

# Adjuvants

## A guide to oils, surfactants and other additives

**Integrated  
Crop Protection**  
PROTECTING CROPS

### Introduction

Adjuvants are additives that enhance the properties of a chemical to improve performance and/or physical characteristics. While many adjuvants are added by manufacturers, producers may add 'after-market' adjuvant products to further enhance the efficacy (effectiveness) and overall cost effectiveness of their chemical applications. The most common types of adjuvants include:

- Surfactants
- Oils
- Acidifiers and buffers
- Fertiliser adjuvants

### How do they work?

Adjuvants can work in three main ways.

#### 1. Modifying how chemical products or components interact within a spray solution

Products with this action include compatibility agents and drift retardants. Compatibility agents help spray solutions mix together, avoiding the 'layering' of water and chemical within the tank. These agents are especially useful when using oil based spray solutions, and are commonly included in 'off-the-shelf' chemicals.

Drift retardants alter the solution by increasing surface tension. This decreases the number of fine driftable droplets, by increasing the viscosity of the mix. Management practices, however, may negate the need for a drift retardant, including:

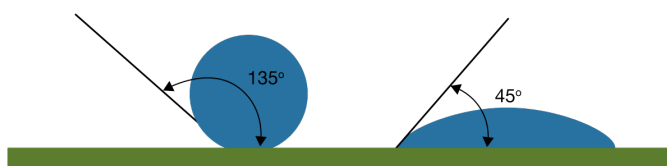
- Selecting the appropriate nozzle for the situation;
- Operating the sprayer at a lower pressure to obtain the optimal droplet size; and
- Spraying when conditions are favourable, for example, when there is not excessive wind speed.

#### 2. Modifying how the product interacts with the target surface

Surfactants work to lower the surface tension between the droplet and the target surface. This action increases the ability for the droplet to spread and stick, enhancing product efficacy.

Droplets with a high surface tension are spherical in shape. This is in comparison with droplets with a low surface tension, that will readily spread out across the surface to which they are applied (Figure 1a).

**Figure 1a:** Contact angle of a droplet on the leaf surface without (L) and with (R) surfactants.



(Source: Devine et al., 1993 adapted by Hall, 1999)

Although a lower surface tension is preferred, if the surface tension is too low, droplet size will decrease. This increases the likelihood of spray drift, reinforcing the importance of selecting the appropriate pressure and nozzles.

### Key messages

- Adjuvants are additives that enhance or modify the action of a chemical.
- They are commonly classified into broad categories including oils, surfactants, buffers, acidifiers and fertiliser adjuvants.
- Adjuvants can modify how a chemical forms, spreads or behaves within the spray solution and/or on the target pest.

For herbicides, low surface tension does not always increase product efficacy. Research has shown that for glyphosate, imazethapyr, nicosulfuron, primisulfuron and thiensulfuron-methyl herbicides, reduced droplet size does not always correlate with improved weed control. It is important to always consider the product you're using, if it has any pre-added adjuvants and if any further additives are required.

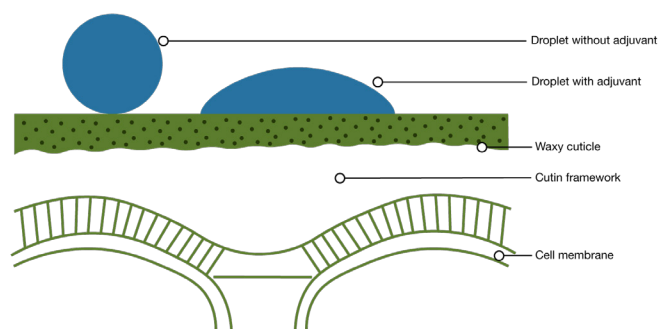
### 3. Modifying how a product moves into a target

To enhance performance, adjuvants may alter the behaviour of droplets or the surface of target pests.

Adjuvants can alter droplet behaviour once in contact with a leaf or insect surface. This will assist in targeted penetration into the pest, as shown in Figure 1b. This can be achieved through:

- Physically disrupting the target surface by dissolving waxy deposits. This may cause the spray to be less effective and damage the crop by reducing the selectivity of the chemical.
- Reducing surface tension. An example of this is how glyphosate, with an added surfactant, reduces surface tension to enter through the stomata.

**Figure 1b:** Cross section of a leaf surface with a spray droplet on the surface without (L) and with (R) an adjuvant. The waxy surface acts as a barrier to water droplets.



(Source: Rochecouste, 2004)

It should be noted that the use of oils may cause phytotoxicity to crop plants under certain conditions, such as heat or ultraviolet light, following application.

## What types are available?

### 1. Surfactants

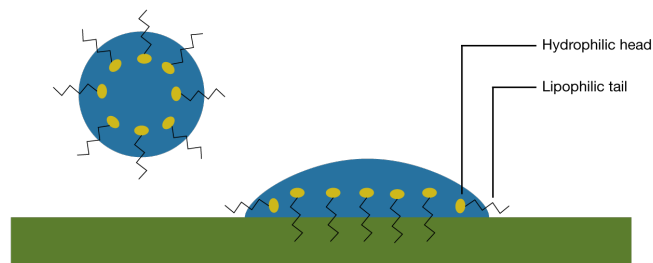
Surfactants are the largest group of spray adjuvants, acting as wetters or spreading agents. Their main role is to act on the surface of the droplet to reduce surface tension, improving the spread of the chemical on the target pest.

