# SPRAY ADJUVANTS – AN IMPORTANT INVESTMENT OR JUST ANOTHER INPUT COST?

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## TAKE HOME MESSAGES

- Adjuvants are any product that modifies the physical, chemical or biological properties of the spray.
- Adjuvants can improve performance of products used to spray crops and/or weeds, but careful consideration is needed to choose the correct one.
- It is not a one-size-fits-all approach; some adjuvants are better suited to particular situations than others.

## BACKGROUND

Spray adjuvants have become a multimillion-dollar industry in the past 50 years, but they're still often considered the mystery component of any spray mix. Common questions include:

- Has the investment delivered on the promise?
- How can we be more astute in the way we use adjuvants?
- Are there any potential downsides when we add adjuvants to the spray tank?
- What are spray adjuvants and why are they important?

This article may help answer some of these questions.

## WHAT ARE SPRAY ADJUVANTS?

A spray adjuvant is any material included in the preparation of spray mixes that does not have pesticidal activity, but modifies the physical, chemical or biological properties of the spray.

### Physical effects of adjuvants

At the physical level, many spray adjuvants comprising surfactants or oils (petroleum or plant-based) affect the way in which droplets are formed by an atomiser (nozzle). They alter surface tension and the rate at which droplets evaporate once released. The composition of herbicides can alter droplet characteristics and some adjuvants can further change spray properties to either increase or decrease the potential for drift.

Results of drift studies (Congreve M., *et al*, 2019) show the addition of BS1000 increased the percentage of droplets drifting through an AIXR 110-02 nozzle. LI-700®, Deadsure®, Kombo 950 and Liberate® reduced this percentage compared to nine common summer fallow herbicides applied alone or in combination. This highlights the need for careful decisions about adjuvants, particularly in sensitive crops or adverse weather conditions.

### Chemical effects of adjuvants

At the chemical level, inclusion of spray adjuvants can positively or negatively affect the physical compatibility of products in the spray tank. For example, the integrity of some emulsifiable concentrate herbicides can be undermined in tank mixing with other surfactant-containing products. Separation can lead to filter blockages as a relatively insoluble active constituent is drawn out of solution. In another example, the reduction in pH of solution from adding an acidifying material can be enough to cause 2,4-D amine to become insoluble, leading to filter blockage. This can occur when mixing glyphosate and 2,4-D formulations because glyphosate has an acidifying effect on the solution. Care must be taken in rate selection, water volumes at time of mixing and ensuring adequate agitation, before adding extra products to the tank. In the case of acidifying products, adding an adjuvant such as sodium bicarbonate can restore solution pH to a level that will enable 2,4-D amine to remain in the solution.

### Compatibility effects of adjuvants

Compatibility agents are adjuvants which enable mixing of products including liquid fertilisers and micronutrients into a sprayable solution. They are quite often used to alter the pH of a chemical mix or for overcoming instability by introducing additional surfactant. This can re-balance emulsion or suspensions in solution, allowing effective mixing and activity of products.

## WHY ARE ADJUVANTS IMPORTANT?

Most interest in spray adjuvants is directed at the biological effectiveness of applied pesticides. In the first instance, products including surfactants reduce surface tension of spray droplets – this enables a more effective spread over treated surfaces and reduces the possibility of spray droplets rolling or bouncing off leaf surfaces. Many spray adjuvants also reduce the evaporation of spray deposits from leaf and stem surfaces (humectancy). This is particularly important for glyphosate.

The principal role for spray adjuvants is that of 'activation' or facilitating uptake of the active constituent across the plant cuticle. This effect is not always well defined but helps explain why the effectiveness of adjuvants modifying surface tension often exceeds that considered optimal for spreading and wetting. It also might explain why products that are very effective as 'wetters' do not always result in optimal activity by herbicides.

Where are spray adjuvants crucial for herbicide effectiveness? Table 1 summarises the mode of action groups for various foliar-applied herbicides. It should be noted that many products already contain adjuvants to encourage activation. These include glyphosate, glufosinate and paraquat (excluding high load formulation Gramoxone® Pro) but levels are not always optimum at all rates or in all spray volumes, so an additional adjuvant is recommended in some cases. Also, the effectiveness of herbicides on some specific weeds can be further improved by including some spray adjuvants but not others.

A further complication is the possibility that adding spray adjuvants might even reduce the effectiveness of applied treatments. Examples have been noted where addition of some surfactants has reduced the performance of glyphosate formulations compared to the product applied alone with no adjuvant addition. For this reason, there is a need to closely examine routine use of spray adjuvants and test assumptions that adding a spray adjuvant can do no harm to product performance.

