dried.
- Not for use on golf courses and sod farms.

\*Not approved in California.

### APPLICATION INSTRUCTIONS – LANDSCAPE ORNAMENTALS

*Aloft* LC SC Insecticide is a contact and long lasting systemic insect control product for listed insects infesting landscape ornamentals adjacent to turf areas. *Aloft* LC SC Insecticide can be used around residences, business complexes, industrial complexes, airports, playgrounds, school yards, parks and recreation areas, athletic fields, cemeteries and arboretums.

For foliar applications, apply enough spray solution to wet the surface of the leaves to the point of drip.

For control of listed surface insects and insects that crawl along the surface of the soil or mulch under ornamentals, water in lightly after application to move the insecticide into the areas where insects are active. Water in with enough irrigation or rainfall to move the active ingredient into the zone where the target insects are active. Soil surface applications will provide control of foliage feeding insects; however, optimum control will not be achieved until the active ingredient is taken up by the plant roots and translocated to the area where insects are feeding.

**LANDSCAPE ORNAMENTALS**

<b>FOLIAR APPLICATION ALOFT LC SC INSECTICIDE RATE (fl oz/100 gals)</b>	<b>FOLIAR INSECT PESTS CONTROLLED</b>	<b>APPLICATION INSTRUCTIONS</b>
<p align="center">3.6 - 15.5 (5.0 - 22.5 fl oz/A based on 150 gallons of spray per acre)</p>	<p>Aphids Caterpillars Leafhoppers Mealybugs White Flies</p>	<p>Target the spray towards the areas where the insects are active.</p> <p>Use enough water carrier to wet the surfaces on the target plants to the point of drip.</p> <p>Repeat applications may be made if insects reappear but do not exceed a total of 0.54 fl oz <i>Aloft</i> LC SC Insecticide per 1,000 sq ft of landscape.</p>
<p align="center">5.0 - 15.5 (7.5 - 22.5 fl oz/A based on 150 gallons of spray per acre)</p>	<p>Ants<sup>1</sup> (Excluding Fire, Harvester, Pharaoh, and Carpenter Ants) Bagworms Black Vine Weevil (adults) Brown Soft Scale Budworms California Red Scale (crawlers) Chiggers Clover Mites Crickets Cutworms Earwigs Elm Leaf Beetles Flea Beetles Japanese Beetles (Adults) Plant Bugs Spiders Tent Caterpillars Tip Moths Weevils</p>	<p>Target the spray towards the areas where the insects are active.</p> <p>Use enough water carrier to wet the surfaces on the target plants to the point of drip.</p> <p>Repeat applications may be made if insects reappear but do not exceed a total of 0.54 fl oz <i>Aloft</i> LC SC Insecticide per 1,000 sq ft of landscape.</p>
<p align="center">8.0 - 15.5 (12 - 22.5 fl oz/A based on 150 gallons of spray per acre)</p>	<p>Adelgids Azalea Lacebug Beetles Cicadas (Adults) Citrus Thrips <i>Diaprepes</i> (adults) Florida Wax Scale Glassy-winged Sharpshooter Gypsy Moth Lacebugs Leafminers Leafrollers Mites<sup>2</sup> Pine Needle Scale (crawlers) Plant Bugs (incl. <i>Lygus</i> spp.) Scales, soft</p>	<p>Target the spray towards the areas where the insects are active.</p> <p>Use enough water carrier to wet the surfaces on the target plants to the point of drip.</p> <p>Repeat applications may be made if insects reappear but do not exceed a total of 0.54 fl oz <i>Aloft</i> LC SC Insecticide per 1,000 sq ft of landscape.</p>

(continued)

**LANDSCAPE ORNAMENTALS** (continued)

<sup>1</sup> *Aloft* LC SC Insecticide will control aphids, scale insects, mealybugs and other sucking pests on ornamentals and limit the honeydew available as a food source for ant populations. Ants (excluding fire, harvester, carpenter and pharaoh ants) present at the time of application will also be controlled.

<sup>2</sup> *Aloft* LC SC Insecticide will provide suppression of Broad Mites, Clover Mites, European Red Mites and Spider Mites when used for control of other listed insects. Use a surfactant on hard to wet plants. The use of an alternate class of chemistry in a mite treatment program is recommended to prevent or delay development of bifenthrin resistant mite populations.

**RESTRICTIONS**

- Do not apply more than a total of 23.3 fl oz of *Aloft* LC SC Insecticide (0.4 lb of clothianidin active ingredient, 0.2 lb bifenthrin) per acre per year.
- If the maximum season limit of *Aloft* LC SC Insecticide has been applied and pest populations require additional treatments, use another pesticide labeled for control of the targeted insects that does not contain clothianidin. You may also use additional products containing bifenthrin as long as the maximum amount of bifenthrin does not exceed 0.4 lb active ingredient per acre per year.
- Follow application restrictions on this label, designated by the bee icon, to protect bees and other insect pollinators.

<b>SOIL SURFACE OR MULCH APPLICATION</b>	<b>SOIL INSECT PESTS CONTROLLED</b>		<b>APPLICATION INSTRUCTIONS</b>
0.27 - 0.54 fl oz per 1,000 sq ft (11.65 - 23.3 fl oz/A)	Ants, Nuisance (Excluding Fire, Harvester, Pharaoh, and Carpenter Ants) Beet Armyworm Beetles Black Vine Weevils (Larvae) Centipedes Crickets Cutworms <i>Diaprepes</i> (Adults) Earwigs Fall Armyworms	Grasshoppers Millipedes Pillbugs White Grubs (Asiatic Garden Beetle, European Chafer, Green June Beetle, Japanese Beetle, Northern Masked Chafer, <i>Phyllophaga</i> spp. (May or June Beetle), Oriental Beetle, Southern Masked Chafer)	Apply in enough water to wet the areas where the insects are active or water in after applications with enough irrigation to move the insecticide into the areas where insects are active.  For ornamental trees and woody shrubs see below.
<b>SOIL SURFACE OR MULCH APPLICATION</b>	<b>ABOVE GROUND INSECT PESTS CONTROLLED</b>		<b>APPLICATION INSTRUCTIONS</b>
0.34 - 0.54 fl oz per 1,000 sq ft (15 - 23.3 fl oz/A)	Aphids Azalea Lacebug Borers* Black Vine Weevils (Adults) Caterpillars Flea Beetles Florida Wax Scale Glassy-winged Sharpshooter Gypsy Moth Caterpillars	Japanese Beetles (Adults) Leafhoppers Leafminers Leafrollers Mealybugs Plant Bugs (incl. <i>Lygus</i> spp.) Root Weevils (incl. Black Vine Weevils) Scales, Soft Whiteflies	Apply in enough water to wet the root zone of the plants. Control of leaf feeding insects will be delayed until the insecticide is taken up by the roots and moved into the areas where insects are feeding, usually 2 - 4 weeks.  For ornamental trees and woody shrubs see below.

**RESTRICTIONS**

- Do not apply more than a total of 23.3 fl oz of *Aloft* LC SC Insecticide (0.4 lb of clothianidin active ingredient, 0.2 lb bifenthrin) per acre per year.
- If the maximum season limit of *Aloft* LC SC Insecticide has been applied and pest populations require additional treatments, use another pesticide labeled for control of the targeted insects that does not contain clothianidin. You may use additional products containing bifenthrin as long as the maximum amount of bifenthrin does not exceed 0.4 lb active ingredient per acre per year.

**Drench application to ornamental trees and woody shrubs adjacent to turf:**

*Aloft* LC SC Insecticide can be used for systemic control of listed insects with an application to trees in landscapes and interior plantscapes. *Aloft* LC SC Insecticide contains clothianidin which is systemic and will be translocated throughout the tree. Treat the area over the root zone of the trees or apply the insecticide in the "root well" of the plant.

Apply the insecticide in enough water to get uniform coverage and water in after application. *Aloft* LC SC Insecticide is a systemic product and will be translocated upward into the plant system from root uptake. It must be placed in an area where the roots can absorb the active ingredient. It may take 2 - 4 weeks for the active ingredient to move from the root zone to the areas of the trees affected. If insect pests are already present and causing damage, consider making a foliar application and then following up with a drench application.

For ornamental trees and shrubs adjacent to turf areas, use 0.06 - 0.12 fl oz *Aloft* LC SC Insecticide per inch of cumulative trunk diameter (DBH) of the plant(s). For hedges six feet or less in height use 0.6 fl oz *Aloft* LC SC Insecticide per 100 linear feet of hedge. For hedges greater than six feet in height, use an additional 0.15 fl oz per 100 linear feet of hedge for each foot of hedge height over six feet. Before application remove any plastic or other barriers that may prevent the insecticide from reaching the root zone of the plants.

\*For Bronze Birch Borers, Flatheaded Borers and other borers (excluding Emerald Ash Borer and Asian Longhorned Beetles): Use a drench treatment around the trunk of the trees when the trees are actively growing. Mix 0.5 fl oz *Aloft* LC SC Insecticide in 10 gallons of water and apply 2 qt of the mixture per 1 inch DBH in a 1 - 2 ft area around the trunks of the trees.

For outdoor ornamentals, do not apply more than a total of 23.3 fl oz *Aloft* LC SC Insecticide (0.4 lb of clothianidin active ingredient, 0.2 lb bifenthrin) per acre per year.

**NUT TREES and Ornamental Trees (including Non-bearing Fruit Trees) In Landscapes that are NOT for Food Use**

Apply *Aloft* LC SC Insecticide when threshold populations are observed. Do not wait until large insect populations have been established. For foliar applications, apply *Aloft* LC SC Insecticide in sufficient water to ensure uniform and thorough coverage of foliage. Thorough coverage is required for listed insect control. To achieve optimum coverage, use proper spray pressures, nozzles, nozzle spacing and water volume per acre. For soil applications, apply as a soil surface spray to the entire root zone or as a banded spray to the tree well area.

**APPLICATION RATES (POST-BLOOM APPLICATION)**

PEST	APPLICATION RATE	
Aphids	<b>Soil Application:</b> for trees under 6 feet tall	<b>Foliar Application:</b> 8.0 - 15.5 fl oz per 100 gallons*
Adelgids		
Leafhoppers	0.35 - 0.54 fl oz per 1,000 sq ft	
Plum curculio		
Apple maggot	<b>Soil Application:</b> for trees over 6 feet tall	
Codling moth <sup>1</sup>		
Oriental fruit moth <sup>1</sup>	0.54 - 1.25 fl oz per 1,000 sq ft	
Spotted tentiform leafminer <sup>2</sup>		
Western tentiform leafminer <sup>2</sup>		
Obliquebanded leafrollers <sup>2</sup>		
Whiteflies (suppression) <sup>2</sup>		

\*The amount of *Aloft* LC SC Insecticide per acre will depend on tree size, pest pressure and the volume of foliage present.

<sup>1</sup> To control Codling moth and Oriental fruit moth, apply *Aloft* LC SC Insecticide in a program of rotational sprays with other labeled insecticides. When using the foliar application rates of 8.0 - 15.5 fl oz per 100 gallons of *Aloft* LC SC Insecticide to control Codling moth and/or Oriental fruit moth, do not apply treatments less than a 14 day interval.

<sup>2</sup> For control of leafminers and leafrollers, apply as a soil application in early spring when the soil is not frozen. A foliar application may result in suppression only and a repeat foliar application may be necessary to maintain control.

It may take 2-4 weeks for the active ingredient to move from the root zone to the areas of the trees affected. If insect pests are already present and causing damage, consider making a foliar application and then following up with a drench application.

**RESTRICTIONS**

- Do not consume fruit or nuts from these trees at any time.
- Do not apply more than a total of 23.3 fl oz of *Aloft* LC SC Insecticide (0.4 lb of clothianidin active ingredient, 0.2 lb bifenthrin) per acre per year.
- When using the rates for trees larger than 6 feet, apply only to the target root area as a surface spray or as a band treatment, do not apply more than 23.3 ounces per acre on the treatment site or property.
- For foliar applications, apply *Aloft* LC SC Insecticide in a full coverage spray to the point of drip. The spray volume will depend on tree size and density of canopy. Repeat applications as needed to maintain control but do not apply more often than every 10 days.
- Do not apply foliar treatments less than 10 days apart.
- Do not apply *Aloft* LC SC Insecticide through any type of irrigation system.

## STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

### PESTICIDE STORAGE

Store in a cool, dry place away from excessive heat. Do not store near food, feed, fertilizers, seeds, or other pesticides.

Keep this product out of reach of children and animals at all times.

Store in original container only.

Open the product container carefully and after use, seal tightly.

For help with any spill, leak, fire or exposure involving this material, call day or night (800) 892-0099.

### PESTICIDE DISPOSAL

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

### CONTAINER HANDLING:

Non-refillable container. Do not reuse or refill this container. Triple 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. Offer for recycling, if available, or puncture and dispose of in a sanitary landfill.

## DISCLAIMER, RISKS OF USING THIS PRODUCT, LIMITED WARRANTY AND LIMITATION OF LIABILITY

**IMPORTANT:** Read the entire Label including this Disclaimer, Risks of Using this Product, Limited Warranty, and Limitation of Liability before using this product. If the terms are not acceptable THEN DO NOT USE THE PRODUCT; rather, return the unopened product within 15 days of purchase for a refund of the purchase price.

### RISKS OF USING THIS PRODUCT

The Buyer and User (referred to collectively herein as "Buyer") of this product should be aware that there are inherent unintended risks associated with the use of this product which are impossible to eliminate. These risks include, but are not limited to, injury to plants and crops to which this product is applied, lack of control of the target pests or weeds, resistance of the target pest or weeds to this product, injury caused by drift, and injury to rotational crops caused by carryover in the soil. Such risks of crop injury, non-performance, By applying this product Buyer acknowledges and accepts these inherent unintended risks AND TO THE

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(continued)

FULLEST EXTENT ALLOWED BY LAW, AGREES THAT ALL SUCH RISKS ASSOCIATED WITH THE APPLICATION AND USE ARE ASSUMED BY THE BUYER.

