

## Approximate Time from Pollination to Market Maturity Under Warm Growing Conditions

| Vegetable                                    | Days to Market Maturity |
|--|-------------------------|
| Bean   | 7-18                    |
| Cantaloupe                                   | 40-50                   |
| Corn, market                                 | 18-23 <sup>1</sup>      |
| Corn, processing                             | 21-27 <sup>1</sup>      |
| Cucumber, pickling (3/4-1 1/8-inch diameter) | 4-5                     |
| Cucumber, slicing                            | 15-18                   |
| Eggplant (2/3 maximum size)                  | 25-40                   |
| Okra   | 4-6                     |
| Pepper, green stage (about maximum size)     | 45-55                   |
| Pepper, red stage                            | 60-70                   |
| Pumpkin, jack-o-lantern                      | 60-90                   |
| Pumpkin, baking                              | 65-75                   |
| Squash, summer, zucchini                     | 3-4 <sup>2</sup>        |
| Squash, winter, butternut                    | 60-70                   |
| Squash, winter, hubbard                      | 80-90                   |
| Squash, winter, acorn                        | 55-60                   |
| Tomato, mature green stage                   | 34-45                   |
| Tomato, red ripe stage                       | 45-60                   |
| Watermelon                                   | 40-50                   |

<sup>1</sup>From 50% silking.

<sup>2</sup>For a weight of 0.25-0.5 lbs.

## Precautions with Pesticides

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.

## Handling Pesticides

### Calibrating Application Equipment

Rate of application, granular and sprays, may vary with materials used. Equipment must be calibrated for each material applied to obtain accurate delivery. Here are suggested steps to calibrating selected applicators.

#### Boom-type Sprayers

High-pressure, high-volume sprayers have been used for row-crop pest control for many years. However, there is a growing trend to use sprayers that use lower volumes and pressures, and satisfactory pest control is possible at lower rates (if the sprayer is properly calibrated).

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

1. Clean sprayer, and replace all worn or defective parts; 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:**

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

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.

- Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
- Calculate acres covered by tank of spray solution, and add required amount of pesticide for total area sprayed.

It is of utmost importance that the spray unit functions properly. To obtain complete plant coverage and penetration, check the cleanliness of nozzles, nozzle wear, boom height, pressure gauge accuracy, agitation in tank, forward ground speed, mixing of materials, and nozzle spacing.

Also, due to lower pressures and volumes, paying attention to the wind becomes more important. Avoid using a boom-type sprayer in high winds. For more information, see *Boom Sprayer Calibration* (Ohio State University Extension FactSheet AEX-520-92), available from Ohioline, [ohioline.osu.edu](http://ohioline.osu.edu).

### **Band Sprayer**

- Clean sprayer, and replace all worn or defective parts; fill tank with water.
- Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
- 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 1630 ft. to cover 1/4 acre:**

$$\frac{1/4 \text{ acre (10,890 sq. ft.)}}{\text{Nozzles (4) x spray band width (1.67 ft.)}} = \frac{10,890 \text{ sq. ft.}}{6.68 \text{ ft.}} = \begin{array}{l} \text{distance} \\ \text{of travel} \\ \text{(1630 ft.)} \end{array}$$

**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.**

- Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
- Calculate acres covered by tank of spray solution, and add required amount of pesticide for total actual area to be band treated.

### **Granular Band Applicator**

- Set applicator dial or dials to give desired delivery rate of granules suggested for band treatment according to manufacturer's instructions.
- Fill hoppers with granules to be used.
- 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:**

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

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

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

### **Airblast-type Sprayers**

Vegetable growers use airblast sprayers to control insects and diseases. However, pest control has been erratic. Airblast sprayer operation is more critical than a boom-type sprayer, so the operator must fully understand the machine and the job.

Do not operate an airblast sprayer under high-wind conditions. Preferably, that means wind speeds should be less than 5 mph unless it is necessary to apply the pesticide for timely control — even then, applicators must consider drift.

Do not overextend the coverage of the machine. Considerable visible mist from the machine moves into the atmosphere and does not deposit on the plant. If in doubt, use black plastic indicator sheets in the rows to determine deposit and coverage before a pest problem appears as evidence.

Use the correct gallonage and pressures to obtain proper droplet size to ensure uniform coverage across the effective swath width.

Adjust the vanes and nozzles on the sprayer unit to give best coverage. Vane adjustment must occur in the field, depending on terrain, wind, and crop.

Cross drives in the field allow the material to be blown down the rows instead of across them and help to give better coverage in some crops, such as tomatoes.

## Sprayer Delivery Rates

It is essential to apply pesticides at the specified rates for best control and protection and to not exceed residue tolerance. Check sprayers carefully several times a season for accurate delivery rates. Use new nozzle disks when needed. Use a speedometer operated from a nondriven wheel to determine the speed and delivery rate of the sprayer.

## Water Quality and Pesticide Applications

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, [www.edustore.purdue.edu](http://www.edustore.purdue.edu).

