



FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

ENT-121: Fundamentals of Entomology

Lecture 26: Insecticide formulations:

Pesticides are available in various "formulations". A formulation is simply the form of a specific product that you use. Some insecticide formulations include dusts, gels, granules, liquids, aerosols, wettable powders, concentrates, and pre-mixed solutions.

A solution is made by dissolving a substance in a liquid. A true solution is a mixture, but it cannot be separated by filtration or other mechanical means. Once made, a true solution will not "settle out" and does not need shaking or stirring (agitation) to keep the mixed components in solution. Solutions are transparent: they will allow light to pass through them.

A suspension is also a liquid mixture. However, a suspension is formed by dispersing fine (very small), solid particles in a liquid. These solid particles do not dissolve in the liquid carrier. Suspensions must be agitated to maintain uniform particle distribution. Otherwise, the undissolved parts of suspension mixtures will settle (or float to the top). Most suspensions are cloudy or opaque: they will not allow light to pass through them.

An emulsion is a special kind of suspension: a mixture made by suspending droplets of one liquid in another. Each ingredient retains its unique properties and identity. To make an emulsion, an active ingredient is dissolved in an oil-based solvent and then further diluted with water. Some agitation may be necessary to keep an emulsion from separating. However, most emulsion pesticide product formulations have additives (emulsifiers or emulsifying agents) that prevent the product from settling. As a rule, emulsions have a "milky" appearance. An emulsifiable concentrate (E or EC) is an emulsion. Homogenized milk is an example of an emulsion.

Some pesticide products are sold in concentrate form and must be mixed or diluted before use. Concentrates come in both liquid and solid form.

A = Aerosol AF = Aqueous flowable B = Bait C = Concentrate D = Dust DF = Dry flowable (see WDG) E = Emulsifiable concentrate EC = Emulsifiable concentrate F = Flowable G = Granules GL = Gel L = Liquid LC = Liquid concentrate LV = Low volatile M = Microencapsulated P = Pellets PS = Pellets RTU = Ready-to-use S = Solution SP = Soluble powder (or soluble packet; see WSP) ULV = Ultra-low volume W = Wettable powder WDG = Water-dispersible granules (see DF) WP = Wettable powder WS = Water soluble WSB = Water-soluble bag (see WSP: water-soluble packet) WSC = Water-soluble concentrate WSL = Water-soluble liquid WSP = Water-soluble powder (or water-soluble packet; see WSB) Table 4.1 Abbreviations for Common Formulations sifiable concentrate is an example of a liquid concentrate (LC). Wettable powders (WP), soluble powders (SP), and water-dispersible granules/dry flowable (WDG/DF) are examples of concentrated materials sold in solid form. Other formulations are sold ready to-use. You can apply ready-to-use products with no further

dilution or mixing. Examples include liquids prepared as end-use dilutions and aerosol (A), dust (D), pellet (P), granule (G), and most bait (B) formulation products. Manufacturers package many specialized pesticides, including products intended for residential uses by nonoccupational users, in ready-to-use formulations.

Emulsifiable Concentrates:

Advantages:

- Relatively easy to handle, transport, and store.
- Easy to pour and measure.
- Little agitation required; will not settle out or separate when equipment is running.
- Not abrasive; does not cause excessive equipment wear.
- Will not usually plug screens or nozzles.
- Leave little visible residue on treated surfaces.

Disadvantages:

- High concentration of active ingredient(s) makes it easy to overdose or underdose through mixing or calibration errors.
- May damage treated plants or surfaces (petroleum-based solvents or overdosing may cause phytotoxicity).
- Easily absorbed through skin of humans or animals.
- Splashes and spills are relatively difficult to clean up and/or decontaminate.
- Many have a strong odor.
- Solvents may cause equipment “wear and tear.” For example, rubber or plastic hoses, gaskets, pump parts, and other exposed surfaces may deteriorate.
- May cause pitting or discoloration of painted finishes or other treated surfaces.
- Flammable; should be used and stored away from heat or open flame

Solutions:

Advantages:

- Convenient; neither measuring nor mixing is required.
- Some are packaged and sold in— or with—an application device. If this is the case, no loading is required.
- Less personal exposure risk due to reduced toxicity and handling.

Disadvantages:

- Limited availability.
- High cost per unit of active ingredient.

Concentrate Solutions:

Advantages:

- Relatively easy to handle, transport, and store; easy to pour and measure.
- No agitation necessary.
- Not abrasive; do not cause excessive equipment wear.
- Do not plug screens or nozzles.
- Do not usually leave visible residues on treated surfaces.

Disadvantages:

- Limited availability, especially water-based solutions.

- Spills and splashes may be difficult to clean up and/or decontaminate.
- Some are easily absorbed through skin of humans or animals

Invert Emulsions: Invert emulsions contain a water-soluble pesticide dispersed in an oil carrier. These products require a special kind of emulsifier that allows the pesticide to be mixed with a large volume of petroleum-based carrier, usually fuel oil. Invert emulsions are less susceptible to drift because oil evaporates more slowly than water.

Advantages:

- Low drift.
- Increased rate of penetration and/or absorption.
- Increased rain fastness and reduced runoff.

Disadvantages:

- Difficult to treat the underside of foliage or other targets because droplets are large and heavy.
- Limited availability.

Aerosols (A): Aerosol formulations contain one or more active ingredients and a solvent. Most aerosols contain a low percentage of active ingredient. Eg. Smoke or fog

Advantages:

- Easy to use; convenient.
- Portable.
- Easily stored.
- Convenient way to buy and apply a small amount of pesticide.
- Retain potency for some time.

