



Be sure to incorporate pesticides in the proper order when tank mixing.

Making sense of pesticide formulations

By Brandon White

Editor's note: This article grants one continuing education unit (CEU) in the Core category toward the renewal of a Florida Department of Agriculture and Consumer Services restricted-use pesticide license when the accompanying test is submitted and approved.

Have you ever wondered what the numbers or letters following the trade name of your pesticide stand for or why they matter? Or whether you need to agitate a pesticide during use? Or if you have the right equipment to spray a certain product? If not, you can go to lunch and skip this article. However, if you could use a refresher or some clarity on the sometimes-confusing world of pesticide formulations and want that free CEU, please read on and I'll try to make it as painless as possible!

Pesticides are created and sold in a variety of forms. It can be helpful to learn and review the nuances surrounding them to make the best decisions about their use. Many of us are familiar

with the concept of active vs. inert or other ingredients. It is the combination of these ingredients that make up a pesticide formulation.

This article covers why ingredients matters as well as some common formulations, their advantages and disadvantages, and other helpful tidbits. Adjuvants are substances used during formulation or at the time of mixing by the applicator to enhance pesticide performance. While they are important and certainly have their place in a conversation about pesticide formulations, they are in their own category and were recently well covered in another article (see CEU article #1 of 2022 by Ajia Paolillo, "Increasing Pesticide Effectiveness With Adjuvants").

INGREDIENT TYPES

Each active ingredient (a.i.) and its percentage by weight are required by law to be on the first page of a pesticide label. The a.i. can be thought of as the part of the product that does the work, while the other ingredients make it effective. Pesticides usually only have one active ingredient but can contain more.

A single a.i. can be found in multiple formulations, such as a liquid or dry form. A particular a.i. can be found in pesticides from different manufacturers and trade names. For example, glyphosate is the active ingredient in Round Up®, Ranger Pro®, Cornerstone Plus® and several other trade names.

Inert ingredients used to be referred to as such on labels but are now called other ingredients and are found just under the active ingredients. Their percentage by weight is also included. Other ingredients may be added to help with safe handling and solubility, act as a carrier or improve storage properties of the product but have no inherent pesticidal activity on their own. While you will sometimes find some other ingredients identified, it is generally not required by law for them to be listed.

Pesticide formulations can be broken down into three main categories: liquid, dry and other.

LIQUID FORMULATIONS

Most of the pesticides used in agriculture are liquid forms. Liquids are usually mixed with water for application but can also be mixed with oils or other carriers. The amount of active ingredients in liquid formulations is given as pounds a.i. per gallon. This number is on the label under the ingredient percentages on the first page.

Sometimes, manufacturers will indicate the amount of a.i. in the trade name. For example, a

hypothetical pesticide called Good Pesticide 3EC would contain 3 pounds of a.i. in one gallon, whereas Good Pesticide 4F would contain 4 pounds of a.i. in one gallon. You get the picture.

Solutions are the most basic and easiest to understand of liquid formulations. Many pesticides come as solutions that can be mixed with water to form a uniform mixture that does not need to be agitated because it will be mixed easily and have nothing to settle out. Solutions are easy to measure, can be used in any type of sprayer, rarely leave residues on plants, are simple to use and are usually soft on equipment.

Another common type of liquid formulation is a class called emulsifiable concentrates, abbreviated as EC, E or EW. Pesticide formulation abbreviations are sometimes used in the trade name of pesticides (e.g., Mentor® EC). ECs usually contain a liquid active ingredient, petroleum-based solvents and an emulsifier that will allow the product to mix with water to form an emulsion, as the name implies.

ECs take on a cloudy or milky look when mixed with water. This type of formulation can be used for a variety of applications. ECs are easy to handle and store, are not abrasive to equipment, require less agitation than some other formulations during spraying and do not leave a large amount of residue on plant surfaces.

However, ECs usually have a higher a.i. concentration, which can lead to overdosing or underdosing. Overdosing ECs increases the risk of phytotoxicity or harm to users, as this type of formulation is easily absorbed through the skin. The solvents used in ECs can make them corrosive and flammable.

