Adjuvants 101

NAPPC – PESTICIDE EDUCATION TASK FORCE

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This presentation is a product of the North American Pollinator Protection Campaign (NAPPC) Pesticide Education Task Force.

NAPPC is a collaborative body of over 140 organizations that work for the protection of pollinators across Mexico, Canada, and the United States.

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Water Droplets – Leaf Surface

It's a good idea to think about the surface of the leaf, as that is often the starting place for a discussion of adjuvants and their use in pesticides.

What is an Adjuvant?

An adjuvant is any additive used in conjunction with a pesticide to increase biological activity and/or to modify various physical properties of a spray solution.

Adjuvants are used to overcome bio-delivery issues inherent in the active ingredient (AI).

Most active ingredients have physical-chemical issues which require formulation/adjuvancy techniques to maximize potential.

Active ingredients must ultimately reach the target site within the organism to obtain biological activity.

Importance of Adjuvants

Spray applications are affected by many physical variables

Adjuvants play a key role in controlling these variables:

- Pesticide Stability
- Adherence
- Compatibility
- Coverage
- Droplet Size
- Drift
- Foaming
- Penetration
- Solubility
- Suspension
- Surface Tension
- Volatilization

Adjuvants Are Classified Into Four Categories

Activator Adjuvants

- Enhance Pesticide Performance
  - Surfactants, Crop Oil Concentrates, Methylated Seed Oils, Fertilizer Solutions, Penetrants

Spray Modifier Adjuvants

- Affects Physical Properties Of Spray Solutions
  - Stickers, Deposition Aids, Drift Retardants, Evaporation Aids

Adjuvants Are Classified Into Four Categories

Utility Modifier Adjuvants

- Minimize Handling and Application Problems
  - Compatibility Agents, Buffering Agents, Defoamers, Anti-foams

Utility Products

- Minimize Application Problems
  - Foam Markers, Tank Cleaners

Main Types of Tank-Mix Adjuvants

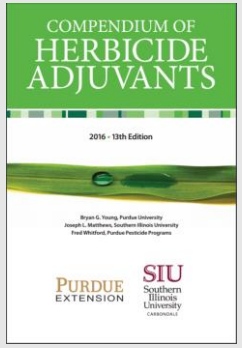
Chemistry	Mode(s) of action
Organic surfactants (ionic and nonionic)	Enhanced foliar retention, increased penetration, coverage
Organosilicone	Enhanced foliar coverage, stomatal flooding, enhanced rainfastness
Oils (mineral, vegetable, trans-esterified vegetable)	Enhanced coverage, foliar penetration, increased availability of a.i. (insecticides)
Terpene derivatives (polymer forming compounds)	Increased resistance of foliar deposits to wash-off. Volatility reduction.
Polymers (polyacrylamide, polyvinylalcohol) and synthetic latex	Reduced spray drift, enhanced foliar retention
Inorganic salts	Increased penetration (overcoming antagonism by divalent cations)

U.S. Adjuvant Terminology - ASTM

- American Society for Testing and Materials Standards (ATSM). www.astm.org
- ASTM International is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.
- For the U.S., ASTM has an extensive list of adjuvant terminology.
- ASTM classification is a combination of chemical descriptions and simplified mode-of-action descriptions.

Adjuvant Information

- Compendium of Herbicide Adjuvants – www.herbicide-adjuvants.com
- The Chemical Producers and Distributors Association (CPDA) has developed an adjuvant certification program as a means of ensuring that adjuvants meet official ASTM standards – www.cpda.com
- A list of CPDA Certified Adjuvants is available online at - http://cpda.com/adjuvant-certified-program/



Label Language - Adjuvants

EPA PR Notice 98-10 (2006)

- Allows a registrant's labels to recommend the use of certified adjuvants.
- A registered pesticide product's label can carry the following statement recommending use of CPDA certified adjuvants:
- "When an adjuvant is to be used with this product, the use of an adjuvant that meets the standards of the Chemical Producers and Distributors Association (CPDA) adjuvant certification program is recommended."

