POISON CONTROL CENTERS IN ARKANSAS

The United States Environmental Protection Agency has established a Poison Control System throughout the nation. Participating hospitals function on a voluntary basis to provide special emergency aid in case of chemical intoxication. Each Poison Control Center has the capability to determine the toxic constituent of commercial products, respond to calls from physicians or individuals and provide supportive or antidotal treatment.

In a pesticide or poisoning emergency, call 1-800-222-1222. Your call will be directed to the nearest Poison Control Center.

INSECTICIDE APPLICATION

The success of any insecticide treatment depends upon proper application. There are several variables that impact proper application. This material briefly discusses application guidelines such as calibration, tank mixing, agitation, spray volume, drift control and nozzle selection. For more detailed information on most aspects of spray application, contact your county Extension office.

Checklist for Proper Spray Application

If you cannot check all the following (where applicable), perhaps you have a weakness in your sprayer program that can be corrected.

☐ Sprayer is calibrated accurately. (**Pages 4 and 5**)

☐ Band width is accurately measured and broadcast rates are changed for banding applications. (**Page 5**)

☐ Use a minimum screen size of 50 mesh for wettable powders or flowables.

☐ Have proper agitation (not just bypass) for powders and flowables. (**Page 8**)

☐ Refer to label and precautions in this publication to choose proper spray volume and pressure for insecticide used. (**Page 8**)

☐ Use the appropriate style nozzle designed to balance drift control and coverage (**Pages 6 and 7**)

☐ Use nozzles designed to resist wear when applying wettable powders or flowables. (**Page 6**)

☐ Properly clean application equipment when switching pesticides and at the end of day. (**Page 9**)

Sprayer Calibration

No single aspect of spray application is as important and as abused as sprayer calibration. There is no way to accurately apply an insecticide without accurately calibrating the sprayer and figuring the tank mix. Using the following method and examples, you can calibrate quickly and easily.

Measuring Travel Speed

Measure a test course in the area to be sprayed or in an area with similar surface conditions. Minimum lengths of 100 and 200 feet are recommended for measuring speeds up to 5 and 10 mph, respectively. Determine the time required to travel the test course. To help ensure accuracy, conduct the speed check with a loaded sprayer and select the engine throttle setting and gear that will be used when spraying. Repeat the above process and average the times that were measured. Use the following equation or the table below to determine ground speed.

$$Speed\ (mph) = \frac{Distance\ (ft) \times 60}{Time\ (seconds) \times 88}$$

Determining Gallons Per Acre (Ounce Method)

1. Check the table below for the proper distance related to the row or nozzle spacing on your sprayer. For broadcast, use nozzle spacing; for band application such as post directed or band behind press wheel, use row spacing. Mark off this distance in the field you will be spraying.

Row or Nozzle Spacing (inches)	Calibration Distance (feet)	Row or Nozzle Spacing (inches)	Calibration Distance (feet)
40	102	28	146
38	107	26	157
36	113	24	170
34	120	22	185
32	127	20	204
30	136	18	227

For row or nozzle spacing's and calibration distances not shown here – any calibration distance (feet) may be determined by the following equation:

$$4080/average\ row\ or\ nozzle\ spacing\ (in\ inches).$$

All rates are given as broadcast rates. For band application, you must adjust the rate by the following formula:

$$\frac{Band\ Width}{Row\ Width} \times Broadcast\ Rate = Band\ Rate$$

2. Attach row conditioner, Triple-K, planter or whatever tool is to be pulled by the tractor when spraying. Engage the tool to the proper depth and use the throttle setting and gear that will be used for spraying. Note the time in seconds on a stopwatch that it takes to drive the calibration distance measured.

3. Catch the nozzle discharge for the noted time in Step 2 in a container graduated in ounces (plastic measuring cup, baby bottle, etc.). If you are using a broadcast boom with nozzles spaced evenly, catch the output from one nozzle for the time measured in Step 2. If more than one nozzle per row is used (directed, insecticide or fungicide rig), catch the spray from each nozzle for the time noted in Step 2. Then combine the amount from all nozzles spraying on a single row.

4. The total discharge measured in ounces is equal to the gallons per acre applied. With a broadcast boom, this is the amount caught from one nozzle. Where you have used row spacing in Step 1, all nozzles directed to that row must be measured to determine the gallons per acre.

5. Check each nozzle to ensure equal spray distribution across the width of the sprayer. Repeat Steps 3 and 4 to ensure that nozzles do not vary more than 10 percent across the width of the sprayer.

Determining Tank Mix

Divide tank refill capacity by the calibrated gallons per acre (determined in Step 4). This is the number of acres the sprayer will cover per refill. Multiply the broadcast rate of insecticide (or band rate) times the acreage per refill to get the amount of insecticide (commercial product) to be put in the tank.

Example 1 – Broadcast Application

A grower will apply Anychem 1 with a broadcast boom having nozzles spaced 20 inches apart while pulling a disk for incorporation.

1. The distance to travel for 20-inch nozzle spacing is 204 feet. Next, measure and flag off 204 feet in the field to be sprayed.
2. Select the desired gear and throttle setting with the disk down. Let's say it takes 20 seconds to cover the 204 feet.
3. Set the pressure to be used and catch the output from one nozzle for 20 seconds (the time required to travel the 204 feet).
4. The output in ounces is the amount applied in gallons per acre. If the nozzle output was 15 ounces in 20 seconds, the sprayer applies 15 gpa.
5. Repeat Step 4 checking each nozzle.

Let's assume you have a 200-gallon tank and wish to apply one pint of Anychem 1 per acre.

$$\frac{200\ gal/refill}{15\ gpa} = 13.3\ acres\ covered\ per\ tank\ (or\ refill)$$

Since you wish to use 1 pt/A, you would use 13.3 pints of Anychem 1 per refill; i.e.,1 pt/A × 13.3 acres = 13.3 pints. [See Note in Example 2.]

Example 2 – Band Behind Planter

A grower will apply Anychem 2 behind his planter with a 14-inch spray band on a 38-inch row.

1. The distance to travel for a 38-inch row is 107 feet.
2. Select the planting speed and travel the measured 107 feet with planter down. Let's say it takes 18 seconds in this example.
3. Set the pressure and catch the output from one nozzle for 18 seconds (the time required to travel 107 feet).
4. The output in ounces is the amount applied in gallons per acre. If the nozzle output was 10 ounces in 18 seconds, the sprayer applies 10 gpa. (This is all on a band.)
5. Repeat Step 4 checking each nozzle.

Let's assume a 400-gallon tank (two 200-gallon saddle tanks) refill capacity and the rate of Anychem 2 50W for your soil is 1 pound/A broadcast. Reduce this rate to a 14-inch band.

$$\frac{14"\ band}{38"\ row} \times \frac{1\ lb}{A} = \frac{0.37\ lb}{A}\ to\ be\ applied\ on\ the\ band$$

$$\frac{400\ gal/refill}{10\ gpa} = 40\ acres\ per\ tank\ refill$$

$$40\ acres \times 0.37\ lb/A = 14.8\ lb\ of\ Anychem\ 2\ 50W\ per\ tank\ refill$$

$$(7.4\ pounds\ in\ each\ 200\text{-}gallon\ saddle\ tank)$$

NOTE: Plan on the amount of water required to refill the tank, not the capacity of the tank itself. For example, if you have the above 200-gallon saddle tanks but you have 50 gallons of spray left in each when you refill, it only takes 300 gallons to refill them.

Therefore:

$$\frac{300\ gal/refill}{10\ gpa} = 30\ acres\ per\ refill$$

$$30\ A/refill \times 0.37\ lb/A = 11\ lb\ of\ Anychem\ 2\ 50W\ per\ refill$$

(5.5 pounds in each of the two tanks)

Example 3 – Directed Spray

A grower will apply Anychem 3 + Anychem 4 on a 16-inch band on a 32-inch row using 2 OC-02 nozzles per row (one on each side). **[Step 1]** The distance to travel for a 32-inch row is 127 feet. **[Step 2]** Select speed and drive the 127 feet. Assume it takes 15 seconds. **[Step 3]** Set the pressure and catch each of the two nozzles per row for 15 seconds or time determined in Step 2. **[Step 4]** Add the quantity from the two tips. The amount in ounces is the gallons per acre. Assume 5 ounces per tip for a total of 10; therefore, a 10 gpa output. **[Step 5]** Repeat Step 4 checking the nozzles on each row.

Let's assume two 200-gallon saddle tanks and the broadcast rate is 1 pound Anychem 3 50W + 1 pint Anychem 4 per acre. Reduce the rates for the 16-inch band.

$16/32 \times 1\ lb = 1/2\ lb\ Anychem\ 3$ $16/32 \times 1\ pt = 1/2\ pt\ Anychem\ 4/A$

$$\frac{400\ gal\ tank\ capacity}{10\ gpa} = 40\ acres\ per\ refill$$

$$40\ acres \times 1/2\ lb\ Anychem\ 3 = 20\ lb\ Anychem\ 3$$

$$40\ acres \times 1/2\ pt\ Anychem\ 4 = 20\ pt\ Anychem\ 4$$

Put 1/2 this amount (10 lb Anychem 3 + 10 pt Anychem 4) in each tank.