Valent shall not be responsible for losses or damages (including, but not limited to, loss of yield, increased expenses of farming the crop or such incidental, consequential or special damages that may be claimed) resulting from use of this product in any manner not set forth on the label. Buyer assumes all risks associated with the use of this product in any manner or under conditions not specifically directed or approved on the label.

### LIMITED WARRANTY

Valent warrants only that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated in the label, under average use conditions, when used strictly in accordance with the label **and subject to the Risks of Using This Product as described above. To the extent consistent with applicable law AND AS SET FORTH ABOVE, VALENT MAKES NO OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED.** No agent or representative of Valent or Seller is authorized to make or create any other express or implied warranty.

### LIMITATION OF LIABILITY

**To the fullest extent allowed by law, Valent or Seller is not liable for any incidental, consequential, indirect or special damages resulting from the use or handling of this product. The limitation includes, but is not limited to, loss of yield on all or any portion of the treated acreage, increased care, treatment or other expenses required to take the crop to harvest, increased finance charges or altered finance ratings, emotional or mental distress and/or exemplary damages. TO THE FULLEST EXTENT ALLOWED BY LAW, THE EXCLUSIVE REMEDY OF THE BUYER, AND THE EXCLUSIVE MAXIMUM LIABILITY OF VALENT OR SELLER FOR ANY AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OF WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT SHALL BE THE RETURN OF THE PURCHASE PRICE OF THIS PRODUCT OR, AT THE ELECTION OF VALENT OR SELLER, THE REPLACEMENT OF THE PRODUCT.**

### PROMPT NOTICE OF CLAIM

To the extent consistent with applicable law allowing such requirements, Valent must be provided notice as soon as Buyer has reason to believe it may have a claim, but in no event later than twenty-one days from date of planting, or twenty-one days from the date of application, whichever is later, so that an immediate inspection of the affected property and growing crops can be made.

(continued)

(continued)

To the extent consistent with applicable law, if Buyer does not notify Valent of any claims, in such period, it shall be barred from obtaining any remedy.

**NO AMENDMENTS**

Valent and Seller offer this product, and Buyer accepts it, subject to the foregoing **Disclaimer, Risks of Using This Product, Limited Warranty** and **Limitation of Liability**, which may not be modified by any oral or written agreement.

**TANK MIXES**

NOTICE: Tank mixing or use of this product with any other product which is not specifically and expressly authorized by the label shall be the exclusive risk of user, applicator and/or application advisor to the extent allowed by applicable law.

It is the pesticide user's responsibility to ensure that all products in the listed mixtures are registered for the intended use. Read and follow the most restrictive directions and precautionary language of each product to be used in the tank mix with this product.

*Aloft* and *Products That Work, From People Who Care* are registered trademarks of Valent U.S.A. Corporation.

Manufactured for:

**Valent U.S.A. Corporation**

P.O. Box 8025

Walnut Creek CA 94596-8025

Made in U.S.A.

Form 2041-A

EPA Reg. No. 59639-213

EPA Est. 70815-GA-001

059639-00213.20151208.Aloft\_LC\_SC.NOTIF

Information contained in this booklet is accurate at the time of printing. Since product testing is a continuous process, please read and follow the directions on the product label for the most current directions and precautionary statements.

Always check with your state to verify state registration status or call 800-89-VALENT (898-2536).



For state registration and/or supplemental labels, please call or visit us online.

*Products That Work, From People Who Care*® | [valentpro.com](http://valentpro.com) | 800-89-VALENT (898-2536)

***Always read and follow label instructions.***

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### **XtendiMax® with VaporGrip® Technology Scenario**

A postemergence (in-crop) broadcast application of XtendiMax® with VaporGrip® Technology is planned for the 80-acre RR2 Xtend soybean field southwest of the river. The crop was planted on April 6. You completed the required Dicamba training on April 17 of this year. The product will be applied at a rate of 22 fl oz/acre. The application is planned for May 9, and that day's high temperature is expected to be 82°F. Sunrise will occur at 6:26 a.m. and sunset will occur at 8:37 p.m. that day. You consulted FieldWatch on April 29, and you physically scouted the area for sensitive crops and areas on April 30. You drew the map based on FieldWatch and your scouting. You checked the Endangered Species Protection Bulletin on March 29 and found no pesticide use limitations for the area for your anticipated spray date. The purchase receipt and pesticide label are on file in your office.

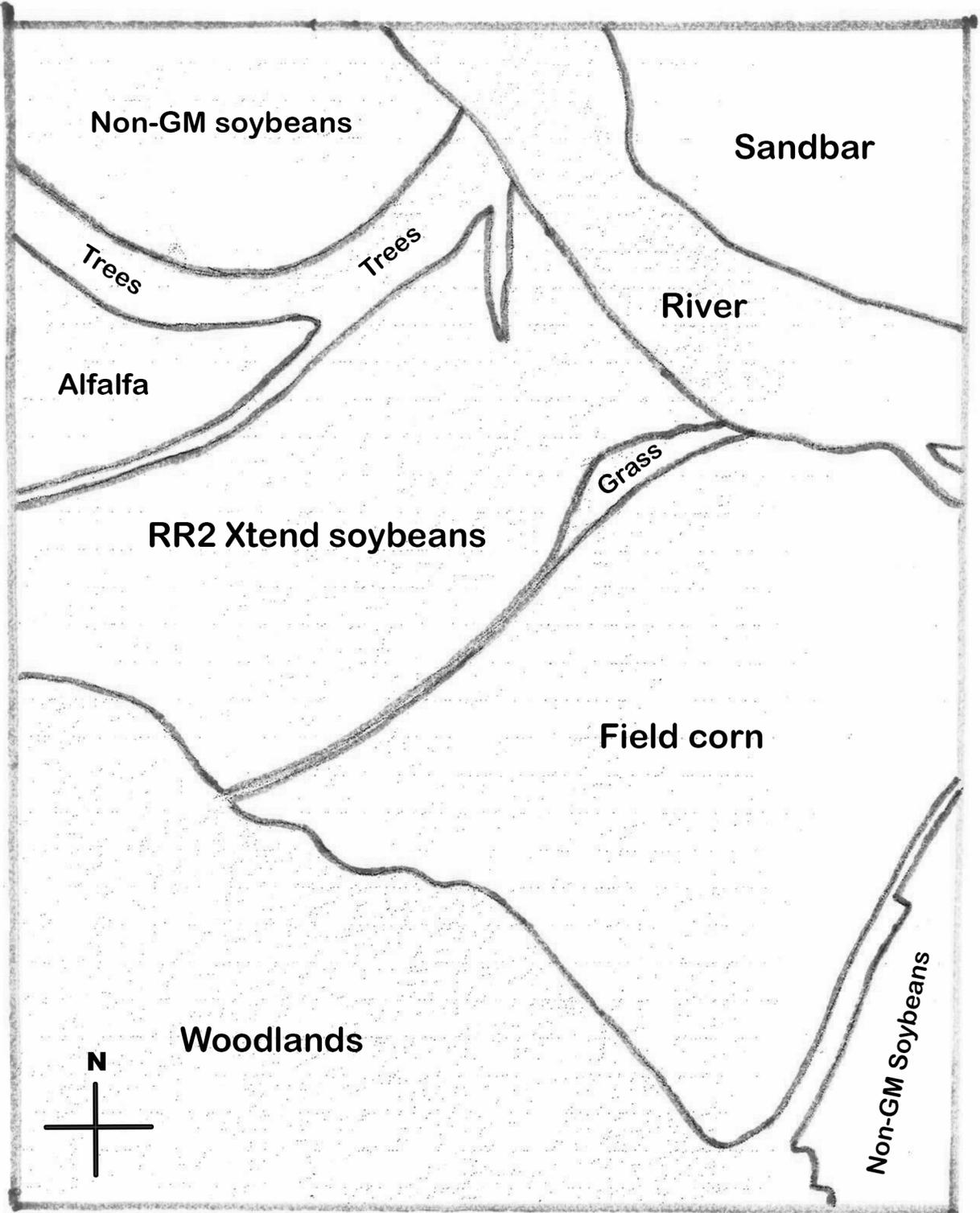
1. The surroundings of the target field present a number of concerns for the application. Which surroundings should the applicator be concerned about? Why?
2. If a 9mph wind is blowing from the north, will a downwind buffer be necessary? If so, where and how wide?
3. If a 4mph wind is blowing from the south, will a downwind buffer be necessary? If so, where and how wide?
4. If a 14mph wind is blowing from the west, will a downwind buffer be necessary? If so, where and how wide?
5. What is the earliest time of day this application may begin on May 9? What is the latest time of day this application may end on May 9?
6. Can the application rate be increased to 44 fl oz/acre for this application? Why or why not?
7. How should you determine if a 57-foot Endangered Species buffer needs to be incorporated for this application?
8. You are concerned about dicamba-resistant weed escapes, and want to tank-mix XtendiMax with another product. Which herbicide group would you avoid? How can you tell if a product is approved for tank-mixing with XtendiMax? When must you check for this approval?
9. If you were to tank mix XtendiMax with a wettable powder formulation, which product should be added to the tank first: the wettable powder formulation or the XtendiMax (water-soluble)?

10. Complete the required recordkeeping for this application (to the extent permitted by the information provided in the Scenario). Also, assume the wind is blowing from the north at 9mph at both the start and finish of the application.

- a. Brand/product name:
- b. EPA Reg. No.:
- c. Total amount applied:
- d. Month, day, and year of application:
- e. Location:
- f. Crop/commodity:
- g. Size of area treated:
- h. Name of applicator:
- i. Certification number:
- j. Training date (must be in the same calendar year as the application):
- k. Receipt of purchase:
- l. Product label:
- m. Planting date:
- n. Buffer requirement:
- o. Sensitive crop registry consultation:
- p. Sensitive crop/area survey:
- q. Start/finish time of application:
- r. Application timing:
- s. Air temperature at start and finish:
- t. Wind speed/direction at start and finish:
- u. Nozzle and pressure:
- v. Tank mix product(s):
- w. Spray system cleanout:

What information has NOT been provided that is needed to complete the records?

XtendiMax Scenario Map





35008S2-40

# RESTRICTED USE PESTICIDE

For retail sale to and use only by Certified Applicators

DICAMBA	GROUP	4	HERBICIDE
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# XTENDIMAX<sup>®</sup>

With VaporGrip<sup>®</sup> Technology

This labeling expires on 12/20/2020. Do not use or distribute this product after 12/20/2020.

This label supersedes any previously issued labeling for this product, including previously issued supplemental labeling.

For weed control in asparagus, conservation reserve programs, corn, cotton, fallow croplands, general farmstead (noncropland), sorghum, grass grown for seed, hay, proso millet, pasture, rangeland, small grains, sod farms and farmstead turf, soybean, sugarcane, cotton with XtendFlex<sup>®</sup> Technology, Roundup Ready 2 Xtend<sup>®</sup> Soybean, and XtendFlex<sup>®</sup> Soybean.

XtendiMax<sup>®</sup> With VaporGrip<sup>®</sup> Technology is approved by U.S. EPA for all uses specified on this label in the following states, subject to county restriction as noted: Alabama, Arkansas, Arizona, Colorado, Delaware, Florida (excluding Palm Beach County), Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Ohio, Pennsylvania, South Carolina, South Dakota, Tennessee (excluding Wilson County), Texas, Virginia, West Virginia, Wisconsin.

Check the registration status of each product in each state before using.

READ THE ENTIRE LABEL FOR XTENDIMAX<sup>®</sup> WITH VAPORGRIP<sup>®</sup> TECHNOLOGY BEFORE PROCEEDING WITH THE USE DIRECTIONS CONTAINED IN THIS LABEL

READ AND FOLLOW ALL APPLICABLE DIRECTIONS, RESTRICTIONS, AND PRECAUTIONS ON THE CONTAINER LABEL AND BOOKLET AND [WWW.XTENDIMAXAPPLICATIONREQUIREMENTS.COM](http://WWW.XTENDIMAXAPPLICATIONREQUIREMENTS.COM).

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

Keep out of reach of children.

## CAUTION!

### ACTIVE INGREDIENT:

Diglycolamine salt of dicamba (3,6-dichloro-*o*-anisic acid)\* ..... 42.8%

OTHER INGREDIENTS: ..... 57.2%

TOTAL: ..... 100.0%

\* contains 29.0%, 3,6-dichloro-*o*-anisic acid (2.9 pounds acid equivalent per U.S. gallon or 350 grams per liter).

EPA Reg. No. 524-617

Packed for:  
MONSANTO COMPANY  
800 N. LINDBERGH BLVD.  
ST. LOUIS, MISSOURI, 63167 U.S.A.  
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181101

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## 1.0 INGREDIENTS

### ACTIVE INGREDIENT:

Diglycolamine salt of dicamba (3,6-dichloro- <i>o</i> -anisic acid)*	42.8%
OTHER INGREDIENTS:	57.2%
TOTAL:	100.0%

\* contains 29.0%, 3,6-dichloro-*o*-anisic acid (2.9 pounds acid equivalent per U.S. gallon or 350 grams per liter).

## 2.0 IMPORTANT PHONE NUMBERS

1. FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT, CALL TOLL-FREE, 1-800-332-3111.
2. IN CASE OF AN EMERGENCY INVOLVING THIS HERBICIDE PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT, (314)-694-4000.

### IN CASE OF SPILL:

#### Steps to be taken in case material is released or spilled:

Dike and contain the spill with inert material (sand, earth, etc.) and transfer liquid and solid diking material to separate containers for disposal. Remove contaminated clothing, and wash affected skin areas with soap and water. Wash clothing before re-use. Keep the spill out of all sewers and open bodies of water.

## 3.0 PRECAUTIONARY STATEMENTS

### 3.1 Hazards to Humans and Domestic Animals

Keep out of reach of children.

## CAUTION!

Causes moderate eye irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.

