CHAPTER 4

Pesticide Formulations

Chapter 4

National Pesticide Applicator Certification Core Manual

WASHINGTON STATE UNIVERSITY EXTENSION

CHAPTER 4

Pesticide Formulations

- This module will help you:
- Recognize formulation abbreviations
- Identify formulation advantages and disadvantages
- Understand role of adjuvants

Important Definitions

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

Pesticide Formulation

Formulations consist of:

- Active ingredient, (Ai)—the pesticide/s/ that actually control the pest.
- Carrier—such as an organic solvent or mineral clay.
- Surface-active ingredients, 'surfactants' such as stickers or spreaders.
- Other ingredients, such as stabilizers or dyes

Pesticide Formulation

active ingredient (Ai)

each Ai will be listed

+

inert ingredients

water, emulsifiers

solvents, dry carrier material

stabilizers, dye

surfactants: spreaders, stickers

wetting agents

Pesticide Spray Batch

Pesticide Formulation

+

Water or oil

Spray additives=Adjuvants

Product Formulations

- Active and Inert Ingredients

Lexone DF

- Active Ingredient
- Metribuzin **(4-amino-6-1-1 dimethlyethly-3-methythio 1,2,4,triazine 5 4H-one)** 25%
- Inert Ingredients 75%
- TOTAL 100%
- **EPA Reg. No. 12333-344**

Lexone DF

Dry

- Active Ingredient
- Metribuzin 25%
- Inert Ingredients 75%
- TOTAL 100%

Lexone 2E

Liquid

- Active Ingredient
- Metribuzin* 25%
- Inert Ingredients 75%
- TOTAL 100%
- * contains 2 lbs metribuzin per gallon

Why Add Inert Ingredients?

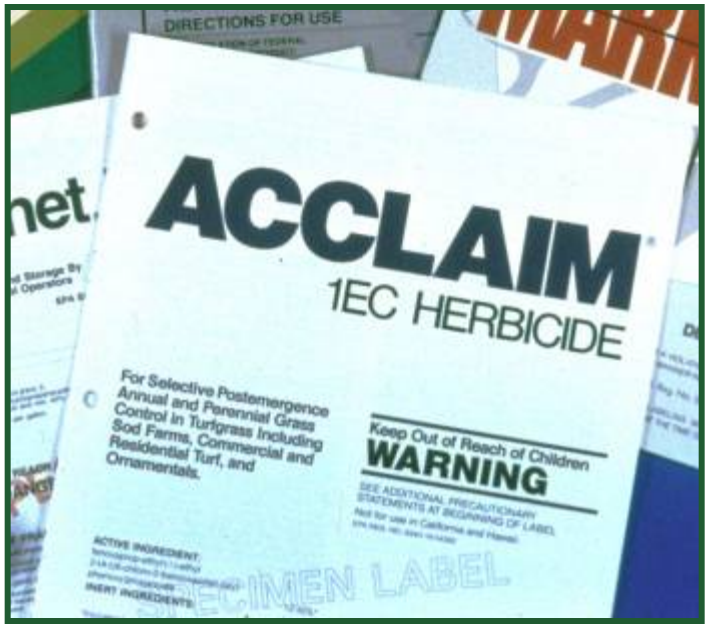
1. For ease of pesticide product handling
2. Inerts make measuring and mixing pesticides easier
3. To provide for safety
4. Makes the Ai work better
   - Better penetration
   - More selectivity
   - Increased effectiveness

Adjuvant

- The term adjuvant basically means additive (you need to memorize it)
  - Formulation additive
  - Additive which is sold separately to mix with the product when tank mixing

- Labels will often recommend to add an adjuvant
- Include surfactants, spreaders, wetting agents, colorant dyes, buffers, antifoaming agents, safeners, etc.

