Pesticide Application and Safety

Reviewed by Ben Phillips – Sept 2021

Pesticides are designed to poison or otherwise manage pests. Many pesticide products may poison people, pets, livestock, wildlife, ornamental plants, and other non-target organisms. Pesticide applicators and their families are at increased risk of pesticide exposure. It is important to keep all pesticide exposures to an absolute minimum.

You must protect your family members, field workers, and other people from pesticide injuries. Most pesticide accidents result from careless practices or lack of knowledge about safe handling. The time you spend to learn about the safe use of pesticides is an investment in the health and safety of you, your family, and others.

The U.S. Environmental Protection Agency (EPA) places certain restrictions on the use of pesticide chemicals.

These restrictions apply to chemicals applied to control insects, mites, plant diseases, weeds, nematodes, and other pests. Such restrictions may prohibit the use of a chemical or allow residue tolerances on harvested vegetables. Growers must know what chemical to use on each vegetable; how to apply the products; the post- treatment re-entry interval, if any; when to use the chemicals with respect to farm worker and/or picker safety; and the environment and the harvest of each vegetable crop.

Growers must follow all label instructions regarding harvest restrictions to assure consumers that the food is free of dangerous residues and to comply with the law to prevent seizure of their crops. Here are some rules for the safe use of pesticides:

- Only mix the amount of a pesticide you can use in one day.
- If you do have leftover spray mix, the best way to dispose of it is by applying it to a labeled crop in a legal manner.
- Never dispose of surplus pesticides in a way that will result in the contamination of ground or surface waters.
- Rinse all empty containers three times before disposal.
- Pour the rinse water into the spray tank. Puncture or break triple-rinsed containers to facilitate drainage and to prevent reuse for any other purpose.
- Then dispose of the container according to label directions.

Pesticide Signal Words

Each pesticide container is required by law to have signal words to quickly communicate information about the product's acute toxicity. The three signal words, as provided by the National Pesticide Information Center, are:

- CAUTION. This signal word means the pesticide is slightly toxic if eaten, absorbed through the skin, or inhaled, or it causes slight eye or skin irritation.
- WARNING. This signal word means the pesticide is moderately toxic if eaten, absorbed through the skin, or inhaled, or it causes moderate eye or skin irritation.
- DANGER. This signal word means the pesticide is highly toxic by at least one route of exposure. It may be corrosive, which would cause irreversible damage to the skin or eyes. It may be highly toxic if eaten, absorbed through the skin, or inhaled. If this is the case, then POISON must also be included in red letters on the front panel of the product label.

Minimizing Pesticide Exposure

Signal words convey the acute toxicity of a pesticide. However, exposure to any pesticide, even those without signal words, can lead to long-term health effects. It's important to take precautions to minimize exposure to any and all pesticides. Check the product label for specific instructions to minimize exposure. Some label precautions include:

- Wear the proper respiratory equipment when handling or applying.
- Wear protective clothing that covers as much of the body as possible.
- Always use rubber gloves, not leather or cloth gloves, and never use bare hands to handle pesticides.
- Do not breathe in these pesticides when opening containers or mixing into spray tanks.
- Always wash hands, arms, and face immediately after handling, and before eating or smoking.
- Never smoke while handling or applying.
- Reduce all possible hazards of coming into direct contact with spray drift, and avoid spraying if conditions are too windy.
- Shower or bathe thoroughly after each day's work, and change clothes.
- Wash spray clothes separately from the family wash, then run another complete hot water and detergent wash cycle before washing other clothes.
- Wear clean overalls, underwear, socks, and cap each day you spray.
- Always keep pesticides in their original labeled containers, and store in a safe place.
- Store and dispose of containers according to information on pesticide labels.

Worker Protection Standard

All pesticides with an "Agricultural Use Requirements" box on the label are subject to the regulations of the Worker Protection Standard (WPS). The WPS requires all employers to provide annual pesticide safety training to employees in a language that employees understand. Training must be approved by the Environmental Protection Agency. The Pesticide Educational Resources Collaborative (PERC) has a library of free EPA-approved training materials available in multiple languages on its website, including videos and flip charts.

Restricted Pesticides

Most states have laws that restrict the use of certain pesticides and that describe where such pesticides can be obtained and used. Only individuals who are licensed by the state can apply restricted use pesticides.

Some restricted pesticides require applicators to notify occupants of land within 1,000 feet of the area to be treated at least 24 hours before application. Occupants also must be notified of any precautions they must take to ensure the safety of livestock and humans.