FIRST AID	
<b>IF IN EYES:</b>	<ul style="list-style-type: none"><li>• Hold eye open and rinse slowly and gently with water for 15 to 20 minutes.</li><li>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.</li><li>• Call a poison control center or doctor for treatment advice.</li></ul>
<b>IF SWALLOWED:</b>	<ul style="list-style-type: none"><li>• Call a poison control center or doctor immediately for treatment advice.</li><li>• Have person sip a glass of water if able to swallow.</li><li>• Do not induce vomiting unless told to do so by a poison control center or doctor.</li><li>• Do not give anything by mouth to an unconscious person.</li></ul>
<b>IF ON SKIN OR CLOTHING:</b>	<ul style="list-style-type: none"><li>• Take off contaminated clothing.</li><li>• Rinse skin immediately with plenty of water for 15 to 20 minutes.</li><li>• Call a poison control center or doctor for treatment advice.</li></ul>
<ul style="list-style-type: none"><li>• Have the product container or label with you when calling a poison control center or doctor, or going for treatment.</li><li>• You can call (314) 694-4000, collect day or night, for emergency medical treatment information.</li><li>• This product is identified as <b>XtendiMax® With VaporGrip® Technology, EPA Registration No. 524-617.</b></li></ul>	

### PERSONAL PROTECTIVE EQUIPMENT (PPE)

#### All mixers, loaders, applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Waterproof gloves
- Shoes plus socks

See "Engineering Controls Statement" for additional requirements.

Follow the manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

### ENGINEERING CONTROLS STATEMENT

When handlers use closed systems, or enclosed cabs in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides (40 CFR 170.240 (d) (4-6)), the handler PPE requirements may be reduced or modified as specified in the WPS.

**IMPORTANT:** When reduced PPE is worn because a closed system is being used, handlers must be provided all PPE specified above for "all mixers, loaders, applicators and other handlers" and have such PPE immediately available for use in an emergency, such as a spill or equipment breakdown.

### USER SAFETY RECOMMENDATIONS

#### Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

## 3.2 Environmental Hazards

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Apply this product only as directed on the label.

This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination.

### Ground and Surface Water Protection

**Point source contamination** - To prevent point source contamination, do not mix or load this pesticide product within 50 feet of wells (including abandoned wells and drainage wells), sink holes, perennial or intermittent streams and rivers, and natural or impounded lakes and reservoirs. Do not apply pesticide product within 50 feet of wells. This setback does not apply to properly capped or plugged abandoned wells and does not apply to impervious pad or properly diked mixing/loading areas as described below.

Mixing, loading, rinsing, or washing operations performed within 50 feet of a well are allowed only when conducted on an impervious pad constructed to withstand the weight of the heaviest load that may be on or move across the pad. The pad must be self-contained to prevent surface water flow over or from the pad. The pad capacity must be maintained at 110% that of the largest pesticide container or application equipment used on the pad and have sufficient capacity to contain all product spills, equipment or container leaks, equipment wash waters, and rainwater that may fall on the pad. The containment capacity does not apply to vehicles delivering pesticide shipments to the mixing/loading site. States may have in effect additional requirements regarding wellhead setbacks and operational containment.

Care must be taken when using this product to prevent: a) back siphoning into wells, b) spills or c) improper disposal of excess pesticide, spray mixtures or rinsates. Check valves or anti-siphoning devices must be used on all mixing equipment.

**Movement by surface runoff or through soil** - Do not apply under conditions which favor runoff. Do not apply to impervious substrates such as paved or highly compacted surfaces in areas with high potential for ground water contamination. Ground water contamination may occur in areas where soils are permeable or coarse and ground water is near the surface. Do not apply to soils classified as sand with less than 3% organic matter and where ground water depth is shallow. To minimize the possibility of ground water contamination, carefully follow application rate recommendations as affected by soil type in the Crop Specific Information section of this label.

**Movement by water erosion of treated soil** - Do not apply or incorporate this product through any type of irrigation equipment nor by flood or furrow irrigation. Ensure treated areas have received at least one-half inch rainfall (or irrigation) before using tailwater for subsequent irrigation of other fields.

### Endangered Species Concerns

Use of this product in a manner inconsistent with its labeling may pose a hazard to endangered or threatened species. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the area in which you are applying the product. To obtain Bulletins, no more than six months before using this product, consult <https://www.epa.gov/endangered-species> or call 1-844-447-3813. You must use the Bulletin valid for the month in which you will apply the product.

It is a Federal offense to use any pesticide in a manner that results in the death of an endangered species.

## 3.3 Physical or Chemical Hazards

Do not store or heat near oxidizing agents, hazardous chemical reaction may occur.

## 4.0 DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. This product can only be used in accordance with the Directions for Use on this label. This labeling must be in the user's possession during application.

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 regulations.

This is a restricted use pesticide.

### 4.1 Training

Prior to applying this product in the 2019 growing season and each growing season thereafter, all applicator(s) applying this product must complete dicamba or auxin-specific training. If training is available and required by the state where the applicator intends to apply this product, the applicator must complete that training. If the state where the application is intended does not require auxin or dicamba-specific training, then the applicator must complete dicamba or auxin-specific training provided by one of the following sources: a) a registrant of a dicamba product approved for in-crop use with dicamba-tolerant crops, or b) a state or state-authorized provider.

### 4.2 Record Keeping

Record keeping is required for applications of this product. **The certified applicator must keep the following records for a period of two years;** records must be generated as soon as practical but no later than 72 hours after application and a record must be kept for each application of XtendiMax® with VaporGrip® Technology. Records must be made available to State Pesticide Control Official(s), USDA, and EPA upon request. An example form summarizing record keeping requirements can be found on [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com).

1. All Items required by 7 CFR Part 110 (RECORDKEEPING ON RESTRICTED USE PESTICIDES BY CERTIFIED APPLICATORS) including:
  - a. The brand or product name
  - b. The EPA registration number
  - c. The total amount applied
  - d. The month, day, and year of application
  - e. The location of the application
  - f. The crop, commodity, stored product, or site of application
  - g. The size of treated area
  - h. The name of the certified applicator
  - i. The certification number of the certified applicator
2. Training: Date and provider of required training completed and proof of completion.
3. Receipts of Purchase: Receipts or copies for the purchase of this product.
4. Product Label: A copy of this product label, and any state special local needs label that supplements this label.
5. Crop Planting Date: Record of the date at which the crop was planted.
6. Buffer Requirement: Record of the buffer distance calculation and any areas included within the buffer distance calculations as allowed in Section 9.1.4.a.
7. Sensitive Crops Awareness: Record that a sensitive crop registry was consulted and survey adjacent fields documenting the crops/areas surrounding the field prior to application. At a minimum, records must include the name of the sensitive crop registry and the date it was consulted and documentation of adjacent crops/areas and the date the survey was conducted (read Section 9.1.4.b for additional information).
8. Start and Finish Times of Each Application: Record of the time at which the application started and the time when the application finished.
9. Application Timing: Record of the type of application (for example: pre-emergence, post-emergence) and number of days after planting if post-emergence.
10. Air Temperature: Record of the air temperature in degrees Fahrenheit at the start and completion of each application.
11. Wind Speed and Direction: Record of the wind speed and direction (the direction from which the wind is blowing) at boom height at the start and completion of each application of this product (Read Section 9.1.1 for information on wind speed).
12. Nozzle and Pressure: Record of the spray nozzle manufacturer/brand, type, orifice size, and operating pressure used during each application of this product (Read Section 9.1.1 for information on nozzles and pressures.)
13. Tank Mix Products: Record of the brand names and EPA registration numbers (if available) for all products (pesticides, adjuvants, and other products) that were tank mixed with this product for each application (Read Section 8.0 for more information on tank mixing.)
14. Spray System Cleanout: Record of compliance with the section of this label titled Section 9.5: Proper Spray System Equipment Cleanout. At a minimum, records must include the confirmation that the spray system was clean before using this product and that the post-application cleanout was completed in accordance with Section 9.5.

### 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 intervals. The requirements in this box only apply to uses of this product that are covered by the WPS.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 24 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as, plants, soil, or water is:

- Coveralls worn over short-sleeved shirt and short pants
- Chemical-resistant footwear plus socks
- Waterproof gloves
- Chemical-resistant headgear for overhead exposure
- Protective eyewear

### 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 applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Do not enter or allow people (or pets) to enter the treated area until sprays have dried. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Do not enter or allow other people or pets to enter until sprays have dried.

## 5.0 STORAGE AND DISPOSAL

Proper pesticide storage and disposal are essential to protect against exposure to people and the environment due to leaks and spills, excess product or waste, and vandalism. Do not allow this product to contaminate water, foodstuffs, feed or seed by storage and disposal. Open dumping is prohibited. This product may not be mixed, loaded, or used within 50 feet of all wells including abandoned wells, drainage wells, and sinkholes. This setback does not apply to properly capped or plugged abandoned wells and does not apply to impervious pad or properly diked mixing/loading areas as described above.

### 5.1 Pesticide Storage

Groundwater contamination may be reduced by diking and flooring of permanent liquid bulk storage sites with an impermeable material. Spillage or leakage should be contained and absorbed with clay granules, sawdust, or equivalent material for disposal.

Store in original container in a well-ventilated and away from food, pet food, feed, seed, fertilizers, and veterinary supplies. Avoid cross-contamination with other pesticides. Keep container closed to prevent spills and contamination.

### 5.2 Pesticide Disposal

To avoid wastes, use all material in this container, including rinsate, by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program. Such programs are often run by state or local governments or by industry. All disposal must be in accordance with applicable federal, state and local regulations and procedures.

### 5.3 Container Handling and Disposal

See container label for container handling and disposal instructions and refilling limitations.

## 6.0 PRODUCT INFORMATION

XtendiMax® With VaporGrip® Technology is approved by U.S. EPA for all uses specified on this label in the following states, subject to county restriction as noted: Alabama, Arkansas, Arizona, Colorado, Delaware, Florida (excluding Palm Beach County), Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Ohio, Pennsylvania, South Carolina, South Dakota, Tennessee (excluding Wilson County), Texas, Virginia, West Virginia, Wisconsin.

Additional state restrictions and requirements may apply. The applicator must comply with any additional state requirements and restrictions.

This product is a water-soluble formulation intended for control and suppression of many annual, biennials, and perennial broadleaf weeds, as well as woody brush and vines listed in the WEEDS CONTROLLED section of this label. This product may be used for control of these weeds in asparagus, corn, cotton, conservation reserve programs, fallow cropland, grass grown for seed, hay, proso millet, pasture, rangeland, general farmstead (noncropland), small grains, sod farms and farmstead turf, sorghum, soybean, sugarcane, Cotton with XtendFlex Technology, Roundup Ready 2 Xtend Soybean, and XtendFlex Soybean.

XtendiMax® With VaporGrip® Technology is a contact, systemic herbicide, which can have moderate residual control on small seeded broadleaf weeds, including waterhemp, lambsquarters and Palmer pigweed, depending on rainfall and soil type.

XtendiMax® With VaporGrip® Technology is readily absorbed by plants through shoot and root uptake, translocates throughout the plant's system, and accumulates in areas of active growth. XtendiMax® With VaporGrip® Technology interferes with the plant's growth hormones (auxins) resulting in death of many broadleaf weeds.

Failure to properly clean the entire spray system can result in inadvertent contamination of the spray system. You must ensure that the spray system used to apply this product is clean before using this product.

**Rainfast period:** Rainfall or irrigation occurring within 4 hours after postemergence applications may reduce the effectiveness of this product.

Refer to the CROP-SPECIFIC INFORMATION AND CROPS WITH XTEND TECHNOLOGY sections for application timing and other crop-specific details.

### 6.1 Restrictions

The applicator must read the entire label, including product labeling and follow all restrictions for XtendiMax® With VaporGrip® Technology. Restrictions included, but are not limited to:

- DO NOT APPLY THIS PRODUCT AERIALY
- DO NOT TANK MIX WITH PRODUCTS CONTAINING AMMONIUM SALTS SUCH AS AMMONIUM SULFATE (AMS) AND UREA AMMONIUM NITRATE. Small quantities of AMS can greatly increase the volatility potential of dicamba. Read the TANK MIXING INSTRUCTIONS of this label (Section 8.0) for instructions regarding other tank mix products.
- DO NOT APPLY TO CROPS UNDER STRESS DUE TO LACK OF MOISTURE, HAIL DAMAGE, FLOODING, HERBICIDE INJURY, MECHANICAL INJURY, INSECTS, OR WIDELY FLUCTUATING TEMPERATURES AS INJURY MAY RESULT.
- DO NOT APPLY THROUGH ANY TYPE OF IRRIGATION EQUIPMENT. DO NOT TREAT IRRIGATION DITCHES OR WATER USED FOR CROP IRRIGATION OR DOMESTIC PURPOSES.
- DO NOT MAKE APPLICATION OF THIS PRODUCT IF RAIN THAT MAY EXCEED SOIL FIELD CAPACITY AND RESULT IN SOIL RUNOFF IS EXPECTED IN THE NEXT 24 HOURS.

Review the entire label including, specific crop use direction sections for additional restrictions.

## 7.0 WEED RESISTANCE MANAGEMENT

DICAMBA	GROUP	4	HERBICIDE
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Dicamba mimics auxin (a plant hormone) resulting in a hormone imbalance in sensitive plants that interferes with normal cell division, cell enlargement, and protein synthesis. Dicamba active ingredient is a Group 4 herbicide based on the mode of action classification system of the Weed Science Society of America. Any weed population can contain plants naturally resistant to Group 4 herbicides. Weed species resistant to Group 4 herbicides can be effectively managed utilizing another herbicide from a different Group, or by using other cultural or mechanical practices.

### 7.1 Weed Management Practices

Certain agronomic practices can delay or reduce the likelihood that resistant weed populations will develop and can be utilized to manage weed resistance once it occurs.

Do not use less than the labeled rate of this product in a single application. Using the appropriate application rate can minimize the selection for resistant weeds.

Proactively implementing diversified weed control strategies to minimize selection for weed populations resistant to one or more herbicides is a best practice. A diversified weed management program may include the use of multiple herbicides with different sites of action and overlapping weed spectrum with or without tillage operations and/or other cultural practices. Research has demonstrated that using the labeled rate and directions for use is important to delay the selection for resistance.