**Table 1. Responsiveness of herbicides to spray adjuvant addition.**

| Mode of Action (MOA) | | Example | Surfactants | Plant oils | Mineral oils | Other |
|---|---|---|---|---|---|---|
| A | Haloxyfop | Verdict™ | Not preferred | Yes | Yes | |
| | Clodinafop | Topik® | Yes | Yes | Yes | |
| | Propaquizafop | Shogun® | Yes | Yes | Yes | |
| | Quizalofop | Targa® | | Yes | Yes | |
| | Pinoxaden | Axial® | | Yes | No | |
| | | Axial® Plus | | No | Yes | |
| | Butroxydim | Factor® | | | Yes | |
| | Tralkoxydim | Achieve® | | | Yes | Ammonium sulphate |
| | Clethodim | Select® | | Yes | | Ammonium sulphate |
| B | Chlorsulfuron | Glean® | Yes | | | |
| | Iodosulfuron | Hussar® | Yes | Yes | | |
| | Mesosulfuron | Atlantis® | Yes | Yes[2] | | |
| | Metsulfuron | Ally® | Yes | | | |
| | Triasulfuron | Logran® | Yes | | | |
| | Tribenuron | Express® | Yes[1] | | | |
| | Florasulam | | Yes | | Yes[3] | |
| | Flumetsulam | Broadstrike™ | Yes | | Yes | |
| | Metosulam | Eclipse® | | | Yes[7] | |
| | Pyroxsulam | | Yes[4] | | | |
| | Imazethapyr | Spinnaker® | Yes | Yes | | |
| | Imazamox | Raptor® | Yes | Yes | | |
| | Imazapyr + imazamox | Intervix® | | Yes | | |
| | Imazapic + imazapyr | Sentry® | | Yes | | |
| C | Atrazine | Gesaprim® | Yes | Yes | Yes | |
| | Terbuthylazine | Terbyne® | | Yes | | |
| | Simazine | | | | | |
| | Diuron | | | | | |
| G | Oxyfluorfen | Goal® | | | | |
| | Carfentrazone – fallow | Hammer® | | Yes | | |
| | Carfentrazone – crop | Affinity® | | No | | |
| | Flumioxazin | Terrain® | | Yes | | |
| | Saflufenacil | Sharpen® | | Yes | | |
| H | Pyrasulfotole | Velocity® | | Yes | | |
| | | Precept® | | Yes | | |

| Mode of Action (MOA) | | Example | Surfactants | Plant oils | Mineral oils | Other |
|---|---|---|---|---|---|---|
| I | 2,4-D | | | | | |
| | MCPA | | | | | |
| | Fluroxypyr | | | | | |
| | Triclopyr | | | | Yes[1] | |
| | Clopyralid | | | | | |
| | Aminopyralid | | Yes[5] | | | |
| | Halauxifen | | Yes[4] | | Yes[3] | |
| L | Paraquat | Gramoxone® | | | | |
| | | Gramoxone® Pro | Yes | Adigor | | |
| M | Glyphosate | Glyphosate 450 | Yes[6] | No | | Yes |
| | | Roundup® Ultramax | No | No | | Yes |
| N | Glufosinate | Basta® | No | | | |

1. When used alone. 2. For brome grass and barley grass only. 3. When used as Paradigm™. 4. When used as Rexade™.
5. When used as Stinger™. 6. When used at low concentrations (<1.5 % v/v). 7. Not in mixtures with metsulfuron.

Table 1 shows the performance of products from Groups A, B, C (foliar applied only), G, H and L (Gramoxone® Pro only) are highly dependent on the addition of a recommended spray adjuvant to achieve best results.

On the other hand, adjuvants used to assist performance of Group I products are infrequently required, except in instances where they are formulated with other products highly dependent on adjuvants for activity. These include Paradigm™ (Arylex™ + florasulam) and Stinger™ (aminopyralid + metsulfuron). This approach would also apply to tank mixes of products.

Basta® and similar products containing glufosinate have a high concentration of surfactant so the addition of more is unlikely to be of benefit.

Glyphosate products are more complex as they vary widely in both the type and concentration of surfactant in commercial formulations. In the original formulation, glyphosate was formulated with tallowamine ethoxylate surfactants as these proved most effective over a wide range of target weeds. Most of the current 450g/L formulations still use this type of surfactant, but concentrations have progressively been reduced: as a way of decreasing costs of production and based on the assumption that commonly used surfactants such as the alkyl alkoxylate type (eg. BS1000) will make up for any deficiency in the formulated product. This may be true in some instances, but not in others where low dilution rates are used in commercial practice (<1.5% v/v). On the other hand, where high concentrations are used, such as in spring and summer fallow situations, surfactant concentration will be enough to ensure optimum performance.

High load formulations are a separate case. Branded products have been formulated and tested to support the claim that no additional surfactant is required for most uses. Most of these formulations contain a blend of surfactants and some still retain the highly effective tallowamine ethoxylate product. In most situations, the addition of a surfactant is not required and in some cases there may be a downside to it.

## AMMONIUM SULPHATE

The use of ammonium sulphate as a 'water conditioner' developed around uses with glyphosate, particularly where water containing high concentrations of divalent metal ions, including calcium and magnesium, were present. However, benefits to glyphosate performance were seen more widely – though not on all weed species – and in situations where tank mix partners that reduced glyphosate activity were included. Ammonium sulphate was found to reduce antagonism caused by including simazine with glyphosate and with some Group I herbicides including 2,4-D amine and fluroxypyr.

Ammonium sulphate also has been useful with 'dim' herbicides, especially clethodim, where water containing high concentrations of bicarbonate ions was present. It seems prudent to consider using ammonium sulphate more often with dim herbicides, in light of Group A resistance.

## NEW ADJUVANTS AND THE NEED FOR EVIDENCE-BASED USE

There is much at stake in preserving or enhancing the effectiveness of farm chemicals as there is no guarantee of a replacement around the corner.

Opportunities to employ new spray adjuvant products are seemingly endless. Some new products are promoted widely on the back of a relatively narrow body of evidence, so a measure of caution is needed. It is also clear that use situations, environmental conditions and application methods vary widely, and this points to the need to prove up our spray adjuvant use on a local basis. This highlights the need for cooperative farm-based evaluation to supplement data generated at locations distant from the intended place of use.

### REFERENCES

Congreve M., and Cameron J., (eds) 2019. Adjuvants – Oils, surfactants and other additives for farm chemicals used in grain production. Revised 2019 edition. Accessed at https://grdc.com.au/adjuvants-booklet

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