Central Oregon Pest Mgt. Course
Deschutes County Fairgrounds & Expo
Redmond, OR

Adjuvants 101

Dan Comingore
Wilbur-Ellis Company
Branded Product Specialist
Adjuvant

• An adjuvant is a material added to a mixture to aid or modify the action of an agrichemical, or alter the physical characteristics of the mixture.

ASTM Definition
Adjuvant Types

• Spreadsers
• Spreadsers + AMS
• Spreader-Activators
• Penetrator-Activator
• Spreader-Stickers
• Sticker-Extenders
• Silicones
• Crop Oil Concentrates
• High Surfactant Oil Concentrate
• Modified Seed Oils
• Modified Seed Oil + Organosilicone Blend
• Modified Seed Oil + Nitrogen
• Acidifier/Buffers
• Alkaline/Buffers
• Water Conditioners
• Deposition and Drift Management
CPDA
Council of Producers & Distributors of Agrotechnology

- Only organization representing adjuvants to the EPA.

- Certification program that sets viable minimum standards
  - Toxicology on all products required
  - Must meet ASTM definitions
  - Standards for active ingredients.
  - Certified formulation facilities
CPDA
What the Adjuvant Standards Were Intended to Do

– Establish **minimum guidelines** for good product stewardship

– Establish use of **EPA approved inerts** in adjuvant formulations

– Establish good product communication guidelines (MSDS, product labeling, and hazard identification)

– **Support product functionality claims** by meeting **ASTM definitions for function**

– **Give end user useful information** so they can make an **informed choice**
CPDA

CPDA Certified Products

- Started Certifying Products in 2001
- Probably in excess of 2000 adjuvants in marketplace.
- Currently 97 adjuvants have received CPDA Certification
- Supporting companies are Wilbur-Ellis, Winfield Solutions, Helena, Loveland/CPS, United Suppliers, Intec and others.
Adjuvant Selection Factors

• Consider all factors and your experiences to make the proper adjuvant choice.

- Contact, translaminar, systemic
- Water hardness, pH & solubility
- Target or Pest
- Target Leaf Structure
- Crop Leaf Structure
- Drift Off-Target
- Social/Political Concerns
- Equipment
- Weather
- Miscellaneous
- Pesticide
- Water Quality
- Grass, Broadleaf
- Ground, aerial air blast, chemigation backpack
- Hot & Dry
- Cool & Humid
- Backpack
Surfactants

Surfactant is a word derived from the term “surface-active agent." Surfactants are adjuvants that reduce the surface tension of water or increases its wettability. They aid the emulsifying, spreading, wetting or other surface-modifying properties of liquids.

ASTM Definition
Surfactant Types

**ANIONIC** - surfactant that has a negative (-) charge and **limited compatibility**.

**CATIONIC** - surfactant that has a positive (+) charge and **limited compatibility**.

**NON-IONIC** - surfactant that has no electrical charge and is generally **compatible with all pesticides**.
Functions of a High Quality Surfactant

- Reduces surface tension
- Solubilizes spray materials
- Increases spreading
- Improves retention
- Improves penetration

Better spray material PERFORMANCE!
Surfactants

• For Herbicide, Fungicide and Insecticide Enhancement

• Surfactants work to increase the spreading of spray material over the leaf surface.

• Surfactants work to improve coverage and increase adhesion of the spray material to the plant surface.
Spray Droplet Without Surfactant

- Surface tension of water is 72 dynes/cm
- Droplets sit on leaf hairs or leaf surface
- Little leaf contact
- Reduced spray activity
Surfactant Effects

- Surfactant reduces surface tension to 20-40 dynes/cm.
- Droplets spread over leaf, penetrate hairy surface
- Increased leaf contact
- Increased spray activity
Japanese Maple with and without ProNatural® Spreader-Sticker

With Surfactant

Without Surfactant
Hairs, trichomes, and glands
Differences Between Spreaders, Spreader-Activators and Penetrator-Spreader-Activators

• **Spreader** – reduces the surface tension and increase the surface area covered by the pesticide.

