College of Tropical Agriculture and Human Resources
University of Hawai'i at Manoa

Pesticide Compatibility

Jar Testing Before Tank Mixing

At A Glance: Pesticides are often tank-mixed with other pesticides, fertilizers, wetting agents, or chemicals in order to increase efficacy, save time, and reduce the number of spray operations. Many of these chemical mixes are compatible with each other, but some are not. There are no exhaustive lists detailing which chemicals are compatible.

For this reason, when mixing a new combination of chemicals, it is important to read and follow all label instructions, and perform what is called a Jar Test. A Jar Test will help you to determine if the chemicals you want to tank mix will be compatible.

There are two types of incompatibility: chemical and physical. **Chemical incompatibility** results in chemical degradation of one or more chemicals in the mixture, which usually results in poor efficacy of the products. It can also lead to more detrimental effects, like crop injury. Chemical incompatibility cannot be determined by a Jar Test. The pesticide label is the best resource to determine if that chemical can be tank mixed, and what combinations to avoid.

It is also wise to trial a new tank mix on a small population of the target crop to determine efficacy and phytotoxicity before applying it to the whole crop.

Physical incompatibility results in curdling, gel, or sludge-like material formation. This can be caused by improper mixing order.

Tank mixing order is generally in the following order: add wettable powders, dry flowables, water dispersing flowables, and flowables first. Follow with suspended concentrate liquid products, emulsifiable concentrates, and surfactants last.

November 2022
Subject Category: Pesticide Risk Reduction Education, PRRE-11

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THIS INFORMATION HAS BEEN REVIEWED BY CTAHR FACULTY

An easy way to remember the fill sequence is to use **WALES:**

W: Wettable powders, water-dispersible granules
A: Agitate until uniformly dispersed
L: Liquid flowables (e.g., SC formulations)
E: Emulsifiable concentrates
S: Soluble liquid products

Physical incompatibility, which can also be caused by inadequate agitation or lack of stable emulsifiers, can be tested by using the Jar Test.

Jar Test Instructions

A clean, clear glass quart jar is the recommended container for jar testing. **Make sure to mark this jar with a warning label stating that it is for pesticide use only.** You will also need a container that can measure in milliliters (for liquid chemicals) and a household scale that can measure in grams to the 100th decimal place (for dry chemicals).

The materials must be added in amounts proportional to their labeled rates. You will use 1 pint of final mix for this jar test, which equals .125 gallons or 16 fl. oz. Use the following conversion calculation to determine the amount of product to add to the jar:

Let ***n*** be the number on the label for the amount product to add, and ***m*** be the number on the label for the amount of water to add in a finished spray solution.

Let ***x*** be the number to solve for, to determine how much product to add to the jar.

$$\frac{\boldsymbol{n}\text{ amount of product on label}}{\boldsymbol{m}\text{ amount of gallons water on label}} = \frac{\boldsymbol{x}\text{ amount of product to mix in jar}}{\mathbf{0.125}\text{ gallons (amount of water for jar)}}$$

We will use Bifen I/T as an example. The label states the use of 1 oz. of product per gallon of finished solution (Bifen I/T Label can be found in supplemental section).

Set up the equation with two fractions representing concentration; gallons on the bottom (left and right), and product on the top (left and right). The recommended label amounts are on the left and desired amounts for the jar on the right. The equation is:

$$\frac{\mathbf{1}\text{ (fl oz)}}{\mathbf{1}\text{(gal)}} = \frac{x\text{ amount of product to mix in jar}}{0.125\text{ gal}}$$

Then cross multiply and divide. First cross multiply 1 (fl oz.) x 0.125 gal and x for amount of product x 1 (gal).

$$\frac{\mathbf{1}\text{ (fl oz)}}{\mathbf{1}\text{(gal)}} = \frac{x\text{ amount of product to mix in jar}}{0.125\text{ gal}}$$

$$\mathbf{1} \times \boldsymbol{x} = \mathbf{1} \times .\mathbf{125} \Rightarrow \mathbf{1}\boldsymbol{x} = \mathbf{0.125}$$

Then solve for x by dividing 1x and .125 (gal.) by 1. You will always divide the number that is next to x from both sides.

$$\frac{\mathbf{1}\boldsymbol{x}}{\mathbf{1}} = \frac{\mathbf{.125}}{\mathbf{1}} \Rightarrow \boldsymbol{x} = \mathbf{.125}\text{ fl oz. Bifen I/T to mix into 16 oz jar test water}$$

This gives you the amount of fl. oz. of Bifen I/T you need for the jar test. Multiply by 29.574 to give yourself the number of milliliters to add to the jar.

$$\mathbf{.125} \times \mathbf{29.574} = \mathbf{3.69}\text{ mL to add to jar test water}$$

So for this sample conversion, the label called for 1 oz of Bifen I/T per 1 gallon, and the conversion states that .125 fl oz. of Bifen I/T (3.69 mL) should be added to the Jar Test.

