From the introduction of 2,4-D, the first modern herbicide in the early 1940s, to the development of biotech traits in the 1990s, to the latest technology launches in 2020, agriculture has created powerful weapons to control weeds, insects and disease. However, the effectiveness of these powerful weapons still depends on several environmental and physical factors working with the chemistry. You may have heard that adjuvants can help to make these chemical, environmental and physical factors work more efficiently together in your tank mix, but if you’ve found yourself confused as to what an adjuvant is, what it does and how to use it properly, you aren’t alone. Many questions still exist about this growing product category.

Use this guide to build your understanding of adjuvants and how to use them to increase crop protection product performance. We’ll cover topics like:

- What adjuvants are
- How they are grouped
- The functions they perform
- How to select the right ones for your operation
- Tank mixing
- Retailer opportunities
What is an Adjuvant?
An adjuvant is a broad term for any substance in a spray solution used to improve pesticide activity or application characteristics. Adjuvants can perform one or several functions, including:
• Improved pesticide coverage, adherence and penetration to a pest
• Water conditioning
• Increased water droplet size
• Additional stability, solubility and compatibility of a solution
• Decreased tank mix foaming
• Field marking

Spray Adjuvants: Two Groups
While all adjuvants serve to improve crop protection performance, they do so in one of two specific ways – hence two core group names. The first group gets its name from the specific purpose the adjuvants in this group do: activate crop protection products. The second group contains a broader list of adjuvant types, but each one serves to make tank mix ingredients work better together.

Activator Adjuvants
Activator adjuvants enhance the biological activity of a specific crop protection product. For example, herbicides already have the ability to enter into and kill a weed, depending on their active ingredient formulations. When an activator adjuvant is added to the equation, it helps the herbicide to more readily enter the weed. Crop protection products applied with an activator adjuvant will have increased absorption and penetration rates, allowing for better weed, insect or disease control. This group of adjuvants includes:

Surfactants
Oil concentrates
Liquid fertilizer solutions

Special Purpose/Utility Adjuvants
Special purpose/utility adjuvants work by altering the physical characteristics of the spray solution for maximum performance. They correct issues in the tank mix that could negatively affect spray applications, so you can be confident that every droplet leaving the sprayer is providing effective weed control. This group includes:

Drift control agents
Deposition aids
Compatibility agents
Water conditioners
Other special purpose/utility adjuvants
Types of Activator Adjuvants

Surfactants (Wetter-Spreaders)
For best results, pesticides must be able to spread and adequately cover the surface of the pest—for example, the leaf of a weed. Some weeds have very waxy or hairy surfaces, making it difficult for herbicide to spread out and fully cover a leaf. Surfactants, also known as wetter-spreaders or wetting agents, help to spread herbicide by reducing the surface tension between the spray solution and the target surface. This allows water droplets to spread across the weed’s leaf—for example, increasing the contact area for better absorption. Surfactants are one of the most commonly recommended adjuvants on herbicide labels, especially for water-soluble and systemic herbicides.

Surfactants are categorized by ionic charge. Non-ionic surfactants (NIS) have no ionic charge and are the most common type required on labels. Organo-silicone surfactants are a newer type of surfactant and are often called “super-spreaders” due to their ability to provide greater spreading of spray solutions. Other types include cationic surfactants (positively charged) and anionic surfactants (negatively charged), but they are rarely mentioned on labels.

Oil Concentrates
Pesticides are only effective if their active ingredients are able to penetrate into the target pest, such as an insect’s tough exoskeleton. Traditional crop oils are used more often for insect and disease control than herbicides but can also be used to increase penetration through a waxy leaf coating. Many oil concentrates contain a surfactant, providing the penetration properties of oil and the spreading properties of a surfactant. Choosing the right oil concentrate depends on the source of oil base required on the product label. Oil concentrates are categorized by the oil source as shown in the chart below.