Deciphering the Ai Code in Product Names



1EC

1 lb Ai/gallon emulsifiable concentrate

80SP

80% active ingredient by weight Soluble Powder

40DF

40 % active ingredient Dry Flowable

Brand Name Abbreviations

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

D – dust
G – granular
SP – soluble powder
S – solution
WP – wettable powder
EC – emulsifiable concentrate
DF – dry flowable
WDG – water dispersible granule

WSP – water soluble packet
ULV – ultra low volume
RTU – ready to use
GL – gel
LO – low odor

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

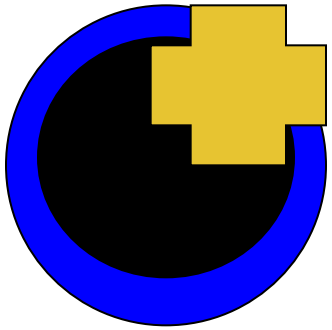
TRULY dissolves in water

just like sugar in water

usually transparent

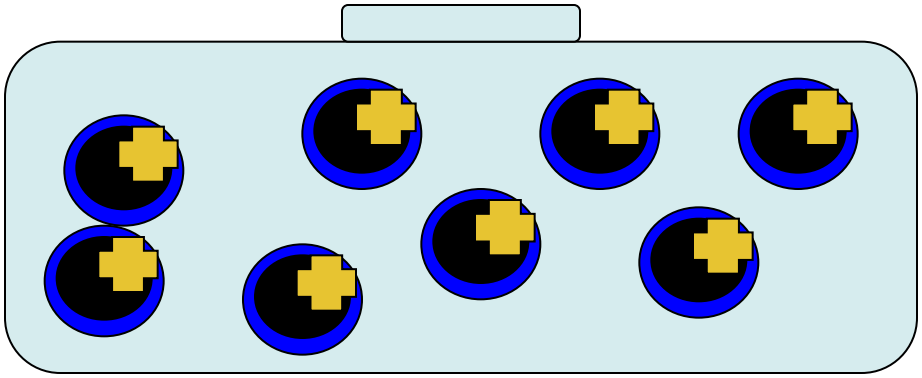
Suspension

Solid particles suspended in a liquid
like hot chocolate



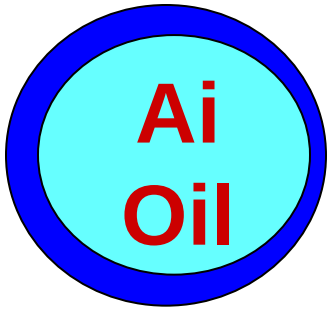
Active Ingredient (high %)
impregnated onto Dry Carrier
and mixed with an
Emulsifier (slick, soapy)

agitation
required



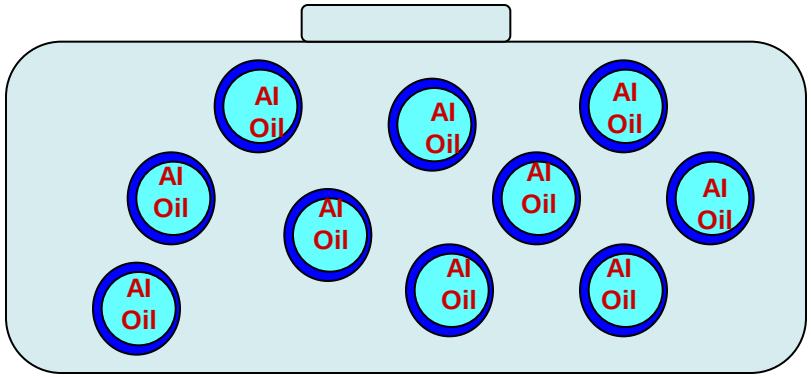
Emulsion

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)

Active ingredient (liquid) dissolved in a petroleum-based solvent with an emulsifier added

product

Turns white when mixed

Smells of solvents

diluted

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)

ADVANTAGES

- Easy to handle
- No agitation
- Easy on equipment
- No residue
- Used indoors/outdoors

DISADVANTAGES

- None

Liquid Formulations

Ready-to-Use Low Concentrate Solutions (RTU)

