

Formulation Information & Adjuvants

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A fungicide's formulation has a big impact on a fungicide's activity. For example the more finely ground the sulfur particles, the more effective as a powdery mildew fungicide but also the more likely that phytotoxicity can occur! Unfortunately, pesticide formulations can be almost as confusing as pesticide classes ([see Tutorial on Fungicides](#)). To know what pesticide formulation will work best for your specific purposes you should know the characteristics, advantages, and disadvantages of the different formulations and adjuvants.

What is a formulation: The pesticide formulation is a mixture of the active and inert ingredients in the pesticide. The active ingredients are the chemicals that affect the target pest. The inert ingredients are all other ingredients in the pesticide, and are also called inactive ingredients. Inert ingredients are used to dilute the active ingredient or make it safer, easier to handle, and more effective. Some formulations are ready to use, others must be further diluted by air (air-blast sprayer), water, or a petroleum-based solvent. A single active ingredient is often sold in multiple formulations - you must choose the formulation that works best for you.

How to choose the formulation: There are several questions that you must answer while choosing the formulation.

1. Do you have the equipment needed for this type of formulation?
2. Can the formulation be applied safely under the conditions of the application area?
3. Will the formulation reach the target and stay there long enough for control?
4. Is there a possibility the formulation will harm the surface on which it is applied?

To answer these questions, you must know the characteristics of the formulations and the advantages and disadvantages of each type. The most common formulations found in grape disease control are:

Liquid Formulations

Emulsifiable Concentrates (EC or E) – contains a liquid active ingredient, one or more petroleum-based solvents, and an agent that allows the product to be mixed with

water to form an emulsion. An emulsion is a mixture of two or more liquids that are not soluble in one another. Each gallon of EC usually contains 25 to 75% (2 to 8-lbs) active ingredient. These are among the most versatile formulations and are adaptable to many application equipment types from small, portable sprayers to hydraulic sprayers, low-volume ground sprayers, and mist blowers.

Advantages:

- Relatively easy to transport, handle, and store.
- Little agitation required (will not settle or separate when equipment is running).
- Non-abrasive.
- Does not plug nozzles or screens.
- Little visible residues on treated surfaces.

Disadvantages:

- Highly concentrated, making it easy to over- or under-dose by mixing and calibration errors.
- May cause phytotoxicity.
- Easily absorbed through skin.
- Solvents may damage rubber or plastic hoses, gaskets, pump parts, and metal or painted surfaces.
- May cause pitting or discoloration of painted surfaces.
- Flammable – must be stored away from open flame or heat.
- May be corrosive.

Solutions (S) – pesticide active ingredients that readily dissolve when mixed with a solvent such as water or a petroleum-based solvent. These formulations form a solution that will not settle out or separate once mixed. Solutions usually contain the active ingredient, the solvent, and one or more inert ingredients. Solutions may be used in any type of sprayer.

Advantages:

- Relatively easy to transport, handle, and store.
- Little agitation required (will not settle or separate when equipment is running).

Disadvantages:

- Easily absorbed through skin.

Concentrate solutions (C or LC) – solutions sold as concentrates that must be further diluted with a liquid solvent. The solvent may be water but more often is refined oil or petroleum-based.

Advantages:

- No agitation needed.

Disadvantages:

- Less formulations of this type.

Other advantages and disadvantages vary depending on the solvent used, the concentration of the active ingredient, and the type of application.

Flowables (F or L) – finely ground active ingredients (in this case, soluble solids) are mixed with liquid along with inert ingredients to form a suspension. A suspension is a substance that contains undissolved particles mixed throughout a liquid. Flowables are mixed with water for application and are similar to EC or WP formulations for ease of handling and use.

Advantages:

- Seldom clogs nozzles.
- Easy to handle and apply.

Disadvantages:

- Requires moderate agitation to maintain solids in suspension.
- May leave a visible residue.

Dry Formulations

Dusts (D) – ready to use formulations containing a low percentage of active ingredient (0.5 to 10%), combined with a fine, dry inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of the dust particle is variable. A few dust formulations are available as concentrates, containing a high percentage of active ingredient, which must be mixed with inert carriers before they are applied. Dusts easily drift onto non-target areas.

Advantages:

- Usually ready to use with no mixing involved.
- Effective where moisture from a spray may be harmful.
- Requires simple equipment.

Disadvantages:

- Easily drifts off target during application.
- May irritate eyes, nose, throat, and skin.
- Does not stick to surfaces as well as liquid formulations do.
- Difficult to achieve even distribution of particles on surfaces.

Granules (G) – similar to dust formulations except granules have larger and heavier particles. These coarse particles are composed of absorptive materials such as clay, corn cobs, or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them. The amount of active ingredient in this formulation is relatively low, typically ranging from 1 to 15%. Granular pesticides are most often applied to control weeds, nematodes, and soil insects.

Advantages:

- Ready to use with no mixing involved.
- Drift hazard is low because heavier particles quickly settle.
- Fewer hazards to the applicator (no spray, little dust).