The continued effectiveness of this product depends on the successful implementation of a weed resistance management program.

To aid in the prevention of developing weeds resistant to this product:

- Scout fields before application to ensure herbicides and rates will be appropriate for the weed species and weed sizes present.
- Start with a clean field, using either a burndown herbicide application or tillage.
- Control weeds early when they are relatively small (less than 4 inches).
- Apply full rates of XtendiMax® With VaporGrip® Technology for the most difficult to control weed in the field at the specified time (correct weed size) to minimize weed escapes.
- Avoid tank mixtures with other herbicides that reduce the efficacy of this product (through antagonism), or with ones that encourage application rates of this product below those specified on this label.
- Scout fields after application to detect weed escapes or shifts in weed species.
- Control weed escapes before they reproduce by seed or proliferate vegetatively.
- Report any incidence of non-performance of this product against a particular weed species to your retailer or Bayer representative or call 1-844-RRXTEND (1-844-779-8363).
- If resistance is suspected, treat weed escapes with an herbicide having a site of action other than Group 4 and/or use non-chemical methods to remove escapes, as practical, with the goal of preventing further seed production. EPA defines suspected herbicide resistance as the situation where the following three indicators occur at a site or location:
  - o Failure to control a weed species normally controlled by the herbicide at the dose applied, especially if control is achieved on adjacent weeds;
  - o A spreading patch of non-controlled plants of a particular weed species; and
  - o Surviving plants mixed with controlled individuals of the same species.

Additionally, users should follow as many of the following herbicide resistance management practices as is practical:

- Use a broad spectrum soil-applied herbicide with other sites of action as a foundation in a weed control program.
- Utilize sequential applications of herbicides with alternative sites of action.
- Rotate the use of this product with non-Group 4 herbicides.
- Avoid making more than two applications of dicamba and any other Group 4 herbicides within a single growing season unless mixed with an herbicide with a different mechanism of action with an overlapping spectrum for the difficult to control weeds.
- Incorporate non-chemical weed control practices, such as mechanical cultivation, crop rotation, cover crops and weed-free crop seeds, as part of an integrated weed control program.
- Use good agronomic principles that enhance crop development and crop competitiveness.
- Thoroughly clean plant residues from equipment before leaving fields suspected to contain resistant weeds.
- Manage weeds in and around fields, during and after harvest to reduce weed seed production.

Contact the local agricultural extension service, Bayer representative, agricultural retailer or crop consultant for further guidance on weed control practices as needed.

### 7.2 Management of Dicamba-Resistant Biotypes

Appropriate testing is critical in order to determine if a weed is resistant to dicamba. Contact your Bayer representative to determine if resistance in any particular weed biotype has been confirmed in your area, or visit on the Internet [www.iwilltakeaction.com](http://www.iwilltakeaction.com) or [www.weedscience.org](http://www.weedscience.org). Monsanto Company is not responsible for any losses that result from the failure of this product to control dicamba-resistant weed biotypes.

The following good agronomic practices can reduce the spread of confirmed dicamba-resistant biotypes:

- If a naturally occurring resistant biotype is present in your field, this product may be tank-mixed or applied sequentially with an appropriately labeled herbicide with a different mode of action to achieve control (read Section 8.0 for more information on tank mixing).
- Cultural and mechanical control practices (e.g., crop rotation or tillage) can also be used as appropriate.
- Scout treated fields after herbicide application and control weed escapes, including resistant biotypes, before they set seed.
- Thoroughly clean equipment, as practical, for all weed seeds before leaving fields known to contain resistant biotypes.

## 8.0 TANK MIXING INSTRUCTIONS

Auxin herbicides such as dicamba have the potential to volatilize in lower pH spray mixtures. Knowing the pH of your spray mixture and making the appropriate adjustments to avoid a low pH spray mixture (e.g., pH less than 5) can reduce the potential for volatilization to occur. Talk to your local agricultural consultant, extension agent, or Bayer representative for recommendations to prevent low pH spray mixtures.

XtendiMax® With VaporGrip® Technology may only be tank-mixed with products that have been tested and found not to adversely affect the offsite movement potential of XtendiMax® With VaporGrip® Technology. The applicator must check the website found at [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com) no more than 7 days before applying XtendiMax® With VaporGrip® Technology.

DO NOT tank mix any product with XtendiMax® With VaporGrip® Technology unless:

1. The intended tank-mix product is identified on the list of tested products found at [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com);
2. The intended products are not prohibited on either this label or the label of the tank mix product; and
3. All requirements and restrictions on [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com) are followed.

TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, MONSANTO MAKES NO RECOMMENDATION OR WARRANTY HEREIN REGARDING THE USE OF ANY PRODUCT THAT MAY APPEAR ON THE WEBSITE REFERENCED ABOVE, REGARDLESS OF WHETHER SUCH PRODUCT IS USED ALONE OR IN A TANK MIX WITH XTENDIMAX® WITH VAPORGRIP® TECHNOLOGY. BUYER AND ALL USERS ARE SOLELY RESPONSIBLE FOR ANY LACK OF PERFORMANCE, LOSS, OR DAMAGE IN CONNECTION WITH THE USE OR HANDLING OF ANY SUCH PRODUCT ALONE OR IN A TANK MIX WITH XTENDIMAX® WITH VAPORGRIP® TECHNOLOGY. See the section titled "LIMIT OF WARRANTY AND LIABILITY" herein for more information.

### 8.1 Compatibility Test for Mix Components

Before mixing components, always perform a compatibility jar test.

- For 15 gallons per acre spray volume, use 2.5 cups (591.5 mL) of water. For other spray volumes, adjust rates accordingly. Only use water from the intended source at the source temperature.
- Add components in the sequence indicated in the Mixing Order section below using 2 teaspoons for each pound or 1 teaspoon for each pint of labeled use rate per acre.
- Cap the jar and invert 10 cycles between component additions.
- When the components have all been added to the jar, let the solution stand for 15 minutes.
- Evaluate the solution for uniformity and stability. The spray solution should not have free oil on the surface, fine particles that precipitate to the bottom; or thick (clabbered) texture. If the spray solution is not compatible, repeat the compatibility test with the addition of a suitable compatibility agent. If the solution is then compatible, use the compatibility agent as directed on its label. If the solution is still incompatible, then do not mix the ingredients in the same tank.

## 8.2 Mixing Order

Only use approved tank mix products as directed on [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com). Always read and follow label directions for all products in the tank mixture. It is the pesticide user's responsibility to ensure that all products in the listed mixtures are registered for the intended use. Users must follow the most restrictive directions for use and precautionary statements of each product in the tank mixture. See section 8.0 for additional restrictions on tank mixing.

1. Ensure application and mixing equipment are clean and in proper working order
2. Water - Begin by agitating a thoroughly clean sprayer tank three-quarters full of clean water.
3. Agitation - Maintain constant agitation throughout mixing and application.
4. Drift Reducing Adjuvants (DRA) - (when applicable)
5. Inductor - If an inductor is used, rinse it thoroughly after each component has been added.
6. Products in PVA bags - Place any product contained in water-soluble PVA bags into the mixing tank. Wait until all water-soluble PVA bags have fully dissolved and the product is evenly mixed in the spray tank before continuing.
7. Water-dispersible products (dry flowables, wettable powders, suspension concentrates, or suspo-emulsions)
8. Water-soluble products (such as XtendiMax® With VaporGrip® Technology)
9. Emulsifiable concentrates (such as oil concentrate when applicable)
10. Water-soluble additives (when applicable)
11. Add remaining quantity of water.

Maintain constant agitation during application

### 8.3 Adjuvants, Drift Reducing Adjuvants, Surfactants, and Other Tank Mixed Products

See Section 8.0 TANK MIXING INSTRUCTIONS for tank mixing instructions for adjuvants, drift reducing adjuvants, surfactants, and other tank mixed products.

## 9.0 APPLICATION EQUIPMENT AND TECHNIQUES

DO NOT APPLY THIS PRODUCT USING AERIAL SPRAY EQUIPMENT.

XtendiMax® With VaporGrip® Technology can be applied to actively growing weeds as broadcast, band, or spot spray applications using water as a carrier. For best results, treat weeds early when they are relatively small (less than 4 inches). Timely application to small weeds early in the season will improve control and reduce weed competition. Refer to Table 1 for XtendiMax® With VaporGrip® Technology application rates for control or suppression by weed type and growth stage. For crop-specific application timing and other details, refer to the CROP-SPECIFIC INFORMATION section of this label.

APPLY THIS PRODUCT USING PROPERLY MAINTAINED AND CALIBRATED EQUIPMENT CAPABLE OF DELIVERING THE REQUIRED VOLUMES.

Using a hooded sprayer or other drift reduction technology in combination with approved nozzles may further reduce drift potential.

**Cultivation:** Do not cultivate within 7 days after applying this product.

**Table 1. XtendiMax® With VaporGrip® Technology Application Rates for Control or Suppression by Weed Type and Growth Stage**

Use rate limitations are given in sections 10 (RESTRICTIONS), 11 (CROP-SPECIFIC INFORMATION), and 12 (CROPS WITH XTEND TECHNOLOGY)

Weed Type and Stage	Rate Per Acre	Weed Type and Stage	Rate Per Acre
<b>Annual<sup>1</sup></b> Small, actively growing Established weed growth	11 – 22 fluid ounces  22 – 33 fluid ounces	<b>Perennial</b> Top growth suppression Top growth control and root suppression Noted perennials (footnote 1 in Section 13.0). Other perennials (without footnote 1 in Section 13.0) <sup>2</sup>	11 – 22 fluid ounces 22 – 44 fluid ounces 44 fluid ounces 44 fluid ounces
<b>Biennial</b> Rosette diameter 1 – 3 inches Rosette diameter 3 inches or more Bolting	11 – 22 fluid ounces  22 – 44 fluid ounces 44 fluid ounces	<b>Woody Brush &amp; Vines</b> Top growth suppression Top growth control <sup>3</sup> Stems and stem suppression <sup>3</sup>	22 – 44 fluid ounces 44 fluid ounces 44 fluid ounces

<sup>1</sup> Rates below 11 fluid ounces per acre may provide control or suppression but should typically be applied with other herbicides that are effective on the same species and biotype.

<sup>2</sup> Woody Species listed in section 13.0 may require tank mixes for adequate top growth control.

<sup>3</sup> DO NOT broadcast apply more than 44 ounces per acre for a single application and DO NOT exceed broadcast applications of more than 88 ounces per acre within the growing season when a sequential application is needed for control. Use the higher rate when treating dense vegetation or perennial weeds with established root growth. Perennials and Woody Species are defined as those listed in Section 13.0.

## 9.1 Spray Drift Management

Do not allow herbicide solution to mist, drip, drift or splash onto desirable vegetation because severe injury or destruction to desirable broadleaf plants could result.

The most effective way to reduce drift potential is to apply large droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if the application is made improperly, or under unfavorable environmental conditions (see the "Temperature and Humidity" and "Temperature Inversions" sections of this label).

### 9.1.1 Sprayer Setup

The following sprayer setup requirements for drift management must be followed:

- **Nozzle type.** The applicator must use an approved nozzle within a specified pressure range as found at [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com) when applying XtendiMax® With VaporGrip® Technology. Do not use any other nozzle and pressure combination not specifically listed on this website.
- **Spray Volume.** The applicator must apply this product in a minimum of 15 gallons of spray solution per acre. See Section 8.0 for information on approved tank mix products.
- **Equipment Ground Speed.** Do not exceed a ground speed of 15 miles per hour. Select a ground speed that will deliver the desired spray volume while maintaining the desired spray pressure, but slower speeds generally result in better spray coverage and deposition on the target area. Provided the applicator can maintain the required nozzle pressure, it is recommended that tractor speed is reduced to 5 miles per hour at field edges.
- **Spray boom Height.** Do not exceed a boom height of 24 inches above target pest or crop canopy. Excessive boom height will increase the drift potential.
- **Wind Speed.** Do not apply when wind speeds are less than 3 MPH or greater than 10 MPH. Only apply when wind speed at boom height is between 3 and 10 mph.

### 9.1.2 Temperature and Humidity

When making applications in low relative humidity or temperatures above 91 degrees Fahrenheit, set up equipment to produce larger droplets to compensate for evaporation (for example: increase orifice size and/or increase spray volume as directed on [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com)). Larger droplets have a lower surface to volume ratio and can be impacted less by temperature and humidity. Droplet evaporation is most severe when conditions are both hot and dry.

### 9.1.3 Temperature Inversions

Do not apply this product during a temperature inversion as the off-target movement potential is high.

In general, temperature inversions are more likely during nighttime hours. Applications of this product may ONLY occur one hour after sunrise through two hours before sunset.

• During a temperature inversion, the atmosphere is very stable and vertical air mixing is restricted, which can cause 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 can be characterized by increasing temperatures with altitude and can be common on evenings and nights with limited cloud cover and light to no wind. Cooling of air at the earth's surface takes place and warmer air is trapped above it. Temperature inversions can 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 movement of smoke 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.

• The inversion will typically dissipate with increased winds (above 3 miles per hour) or at sunrise when the surface air begins to warm (generally 3°F from morning low).

### 9.1.4 Buffer Requirements and Protection of Sensitive Crops

Do not apply under circumstances where drift may occur to food, forage, or other plantings that might be damaged or the crops rendered unfit for sale, use, or consumption.

#### 9.1.4.a. Buffer Requirement

The applicator must always maintain a 110 foot downwind buffer (when applying up to 22 fluid ounces of this product per acre) or a 220 foot downwind buffer (when applying greater than 22 up to 44 fluid ounces of this product per acre) between the last treated row and the nearest downwind field edge (in the direction the wind is blowing).

If you have questions regarding Buffer Requirement contact Bayer at 1-844-RRXTEND prior to application.



The following areas may be included in the buffer distance calculation when directly adjacent to the treated field edges:

- Roads, paved or gravel surfaces, mowed and/or managed areas adjacent to field such as rights of way.
- Planted agricultural fields containing: corn, dicamba tolerant cotton, dicamba tolerant soybean, sorghum, proso millet, small grains and sugarcane. If the applicator intends to include such crops as dicamba tolerant cotton and/or dicamba tolerant soybeans in the buffer distance calculation, the applicator must confirm the crops are in fact dicamba tolerant.
- Agricultural fields that have been prepared for planting
- Areas covered by the footprint of a building, silo, or other man made structure with walls and or roof.

