

# Mixing Pesticides

Although mixing pesticides can be a mundane task, it should be performed with extreme caution. After all, pesticide injuries are most likely to occur while chemicals are being mixed. Why? First, pesticide containers are opened during mixing, and pesticide formulations are usually highly concentrated. Second, people who work with pesticides tend to be less safety-conscious when they are mixing pesticides than when they are actually spraying them. People climb on equipment carrying pesticides, lift and pour open containers of pesticide, and often work alone with pesticides — all of which can be dangerous.

### General Guidelines

Mix pesticides carefully and accurately, using only the recommended amount. Read the label carefully and follow the directions exactly. Wear gloves, splash-proof goggles or face shield, and other required personal protective clothing. Keep hands away from the face, head and neck when mixing. Open liquids on a level surface and below eye level to avoid spilling and splashing. Pour liquids below eye level and as close to the ground as possible. Do not try to pour from a container that is too heavy. Open powders with scissors to avoid spreading dust. Use the proper measuring tools when mixing pesticides. Mix pesticides outdoors or in a well-lit and ventilated area.

Take the following steps when mixing pesticides:

- Always be sure the sprayer has been checked for uniform application and calibrated properly for application at the recommended rate.
- Calculate the amount of pesticide to add to the sprayer tank based on the active material in each gallon of pesticide concentrate, or the percentage of active ingredient of dry pesticide formulations.
- Read and follow instructions on the manufacturer's label pertaining to personal hazards in handling.
- Fill the sprayer tank with at least half the volume of water or fertilizer solution you ultimately will need.
- Start moderate agitation and keep it going throughout the process.
- Add compatibility agents if needed. For maximum benefit, they must be in solution before pesticides are added.
- Add, mix, and disperse dry pesticides (wetable powders, dry flowables, or water-dispersible granules). These formulations usually contain wetting and dispersing agents that aid in mixing.
- Add liquid flowables and allow thorough mixing. Liquid flowables also contain wetting and dispersing agents.
- Add emulsifiable concentrates and allow thorough mixing.

- Finish by adding water-soluble formulations (2,4-D amine, etc.).
- Add any surfactants, crop oil concentrates, etc., last. Crop oils especially do not mix and disperse well if added first.
- Add the remainder of water or liquid fertilizer and maintain agitation while spraying until the tank is empty. Caution: Never pour concentrated herbicides into an empty tank. Never allow a sprayer containing mixed chemicals to stand without agitation, as heavy wettable powders may clog nozzles or settle into corners of the sprayer tank.

### Read The Label

Always, the first step in the safe mixing of pesticides is to read the pesticide label. A pesticide label may indicate if two products can be mixed together and provide guidance as to the proper order in which they need to be mixed. A pesticide can be tank mixed if the label does not prohibit its application with other products and the pesticides in the mix must be registered individually on the crop you are treating. In this case, the applicator assumes all responsibility for the application. Be sure to make special note of:

- The relative toxicity of the pesticide. This will be stated on the label as "DANGER-POISON" or "DANGER" (highly toxic), "WARNING" (moderately toxic), or "CAUTION" (least toxic).
- The statement of practical treatment (first aid).
- Emergency telephone numbers.
- Precautionary statements.
- Required personal protective equipment.
- Instructions regarding mixing, application, use rates, and labeled sites.
- Storage information.

### Proper Mixing Procedures

#### *MIXING ORDER*

Pesticide labels usually provide directions for mixing different materials, often describing the sequence of mixing. Whenever a label provides such directions, you should follow them. In general, follow the W-A-L-E-S plan when adding herbicides to a tank mix.

1. Wettable Powders (WP) then Flowables (F, DF)
2. Agitate, then add adjuvants such as anti-foaming compounds, buffers
3. Liquid and Soluble products
4. Emulsifiable Concentrates (EC)
5. Surfactants

Prior to mixing you should fill your spray tank with half of the carrier you intend to use, usually water. Then start the sprayer and check to make sure that all valves and

# TECHNICAL USE & HANDLING

## Premixing

Premixing in a smaller, separate container or tank is necessary for many pesticide formulations.

**Wettable Powders (WP):** Make a slurry in a separate container by adding small increments of water until it forms a gravy-like consistency. Slowly add this slurry to the tank with the spray tank agitator running.

### Dry Flowable (DF) and Water-Dispersing Granules (WDG):

Premix with 1 part flowable to 1 part water (start with the water and add the flowable to it) and then pour the mix slowly into the tank.

### Liquid Flowables:

Premix liquid flowables by adding 1 part liquid chemical to 2 parts water (or liquid fertilizer) before blending in the tank. Many labels for liquid flowable products describe the proper mixing procedure.

gauges work and that you have proper tank agitation.