The EPA approval of this standardized label language provides greater consistency in pesticide labeling for adjuvant use.

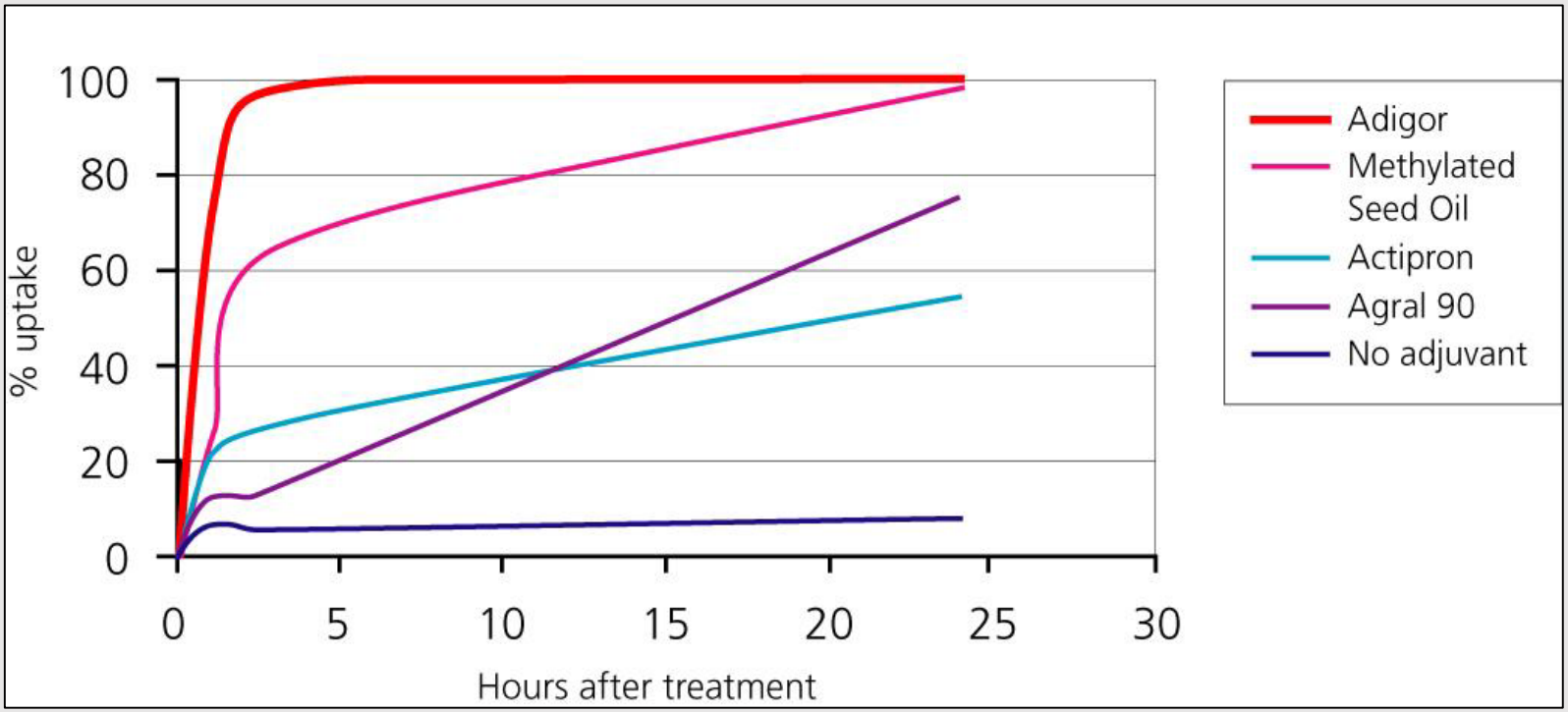
Adjuvant Label Language Examples - Insecticides