• **Spreader-Activator** – reduces surface tension, increases the surface area covered and **moves** pesticide around, under and into the water channels of the leaf.

• **Penetrator-Spreader-Activator** – Lifts and dissolves the wax on the leaf surface allowing the pesticide to enter the leaf.
Penetration vs Coating

- **Hasten**® is an Modified Seed Oil (MSO)
  - Very high KB value
  - Exceptional penetration
- **R-11**® is a nonionic surfactant (NIS)
  - Spreader-Activator
- **Mor-Act**® is a Crop Oil Concentrate (COC)
  - Coats versus penetrate
Where do you want the product?

- Do want to spread and coat the outside of the leaf/plant?
- Do you want the product inside the leaf, so it can move throughout the leaf and entire plant?
  - Is it a **Contact** product?
  - Is it a **Translaminar** product?
  - Is it a **Systemic** product?
Super Spread™ MSO  R-11®  Mor-Act®
Water Quality
It All Starts With The... Water....
Why Is Water Important?

- Water is the carrier for 98% of all pesticides sprayed.

- Once you put pesticides into bad water the damage is done and can’t be reversed.
When Do You Treat?

• If you are conditioning your water for:
  • pH adjustment
    up
    down
  • water hardness

YOU MUST

Treat the water before adding any pesticide to the spray water !!!!
What Are The Problems?

- **pH Sensitivity**
  - Certain spray materials break down if spray water is either too **BASIC** (high pH) or **ACIDIC** (low pH).

- **Solubility of Pesticides**
  - Some pesticides increase in solubility as the spray water pH increases.

- **Mineral Antagonism**
  - Water Hardness (dissolved minerals) directly interfere with a broad range of spray materials.
    - **Calcium**
    - **Magnesium**
    - **Iron**
    - **Sodium**
What Is Your Spray Water pH?
Washington State pH Map 11/8/07

pH Levels

5.5 - 5.99 – Yellow
6.0 - 6.49 – Red
6.50 - 6.99 – Turquoise
7.0 - 7.49 – Blue
7.5 - 7.99 – Green
8.0 - 8.49 – Purple
8.5 - 8.99 – Black
9.0 > - White
Basic pH above 7 is considered basic.

Neutral pH of 5 - 6.5 is generally the optimum for most spray solutions.

Acidic pH below 7 is considered acidic.
pH Sensitivity

- Generally, the ideal pH for water used in applying spray materials is slightly acidic (pH 5 to 6.5) but some exceptions exist. Read Labels.

- Sulfonylureas such as Ally®, Escort®, Amber®, Harmony®Extra, Express® and Accent® begin to degrade when left in spray solution that is below pH 7.

- Some herbicides, insecticides and fungicides, such as Topsin®, Captan™ & Imidan® break down in basic (pH above 7) ALKALINE HYDROLYSIS.
### Effects of pH on Imidan Half Life

<table>
<thead>
<tr>
<th>pH</th>
<th>Half Life</th>
</tr>
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<tbody>
<tr>
<td>5.0</td>
<td>178 hours</td>
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<tr>
<td>5.5</td>
<td>92 hours</td>
</tr>
<tr>
<td>6.0</td>
<td>36 hours</td>
</tr>
<tr>
<td>6.5</td>
<td>14 hours</td>
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<tr>
<td>7.0</td>
<td>10 hours</td>
</tr>
<tr>
<td>7.5</td>
<td>2 hours</td>
</tr>
<tr>
<td>8.2</td>
<td>33 minutes</td>
</tr>
</tbody>
</table>

Effects of Field-Aged Residues on Efficacy J. Brunner, WSU. 1996.

From field studies conducted for Gowan Company
Solubility vs Spray Water pH

• As the spray water pH increases some products increase in solubility.