Compatibility agents are adjuvants that reduce the risk of incompatibility in pesticide or pesticide/fertilizer combinations. If you use a compatibility agent, it should be the first thing you put in the tank.

## Pesticide Interactions

Applying a tank mix of pesticides, or a pesticide and a liquid fertilizer, can save time, labor, energy and equipment costs. Pesticide combinations usually alter plant absorption and translocation as well as metabolism and toxicity at the site of action of one or more of the mixed products. Not all changes are for the better, however. Negative effects can occur such as reduced pest control, increased damage to non-target plants (phytotoxicity) and incompatibility problems between materials.

There are basically four types of interactions that change the efficacy of pesticide combinations.

1. Additive effects occur when mixing two pesticides provide the same response as the combined effects of each material when applied alone. The products neither hurt nor enhance each other. Such mixes save time, labor, and equipment use.
2. Synergistic responses are often confused with additive effects and occur when two pesticides provide a greater response than the added effects of each material when applied separately. Unlike additive effects, the chemicals in a synergistic combination are not neutral toward each other. Rather, they interact in some way that increases their effect and may increase control. With true synergism, you can often reduce pesticide application rates without sacrificing control. An example would be the use of piperonyl butoxide with pyrethroid insecticides.
3. Antagonism. When two pesticides applied together produce less control than if you applied each material separately is called antagonism. In addition to reducing control, antagonistic responses also may increase phytotoxicity to plants. For example, when the herbicides

Assert\* (imazamethabenz-methyl) and Banvel\* (dicamba) are mixed together, they negatively affect each other's performance.

4. Enhancement is another type of interaction, but not between two pesticides. Enhancement occurs when a pesticide is mixed with an additive to provide a greater response than if you applied the pesticide alone. A common example of enhancement is mixing an adjuvant with a pesticide.

## Testing For Incompatibility

Two or more pesticides, or a pesticide and a fertilizer, are compatible if no adverse effects occur as a result of mixing them together. The deactivation of an active ingredient often occurs with chemical incompatibility. This is most affected by temperature, tank pH, and length of time that you hold a spray mixture in the tank before use. Physical incompatibilities usually involve the inert ingredients of a formulation. The mixture may become unstable, forming crystals, flakes, or sludge that may clog spray equipment.

For herbicides, incompatibility most often occurs when you mix an emulsifiable concentrate formulation with wettable powders. Similarly, you should not mix EC insecticides with fungicides or herbicides. Liquid fertilizers can also cause compatibility problems, mainly due to their strong electrochemical nature.

When attempting pesticide combinations that are unfamiliar to you, use a jar test to check for incompatibility. In addition, test the combination on a few plants or a small area before larger-scale treatments. Wait at least 2 to 3 days for any problems to become apparent. Keep accurate records on compatible, safe combinations for future reference.

Always wear personal protective equipment (PPE) when pouring or mixing pesticides. Perform this test in a safe area away from food and sources of ignition. Pesticides used in this test should be put into the spray tank when completed and applied to a labeled site. Rinse all utensils and jars and pour the rinse water (rinsate) into the spray tank. Do not use utensils or jars for any other purpose after they have contacted pesticides.

Step 1. Measure 1 pint of water into a clear quart jar. Use the same water (or other diluent) that you will use when making up the larger mixture.

Step 2. Add ingredients in the following order. Stir each time a formulation has been added.

- Compatibility agents and activators. Add 1 teaspoon for each pint per 100 gallons of final spray mixture.
- Wettable powders and dry flowables. Add 1 tablespoon for each pound per 100 gallons of final spray mixture.
- Water soluble concentrates or solutions. Add 1 teaspoon

# TECHNICAL USE & HANDLING

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for each pint per 100 gallons of final spray mixture.

- **Emulsifiable concentrates.** Add 1 teaspoon for each pint per 100 gallons of final spray mixture.
  - **Soluble powders.** Add 1 teaspoon for each pint per 100 gallons of final spray mixture.
  - **Remaining adjuvants and surfactants.** Add 1 teaspoon for each pint per 100 gallons of final spray mixture.
- Step 3. After mixing, let the solution stand for 15 minutes. Stir well and observe the results. Feel the sides of the jar to

determine if the mixture is giving off heat. If so, the mixture may be undergoing a chemical reaction and the pesticides should not be combined. Let the mixture stand for about 15 minutes and feel again for unusual heat.

If scum forms on the surface, if the mixture clumps, or if any solids settle to the bottom (except for wettable powders), the mixture probably is not compatible. Finally, if no signs of incompatibility appear, test the mixture on a small area of the surface where it is to be applied.

*Sources: Cornell University Extension, Montana State University Extension, and Minnesota Department of Agriculture.*