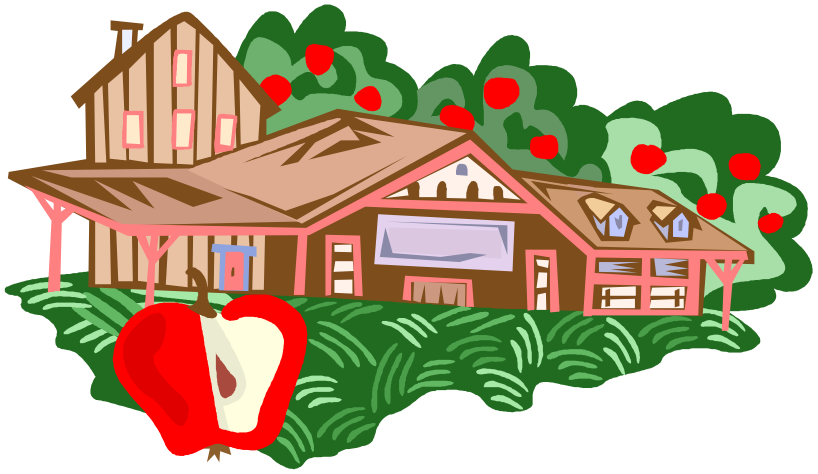
Easy and relatively safe to handle

Less than 1% per unit volume of active ingredient; high cost

Liquid Formulations

Ultra-Low Volume (ULV)

- Special-purpose formulation
- Almost 100% active ingredient
- Agriculture, forestry, mosquito control



Liquid Formulations

Ultra-Low Volume (ULV)

ADVANTAGES

- Easy to handle
- Little or no agitation
- Easy on equipment
- No residue
- Will not plug nozzles
- Used indoors/outdoors

DISADVANTAGES

- High drift hazard
- Easily absorbed through skin
- Specialized equipment needed
- Solvent wear on rubber and plastic
- Calibration critical

Liquid Formulations

Emulsifiable Concentrate (EC or E)

ADVANTAGES

- Easy to handle
- Little or no agitation
- Easy on equipment—will not plug screens or nozzles
- No visible residue
- Used indoors/outdoors

DISADVANTAGES

- High drift hazard
- High Ai (24-75%)
- May cause phytotoxicity
- Solvent wear on rubber and plastic
- May be corrosive
- Highly absorbable through skin

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

Flowables (F) Liquids (L)

ADVANTAGES

- Easy to apply

DISADVANTAGES

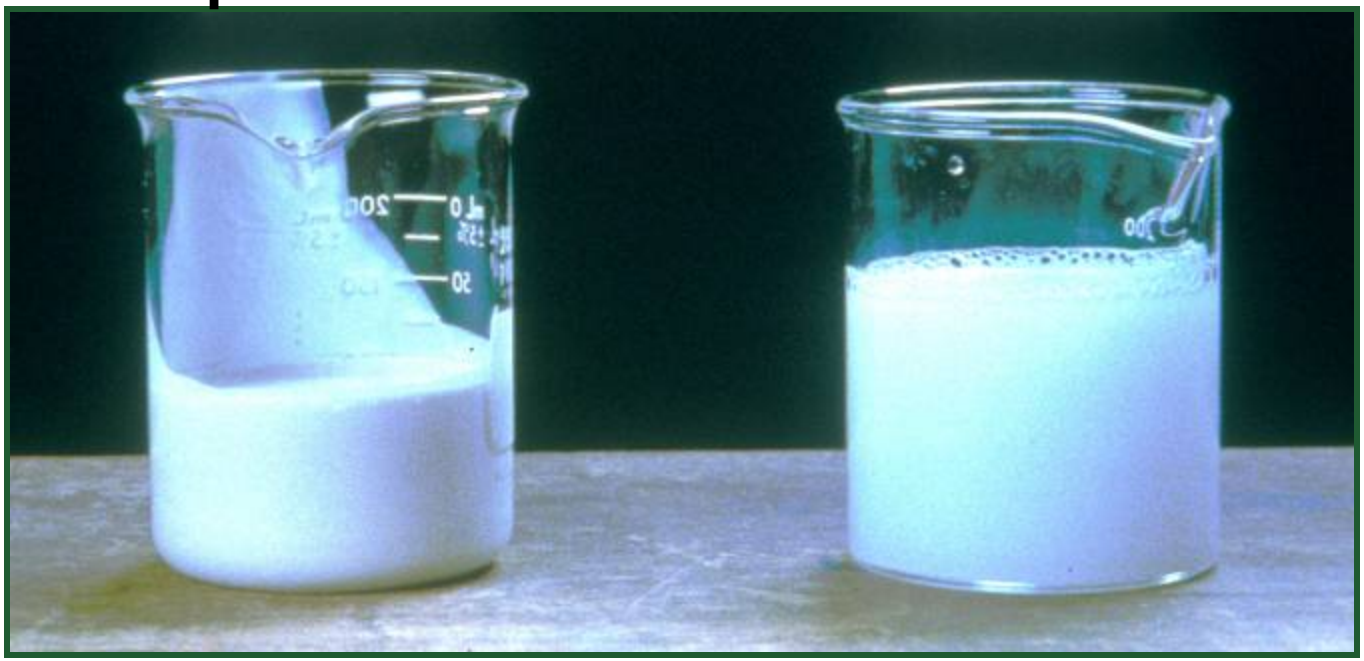
- Abrasive to nozzles and pumps
- Require constant agitation
- Leave visible residues