Nozzle Selection

Insecticides are best applied with the proper nozzle tip design. A balance must be struck for each application between responsible drift control and acceptable coverage. This balance will change depending on controllable factors like the pesticide formulation, pressure, rate and equipment speed. Nozzle manufacturers have made much advancement in spray technology recently. These advancements have set producers up to be more effective, more efficient and more responsible applicators. Next to calibration and proper tank mixing, nozzle selection is key to proper application.

Nozzle Nomenclature

In addition to a company's name, most nozzle tips are coded with important information – often starting with an abbreviation of a nozzle type, next is usually fan angle, then flow rate and finally the tip material composition.

Example – TeeJet AIXR11002 VS is an air induction (AI), extended range (XR), 110° flat fan, size number 02 (0.2 GPM), color coded (V - ISO color coding system) and stainless steel nozzle (S) that is made by Spray Systems Company.

Tip Materials and Durability

Tips are available in a number of materials. Stainless steel, hardened stainless steel, nylon and ceramics offer the best wear characteristics and are often worth the additional cost, especially when using abrasive products like wettable powders. Plastic tips are now available that are imbedded with more durable materials in key locations. These tips offer the durability of stainless steel or ceramic nozzles at a fraction of the cost.

Common Nozzle Spray Patterns

- **Standard Flat-Fan** – common broadcast nozzle, poor drift control and narrow recommended pressure range. ***30-60 psi***
- **Extended Range Flat** – better spray distribution over wider pressure range. Provides some drift control at low pressures (<30 psi). ***15-60 psi***
- **Even Flat-Fan** – used to band rows uniformly. Not a broadcast tip. ***20-60 psi***
- **Off-Center Flat** – used on boom ends to increase uniformity and width of spray swath. Also used for banding under foliage. ***30-115 psi***
- **Twin Orifice Flat** – produces one fan tilted forward and one tilted backward. Improves coverage of contact pesticides but highly drift prone. ***30-60 psi***
- **Hollow Cone** – common in directed contact pesticides because of fine spray pattern and excellent coverage. Very drift prone. ***40-100 psi***

Many of the listed spray patterns offer excellent coverage of both contact and systemic pesticides. Excellent coverage can come with very small spray droplets known as driftable fines. Nozzle manufacturers have worked hard to maintain desired levels of coverage while reducing economic and environmental damage caused by pesticide drift. This work has produced many options of common spray patterns with added drift control technology from which applicators can select. Applicators should select nozzle options carefully to ensure proper coverage while responsibly controlling driftable fines.

Tips for Balancing Drift Control and Coverage

When wind velocity is too high to be practical, the best solution is to park the sprayer. However, there are approaches to compensate for some wind. Spray droplets should always be as large as possible while still obtaining appropriate coverage. This is particularly true in a high drift potential application. One solution is to change tips. Use a larger tip (i.e., an 8005 instead of an 8003), and lower the spray pressure (i.e., go up on the nozzle size and down on the pressure). Also, consider a wider angle tip such as a 11003 instead of an 8003. This allows the nozzle to be adjusted closer to the ground without changing the width of the spray pattern where it contacts the ground. A more recent option is to change your tip design, such as adding tips with air induction, pre-orifice and/or turbulence chamber technology. Coverage can be improved with drift reduction tips by using tips with multiple nozzles facing different angles across the boom.

Air induction style nozzles emit fewer fines and can be a very good tool to avoid drift potential. Air induction tips are typically not as sensitive to droplet size changes as operating pressures increase. This helps avoid small droplet formations when the sprayer is operating at higher speeds and the flow control is increasing pressure to ensure the correct dosage. Some examples of tips that have air induction capabilities are Greenleaf Technologies Air Mix and TurboDrop series; Hypro's Ultra Low Drift (ULD) and Guardian Air (GA) series; and TeeJet Technologies Air Induction (AI) and Turbo Tee Induction (TTI) series.

Pre-orifices meter the flow of pesticide before it reaches the spray orifice. This produces a larger droplet spectrum and helps to reduce the number of drift-prone fines. Examples of tips using pre-orifice technology include Wilger Industries Small Range (SR), Medium Range (MR) and Drift Reduction (DR) tips; TeeJet Technologies Drift Guard (DG), Air Induction (AI), Turbo Tee (TT), Turbo Tee Induction (TTI) and Air Induction Extended Range (AIXR) series; Hypro's Guardian (GRD) and Guardian Air (GA) series; and Greenleaf Technologies Turbo Drop XL (TDXL) series.

Nozzles that use **turbulence chambers** go one step further. This design uses a pre-orifice to meter the pesticide into the turbulence chamber and then out of the final orifice (often a smaller size). These nozzles are designed to produce a larger droplet with more uniform coverage along the boom. Examples of tips using turbulence chamber technology include Hypro's Guardian (GRD) and Guardian Air (GA) series; TeeJet Technologies Drift Guard (DG) and Turbo Tee (TT) series: and Wilger Industries Small Range (SR), Medium Range (MR), and Drift Reduction (DR) tips.

Twin or duo nozzles facing forward and backward across the boom can increase coverage when using drift control tips. Depending on the manufacturer, these will be two nozzles molded into one body or two separate nozzles plumbed together. If used properly, twin nozzle configuration can improve foliar penetration and coverage while using drift control tips. Examples of twin or duo nozzles are TeeJet Technologies Turbo TeeJet Duo Dual Polymer Nozzle and Greenleaf Technologies TurboDrop Asymmetric DualFan Nozzle.

Quick Reference Guide to Selecting a Nozzle

1. **Read the pesticide label** to find the following information. Some information may not be on the label and should be determined by University of Arkansas Systems Division of Agriculture recommendations or equipment capabilities.

   a. Spray volume (GPA) _____
   b. Droplet classification (for example, coarse) _____
   c. Nozzle type (if listed) _____
   d. Select an appropriate travel speed (mph) _____
   e. Determine boom spacing in inches (W)* _____

2. **Calculate needed nozzle discharge** using the following formula.

$$GPM\ (per\ nozzle) = \frac{GPA \times mph \times W}{5{,}940}$$

   ***W** – Spray width (inch) for single nozzle, band spraying or boomless spraying.
   – For directed spraying, divide row spacing (inch) by the number of nozzles per row.
   – If the "W" term is the width of the band, do not worry about converting for bandwidth, it is inclusive.

3. **Consult a nozzle catalog or website** to select a nozzle**.** Nozzle catalogs will be organized by nozzle type first. Use the information described in this section and the information from the catalog to select a nozzle type. Next, use the recommended droplet classification from the label and the nozzle discharge rate calculated from Step 2 to determine the proper tip size.

   Many nozzles may fit your qualifications. Try to find a nozzle that operates at a lower pressure and allows you to operate comfortably in your droplet classification.

4. Once nozzles are installed, do not forget to **recalibrate your sprayer**.

Another way to quickly and easily obtain a nozzle recommendation is to visit a nozzle manufacturer's website and locate their nozzle selection tool. Simply type in the information that has been identified from **Step 1** and the website will generate a list of appropriate nozzles from which you may select. Nozzle manufacturer URLs and their Nozzle Selection Tools URLs are listed on page 8.

Nozzle Resources

Manufacturers of spray nozzles provide a wealth of information about the selection, setup and use of their products in their catalogs. These include such things as hose flow information and nozzle selection guides. Typically, the guides will show setup criteria and give recommendations for contact and systemic differences. It would be impractical to reprint all of that information here. Manuals or catalogs for the specific product you are using can be obtained from dealers. If you cannot locate a personal copy, each county Extension office usually keeps at least one copy of popular brand item catalogs. The more common way is to access this information over the Internet. Several URL listings are included for some of the more popular manufacturers on page 8.

Nozzle and Tip Companies

Greenleaf Technologies
Phone: 800-881-4832
http://www.greenleaftech.com
greenleaftech.com/dynamic.php?pg=Choosing_the_Right_Nozzle/Nozzle_Calculator

Pentair Hypro Shurflo
Phone: 800-445-8360
http://hypro.pentair.com/en/spray-it

Spray Systems Company - Teejet Technologies
Phone: 630-665-5000
www.teejet.com

Wilger Industries Ltd.
Phone: 877-968-7695 or 731-968-7695
www.wilger.net
http://www.wilger.net/index.php/tip-wizard

Sprayer Tank Agitation

The type of pesticide formulation dictates the need for agitation. Soluble liquids, soluble powders and emulsifiable concentrates require little agitation. Usually the flow from the bypass hose maintains a uniform mixture.

Wettable powders and flowable formulations are only in suspension, and they require vigorous agitation to prevent settling out. Many instances can be cited where insufficient agitation has resulted in undesirable responses. Consider the following when examining the need for agitation in application equipment:

- Insufficient agitation can cost more than the entire sprayer costs.
- Running a bypass hose into the tank is not agitation.
- Agitation can be expected to use more pump capacity than the nozzles require.
- Pre-mixing wettable powders will get pesticides into suspension; insufficient agitation allows them to drop out. Continue agitation until all the spray is distributed.

Spray Volumes

In general, spray volumes should be in the 10 to 20 GPA range for most insecticides. For band applications, a volume equivalent to 1/2 gallon per inch of band is sufficient (i.e., 10 GPA on a 20-inch band). Refer to the comments on each insecticide to note any specific application instructions.

