



## Spray Additives and Pesticide Formulations<sup>1</sup>

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### Spray Adjuvants

Spray adjuvants (additives) are added to pesticides to enhance the performance or handling of those pesticides. Adjuvant is a broad term and includes surfactants, crop oils, antifoaming agents, stickers, and spreaders. Adjuvants are usually classified according to their use rather than their chemistry.

Adjuvants are not under the same guidelines for registration as are pesticides. Anyone can mix up a nonpesticidal concoction, give it a name, and sell it as an adjuvant.

The best way to avoid a "snake oil" is to buy a recognized name-brand product from a reputable dealer. If the claims sound too good to be true, they probably are.

### Surfactants (Surface-Active Agent)

Surfactants are chemicals that modify the surface properties of materials they contact. Surfactants are often added to herbicides to increase the activity on weeds. However, surfactants may also increase crop injury. Three major surfactant types are emulsifiers, wetting agents, and stickers.

Soaps and household detergents are essentially surfactants. However, these are not generally as effective because:

- they contain low concentrations of surfactant (10 to 20%) compared to agricultural preparations (50 to 95%);
- they combine with hard water to form scum and precipitants that affect sprayer performance;
- they make too much foam in the spray tank.

**Emulsifiers.** Emulsifiers promote the suspension of liquid in another. Emulsifiers are most commonly used to disperse oil in water.

**Wetting agents.** Wetting agents reduce interfacial tensions between normally repelling substances. Normally *non-ionic* surfactants are used as wetting agents due to their compatibility with most pesticides and low toxicity to plants and animals.

**Stickers.** Stickers are adjuvants that cause the pesticide to adhere to the plant foliage and also to resist wash-off. Spreader-stickers are combined products that provide better spray coverage and adhesion. These are more commonly used with fungicides and insecticides.

1. This document is Fact Sheet ENH-82, a series of the Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. First published: May 1991. Revised: February 25, 2003.

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## Crop Oils and Crop Oil Concentrate

These are nonphytotoxic, light, petroleum-based oils that contain 1 to 2% surfactant and are used at a concentration of 1 gallon in 20 to 25 gallons of spray solution. Crop oil concentrates contain 17 to 20% surfactant and are used at approximately 1 quart per 20 to 25 gallons of spray.

Utility modifiers allow a given formulation to be used under a wider range of conditions.

**Antifoam agents (foam suppressants).** Antifoam agents suppress the foam formed when pesticides are agitated in the spray tank.

**Compatibility agents.** Compatibility agents are adjuvants used to reduce incompatibility (lack of mixing) of pesticides or pesticide and liquid fertilizer mixtures.

## Pesticide Formulations

A formulation is a pesticide preparation supplied by the manufacturer. The formulation includes all contents inside the container—active ingredient plus inert ingredients (such as solvents, diluents, and various adjuvants).

### Purpose of Formulating a Pesticide

**Ease of application.** Formulating a pesticide allows a small quantity to be mixed with a larger quantity of carrier so that the pesticide can be applied more uniformly to a large area.

**Improved pesticide performance.** Formulating a pesticide aids in application, aids in mixing, improves coverage and aids in uptake.

**Stability of product.** Formulating a pesticide provides better stability in shipping and a longer shelf life.

**Safety.** Formulating a pesticide dilutes the active ingredient and its acute toxic effect; the user is exposed to lower concentrations.

**Compatibility.** Formulating a pesticide aids mixing with carriers.

## Types of Formulations

### Sprayable Formulations

#### Water-soluble liquids

- are designated as S or SL or SC;
- form true solutions when mixed with water;
- are nonabrasive;
- will not separate or settle out upon standing; require no agitation once initially mixed.

example: Vantage<sup>®</sup>.

#### Water-soluble powders

- are designated as SP or WSP;
- are finely divided solids that dissolve completely in water;
- form true solutions when mixed with water;
- will not separate or settle out upon standing and require no agitation once initially mixed.
- example: Kerb 51<sup>®</sup> WSP, Sevin<sup>®</sup> WSP.

#### Emulsifiable concentrates

- are designated as E or EC;
- are oil-soluble herbicide containing emulsifiers;
- form emulsions when mixed with water;
- require mild agitation to keep properly mixed in spray tank;
- can have normal emulsions and invert emulsions.
- examples: Pre-M<sup>®</sup> 3.3 EC, Illoxan<sup>®</sup> 3 EC.

#### Wettable powders

- are designated as W or WP;
- are finely ground solids consisting of a dry carrier (a finely ground hydrophilic clay), pesticide, and dispersing agents;

- form an unstable suspension when mixed with water, and require continuous vigorous agitation; without agitation, a solid precipitate forms at the bottom of the tank;
- must be made into a slurry before they are added to a spray tank;
- cause rapid nozzle wear.
- example: Diazinon<sup>®</sup> 50 WP.

#### **Water-dispersible liquids**

- are frequently designated as liquids or flowables; WDL, L, F, AS;
- are finely ground solids suspended in a liquid system;
- form suspension when added to water in spray tank;
- consist of particles smaller than a WP, with an agitation requirement intermediate between that for WP and EC;
- cause nozzle wear intermediate between WP and EC, more similar to WP;
- tend to settle out in storage; container must be vigorously shaken before use.
- examples: Surflan<sup>®</sup> 4AS and Aatrex<sup>®</sup> 4L.