#### 9.1.4.b. Sensitive Crops

DO NOT APPLY this product when the wind is blowing toward adjacent non-dicamba tolerant sensitive crops; this includes **NON-DICAMBA TOLERANT SOYBEAN AND COTTON**.

It is important for the applicator to be aware that wind direction may vary during the application. If wind direction shifts such that the wind is blowing toward adjacent non-dicamba tolerant sensitive crops, the applicator must cease the application.



Before making an application, consult a sensitive crop registry (such as FieldWatch); and survey adjacent fields and confirm the crops/areas surrounding the field prior to application. At a minimum, records must include the name of the sensitive crop registry and the date it was consulted and documentation of adjacent crops/areas and the date the survey was conducted.

Sensitive crops include, but are not limited to non-dicamba tolerant soybeans and cotton, tomatoes and other fruiting vegetables (EPA crop group 8), fruit trees, cucurbits (EPA crop group 9), grapes, beans, flowers, ornamentals, peas, potatoes, sunflower, tobacco, other broadleaf plants, and including plants in a greenhouse. Severe injury or destruction could occur if any contact between this product and these plants occurs.

If you have questions regarding sensitive crop registries contact Bayer at 1-844-RRXTEND prior to application.

### 9.1.5 Application Awareness

AVOIDING SPRAY DRIFT AT THE APPLICATION SITE IS THE RESPONSIBILITY OF THE APPLICATOR.

The interaction of equipment and weather related factors must be monitored to maximize performance and on-target spray deposition. The applicator is responsible for considering all of these factors when making a spray decision. The applicator is responsible for compliance with state and local pesticide regulations, including any state or local pesticide drift regulations.

## 9.2 Ground Application (Banding)

When applying XtendiMax® With VaporGrip® Technology by banding, determine the amount of herbicide and water volume needed using the following formula:

$$\frac{\text{Bandwidth in inches}}{\text{Row width in inches}} \times \text{Broadcast rate per acre} = \text{Banding herbicide rate per acre}$$

$$\frac{\text{Bandwidth in inches}}{\text{Row width in inches}} \times \text{Broadcast volume per acre} = \text{Banding water volume per acre}$$

## 9.3 Ground Application (Broadcast)

**Water Volume:** Use a minimum of 15 gallons of spray solution per broadcast acre for optimal performance. Use 20 gallons per acre when treating dense or tall vegetation.

**Application Equipment:** Select nozzles (refer to section 9.1.1 Nozzle type of this product label) designed to produce minimal amounts of fine spray particles. Spray with nozzles as close to the weeds as practical for good weed coverage.

Using a hooded sprayer or other drift reduction technology in combination with approved nozzles may further reduce drift potential.

## 9.4 Ground Application (Wipers)

XtendiMax® With VaporGrip® Technology may be applied through wiper application equipment to control or suppress actively growing broadleaf weeds, brush and vines. Use a solution containing 1 part XtendiMax® With VaporGrip® Technology to 1 part water. Do not apply greater than 1 lb dicamba acid equivalent (44 fluid ounces of this product) per acre per application. Do not contact desirable vegetation with herbicide solution. Wiper application may be made to crops (including pastures) and non-cropland areas described in this label except for non-dicamba-tolerant cotton, sorghum, and non-dicamba-tolerant soybean.

## 9.5 Proper Spray System Equipment Cleanout

You must ensure that the spray system used to apply this product is clean before using this product.

Failure to properly clean the entire spray system can result in inadvertent contamination of the spray system. Small quantities of dicamba may cause injury to non-dicamba tolerant soybeans and other sensitive crops (see Section 9.1.4 of this label for more information).

Inadvertent contamination can also occur in equipment used for bulk product handling and mixing prior to use in the spray system. Care should be taken to reduce contamination not only in the spray system but in any equipment used to transfer or deliver product. For example, bulk handling and mixing equipment containing this product should be segregated when possible to reduce potential for cross-contamination. Consider using block and check valves to avoid backflow during transfer. Piping should be reviewed to ensure there not potential for product build-up. Dedicated nurse trucks and tender equipment should be used when possible.

**Clean equipment immediately after using this product,** using a triple rinse procedure as follows:

1. After spraying, drain the sprayer (including boom and lines) immediately. Do not allow the spray solution to remain in the spray boom lines overnight prior to flushing.
2. Flush tank, hoses, boom and nozzles with clean water. If equipped, open boom ends and flush.
3. Inspect and clean all strainers, screens and filters.
4. Prepare a cleaning solution with a commercial detergent or sprayer cleaner or ammonia according to the manufacturer's directions.
5. Take care to wash all parts of the tank, including the inside top surface. Start agitation in the sprayer and thoroughly recirculate the cleaning solution for at least 15 minutes. All visible deposits must be removed from the spraying system.
6. Flush hoses, spray lines and nozzles for at least 1 minute with the cleaning solution.
7. Remove nozzles, screens and strainers and clean separately in the cleaning solution after completing the above procedures.
8. Drain pump, filter and lines.
9. Rinse the complete spraying system with clean water.
10. Clean and wash off the outside of the entire sprayer and boom.
11. All rinse water must be disposed of in compliance with local, state, and federal guidelines.

## 10.0 ADDITIONAL RESTRICTIONS

**Maximum Application Rates:** The maximum application or use rates stated throughout this label are given in units of volume (fluid ounces or quarts) of this product per acre. However, the maximum allowed application rates apply to this product combined with the use of any and all other herbicides containing the active ingredients dicamba, whether applied separately or as a tank mixture, on a basis of total pounds of dicamba (acid equivalents) per acre. If more than one dicamba-containing product is applied to the same site within the same year, you must ensure that the total use of dicamba (pounds acid equivalents) does not exceed 2 pounds per Acre per year from all applications. See the INGREDIENTS section of this label for necessary product information.

**Maximum seasonal use rate:** Refer to Table 2. Crop-Specific Restrictions for crop-specific maximum seasonal use rates. Do not exceed 88 fluid ounces of XtendiMax® With VaporGrip® Technology (2 pounds acid equivalent) per acre, per year.

**Preharvest Interval (PHI):** Refer to the CROP-SPECIFIC INFORMATION section for preharvest intervals.

**Restricted Entry Interval (REI): 24 hours**

#### Crop Rotational Restrictions

No rotational cropping restrictions apply when rotating to Roundup Ready 2 Xtend® Soybeans, XtendFlex® Soybeans, or cotton seed with XtendFlex® Technology (including Bollgard® 3 XtendFlex® Cotton, Bollgard II® XtendFlex® Cotton, or XtendFlex® Cotton). For other crops the interval between application and planting rotational crop is given below. When counting days from the application of this product, do not count days when the ground is frozen. Planting at intervals less than specified below may result in crop injury. Moisture is essential for the degradation of this herbicide in soil. If dry weather prevails, use cultivation to allow herbicide contact with moist soil.

**Planting/replanting restrictions at application rates of 33 fluid ounces of this product per acre per season or less:** Follow the planting restrictions in the directions for use for Preplant application in the Crop Specific Information section of this label. For corn, cotton (except cotton seed with XtendFlex® Technology), sorghum, and soybean (except Roundup Ready 2 Xtend® Soybean and XtendFlex® Soybean), follow the planting restrictions in the directions for use for preplant application in Section 11. Crop-Specific Information of this label. Do not plant barley, oat, wheat, and other grass seedlings for 15 days for every 11 fluid ounces of this product applied per acre east of the Mississippi River and 22 days for every 11 fluid ounces per acre applied west of the Mississippi River. No planting restrictions apply beyond 120 days after application of this product.

**Planting/replanting restrictions at application rates of more than 33 fluid ounces and up to 88 fluid ounces of this product per acre per season:** Wait a minimum of 120 days after application of this product before planting corn, sorghum and cotton (except cotton seed with XtendFlex® Technology) east of the Rocky Mountains and before planting all other crops (except Roundup Ready 2 Xtend® Soybean and XtendFlex® Soybean) grown in areas receiving 30 inches or more rainfall annually. Wait a minimum of 180 days before planting crops in areas with less than 30 inches of annual rainfall. Wait a minimum of 30 days for every 22 fluid ounces of this product applied per acre before planting barley, oat, wheat, and other grass seedlings east of the Mississippi River and 45 days for every 22 fluid ounces of this product applied per acre west of the Mississippi River.

Table 2. Crop-Specific Restrictions<sup>1</sup>

Crop	Maximum Rate Per Acre Per Application (fl oz)	Maximum Rate Per Acre Per Season (fl oz)	Livestock Grazing or Feeding
Asparagus	22	22	Yes
Barley, Fall	11	16.5	Yes
Spring	11	15	Yes
Conservation Reserve Program (CRP)	44	88	Yes
Corn	22	33	Yes <sup>2</sup>
Cotton	11	11	Yes
Cotton with XtendFlex Technology	44	88	Yes
Fallow Ground	44	88	Yes
Grass grown for seed	44	88	Yes
Oats	5.5	5.5	Yes
Pastureland	44	44	Yes
Proso Millet	5.5	5.5	Yes
Small grains grown for grass, forage, fodder, hay and/or pasture	22	22	Yes
Sorghum	11	22	Yes
Soybean	44	44	Yes
Roundup Ready 2 Xtend Soybean and XtendFlex Soybean	44	88	Yes
Sugarcane	44	88	Yes
Triticale	5.5	5.5	Yes
Sod farms and farmstead turf	44	44	Yes
Wheat	11	22	Yes

<sup>1</sup> Refer to section 11. CROP-SPECIFIC INFORMATION and section 12. CROPS WITH XTEND TECHNOLOGY for more details.

<sup>2</sup> Once the crop reaches the ensilage (milk) stage or later in maturity

## 11.0 CROP-SPECIFIC INFORMATION

Read Sections: 8.0 for Tank Mixing Instructions and 9.1.4 for Buffer Requirements and Sensitive Crops for information on tank mixing, buffer requirements, and sensitive crops.

### 11.1 Asparagus

Apply XtendiMax® With VaporGrip® Technology to emerged and actively growing weeds in 40 - 60 gallons of diluted spray per treated acre immediately after cutting the field, but at least 24 hours before the next cutting. Multiple applications may be made per growing season.

If spray contacts emerged spears, crooking (twisting) of some spears may result. If such crooking occurs, discard affected spears.

Rates: Apply 11-22 fluid ounces of XtendiMax® With VaporGrip® Technology to control annual sowthistle, black mustard, Canada and Russian thistle, and redroot pigweed (carelessweed).

Apply 22 fluid ounces of XtendiMax® With VaporGrip® Technology to control common chickweed, field bindweed, nettleleaf goosefoot, and wild radish. Up to 2 applications may be made per growing season. Do not exceed a total of 22 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre, per crop year.

Do not harvest prior to 24 hours after treatment.

### 11.2 Between Crop Applications

**Preplant Directions (Postharvest, Fallow, Crop Stubble, Set-Aside) for Broadleaf Weed Control:**

XtendiMax® With VaporGrip® Technology can be applied either postharvest in the fall, spring, or summer during the fallow period or to crop stubble/set-aside acres. Apply XtendiMax® With VaporGrip® Technology as a broadcast or spot treatment to emerged and actively growing weeds after crop harvest (postharvest) and before a killing frost or in the fallow cropland or crop stubble the following spring or summer.

See the "Crop Rotational Restrictions" in Section 10 of this label for the recommended interval between application and planting to prevent crop injury.

#### Rates and Timings:

Apply 5.5 - 44 fluid ounces of XtendiMax® With VaporGrip® Technology per acre. Refer to Table 1 to determine use rates for specific targeted weed species. For best performance, apply XtendiMax® With VaporGrip® Technology when annual weeds are less than 4 inches tall, when biennial weeds are in the rosette stage and to perennial weed regrowth in late summer or fall following a mowing or tillage treatment. The most effective control of upright perennial broadleaf weeds such as Canada thistle and Jerusalem artichoke occurs if XtendiMax® With VaporGrip® Technology is applied when the majority of weeds have at least 4 - 6 inches of regrowth or for weeds such as field bindweed and hedge bindweed that are in or beyond the full bloom stage.

Avoid disturbing treated areas following application. Treatments may not kill weeds that develop from seed or underground plant parts such as rhizomes or bulbets, after the effective period for XtendiMax® With VaporGrip® Technology. For seedling control, a follow-up program or other cultural practices could be instituted. For small grain in-crop uses of XtendiMax® With VaporGrip® Technology, refer to the small grain section for details.

### 11.3 Conservation Reserve Program (CRP)

XtendiMax® With VaporGrip® Technology is recommended for use on both newly seeded and established grasses grown in Conservation Reserve or federal Set-Aside Programs. Treatments of XtendiMax® With VaporGrip® Technology will injure or may kill alfalfa, clovers, lespedeza, wild winter peas, vetch, and other legumes.

#### Newly Seeded Areas

XtendiMax® With VaporGrip® Technology may be applied either preplant or postemergence to newly seeded grasses or small grains such as barley, oats, rye, sudangrass, wheat, or other grain species grown as a cover crop. Postemergence applications may be made after seedling grasses exceed the 3-leaf stage. Rates of XtendiMax® With VaporGrip® Technology greater than 22 fluid ounces per treated acre may severely injure newly seeded grasses.

Preplant applications may injure new seedlings if the interval between application and grass planting is less than 45 days per 22 fluid ounces of XtendiMax® With VaporGrip® Technology applied per treated acre west of the Mississippi River or 20 days per 22 fluid ounces applied east of the Mississippi River.

#### Established Grass Stands

Established grass stands are perennial grasses planted one or more seasons prior to treatment. Certain species (bentgrass, carpetgrass, smooth brome, buffalograss, or St. Augustine grass) may be injured when treated with more than 22 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre.

When applied at recommended rates, XtendiMax® With VaporGrip® Technology will control many annual and biennial weeds and provide control or suppression of many perennial weeds.

