Spray Additives for Improving Pest Control

Paul Domoto
Dept. of Horticulture
Iowa State University

Presented at the
Iowa Wine Growers Conference
January 29, 2005
Definition:

Spray Additive (Adjuvant)

A material added to the spray mixture to aid or enhance the function of the pesticide.
Spray Adjuvants can function in several ways to improve the function of a pesticide application:

- Wetting of foliage and/or pest.
- Improving the uniformity of spray deposit.
- Enhancing penetration and translocation.
- Modifying the rate of spray evaporation.
- Improving the weatherability of the spray deposit.
- Adjusting the pH of the spray mixture & deposit to prolong the life of alkaline sensitive pesticides.
- Improving the compatibility of spray mixtures.
- Providing safety to the treated crop.
- Reducing the drift hazard.
When a Spray Adjuvant needed is dependent upon:

A. How the pesticide is formulated.
   - EC, WP, F, DF, L, SP

B. The targeted pest / practice.
   - Insects, diseases, weeds, growth regulation, nutritional enhancement.

C. Pesticide mode-of-action.
   - Contact agent, consumed by pest, surface protectant, absorbed by plant, absorbed & translocated to site of action.

D. Site of application.
   - On the crop, to the soil, weeds growing around the crop.
A. How Pesticides are Formulated

Most pesticides in their pure form (technical material, TM) are not soluble in water.

1. TM is soluble in oil: (most common)
   a. TM is dissolved in oil & an emulsifying agent is added.
      - Forms a cloudy, disbursed emulsion when mixed with water.
      - Emulsifiable Concentrate (EC)
   b. TM, dissolved in oil, is impregnated on a powder & a wetting agent is added.
      - Forms a cloudy suspension when mixed with water.
      - Stored dry: Wettable Powder (W or WP) or Dry Flowable (DF)
      - Stored semi-wet: Flowable (F)
A. How Pesticides are Formulated

2. TM is manufactured as a solid.
   - Ground to a fine powder & a wetting agent is added.
   - **Wettable powder (W or WP) or Dry Flowable (DF)**

3. TM is manufactured as a fine particulate semi-solid.
   - A wetting agent is added: **Flowable (F)**

4. TM is soluble in a solvent that disperses when mixed with water (alcohol).
   - Forms a clear suspension: **Water Miscible Liquid (L)**

5. TM is soluble in water.
   - Manufactured dry
   - Forms a clear solution: **Soluble Powder (SP)**
There are several classes of spray adjuvants that can be used to improve the function of a pesticide:

1. Surfactants
2. Emulsified (Crop) Oils
3. Ammoniated salts
4. Acidifiers & Buffers
5. Safeners
6. Drift Retardants
7. Foam Retardants
1. **Surfactants:**

These are surface active agents, or “soap-like” materials.

- When manufactured in the pesticide formulation, they aid in mixing:
  - Wetting agents
  - Emulsifying agents

- When added to the spray mixture, they aid in depositing the spray & improve the pesticide’s function:
  - Spreaders
  - Activators / penetrating agents
  - Stickers
There are 2 basic types of surfactants:

- **Non-ionic**
  - Alcohol or fatty acid base
    - Most common type
  - **Organo-silicones**
    - Better penetrating properties
    - Faster evaporation
    - High foaming
    - Greater risk of eye injury

- **Ionic**
  - Cationic (+ charge)
  - Anionic (- charge)
Non-ionic Surfactant: A molecule with a polar (water-loving) head and a non-polar (oil-loving) tail that forms an interface to break the surface tension of water.
**Non-ionic Surfactants:**

- **Activator / Penetrating Agent**
  - Acts to break down the waxy cuticle layer to allow the pesticide to be more easily absorbed.

- **Sticker**
  - A resin or latex based surfactant that acts to bond the pesticide particles to the target after the spray droplets have dried.
Ionic Surfactants:

- A surfactant with a positive or negatively charged end that provides the surface active properties.

- The ionic charge aids in spreading and binding the spray droplets and pesticide to a surface with an opposite charge.
2. **Emulsified (Crop) Oils:**

- Composed of petroleum-based oils or seed oils that have been emulsified with a surfactant.