Tips for Proper Mixing

1. See that equipment is clean and in good running condition, free of oil, grease or residue.
2. Be sure to have a shut-off valve installed in the bottom of each tank.
3. Use a 16-mesh suction screen to allow chemicals to circulate through the pump.
4. If there is any question about chemical compatibility, do a jar test first.
5. Always follow label instructions about mixtures. In absence of instructions, use the WALE method.
6. Add chemicals in the W-A-L-E sequence.
    - Wettable powders or water dispersible granules
    - Agitation
    - Liquids (flowable liquids)
    - Emulsifiable concentrates
    - Surfactants and solutions
7. Begin with tank 1/4 full of carrier and start agitation until solution is rolling.
8. W – Add all W and WDG chemicals to solution.
9. A – Get good, strong agitation with a rolling effect on the surface of the carrier. Allow time for good dispersal.
10. L – Next add all L or F while continuing to agitate.
11. E – Finally, add all E or EC.
12. Empty the tank as much as possible before mixing a new batch.

Compatibility Test

Since liquid fertilizers can vary, even within the same analysis, always check compatibility with insecticide(s) each time before use. Be especially careful when using complete suspension or fluid fertilizers, as serious compatibility problems are more likely to occur. Commercial application equipment may improve compatibility in some instances. The following test assumes a spray volume of 25 gallons per acre. For other spray volumes, make appropriate changes in the ingredients. Check compatibility using this procedure:

1. Add 1 pint of fertilizer to each of two 1-quart jars with tight lids.
2. To one of the jars, add 1/4 tsp or 1.2 milliliters of a compatibility agent approved for this use, such as Compex or Unite (1/4 tsp is equivalent to 2 pt per 100 gal spray). Shake or stir gently to mix.
3. To both jars, add the appropriate amount of insecticide(s). If more than one insecticide is used, add them separately with dry insecticides first, flowables next and emulsifiable concentrates last. After each addition, shake or stir gently to thoroughly mix. The appropriate amount of insecticides for this test follows.
4. *Dry Insecticides:* For each pound to be applied per acre, add 1.5 level teaspoons to each jar. *Liquid Insecticides:* For each pint to be applied per acre, add 0.5 teaspoon or 2.5 milliliters to each jar.
5. After adding all ingredients, put lids on and tighten. Invert each jar ten times to mix. Let the mixtures stand 15 minutes and then look for separation, large flakes, precipitates, gels, heavy oily film on the jar or other signs of incompatibility. Determine if the compatibility agent is needed in the spray mixture by comparing the two jars. If either mixture separates but can be remixed readily, the mixture can be sprayed as long as good agitation is used. If the mixtures are incompatible, test the following methods of improving compatibility: (A) slurry the dry insecticide(s) in water before addition or (B) add one-half of the compatibility agent to the fertilizer and the other one-half to the emulsifiable concentrate or flowable insecticide before addition to the mixture.

Application Equipment Cleanout

Equipment cleanout is essential to avoid crop injury from a contaminated sprayer. It is particularly important when changing from wettable powders that are more prone to collect in filters, boom and nozzle bodies. Ensure proper clean-out by disassembling, inspecting and cleaning trouble areas when using these products. Also, many growth regulating herbicides can be particularly destructive to sensitive crops even in extremely small concentrations. Ensure proper cleanout by using proper soaking procedures and always refer to product labels for any clarification.

Following the procedures specified on the pesticide or commercial cleaner label is critical to removing pesticide residue from the sprayer system. Consult labels of the products that were previously in the tank and for the products that will be used for the next application for specific cleaning and mixing/loading instructions.

The University of Arkansas System Division of Agriculture recommends a minimum triple rinse for cleanout of all pesticides regardless of label recommendations.

FORMULATIONS AND CONCENTRATIONS

Aerosols (A) – solid or liquid air suspensions of ultramicroscopic size which remain suspended for long periods.

Baits (B) – a poison or poisons plus some substance which will attract the insect.

Dusts (D) – diluted toxicant with finely ground, dried plant materials or minerals. These include wheat, soybean, walnut shells, talc, clay or sulfur.

Emulsifiable Concentrates (E or EC) – insecticide and an emulsifying agent in a suitable solvent. These are diluted with water to form an emulsion and applied as sprays.

Flowable (F)/Liquid (L) – viscous concentrate of suspended pesticide in water.

Fumigant – substance or mixture of substances which produce gas, vapor, fume or smoke intended to destroy insects, bacteria, rodents or other organisms.

Granules (G) – insecticide attached to an inert carrier of 30- to 60-mesh particle size.

Low Volume (LV)/Concentrated Low Volume (CLV)/Ultra Low Volume (ULV) – formulation containing higher concentration of active ingredient per gallon of formulation that results in a lower volume of formulation per unit area.

Pellet (P or PS) – granular formulation where all of the particles are of the same weight and size.

Ready To Use (RTU) – formulation in a form that requires no mixing before use.

Soluble Powder (SP)/Water Soluble Powders (WSP) – powder formulation that dissolves in water.

Solutions (S) – liquid forms of insecticides that are dissolved in suitable solvents such as petroleum distillates or liquid gas. Oil-based cattle sprays, household sprays and gas-propelled aerosols are examples of insecticide solutions.

Suspension Concentrates (SC) or **Capsule Suspensions (CS)** – particles in suspension.

Water-Dispersible Granules (WDG)/Dry Flowables (DF) – granules of a pesticide formulation that disperse in water to form a spray solution.

Wettable Powders (WP) – dry forms of insecticides in which the toxicant is impregnated or absorbed on powders that can be readily mixed with water because a wetting agent has been added. These form a suspension-type spray that must be kept agitated in a sprayer tank.

TABLE OF WEIGHTS, MEASURES AND DILUTIONS

Weights

28.35 grams = 1 ounce
16 ounces = 1 pound = 453.6 grams
1 gallon water = 8.34 pounds
1 cubic foot water = 62.4 pounds
1 gallon No. 2 fuel oil = 7 pounds
1 gallon kerosene = 6.7 pounds

Volume and Liquid Measure

3 teaspoons = 1 tablespoon = 14.8 cc/ml
2 tablespoons = 1 fluid ounce = 29.6 cc/ml
8 fluid ounces = 16 tablespoons = 1 cup = 236.6 cc/ml
2 cups = 32 tablespoons = 1 pint = 473.1 cc/ml
2 pints = 64 tablespoons = 1 quart = 946.2 cc/ml
4 quarts = 256 tablespoons = 1 gallon = 3785 cc/ml
128 fluid ounces = 1 gallon = 3785 cc/ml

Land Measure

16 1/2 feet = 5 1/2 yards = 1 rod
66 feet = 4 rods = 1 chain
272 1/4 square feet = 30 1/4 square yards = 1 square rod
4356 square feet = 16 square rods = 1 square chain
43560 square feet = 160 square rods = 1 acre
43560 square feet = 10 square chains = 1 acre

Length of Row Required for One Acre

Row Spacing	Length or Distance
24 inch	7,260 yards = 21,780 feet
30 inch	5,808 yards = 17,424 feet
36 inch	4,840 yards = 14,520 feet
38 inch	4,585 yards = 13,756 feet
40 inch	4,356 yards = 13,068 feet
42 inch	4,149 yards = 12,446 feet
48 inch	3,630 yards = 10,890 feet

Determining Contents — Standard 55-Gallon Drum

Drum on Side		Drum Upright	
Depth of Liquid in Inches	Volume in Gallons	Depth of Liquid in Inches	Volume in Gallons
1	0.89	1	1.7
2	2.4	2	3.4
3	4.4	3	5.2
4	6.7	4	6.7
5	9.3	5	8.6
6	12.0	6	10.3
7	14.8	7	12.0
8	17.8	8	13.8
9	20.9	9	15.5
10	24.0	10	17.2
11	27.2	11	18.9
12	30.2	12	20.6
13	33.4	13	22.4
14	36.5	14	24.1
15	39.5	15	25.0
16	42.5	16	27.5
17	45.3	17	29.3
18	47.9	18	30.9
19	50.3	19	32.7
19.75	52.0	20	34.4
		21	36.1
		22	37.8
		23	39.6
		24	41.3
		25	43.0
		26	44.8
		27	46.5
		28	48.2
		29	49.9
		30	51.6
		30.19	52.0

Travel Speed Chart

Miles per Hour	Time Required in Seconds to Travel		
	100 Ft	200 Ft	300 Ft
1	68	136	205
2	34	68	102
3	23	46	68
4	17	34	51
5	14	27	41
6	11	23	34
7	10	20	29
8	9	17	26
9	8	15	23
10	7	14	21

1 MPH = 88 feet per minute

1 MPH = 1.466 feet per second

$$\text{Speed in MPH} = \frac{\text{Distance (ft)} \times 60}{\text{Time (seconds)} \times 88}$$

Tables of Dilutions for Liquids and Dusts

1. Equivalent Quantities of Liquid Materials When Mixed by Parts.

Water	Amount of Insecticides for Different Dilutions		
	1-400	1-800*	1-1600
100 gals	1 qt	1 pt	1 cup
50 gals	1 pt	1 cup	1/2 cup
5 gals*	3 T	5 t*	2 1/2 t
1 gal	2 t	1 t	1/2 t

*Example: If a recommendation calls for 1 part of the chemical to 800 parts of water, it would take 5 teaspoonfuls in 5 gallons of water to give 5 gallons of a mixture of 1-800.

