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Tech Pesticide Programs

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Pesticide Formulations (Part 1 of a 2 Part Series)

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As a pesticide applicator, understanding pesticide formulations is essential for selecting and using products safely and effectively. Pesticides are sold as formulations, rather than technical-grade chemicals, to make them more suitable for end users. Different formulations are developed for various reasons, including applicator safety, cost, and environmental concerns. In this article, we will take a deeper dive into pesticide formulations — why they are used, common types you may encounter, and advantages and disadvantages of each one.

What Are Pesticide Formulations?

A pesticide formulation is an end-use product composed of active and inert ingredients. Active ingredients are the

chemicals responsible for controlling the target pest. Inert ingredients do not have pesticidal activity but serve other important functions. Some inert ingredients act as carriers, diluting the active ingredient to reduce toxicity and make the product easier to handle and apply. Others, such as adjuvants, enhance the product's effectiveness, safety, or application performance.

Many pesticides are available in multiple formulations, meaning they contain the same active ingredient but differ in formulation type and concentration. Some products are sold as ready-to-use formulations that are pre-mixed and packaged in an application device. Others must be diluted or mixed before application.

Why Do We Use Pesticide Formulations?

Technical-grade (99%) active ingredients are not suitable for end use. Some

active ingredients may be highly toxic. Others may not mix well with water or are very unstable. For these reasons, pesticides are formulated into end-use products to dilute them, make them more effective, and/or make them safer and easier to use (i.e., measure, mix, apply, and store).

Pesticide active ingredients vary greatly in their physical and chemical properties, which influence how they are formulated. One important property is solubility — the ability of a substance to dissolve in another liquid. The solubility of an active ingredient largely determines its formulation. Many active ingredients do not dissolve readily in water; however, they may instead dissolve in oils or organic solvents. In some cases, the active ingredient may not dissolve in water or oils and therefore must be applied dry.

To better understand the differences between formulation types, a brief overview of relevant chemical terms is provided below.

- **Mixture** – A combination of two or more substances that are not chemically bound to one another. Mixtures may be homogeneous (uniform) or heterogeneous (non-uniform).
- **Solution** – A homogeneous mixture of two or more substances. Liquid solutions are transparent and do not separate, even without agitation (continuous mixing).
- **Suspension** – A heterogeneous mixture of fine, solid particles dispersed in a liquid. The particles remain suspended in the liquid and do not dissolve. Suspensions are opaque and will separate without agitation.
- **Emulsion** – A heterogeneous mixture of two or more liquids that are not soluble in one another. Emulsions form when one liquid is dispersed as droplets within the other, and each liquid retains its identity and properties. Agitation is typically required to prevent the emulsion from separating. Emulsions have a cloudy or milky appearance.
- **Sorption** – The ability of an active ingredient to stick to or be taken up by a solid carrier. The sorptive properties of an active ingredient can occur two ways:
 - **Adsorption** – The process of an active ingredient adhering to the outer surface of a solid.

- **Absorption** – The process of an active ingredient entering and soaking into a solid.

Types of Formulations

Most pesticide active ingredients are available in more than one formulation type. This allows users to purchase the formulation most appropriate for their specific application. Pesticide formulations can be divided into three groups: dry, liquid, and other.

Dry formulations contain the pesticide's active ingredient(s) combined with an inert, solid carrier (e.g., talc, clay, chalk, ground plant material, etc.). These formulations can be separated into two categories: ready-to-use and concentrates. Dry ready-to-use formulations do not require further preparation and are ready to be applied, whereas dry concentrates must be mixed with water and applied as a spray.

Liquid formulations are typically sold as concentrates that must be mixed with a carrier prior to spraying. Water is the most common carrier, but in some instances, pesticide users may be directed to use an oil carrier.

Pesticide formulations that do not fit neatly into the dry or liquid formulation categories are grouped as **other formulations**. This is because they are not easily classified as liquid or solid, and/or they are manufactured using a special packaging or delivery method.

Dry Pesticide Formulations

Dusts (D) – Pesticide products formulated as dusts contain the active ingredient(s) and a very fine, dry inert carrier (e.g., talc, chalk, or clay) (fig. 1). Dusts are ready-to-use and, because they are not water soluble, are always applied dry. In agricultural operations, dusts are commonly used for seed treatment. Dusts are useful for spot treating cracks and crevices within structures, as well as for managing external parasites on livestock.