Use Information or Directions for Use

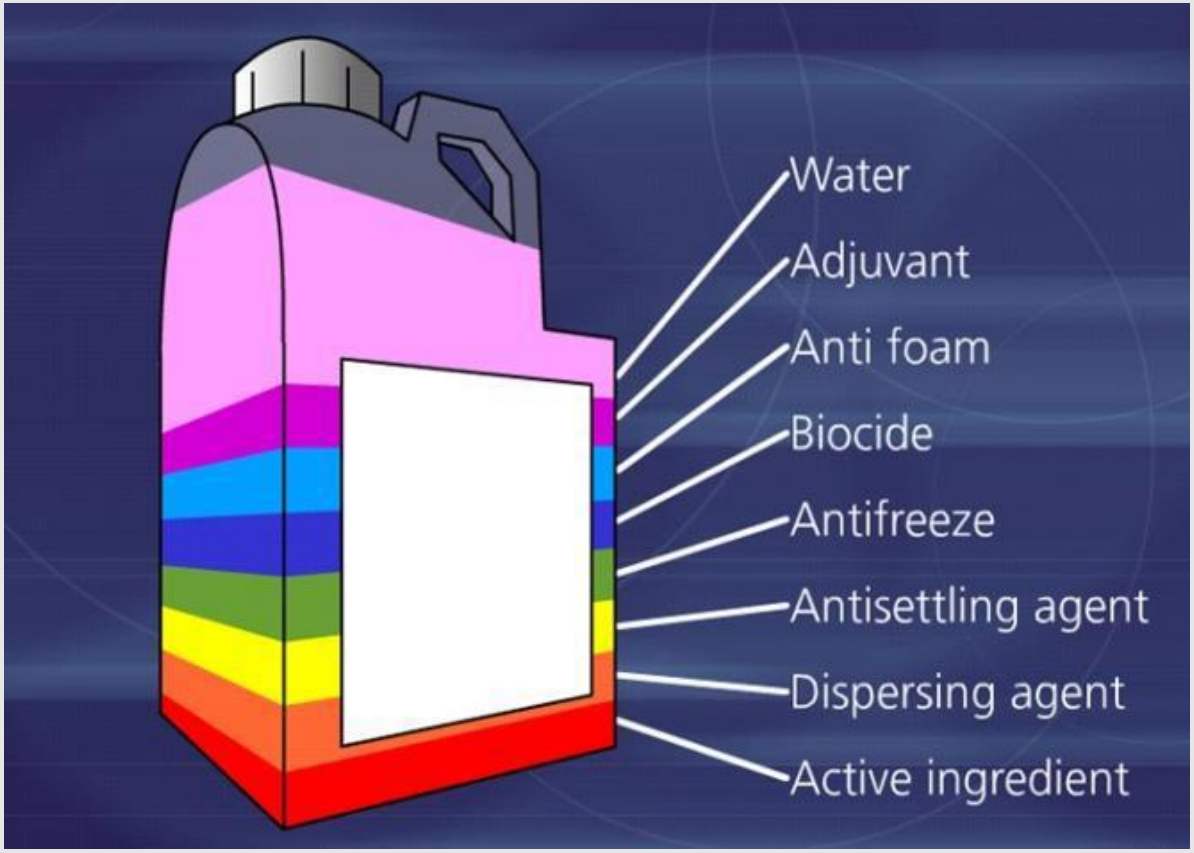
Examples:

- The use of a spray adjuvant may improve spray coverage but is not required.
- With all applications of X Insecticide, the use of a penetrating type spray adjuvant, at the manufacturer's specified rate, will improve coverage and result in optimum insect control, especially in hard-to-wet crops.
- Must be tank-mixed with a spray adjuvant / additive having spreading and penetrating properties to maximize leaf uptake and systemicity of the active ingredient within treated plants.
- X Insecticide must always be mixed with a non-phytotoxic, non-ionic activator type wetting, spreading and/or penetrating spray adjuvant or horticultural oil (not a dormant oil)

Adjuvant Example - Impact of a range of adjuvants on uptake of herbicide X into wild oat leaves.