- Function as a:
  - **Spreader** (surfactant).
  - **Activator / penetrating agent** (surfactant & oil).
  - **Sticker** (oil).
  - Slow the rate of evaporation to increase absorption (oil).
  - Some control of droplet size or bounce to **reduce drift** (oil + surfactant).
3. **Ammoniated Salts:**

Ammonium Sulfate, Ammonium Nitrate, Urea

- Used mainly with post-emergence herbicides.
- Function as:
  - **Acidifiers**
    - Extend the life of alkaline (high pH) or hard water sensitive pesticides.
  - **Activator / penetrating agents**
    - Chelate with the pesticide to aid in its absorption through the cuticle.
  - **Evaporation modifiers**
    - Hydrosopic (water attracting).
    - Slows the rate of evaporation to allow for greater absorption of the pesticide.
4. **Acidifiers & Buffers:**

- Extend the life of alkaline (high pH) sensitive pesticides.
  - Organophosphates
  - Some carbamates
  - Some fungicides
  - Many growth regulators

- **Types of materials**
  - Phosphoric acid and derivatives
  - Organic acids
  - (Ammoniated salts)
5. **Safeners:**

Materials that function to reduce the potential of a phytotoxic reaction when added to the spray mixture.

- With modern pesticides this is not the problem it once was, or the safener is already formulated in the pesticide.

- **Examples:**
  - Hydrated lime added to a liquid sulfur spray *(liquid lime sulfur)*
  - Hydrated lime added when sulfate-salts are applied as a foliar sprays *(CuSO₄ (Bordeaux mix), ZnSO₄)*
6. **Drift Retardants:**

Reduce the potential of off-target drift when applying a pesticide.

- **Function by increasing surface tension:**
  - Controlling droplet size
    - Reduces the number of very small droplets
  - Minimizing droplet bounce

- **Types of materials:**
  - Polyvinyl polymers
  - Cationic surfactants
7. **Foam Retardants:**

Function in the spray tank to reduce foaming.
- Allows a greater amount of the spray mixture to be uniformly sprayed out near the bottom of the tank (avoids “streaking” of the spray pattern).
- Types of materials:
  - **Silicone/carbon polymer** (Dimethylpolysiloxane)
  - **No-ionic surfactants** with a low-foaming fatty acid or alcohol base.
- Must be careful! Too much added to the spray tank can cause the suspension of the pesticide in water to “break”.
When is a Spray Adjuvant Needed?

In relation to:

- How the pesticide is formulated.
- The targeted pest / practice.
- Pesticide mode-of-action.
- Site of application.

The following tables indicate the need for various types of spray adjuvants based on the formulation, intended target and mode-of-action.
# Insect Control with Contact & Stomach Poisons

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Spreader</th>
<th>Sticker</th>
<th>Activator *</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>no (^z)</td>
<td>no (^z)</td>
<td>no</td>
</tr>
<tr>
<td>F</td>
<td>maybe (^y)</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>WP, DF</td>
<td>maybe (^y)</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>L</td>
<td>yes (^x)</td>
<td>yes (^x)</td>
<td>no</td>
</tr>
<tr>
<td>SP</td>
<td>yes (^x)</td>
<td>yes (^x)</td>
<td>no</td>
</tr>
</tbody>
</table>

* Not required because of the mode-of-action of the pesticide.

\(^z\) Emulsifier & oil are functioning as a spreader and sticker.

\(^y\) Depends upon the effectiveness of the wetting agent.

\(^x\) Formulation does not contain a surfactant.
# Disease Control on the Crop with protectants

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Spreader</th>
<th>Sticker</th>
<th>Activator *</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>no (^z)</td>
<td>no (^z)</td>
<td>no</td>
</tr>
<tr>
<td>F</td>
<td>maybe (^y)</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>WP, DF</td>
<td>maybe (^y)</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>L</td>
<td>yes (^x)</td>
<td>yes (^x)</td>
<td>no</td>
</tr>
<tr>
<td>SP</td>
<td>yes (^x)</td>
<td>yes (^x)</td>
<td>no</td>
</tr>
</tbody>
</table>

* Not required because of the mode-of-action of the pesticide.

\(^z\) Emulsifier & oil are functioning as a spreader and sticker.

\(^y\) Depends upon the effectiveness of the wetting agent.

\(^x\) Formulation does not contain a surfactant.
# Insect & Disease Control with Systemics

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Spreader</th>
<th>Sticker *</th>
<th>Activator</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>no (^z)</td>
<td>no</td>
<td>maybe</td>
</tr>
<tr>
<td>F</td>
<td>maybe (^y)</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>WP, DF</td>
<td>maybe (^y)</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>L</td>
<td>yes (^x)</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>SP</td>
<td>yes (^x)</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

\(^*\) Not required because of the mode-of-action of the pesticide.

\(^z\) Emulsifier & oil are functioning as a spreader.

\(^y\) Depends upon the effectiveness of the wetting agent.

\(^x\) Formulation does not contain a surfactant.
# Weed Control with Pre-emergence Herbicides

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Spreader</th>
<th>Sticker *</th>
<th>Activator *</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>no (^z)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>F</td>
<td>no (^z)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>WP, DF</td>
<td>no (^z)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>L</td>
<td>maybe (^y)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>SP</td>
<td>maybe (^y)</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

* Not required because of the pesticide at the soil.