The U.S. EPA, state regulatory agencies, or pesticide companies can label specific pesticide formulations as "Restricted Use Only." To learn more about your state's laws about restricted use pesticides, contact your state department of agriculture or local extension office.

Calibrating Application Equipment

It is essential to apply pesticides at the specified rates for best control and protection and to not exceed residue tolerance. Calibrate and check sprayers carefully several times a season for accurate delivery rates. Ensure equipment is clean and functional, and replace broken parts prior to calibration.

Spreaders

Some granular spreaders are gravimetric and ground-driven, meaning that a constant rate of granules are delivered by gravity out of a feed gate, and a wheel running along the ground is attached to gears and chains that drive the rotor that displaces a fixed amount of granules per revolution. This locks the spreading rate to ground speed, as long as the feed gate is set at a consistent opening. If the feed gate opening remains the same, then **changing ground speed will not affect output**. However, **doubling the rate of granules released from the feed gate with a larger opening will double the output, and halving the rate of granules released from the feed gate with a smaller opening will halve the output**.

Some granular spreaders have a metering unit that is independent from ground speed, and is run hydraulically, electrically, or through a hand crank or the tractor PTO. If the meter rate remains constant, then **halving ground speed will double output, and doubling ground speed will halve output**. If ground speed remains constant, then **doubling meter rate will double output, and halving meter rate will halve output**.

Rotary spreaders fling the material in a fan-like pattern to either side of the spreader, drop spreaders release material in a sheet-like pattern straight down directly over the footprint of the spreader, and band spreaders meter out granules along a row.

Here are suggested steps to calibrating selected spreaders.

Granular Rotary Spreader Calibration

1. Set applicator dial or dials to give desired delivery rate of granules suggested for spreading according to manufacturer's instructions.
2. Fill hopper with granules to be used.
3. Lay out a tarp that is smaller than the spread pattern. Travel across tarp at desired speed and collect granules off of the tarp into a bag, bucket, or other container.
4. Weigh granules, and multiply by fraction of an acre that the tarp represents to find delivery per acre.

   For example: granular rotary spreader that leaves 0.25 lb. on a 20 sq. ft. tarp applies 544.5 lbs. per acre:

$$\text{weight collected (0.25 lb.)} \times \frac{\text{1 acre (43560 sq. ft.)}}{\text{area of tarp (20 sq. ft.)}} = \text{output (544.5 lb./ac.)}$$

5. Adjust each setting, and recalibrate until the desired delivery rate is obtained.

Granular Band Spreader Calibration

1. Set applicator dial or dials to give desired delivery rate of granules suggested for band treatment according to manufacturer's instructions.
2. Fill hoppers with granules to be used.
3. Travel across field at planting speed for the distance required to cover 1/16 acre (2,722 sq. ft.) per row. Collect granules for each row in a bag, bucket, or other container.

   For example: granular band application for a 40-inch row requires 817 ft. to cover 1/16 acre:

$$\frac{\text{1/16 acre (2,722 sq. ft.)}}{\text{row width (3.33 ft.)}} = \text{distance of travel (817 ft.)}$$

4. Weigh granules from each row separately, and multiply by 16 to find delivery per acre for each row.

5. Adjust each setting, and recalibrate until the desired delivery rate is obtained.

Sprayers

Sprayers use a pump mechanism that runs independently from the tractor wheels, or your legs. They are often powered hydraulically, electrically, or through a hand pump or the tractor PTO. If the pressure remains constant, then **halving ground speed will double output, and doubling ground speed will halve output**. If ground speed remains constant, then **quadrupling pressure will double output, and quartering pressure will halve output.**

Boom sprayers apply a sheet-like mist along the length of the boom, band sprayers apply a narrow band over a row with one or more nozzles grouped together, wand sprayers have one nozzle used for small or irregular shaped targets, and airblast sprayers generate a high-speed directional fog.

Here are suggested steps to calibrating selected sprayers. Once output is found in gallons per acre, calculate acres per tankful of spray solution by dividing gallons per tank by gallons per acre of output, and determine the required amount of product to dilute in the tank by multiplying acres per tankful by the rate per acre of product.

Boom Sprayer Calibration

For effective applications, make sure to calibrate boom sprayers carefully. To calibrate a boom sprayer:

1. Fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 1/4 acre (10,890 sq. ft.). Distance of travel will vary with boom width.