2. Backpack or Pump-up Sprayer Quick Calibration Table

The table below gives the amount of insecticide needed to spot spray an area. For example if you want to spray bifenthrin at a rate of 4 fl oz per acre, you would need to add 0.16 oz of product to 1 gallon of water. This table supplies the amount of product you would need per fill-up for your sprayer assuming 25 GPA output.

Rate	Product needed for a 1 gallon sprayer*	Product needed for a 2.5 gallon sprayer*
2 fl oz/A	0.08 oz	0.2 oz
3 fl oz/A	0.12 oz	0.3 oz
4 fl oz/A	0.16 oz	0.4 oz
5 fl oz/A	0.20 oz	0.5 oz
6 fl oz/A	0.24 oz	0.6 oz

*All applications assume output of 25 GPA – foliage sprayed until liquid is running off.

Field Re-Entry Times for Insecticides

TRADE NAME	COMMON NAME	RE-ENTRY PERIOD-HOURS
Admire, Alias, Couraze, Trimax, Axcess, Senator, Concur, Wrangler	imidacloprid	12
AgLogic	aldicarb	48
Agri-Mek, Abba	abamectin	12
Ambush, Pounce, Perm-Up	permethrin	12
Applaud, Centaur, Courier, Talus	buprofezin	12
Argyle	acetamiprid/bifenthrin	12
Asana XL, S-FenvaloStar	esfenvalerate	12
Azatrol, Azatin XL, Neemix	azadirachtin	4
Aztec, Defcon	cyfluthrin/phostebupirim	48
Baythroid XL, Tempo Ultra, Tirade Ultra	beta-cyfluthrin	12
Belay, Poncho, NipsIt	clothianidin	12
Besiege, Voliam Xpress	chlorantraniliprole/lambda-cyhalothrin	24
Bidrin, Dicromax	dicrotophos	72
Biobit, Dipel, Javelin, Agree, XenTari	Bacillus thuringiensis	4
Blackhawk, Tracer, Spintor, Entrust	spinosad	4
Brigade, Capture, Discipline, Fanfare	bifenthrin	12
Brigadier, Swagger	imidacloprid/bifenthrin	12
Carbine, Beleaf, Bestero, Sabano	flonicamid	12
Centric, Actara, Cruiser, Platinum	thiamethoxam	12
Lambdafos	chlorpyrifos/lambda-cyhalothrin	24
Comite, Omite	propargite	2-20 days
Cormoran	acetamiprid/novaluron	12
Counter	terbufos	48
Deadline, Metarex, Slug-Fest	metaldehyde	12
Denim, Proclaim	emamectin benzoate	12
Diamond, Rimon	novaluron	12
Dimate, Dimethoate	dimethoate	48
Dimilin, Unforgiven, Durant, Micromite	diflubenzuron	12
Endigo	thiamethoxam/lambda-cyhalothrin	24
Fastac	alpha-cypermethrin	12
Fyfanon	malathion	12
Heligen	nucleopolyhedrovirus	4
Hero	zeta-cypermethrin+bifenthrin	12
Holster, Up-Cyde	cypermethrin	12
Imidan	phosmet	1-14 days
Intrepid Edge	methoxyfenozide/spinetoram	4
Intrepid, Troubador, Invertid	methoxyfenozide	4
Intruder, Assail, Afflict, Verso	acetamiprid	12
Lannate, Lanveer, Nudrin	methomyl	2-7 days
Leverage	cyfluthrin/imidacloprid	12
Lindane	lindane	24
Lorsban, Warhawk, Pilot	chlorpyrifos	24
Magister, Magus	fenazaquin	12
Mesurol	methiocarb	24
Mustang Maxx, Cortes Maxx	zeta-cypermethrin	12
Nurizma	broflanilide	12
Oberon, Sepoy, Spear	spiromesifen	12
Orthene, Bracket, Livid	acephate	24
Portal, Fujimite, Tyoga, Akola	fenpyroximate	12
PQZ	pyrifluquinazon	12
Prevathon, Altacor, Shenzi, Vantacor	chlorantraniliprole	4
Proaxis, Declare, Announce	gamma-cyhalothrin	24
Radiant, Delegate, Hemi	spinetoram	4
Regent	fipronil	0
Sefina, Versys	afidopyropen	12
Sevin	carbaryl	12
Sivanto	flupyradifurone	4
Spear-LEP	GS-omega/kappa-Hxtx-Hv1a	4
Steward, Avaunt, Comber, Host, Sedaire	indoxacarb	12
Supracide	methadathion	72
Tempo, Tombstone	cyfluthrin	12
Tenchu, Scorpion, Venom	dinotefuran	12
Thimet, Phorate	phorate	48
Transform, Closer	sulfoxaflor	24
Vydate	oxamyl	48
Warrior II, Karate, Silencer, Ravage, Grizzly	lambda-cyhalothrin	24
Zeal, Stifle, Zara, Maven, Zamdia	etoxazole	12

COMMON AND TRADE NAMES OF SOME OF THE CHEMICALS MENTIONED IN THIS GUIDE

Common Name	Trade Name	Company	Spray Formulations
abamectin	Varsity, Raid Fire Ant Bait, Agri-Mek, Avid,Clinch	Syngenta	0.011% granular bait, 0.15 lb EC, 0.7 SC
	Abba	AMVAC	0.3 EC
	Abacus	Rotam Agro	0.15 EC
	AbamectinE	Etigra	0.15 EC
	Reaper	Loveland Products	0.15 EC
acephate	Orthene	Amvac Chemical	15.6% EC, 75 S, 90 S, 97 WDG
	Bracket	Agriliance LLC	90 S, 97 WDG
	Livid Prill	Innvictus Crop Care, LLC	90 DG, 97 DG
acequinocyl	Shuttle	Arysta LifeScience North America Corporation	15.8% SC
acetamiprid	Assail	Cerexagri, Inc., Cerexagri-Nisso LLC	30 SG, 70 WP, 70 WSP
	Intruder	UPL NA	70 WSP
	Tristar	Cleary Chemical Corporation	30 SG, 70 WSP
afidopyrofen	Sefina, Versys	BASF	0.42 DC, 0.83 DC
azadirachtin	Azatrol	PBI Gordon Corporation	1.2% EC
	Azatin XL	OHP, Inc.	3.0%
	Debug	Agro Logistics	0.7% EC
	Neemix	Advan LLC	4.5%
	Aza-Direct, Azahar, Ecozin Plus	Gowan Company	1.2%
Bacillus thuringiensis aizawai	Agree WG	Certis USA	WG
	XenTari	Valent U.S.A Corporation	DF
Bacillus thuringiensis israelensis	Gnatrol	Valent U.S.A. Corporation	WDG
Bacillus thuringiensis kurstaki	Crymax WDG, Deliver, Javelin WG	Certis	WDG, WG
	BT Now	BioSafe Systems	
	Dipel ESNT, Biobit HP	Valent U.S.A. Corporation	DF, ES, 10G, WP
	Leprotec	Vestaron	S, WG
	Thuricide	Bonide Products, LLC	SC
beta-cyfluthrin	Tempo	Bayer Crop Science	1% D, 20% WP, 11.8% SC, 10% WP, 10% WSP
	Bayer Advanced Power Force	Bayer Crop Science	0.05% RTU, 0.05% G
	Bayer Advanced Home Pest Control	Bayer Crop Science	0.05% RTU
	Baythroid XL	Bayer Crop Science	1 EC
bifenazate	Floramite	Chemtura Corporation	22.6% SC, 50% WSP
bifenthrin	Capture, Brigade	FMC Corporation	2 EC, 10% WSB, 1.15 G
	Bifenthrin Pro	BASF Specialty Products	7.9% EC
	Home Defense MAX	Ortho	0.115% G
	Bug-B-Gon MAX	Ortho	0.3% EC
	Onyx	FMC Corporation	23.4% EC
	Talstar	FMC Corporation	7.9% F, 0.2% G
	Sniper, Bisect L	Loveland Products	2 EC, 7.9% EC
	Bifenture, UpStar	United Phosphorus, Inc.	2 EC, 0.2% G, 7.9% SC, 10 DF
	Menace	NuFarm	7.9% F
	Tundra	Agrisolutions	2 EC
	Fanfare	MANA	2 EC
	Bifenthrin, Empower2	Helena	2 EC
	Discipline	Amvac Chemical	2 EC