• As solubility increases, it increases the bioavailability of active ingredient for better and more consistent efficacy.
# pH Sensitivity

## Spray Material SOLUBILITY Chart 2006

Adjusting the pH of the spray solution can increase spray material solubility in the spray tank solution and make the spray more effective. The following chart shows spray material solubility as indicated by the HERBICIDE HANDBOOK Eight Edition 2002.

<table>
<thead>
<tr>
<th>Spray Material Product</th>
<th>Spray Material Chemistry</th>
<th>Optimum Solubility pH</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
<th>7.0</th>
<th>8.0</th>
<th>9.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accent(R) Gold</td>
<td>nicosulfuron+rimsulfuron+flumetsulam+clopyralid</td>
<td>Acidic</td>
<td>360 ppm</td>
<td>12,200 ppm</td>
<td>39,000 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accent®</td>
<td>nicosulfuron</td>
<td>Acidic</td>
<td>360 ppm</td>
<td>12,200 ppm</td>
<td>39,000 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achieve®</td>
<td>tralkoxydim</td>
<td>Acidic</td>
<td>6 ppm</td>
<td>6.7 ppm</td>
<td>9,800 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ally(R) Escort®</td>
<td>metsulfuron+thiostansulfuron+tribenuron</td>
<td>Acidic</td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amber®</td>
<td>triasulfuron</td>
<td>Acidic</td>
<td>32 ppm</td>
<td>5,615 ppm</td>
<td>13,500 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basis®</td>
<td>nicosulfuron+trifensulfuron</td>
<td>Acidic</td>
<td>223 ppm</td>
<td>2,240 ppm</td>
<td>8,830 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basis® Gold</td>
<td>rimsulfuron+trifensulfuron+atrazine</td>
<td>Acidic</td>
<td>223 ppm</td>
<td>2,240 ppm</td>
<td>8,830 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beacon®</td>
<td>primisulfuron</td>
<td>&gt;8.0</td>
<td>&gt;2,200 ppm</td>
<td>&gt;2,000 ppm</td>
<td>15,000 ppm</td>
<td>22,000 ppm</td>
<td></td>
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</tr>
<tr>
<td>Callisto®</td>
<td>mesotrione</td>
<td>Acidic</td>
<td>2,000 ppm</td>
<td>2,000 ppm</td>
<td>15,000 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canopy® Ex</td>
<td>chlorimuron ethyl+tribenuron</td>
<td>Acidic</td>
<td>48 ppm</td>
<td>2,040 ppm</td>
<td>18,300 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canopy® Sp</td>
<td>chlorimuron ethyl+sulfentrazone</td>
<td>&gt;7.0</td>
<td>11 ppm</td>
<td>450 ppm</td>
<td>1,200 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canopy® XL</td>
<td>chlorimuron+metribuzin</td>
<td>&gt;7.0</td>
<td>11 ppm</td>
<td>450 ppm</td>
<td>1,200 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cimarron®</td>
<td>metsulfuron</td>
<td>Acidic</td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cimarron® Max</td>
<td>metsulfuron+chlorosulfuron</td>
<td>Acidic</td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cimarron® Xtra</td>
<td>metsulfuron+weedmaster</td>
<td>Acidic</td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarion®</td>
<td>nicosulfuron+rimsulfuron</td>
<td>Acidic</td>
<td>360 ppm</td>
<td>12,200 ppm</td>
<td>39,000 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classic®</td>
<td>chlorimuron</td>
<td>&gt;7.0</td>
<td>11 ppm</td>
<td>450 ppm</td>
<td>1,200 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distinct®</td>
<td>diflufenzopyr</td>
<td>Acidic</td>
<td>63 ppm</td>
<td>5,850 ppm</td>
<td>10,546 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Weed Science Society of America 2002
Granule/particle formulation

Nicosulfuron WDG
*(Accent)

Dispersion

Nicosulfuron WDG + pH Adjuster
*(Accent)

