Pesticide Formulations
Bedding Plant Meetings
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What is a Formulation?

- **Active Ingredient (Ai)** - the actual chemical in the product mixture that controls the pest

- **Inert Ingredient** - other materials added with the AI when the product is formulated

- **Adjuvant** - product added to spray tank to assist pesticide in its application

- **Carriers** – Water, corn husks, pellets, etc. diluting agents
Brand Name Abbreviations

- Often brand names include abbreviations that describe something about the formulation

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>D</td>
<td>dust</td>
</tr>
<tr>
<td>G</td>
<td>granular</td>
</tr>
<tr>
<td>SP</td>
<td>soluble powder</td>
</tr>
<tr>
<td>S</td>
<td>solution</td>
</tr>
<tr>
<td>WP</td>
<td>wettable powder</td>
</tr>
<tr>
<td>EC</td>
<td>emulsifiable concentrate</td>
</tr>
<tr>
<td>DF</td>
<td>dry flowable</td>
</tr>
<tr>
<td>WSP</td>
<td>water soluble packet</td>
</tr>
<tr>
<td>ULV</td>
<td>ultra low volume</td>
</tr>
<tr>
<td>RTU</td>
<td>ready to use</td>
</tr>
<tr>
<td>GL</td>
<td>gel</td>
</tr>
<tr>
<td>LO</td>
<td>low odor</td>
</tr>
<tr>
<td>WDG</td>
<td>water dispersible granule</td>
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Selecting a Formulation

- Evaluate advantages and disadvantages
- Do you have the right application equipment?
- Can the formulation be applied when and where it is needed?
- Will the formulation reach the target pest and be there long enough?
Spray Mix Terminology

- solution
- suspension
- emulsion

How does it really mix in the spray tank?
Solution

Active Ingredient
Either liquid or dry substance
TRULY dissolves in water

just like sugar or whiskey in water
*usually transparent*
Suspension

Solid particles suspended in a liquid like hot chocolate

Active Ingredient (high %) impregnated onto Dry Carrier and mixed with an Emulsifier (slick, soapy)

agitation required
Liquid Formulations

**Emulsion**

One liquid dispersed within another liquid like milk

Ai is dissolved in oil (oil/ai droplet) and mixed with an emulsifier

Ai/Oil mixture is suspended in water forming a white emulsion
Liquid Formulations

Emulsifiable Concentrate (E or EC)
High Ai%

**ADVANTAGES**
- Easy to handle
- Little agitation
- Relatively easy on equipment
- Leaves little residue

**DISADVANTAGES**
- Phytotoxic – plant injury
- Easily absorbed by the skin
- Flammable
- Deterioration of rubber and plastic hoses
Liquid Formulations

Solutions (S)

Ai dissolves in liquid carrier; once mixed with water, solutions do not settle out.

product           diluted
# Liquid Formulations

## Solutions (S)

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to handle</td>
<td>None</td>
</tr>
<tr>
<td>No agitation</td>
<td></td>
</tr>
<tr>
<td>Easy on equipment</td>
<td></td>
</tr>
<tr>
<td>No residue</td>
<td></td>
</tr>
<tr>
<td>Used indoors/outdoors</td>
<td></td>
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</tbody>
</table>
Liquid Formulations

Ultra-Low Volume (ULV)

- Special-purpose formulation
- Almost 100% active ingredient
- Agriculture, forestry, mosquito control
## Ultra-Low Volume (ULV)

### ADVANTAGES
- Easy to handle
- Little or no agitation
- Easy on equipment
- No residue
- Used indoors/outdoors

### DISADVANTAGES
- High drift hazard
- Specialized equipment needed
- Solvent wear on rubber and plastic
- Calibration critical
Liquid Formulations

Invert Emulsions

- Oil carrier with water-soluble pesticide – consistency of mayonnaise
- Reduce drift and runoff
- Sticker-spreader
- Specialty uses: Rights-of-way and near sensitive areas
Liquid Formulations

Aerosols (A)

- Some are ready-to-use
- Little active ingredient
- High drift potential

- Some require highly specialized equipment
- Difficult to confine
- Respiratory protection needed
Dry or Solid Formulations

Dusts (D) and Granules (G)

- Ready-to-use
- Can reach hard to get places
- Very little active ingredient
- Very fine, dry inert carrier
- High drift potential
- Distribution and calibration a problem
- Dusts: Irritating to eyes, nose, throat, skin
Dry Formulations
Granules (G) and Pellets (P or PS)