COMMON AND TRADE NAMES OF SOME OF THE CHEMICALS MENTIONED IN THIS GUIDE

Common Name	Trade Name	Company	Spray Formulations
buprofezin	Talus	SePRO Corporation	40%
	Applaud, Centaur, Courier	Nichino America	70 DF, 70 WDG, 3.6 SC
carbaryl	Sevin	Bayer Crop Science, Prokoz, Loveland Products	XLR, 4 lb EC, 80 S and 50% WP, 20% B
chlorantraniliprole	Altacor, Coragen, Prevathon, Dermacor, Vantacor	FMC Corporation	35 WG, 1.67 SC, 0.43 SC
	Shenzi	UPL	400SC and 700WG
chlorantraniliprole + bifenthrin	Elevest	FMC Corporation	2.22 SC
chlorantraniliprole + lambda-cyhalothrin	Besiege, Voliam Xpress	Syngenta	1.252 SC
chlorpyrifos	CPF	Direct Ag Source, LLC	4 lb EC, 15% G
	Lorsban, Dursban, Hatchet	Corteva, Gowan Company	4 lb EC, 2 lb EC, 15% G, 50 W
	Eraser	Independent Agribusiness Professionals	4 lb EC
	Govern	Tenkoz, Inc.	4 lb EC
	Pilot	Gharda Chemicals LTD	4 lb EC, 15G
	Vulcan	Makhteshim-Agan of North America	2.5% G
chlorpyrifos-methyl + deltamethrin	Storcide II	Bayer CropScience	2.11 EC
clofentazine	Ovation	Scotts-Sierra Crop Protection Company	42% SC
clothianidin	Celero, Arena	Arysta LifeScience North America	16% WSG, 0.25% G, 0.5% G, 50% WDG
	Poncho	Bayer Crop Science	5 F
	Belay, Clutch, NipsIt Inside	Valent U.S.A. Corporation	2.13 EC, 50 WDG, 5 F
coumaphos	Co-Ral, Checkmite	Bayer Crop Science	4% pour on, 1 lb EC, 25% WP, 5 D
cyantraniliprole	Fortenza	Syngenta Crop Protection	5 FS
cyfluthrin	Renounce, Tempo	Bayer Crop Science	20 WP
	Decathlon	OHP, Inc.	20 WP
	Bayer Advanced Power Force	Bayer Crop Science	0.75% EC
	Tombstone	Loveland Products	2 EC
cyfluthrin + tebupirimfos	Aztec	Bayer Crop Science, Amvac Chemical	2.1 G, 4.67 G
	Defcon	Helena	2.1 G
cypermethrin	Battery	Agriliance LLC	2.5 EC
	Cyper G-Ag	Direct Ag Source, LLC	2.5 EC
	Cypermethrin	Tenkoz, Inc.	2.5 EC
	Holster	Loveland Products	2.5 EC
	UP-Cyde	United Phosphorus, Inc.	2.5 EC, 2.0 EC
cyromazine	Citation	Syngenta Professional Products	75% WSP
deltamethrin	Battalion	Arysta LifeScience North America	0.5 EC, 1.5 EC
	Centynal	Wellmark International	0.42 EC
	Chipco Choice	Bayer Crop Science	0.1% G
	Chipco FireStar	Bayer Crop Science	0.00015% granular bait
	MaxForce	Bayer Crop Science	0.01% bait station (BS), 0.1% BS, 0.05% BS, 0.0001% gel bait (GB), 0.05% GB
	DeltaDust	Bayer Crop Science	0.05% D
	DeltaGard, Suspend	Bayer Crop Science	0.1% G, 4.75% SC
	Over 'n Out!	GardenTech	0.0103% G
	Top Choice	Bayer Crop Science	0.0143% G
	Delta Gold	AgriSolutions	1.5 EC
	Shooter	Arysta LifeScience	0.05 EC
	Suspend	Bayer Crop Science	0.42 SC

COMMON AND TRADE NAMES OF SOME OF THE CHEMICALS MENTIONED IN THIS GUIDE

Common Name	Trade Name	Company	Spray Formulations
diazinon	Spectracide	Syngenta	4 and 2 lb EC, 50% WP, 14 G
dichlorvos	DDVP, Vapona	Fermenta Animal Health	4 lb EC, 1.6 lb EC
dicrotofos	Bidrin	Amvac Chemical	8 lb EC
dicrotofos + bifenthrin	BidrinXP II	Amvac Chemical	4 lb + 1 lb EC
diflubenzuron	Dimiln	Chemtura Corporation	25 W, 2 L, 4 L
dimethoate	Dimate	Agriliance LLC	4 E
	Dimethoate	Arysta LifeScience, Drexel, Helena, Loveland Products, Gowan, Britz	2.67 EC, 4 EC
dinotefuran	Safari, Venom	Valent U.S.A. Corporation Professional Products	20% SG
	Tenchu	Mitsui Chemicals Agro	20% SG
emamectin benzoate	Denim	Syngenta	0.16 lb EC
endosulfan	Thiodan, Endosulfan	UCP, Drexel	3 lb EC
	Thionex	Makhteshim-Agan of North America	3 EC, 50 WP
esfenvalerate	Asana XL	Valent	1.9 lb EC, 0.66 lb EC
	Adjourn	MANA	0.66 EC
	S-FenvaloStar	LG International	0.66 EC
ethioprop	Mocap	Bayer Crop Science	10, 15 and 20 G, 6 EC
etoxazole	TetraSan, Zeal	Valent U.S.A. Corporation Professional Products	5% WDG, 70 WSP
famphur	Famophos, Warbex	BASF	1% D, 13.2% ready-mix
fenazaquin	Magister, Magus	Gowan Company	1.6 SC
fenbutatin-oxide	Vendex	DuPont	50% WP, 4 L
fenpropathrin	Tame	Valent U.S.A. Corporation	2.4 EC
fenpyroximate	Portal, Fujimite	Nichino America	5 EC
	Tyoga	Sipcam Agro USA	0.42 EC
fipronil	Regent	BASF	4 SC
flupyradifurone	Sivanto	Bayer Crop Science	1.67 SL
gamma-cyhalothrin	Proaxis	UAP-Loveland Products, Inc., TENKOZ, Inc.	0.5 lb
	Declare	Cheminova	1.5 lb
GS-omega/kappa-Hxtx-Hv1a	Spear-LEP	Vestaron Corporation	0.17 L
hexythiazox	Hexygon	Gowan Company	50% DF
hydramethylnon	Amdro, Amdro Pro Fire Ant Bait	BASF	0.73% granular bait
imidacloprid	Provado, Admire, Trimax Pro, Gaucho	Bayer Crop Science	1.6 F, 2 F, 4.44 F, 4 F
	Alias, Pasada	MANA	2 F, 4 F, 75 WSB
	Couraze	Cheminova	1.6 F, 2 F, 4 F
	Prey, Sherpa, Widow, Wrangler	Loveland Products	1.6 F, 2 F, 4 F
	Advise, Concur	AgriSolutions	2 F, 4 F

COMMON AND TRADE NAMES OF SOME OF THE CHEMICALS MENTIONED IN THIS GUIDE

Common Name	Trade Name	Company	Spray Formulations
imidacloprid	ImiGold	United Phosphorus, Inc.	0.5 G, 2 F, 70 DF
	Nuprid, Senator	NuFarm	1.6 F, 2 F, 4.6 F, 4 F, 5 FS
	Axcess	BASF	5 FS
indoxacarb	Steward, Avaunt	FMC Corporation	1.25 lb SC, 30% DG
	Advion	DuPont Professional Products	0.045% bait, 0.05% bait, 0.1% bait, 0.22% bait, 0.6% gel, 30% DG
	Spectracide Fire Ant Killer Plus Preventer Bait Once & Done	Spectrum Brands, Inc.	0.016% bait
	Comber, Host	Sharda USA, LLC	30 DG, 1.25 EC
lambda-cyhalothrin	Battle	Lesco	9.7% EC
	Scimitar, Lamcap	Syngenta Professional Products	9.7% EC, 1 CS
	Spectracide Triazicide Once & Done	Spectrum Brands, Inc.	0.002% RTU, 0.1% G, 0.25% EC
	Jitzu	Fuzion Technologies, LLC	1 EC
	Karate Z, Warrior Z	Syngenta	2.08 CS, 1 CS
	Kendo	Helm Agro US	1 EC, 9.7 CS
	Grizzly Z, Taiga Z, Mystic Z	Agrisolutions	1 CS, 2.08 CS
	Helena Lambda, Lambda-T	Helena	2.08 CS, 1 CS
	Kaiso, Lambda-Cyhalothrin	NuFarm	24 WG, 1 EC
	Lambda-Cy	United Phosphorus, Inc.	1 EC
	LambdaStar	LG International	1 EC
	Silencer, Paradigm	MANA	1 EC
lindane	Kwell Shampoo	Various (FDA regulated)	1% shampoo (by prescription only)
malathion	Malathion, Fyfanon	Cheminova, Helena, Gowan, Arysta	5 lb EC, 8 lb EC, 5% D, 6% D, 25% WP
metaldehyde	Slug and snail bait, Deadline, Axcela	Several companies	Snarol pellets, etc.
methiocarb	Mesurol	Bayer Corporation	2% ready-to-use bait, 75% WP
methomyl	Lannate	DuPont	1.8 lb EC, 90% WS powder, 2.4 LV
methoxyfenozide	Intrepid	Corteva Agriscience	2.0 lb F
methoxyfenozide + spinetoram	Intrepid Edge	Corteva Agriscience	3 F
neem oil	Triact	OHP, Inc.	70%
novaluron	Pedestal, Rimon	Chemtura Corporation	0.83 SC
	Diamond	MANA	0.83 EC
nucleopolyhedrovirus	Heligen	AgRiTech, LLC	50% SC
oxamyl	Vydate C, CLV	Corteva Agriscience	2 EC, 3.77 EC
permethrin	Ambush, Ectiban	Amvac Chemical	2 lb EC, 5.7% EC, 25 W
	Astro, Pounce	FMC Corporation	36.8% EC, 3.2 EC, 25 WP, 1.5 G
	Atroban	Cooper Chemical Company	11% EC, ear tag
	Permectrin II	Anchor Chemical Company	10% EC
	Permethrin Pro	Micro Flo Company	36.8% EC
	Perm-Up	United Phosphorus, Inc.	25% WP, 36.8% EC
	Arctic	AgriSolutions	3.2 EC
phorate	Thimet, Phorate	BASF, AgriSolutions	15% G, 20% G
phosmet	Imidan	Gowan Corporation	50 WP
pirimiphos-methyl	Actellic	Syngenta	5 E
propargite	Comite, Omite	Uniroyal/Crompton Corporation	6.55 and 6.0 EC, 30% W