- Requires simple application equipment such as seeders or fertilizer spreaders.
- May break down more slowly than WP's or EC's by slow release coating.

Disadvantages:

- Does not stick to foliage or other non-level surfaces.
- May need to incorporate into soil.
- May require moisture to start pesticide action.
- May be hazardous to nontarget species that mistake granule for grain or seed.

Pellets (P or PS) similar to granular formulations, the terms are often used interchangeably. However, in a pellet formulation all the particles are the same weight and shape. This uniformity allows pellets to be applied by precision applicators such as those used for precision planting of pelleted seed.

Wettable Powders (WP or W) – dry, finely ground formulations that look like dusts. Wettable powders are usually mixed with water for application as a spray. A few products are available that may be applied as dusts or as a spray. Wettable powders contain 5 to 95% active ingredient (usually 50% or more). The powder particles do not dissolve in water, and settle out quickly unless constantly agitated. This is one of the most widely used pesticide formulations, useable for most pest problems and with most types of spray equipment if agitation is available.

Advantages:

- Easy to transport, store, and handle.
- Less likely to cause phytotoxicity than EC's and other petroleum-based pesticides.
- Easily measured and mixed.
- Less skin and eye absorption than EC's and other liquid formulations.

Disadvantages:

- Inhalation hazard when handling the concentrated powder.
- Requires good and constant agitation (usually mechanical agitation in the spray tank).
- Abrasive on many pumps and nozzles.
- Difficult to mix in hard or alkaline water.
- Often clogs nozzles and screens.
- Residues may be visible.

Soluble Powders (SP or WSP) – looks like wettable powders; however, when mixed with water dissolves readily and forms a true solution. After soluble powders are mixed thoroughly no additional agitation is necessary. The amount of active ingredient in soluble powders ranges from 15 to 95% (usually 50% or more). Soluble powders have all the advantages of wettable powders and none of the disadvantages except an inhalation

hazard while mixing. Few pesticides are available in this formulation because few active ingredients are water soluble.

Water-Dispersible Granules or Dry Flowables (WDG or DF) – like wettable powders except the active ingredient is prepared as granule-sized particles. Water-dispersible granules must be mixed with water to be applied. In the water, the granules break into fine particles. This formulation requires constant agitation to keep the solids in suspension. Water-dispersible granules have the same advantages and disadvantages of wettable powders except that WDGs are more easily mixed and measured and have less inhalation hazard to the handler.

Adjuvants

An adjuvant is a chemical added to the pesticide formulation or tank mix to increase the safety or efficacy of a pesticide. Most pesticide formulations are composed of a small percentage of adjuvants.

Common adjuvants are:

- Surfactants or surface active ingredients – alter the dispersal, spreading, and wetting properties of spray droplets.
- Wetting agents – allow wettable powders to be mixed with water.
- Emulsifiers – allow petroleum-based pesticides (EC's) to mix with water.
- Invert emulsifiers – allow water-based pesticides to be mix with a petroleum carrier.
- Spreaders – allow pesticides to form a uniform layer on the treated surface.
- Penetrants – allow the pesticide to get through the outer surface to the interior of the treated area (e.g. a leaf).
- Stickers – allow pesticides to stay on the treated surface.
- Foaming agents – reduce drift.
- Thickeners – reduce drift by increasing droplet size.
- Safeners – reduce toxicity of a pesticide formulation to the handler or treated surface.

Formulation Abbreviations

A	=	Aerosol
AF	=	Aqueous Flowable
AS	=	Aqueous Solution of Aqueous Suspension
B	=	Bait
C	=	Concentrate
CM	=	Concentrate Mixture
CG	=	Concentrate Granules
D	=	Dust
DF	=	Dry Flowable
DS	=	Soluble Dust
E	=	Emulsifiable Concentrate
EC	=	Emulsifiable Concentrate
F	=	Flowable
G	=	Granules
H/A	=	Harvest Aid
L	=	Flowable
LC	=	Liquid Concentrate or Low Concentrate
LV	=	Low Volatile
M	=	Microencapsulated
MTF	=	Multiple Temperature Formulation
P	=	Pellets
PS	=	Pellets
RTU	=	Ready To Use
S	=	Solution
SD	=	Soluble Dust
SG	=	Soluble Granule
SP	=	Soluble Powder
ULV	=	Ultra Low Volume
ULW	=	Ultra Low Weight or Ultra Low Wettable
WS	=	Water Soluble
WSG	=	Water-Soluble Granules
WSL	=	Water-Soluble Liquid
W	=	Wettable Powder
WSP	=	Soluble Powder

- Compatibility agents – aid in combining pesticides.
- Buffers – allow pesticides to be mixed with diluents or pesticides of different acidity or alkalinity.
- Anti-foaming agents – reduce foaming of spray mixtures that require vigorous agitation.

Selected references:

“Formulations”. Applying Pesticides Correctly – A Guide for Private and Commercial Applicators, revised 1991. The Ohio State University and Information Impact; Extension Service, USDA; and Office of Pesticide Programs, EPA. Pgs. 31 – 37.