Liquid Formulations

Flowables (F) or Liquids (L)

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

product **diluted**



Liquid Formulations

Aerosols (A)

- Some are ready-to-use, often available in small quantities
- Little active ingredient
- High drift potential
- Some require highly specialized equipment
- Risk of inhalation injury—respiratory protection needed
- Difficult to confine

Liquid Formulations

Aerosols for Smoke of Fog Generators

ADVANTAGES

- Easy fill a large, enclosed space

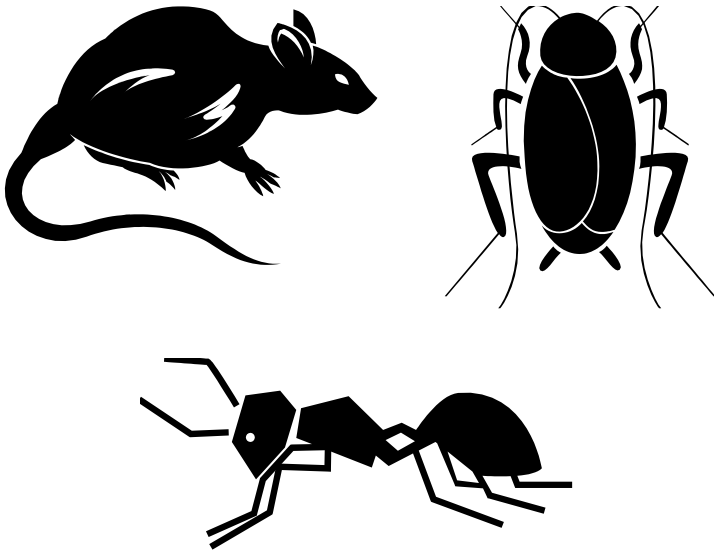
DISADVANTAGES

- Require highly specialized equipment
- Difficult to confine
- May require respiratory equipment to prevent inhalation injury

Dry Formulations

Baits (B)

A bait is an example of a dry or liquid product that is applied without mixing



Dry or Solid Formulations

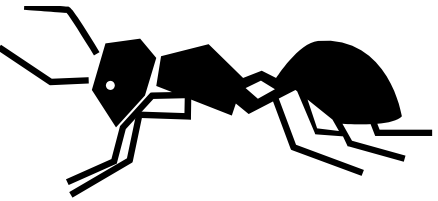
Baits (B)

ADVANTAGES

- Ready to use
- Coverage not critical
- Control pest that move in and out of area

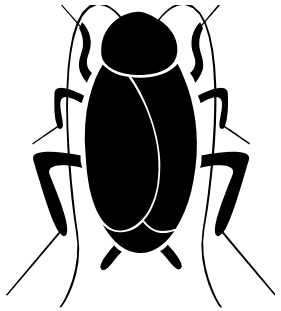
DISADVANTAGES

- Attractive to children
- May kill domestic animals and wildlife
- Dead pest odors
- Old bait may serve as food source if inactive
- Baits may kill predators of the pests that the baits were places for