- Pros: Ready-to-use, require simple equipment, and are effective in hard-to-reach areas.
- Cons: High inhalation hazard and drift hazard.

Granules (G) – Granular formulations are similar to dust formulations; however, the solid carrier particles

are much larger and heavier (fig. 1). Granules are used in a variety of pest management settings, including agricultural, structural, ornamental, and turf applications. Like dusts, granules are not water soluble and are applied dry.

- Pros: Ready-to-use, reduced drift and inhalation hazards, and can be applied with commonly available equipment (e.g., seeders or fertilizer spreaders).
- Cons: Do not adhere to foliage, may require moisture or soil incorporation to release the active ingredient, and application equipment requires frequent calibration.

Pellets (P) – Pellet formulations are similar to granules, except pellets are uniform in weight and shape (fig. 1), allowing for a more precise application. Pellets are typically applied as spot treatments to manage soil-dwelling or structural pests.

- Pros: Ready-to-use, reduced drift and inhalation hazards, more precise application, and can be applied with commonly available equipment (e.g., seeders or fertilizer spreaders).
- Cons: Do not adhere to foliage and may require moisture to release the active ingredient.



Figure 1. Dusts, granules, and pellets are examples of ready-to-use dry formulations.

Wettable Powders (WP or W) – WPs are similar to dusts because they have one or more active ingredient(s) and a very fine, dry inert carrier (fig. 2). However, wettable powders also include wetting and/or dispersing agents. Unlike dusts, WPs are mixed with a liquid carrier and applied as a spray mixture.

This mixture forms a suspension that will separate without agitation. WPs are one of the most commonly used pesticide formulations.

- Pros: Excellent residual activity and are generally not phytotoxic (harmful to plants).
- Cons: Require constant agitation, can cause equipment wear and clogging, and pose an inhalation hazard during mixing.

Water Dispersible Granules (WDG) or Dry Flowables (DF)

WDGs or DFs are similar to wettable powders but are compressed into granule-sized particles (fig. 2). These particles are mixed with water to form a spray suspension. WDGs and DFs are usually sold with their own measuring device.

- Pros: Reduced inhalation hazard and are easy to pour and measure.
- Cons: Require constant agitation and can be hard on equipment.

Soluble Powders (SP) or Water-Soluble Powders (WSP)

Soluble powders look very similar to wettable powders, but dissolve readily in water to form a true solution (fig. 2). SP and WSP formulations are not very common; however, when available they offer several advantages.

- Pros: Easy to mix, do not require agitation, and are nonabrasive to equipment.
- Cons: Inhalation hazard during mixing.



Figure 2. Wettable powders, water dispersible granules, and soluble powders are examples of concentrated dry formulations which are mixed with water and applied as a spray.

Dry Baits (B) – Dry baits contain one or more active ingredients mixed with food or another attractive substance to lure pests. They are sold as blocks, granules, or pellets and kill the target pest through ingestion. Dry baits are commonly used to control pests like rodents, slugs, and some insects.

- Pros: Ready-to-use and can be used as spot treatments.
- Cons: Children and pets may find them attractive; can be harmful to nontarget species; need to be carefully placed and inspected regularly; pests may prefer other food sources rather than the bait; and odor problems can occur where vertebrate pests have died after eating baits.

Coming Up!

In part 2 of our “Pesticide Formulations” series, we will discuss liquid and other pesticide formulations, factors to consider when selecting a formulation, and proper measuring techniques.

For more information on pesticide formulations, please see Purdue Pesticide Programs publication, *Pesticides and Formulation Technology*: <https://ag.purdue.edu/departments/extension/ppp/resources/ppp-publications/publications-archive/docs/ppp-31.pdf>

Blast From the Past

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Paris Green Insecticide

Paris Green (figs. 3 and 4) was used as an insecticide from the late 1800s to the early 1900s. This chemical was first manufactured in the early 1800s as a pigment for artist’s paint, which produced a brilliant emerald, green color. It was also used in wallpaper, book bindings, and fabric. Due to the presence of arsenic, production of this pigment was a dangerous business, and factory workers were often poisoned during its manufacture. Although it became clear that the pigment was toxic to humans, it was later reformulated and used in pest control as a rodenticide and insecticide.