## Rates and Timings

Apply 5.5 - 44 fluid ounces of XtendiMax® With VaporGrip® Technology per acre. Refer to **Table 1** for rates based on target weed species. Retreatments may be made as needed; however, do not exceed a total of 88 fluid ounces (4 pints) of XtendiMax® With VaporGrip® Technology per acre per year.

### 11.4 Corn (Field, Pop, Seed, And Silage)

Direct contact of XtendiMax® With VaporGrip® Technology with corn seed must be avoided. If corn seeds are less than 1.5 inches below the surface, delay application until corn has emerged. Applications of XtendiMax® With VaporGrip® Technology to corn during periods of rapid growth may result in temporary leaning. Corn will usually become erect within 3 to 7 days. Cultivation should be delayed until after corn is growing normally to avoid breakage.

Corn may be harvested or grazed for feed once the crop has reached the ensilage (milk) stage or later in maturity.

Up to 2 applications of XtendiMax® With VaporGrip® Technology may be made during a growing season. Sequential applications must be separated by 2 weeks or more.

Do not apply XtendiMax® With VaporGrip® Technology to seed corn or popcorn without first verifying with your local seed company (supplier) the selectivity of XtendiMax® With VaporGrip® Technology on your inbred line or variety of popcorn. This precaution will help avoid potential injury of sensitive varieties.

Avoid using crop oil concentrates after crop emergence as crop injury may result. Use crop oil concentrates only in dry conditions when corn is less than 5 inches tall when applying XtendiMax® With VaporGrip® Technology.

Use of sprayable fluid fertilizer as the carrier is not recommended for applications of XtendiMax® With VaporGrip® Technology made after corn emergence.

XtendiMax® With VaporGrip® Technology is not registered for use on sweet corn.

#### Preplant and Preemergence Application in No-Tillage Corn:

**Rates:** Apply 22 fluid ounces of XtendiMax® With VaporGrip® Technology per acre on medium- or fine-textured soils containing 2.5% or greater organic matter. Use 11 fluid ounces per acre on coarse soils (sand, loamy sand, and sandy loam) or medium- and fine-textured soils with less than 2.5% organic matter.

**Timing:** XtendiMax® With VaporGrip® Technology can be applied to emerging weeds before, during, or after planting a corn crop. When planting into a legume sod (e.g., alfalfa or clover), apply XtendiMax® With VaporGrip® Technology after 4 – 6 inches of regrowth has occurred

#### Preemergence Application in Conventional or Reduced Tillage Corn:

**Rates:** Apply 22 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre on medium- or fine-textured soils containing 2.5% organic matter or more. Do not apply to coarse textured soils (sand, loamy sand, or sandy loam) of any soil with less than 2.5% organic matter until after corn emergence (See Early Postemergence uses below).

**Timing:** XtendiMax® With VaporGrip® Technology may be applied after planting and prior to corn emergence. Pre-emergence application of XtendiMax® With VaporGrip® Technology does not require mechanical incorporation to become active. A shallow mechanical incorporation is recommended if application is not followed by adequate rainfall or sprinkler irrigation. Avoid tillage equipment (e.g., drags, harrows) which concentrates treated soil over seed furrow as seed damage could result.

Preemergence control of cocklebur, jimsonweed, and velvetleaf may be reduced if conditions such as low temperature or lack of soil moisture cause delayed or deep germination of weeds.

#### Early Postemergence Application in All Tillage Systems:

**Rates:** Apply 22 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre. Reduce the rate to 11 fluid ounces per treated acre if corn is growing on coarse textured soils (sand, loamy sand, and sandy loam).

**Timing:** Apply between corn emergence and the 5-leaf stage or 8 inches tall, whichever occurs first. Refer to Late Postemergence Applications if the sixth true leaf is emerging from whorl or corn is greater than 8 inches tall.

#### Late Postemergence Application:

**Rate:** Apply 11 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre.

**Timing:** Apply XtendiMax® With VaporGrip® Technology from 8 - 36 inch tall corn or 15 days before tassal emergence, whichever comes first. For best performance, apply when weeds are less than 3 inches tall.

Apply directed spray when corn leaves prevent proper spray.

### 11.5 Cotton

For directions for use with crops with Xtend Technology see the "CROPS WITH XTEND TECHNOLOGY" section of this label.

#### Preplant Application:

Apply up to 11 fluid ounces of XtendiMax® With VaporGrip® Technology per acre to control emerged broadleaf weeds prior to planting cotton in conventional or conservation tillage systems.

For best performance, apply XtendiMax® With VaporGrip® Technology when weeds are in the 2 - 4 leaf stage and rosettes are less than 2 inches across.

Following application of XtendiMax® With VaporGrip® Technology and a minimum accumulation of 1 inch of rainfall or overhead irrigation, allow a minimum of 21 days between treatment and planting per application of 11 fluid ounces per acre or less. This plant back interval must be observed prior to planting cotton.

Do not apply to preplant to cotton west of the Rockies.

Do not make XtendiMax® With VaporGrip® Technology preplant applications to cotton in geographic areas with average annual rainfall less than 25 inches.

If applying a spring preplant treatment following application of a fall preplant (postharvest) treatment, then the combination of both treatments may not exceed 2 pounds acid equivalent per acre.

### 11.6 Grass Grown For Seed

Apply 11 - 22 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre on seedling grass after the crop reaches the 3 - 5 leaf stage. Apply up to 44 fluid ounces of XtendiMax® With VaporGrip® Technology on well-established perennial grass. For best performance, apply XtendiMax® With VaporGrip® Technology when weeds are in the 2 - 4 leaf stage and rosettes are less than 2 inches across. Use the higher level of listed rate ranges when treating more mature weeds or dense vegetative growth.

To suppress annual grasses such as bromes (downy and rigid), rattail fescue, and windgrass, apply up to 44 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre in the fall or late summer after harvest and burning of established grass seed crops. Applications should be made immediately following the first irrigation when the soil is moist and before weeds have more than 2 leaves.

Do not apply XtendiMax® With VaporGrip® Technology after the grass seed crop begins to joint. Refer to the Pasture, Hay, Rangeland, and General Farmstead section for grazing and feeding restrictions.

### 11.7 Proso Millet

For use only within Colorado, Nebraska, North Dakota, South Dakota.

XtendiMax® With VaporGrip® Technology combined with an appropriate tank-mix partner will provide control or suppression of the annual broadleaf weeds listed in **Section 13**.

### 11.8 Pasture, Hay, Rangeland, And General Farmstead (Noncropland)

XtendiMax® With VaporGrip® Technology is recommended for use on pasture, hay, rangeland, and general farmstead (non-cropland) (including fencerows and non-irrigation ditch banks) for control or suppression of broadleaf weed and brush species listed in **Section 13**.

XtendiMax® With VaporGrip® Technology may also be applied to non-cropland areas to control broadleaf weeds in noxious weed control programs, districts, or areas including broadcast or spot treatment of roadsides and highways, utilities, railroad, and pipeline rights-of-way. Noxious weeds must be recognized at the state level, but programs may be administered at state, county, or other level.

XtendiMax® With VaporGrip® Technology uses described in this section also pertain to grasses and small grains (forage sorghum, rye, sudangrass, or wheat) grown for grass, forage, fodder, hay and/or pasture use only. Grasses and small grains not grown for grass, forage, fodder, hay and/or pasture must comply with crop-specific uses in this label. Some perennial weeds may be controlled with lower rates of XtendiMax® With VaporGrip® Technology (refer to **Table 1**).

#### Rates and Timings

Refer to **Table 1** for rate selection based on targeted weed or brush species.

Rates above 44 fluid ounces of XtendiMax® With VaporGrip® Technology per acre are for spot treatments only. Spot treatment is defined as no more than a total of 1000 square feet of treated area per acre. Do not broadcast apply more than 44 fluid ounces per acre.

Retreatments may be made as needed; however, do not exceed a total of 44 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre during a growing season.

Grass grown for hay requires a minimum of 7-days between treatment and harvest.

#### Crop-Specific Restrictions

Do not apply more than 22 fluid ounces of XtendiMax® With VaporGrip® Technology per acre to small grains grown for pasture.

Newly seeded areas may be severely injured if more than 22 fluid ounces of XtendiMax® With VaporGrip® Technology is applied per acre.

Established grass crops growing under stress can exhibit various injury symptoms that may be more pronounced if herbicides are applied. Bentgrass, carpetgrass, buffalograss, and St. Augustine grass may be injured if more than 22 fluid ounces of XtendiMax® With VaporGrip® Technology is applied per acre. Usually colonial bent grasses are more tolerant than creeping types. Velvet grasses are most easily injured. Treatments will kill or injure alfalfa, clovers, lespedeza, wild winter peas, vetch, and other legumes.

**Table 3** lists the timing restrictions for grazing or harvesting hay from treated fields. There are no grazing restrictions for animals other than lactating dairy animals.

**Table 3. Timing Restrictions for Lactating Dairy Animals Following Treatment**

XtendiMax® With VaporGrip® Technology Rate per Treated Acre (fluid ounces)	Days Before Grazing (days)	Days Before Hay Harvest (days)
Up to 22	7	37
Up to 44	21	51

• **Spot Treatments:** XtendiMax® With VaporGrip® Technology may be applied to individual clumps or small areas of undesirable vegetation using handgun or similar types of application equipment. Apply diluted sprays to allow complete wetting (up to runoff) of foliage and stems.

#### Cut Surface Treatments:

XtendiMax® With VaporGrip® Technology may be applied as a cut surface treatment for control of unwanted trees and prevention of sprouts of cut trees.

**Rate:** Mix 1 part XtendiMax® With VaporGrip® Technology with 1 - 3 parts water to create the application solution. Use the lower dilution rate when treating difficult-to-control species.

- **For Frill or Girdle Treatments:** Make a continuous cut or a series of overlapping cuts using an axe to girdle tree trunk. Spray or paint the cut surface with the solution.
- **For Stump Treatments:** Spray or paint freshly cut surface with the water mix. The area adjacent to the bark should be thoroughly wet.

#### Applications For Control of Dormant Multiflora Rose:

XtendiMax® With VaporGrip® Technology can be applied when plants are dormant as an undiluted spot treatment directly to the soil or as a Lo-Oil basal bark treatment using an oil-water emulsion solution.

- **Spot treatments:** Spot treatment applications of XtendiMax® With VaporGrip® Technology should be applied directly to the soil as close as possible to the root crown but within 6 - 8 inches of the crown. On sloping terrain, apply XtendiMax® With VaporGrip® Technology to the uphill side of the crown. Do not apply when snow or water prevents applying XtendiMax® With VaporGrip® Technology directly to the soil. The use rate of XtendiMax® With VaporGrip® Technology depends on the canopy diameter of the multiflora rose.

**Examples:** Use 0.34, 1.38, or 3.23 fluid ounces of XtendiMax® With VaporGrip® Technology respectively, for 5, 10, or 15 feet canopy diameters.

- **Lo-Oil basal bark treatments:** For Lo-Oil basal bark treatments, apply XtendiMax® With VaporGrip® Technology to the basal stem region from the ground line to a height of 12 - 18 inches. Spray until runoff, with special emphasis on covering the root crown. For best results, apply XtendiMax® With VaporGrip® Technology when plants are dormant. Do not apply after bud break or when plants are showing signs of active growth. Do not apply when snow or water prevents applying XtendiMax® With VaporGrip® Technology to the ground line.

To prepare approximately 2 gallons of a Lo-Oil spray solution:

- 1) Combine 1.5 gallons of water, 1 ounce of emulsifier, 22 fluid ounces of XtendiMax® With VaporGrip® Technology, and 2.5 pints (No. 2 diesel fuel).
- 2) Adjust the amounts of materials used proportionately to the amount of final spray solution desired.

Do not exceed 8 gallons of spray solution mix applied per acre, per year.

### 11.9 Small Grains

#### 11.9.1 Small Grains Not Underseeded To Legumes (fall- and spring-seeded barley, oat, triticale and wheat)

Refer to the specific crop sections below for use rates. When treating difficult to control weeds such as kochia, wild buckwheat, cow cockle, prostrate knotweed, Russian thistle, and prickly lettuce or when dense vegetative growth occurs, use the 4.12 - 5.5 fluid ounces of XtendiMax® With VaporGrip® Technology per acre.

**Timings:** Apply XtendiMax® With VaporGrip® Technology before, during, or after planting small grains. See specific small grain crop uses below for maximum crop stage. For best performance, apply XtendiMax® With VaporGrip® Technology when weeds are in the 2 - 3 leaf stage and rosettes are less than 2 inches across. Applying XtendiMax® With VaporGrip® Technology to small grains during periods of rapid growth may result in crop leaning. This condition is temporary and will not reduce crop yields.

Restrictions for small grain areas that are grazed or cut for hay are indicated in **Table 3** in Pasture, Hay, Rangeland, and General Farmstead section of this label.

#### 11.9.2 Small Grains: Barley (fall- and spring-seeded)

##### Early season applications:

Apply 2.75 - 5.5 fluid ounces of XtendiMax® With VaporGrip® Technology to fall-seeded barley prior to the jointing stage. Apply 2.75 - 4.12 fluid ounces of XtendiMax® With VaporGrip® Technology before spring-seeded barley exceeds the 4-leaf stage.

**Note:** For spring barley varieties that are seeded during the winter months or later, follow the rates and timings given for spring-seeded barley.

##### Preharvest applications:

XtendiMax® With VaporGrip® Technology can be used to control weeds that may interfere with harvest of fall and spring-seeded barley. Apply 11 fluid ounces of XtendiMax® With VaporGrip® Technology per acre as a broadcast or spot treatment to annual broadleaf weeds when barley is in the hard dough stage and the green color is gone from the nodes (joints) of the stem. Best results will be obtained if application can be made when weeds are actively growing, but before weeds canopy.

Allow a minimum of 7 days between treatment and harvest. Do not use preharvest-treated barley for seed unless a germination test is performed on the seed with an acceptable result of 95% germination or better.