<table>
<thead>
<tr>
<th>Name</th>
<th>Ingredients</th>
<th>Ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop Oil Concentrates (COCs)</td>
<td>80-85% petroleum oil</td>
<td>15-20% nonionic surfactant</td>
</tr>
<tr>
<td>Vegetable Oil Concentrates (VOCs)</td>
<td>80-85% seed oil (corn, cotton, peanut, rapeseed, sunflower, canola or soybean)</td>
<td>15-20% nonionic surfactant</td>
</tr>
<tr>
<td>Methylated Seed Oil (MSOs)</td>
<td>80-85% methylated seed oil (modified vegetable oil)</td>
<td>15-20% nonionic surfactant</td>
</tr>
<tr>
<td>High Surfactant Oil Concentrates</td>
<td>50% petroleum or methylated seed oil</td>
<td>50% surfactant</td>
</tr>
<tr>
<td>(HSOC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Oil</td>
<td>95% paraffin or naphtha-based petroleum oil</td>
<td>5% nonionic surfactant</td>
</tr>
</tbody>
</table>
Types of Special Purpose/Utility Adjuvants

Drift Control Agents (Drift Reduction Agents)
Drift is the unintentional, off-target application of crop protection products. Factors such as severe temperatures, high wind speeds, nozzles used and small droplet size can increase drift and decrease performance of crop protection products. Drift control agents are especially important to use near sensitive sites to prevent damage to surrounding crops and when facing less than ideal weather conditions.

Drift control agents can help to improve the precise placement of a pesticide spray by increasing the spray droplet size. Larger droplets remain on leaves longer and spread better than smaller droplets, helping with improved foliar intake. Consult the product label for information about optimal droplet size and calibration of nozzles. Drift control agents are the most common adjuvant used with crop protection products, and some new dicamba herbicides even require an approved drift reduction agent (DRA) in the tank mix.

Deposition Aids (Stickers)
Deposition aids, or stickers, are often used to increase the ability of water-soluble pesticide particles to stick to a plant's surface, reducing evaporation for a waterproof coating. This stickiness helps to keep the particles in place through rain and irrigation, while preventing degradation from UV rays. Deposition aids are one of the most used adjuvants on the market, and many include a surfactant for better coverage and stickiness on a target surface.

Compatibility Agents
When aid is needed to stabilize and disperse formulations, compatibility agents are used. They ensure tank mix ingredients work together physically and chemically. By reducing clumps and uneven distribution in the tank, they prevent clogging of pumps and hoses, which can cause application problems and expensive cleanup and repairs.
**Water Conditioners**
Water is an essential and working part of any spray solution. The molecular, chemical and physical properties of water used in a tank mix can change the effectiveness of the solution. Before starting a tank mix, water should be tested to see if any properties need to be altered for maximum spray application effectiveness. Below are the different types of water conditioners used if hardness, acidity or alkalinity is detected.

► **Conditioning Agents**
Hard water can contain positively charged ions like potassium (K+), calcium (Ca+), magnesium (Mg+) and sodium (Na+). These ions can bind to and deactivate active ingredients, decreasing crop protection product performance. A water conditioner or water-softening agent will bind to molecules in hard water ions, ensuring the efficacy of the spray solution.

► **Acidifiers and Buffering Agents**
Some crop protection products like herbicides perform best in slightly acidic water with a pH of 4.0-6.5. If water is alkaline, an acidifier adjuvant can lower the pH. Adding a buffering agent, or buffer, can then stabilize the solution at an acceptable pH level for maximum performance.

**Other Special Purpose/Utility Adjuvants**
While 80% of adjuvants fall into five categories, surfactants or deposition aids (50%) and oils, foliar nutrients and compatibility agents (30%), there are several smaller categories of adjuvants as shown in figure below.

<table>
<thead>
<tr>
<th>Type of Adjuvant</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorants</td>
<td>Alter the color of spray solution to visually aid in placement</td>
</tr>
<tr>
<td>Defoaming/Anti-foaming Agents</td>
<td>Reduce or eliminate foam caused by a surfactant or agitation</td>
</tr>
<tr>
<td>Humectants</td>
<td>Slow evaporation for greater absorption; often used during high temperatures, low humidity and low spray volume situations</td>
</tr>
<tr>
<td>Foam Markers</td>
<td>Produce foam to leave a mark where product is applied to avoid skips or overlapping areas</td>
</tr>
<tr>
<td>Suspension Agents</td>
<td>Extend the amount of time a pesticide will remain in suspension once agitation has stopped</td>
</tr>
<tr>
<td>Tank Cleaners</td>
<td>Clean spray equipment by degrading or deactivating active ingredients</td>
</tr>
</tbody>
</table>
Multifunctional Adjuvants
While some adjuvants only perform one function, multifunctional adjuvants can be used to perform several functions simultaneously, according to product label needs. Multifunctional adjuvants offer added convenience and can help avoid specific compatibility issues, which can be costly and time-consuming.