Dry Formulations

Pastes (P), Gels (GL)



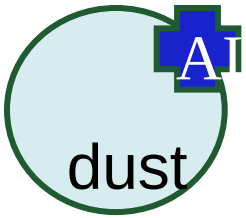
A bait formulated as a paste or gel that is applied with a syringe or bait gun

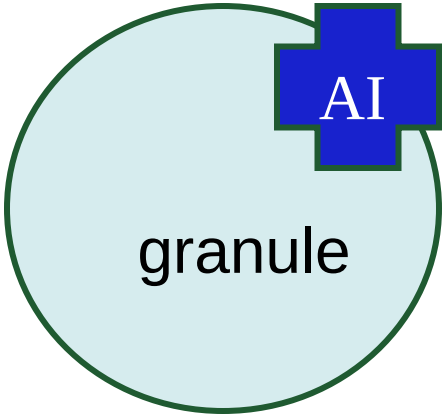
- Odorless
- Minimal exposure to applicator, humans, pets
- Easy to place
- Melt at high temperatures
- May stain porous surfaces
- Repeat application can create unsightly buildup

Dry or Solid Formulations

Dusts (D) and Granules (G)

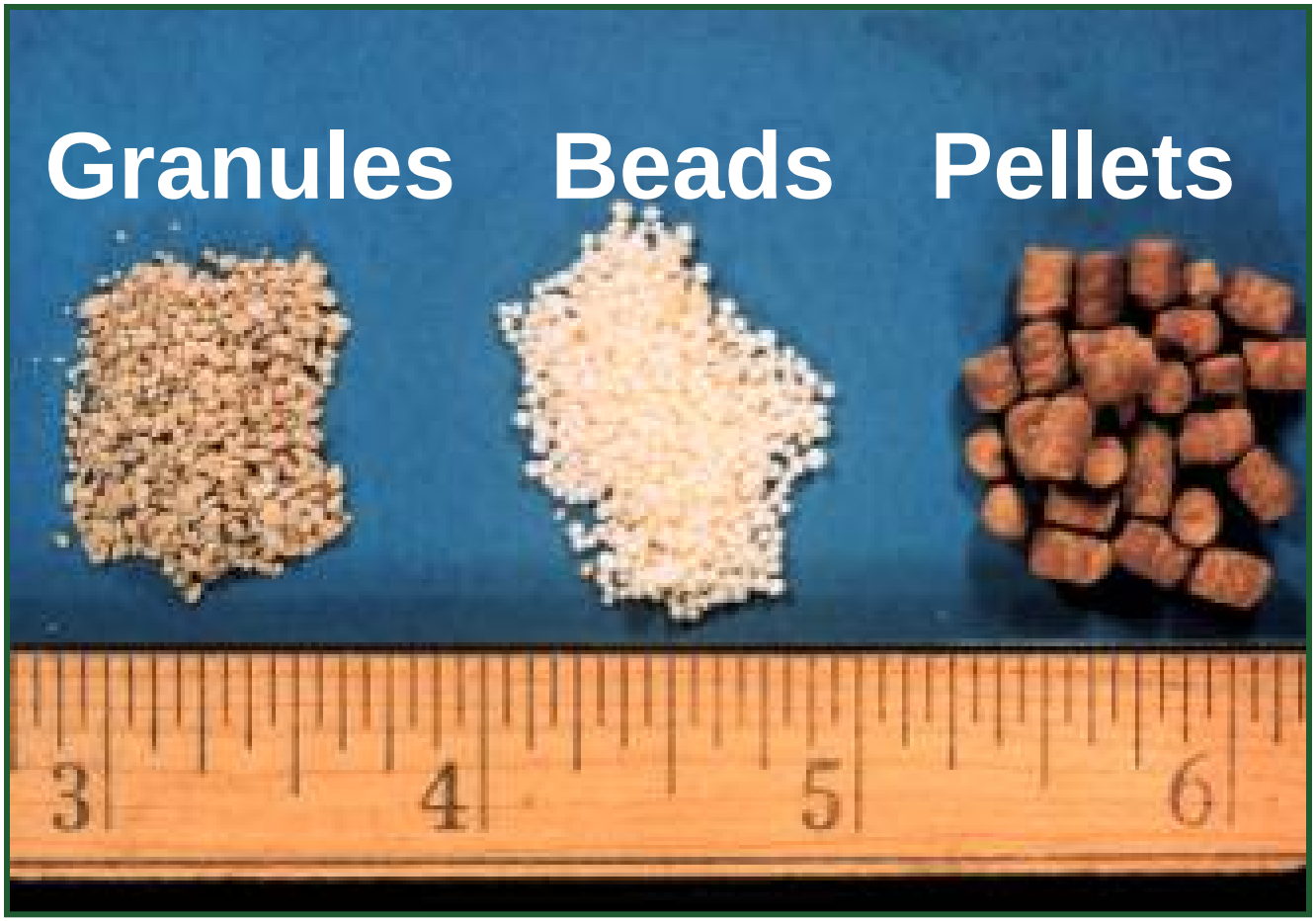
- Ready-to-use
- Can reach hard to get places
- Very little active ingredient
- Very fine, dry inert carrier
- High drift potential
- Distribution and calibration a problem
- Dusts: Irritating to eyes, nose, throat, skin