Built In Adjuvant vs. Tank Mix Adjuvant Considerations



Built-In Adjuvant vs. Tank-Mix Adjuvant

Technical Considerations

- Physical & Chemical Compatibility.
- Space within the formulation.

Regulatory Considerations.

End user considerations & flexibility

Different acceptance levels according to market segment

- e.g. common practice to tank-mix adjuvants with many herbicides.

Built-in products - fixed Adjuvant: Active Ingredient ratio.

- Potential issues for reduced dose application and in high volume applications.

Built-in Adjuvant - Considerations

Aqueous formulations need an aqueous soluble adjuvant.

- SL (Soluble Liquid) Formulations
- Aqueous SC (Soluble Concentrate) formulations

“Oil”/solvent formulations need an oil/solvent soluble adjuvant.

- EC (Emulsifiable Concentrate) based formulation

The solubility of adjuvants and AI’s in water and oil can be measured (using the octanol-water partition coefficient)

U.S. Adjuvant Terminology - ASTM

- **Acidifier** -A material that can be added to spray mixtures to lower the pH.
- **Activator** - A material that increases the biological efficacy of agrichemicals.
- **Active Ingredient** - A component of the formulation that produces a specific effect for which the formulation is designed.
- **Adjuvant** - A material added to a tank mix to aid or modify the action of an agrichemical, or the physical characteristics of the mixture.

U.S. Adjuvant Terminology - ASTM

- **Anionic Surfactant** - A surface-active agent in which the active portion of the molecule containing the lipophilic segment forms exclusively a negative ion (anion) when placed in aqueous solution.
- **Antifoaming Agent** - A material used to inhibit or prevent the formation of foam.
- **Attractant** - A material that attracts specific pests.
- **Basic Blend** - An adjuvant that raises the pH of the solution and contains a nitrogen source.

U.S. Adjuvant Terminology - ASTM

- **Buffer or Buffering Agent** - A compound or mixture that, when contained in solution, causes the solution to resist change in pH. Each buffer has a characteristic limited range of pH over which it is effective.
- **Canopy Penetrating Agent** - An adjuvant that increases the penetration of the spray material into the crop canopy.
- **Cationic Surfactant** - A surface-active agent in which the active portion of the molecule containing the lipophilic segment forms exclusively a positive ion (cation) when placed in aqueous solution.

U.S. Adjuvant Terminology - ASTM

- **Colorant** - A material used to alter the color of the tank mix.
- **Compatibility Agent** - A surface-active agent that allows simultaneous application of liquid fertilizer and agrichemical, or two or more agrichemical formulations, as a uniform tank mix, or improves the homogeneity of the mixture and the uniformity of the application.
- **Crop Oil Concentrate** - An emulsifiable, petroleum oil-based product containing 15% to 20% w/w surfactant and a minimum of 80% w/w phytobland oil.

U.S. Adjuvant Terminology - ASTM

- **Crop Oil (Emulsifiable)** - An emulsifiable, petroleum oil-based product containing up to 5% w/w surfactant and the remainder of a phytobland oil.
- **Crop Oil (Nonemulsifiable)** - A highly refined paraffinic material with minimum unsulfonated residue of 92% v/v.
- **Defoaming Agent** - A material that eliminates or suppresses foam in the spray tank.
- **Deposition Aid** - A material that improves the ability of agrichemical sprays to deposit on target surfaces.