COMMON AND TRADE NAMES OF SOME OF THE CHEMICALS MENTIONED IN THIS GUIDE

Common Name	Trade Name	Company	Spray Formulations
propoxur	Invader	FMC Corporation	1%
pymetrozine	Endeavor	Syngenta Professional Products	50% WDG
pyrethrins + rotenone	Pyrellin E.C.	Webb Wright Corporation	0.6% + 0.5% EC
pyriproxyfen	Distance, Esteem, Spectracide Fire Ant Bait	Valent U.S.A. Corporation	0.5%, 0.5% and 0.05% granular bait
S-methoprene	Extinguish Fire Ant Bait	Zoecon	0.5% granular bait
	Diacon	Wellmark International	0.8% D, 2.5 SC
silicon dioxide (diatomaceous earth)	Insecto	Natural Insecto Products, Inc.	90% D
	Dryacide	WinField Solutions	88.25% D
spinetoram	Radiant, Delegate	Corteva Agriscience	1 SC, 25 WG
spinosad	Conserve	Corteva Agriscience	11.6% SC
	Contain, Sensat	Bayer CropScience	8.66%
	Tracer, Spintor, Blackhawk, Success, Entrust	Corteva Agriscience	4 L, 2 L
spiromesifen	Oberon	Bayer Crop Science	2 SC, 4 SC
	Judo	OHP, Inc.	45.2%
sulfoxaflor	Closer, Transform	Corteva Agriscience	2 SC, 50 WG
tebufenozide	Confirm	Corteva Agriscience	2 F
tefluthrin	Force	Syngenta, Amvac Chemical	3 G
temephos	Abate	BASF	4 lb EC, 5% CG, 2% CG, 1% SG, 15 G
terbufos	Counter	BASF, Amvac	20 G, 15 G
tetrachlorvinphos	Rabon, Ravap	Fermenta Animal Health Company	75% WP, 50% WP, 3% D, 23% EC
thiamethoxam	Centric, Actara, Meridian, Cruiser	Syngenta	25% WG, 40% WG, 0.33% G, 5 FS
	Flagship, Optigard	Syngenta Professional Products	0.22% G, 25% WG, 0.01% gel, 2 SC
	Warden CX	Winfield Solutions	1.9 FS
thiamethoxam + chlorantraniliprole	Voliam Flexi	Syngenta	40 WG
thiamethoxam + lambda-cyhalothrin	Endigo	Syngenta	2.06 ZC
trichlorfon	Dipterex, Dylox, Neguvon, Proxol	Bayer Crop Science	80% SP, 4 lb LS
zeta-cypermethrin	Mustang Maxx	FMC Corporation	0.8 EC
	Respect	BASF	0.8 EC
zeta-cypermethrin + bifenthrin	Hero	FMC Corporation	1.24 EC

B = Bait
CG = Concentrate granules
CS = Capsule suspension
D = Dust
DC = Dispersable concentrate
DF = Dry flowable
DG = Water dispersible granules
E = Emulsifiable concentrate
EC = Emulsifiable concentrate
F = Flowable
G = Granules
L = Liquid
LS = Liquid soluble
LV = Low volatile
RTU = Ready to use
S = Solution
SC = Suspension concentrate
SG = Soluble granules
SP = Soluble powder
W = Wettable powder
WDG = Wettable dispersible granules
WDL = Water dispersible liquid
WG = Water dispersible granules
WP = Wettable powder
WSB = Water soluble bags
WSG = Water soluble granules
WSP = Water soluble packet
ZC = Zeon capsule technology

NAMES, CLASSIFICATION, AND TOXICITY OF INSECTICIDES

The following chart will help you identify specific pesticides and give you an indication of their toxicities, as well as their mode of action (IRAC code).

Names — Each generally used name of each pesticide is listed alphabetically in the left-hand column of the chart. Synonyms in general usage are listed in the next column opposite each entry. Trade names are indicated by the superscript "*"; they should be capitalized. Other names are usually not capitalized.

Classes — Most insecticides are classified chemically as:

Class	Primary Site of Action	IRAC CODE	Class	Primary Site of Action	IRAC CODE
Car. = carbamate	Acetylcholinesterase inhibitor	1A	B = bacterial origin	Insect midgut membranes	11A, 11B
OP = organophosphate	Acetylcholinesterase inhibitor	1B	PRO = propargite	ATP synthase inhibitors	12C
OC = organochlorines	GABA-gated chloride channel antagonists	2A	IGR = insect growth regulator	Chitin synthesis inhibitors	15, 16, 17, 18
PP = phenylpyrazoles	GABA-gated chloride channel antagonists	2B	METI= Meti-acaricides/insecticides	Mitochondial complex inhibitors	21A
SyP = synthetic pyrethroids	Sodium channel modulators	3A	OX = oxadiazine	Sodium channel blocker	22A
NEO = neonicotinoids	Nicotinic acetylcholine receptor	4A	TET= tetronic & tetramic acid derivatives	Acetyl CoA carboxylase inhibitor	23
SX = sulfoximines	Nicotinic acetylcholine receptor agonist	4C	Phos. = phosphine	Mitochondrial inhibitors	24A
BU = butenolides	Nicotinic acetylcholine receptor agonist	4D	DM = diamides	Ryanodine receptor	28
SP = spinosyns	Nicotinic acetylcholine receptor activator	5	FL = flonicamid	Chordotonal organ inhibitors	29
AV = avermectins	Chloride channel modulators	6	MDM = meta-diamides	Gaba-gated chloride channel	30
JH = juvenile hormone	Juvenile hormone mimic	7A	NPV= nucleopolyhedrovirus	Baculoviruses	31
PAD= pyridine azomethine derivatives	Chorodotonal organ	9B	GSO=GS-omega/kappa HXTX-Hv1a	Nicotinic ACH modulator	32
Pyr=pyropenes	Chorodotonal organ	9D	MISC = chemistry unclear	Uncertain mode of action	UN
ET = etoxazole	Mite growth inhibitors	10B	MD = mechanical disruptors	Non-specific mechanical/physical disruption	UNM

Toxicity Categories and LD_{50} Values — When registering pesticides, the Environmental Protection Agency uses acute LD_{50} values to determine the toxicity category and words or symbols that must be placed on the label. For this purpose, the test animals are usually rats, mice, or rabbits, but other mammals are sometimes used.

Toxicity Category	Signal Words Required On Label by EPA	ORAL LD_{50} (mg/kg)	DERMAL LD_{50} (mg/kg) 24-Hr. Exposure	Probable Lethal Oral Dose For Adult Humans
I. Highly Toxic	DANGER, POISON, Plus Skull & Crossbones Symbol	0 to 50	0 to 200	A few drops to 1 t
II. Moderately Toxic	WARNING	50 to 500	50 to 2,000	1 t to 2 T
III. Slightly Toxic	CAUTION	500 to 5,000	2,000 to 20,000	1 oz to 1 pt (1 lb)
IV. Low Toxicity	CAUTION	5,000	20,000	1 pt (1 lb) or more

The LD_{50} is the dosage of the chemical at which one-half of the test animals are killed. It is based on the bodyweight of the animal and is expressed in milligrams of the chemical per kilogram of animal (mg/kg). A mg/kg is equivalent to 1 ppm. The lower the LD_{50} value, the higher the toxicity. Although most reported LD_{50} values are for technical material or actual toxicant, they are based on formulated products in some instances. All of these in the charts are for the technical material unless otherwise indicated. The toxicity categories given in the following charts are based on available data and are not necessarily the toxicity categories that would be assigned by EPA for the specific pesticides. Formulated pesticides usually have a higher LD_{50} than the technical material and may not fall in the same toxicity category as the technical material.

The usual ways of administering chemicals are oral (by mouth), dermal (applied to the skin), and inhalation. Inhalation toxicity is expressed as LC_{50} (lethal concentration). It is not as generally used as the other two.

Toxicity may be either acute or chronic. Acute refers to rather quick action from a single exposure, while chronic refers to the toxic effect of many exposures over a period of time.