   For example, a 22-foot boom must travel 495 feet to cover 1/4 acre:

$$\frac{\text{1/4 acre (10,890 sq. ft.)}}{\text{boom width (22 ft.)}} = \text{distance of travel (495 ft.)}$$

4. Measure amount of water needed to refill the tank. This amount was applied to the 1/4 acre; thus, four times this amount is the gallonage per acre.

Band Sprayer Calibration

1. Fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 1/4 acre (10,890 sq. ft.). Distance traveled will vary with number of nozzles on the sprayer and width of the band sprayed by each nozzle.

   For example, spraying a 20-inch band over 4 rows using 1 nozzle per row requires 1,630 ft. to cover 1/4 acre:

$$\frac{\text{1/4 acre (10,890 sq. ft.)}}{\text{band width (1.67 ft.)}} \div \text{number of nozzles (4)} = \text{distance of travel (1,630 ft.)}$$

4. Measure amount of water needed to refill the tank. This amount was applied to the 1/4 acre; thus, four times this amount is the gallonage per acre.

Wand Sprayer Calibration

1. Fill tank with water.
2. Spray 1/128 acre (340 sq ft.) with the pace and nozzle distance you would be using for application.
3. Measure amount of water needed to refill the tank. This amount was applied to the 1/128 acre; thus, the number of fl. oz. required to refill the sprayer is equal to gallonage per acre.
4. Calculate acres per tankful of spray solution by dividing gallons per tank by gallons per acre of output, and determine the required amount of product to the tank by multiplying acres per tankful by the rate per acre of product recommended.

Airblast Sprayer Calibration

1. Fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 164 ft., measure the time to complete the course, and measure the effective spray swath. For a unidirectional unit, measure the swath from the sprayer to the end of the deposition cloud. For a bidirectional unit, measure the swath from one end to the other end of the deposition cloud. Do this three times to calculate the average time to travel 164 ft, and spray swath. Record speed and PTO speed or pressure settings for future reference.
4. Measure amount of water needed to refill the tank. This amount was applied to the fraction of an acre; thus, four times this amount is the gallonage per acre.

   For example, spraying a 10 ft. swath over a164 ft course used 2 gallons. The gallons per acre is calculated this way:

$$\text{volume measured (2 gal.)} \times \frac{\text{1 acre (43,560 sq. ft.)}}{\text{area of swath (10 ft. x 164 ft.)}} = \text{output (53 gal/ac.)}$$

Conversions for Liquid Pesticides on Small Areas

Convert per acre rates to smaller areas by first converting the rate to fl. oz. or dry oz. Then, find 100 sq. ft. rates by dividing by 435.6, or 1,000 sq. ft. rates by dividing by 43.56. You can convert fl. oz. or dry oz. back to a larger unit from there. Or, use this table, which approximates the rate reductions into common measuring increments.

Rate per Acre	Rate per 1,000 Square Feet	Rate per 100 Square Feet
1 pint	0.75 tablespoon	0.25 teaspoon
1 quart	1.5 tablespoons	0.5 teaspoon
2 quarts	3 tablespoons	1 teaspoon
1 gallon	6 tablespoons	2 teaspoons
25 gallons	4.5 pints	1 cup
50 gallons	4.5 quarts	1 pint
75 gallons	7 quarts	1.5 pints
100 gallons	9 quarts	1 quart

Check the pesticide label for the particular crop, pest, and site of your planned use.

Evaluating Water Quality and Compatibility of Pesticides Before Tank-Mixing

Water that is added to the pesticide spray tank may vary in pH, hardness and other qualities. These variations in water types may influence the effectiveness of the pesticide application. To learn about this subject, see *The Impact of Water Quality on Pesticide Performance* (Purdue Extension publication PPP-86) available from the Education Store, edustore.purdue.edu.

Read the label and follow directions. If the label states, "Do not mix with other products," that direction must be followed. If using different products, and one label states, "Add last to spray tank", that direction must be followed If the label states, "Do not use adjuvants", that direction must be followed.

Follow these steps to do a jar test of a new mixture of chemistries to ensure compatibility in the tank. These ratios will approximate 25 gallons per acre. Between each ingredient, let it stand for a few minutes to see if there is a reaction. If there is a precipitate, or the material greases out, or heats up, don't use it in the field. The allowable separation in the jar depends on the amount of agitation in your equipment.