Dr. Jerry Green, DuPont
<table>
<thead>
<tr>
<th></th>
<th>pH 5.0</th>
<th>pH 7.0</th>
<th>pH 9.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maverick</strong></td>
<td>18 ppm</td>
<td>1,627 ppm</td>
<td>482 ppm</td>
</tr>
<tr>
<td><strong>Amber</strong></td>
<td>32 ppm</td>
<td>815 ppm</td>
<td>13,500 ppm</td>
</tr>
<tr>
<td><strong>Peak</strong></td>
<td>30 ppm</td>
<td>3,580 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Glean</strong></td>
<td>587 ppm</td>
<td>31,800 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Finesse</strong></td>
<td>587 ppm</td>
<td>31,800 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
</tr>
<tr>
<td><strong>Ally</strong></td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
</tr>
<tr>
<td><strong>Express</strong></td>
<td>48 ppm</td>
<td>2,040 ppm</td>
<td>18,300 ppm</td>
</tr>
<tr>
<td><strong>Harmony Extra</strong> (Harmony GT + Express)</td>
<td>223 ppm</td>
<td>2,240 ppm</td>
<td>8,830 ppm</td>
</tr>
<tr>
<td><strong>Harmony GT</strong></td>
<td>223 ppm</td>
<td>2,240 ppm</td>
<td>8,830 ppm</td>
</tr>
<tr>
<td>Herbicide</td>
<td>pH 5.0</td>
<td>pH 7.0</td>
<td>pH 9.0</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Olympus</td>
<td>2,900 ppm (pH 4.0)</td>
<td>42,000 ppm</td>
<td>42,000 ppm</td>
</tr>
<tr>
<td>Osprey</td>
<td>7 ppm</td>
<td>483 ppm</td>
<td>15,390 ppm</td>
</tr>
<tr>
<td>Everest</td>
<td>3,000 ppm</td>
<td>44,000 ppm</td>
<td>44,000 ppm</td>
</tr>
<tr>
<td>Rave</td>
<td>32 ppm</td>
<td>5,815 ppm</td>
<td>13,500 ppm</td>
</tr>
<tr>
<td>Ally Extra</td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
</tr>
<tr>
<td>Achieve</td>
<td>6 ppm</td>
<td>7 ppm</td>
<td>9,800 ppm</td>
</tr>
<tr>
<td>UpBeet</td>
<td>3 ppm</td>
<td>110 ppm</td>
<td>11,000 ppm</td>
</tr>
<tr>
<td>Poast</td>
<td>257 ppm</td>
<td>4,390 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td>Beacon</td>
<td>3 ppm</td>
<td>243 ppm</td>
<td>5,280 ppm</td>
</tr>
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</table>

## Spray Solution pH vs Solubility

<table>
<thead>
<tr>
<th></th>
<th>pH 5.0</th>
<th>pH 7.0</th>
<th>pH 9.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oust</strong></td>
<td>10 ppm</td>
<td>300 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Telar</strong></td>
<td>587 ppm</td>
<td>31,800 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Escort</strong></td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
</tr>
<tr>
<td><strong>Landmark</strong></td>
<td>10 ppm</td>
<td>300 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td>(Oust + Telar)</td>
<td>587 ppm</td>
<td>31,800 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Weststar</strong></td>
<td>10 ppm</td>
<td>300 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Oust Extra</strong></td>
<td>10 ppm</td>
<td>300 ppm</td>
<td>n/a</td>
</tr>
<tr>
<td>(Oust + Escort)</td>
<td>548 ppm</td>
<td>2,790 ppm</td>
<td>213,000 ppm</td>
</tr>
</tbody>
</table>

*WSSA Herbicide Handbook 2002 eighth edition*
Oust® Extra pre-slurry by Bruce Alber - Wilbur-Ellis.
Oust® Extra pre-slurry by Bruce Alber, Wilbur-Ellis.
Oust® Extra pre-slurry using CLIMB® by Bruce Alber, Wilbur
Oust® Extra pre-slurry using CLIMB® by Bruce Alber, Wilbur-
The clear solution to *Improved Performance*