\(^z\) Spreader in the formulation is adequate.

\(^y\) May require to improve dispersion.
## Weed Control with Post-emergence Herbicides

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Spreader</th>
<th>Sticker *</th>
<th>Activator</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>no (^z)</td>
<td>no</td>
<td>maybe</td>
</tr>
<tr>
<td>F</td>
<td>maybe (^y)</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>WP, DF</td>
<td>maybe (^y)</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>L</td>
<td>yes (^x)</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>SP</td>
<td>yes (^x)</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

* Not required because of the mode-of-action of the pesticide.

\(^z\) Emulsifier & oil are functioning as a spreader.

\(^y\) Depends upon the effectiveness of the wetting agent.

\(^x\) Formulation does not contain a surfactant.
# Growth Regulator

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Spreader</th>
<th>Sticker *</th>
<th>Activator</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>no ^z</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>F</td>
<td>maybe ^y</td>
<td>no</td>
<td>maybe ^w</td>
</tr>
<tr>
<td>WP, DF</td>
<td>maybe ^y</td>
<td>no</td>
<td>maybe ^w</td>
</tr>
<tr>
<td>L</td>
<td>yes ^x</td>
<td>no</td>
<td>maybe ^w</td>
</tr>
<tr>
<td>SP</td>
<td>yes ^x</td>
<td>no</td>
<td>maybe ^w</td>
</tr>
</tbody>
</table>

* Not required because of the mode-of-action of the pesticide.

^z Emulsifier & oil are functioning as a spreader.

^y Depends upon the effectiveness of the wetting agent.

^x Formulation does not contain a surfactant.

^w Surfactants can double the effectiveness of a growth regulator.
## Foliar Applied Nutrients

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Spreader</th>
<th>Sticker</th>
<th>Activator</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>F</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>WP, DF</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>L</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>SP *</td>
<td>maybe</td>
<td>maybe</td>
<td>maybe</td>
</tr>
</tbody>
</table>

* Nutrient sprays are generally tanked mixed and applied with pesticides to save on the number of spray applications. Surfactants in the pesticide mixture are adequate.
# Need for other Spray Adjuvants

<table>
<thead>
<tr>
<th>Adjuvant Type</th>
<th>Evap. Control</th>
<th>Acidifier Buffer</th>
<th>Safener</th>
<th>Drift Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide</td>
<td>systemic</td>
<td>Alkali sensitive</td>
<td>- -</td>
<td>maybe</td>
</tr>
<tr>
<td>Fungicide</td>
<td>systemic</td>
<td>Alkali sensitive</td>
<td>Coppers Sulfurs</td>
<td>maybe</td>
</tr>
<tr>
<td>Pre-emergence Herbicide</td>
<td>maybe</td>
<td>- -</td>
<td>- -</td>
<td>sometimes</td>
</tr>
<tr>
<td>Post-emergence Herbicide</td>
<td>yes</td>
<td>Alkali sensitive</td>
<td>- -</td>
<td>sometimes</td>
</tr>
<tr>
<td>Growth Regulator</td>
<td>maybe</td>
<td>maybe</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>Foliar Nutrient</td>
<td>- -</td>
<td>- -</td>
<td>Sulfate salts</td>
<td>- -</td>
</tr>
</tbody>
</table>
What is Available?

Surfactants

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-ionic</td>
</tr>
<tr>
<td>Spreader</td>
<td>4</td>
</tr>
<tr>
<td>+ other adjuvants</td>
<td>1</td>
</tr>
<tr>
<td>Spreader / Sticker</td>
<td>25</td>
</tr>
<tr>
<td>Spreader / Activator</td>
<td>19</td>
</tr>
<tr>
<td>+ other adjuvants</td>
<td>21</td>
</tr>
</tbody>
</table>

Refer to the accompanying table listing the characteristics of the various spray adjuvants.
## What is Available? Other Adjuvants

Refer to the accompanying table listing the characteristics of the various spray adjuvants.

<table>
<thead>
<tr>
<th>ADJUVANT</th>
<th>Number</th>
<th>w/ other Adjuvants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulsified Oil</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Ammoniated Salt</td>
<td>8</td>
<td>29</td>
</tr>
<tr>
<td>Buffer</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Drift Retardant</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Foam Retardant</td>
<td>10</td>
<td>-</td>
</tr>
</tbody>
</table>
READ THE PESTICIDE LABEL

- Targeted pest, rate, compatibility, timing, environmental hazards, safety precautions, personnel protective gear.
- Types of spray adjuvants recommended / suggested.

READ THE SPRAY ADJUVANT LABEL

- Intended use, precautions, environmental hazards.
- Mixing rate.
- Mixing directions.