U.S. Adjuvant Terminology - ASTM

- **Dormant Oil** - A horticultural spray oil applied during the dormant phase of the targeted plant.
- **Drift Control Agent** - A material used in liquid spray mixtures to reduce spray drift.
- **Emulsifier** - A surfactant that promotes the suspension of one immiscible liquid in another.
- **Esterification** - The process of reacting fatty acids with an alcohol. Although methanol is the most commonly used alcohol (methylated), ethanol (ethylated), n-butanol and isopropyl alcohol could be used.

U.S. Adjuvant Terminology - ASTM

- **Evaporation Reduction Agent** - A material that reduces the evaporation rate of a spray mix during, after, or both during and after, application.
- **Extender** - A material that increases the effective life of an agrichemical after application.
- **Foam Suppressant** – A material that eliminates or suppresses foam in the spray tank.
- **Foaming Agent** - A material that increases the volume or stability of the foam formed in a spray mixture.

U.S. Adjuvant Terminology - ASTM

- **High Surfactant Oil Concentrate** - An emulsifiable oil based product containing 25-50% w/w surfactant and a minimum of 50% w/w oil.
- **Humectant** - A material which increases the equilibrium water content and increases the drying time of an aqueous spray deposit.
- **Modified Vegetable Oil** - An oil extracted from seeds that has been chemically modified (for example, methylated).

U.S. Adjuvant Terminology - ASTM

- **Modified Vegetable Oil Concentrate** - An emulsifiable, chemically modified vegetable oil product containing 5% to 20% w/w surfactant and the remainder chemically modified vegetable oil.
- **Naphtha-Based Oil** - A petroleum oil containing a majority of the naphtha fraction.
- **Nonionic Surfactant** - A surface-active agent having no ionizable polar end groups but comprised of hydrophilic and lipophilic segments.

U.S. Adjuvant Terminology - ASTM

- **Oil** - See petroleum, vegetable, paraffinic and so forth.
- **Paraffinic Oil** - A petroleum oil (derived from paraffin crude oil) whose paraffinic-carbon type content is typically greater than 60%.
- **Penetrant** - A material that enhances the ability of an agrichemical to enter a substrate or penetrate a surface.
- **Petroleum Oil** - Oil derived from petroleum: contains a mixture of hydrocarbons that are broadly classified as paraffins, naphthenes, aromatics, or other unsaturates, or combinations thereof.

U.S. Adjuvant Terminology - ASTM

- **Phytobland Oil** - A highly refined paraffinic material with minimum unsulfonated residue of 92% v/v.
- **Spreader** - A material which increases the area that a droplet of a given volume of spray mixture will cover on a target.
- **Spreader/Sticker** - A material that has the properties of both a spreader and a sticker.
- **Sticker** - A material that assists the spray deposit to adhere or stick to the target and may be measured in terms of resistance to time, wind, water, mechanical action or chemical action.

U.S. Adjuvant Terminology - ASTM

- **Surface Agent/Surfactant** - A material that when added to a liquid agent medium, modifies the properties of the medium at a surface or interface. This is a general term that includes soluble detergents in liquid medium, dispersing agents, emulsifying agents, foaming agents, penetrating agents and wetting agents.
- **Surfactant** - See Surface Agent.

U.S. Adjuvant Terminology - ASTM

- **Vegetable Oil** - Oil extracted from seeds; typically those of corn, cotton, peanut, rapeseed, sunflower, canola or soybean.
- **Vegetable Oil Concentrate** - An emulsifiable vegetable oil product containing 5% to 20% w/w surfactant and a minimum of 80% w/w vegetable oil.
- **Wetting Agent** - Wetting agents can be considered synonymous with spreading agents in function.

Summary

- An adjuvant is any additive used in conjunction with a pesticide to increase biological activity and/or to modify various physical properties of a spray solution.
- Many different modes of action of adjuvants e.g. spreading/wetting, penetration.
- Adjuvants can be built-in or added as tank mix.
- It is important to read the label for specific adjuvant recommendations

Questions? Contact the NAPPC Pesticide Task Force at info@pollinator.org

North American Pollinator Protection Campaign