They are made up of two functional components, a 'water-loving' (hydrophilic) structure, attached to a 'fat-loving' (lipophilic) component, as shown in Figure 1c. Referred to as a hydrophilic-lipophilic balance, this is a measure of the degree to which the surfactant is hydrophilic or lipophilic.

The balance, size and type of hydrophilic and lipophilic portions can have a significant impact on the efficacy of adjuvants.

Surfactants can be positive (anionic), negative (cationic) or no-charge (non-ionic), and are classified on the charge held by the hydrophilic group.

**Figure 1c:** Interaction of hydrophilic and lipophilic parts of a surfactant to reduce surface tension and spread the droplet.



(Source: Hall et al., 1999)

### 2. Oils

Oils work to increase penetration into the plant or pest target, reduce evaporation, and extend the active life of chemicals. They can be classified into two main categories based on their origin:

- Vegetable based oils (plant)
- Petroleum based oils (mineral)

Further classification is based on their formation. Petroleum based oils are classified by the levels of the surfactant/emulsifier added, whereas vegetable based oils are classified according to whether or not the adjuvant is esterified.

Although chemical performance is generally enhanced by the inclusion of oils, it is not applicable to all herbicides. For example, the addition of oils to glyphosate, which is highly soluble in water, may reduce performance. It is important to check compatibility before adding an adjuvant to the spray tank.



*Many pesticides come with adjuvants already added, so it's worth checking the label before adding a product. (Amazone, 2010)*

### 3. Acidifiers and Buffers

Acidifiers and buffers work to modify a solution through reducing or stabilising pH. This can enhance the efficacy of herbicides and fungicides, reducing the risk of alkaline hydrolysis. Most acidifiers and buffers are 'dual-purpose' with a surfactant added to improve performance.

**Acidifiers** are a mix of organic acids with surfactants, and inorganic acids.

**Buffers** are based on various salts of organic or inorganic acids and occasionally include non-ionic surfactants.

For herbicides present in a salt form, such as 2,4-D, a low pH may increase efficacy. Research has shown that products such as 2,4-D and other weak acid herbicides, may benefit through increased absorption and translocation if applied at a pH below 6. It must be noted that acidifiers are not always helpful to all chemicals, and may result in 'salt out' or gelling of a product at low pH.

As for insecticides, currently, no labels recommend the use of these agents to ensure efficacy. Although acidifiers and buffers reduce the impact of alkaline hydrolysis, it is best to use a formulated product that has buffering capacity built in.

### 4. Fertiliser Adjuvants

Fertiliser adjuvants are fertilisers added to herbicides to increase performance. The most common active ingredient of these adjuvants is ammonium sulphate.

Research indicates that ammonium sulphate increases the efficacy of many salt-based formulations such as glyphosate and 2,4-D. It is important to always check the label for advice, as only a limited group of herbicides recommend the use of ammonium sulphate, including glyphosate, imazethapyr and pyrasulfotole.

Prilled ammonium sulphate is antagonistic to glyphosate and the products should not be used together.

Other fertilisers, such as urea and liquid fertilisers, with nitrogen in an ammonium form, may also increase efficacy.

### 5. Others

#### Organic Acids

Organic acids may be used to 'condition' water for use in a spray solution to improve efficacy. The most commonly used organic acid is food grade citric acid.

#### Feeding Modifiers

These include products that modify the feeding behaviour of their insect host, including milk powders and 'AminoFeed', among other biological products.

#### Dyes

Dyes improve the consistency of application and subsequent performance by visually indicating the treated areas and coverage to operators. Although red and blue dyes are most commonly used, titanium dioxide based dyes are also available, lasting for several months. These white dyes are highly visible and are useful when sprinkler and gas-gun application methods are used.

#### Activators

Activators work to increase the biological effectiveness of chemicals. Substances used as activators include surfactants, fertilisers (ammonium based) and oils.

## Adjuvant Recommendations

The most important rule to follow when considering using adjuvants, is to read the label carefully and use the adjuvant recommended by the manufacturer. If there is no adjuvant recommended, you do not need to add one.

When choosing an adjuvant, it is important to choose one that is compatible with your pesticides active ingredients. For further information and advice on adjuvant use, you should consult with the company who manufactures the product you are using. As an indicative guide only, you can use the products mode of action to support adjuvant selection, as shown in Table 1.

**Table 1:** A quick guide to adjuvant use recommendations based on pesticide mode of action (MOA).

I WANT TO SPRAY...	ANSWER
<b>Herbicide Groups</b>	
A, B, C, G, M	Adjuvants frequently recommended for most products in these groups
F, H, I, J, L, N, Q, R, Z	Some adjuvants required for some products
D, E, K, O, P	No adjuvants recommended
<b>Insecticide Groups</b>	
1A, 1B, 2B, 3A, 5, 6, 7, 10, 11, 12, 13, 1B, 22A, 28	Adjuvants required for some products in some applications
2A, 7, 8, 15, 16, 17, 19, 20, 21, 24, UN	No adjuvants recommended
4A, 9B	Adjuvants mostly recommended
<b>Fungicide Groups</b>	
1, 2, 4, 9, 11, 33, M1, M2, M7, M9	Adjuvants required for some products in some applications
3, 40, M3	Adjuvants recommended in many situations
5, 7, 8, 12, 13, 14, 17, 20, 28, 29, M, M6, M7	No adjuvants recommended
Plant growth regulators	Adjuvants recommended in many situations
Harvest aid products	Adjuvants recommended in many situations
Foliar nutrients	Adjuvants sometimes recommended

## Acknowledgement

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