# SPRAY MIXING REQUIREMENTS FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

**NATIONAL**
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## Mixing requirements for spraying operations

PHOTO: GRAHAM BETTS


**Jar tests can be done in the paddock prior to mixing the chemicals. Chemicals can be measured using syringes, by substituting mL for L/ha and mixing in the same ratio and order as the actual tank mix.**

### Importance of correct mixing order

Correct mixing order reduces the risk of products interacting in a way that may reduce their efficacy or affect the stability of the tank mix.

The addition of multiple products to the spray tank must take place in a specific order to ensure they can be adequately mixed through the solution, according to their solubility and formulation type.

Bringing most products into contact with each other in a concentrated form will usually result in undesirable interactions between products.

Applicators must understand what the formulation and adjuvant type is for each of the products they intend mixing.

Information about the correct mixing order can often be found on the product label. However, for some tank mix combinations, further information may be required from the manufacturer through tech notes or product guides.

### KEY POINTS

- Understand what the formulation type is for each product and adjuvant being used.
- Never bring concentrated products into contact with each other through mixing equipment or in low tank volumes.
- Know the correct mixing order for every tank mix you use.

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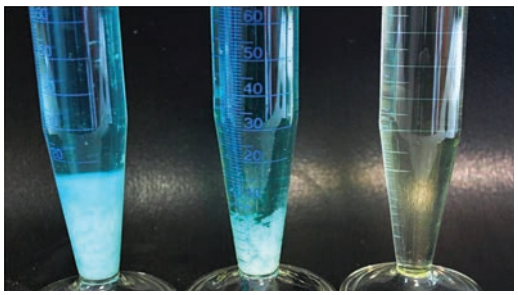
## TABLE 1 Formulation types and products.

| Formulation type | Code | Example of products |
|---|---|---|
| Water dispersible granules, water-soluble granules and dry flowables | WDG | Spinnaker 700 WDG |
| | WDG | Simazine 900 WG |
| | DF | Penncozeb 750 DF |
| Suspension concentrates | SC | Regent® 200SC |
| | SC | Mancoflo 420 SC |
| Emulsifiable concentrates | EC | Broadside® |
| | EC | Bromicide® 200 |
| | EC | Triclopyr 600 |
| | EC | TriflurX® |
| | EC | Fastac® Duo |
| Soluble liquids (which include soluble concentrates and aqueous concentrates) | SL | Amicide Advance® 700 |
| | SL | Kamba® M |
| | SL | Spray.Seed® |
| Soluble liquid (containing glyphosate) | SL | Weedmaster® Argo |
| | SL | Roundup® Ultramax |
| | SL | Gladiator CT |

## TABLE 2 Adjuvant types and products.

| Adjuvant type | Types of products | Examples |
|---|---|---|
| Surfactants | Wetter 1000 products | BS 1000® |
| | Organosilicones | Pulse® |
| | Stickers | Bond® |
| Oils | Petroleum-based oils | Uptake® |
| | Vegetable oils | Hasten® |
| Acidifiers and buffers | Acidifier/buffer | LI 700® or Collide® |
| | Buffer | Primabuff® |
| Fertiliser adjuvants | Ammonium sulfate based | Liase® |
| | | Boost® |
| | | Free Flow Ammo® |



Three possible outcomes of the jar test: Left – layers forming, middle – sediment produced, right – well mixed.
PHOTO: NUFARM LTD

## TABLE 3 Basic chemical mixing order.

| Mixing order | Water – chemical – additives | Example of product |
|---|---|---|
| 1 | Water conditioners, acidifiers, etc. | Liase®, LI 700® |
| 2 | Wettable, dispersible granules | Lusta®, Nugran®, Associate® |
| 3 | Dry, flowable (DF) | Diuron (WG), Simazine (DF) |
| 4 | Flowables (suspension concentrates) | Regent® 200SC |
| 5 | Wetter if using ECs*1 | Activator®, BS 1000® |
| 6 | Emulsifiable concentrate (EC) | Triflur® X™, Avadex® Xtra, Estercide Xtra 680® |
| 7 | Water soluble concentrates | Amicide Advance 700®, Gladiator CT |
| 8 | Adjuvants | Oils*2, LI 700®*3, BS 1000® |
| 9 | Liquid UAN | Easy N |

*1 Wetter to be added at stage 5 if using ECs

*2 Oils must be added last to all mixes

*3 If added at stage 1, do not add at stage 5 or 8

When adding water conditioner, fill spray tank as full as practical while adding water conditioner.

Add water conditioners before adding any chemicals.

There are some exceptions to these basic guidelines:

- Glyphosate and some 2,4-D products. See mixing instructions for isopropylamine forms of 2,4-D:
  1. Clean water
  2. Add water conditioners
  3. Add other herbicides, insecticides, etc. Mix thoroughly
  4. Add 2,4-D product
  5. Fill the tank to around 95%
  6. Add glyphosate
  7. Add other adjuvants
  8. Add remaining water
- Glyphosate and Starane™ Advanced Herbicide. Refer to the Starane™ Advanced label. Glyphosate is put in the spray tank before Starane™ Advanced.