#### **Water-dispersible granules**

- are also called dry flowables; are designated as WDG or DF;
- are dry formulations of granular dimensions;
- contain granules made up of finely divided solids (a size similar to that in flowables) that combine with suspending and dispersing agents;
- have an easy pouring advantage over WP and F;
- have other properties (such as nozzle wear and agitation requirements) similar to F.
- examples: Gallery<sup>®</sup> 75DF, Pendulum<sup>®</sup> 60 WDG.

#### **Dry Formulations (for Direct Application)**

These formulations are applied directly from the package ("straight out of the bag") to the field without dilution in a liquid carrier. They usually come as low concentration formulations (2 to 25% active).

#### **Granules**

- are designated as G;
- consist of dry material in which small, dry carrier particles of uniform size are impregnated with the active ingredient. The carrier can be clay, sand, vermiculite, or corn cob; granule size less than 0.61 cubic inches;
- are applied with granular applicators; in general, they are more difficult to apply uniformly than a sprayed material;
- may be moved from applied area by wind or rain (for example, a banded application can be blown or washed off the top of the bed);
- in general, require slightly more rainfall for activation than a sprayable formulation; on the other hand, rate of pesticide loss by volatilization is somewhat slower.
- examples: Diazinon<sup>®</sup> 5G and Ronstar<sup>®</sup> 2G.

#### **Pellets**

- are designated as P;
- are dry formulations of pesticide and other components in discrete particles usually larger than 0.61 cubic inches;
- are frequently used for spot applications, applied by hand from shaker cans or with hand spreaders;
- have a low concentration, usually 5 to 20%.

## Proper Order for Tank Mixing

When mixing two or more compatible pesticides, the order in which they should be added to the spray tank varies with the formulations. In general, the proper order is: (first to last) WP, DF, F, EG, S. Agitate after each addition.

## Glossary

- **Solution:** a physically homogeneous mixture of two or more substances; cannot be separated by mechanical means; transparent, but may be colored; nonabrasive.
- **Suspension:** a mixture containing finely divided particles dispersed in a liquid. Particles retain identity and can be physically separated from liquid.
- **Emulsion:** one liquid dispersed in another liquid; each liquid maintains original identity.

Example: **normal emulsion** (oil-in-water emulsion): water is continuous phase, oil is discontinuous phase.

Example: **invert emulsion** (water-in-oil emulsion): oil is continuous phase, water is discontinuous phase.

## Carriers

Carriers serve as the diluent for the pesticide formulation. The carrier is the material to which the formulated pesticide is added for field application. The primary purpose of the carrier is to enable uniform distribution of a small amount of formulated pesticide to a large area. There are three types of carriers: liquid, dry and foam.

**Liquid.** Liquid carriers for spray applications include water (most widely used), liquid fertilizers, vegetable oils, and diesel oil.

**Dry.** Dry carriers are used to apply herbicides without further dilution and are the major components of granules and pellets. They include attapulgit, kaolinite, vermiculite, starch polymers, corn cob, and others.

Dry fertilizers can also be carriers. They can be impregnated with herbicides and insecticides. The label will have details. Some fertilizers cannot be used. From 200 to 450 pounds of fertilizer per acre is necessary to have enough volume for uniform application. A major problem is uniformity of application.

**Foam.** Used only in special applications. Special equipment is needed.

## Compatibility Tests

Tank mixes of two or more pesticides are commonly applied. Sometimes these pesticides may not mix well in the tank even though each product alone mixes well. Also, there are situations where it is desirable to use a fluid fertilizer or liquid nitrogen as the carrier. Some pesticides are compatible with fluid fertilizers and some are not. Never mix fungicide with fertilizers. By conducting a simple compatibility test before adding the pesticides to the tank, one can usually avoid making "Jello" in the tank. Every batch of fluid fertilizer or liquid nitrogen should be tested for compatibility. Batches can vary in pH, salt concentration, or even temperature. Minor differences may affect compatibility.

## Materials Required for a Compatibility Test

- Two 1-quart jars with lids (mark one "with" and the other one "without");
- Teaspoons;
- Fluid fertilizer or liquid nitrogen to be tested;
- The pesticide(s) to be tested;
- A compatibility agent. (example: Blendex<sup>®</sup>, Unite<sup>®</sup>)

**Table 1.** Amount of pesticides to add for a compatibility test.

Type of Pesticide	Rate/Acre	Teaspoons to Add
WP or DF	1 lb	1.5
	2 lb	3.0
	3 lb	4.5
	4 lb	6.0
EC, F, L, or S	1 pt	0.5
	1 qt	1.0
	2 qt	2.0
	4 qt	4.0

### Procedure

The procedure for a compatibility test is often outlined on a pesticide label. Follow these steps, in order to perform a compatibility test.

1. Add 1 pint of the fluid fertilizer to each quart jar.
2. To the jar marked "with", add 1/4 teaspoon of compatibility agent. Shake gently for 5 to 10 seconds.
3. To each jar, add the appropriate amount of pesticide(s), (table 1). Shake gently for 5 to 10 seconds.
4. Let the jars sit for 5 minutes, then look at them. See if there are any flakes, sludge, gels, or other precipitants. Also see if there is any separation or layering, or small oil particles in solution.

If incompatibility occurs in "without" jar but not in "with" jar, use a compatibility agent.

If incompatibility is observed in the "with" jar, this combination is not compatible and should not be used.

5. If separate layers are formed after sitting up to 30 minutes but can be resuspended by shaking, using agitation in the sprayer will make commercial application possible.

If there is layering, an emulsifiable concentrate will normally rise to the top. Wettable powders will either settle to the

bottom or float on top, depending upon the density of the fertilizer carrier.