

### **Adjuvants: Why are adjuvants important and what is the difference between adjuvants?**

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Adjuvants are products used to enhance herbicide activity. They act as an herbicide activator or stabilizer by modifying the physical properties of spray solutions. There are numerous adjuvants on the market including nonionic surfactants, crop oil concentrates, methylated seed oils, buffering agents, antifoam agents, drift control agents, and fertilizers; consequently, there are often questions about adjuvant importance and interchangeability. Knowledge of adjuvant activation can help with proper adjuvant selection. There are three primary adjuvant categories: surfactants, oil-based adjuvants, and spray utility agents.

#### **Surfactants**

Surfactants (spreaders, stickers, emulsifiers, wetting agents) increase surface contact, reduce runoff, and increase leaf penetration. Surfactants are activator agents that enhance herbicide performance.

- Nonionic surfactants (NIS) are water soluble chemical and lipid compounds that are not molecularly charged (positive or negative). Surfactants reduce the surface tension of the water molecule enabling the water droplet to cover a greater leaf surface area; essentially the water droplet spreads out across a larger area. Typical recommendations are 1–2 pints per 100 gallons of spray solution or 0.25 to 0.5% volume per volume (v/v). NIS typically cause less crop injury than other adjuvants, although injury can occur at higher than labeled rates. NIS are often referred to as wetting agents or spreading agents. NIS are commonly used under “average” growing conditions.
- Anionic surfactants are binding agents that form a negative ion (anion) when placed in water to enhance foaming and spreading. If the sprayer has an agitator, excessive foam can be created causing application issues.
- Cationic surfactants are binding agents that form a positive ion (cation) when placed in water. Cationic surfactants are used in cleaning compounds and NOT labeled for crop use. For this reason, be careful about using soaps as an adjuvant.

Producers often ask, “can I use kitchen dishwashing detergent (dish soap) as a surfactant?” Dishwashing detergent contains both nonionic and anionic surfactants, and depending on the concentration, there can be antagonism between the two surfactants and the herbicide resulting in crop injury and/or a reduction in efficacy. Dishwashing detergents are not labeled

for crop use, so the producer will not be protected if injury occurs. Dishwashing detergent also may leave a residue on the leaf surface.

### **Oil Based Adjuvants**

There are three categories of oil-based adjuvants: crop oil concentrates, crop oil, and vegetable oil. Oil based adjuvants slow the drying of the herbicide droplet on the leaf surface, which increases the potential for herbicide absorption. Oil based adjuvants also can improve penetration into the leaf by modifying (solubilizing) leaf surface waxes. These oil-based adjuvants can cause injury (leaf burn) if applied with an herbicide under less than ideal moisture conditions.

- Crop oil concentrates (COCs) are primarily composed of emulsifiable petroleum-based oil (83 to 85%) and a small percentage of a nonionic surfactant. Typical recommendations are 1–2 quarts per acre (or 1 to 2.5% v/v). COCs are often known as penetrating agents.
- Vegetable oil concentrates (VOCs) are primarily a crop oil such as cotton, linseed or soybean oil and a small percentage of a non-ionic surfactant. Methylated seed oils (MSOs) are vegetable oils that have been modified through a process of esterification. MSOs are typically recommended at 0.25 to 1.0% v/v of spray solution.
- Crop Oils are not vegetable based. They are more than 95 percent paraffin or naphtha-based petroleum oil with 1 to 2 percent nonionic surfactant. Basic crop oils are not commonly used with herbicides.

### **Spray Utility Agents**

Spray utility agents are adjuvants that may change the physical characteristics of the spray solution. Spray utility agents include buffering agents, antifoam agents, and drift control agents.

- Buffering agents are used to lower the spray solution pH to stabilize herbicide activity. Most pesticide activity is enhanced when the pH of the spray solution is between 4.0 and 6.5. With the exception of sulfonyleurea herbicides, pesticide activity is less stable at a pH of 7.0 or greater. Sulfonyleurea herbicides perform better in more neutral and basic spray solutions with a pH greater than 7.0

Drift control agents (DRAs) are adjuvants labeled to minimize drift by increasing droplet size and reducing driftable fines (droplet sizes <150 microns) by increasing the viscosity of the solution. DRAs are often made of vegetable oils, polyacrylamide, polyethylene, and polysaccharides. If applied at higher than labeled rates, DRAs can clog spray nozzles or even result in reduced coverage because droplets are too large resulting in poor coverage. A poor spray pattern may also occur when using DRAs with extremely coarse / ultra coarse nozzles because of the increased droplet size. Increasing spray pressure within the nozzle manufacturer guidelines may be needed to ensure an effective spray pattern.

Nitrogen fertilizers can also be used as adjuvants. Herbicide absorption can improve with the use of common nitrogen sources such as urea ammonium nitrate (UAN) or ammonium

sulfate (AMS). Fertilizers are usually recommended at 1–2 qt or 1–2 lb per acre. AMS is a humectant. Humectants are water-soluble adjuvants that slow the rate of herbicide drying and allow for enhanced absorption. The normal AMS rate is 17.4 lb per 100 gallons of water, but this can vary greatly depending upon the herbicide being used and the manufacturer's label recommendations. There are restrictions to NOT add AMS in tank mix with the new dicamba formulations (Engenia<sup>®</sup>, Xtendimax<sup>®</sup> With VaporGrip<sup>®</sup> Technology, FeXapan<sup>®</sup> herbicide Plus VaporGrip<sup>®</sup> Technology, or Tavium<sup>®</sup> herbicide Plus VaporGrip<sup>®</sup> Technology) for use in dicamba-tolerant (XtendFlex) cotton.

Some herbicides should not be used with adjuvants because of the risk of enhancing herbicide uptake and crop injury. Other herbicides may require only one adjuvant or a combination of several adjuvants. It is important to read the label and confirm the appropriate adjuvant and rate for the herbicide spray solution. Unless noted on the label, recommended adjuvants should not be substituted with other non-recommended adjuvants. With certain herbicides, one adjuvant may work better than another adjuvant or one adjuvant may be more phytotoxic resulting in greater leaf injury than another to the crop. On hot and humid days, crop oil concentrates have been known to cause more crop damage than nonionic surfactants. On the other hand, some herbicide labels may suggest to use crop oil concentrates in the semi-arid west Texas environment. While fertilizers have been known to enhance herbicide activity, fertilizers should only be used according to the label. As with dicamba, fertilizers such as UAN can also enhance the volatility of specific herbicides. Some DRAs are required when tank mixing certain herbicides with Engenia<sup>®</sup>, Xtendimax<sup>®</sup>, FeXapan<sup>®</sup>, or Tavium<sup>®</sup>. It is always advised to consult the label and/or product websites before using any adjuvant. For detailed information about specific adjuvants, consult the adjuvant compendium at: <https://ppp.purdue.edu/wp-content/uploads/2016/11/PPP-115.pdf>

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