INSECTICIDES

Comon Names	Trade Names	Class	Toxicity Category	IRAC Code	Acute LD_{50} Values for White Rats	
					ORAL (mg/kg)	DERMAL (mg/kg)
abamectin	Agri-Mek, Abba*, Abacus*, AbamectinE*, Abamex, Amavi, Ardent, Averland, Avid, Enterik*, Fervid, Reaper*, Clinch*, Timectin	AV	II	6	300	>1800
acephate	Orthene*, Bracket*, Livid*	OP	III	1B	866-945	>10,250 (rabbit)
acetamiprid	Intruder*, Assail*, TriStar*, Strafer*, Anarchy*, ArVida*, Afflict, Aceta, Quasar, Verso	NEO	III	4A	1,064	>2000
afidopyropen	Renestra, Sefina, Versys, Ventigra	Pyr	III	9D	>2000	>5000
aldicarb	AgLogic*	Car.	I	1A	0.93	<5.0 (rabbit)
alpha-cypermethrin	Fastac*, Fendona	SyP	III	3	210-1050	>5000
Aluminum Phosphide	Phostoxin*, Gastoxin*, Fumitoxin*, Weevil-Cide*, Killz-All*, DetiaPhos, PH3	Phos.	I	24A	20	
arprocarb	Baygon*, propoxur	Car.	II	1A	128	800-1000
azadirachtin	Azatrol*, Azatin XL*, Neemix*, Azahar*, Ecozin Plus*, Debug*, Ornazin*, Molt-X, AzaSol	MISC	IV	UN	>5000	>2000
Bacillus thuringiensis var. aizawai	Agree*, Xentari*	B	IV	11A	>5000	>2000 (rabbit)
Bacillus thuringiensis var kurstaki	Dipel*, Thuricide*, Biobit*, Crymax*, Deliver*, Javelin*, Leprotec*	B	IV	11A	Non-toxic to mammals	
Bacillus thuringiensis var. *israelensis*	*Bti**, Bactomos*, Gnatrol*	B	IV	11A	Non-toxic to mammals	
beta-cyfluthrin	Baythroid XL*, Tempo Ultra*, Cryptoid XL, Tirade Ultra	SyP	I	3A	647	>5000
bifenthrin	Bifenture*, Bisect*, Sniper*, UpStar*, Menace*, Tundra*, Capture*, Talstar*, Brigade*, Fanfare*, Discipline*, Banister, Batallion, Bi-Dash, Bidy, Bifen, Lancer, Nirvana, Reveal, Squadron	SyP	II	3A	375	>2000 (rabbit)
broflanilide	Nurizma*, Teraxxa	MDM	II	30	>2000	>5000
buprofezin	Talus*, Courier*	IGR	III	16	>5000	>2000
carbaryl	Sevin*	Car.	III	1A	246-283	4000
chlorantraniliprole	Altacor*, Coragen*, Prevathon*, Dermacor*, GrubEx*, Acelepryn*, Altriset*, Vantacor*, Shenzi*, Lumivia, Turazi, Plaid, Exceliprole, Eventex, Seraco, Trinalor, Riceprole, Osaria, Insectiprole, Kylix, Pixovere	DM	II	28	98.11	>5000
chlorpyrifos	Dursban*, Lorsban*, Govern*, Pilot, Vulcan*, Pyrofos*, Warhawk	OP	II	1B	97-276	2000 (rabbit)
chlorpyrifos-methyl + deltamethrin	Storcide II*	OP + SyP	II	1B + 3A	150	>5000
clothianidin	Poncho*, Belay*, NipsIt Inside*, Arena*, Crossfire*, Lumisure, Stall, Sharda Clothianidin	NEO	III	4A	3044	>5000
coumaphos	Co-Ral*	OP	I	1B	15.5-41	860
cyantraniliprole	Fortenza, Exirel, Verimark, Lumiderm	DM	III	28	>5000	>5000
cyfluthrin	Tombstone*, Decathlon*, Renounce*, Tempo*, Optashield*, Tirade	SyP	I	3A	1015	>2000 (rabbit)
cyfluthrin + tebupirimfos	Aztez*, Defcon*	SyP + OP	I	3A + 1B	1.3	
cypermethrin	Cymbush*, Battery*, UP-Cyde*, Cyper G*, Holster*, Cynoff, Demon	SyP	I	3A	247	>2000
cyromazine	Larvadex*, Flyzine, Neporex, Solitude, Citation, Armor, Trigard, Flynexx, Furtivio	IGR	IV	17	3387	>3100
deltamethrin	DeltaDust*, DeltaGard*, Delta Gold*, Shooter*, Over 'n Out!*, Battalion*, Top Choice*, Maxforce*, Chipco Choice*, Centynal*, Chipco FireStar*, Decis*, Suspend*	SyP	I	3A	42.9	>2000
dichlorvos	Vapona*, DDVP*, Vaportape, Nuvan, LockDown, Ravap, TurboCide	OP	I	1B	56-80	75-107
dicrotophos	Bidrin*, Inject-A-Cide B*, Dicromax*	OP	I	1B	17-22	224 (rabbit)
diflubenzuron	Dimilin*, Durant*, Micromite*, Unforgiven*	IGR	III	15	4540	
dimethoate	Dimate*, Dimethoate*	OP	II	1B	215	400-610
dinotefuran	Kruger, Tenchu*, Certador, Safari, Scorpion, Venom	NEO	IV	4A	>2000	>2000
esfenvalerate	Asana XL*, S-FenvaloStar*	SyP	II	3A	458	>2000 (rabbit)
etoxazole	Zeal*, Zara*, Stifle, Eschaton, Inntervene, Suremite, TetraSan	ET	III	10B	>5000	>5000
famphur	Warbex*	OP	I	1B	35-62	1460-5093 (rabbit)
fenpyroximate	Portal*, Fujimite*, Tyoga*, Akola, Akari	METI	III	21A	810	>5000

INSECTICIDES

Comon Names	Trade Names	Class	Toxicity Category	IRAC Code	Acute LD_{50} Values for White Rats ORAL (mg/kg)	DERMAL (mg/kg)
fipronil	Regent*, Termidor*	PP	II	2B	336	382 (rabbit)
flonicamid	Carbine*, Beleaf*, Aria*, Bestero, Sabano	FL	II	29	>2000	>2000
flupyradifurone	Sivanto*, Altus	BU	III	4D	>2000	>2000
gamma-cyhalothrin	Proaxis*, Prolex*, Declare*, Announce, Scion	SyP	III	3A	2250-2646	>5000
hydramethylnon	Amdro*	MISC	III	20A	>5000	>2000 (rabbit)
Imida*	imidacloprid, Provado*, Alias*, Couraze*	NEO	III	4A	4350	>5050 (rabbit)
imidacloprid	Acceleron, Acronyx, Acurio, Admire, Attendant, Lada, Lesco Bandit, Macho, Madari,Provado, Gaucho, Merit, Alias, Couraze, Imidacloprid, Prey, Sherpa, Widow*, Wrangler*, Advise*, Imida*, ImiGold*, Nuprid*, Concur*, Sativa IM*, Senator*, Delphi, Malice, Mallet, Marathon, Midash, Mineiro, Montana, Premise, Provoke, Resonate, Viloprid	NEO	III	4A	4350	>5050 (rabbit)
indoxacarb	Steward*, Avaunt*, Comber*, Host*	OX	III	22A	268	>5000
Ivermectin*	Ivomec*	AV		6		
lambda-cyhalothrin	Avesta, Crusader, Demand, Lunge, Patrol, Province, Ravage, Serpent, Silencer, Warrior, Battle, Scimitar, Grizzly, Kendo, Helena lambda, Lambda-T, Lamcap*, Lambda-Cyhalothrin*, Lambda-Cy*, LambdaStar*, Paradigm*	SyP	II	3A	180	>2000
malathion	Fyfanon*, Max Kill Dusta-Cide	OP	III	1B	1000-1375	4100 (rabbit)
Metaldehyde*	Slug and snail bait, Deadline*, Durham Metaldahyde*, Metarex*, Slug-Fest*	MISC	II, III		630	
methomyl	Lannate*, Nudrin*, Lanveer*	Car.	I	1A	17-24	5880 (rabbit)
methoprene	Alliance, Altosid*, Diacon*, Extinguish	IGR	III	7A	>34,600	>3000 (rabbit)
methoxyfenozide	Inspirato, Intrepid*, Invertid, Invicar, Thwartex, Turnstyle, Vexer, Zylo	IGR	IV	18A	>5000	>2000
methoxyfenozide + spinetoram	Intrepid Edge*	IGR + SP	IV	18A + 5	>5000	>2000
naled	Dibrom*, Trumpet	OP	II	1B	430	1100 (rabbit)
novaluron	Diamond*, Pedestal*, Rimon*, Tekko, Suprado	IGR	III	15	3914	8000 (rabbit)
nucleopolyhedrovirus	Heligen	NPV	III	31	>4000	>4000
oxamyl	Vydate*, ReTurn, Vy-King, Vypera	Car.	I	1A	5.4	37
paradichlorobenzene	PDB*, Enoz Moth Ice, Moth Guard, Para-Moth, Reefer Galler Moth-Tek	OC	III		500-5000	2000 (rabbit)
permethrin	Ambush*, Atroban*, Overtime*, Permectrin II*, Ectiban*, Pounce*, Astro*, Arctic*, Perm-Up*	SyP	II	3A	430-4000	>4000
phorate	Thimet*	OP	I	1A	2-4	20-30 (guinea pig)
phosmet	Imidan*	OP	II	1B	147-316	>4640 (rabbit)
piperonyl butoxide	Butacide*, Incite*, Exponent*, PBO-8*, Reform	MISC	III		>7500	
propargite	Omite*, Comite*, Cymyte, Mitomax, Victimite	Phos.	III	12C	220-600	>5000
propoxur	Baygon*, arprocarb	Car.	II	1A	128	800-1000
pyrethrins	pyrethrum, Pyganic, Tersus	Pyr.	III	3A	1500	>1800
pyrifluquinazon	PQZ, Rycar	PAD	III	9B	2000	>2000
resmethrin	Chryson*, Synthrin*	Pyr.	III	3A	4240	2500 (rabbit)
slicon dioxide	Insecto*, Dryacide*, diatomaceous earth, Celite, DEsect Crop, Dezone, Diafil	MD	IV	UNM		
spinetoram	Radiant*, Delegate*, Hemi*	SP	IV	5	>5000	>5000
spinosad	Tracer*, Spintor*, Blackhawk*, Success*, Contain*, Sensat*, Entrust*, Execute*, Consero*	SP	IV	5	5000	>5000
spiromesifen	Oberon*, Forbid, Savate	TET	III	23	>2000	>4000
sulfoxaflor	Closer, Transform	SX	IV	4C	>2000	>4000
tebufenozide	Confirm*, Mach II*	IGR	IV	18A	5000	>5000
terbufos	Counter*	OP	I	1B	4.5-9.0	1.1 (rabbit)
tetrachlorvinphos	Rabon*	OP	III	1B	4000-5000	>2500 (rabbit)
thiamethoxam	Centric*, Cruiser*, Actara*, Platinum*, Adage, Elliptica, Flagship, Hub, Legend, Meridian	NEO	III	4A	>5000	>2000
trichlorfon	Dylox*, Dipterex*, Neguvon*	OP	III	1B	560-630	>2000
zeta-cypermethrin	Mustang*, Mustang Maxx*, Cortes Maxx	SyP	II	3A	106	>5000