## Evaluating Compatibility of Pesticides Before Tank-mixing

1. Read the label and follow directions. If the label states, "Do not mix with other products," that direction must be followed.
2. Add products to the mix in this order:
  - a. Wettable powders.
  - b. Flowables.
  - c. Water-solubles.
  - d. Adjuvants.
  - e. Emulsifiable concentrates.
3. If using different products, and one label states, "Add last to spray tank," that direction must be followed.
4. If the label states, "Do not use adjuvants," that direction must be followed.
5. Add 1 pint of the carrier to a 1-quart jar. Use the same water or liquid fertilizer that will be used in the field.
6. Add 1 1/2 teaspoon of the wetttable product(s) for each pound per acre to be used.
7. Next, add 1 teaspoon for each quart per acre of the liquid to be used.
8. These ratios will approximate 25 gallons per acre.
9. Shake the jar after adding each ingredient, and let it stand for a few minutes to see if there is a reaction. Keep adding each ingredient until all are added.
10. If there is a precipitate, or the material greases out, don't use it in the field.
11. The allowable separation in the jar depends on the amount of agitation in your equipment.
12. Good agitation is very important.
13. Storage conditions also are important.
  - a. Temperature: read the label for precautions.
  - b. Avoid contamination.
  - c. Do not leave material in the spray tank overnight or for more than several hours.
14. Normally, if there are problems, a compatibility agent will help.
15. This test only indicates physical compatibility; it does not indicate chemical reactions between products.

## Pesticide Formulations

The common types of pesticide formulations are:

- **Emulsifiable concentrates (EC):** the pesticide is dissolved and the emulsifying agent is added to an organic solvent.
- **Wetttable powders (WP or W):** the pesticide is absorbed or adsorbed on powders that can be mixed with water because of an added wetting agent.
- **Dusts (D):** the pesticide is diluted with finely divided and ground materials.
- **Solutions:** the pesticide has a molecular mixture with the solvent.
- **Microencapsulated:** the pesticide is placed in pinhead-sized capsules that disintegrate slowly over a period of time.

Pesticides must be properly formulated and diluted to prevent injury to plants. Often, physical properties of certain pesticides make dilution difficult, leaving lasting residues that are hazardous to edible crops. New formulations enter the market each year.

## 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.

Here are some common pesticides with observations on their shelf-life under normal conditions:

### **Insecticides**

- acetamiprid (Assail®): Several years.
- carbaryl (Sevin®) WP: Several years.
- carbaryl (Sevin®) F: Watch for settling.
- Diazinon EC®: 5-7 years if tightly sealed.
- Disulfoton (Di-Syston®): 2 years.
- Malathion WP®: Many years, but decomposes under high temperatures.
- Metasystox-R®: 2 years.
- Methoxychlor®: Many years.
- phosmet (Imidan®) WP: 2-3 years.

### **Herbicides**

- glyphosate (Roundup®): 2 years, but do not allow to freeze.
- Casoron® (G): 2 years if cool and dry.
- Dacthal® (WP): 2 years.
- Kerb® (WP): 2 years.
- simazine (Princep®) (G, WP): Many years.
- Surflan® (G): 3 years, must be mixed well.
- Treflan® (G): 3 years if dry and under 80°F

## **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.

## **Biopesticides**

Biopesticides are derived from natural materials such as animals, plants, bacteria, and certain minerals. Biopesticides fall into three major classes: microbial pesticides, plant-incorporated protectants, and biochemical pesticides. The active ingredient in a microbial pesticide (or mycoinsecticide) is a microorganism (bacterium, fungus, virus, or protozoa). These are highly selective in activity against specific target insect pests. Plant-incorporated protectants are substances that plants produce based on genetic material that is incorporated into plants. Biochemical pesticides are naturally occurring substances that control insect pests through nontoxic mechanisms such as sex pheromones or scented plant extracts.

The EPA defines biopesticides as products that include: “naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs.”

In this guide, biopesticides are denoted by the symbol .

As with any product, investigate these or any new products before you need them. If a product is not commonly used in your area, it may not be locally or quickly available.

More information about the EPA's biopesticide program is available at [www.epa.gov/pesticides/biopesticides](http://www.epa.gov/pesticides/biopesticides).

# Pesticide Application Record<sup>1</sup> and Written Notification for EPA Worker Protection Standards<sup>2</sup>

| Business Name |           | Application  |                   |                      |                         |                 |                                 |                |                                 |  |                     |            |                                  |                           |  |  |
|---------------|-----------|--|-------------------|----------------------|-------------------------|-----------------|---------------------------------|----------------|---------------------------------|--|---------------------|------------|----------------------------------|---------------------------|--|--|
| Location      | Pesticide | Application  |                   |                      |                         |                 |                                 |                |                                 |  |                     |            | Restricted Entry Interval (hrs.) | OK to Enter (Date & Time) |  |  |
| Field         | Crop      | Product Brand Name & Chemical Formulation <sup>3</sup> | Active Ingredient | Name of Manufacturer | EPA Registration Number | Pest Controlled | Area Treated (Sq. ft. or Acres) | Pesticide Rate | Total Amount of Pesticides Used | Name & Certification No. of Applicator or Certified Supervisor | Date (Mo./Day/Year) | Start Time | End Time                         |                           |  |  |
|               |           |  |                   |                      |                         |                 |                                 |                |                                 |  |                     |            |                                  |                           |  |  |
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<sup>1</sup>Information required by Federal and State Recordkeeping Requirements for Certified Applicators of Federally Restricted Use Pesticides (RUP). Records for restricted use pesticides must be maintained for two years from date of pesticide application.

<sup>2</sup>For EPA Worker Protection Standard, information in the shaded columns and safety data sheets must be recorded for all pesticides and Must be maintained at the centrally located posting area for two years after the restricted entry interval expires for all pesticides.

<sup>3</sup>Formulation required if included in product name: DF=dry flowable, EC & E=emulsifiable concentrate, G=granules, F=flowable, I=liquid, S=soluble, ULV=ultra low volume, etc.

This form was prepared by a joint effort of the Northwest Horticulture Program, Department of Horticulture and Landscape Architecture, and Purdue Pesticide Programs, Purdue University.