1. In a 1 quart jar, add 1 pint of the same water or liquid fertilizer that will be used in the field.
2. Add and agitate 1 1/2 teaspoon of any wettable dry product(s) for each pound per acre to be used. Formulation abbreviations include W, WP, WDG, DF, D, or G.
3. Next, add and agitate 1 teaspoon for each quart per acre of any liquid flowables and suspensions to be used. Formulation abbreviations include FS, F, WS, SC.
4. Next, add and agitate 1 teaspoon for each quart per acre of any microencapsulated or emulsifiable concentrates to be used. Formulation abbreviations include ME, EC, or E.
5. Finally, add and agitate 1 teaspoon for each quart per acre of any surfactants and solutions to be used. Formulation abbreviations include CS, S, or L.

Storing Pesticides for Next Season

Growers who store pesticides always should consider safety and product quality, whether they will store products for a few weeks or a year or more. It is best not to have leftover pesticides. However, there usually are surplus pesticides at the end of the season because preseason purchases often are very economical.

Before storing pesticides always:

1. Read product labels. Certain formulations or products have special storage requirements, which are printed on the label.
2. Make certain the label is in good condition (legible) to know what is in the container and for directions for safe, effective, and legal use.
3. Write the purchase or delivery date on the label. Store the oldest materials near the front of the storage area and use older or opened products first. Products that are several years old may not be effective.
4. Keep an up-to-date inventory of pesticides to assist in purchase decisions and in emergencies.
    a. Maintain storage temperatures between 32°F and 100°F. Ventilation is important for storage of most pesticides. Keep pesticides dry and out of direct sunlight.
5. Store herbicides away from other pesticides to prevent use mix-up, contamination, and possible plant damage. Never store pesticides with food or seed or near food or drinking water.
6. Permanently identify and lock pesticide storage areas.
7. Keep a supply of cat litter or other absorbent material in the storage to scatter over spills of liquid chemicals.
8. Hang a Class B inflammable liquids fire extinguisher nearby.

Empty Containers

Most states have regulations that regulate the disposal of pesticide containers. The regulations often require that hazardous materials containers be disposed of in designated hazardous waste sites unless commercial applicators meet triple-rinsing and other requirements.

However, farmers and private applicators may be exempt from the regulations as long as they follow all label instructions when disposing of waste pesticides and containers.

Pesticide Poisoning

For humans, call the Nationwide Emergency Number at 800-222-1222.

This number will automatically connect you to the poison center nearest you. Personnel at this number will give first aid instructions and direct callers to treatment centers. For immediate emergency treatment or ambulance service, always call 911.

For pets, call the Animal Poison Control Center at 888-426-4435, or the Pet Poison Helpline at 800-213-6680. A consultation fee may apply.

Pesticide Spills

For information about cleaning up or otherwise dealing with **non-emergency pesticide spills**, you can contact the National Pesticide Information Center at 800-858-7378 and the pesticide manufacturer for SDS and label information. **For emergency pesticide spills, pesticide fires, or pesticide transportation accidents** first call 911, then call your state agency who handles spill response.

- Illinois Emergency Management Agency
  800-782-7860
- Indiana Department of Environmental Management
  888-233-7745
- Iowa Department of Natural Resources
  515-725-8694
- Kansas Department of Health and Environment
  785-291-3333
- Michigan Department of Agriculture and Rural Development
  800-405-0101
- Minnesota Duty Officer
  800-422-0798
- Missouri Department of Natural Resources
  573-634-2436
- Ohio Environmental Protection Agency
  800-282-9378

When federal notification is required, call the National Response Center at 800-424-8802.

Pesticide Use and Greenhouses, Chemigation, and Respirators

Before using any pesticide, always read the product label for mention of greenhouse, chemigation, and respirator restrictions. See the tables for Fungicides, Herbicides, Insecticides, and Nematicides.

Labels

For complete label and Safety Data Sheet (SDS) information, search one of the following databases.
cdms.net/label-database
agrian.com/labelcenter/results.cfm
greenbook.net

To check if a pesticide is registered at the federal level, search this database.
iaspub.epa.gov/apex/pesticides/f?p=PPLS

To check if a pesticide is registered for your state, search one of the following databases. Most states require a federally registered pesticide to also be registered by the state as well.

IA, IN, KS, MN, MO:
kellysolutions.com

IA, IN, MI, MN, OH:
npirspublic.ceris.purdue.edu/state/

IL:
www2.illinois.gov/sites/agr/Pesticides/Pages/Pesticide-Product-Results.aspx