Sometimes, an a.i. will not dissolve in water or oil. Manufacturers can bind it to a carrier such as clay that can be finely ground so that it can be evenly distributed throughout the product while still being a liquid. These types of products are called flowables, which is often abbreviated simply as F or abbreviated as L for liquid flowable.

While flowable products are easy to handle and apply, they must be shaken before being poured or mixed and agitated during application. Flowables can leave residues on plant surfaces. However, using them avoids active ingredients that would otherwise exist

as fine dust and pose complications for mixing and handling. There are particular safety concerns with breathing in the dust. So, creating the product as a flowable liquid makes it safer and easier to handle.

Another type of liquid formulation is ultra-low volume (ULV) products that have high concentrations of a.i. and are applied as very fine droplets over large outdoor areas like forests or vast croplands. Aerosol liquid formulations are applied as a mist or fog with specialized equipment and usually contain a lower percentage of the a.i. Both ULV and aerosol are not commonly used in commercial agriculture in Florida.

It is best to consult the label to determine what pesticides are compatible to tank mix.

DRY FORMULATIONS

Dry formulations exist as dusts, baits and pellets. The main ones used for crop production in Florida are wettable powders (WP or W) and water-dispersible granules (WDG), with the latter also known as dry flowables (DF). With dry formulations, the percentage of a.i. is listed by weight. If a dry product comes in a 2-pound bag and the active ingredient is 50%, then there is 1 pound of a.i. in that formulation.

Wettable powders are a common formulation. They are like liquid flowables in that once they are mixed with water, they have fine solid particles carrying the a.i. that must be agitated during use. They can be abrasive to equipment, and because they come as a fine dust, they pose an increased inhalation hazard during measuring and initial mixing. Wettable powders can be applied directly as a powder in some cases.

Some benefits of WPs include ease with transporting, storing and

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handling. They are also less likely to be absorbed via eyes and skin and cause phytotoxicity than emulsifiable concentrates and other liquid formulations.

Dry flowables are like wettable powders but instead of a fine powder, they are made as small granules that are easy to measure and pose less inhalation risk during measuring. They still require agitation during mixing. WDGs usually have a high a.i. percentage.



Pesticides are manufactured and sold in a variety of formulations.

MIXING IT UP

It is best to consult the label to determine what pesticides are compatible to tank mix. Labels will give clear instructions for what types of products can and cannot be mixed as well as the order in which to mix different formulations. You can usually find these specific instructions near the beginning of the label in the Spray Preparation or Mixing Procedures section. The mixing sequence for the more common formulations mentioned in this article (first to last) is WDG or WP, F, S, EC and then adjuvants.

Water pH can have an impact on how formulations behave during mixing. So along with consulting the label for mixing directions, one of the best ways to determine the compatibility of combining pesticides at your operation is the old-fashioned, but reliable, jar test. The jar test involves mixing pesticides in the given order in a small jar, shaking it, letting it rest and then observing it for signs of incompatibility. These signs can include flaking, layering, excessive heat

formation and flocculation.

When spraying a tank mix for the first time, especially on a crop you are less familiar with, you can go a step further and complete a phytotoxicity (or phyto, for short) test. This is simply mixing up a small batch of the pesticide at the same ratio as the label advises and spraying a small number of plants to see if they show any signs of stress or damage after a few days. This is the surest way to check a tank mix on your crop.

WRAP IT UP

Hopefully, that wasn't so bad! Pesticide formulations can be confusing and *seemingly* pointless to spend time thinking about, but I hope you have learned or been reminded there is value in staying in the know on this subject. In a time when input costs are as high as they are, it pays to make smarter and safer decisions when it comes to pesticide use. 🍊

Sources: Applying Pesticides Correctly, 7th Edition by F. M. Fishel, University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) and the National Pesticide Information Center

Disclaimer: The use of trade names in this article is solely to provide specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this article do not signify approval to the exclusion of other products of suitable composition. Use pesticides safely. Read and follow directions on the manufacturer's label.