Disadvantages:

- Practical for only a few limited or specialized uses.
- Risk of inhalation exposure.
- Hazardous if punctured, overheated, or used near an open flame.
- May be difficult to direct material released to a single target site or pest.

Dusts (D): Most dust formulations are ready to-use and contain a low percentage of active ingredient (usually 10% or less by weight). A few dust formulations, however, are concentrates and contain a much higher percentage of active ingredient. These concentrates must be mixed with dry inert carriers before application. Dusts have one or more active ingredients plus a very fine, dry inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of individual dust particles varies, but all are quite small. Due to their small size, dusts need careful handling to prevent nontarget exposure, including drift. They are not water-soluble. Therefore, do not mix them with a liquid solvent.

Advantages:

- Usually ready-to-use; no mixing.
- A good alternative where moisture from a spray might cause damage.
- Applied with simple application equipment.
- Effective in hard-to-reach indoor areas.

Disadvantages:

- Easily drift off target during application.
- Residues do not adhere to treated surfaces, including foliage, as well as liquids do; may easily wash off or blow away.

- May irritate eyes, nose, throat, and skin; pose a relatively high inhalation exposure risk to handlers.
- Dampness may cause product to clump and equipment to clog; difficult to apply in damp or humid environments.
- Some kinds of application equipment and devices are hard to calibrate.
- Difficult to get an even distribution of particles.

Granules (G): Granular formulations are similar to dust formulations; however, granular particles are larger and heavier. Like dusts, they are not water-soluble. They are ready-to-use—not intended to be mixed with water and applied as a liquid suspension. The coarse particles that serve as carriers for granular formulations are adsorptive substances like clay or absorptive plant material such as ground corncobs or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them. The amount of active ingredient is relatively low, usually ranging from 1% to 15%.

Advantages:

- Ready-to-use; no mixing.
- Drift hazard is low, and particles settle quickly.
- Low applicator hazard: no spray; little dust.
- Weight carries the formulation through foliage to soil or water target.
- Applied with simple application equipment, such as seeders or fertilizer spreaders.
- May break down more slowly than WPs or ECs because of a slow-release coating.

Disadvantages:

- Application equipment needs frequent calibration.
- Uniform application may be difficult with some devices (e.g., rotary spreaders).
- Granules do not stick to foliage or other uneven surfaces. For this reason, contact products are rarely formulated this way.
- May need to be incorporated into soil or planting medium.

Pellets (P or PS): Most pellet formulations are very similar to granular formulations in their uses, advantages, and disadvantages. However, in pellet formulations, all the particles are more or less the same weight and shape.

Advantages:

- Easy to store, transport, and handle.
- Less likely than ECs and other petroleum-based formulations to harm treated plants, animals, and surfaces.
- As a rule, not phytotoxic.
- Less risk of skin and eye absorption than ECs and other liquid formulations.

Disadvantages:

- Not easy to measure; must be weighed.
- Not easy to mix.
- Inhalation hazard to applicator while measuring and mixing the concentrated powder.
- Suspended particles require good and constant agitation (usually mechanical) in the spray tank and quickly settle out if agitation ceases.

Water-Dispersible Granules (WDG) or Dry Flowables (DF): Water-dispersible granular formulations are wettable powder formulations compressed into dust-free, granule sized

particles. Most come with a product-specific measuring device, with dry ounce (or pound) increment marks based on product density (weight per unit volume). Because of this and the fact that they readily flow or pour out of their containers, they are easier to measure and cleaner to handle than WPs. Like wettable powders, water-dispersible granules are mixed with water and applied as a spray suspension. Once in water, the granules break apart into fine powder. The formulation requires constant agitation to keep it suspended in water. Water-dispersible granules share the advantages and disadvantages of wettable powders

Soluble Powders (SP or WSP): Soluble powder formulations look like wettable powders. However, when mixed with water, soluble powders dissolve readily in water and form a true solution.

Baits (B): A bait formulation is an active ingredient mixed with food or another attractive substance. The bait either attracts the pests or is placed where the pests will find it. Many baits are solid (blocks, granules, or pellets), but some are liquids, pastes, or gels. The amount of active ingredient in most bait formulations is quite low, usually less than 5%. Baits are used inside buildings to control ants, cockroaches, flies, and other insects. Outdoors, they can control vertebrate pests, such as rodents, other mammals, and birds as well as snails, slugs, and some insects. Applicators must place bait stations in safe, strategic locations while following label directions to protect children and nontarget organisms.

Advantages:

- Ready-to-use.
- Entire area need not be covered because pest goes to bait.
- Control pests that move in and out of an area.

Disadvantages:

- May be attractive to children and pets.
- May kill domestic animals and nontarget wildlife.
- Require careful placement and inspection.
- Pest may prefer the crop or other food to the bait.
- Dead vertebrate pests may cause odor problems

Fumigants: Fumigants are pesticides that deliver the active ingredient to the target site in the form of a gas. Some active ingredients are liquids when packaged under high pressure but become gases when released. Other active ingredients are volatile liquids. They may be enclosed in an ordinary container and not packaged under pressure. Still others are solids that release gases after application in humid conditions or in the presence of water or water vapor. Fumigants are used for structural pest control, in food- and grain-storage facilities, and in regulatory pest control at ports of entry and state and national borders. In agricultural pest control, fumigants are effective in soil, greenhouses, and commodity storage areas (such as grain bins).

Advantages:

- Toxic to a wide range of pests.
- Can penetrate cracks, crevices, wood, and tightly packed areas (such as soil or grains).
- A single treatment will usually kill most pests in the treated space.

Disadvantages:

- The target site must be enclosed or covered to prevent the gas from escaping.
- Nonspecific and highly toxic to humans and all other organisms.

- High inhalation exposure risk.
- Most require the use of specialized personal protective equipment.