**Oust® Extra**

**Oust® Extra with CLIMB® added**
What Is Your Spray Water Hardness?
Washington State Water Hardness Map 11/8/07

Hardness Levels:
- 0 - 125 – Yellow
- 126 - 250 – Red
- 251 - 375 – Turquoise
- 375 - 500 – Blue
- 501 - 625 – Green
- 626 - 750 – Purple
- 751 - 875 – Black
- 876 - 1000 – White
Mineral Antagonism

- Water hardness (dissolved minerals) directly interfere with a broad range of spray materials.
Mineral Antagonism

Calcium [Ca++]
Magnesium [Mg++]
Iron [Fe++]
Sodium [Na+]
Mineral Antagonism

- **Dissolved minerals** specifically interfere with the performance of some herbicides such as:

  Glyphosate, Achieve®, Poast®, Pursuit®, Raptor®, Beyond®, Select®, Dicamba, Liberty®, Rely®, 2,4-D Amine and MCPA Amine.

  2,4-D is completely deactivated at **500 ppm** water hardness.

  Glyphosate less effective noticeably as low as **150 ppm** hardness.
Addition of Ammonium Sulfate...Why?

The Sulfate ion “blocks” the mineral cation.

The Ammonium ions attach and “escort” the glyphosate into the plant.
Mineral Antagonism

Time of Application | 85° F
Evaporation of Spray Droplet
Effects on Salt Concentration

Time of Application: Hardness = 100 ppm = Low
7.5 % Glyphosate antagonism
Mineral Antagonism
2.5 Minutes Post-Application
50% Evaporation: Hardness = 200 ppm = Low
15 % Glyphosate antagonism
Mineral Antagonism

4 Minutes Post-Application | Note Formation of Salt Deposits
Evaporation of Spray Droplet
Effects on Salt Concentration

90% Evaporation: Hardness = 900 ppm = Extremely High
67.7 % Glyphosate antagonism
University of Idaho Trials 2005 - Dr. Donn Thill
Using sub-lethal rates of Buccaneer™ - Water Hardness of 1100 ppm
Herbicides That May Be Susceptible To Hard Water Tie Up

- 2,4-D (amine) – (Base Camp™ Amine 4, Weedar® 64, Broadrange™ 55)
- 2,4-DB (amine)
- MCPA (amine) (WIL-POWER®, Vengeance® Plus)
- Dichlorprop (amine)
- Mecoprop (amine)
- Dicamba (Banvel®, Clarity®, Vanquish®)
- Picloram (Tordon®)
- Triclopyr (Garlon®, Crossbow™, WIL-POWER®, Vengeance® Plus, DeadLock®)
- Clopyralid (Stinger®, Curtail®, Curtail· M, Transline®, Lontrel®, Confront®, Redeem®, WideMatch™)
- Aminopyralid (Milestone™, Milestone™ VM, Milestone™ VM Plus, CleanWave™, ForeFront™)
- Quinclorac (Q-4®, Facet®, Paramount®)
- Sethoxydim (Poast®)
- Clethodim (Select®, Select Max™, Envoy®, Volunteer™, Shadow®)
- Tralkoxydim (Achieve·)
- Imazamethbenz (Assert·)
- Imazapyr (Arsenal®, Chopper®, Sahara®, Stalker®, Habitat®)
- Imazaquin (Scepter®)
- Imazamox (Raptor®, Beyond®, ClearCast™ ClearMax®)
- Imazapic (Plateau®, Journey®)
- Imazethapyr (Pursuit®)
- Glufosinate (Liberty®, Rely®, Ignite®, Finale®)
- Glyphosate (Roundup®, Touchdown®, Agri Star· Landmaster· BW)

Revised 1/1/09
In Summary…

• Know your Adjuvants
• Know your water quality
• Know what you getting for the dollars your spending
Thank You!!