Dry Formulations

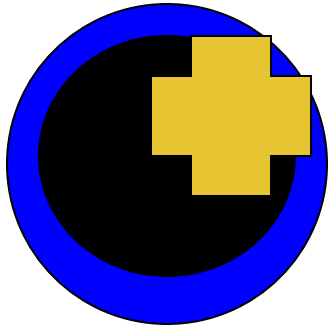
Granules (G) and Pellets (P or PS)



❖Granules: 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

Wettable Powders (WP or W)

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

product **diluted**

Dry Formulations

Wettable Powders (WP or (W)

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

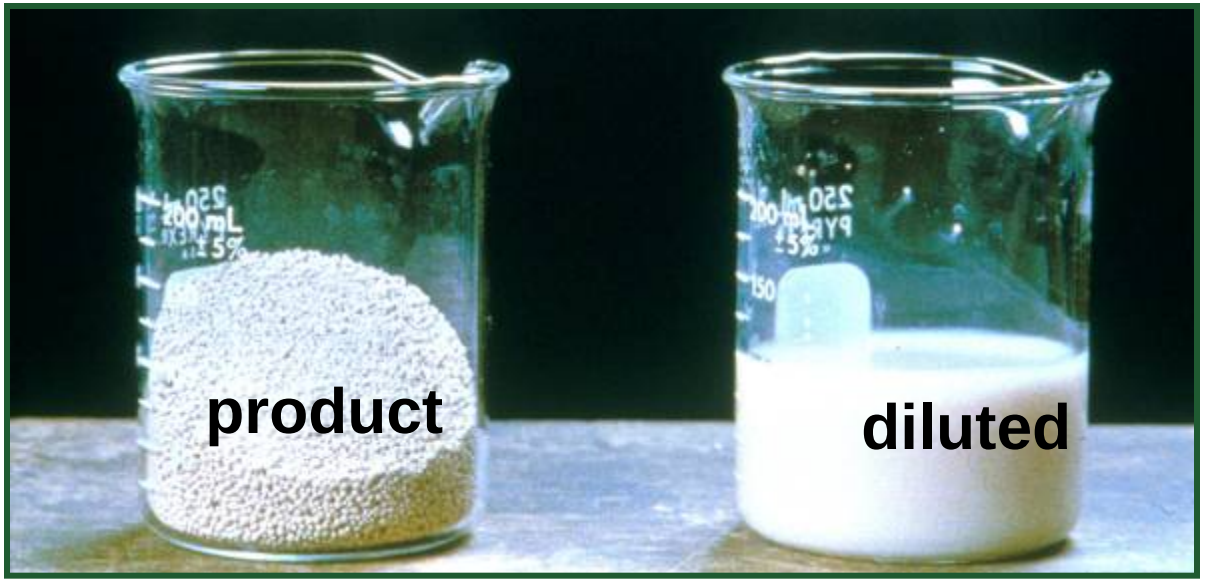
DISADVANTAGES

- Inhalation hazard
- Require Constant agitation
- Difficult to mix in hard water
- Abrasive to pumps and nozzles
- Visible residues