- Granules
- Beads
- Pellets

- Granules: can be mistaken for food/feed
Dry Formulations + Water

- Buy Dry --> Mix with water --> Spray
- Wettable Powders (WP)
- Water Dispersible Granules (WDG)
- Dry Flowables (DF)

Active Ingredient (high %)
Dry Carrier
Emulsifier (slick, soapy)
Dry Formulations

Wetable Powders (WP or W)

Wetable powders settle out quickly, therefore require constant agitation in the spray tank.

product  diluted
Dry Formulations

Wettable Powders – high Ai %

**ADVANTAGES**
- Easy to store
- Easy to measure/mix
- Relatively less harmful to plants, animals and surfaces than ECs
- Less absorption by human skin and eyes

**DISADVANTAGES**
- Inhalation hazard
- Constant agitation
- Difficult to mix in hard water
- Abrasive to pumps and nozzles
- Visible residues
These materials possess some of the same characteristics as wettable powders except they are formulated into granular-sized particles, so are easier to handle with little inhalation hazard.
Dry Formulations

Soluble Powders (SP or WSP)

- Forms true solution, like sugar – no agitation
- Ai is 15-95% by weight
- Few pesticides are soluble powders
Dry Formulations

Soluble Powders – high Ai %

**ADVANTAGES**
- Easy to measure/mix
- Form true solution
- Little phytotoxicity concern
- Less absorption by human skin and eyes

**DISADVANTAGES**
- Inhalation hazard
Liquid Formulations
Flowables (F) or Liquids (L)

Flowables are basically a wettable powder pre-mixed with a liquid carrier.
Other Formulations

- Microencapsulated
  - High toxicity Ai in encased formulation
- Water-soluble packets
  - No human exposure when mixing
Other Formulations

Fumigants

- Active as a poisonous gas, penetrates cracks, crevices, and stored commodities
- Highly toxic to all living organisms
- Very high risk of inhalation exposure
- Specialized protection equipment; enclosed space
Pesticide Mixtures

- **Tank mixing** multiple products is legal *unless* prohibited by the label
- Manufacturer only warranties their product alone or product mixtures listed on the label
- Manufacture notes known incompatibilities on label
- **Incompatibility**
  - Heat, clumping, precipitate
  - Inactivity of active ingredients
  - Increased phytotoxicity
  - Use Jar-Test to test for incompatibility
  - Field incompatibility can still occur
Adjuvants
Purchased additives to add to tank mix or added during formulation process

Surfactants - group
- Wetting agents
- Spreaders
- Emulsifiers
- Stickers/Extenders

Others
- Buffers
- Compatibility agents
- Defoaming agents
- Colorants/dyes
- Safeners
- Thickeners
Adjuvants
How to choose the right one?

- Read the pesticide label for recommendations
  - Some may prohibit use of an adjuvant
- Don’t use industrial products or household detergents
- Test before you spend $$
- Remember, many pesticide products contain an adjuvant
Formulation Summary

- Active and inert ingredients
- Dry and liquid formulations
- Adjuvants
- Carriers
Formulation Summary

- Choose a pesticide formulation that will best suit your pest problem and target site
  - Safety, ease of use
  - Human exposure concerns
  - Phytotoxicity; visible residues
  - Application equipment considerations
A 24 (c) Label is a Supplemental Label for a Special Local Need

- A Special Local Needs (SLN) label is a type of label in which a State registers additional uses, under certain conditions, to a federally registered pesticide label to meet specific needs.

- A SNL is a supplementary label that adds application sites, target pests, or alternative control techniques to those already listed on the federally registered label.
A 24 (c) Label is a Supplemental Label for a Special Local Need

- Pesticide ingredient(s) involving a use on a food crop must have an established tolerance or be exempted from the requirement of a tolerance for that crop under the Federal Food, Drug, and Cosmetic Act (FFDCA).

- 24 (c) Registrations are also issued for non-food/non-feed sites.

- SLN registrations are for distribution and use only within a particular State.
Emergency Exemption from Registration or “Section 18 Label”

- A Section 18 is used when an emergency pest situation arises for which no acceptable pesticide is registered or available in the State.

- Section 18 authorizes EPA to allow an unregistered use of a pesticide for a limited time if EPA determines that an emergency pest condition exits.