#### 11.9.3 Small Grains: Oats (fall- and spring-seeded)

##### Early season applications:

Apply 2.75 - 5.5 fluid ounces of XtendiMax® With VaporGrip® Technology per acre to fall-seeded oat prior to the jointing stage. Apply 2.75 - 5.5 fluid ounces of XtendiMax® With VaporGrip® Technology before spring-seeded oat exceed the 5-leaf stage.

Do not tank mix XtendiMax® With VaporGrip® Technology with 2,4-D in oat.

Allow a minimum of 7 days between treatment and harvest.

#### 11.9.4 Small Grains: Triticale (fall- and spring-seeded)

##### Early season applications:

Apply 2.75 - 5.5 fluid ounces of XtendiMax® With VaporGrip® Technology to triticale.

Early season applications to fall-seeded triticale must be made prior to the jointing stage.

Early season applications to spring-seeded triticale must be made before triticale reaches the 6-leaf stage.

#### 11.9.5 Small Grains: Wheat (fall- and spring-seeded)

##### Early Season Applications:

Apply 2.75 - 5.5 fluid ounces of XtendiMax® With VaporGrip® Technology to wheat unless using one of the fall-seeded wheat specific programs below.

Early season applications to fall-seeded wheat must be made prior to the jointing stage.

Early season applications to spring-seeded wheat must be made before wheat exceeds the 6-leaf stage.

Early developing wheat varieties such as TAM 107, Madison, or Wakefield must receive application between early tillering and the jointing stage. Care should be taken in staging these varieties to be certain that the application occurs prior to the jointing stage.

##### Specific use programs for fall-seeded wheat only:

In Colorado, Kansas, New Mexico, Oklahoma, and Texas, up to 11 fluid ounces of XtendiMax® With VaporGrip® Technology may be applied on fall-seeded wheat after it exceeds the 3-leaf stage for suppression of perennial weeds, such as field bindweed. Applications may be made in the fall following a frost but before a killing freeze.

##### Preharvest applications:

XtendiMax® With VaporGrip® Technology can be used to control weeds that may interfere with harvest of wheat. Apply 11 fluid ounces of XtendiMax® With VaporGrip® Technology per acre as a broadcast or spot treatment to annual broadleaf weeds when wheat is in the hard dough stage and the green color is gone from the nodes (joints) of the stem. Best results will be obtained if application can be made when weeds are actively growing but before weeds canopy.

Allow a minimum of 7 days between treatment and harvest. Do not use preharvest-treated wheat for seed unless a germination test is performed on the seed with an acceptable result of 95% germination or better.

### 11.10 Sorghum

XtendiMax® With VaporGrip® Technology may be applied preplant, postemergence, or preharvest in sorghum to control many annual broadleaf weeds and to reduce competition from established perennial broadleaf weeds, as well as control their seedlings.

Do not graze or feed treated sorghum forage or silage prior to mature grain stage. If sorghum is grown for pasture or hay, refer to Pasture, Hay, Rangeland, and General Farmstead section of this label for specific grazing and feeding restrictions.

Do not apply XtendiMax® With VaporGrip® Technology to sorghum grown for seed production.

#### Preplant Application:

Up to 11 fluid ounces of XtendiMax® With VaporGrip® Technology may be applied per acre if applied at least 15 days before sorghum planting.

#### Postemergence Application:

Up to 11 fluid ounces of XtendiMax® With VaporGrip® Technology per acre may be applied after sorghum is in the spike stage (all sorghum emerged) but before sorghum is 15 inches tall. For best performance, apply XtendiMax® With VaporGrip® Technology when the sorghum crop is in the 3 - 5 leaf stage and weeds are small (less than 3 inches tall). Use drop pipes (drop nozzles) if sorghum is taller than 8 inches. Keep the spray off the sorghum leaves and out of the whorl to reduce the likelihood of crop injury and to improve spray coverage of weed foliage. Applying XtendiMax® With VaporGrip® Technology to sorghum during periods of rapid growth may result in temporary leaning of plants or rolling of leaves. These effects are usually outgrown within 10 - 14 days. Delay harvest until 30 days after a preharvest treatment.

**Preharvest uses in Texas and Oklahoma only:** Up to 11 fluid ounces of XtendiMax® With VaporGrip® Technology per acre may be applied for weed suppression any time after the sorghum has reached the soft dough stage. An agriculturally approved surfactant may be used to improve performance (read Section 8.0 for tank mixing instructions). Delay harvest until 30 days after a preharvest treatment.

#### Split Application:

XtendiMax® With VaporGrip® Technology may be applied in split applications: preplant followed by postemergence or preharvest; or postemergence followed by preharvest. Do not exceed 11 fluid ounces per acre, per application or a total of 22 ounces per acre, per season.

### 11.11 Soybean

For directions for use with crops with Xtend Technology see the "CROPS WITH XTEND TECHNOLOGY" section of this label.

#### Preplant Applications:

Apply 5.5 - 22 fluid ounces of XtendiMax® With VaporGrip® Technology per acre to control emerged broadleaf weeds prior to planting soybeans. Do not exceed 22 fluid ounces of XtendiMax® With VaporGrip® Technology per acre in a spring application prior to planting soybeans.

Following application of XtendiMax® With VaporGrip® Technology and a minimum accumulation of 1 inch rainfall or overhead irrigation, allow a minimum of 14 days between treatment and planting for applications of 11 fluid ounces per acre or less, and allow a minimum of 28 days between treatment and planting for applications of 22 fluid ounces per acre. These plant back intervals must be observed prior to planting soybeans or crop injury may occur.

Do not make XtendiMax® With VaporGrip® Technology preplant applications to soybeans in geographic areas with average annual rainfall less than 25 inches.

#### Preharvest Applications:

XtendiMax® With VaporGrip® Technology can be used to control many annual and perennial broadleaf weeds and control or suppress many biennial and perennial broadleaf weeds in soybean prior to harvest (refer to **Section 10**). Apply 11 - 44 fluid ounces of XtendiMax® With VaporGrip® Technology per acre as a broadcast or spot treatment to emerged and actively growing weeds after soybean pods have reached mature brown color and at least 75% leaf drop has occurred.

Do not harvest soybeans until 7 days after application.

Treatments may not kill weeds that develop from seed or underground plant parts, such as rhizomes or bulbels, after the effective period for XtendiMax® With VaporGrip® Technology. For seedling control, a follow-up program or other cultural practice could be instituted.

Do not use preharvest-treated soybean for seed unless a germination test is performed on the seed with an acceptable result of 95% germination or better.

Do not feed soybean fodder or hay following a preharvest application of XtendiMax® With VaporGrip® Technology.

## 11.12 Sugarcane

Apply XtendiMax® With VaporGrip® Technology for control of annual, biennial, or perennial broadleaf weeds listed in Section 11. Apply 11 - 33 fluid ounces of XtendiMax® With VaporGrip® Technology per acre for control of annual weeds, 22 - 44 fluid ounces for control of biennial weeds, and 44 fluid ounces for control or suppression of perennial weeds.

Use the higher level of listed rate ranges when treating dense vegetative growth.

A single retreatment may be made as needed, however, do not exceed a total of 88 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre during a growing season.

Timing: XtendiMax® With VaporGrip® Technology may be applied to sugarcane any time after weeds have emerged, but before the close-in stage of sugarcane. Applications of 44 fluid ounces of XtendiMax® With VaporGrip® Technology per acre made over the top of actively growing sugarcane may result in crop injury.

When possible, direct the spray beneath the sugarcane canopy to minimize the likelihood of crop injury. Using directed sprays will also help maximize the spray coverage of weed foliage.

Allow a minimum of 87 days between treatment and harvest.

## 11.13 Farmstead Turf (noncropland) and Sod Farms

Do not use on residential sites.

For use in general farmstead (noncropland) and sod farms, apply 4.12 - 44 fluid ounces of XtendiMax® With VaporGrip® Technology per acre to control or suppress growth of many annual, biennial, and some perennial broadleaf weeds commonly found in turf. XtendiMax® With VaporGrip® Technology will also suppress many other listed perennial broadleaf weeds and woody brush and vine species. Refer to Table 1 for rate recommendations based on targeted weed or brush species and growth stage.

Repeat treatments may be made as needed; however, do not exceed 44 fluid ounces of XtendiMax® With VaporGrip® Technology per acre, per growing season.

Apply 30 - 200 gallons of diluted spray per treated acre (3 - 17 quarts of water per 1,000 square feet), depending on density or height of weeds treated and on the type of equipment used.

To avoid injury to newly seeded grasses, delay application of XtendiMax® With VaporGrip® Technology until after the second mowing. Furthermore, applying more than 16 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre may cause noticeable stunting or discoloration of sensitive grass species such as bentgrass, carpetgrass, buffalograss, and St. Augustine grass.

In areas where roots of sensitive plants extend, do not apply more than 5.5 fluid ounces of XtendiMax® With VaporGrip® Technology per treated acre on coarse-textured (sandy-type) soils, or in excess of 8 fluid ounces per treated acre on fine-textured soils. Do not make repeat applications in these areas for 30 days and until previous applications of XtendiMax® With VaporGrip® Technology have been activated in the soil by rain or irrigation.

## 12.0 CROPS WITH XTEND TECHNOLOGY

COTTON WITH XTENDFLEX® TECHNOLOGY (INCLUDING BOLLGARD II® XTENDFLEX® COTTON, BOLLGARD® 3 XTENDFLEX® COTTON, OR XTENDFLEX® COTTON), ROUNDUP READY 2 XTEND® SOYBEAN, AND XTENDFLEX® SOYBEAN CONTAIN A PATENTED GENE THAT PROVIDES TOLERANCE TO DICAMBA, THE ACTIVE INGREDIENT IN THIS PRODUCT. THIS PRODUCT WILL CAUSE SEVERE CROP INJURY OR DESTRUCTION AND YIELD LOSS IF APPLIED TO COTTON AND SOYBEAN THAT ARE NOT DICAMBA TOLERANT, INCLUDING COTTON AND SOYBEAN WITH A TRAIT ENGINEERED TO CONFER TOLERANCE TO AUXIN HERBICIDES OTHER THAN DICAMBA. FOLLOW THE REQUIREMENTS SET FORTH HEREIN TO PREVENT SEVERE CROP INJURY OR DESTRUCTION AND YIELD LOSS. CONTACT WITH FOLIAGE, GREEN STEMS, OR FRUIT OF CROPS, OR ANY DESIRABLE PLANTS THAT DO NOT CONTAIN A DICAMBA TOLERANCE GENE OR ARE NOT NATURALLY TOLERANT TO DICAMBA, COULD RESULT IN SEVERE PLANT INJURY OR DESTRUCTION.

Information on cotton with XtendFlex® Technology, Roundup Ready 2 Xtend® Soybean, and XtendFlex® Soybean can be obtained from your seed supplier or Bayer representative. Cotton with XtendFlex® Technology, Roundup Ready 2 Xtend® Soybean, and XtendFlex® Soybean must be purchased from an authorized licensed seed supplier.

Note: Cotton with XtendFlex® Technology, Roundup Ready 2 Xtend® Soybean, and XtendFlex® Soybean and methods of controlling weeds and applying dicamba in a Cotton with XtendFlex® Technology, Roundup Ready 2 Xtend® Soybean, and XtendFlex® Soybean crop are protected under U.S. patent law. No license to use Cotton with XtendFlex® Technology, Roundup Ready 2 Xtend® Soybean, and XtendFlex® Soybean is granted or implied with the purchase of this herbicide product. Cotton with XtendFlex® Technology, Roundup Ready 2 Xtend® Soybean, and XtendFlex® Soybean are owned by Monsanto and a license must be obtained from Monsanto before using it. Contact your Authorized Monsanto Retailer for information on obtaining a license to Cotton with XtendFlex® Technology, Roundup Ready 2 Xtend® Soybean, and XtendFlex® Soybean.

## 12.1 Cotton with XtendFlex® Technology

DO NOT combine these instructions with other instructions in the "COTTON" Section of this label for use over crops that do not contain the dicamba tolerance trait.

**TYPES OF APPLICATIONS:** Burndown/Early Preplant; Preplant; At-Planting; Preemergence; Postemergence (In-crop)

### USE INSTRUCTIONS

Apply this product in a minimum of 15 gallons of spray solution per acre as a broadcast application. For best performance, control weeds early when they are less than 4 inches. Timely application will improve control and reduce weed competition. Refer to the following table for maximum application rates of this product with cotton with XtendFlex® Technology.

Maximum Application Rates	
Combined total per year for all applications	88 fluid ounces per acre (2.0 lb. a.e. dicamba per acre)
Total of all Burndown/Early Preplant, Preplant, At-Planting, and Preemergence applications	44 fluid ounces per acre (1.0 lb. a.e. dicamba per acre)
Total of all In-crop applications up to mid-bloom stage or no more than 60 days after planting, whichever occurs first	44 fluid ounces per acre (1.0 lb. a.e. dicamba per acre)
Maximum In-crop, single application	22 fluid ounces per acre (0.5 lb. a.e. dicamba per acre)

a.e. — acid equivalent

Refer to Table 1 for application rates for weed type and growth stage controlled by this product. Maximum in-crop application rate should be used when treating tough to control weeds, dense vegetative growth or weeds with a well-established root system.

#### Burndown/Early Preplant, Preplant, At-Planting, Preemergence

**USE INSTRUCTIONS:** This product may be used to control broadleaf weeds and may be applied before, during or immediately after planting cotton with XtendFlex® Technology. Refer to the "WEEDS CONTROLLED" section of this label for XtendiMax® With VaporGrip® Technology for specific weeds controlled.

#### RESTRICTIONS:

- The maximum combined quantity of this product that may be applied for all burndown/early preplant, preplant, at-planting, and preemergence applications is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.
- The maximum application rate for a single, burndown/early preplant, preplant, at-planting, or preemergence application must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre.
- Do not apply less than 22 fluid ounces (0.5 lb a.e. dicamba) per acre.

#### Postemergence (In-crop)

**USE INSTRUCTIONS:** This product may be used to control broadleaf weeds in cotton with XtendFlex® Technology. In-crop applications of this product can be made up to mid-bloom stage or no more than 60 days after planting, whichever occurs first.