The name Paris Green arose from its use in the sewers of Paris to control rodents. The product became more widespread in the late 1860s when it was used to control the Colorado potato beetle in the United States. Paris Green was also used in various locations around the world to control mosquitoes that vectored malaria. It was manufactured and sold in the U.S. for many years (fig. 5) and marketed as a product that provided “sure death to potato bugs, tobacco bud worms, and all leaf eating insects.”

Paris Green insecticide contained arsenious oxide and copper. It was sold as a dry powder that was bright green in color (fig. 6). Depending on the pest, some brands of Paris Green were mixed with water and applied as a spray, while others were used as dusts. Although Paris Green caused phytotoxicity, its use continued until the early 1900s when lead arsenate products became widely available.



Figure 3. Sherwin-Williams Paris Green container, circa late 1800s to early 1900s.



Figure 4. Bob White Paris Green container, circa late 1800s to early 1900s.

Program Updates

VTPP Updates

2026 IPM Workshop and Pesticide Safety Educators Workshop

Registration is now open for the 2026 Integrated Pest Management (IPM) Workshop and the Pesticide Safety Educators Workshop (PSEW). These events are open to all Virginia Cooperative Extension (VCE) Agriculture and Natural Resources (ANR) agents.

The IPM Workshop is designed to help VCE faculty stay current with the latest IPM strategies and techniques, ensuring they can provide accurate, timely, and practical information to their clients. PSEW will feature important updates from Virginia Tech Pesticide Programs (VTPP) and the Virginia Department of Agriculture and Consumer Services (VDACS) that you won't want to miss. PSEW has been approved for private applicator recertification and is currently under review for commercial applicator recertification in Category 10.

Both workshops will be held back-to-back at the Hotel Roanoke & Conference Center from September 2-4. The registration deadline for both events is August 28, but please note that the deadline to reserve a hotel room is August 8. There will be no virtual attendance option. An email with conference and registration details was emailed on July 23 to all VCE ANR agents, VDACS—Office of Pesticide Services personnel, and other constituents. If you did not receive the email and would like more information, contact Rachel Parson at rparson@vt.edu. To register, please visit

- IPM Workshop registration: pears.io/events/vce/9046/
- PSEW registration: pears.io/events/vce/8209/
- Hotel registration: book.passkey.com/e/51305246

VDACS Updates

Virginia Plastic Pesticide Container Recycling Program

The VDACS Plastic Pesticide Container Recycling Program offers pesticide dealers and applicators a convenient, cost-effective, and environmentally friendly way to dispose of properly rinsed plastic pesticide containers. This free service is available to all pesticide applicators and dealers in Virginia and supports a nationwide initiative by chemical manufacturers to reduce plastic waste from pesticide

Acme Paris Green



Scientifically made from finest raw materials, producing a Paris Green outstanding in color, strength and physical properties. Contains about 55 per cent arsenious oxide—more than federal requirements. Free running, will not clog a duster. Where extreme measures are necessary nothing can replace Paris Green. Being much stronger, less material is necessary, making it an economy.

Size		Case	Less than Case	Case Lots
1/4 lb. Non-Sifting	Cartons	24 lbs.	78.50	76.50
1 lb. Non-Sifting	Cartons	24 lbs.	66.50	64.50
5 lb. Non-Sifting	Cartons	30 lbs.	60.50	58.50
14 lb. Metal Cans		28 lbs.	56.50	54.50
100 lb. Steel Drums				50.50

Figure 5. An advertisement for Paris Green, circa early 1900s.



Figure 6. Paris Green insecticide, circa late 1800s to early 1900s.

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packaging. More than 20 cities and counties across Virginia host collection sites for the program. For additional information, or to find a collection site near you, visit: vdacs.virginia.gov/pesticide-container-recycling.shtml.

2026 Pesticide Collection Program

Do you or does someone you know need help disposing of unwanted or outdated pesticides? Location dates and times have been announced for the 2026 Pesticide Collection Program. Information about the program, as well as the 2026 Pesticide Collection Program brochure, can be found at: vdacs.virginia.gov/pesticide-collection.shtml.