Selecting the Right Adjuvant
Adjuvants are extensively tested and formulated to work just right to enhance crop protection products. Selection of an adjuvant, whether single or multifunctional, should always be based on agronomically sound information and customer needs evaluation, including the site to be sprayed, the target pest and equipment to be used. Retailers should work with their CHS Agronomy representative to find the right formulation based on their operation’s needs, and growers should work with their local agronomist for more information about the adjuvants selected for their fields.

Tank Mixing
Combining adjuvants and pesticides at the right rate, in the correct order, ensures maximum efficacy. Before tank mixing, always read and follow label directions to ensure rates and ingredients are added in the correct order, and perform a jar test to ensure compatibility, solubility and stability of ingredients. Any changes to mixing order, rate, agitation, volume, pressure of the sprayer and other environmental conditions can decrease performance.

Mixing Order and Rates
The effectiveness of a tank mix is dependent on how well the products work together. The amount and order of ingredients is extremely important. If mixed out of order or at the wrong rate, products can clump and gel instead of remaining in the solution, reducing performance and causing costly cleanup from clogged equipment. Always consult the label for the amount and order to add products to ensure physical compatibility, proper solubility and pH.

Jar Testing
During a jar test, proportionately smaller amounts of tank mix ingredients are mixed in a clear quart jar to ensure compatibility before a full solution is created. When performing a jar test, always wear personal protective equipment (PPE), and follow the mixing order as prescribed on the label. It’s also important to remember that a jar test will only show the physical compatibility of a tank mix. It will not provide information about how an ingredient may inactivate another or cause toxicity. For questions about incompatibility, retailers should talk to their CHS Agronomy representative.
CHS Agronomy develops and offers a full range of single and multifunctional adjuvants, from drift inhibitors and buffers to compatibility agents, deposition aids and surfactants to enhance herbicide, fungicide and insecticide technologies on the market. CHS Agronomy representatives can provide recommendations to fit a specific operation, such as which adjuvant to use with dicamba, glyphosate and 2,4-D herbicides, as shown below.

**CHS Agronomy Tank Mix Partners**

**Veracity® elite**

- Adjuvant Type:
  - Nonionic surfactant
  - Water conditioning agent
  - Deposition aid
  - Drift reduction agent
  - Defoamer

- Compatible Herbicides:
  - 2,4-D herbicides like Enlist™ One and Enlist Duo™*

**Veracity® elite II**

- Adjuvant Type:
  - AMS-free water conditioner
  - Nonionic surfactant
  - Drift reduction agent
  - Deposition aid
  - Anti-foam

- Compatible Herbicides:
  - Dicamba herbicides like XtendiMax® with VaporGrip® Technology*

**Last Chance™**

- Adjuvant Type:
  - Nonionic surfactant
  - Water conditioner
  - Deposition aid

- Compatible Herbicides:
  - Glyphosate herbicides*

*Always read and follow label directions.
New Soy-Enhanced Adjuvants

Our new, exclusive family of soy-enhanced adjuvants includes soybean oil refined by CHS from soybeans grown by CHS farmer-owners. This refined oil offers superior performance and handling characteristics versus traditional oil emulsion formulas. But, most importantly, using CHS refined soybean oil is another step taken to add value for our farmer-owners and the crops they produce. Learn more about two of these soy-enhanced adjuvants at the bottom of the page.

Petrichor™ is an industry-leading NPE-free oil emulsion deposition and drift reduction agent specifically designed to suppress off-target drift and increase contact activity and penetration of spray applications. Its low 3 oz/acre use rate is equivalent to the industry standard of 4 oz and because it’s made with highly refined soybean oil, it offers enhanced performance, storage stability and mixing.

Covrex™ offers a superior blend of highly refined soybean oil and nonionic surfactants to provide increased penetration and uniform coverage on a leaf surface. Designed for use with a broad range of pesticides and made with soybean oil grown by CHS farmer-owners, this crop oil concentrate provides greater value with enhanced performance, storage stability and mixing at a half-the-use rate of standard crop oil.
Retailer Opportunities
Now more than ever, it’s important for retailers to stay engaged with their CHS Agronomy representative to stay up to date on the latest adjuvant technology in order to select the best adjuvants for their operation and profitability. It’s also important for growers to talk with their agronomist about how adjuvants are vetted, selected and used to enhance crop protection products applied on their operation.

To learn more about adjuvants, visit **InTheFurrow.com**, and for a listing of available adjuvants, visit **CHSAgronomy.com**.

### Bibliography


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Always read and follow label directions.

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