

# Pesticide Interactions and Compatibility

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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. 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 addition of piperonyl butoxide with the pyrethrum 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. 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.

## Incompatibility; chemical and physical

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 (EC) formulation with wettable powders (WP). 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. **Be sure to read and heed all pesticide labels!**

The possible effects of mixing incompatible chemicals are many and include:

- Reduced effectiveness of one or both compounds.
- Precipitate in the tank, clogging screens and nozzles in the sprayer.
- Plant phytotoxicity, stunting or reducing seed germination.
- Excessive residues.
- Excessive runoff.

## Other Incompatibilities

It is necessary to time pesticide applications when the pest is at its most vulnerable stage of development. When using two or more chemicals to manage different pests, it is critical that the mixture be applied at the correct time in the life cycle of the pests. Timing is especially important when applying herbicides. If herbicides are applied to wilted or stressed plants, the efficacy may be less than expected and there is enhanced risk to the desirable plants.

<b>Effect</b>	<b>Examples</b>
Antagonism	Hoelon® (diclofop) + phenoxy herbicides (2,4-D, MCPA, Banvel® (dicamba))
	Hoelon® (diclofop) + Sencor® (metribuzin)
	Assert® (imazamethabenz-methyl) and Curtail® (clopyralid and 2,4-D) Curtail M® is okay). The addition of Curtail® (high pH) raises the pH of the mixture and Assert® falls out of solution.
	Poast® (sethoxydim) + 2,4-D, Banvel® (dicamba), Buctril® (bromoxynil)
	Poast® (sethoxydim), 2,4-D or glyphosate in high-pH tank water (high sodium bicarbonate levels)
	Glyphosate + 2,4-D + Banvel® (dicamba) (on certain weeds)
Synergism	Two- and three-way mixtures of 2,4-D, 2,4-DP, MCPA, MCPA or Banvel® (dicamba). These are more effective when combined -lower rates of each can be used than if you applied them separately
	Garlon® (triclopyr + Stinger® (clopyralid) = Redeem®
	Most post-emergence herbicides + surfactant, crop oil, or adjuvant
	Ammonium nitrate fertilizer + Poast® (sethoxydim)
Enhancement	Glyphosate + 2,4-D (on certain weeds)
Additive effect	Glyphosate + pre-emergence herbicides such as Prowl® (pendimethalin), Surflan® (oryzalin), or Dimension® dithiopyr.

## Tank Mixing

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.

Potential problems with tank mixing include the failure of the products to remain uniformly dispersed generally caused by improper mixing, inadequate agitation, or a lack of stable emulsifiers in some EC formulations. Some pesticides will not mix with liquid fertilizer even when a compatibility agent is added.

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.

### Jar Test for Compatibility of Pesticide Mixtures

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 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.

### Tank Mixing Guidelines

- Read the label. This is your first step when considering tank-mixes.
- Perform a jar test with any new mixes.
- Test pH. Many incompatibilities result from excessively alkaline (sometimes acidic) pH in the tank. The addition of buffering adjuvants can help.
- Make a test application to expose any phytotoxicity or antagonism before you make a large-scale application. If you overlap a few strips, this also can show you how much of a margin of safety you have. Wait a few days for symptoms to become visible.
- Take care with fertilizers. If you add fertilizers, be aware that they can have substantial effects on the chemistry of a tank mix, especially pH. **Read the pesticide label for any fertilizer restrictions.**
- Do not mix iron sulfate with phenoxy herbicides. Iron sulfate is incompatible with amine formulations of some phenoxy herbicides and can cause a precipitate to form, clogging spray equipment.
- Mix no more than one soluble or emulsifiable chemical with any insoluble products such as wettable powders or flowables.
- Avoid mixing strongly acid materials with strongly alkaline materials.

- Apply sprays soon after mixing. Mixes that sit for several hours or longer are prone to degrade, especially if the pH is alkaline.

### 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 gauges work and that you have proper tank agitation.

NOTE: 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.

➤ **Pre-mixing.** Pre-mixing 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).** Pre-mix 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.