Ecological Characteristics of Some Agricultural Insecticides Commonly Used in Arkansas

Insecticide (common name)	Relative Toxicity[a] to: Fish	Birds	Bees
abamectin (Agri-Mek)	VH	VL	VH
acephate (Orthene)	VL	M	H
acetampirid (Assail, Intruder, Strafer)		M	M
afidopyropen (Sefina)	VH	L	L
aldicarb (AgLogic)	M	VH	VL
azadirechtinw	H	NT	VL
Bacillus thuringiensis (DiPel)	NT	NT	NT
bifenthrin (Brigade)	M	L	VH
buprofezine (Applaud)		VL	L
carbaryl (Sevin)	VH	H	VH
chlorantraniliprole (Prevathon, Coragen, Vantacor)		VL	VH
chlorpyrifos (Lorsban-Dursban)	VH	H	H
chlorpyrifos-methyl/deltamethrin (Storcide II)	H	VL	VH
chlothianidin (Belay, Poncho)	H	L	H
cyfluthrin (Tempo, Tombstone)	VH	L	VH
cypermethrin (Holster)	VH	VL	VH
deltamethrin (Battalion, Centynal, Suspend)	VH	H	VH
dicrotophos (Bidrin)	M	VH	VH
diflubenzuron (Dimilin)	VL	VL	NT
dimethoate (Cygon)	M	H	M
dindotefuran (Tenchu)		L	H
esfenvalerate (Adjourn, Asana)	VH	H	L
etoxozole (Stifle, Zeal, Zara)		VL	VL
fenpropathrin (Danitol)	VH	M	VH
fenpyroximate (Portal)		VL	L
fipronil (Regent)		L	VH
flonicamid (Carbine)	VL	L	L
flupyradifurone (Altus, Sivanto)	H		L
imidacloprid (Trimax, Admire, Alias, etc.)		L	M
indoxacarb (Steward)		M	H
lambda-cyhalothrin (Warrior, Grizzly)	VH	L	VH
malathion	M	H	H
metaldehyde (Deadline)		H	L
methiocarb (Mesurol)		H	H
methomyl (Lannate, Nudrin)	M	H	H
methoxyfenozide (Intrepid)	M	L	L
novaluron (Diamond)		L	M
oxamyl (Vydate)	M	VH	VH
permethrin (Ambush, Pounce, etc.)	VH	H	L
phorate (Thimet)	VH	VH	VL
phosmet (Imidan)	VH	VH	VL
pirimifos-methyl (Actellic)		H	VH
propargite (Comite)	VH	L	L
spinetoram (Delegate, Radiant)	M	VL	VH
spinosad (Blackhawk, Entrust, Tracer, Spintor)	L	L	VH
spiromesifen (Oberon)			L
tebufenozide (Confirm)	M	L	L
tefluthrin	VH	H	L
terbufos (Counter)	VH	M	H
thiamethoxam (Centric, Cruiser)		L	H

[a]VL=very low; L=low; M=moderate; H=high; VH=very high; NT=no evidence of acute or chronic toxicity.

TRADE NAMES OF GENERIC INSECTICIDES

Active Ingredient	Trade Names
abamectin	Abba, Abacus, AbamectinE, Agri-Mek, Amavi, Ardent, Averland, Avid, Clinch, Enterik, Fervid, Reaper, Timectin
acephate	Acephate, Bracket, Orthene, Livid
acetamiprid	Aceta, Afflict, Assail, Tristar, Strafer, Anarchy, ArVida, Quasar, Verso
Bacillus thuringiensis	Agree, Biobit, BT Now, Crymax, Deliver, Dipel, Javelin, Leprotec, XenTari
beta-cyfluthrin	Baythroid XL, Cryptoid XL, Sultrus,Tempo Ultra, Tirade Ultra
bifenthrin	Bifenthrin AG, Bifenture, Bisect, Brigade, Capture, Discipline, Empower, Fanfare, Menace, Onyx, Sniper, Talstar, Tundra, UpStar, Wisdom
buprofezin	Courier, Talus
chlorantraniliprole	Coragen, Prevathon, Vantacor, Shenzi, Altacor, Exceliprole, Coragen eVo
chlorpyrifos	Chlorpyrifos, Govern, Hatchet, Lock-On, Lorsban , Eraser, Pilot, CPF, Vulcan, Pilot
cyantraniliprole	Excirel, Fortenza, Lumiderm, Verimark
chlothianidin	Belay, Clutch, Poncho, NipsIt Inside, Arena, Crossfire, Lumisure, Stall
cyfluthrin	Decathalon, Renounce, Tempo, Tombstone, Sultrus
cypermethrin	Battery, Cypermethrin, Mustang, UP-Cyde, Cyper-G, Holster
deltamethrin	Chipco Choice, Chipco Firestar, DeltaDust, DeltaGard, Delta Gold, Over ‘n Out, Shooter, Top Choice, Battalion, Centynal, Suspend
dicrotophos	Bidrin, Dicromax
diflubenzuron	Dimilin, Durant, Micromite, Unforgiven
dinotefuran	Certador, Kruger, Safari, Scorpion, Tenchu, Venom
esfenvalerate	Asana XL, S-Fenvalostar, Zyrate
etoxazole	Inntervene, Stifle, Suremite, Zara, Zeal
fenproximate	Fujimite, Portal, Tyoga
gamma-cyhalothrin	Declare, Proaxis, Prolex
lambda-cyhalothrin	Grizzly, Helena Lambda, Karate, Karate Z, Lambda-Cy, Lambda-Cyhalothrin, LambdaStar, Silencer, Warrior II, Warrior Z, Kendo, Lamcap, Paradigm, Province, Ravage, Serpent
imidacloprid	Admire, Advise, Advise Max, Alias, Couraze, Couraze Max, Imidacloprid, ImiGold, Macho, Montana, Nuprid, Prey, Provado, Provoke, Sherpa, Trimax Pro, Widow, Wrangler
indoxacarb	Avaunt, Comber, Host, Steward, Sedaire, Indolex, Tubrix
malathion	Fyfanon, Malathion
metaldehyde	Axcela, Deadline, Metarex, Slug-Fest, Slugger
methomyl	Lannate, Lanveer, Lemur, Nudrin
methoxyfenozide	Inspirato, Intrepid, Invertid, Invicar, Thwartex, Troubadour, Turnstyle, Vexer
novaluron	Diamond, Rimon
permethrin	Actroban, Ambush, Arctic, Astro, Ectiban, Permectrin, Permethrin, Perm-UP, Pounce
pyriproxyfen	Distance, Esteem, Knack, Seize
silicon dioxide	Insecto, Dryacide, Diatomaceous Earth
spinetoram	Delegate, Radiant, Hemi
spinosad	Blackhawk, Conserve, Entrust, SpinTor, Success, Tracer, Contain, Sensat
thiamethoxam	Actara, Centric, Cruiser, Hub, Platinum
zeta-cypermethrin	Cortes Maxx, Mustang Maxx