Dry Formulations

Water-dispersible Granules (WDG) or Dry Flowables (DF)

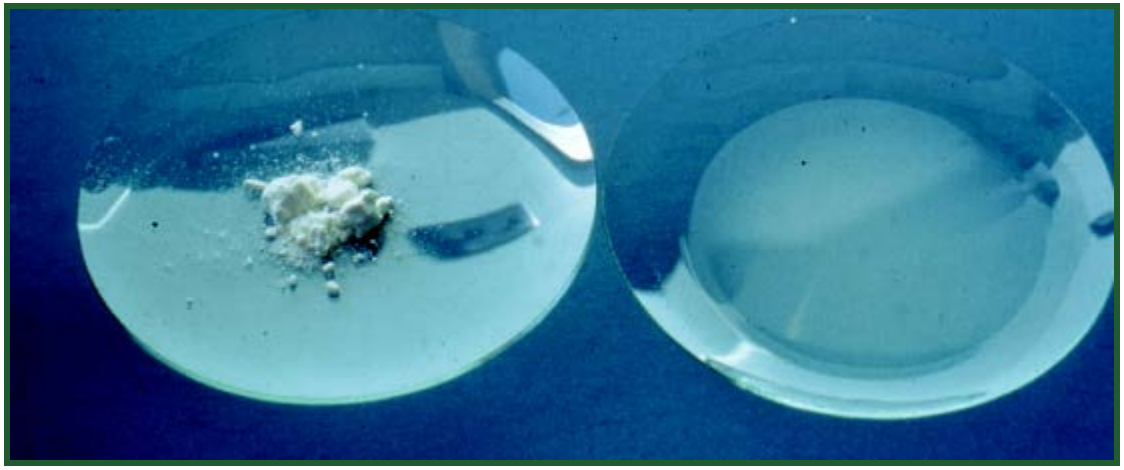
These materials possess some of the same characteristics as wettable powders except they are formulated into granular-sized particles, so are easier to handle with little inhalation hazard



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 (SP or WSP)

ADVANTAGES

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

DISADVANTAGES

- Inhalation hazard

Other Formulations

- Microencapsulated
  - High toxicity Ai in encased formulation

PENNCAP-M®
MICROENCAPSULATED
INSECTICIDE

RESTRICTED USE PESTICIDE

Due to residual effects to avian species and hazard to bees.

For retail sale to and use only by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification.

- Water-soluble packets
  - No human exposure when mixing

Other Formulations

- Attractants/Repellents
- Impregnates
- Pesticide/Fertilizer Combination
- Animal Systemics

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 risk of 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

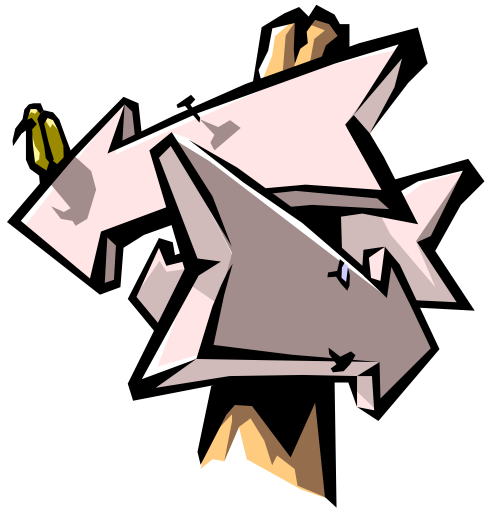
Others

- 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!



CHAPTER 4

Formulation Summary

- Active and inert ingredients
- Dry and liquid formulations
- Adjuvants
- Choose a pesticide formulation that will best suit your pest problem and target site

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

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

A. 1 only
B. 2 and 3 only
C. 2 and 4 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

A. 1 and 2 only	C. 2 and 3 only
B. 1 and 3 only	D. 3 and 4 only