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Unless otherwise noted in the label instructions, use the procedure below for the preparation of a new tank mix:

1. Add wettable powders to tank water
2. Mix well
3. Add liquids and flowables
4. Mix well
5. Add emulsifiable concentrates
6. Mix well

Once the jar test components are mixed together, stir well and let stand for 5-10 minutes to determine whether the mixture separates or forms solid particles at the bottom of the jar. Wettable powders like sulfur do not dissolve in water and will settle out without constant agitation.

Try reversing the order of addition or increasing the amount of water if the combination is not compatible using the above order. NOTE: After increasing the amount of water, if the mixture is found to be compatible, it is necessary to recalibrate the sprayer for a higher volume application. Do not allow the mixture to stand overnight.

Products are not compatible if you experience precipitate, heat is given off, or the products separate into layers.

The following are several examples of jar tests, with corresponding pictures. Note: once you determine the total product volume, subtract this amount from 16 oz to get the amount of water needed in the jar.

Jar Test 1

Application rate (per 1 gallon or 128 oz)	Proportional rates for Jar (16 oz)
1 oz – Bifenthrin	0.125 oz Bifenthrin (3.7 mL)
2 oz Propiconazole	0.25 oz Propriconazole (7.4 mL)
1 oz Si	0.125 oz Si (3.7 mL)
	_____total product 0.5 oz
	Bring up to 16 fl oz with water

Jar Test 2

Application rate (per 1 gallon or 128 oz)	Proportional rates for Jar (16 oz)
1 oz lambda Cyhalothrin	0.125 oz Lambda Cyhalothrin (3.7 mL)
2 oz Propiconazole	0.25 oz Propriconazole (7.4 mL)
6 oz Neem	1.5 oz Neem (44.4 mL)
1 oz Si	0.125 oz Si (3.7 mL)
	_____ total product 2.25 oz
	Bring up to 16 fl oz with water

Glossary

Adjuvant = A substance that is added to a pesticide product or pesticide spray mixture to enhance the pesticide's performance and/or the physical properties of the spray mixture

Emulsifiable concentrates (EC) = A liquid formulation that contains technical material, one or more organic water-immiscible solvents and an emulsifier (such as a surfactant).

Flowables (FL) = Also called liquid flowables. A thick, liquid suspension of finely-ground active ingredient suspended in a small amount of liquid.

Water dispersible granule (WDGs) = A solid, non-dusty granular formulation that disperses or dissolves quickly when added to water in the spray tank to give a fine-particle suspension.

Wettable powders (WP) = An insecticide or other pesticide formulation consisting of the active ingredient in a finely ground state, combined with wetting agents and sometimes bulking agents. Wettable powders are designed to be applied as a dilute suspension through liquid spraying equipment.

Acknowledgements

Special thanks to Dr. Michael Shintaku and Dr. Joseph DeFrank for their review of this publication.

Disclaimer

The pesticides mentioned are provided as suggestions for selecting suitable controls and should not be considered to be recommendations. The pesticide label is the law. Read it before purchasing a pesticide to ensure that it is registered for your intended use. Carefully read the label entirely before use and follow its instructions. Chemical names and trade names are included as a convenience to the reader. Their use in this publication does not imply endorsement, nor discrimination against similar products or services not mentioned. Individuals who use chemicals are responsible for ensuring that the intended use complies with current regulations and conforms to the product label. Be sure to obtain current information about usage and examine a current product label before applying any chemical. For assistance, contact your state pesticide regulating authority.

Figure 1. Jar Test set-up. Be sure to always begin the jar test with some water in the jar. Do not merely start mixing chemicals together in the jar without water.

Figure 2. Jar Test mixing. Vigorously mix the ingredients with a clean plastic, glass, or metal stirrer to ensure the mix is homogenized.

Figure 3. Completed successful Jar Test. No layering, precipitation, water gel, or coagulation is present.

Figure 4. Jar Test showing coagulation of product, which indicates the tank mix will not be successful.

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