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‘Making sense of pesticide formulations’ test

To receive one Core continuing education unit (CEU), read “Making sense of pesticide formulations” in this issue of Citrus Industry magazine. Answer the 20 questions on the magazine’s website (www.CitrusIndustry.net/ceu) or mail the answers and application information to the address at the end of the article. You must answer 70% of the questions correctly to receive one Core CEU. The article and test set are valid for up to one year from the publication date. After one year, this test will no longer grant a CEU.

- | | True | False |
|---|------|-------|
| 1. Adjuvants are substances that can enhance the performance of pesticides. | T | F |
| 2. The active ingredient is required by law to be on the first page of the pesticide label. | T | F |
| 3. If a pesticide has more than one active ingredient (a.i.), only one has to be listed on the label. | T | F |
| 4. All active ingredients are specific to manufacturers and will not exist under different trade names. | T | F |
| 5. It is not required by law for all the inert or other ingredients to be listed on the label. | T | F |
| 6. The amount of a.i. in a liquid pesticide is given in pounds per gallon. | T | F |
| 7. The letters and numbers following the trade name of a pesticide have nothing to do with the formulation. | T | F |
| 8. Pesticides that come as solutions usually do not leave residues on plant surfaces. | T | F |
| 9. Water-dispersible granules are nice because they don’t require agitation during spraying. | T | F |
| 10. Water pH can have an effect on the performance of pesticide formulations. | T | F |
| 11. Unless the label specifically said otherwise, which of the following would not be the correct order when tank mixing (first to last):
A) WP, F, adjuvant B) WDG, S, EC C) Adjuvant, F, S, WDG D) S, Adjuvant | | |
| 12. Which of the following are signs of incompatibility when tank-mixing pesticides?
A) Excessive heat formation B) Flocculation C) Flaking D) All of the above E) None of the above | | |
| 13. Choose the best way to tell if all of the products in your tank mix are compatible.
A) Send a sample of the mixture to your local Extension office to check the pH. B) Send a sample to an analytical lab.
C) As long as it stays somewhat liquid it should be fine.
D) Read the label, follow instructions, perform a jar test and complete a phytotoxicity test if needed. | | |
| 14. Which of the following are usually added last when tank-mixing products?
A) Adjuvants B) Water-dispersible granules C) Wettable powders D) The order doesn’t matter. | | |
| 15. If a dry product comes in a 4-pound bag, how many pounds of active ingredient are in it if the percentage of active ingredient is 10%
A) 1 pound B) 0.4 pounds C) 0.0004 pounds D) 4 pounds | | |
| 16. Which of the pesticide formulation choices below matches the following description? A formulation that comes as a fine dust that can be applied dry or mixed with water, must be agitated during use but less likely to be absorbed by skin and eyes than many liquid formulations.
A) Solutions B) Wettable powders C) Water-dispersible granules D) Pellets | | |
| 17. A pesticide formulation that is not abrasive to equipment, contains an emulsifier and usually has a high percentage of active ingredient is:
A) Emulsifiable concentrate B) Liquid flowable C) Solution D) Aerosol | | |
| 18. Which of the following is most likely true for a pesticide with the name Good Pesticide 2F
A) Results can be seen in as little as two days and offers full control. B) This is the second edition of this pesticide, and it is faster acting.
C) The product is twice as strong as the original formulation.
D) The product contains 2 pounds of active ingredients in 1 gallon and is a flowable formulation. | | |
| 19. You haven’t read the product label yet but know you want to use a product a friend recommended. All you know is the product is a wettable powder. What can you already reasonably expect regarding the use of this product?
A) It will need to be agitated during use. B) It is the best pesticide for the job.
C) It is the safest pesticide for the job. D) It cannot be mixed with other pesticides. | | |
| 20. Of the options listed below, which is the best resource for knowing what products you can tank-mix a pesticide with that you are using for the first time?
A) The owner’s manual of the sprayer you are using B) Research journal articles on the compatibility of the active ingredient.
C) The pesticide label of the product in question D) Dr. Oz | | |

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