- Special restrictions generally accompany the use of these products, which may include additional record keeping, specific safety precautions, or licensing restrictions.
Emergency Exemption from Registration or “Section 18 Label”

- An emergency condition must be an urgent and non-routine situation where:
  
  - 1) no effective registered pesticides are available,
  - 2) no feasible alternative control practices exist, and
  - 3) the situation involves the introduction of a new pest that will present significant risks to human health or the environment, or will cause significant economic loss.
Emergency Exemption from Registration or “Section 18 Label”

- Besides an outbreak of a new pest, an emergency condition may exist with the development of resistance to existing pesticides, unusual weather conditions that caused a pest outbreak, or a product’s cancellation if no alternative exists.

- A Section 18 provision allows for the sale and use of a product for a nonregistered use within a specified area that is only valid for the time period specified on the label, and that addresses the emergency situation only.
Q1. Which of the following formulations typically has the lowest rate of active ingredient?

A. Dusts (D)
B. Wettable Powders (WP)
C. Emulsifiable Concentrate (EC)
D. Soluble Powder (SP)
Q2. Which type of nozzle would pose a concern when using soluble powder formulations?

1. no nozzle type poses a concern
2. brass nozzles
3. aluminum nozzles
4. nylon nozzles

**Answers:**
A. 1 only
B. 1 and 2 only
C. 2 and 3 only
D. 3 and 4 only
Q3. Which of the following are considered surfactant-type adjuvants?

1. spreaders
2. buffers
3. wetting agents
4. colorant dyes

Answers:
A. 1 and 2 only
B. 1 and 3 only
C. 2 and 3 only
D. 3 and 4 only
Endeavour Mixing Procedures

Endeavor + Tank Mixtures:
Endeavor is compatible with most insecticide and fungicide products. However, the physical compatibility of Endeavor with tank mix partners should be tested before use. To determine the physical compatibility of Endeavor with other products, use a jar test.

Using a 1-1/2 qt. jar, add the proportionate amounts of the products to 1 qt. of water. Add wettable powders and water-dispersible granular products first, then liquid flowables, and emulsifiable concentrates last. After thoroughly mixing, let stand for at least 5 minutes. If the combination remains mixed or can be remixed readily, it is physically compatible. Once compatibility has been proven, use the same procedure for adding required ingredients to the spray tank.
If mixture is physically compatible, add 1/2 of the required amount of water to the mix tank. Start the agitator before adding any tank mix partners. Add products in this order: products packaged in water-soluble packaging, wettable powders, wettable granules (dry flowables) such as Endeavor, liquid flowables, liquids, and emulsifiable concentrates.

Always allow each tank mix partner to become fully dispersed before adding the next product. Provide sufficient agitation while adding the remainder of the water. Maintain agitation until all the mixture has been applied.
Note: If using Endeavor in tank mixtures, all products in water-soluble packaging should be added to the tank before any other tank mix partner, including Endeavor. Allow the water-soluble packaging to completely dissolve and the product(s) to completely disperse before adding any other tank mix partner tank.
Mainspring

Mainspring must be diluted with water before application.

MIXING INSTRUCTIONS: Mixing Directions

1. Use clean, well maintained and properly calibrated application equipment.
2. Fill sprayer tank 1/4 to 1/2 full of water.
3. Shake the container of Mainspring well before pouring.
4. Then add Mainspring directly to the sprayer tank.
5. Mix thoroughly to fully disperse the insecticide and continue agitation to keep the insecticide in suspension. Use mechanical or hydraulic agitation. Do not use air agitation.
6. It is recommended that the mixture not be stored in the spray or mix tank overnight.
Tank-mixtures

Mainspring may be tank-mixed with other pesticides. When tank-mixing Mainspring with other pesticides, observe the precautions and limitations on all product labels. Do not exceed label dosage rates. Mainspring may not be mixed with any product containing a label prohibition against such mixing. The physical compatibility of Mainspring will vary with different sources of pesticide products and local cultural practices.
Tank-mixing Sequence

Add different formulation types in the sequence indicated below. Allow time for complete mixing and dispersion after the addition of each product.

1. Water-soluble bags
2. Water-dispersible granules
3. Wettable powders
4. Mainspring and other water-based suspension concentrates
5. Water-soluble concentrates
6. Oil-based suspension concentrates
7. Emulsifiable concentrates
8. Adjuvants, surfactants, oils
9. Soluble fertilizers
10. Drift retardants