The maximum and minimum rate for any single, in-crop application is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. Using the appropriate application rate may reduce the selection for resistant weeds. For best performance, control weeds early when they are less than 4 inches. To the extent permitted by applicable law, Monsanto Company does not warrant product performance of applications to labeled weeds greater than 4 inches in height. Sequential applications of this product may be necessary to control new flushes of weeds or on tough-to-control weeds. Allow at least 7 days between applications.

Postemergence applications of this product mixed with adjuvants may cause a leaf response to cotton with XtendFlex® Technology. The symptoms usually appear as necrotic spots on fully expanded leaves. EC-based products that are tank mixed with products containing dicamba may increase the severity of the leaf damage.

#### RESTRICTIONS:

- The combined total applied in-crop up to mid-bloom stage or no more than 60 days after planting, whichever occurs first, must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre and a maximum of two in-crop applications.
- The maximum single, in-crop application rate must not exceed 22 fluid ounces (0.5 lb a.e. dicamba).
- The combined total per year for all applications must not exceed 88 fluid ounces (2.0 lb a.e. dicamba) per acre. For example, if a preplant application of 44 fluid ounces (1.0 lb a.e. dicamba) per acre was made, then the combined total in-crop applications must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre.

## 12.2 Roundup Ready 2 Xtend® Soybean and XtendFlex® Soybean

DO NOT combine these instructions with other instructions in the "SOYBEAN" Section of this label for use over crops that do not contain the dicamba tolerance trait.

**TYPES OF APPLICATIONS:** Burndown/Early Preplant; Preplant; At-Planting; Preemergence; Postemergence (In-crop)

### USE INSTRUCTIONS

Apply this product in a minimum of 15 gallons of spray solution per acre as a broadcast application. For best performance, control weeds early when they are less than 4 inches. Timely application will improve control and reduce weed competition. Refer to the following table for maximum application rates of this product with Roundup Ready 2 Xtend® Soybean and XtendFlex® Soybean.

Maximum Application Rates	
Combined total per year for all applications	88 fluid ounces per acre (2.0 lb. a.e. dicamba per acre)
Total of all Burndown/Early Preplant, Preplant, At-Planting, and Preemergence applications	44 fluid ounces per acre (1.0 lb. a.e. dicamba per acre)
Total of all In-crop applications from emergence prior to beginning bloom (R1 stage soybeans) or no more than 45 days after planting, whichever occurs first	44 fluid ounces per acre (1.0 lb. a.e. dicamba per acre)
Maximum In-crop, single application	22 fluid ounces per acre (0.5 lb. a.e. dicamba per acre)

a.e. — acid equivalent

Refer to Table 1 for application rates for weed type and growth stage controlled by this product. Maximum in-crop application rate should be used when treating tough to control weeds, dense vegetative growth or weeds with a well-established root system.

#### Burndown/Early Preplant, Preplant, At-Planting, Preemergence

**USE INSTRUCTIONS:** This product may be used to control broadleaf weeds and may be applied before, during or immediately after planting Roundup Ready 2 Xtend® Soybean and XtendFlex® Soybean. Refer to the "WEEDS CONTROLLED" section of this label for specific weeds controlled.

#### RESTRICTIONS:

- The maximum combined quantity of this product that may be applied for all burndown/early preplant, preplant, at-planting, and preemergence applications is 44 fluid ounces (1.0 lb a.e. dicamba) per acre per season.
- The maximum application rate for a single, burndown/early preplant, preplant, at-planting, or preemergence application must not exceed 44 fluid ounces (1.0 lb a.e. dicamba) per acre.
- Do not apply less than 22 fluid ounces (0.5 lb a.e. dicamba) per acre.

#### Postemergence (In-crop)

**USE INSTRUCTIONS:** This product may be used to control broadleaf weeds in Roundup Ready 2 Xtend® Soybean and XtendFlex® Soybean. In-crop applications of this product can be made prior to beginning bloom (R1 stage soybeans) or no more than 45 days after planting, whichever occurs first.

The maximum and minimum rate for any single, in-crop application is 22 fluid ounces (0.5 lb a.e. dicamba) per acre. Using the appropriate application rate may reduce the selection for resistant weeds. For best performance, control weeds early when they are less than 4 inches. To the extent permitted by applicable law, Monsanto Company does not warrant product performance of applications to labeled weeds greater than 4 inches in height.

A second application of this product may be necessary to control new flushes of weeds and can be made prior to beginning bloom (R1 stage soybeans) or no more than 45 days after planting, whichever occurs first. Allow at least 7 days between applications. For best results, apply XtendiMax® With VaporGrip® Technology after some weed re-growth has occurred.

Application of this product postemergence and under stressful environments may cause temporary loss of turgor, a response commonly described as leaf drop in Roundup Ready 2 Xtend® Soybean and XtendFlex® Soybean. Typically, affected plants recover in 1-3 days depending on the level of droop and environmental conditions.

#### RESTRICTIONS:

- The combined total application rate in-crop prior to beginning bloom (R1 stage soybeans) or no more than 45 days after planting, whichever occurs first, must not exceed 44 fluid ounces (1.0 lb. a.e. dicamba) per acre a maximum of two in-crop applications.
- Do not make in-crop applications of this product during and after beginning bloom (R1 stage soybeans) or more than 45 days after planting.
- The maximum single, in-crop application rate must not exceed 22 fluid ounces (0.5 lb. a.e. dicamba) per acre. The combined total per year for all applications must not exceed 88 fluid ounces (2.0 lb. a.e. dicamba) per acre.

## 13.0 WEEDS CONTROLLED

### General Weed List, Including ALS-, Glyphosate, and Triazine-Resistant Biotypes

Annals	
Alkanet	Mayweed
Amaranth, Palmer, Powell, Spiny	Morningglory, lyleaf, Tall
Aster, Slender	Mustard, Black, Blue, Tansy, Treacle,
Bedstraw, Catchweed,	Tumble, Wild, Yellowtops
Beggarweed, Florida	Nightshade, Black, Cutleaf
Broomweed, Common	Pennycress, Field (Fanweed,
Buckwheat, Tartary, Wild	Frenchweed, Stinkweed)
Buffalobur	Pepperweed, Virginia (Peppergrass)
Burclover, California	Pigweed, Prostrate, Redroot
Burcucumber	(Carelessweed), Rough, Smooth, Tumble
Buttercup, Corn, Creeping,	Pineappleweed
Roughseed, Western Field	Poortoe
Carpetweed	Poppy, Red-horned
Catchfly, Nightflowering	Puncturevine
Chamomile, Corn	Purslane, Common
Chevil, Bur	Pusley, Florida
Chickweed, Common	Radish, Wild
Clovers	Ragweed, Common, Giant (Buffaloweed),
Cockle, Corn, Cow, White	Lance-Leaf
Cocklebur, Common	Rocket, London, Yellow
Copperleaf, Hophornbeam	Rubberweed, Bitter (Bitterweed)
Cornflower (Bachelor Button)	Salsify
Croton, Tropic, Woolly	Senna, Coffee
Daisy, English	Sesbania, Hemp
Dragonhead, American	Shepherdspurse
Eveningprimrose, Cutleaf	Sicklepod
Falseflax, Smallseed	Sida, Prickly (Teaweed)
Fleabane, Annual	Smartweed, Green, Pennsylvania
Flaxweed	Sneezweed, Bitter
Fumitory	Sowthistle, Annual, Spiny
Goosefoot, Nettleleaf	Spanish Needles
Hempnettle	Spikeweed, Common
Henbit	Spurge, Prostrate, Leafy
Jacobs-Ladder	Spurry, Corn
Jimsonweed	Starbur, Bristly
Knawel (German Moss)	Starwort, Little
Knotted, Prostrate	Sumpweed, Rough
Kochia	Sunflower, Common (Wild), Volunteer
Ladysthum	Thistle, Russian
Lambsquarters Common	Velvetleaf
Lettuce, Miners, Prickly	Waterhemp, Common, Tall
Mallow, Common, Venice	Waterprimrose, Winged
Marestail (Horseweed)	Wormwood
<b>Biennials</b>	
Burdock, Common	Mallow, Dwarf
Carrot, Wild (Queen Anne's Lace)	Plantain, Bracted
Cockle, White	Ragwort, Tansy
Eveningprimrose, Common	Starthistle, Yellow
Germium, Carolina	Sweetclover
Gronwell	Teasel
Knapweed, Diffuse, Spotted	Thistle, Bull, Milk, Musk, Plumeloss
<b>Perennials</b>	
Alfalfa <sup>1</sup>	Nettle, Stinging
Artichoke, Jerusalem	Nightshade, Silverleaf
Aster, Spiny, Whitehead	(White Horse-nettle)
Bedstraw, Smooth	Onion, Wild
Bindweed, Field, Hedge	Plantain, Broadleaf, Buckhorn
Blueweed, Texas	Pokeweed
Bursage, Woollyleaf <sup>1</sup>	Ragweed, Western
(Bur Ragweed, Povertyweed)	Redvine
Buttercup, Tall	Serica Lespedeza
Campion, Bladder	Smartweed, Swamp
Chickweed, Field, Mousseear	Skakweed, Broom
Chicory <sup>1</sup>	Sorrel <sup>1</sup> , Red (Sheep Sorrel)
Clover <sup>1</sup> , Hop	Sowthistle <sup>1</sup> , Perennial
Dandelion <sup>1</sup> , Common	Spurge, Leafy
Dock <sup>1</sup> Broadleaf (Bitterdock), Curly	Sundrops
Dogbane, Hemp	Thistle, Canada, Scotch
Dogfennel <sup>1</sup> (Cypressweed)	Toadflax, Dalmatian
Fern, Bracken	Tropical Soda Apple
Gallic, Wild	Trumpetreeper (Buckvine)
Goldenrod, Canada, Missouri	Vetch
Goldenweed, Common	Waterhemlock, Spotted
Hawkweed	Waterprimrose, Creeping
Henbane, Black <sup>1</sup>	Woodsorrel <sup>1</sup> , Creeping, Yellow
Horsenettle, Carolina	Wormwood, Absinth, Louisiana
Ironweed	Yankeeweed
Knapweed, Black, Diffuse, Russian <sup>1</sup> ,	Yarrow, Common <sup>1</sup>
Spotted	
Milkweed, Climbing, Common,	
Honeyvine, Western Whorled	

<sup>1</sup> Noted perennials may be controlled using lower rates of XtendiMax® With VaporGrip® Technology than those recommended for other listed perennial weeds.

## Woody Species

Alder	Kudzu
Ash	Locust, Black
Aspen	Maple
Basswood	Mesquite
Beech	Oak
Birch	Oak, Poison
Blackberry <sup>2</sup>	Olive, Russian
Blackgum <sup>2</sup>	Persimmon, Eastern
Cedar <sup>2</sup>	Pine
Cherry	Plum, Sand (Wild Plum) <sup>2</sup>
Chinquapin	Poplar
Cottonwood	Rabbitbrush
Creosotebush <sup>2</sup>	Redcedar, Eastern <sup>2</sup>
Cucumbertree	Rose <sup>2</sup> , McCartney, Multiflora
Dewberry <sup>2</sup>	Sagebrush, Fringed <sup>2</sup>
Dogwood <sup>2</sup>	Sassafras
Elm	Serviceberry
Grape	Spicebush
Hawthorn (Thornapple) <sup>2</sup>	Spruce
Hemlock	Sumac
Hickory	Sweetgum <sup>2</sup>
Honeylocust	Sycamore
Honeysuckle	Tarbrush
Hornbeam	Willow
Huckleberry	Witchhazel
Huisache	Yaupon <sup>2</sup>
Ivy, Poison	Yucca <sup>2</sup>

<sup>2</sup> Growth suppression only

## 14.0 LIMIT OF WARRANTY AND LIABILITY

Monsanto Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein. Specifically, and without limiting the foregoing, MONSANTO MAKES NO RECOMMENDATION OR WARRANTY HEREIN REGARDING THE USE OF ANY PRODUCTS THAT MAY APPEAR ON THE WEBSITE REFERENCED IN THE TANK-MIXING INSTRUCTIONS HEREIN, REGARDLESS OF WHETHER SUCH PRODUCT IS USED ALONE OR IN A TANK MIX WITH XTENDIMAX<sup>®</sup> WITH VAPORGRIP<sup>®</sup> TECHNOLOGY. BUYER AND ALL USERS ARE SOLELY RESPONSIBLE FOR ANY LACK OF PERFORMANCE, LOSS, OR DAMAGE IN CONNECTION WITH THE USE OR HANDLING OF ANY SUCH PRODUCT ALONE OR IN A TANK MIX WITH XTENDIMAX<sup>®</sup> WITH VAPORGRIP<sup>®</sup> TECHNOLOGY.

Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

To the extent consistent with applicable law, buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, failure of this product to control weed biotypes which develop resistance to dicamba, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil, crop or treated vegetation.

This Company does not warrant any product reformulated or repackaged from this product except in accordance with this Company's stewardship requirements and with express written permission from this Company.

For in-crop (over-the-top) uses on crops with Xtend<sup>®</sup> Technology, crop safety and weed control performance are not warranted by Monsanto when this product is used in conjunction with "brown bag" or "bin run" seed saved from previous year's production and replanted.

TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES.

Upon opening and using this product, buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement. If terms are not acceptable, return at once unopened.

Bollgard II<sup>®</sup>, Bollgard<sup>®</sup>, Degree Xtra<sup>®</sup>, Field Master<sup>®</sup>, Harness<sup>®</sup>, Roundup Ready<sup>®</sup>, Roundup Ready 2 Xtend<sup>®</sup>, Roundup PowerMAX<sup>®</sup>, RT 3<sup>®</sup>, Roundup WeatherMAX<sup>®</sup>, XtendiMax<sup>®</sup>, XtendFlex<sup>®</sup> and VaporGrip<sup>®</sup> are registered trademarks of Monsanto Technology LLC. All other trademarks are the property of their respective owners.

EPA Reg. No. 524-617

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181101