TANK-MIXING CHEMICALS

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Tank-mixing pesticides and fertilizers is a convenient and cost effective way to apply two or more chemicals at once. When done appropriately, tank-mixing can reduce labor and equipment costs, and save time and energy. However, chemicals can potentially react with each other and/or change the characteristics of the carrier water. These interactions can change the efficacy of pesticides in both positive and negative ways:

Positive Effects:

Enhancement occurs when an additive is mixed with a pesticide to provide a greater response than if the pesticide was applied alone. Adjuvants are common enhancements added to tank-mixes. Adjuvants include spreaders, stickers and other materials.

Additive effects result from the addition from each chemical added. The additive effect simply equals the sum of the effect if the chemicals would have been applied alone.

Synergism is when the product of two chemicals interacting with each other provides increased efficacy (control). This may allow for lower rates of chemicals to be used.

Negative Effects:

Antagonism is the opposite of synergism. The components react chemically with each other so one or both chemicals are rendered less effective than if they were applied separately. In addition to poor performance, an increase in plant phytotoxicity may occur.

Incompatibilities can occur from *chemical* reactions as mentioned above, or as the *physical* product of mixing chemicals. For example, if flocculants form, screens and nozzles may be clogged and the desired rate of chemical may not be applied. Flocculants and precipitants can also leave a residue on leaf surfaces. Other *chemical* incompatibilities occur from mixing chemical(s) with inadequate carrier water. Also, carrier water that is too low or high in pH and temperature, contain salts, or organic particulate can chemically alter the compound that is to be applied.

Pesticide resistance to two or more chemicals within a tank-mix may develop if the same chemical combination is used repeatedly over a long period of time. Pests may develop resistance faster when the chemicals used in the same tank-mix are of the same mode of action (for example, cyfluthrin and bifenthrin are both synthetic pyrethroids and target the activity site in an insect's nervous system). Resistance may also occur when the chemicals are of different modes of action if they are used frequently.

To make sure that only positive effects occur when tank-mixing, follow these guidelines for developing new tank-mixes:

1- Know the temperature, pH and salinity of your carrier water. Adjust your carrier water temperature and pH to the optimal range of each chemical before mixing in a spray tank or for a jar test.
2- Read the label of all chemicals products considered to be tank-mixed. The product labels will give you information on what type of chemical and carrier to avoid and potential problems that may occur. If you are still unsure about a mix, contact the manufacturer.
3- Perform a jar test following proper mixing procedures (Table 1). This will determine physical incompatibilities.
4- Many chemicals require constant agitation; be sure to follow all label instructions. Many labels will instruct you in the sequence for adding products to the tank mix.
5- Tank-mix enough to make a test application on part of the target site (preferred) or on a non-target site. Schedule the application to allow enough time for any negative effects (chemical incompatibilities) to be apparent before the actual application is made.
6- When making an actual application, spray as soon as possible. Do not use a spray solution that has been sitting for a long time. Some chemicals may degrade in spray solution after several hours.

Performing a Jar Test

Always wear label required personal protective equipment (PPE) when handling any chemical. When working with mixes of chemicals you must wear the PPE on the label of the most toxic material in the mixture.

Step 1: Measure 1 pint of carrier water in a clear quart jar that is not used for any other purpose.

Step 2: Add ingredients in the proper mixing order (Table 1), stirring each time a new chemical is added. Check for the formation of foam, scum or precipitates after adding each ingredient. It is sometimes necessary to premix some chemicals (some wettable powder (WP), dry flowable (DF), water-dispersing granule (WDG), or liquid flowable formulations as indicated on the labels) *before* adding to the spray tank. *Do not mix the chemicals together without dilution before adding to the jar or spray tank.*

Step 3: Let the mixture sit for 15 minutes. Check for foam, scum and precipitates and other unexpected results or appearance (for example, wettable powders will not dissolve). Feel the side of the jar to gauge temperature. If it is warm, let the jar sit and recheck in another 15 minutes.

Table 1. Proper mixing procedures for tank-mixing chemicals and amount of each chemical needed to perform a jar test.

Order of addition	Chemical	Amount for Jar Test (per 100 gal of final spray volume)
1	Water conditioning agents and activators	1 teaspoon for each pint
2	Wettable powders and dry flowables	1 tablespoon for each pound
3	Water soluble concentrates or solutions	1 teaspoon for each pint
4	Emulsifiable concentrates	1 teaspoon for each pint
5	Soluble powders	1 teaspoon for each pint
6	Surfactants and oils	1 teaspoon for each pint
7	Fertilizers	proportional