SOURCE: NUFARM AND ASK GB

### FIGURE 1 A simple jar test

**A guide to the suitability of water for spray applications can be quickly obtained using the following procedure:**

1. Mix at least 500mL of correctly diluted spray in a clear glass sealed container according to the manufacturer's instructions.
2. Mix thoroughly and allow to stand for up to 30 minutes.
3. If creaming (where suspended droplets of product appear to remain in a layer at the top of the jar), sedimentation or separation into layers occurs, the water may be unsuitable for mixing sprays.
4. If suspected of being unsuitable, a sample of this water should be chemically analysed for salt and hardness levels.
5. Different brands of the same chemical may react differently because of different additives in each formulation.

### FIGURE 2 Mixing instructions for isopropylamine forms of 2,4-D

**Ensure the spray tank is free of any residue of previous spray materials.**

**1** **Fill the spray tank with clean water to the recommended amount before introducing the products. Often this requires the tank to be around 70 per cent full before starting the agitation. Do NOT use mechanical agitators as these may cause excessive foaming when herbicides are added.**

**2** **Add water conditioners at the required rate.**

**3** **Add recommended herbicide additive/insecticide to the spray tank and mix thoroughly.**

**4** **Add isopropylamine form of 2,4-D and mix thoroughly.**

**5** **Top up tank to 95 per cent of desired capacity then add the glyphosate product and remaining water.**

**6** **When surfactant is used, add near the end of the filling process to minimise foaming.**

**7** **Always maintain adequate agitation during application and use the tank mix promptly.**

Adapted from a Nufarm label for a product that is no longer registered.

## Jar test – water volume

The easiest way to simulate actual tank-mix ratios is to divide everything by 100. For example, 70 litres per hectare (L/ha) becomes a 0.7L volume in the jar. It is a good idea to use the same water source that is going to be used to spray with. If the initial mixing takes place with 60 per cent tank capacity of water, this should be reflected in the jar test as well. For example, 60 per cent of 0.7L would amount to 0.42L (0.7 x 0.6 = 0.42) for the initial volume of water in the jar.

## Jar test – product rates

Product rates for the jar test should also use the field rate divided by 100 (see Table 4). For example: a rate of 2L/ha, or 2000 millilitres per hectare (mL/ha) becomes 20mL per test, a rate of 800mL/ha becomes 8mL per test, and so on.

Adjuvants can be a little trickier because they are mixed at a rate per 100L. For example, 2000mL per 100L of water with a liquid AMS becomes 20mL per litre. For a tank mix to be applied at 70L/ha, the total jar test volume would be 0.7L, not a whole litre. The amount of liquid AMS to add to the total jar volume of 0.7L would be 14mL (20mL per litre x 0.7L = 14mL).

It is useful to have some syringes to measure small volumes. They are easily obtained from pharmacies or medical supply shops and come in various sizes; 3mL and 20mL should provide sufficient volume variation. Dry products require scales: a portable scale (electronic balance) should provide reasonable accuracy in the 10–20 gram range.

## Conducting the jar test

The mixing order should be the same as that used in the field. Shaking the jar after mixing will simulate agitation. When dry products are used they should be fully dissolved before the next product is introduced (this may require a separate container to dissolve dry products, if that is what you do in the field). Waiting for products to fully dissolve may take some time, (for example, when using crystalline ammonium sulfate), but this is also what will be required for the actual tank mix.

After the mixing is finished the jar should be left to stand for for at least 5 minutes, ideally up to 30 minutes.

## Possible results of the jar test

- The jar contains a homogenous solution. This is where the whole mixture appears consistent in appearance. This is the best result a jar test can produce. The mixed solution seems to be stable and suggests that the planned tank mix is physically compatible and products will be able to be mixed in the tank.
- The jar contains thick layers or banding in the profile. This indicates that the solution is not stable without agitation. If some shakes of the jar can make the solution homogenous again, and it stays this way for two minutes before layers start to form slowly again, it can be assumed that agitation should overcome the problem. However, if the banding returns within about 30 seconds, it is a strong indication that there will be a problem with the tank mix that even good agitation may not be able to overcome.
- There is sediment or precipitate on the bottom of the jar. This indicates strongly that the mix is not physically compatible or the mixing procedure was not right, e.g. adding 2,4-D before allowing sufficient time for crystalline ammonium sulfate to dissolve.

**TABLE 4 An example of field rates and the rates to be used for a jar test.**

| Example of volumes in a jar test (one-hundredths of a hectare rate or volume) | | | |
|---|---|---|---|
| Field rates | | Jar volume or amount | |
| Total application volume | 70L/ha | 70 ÷ 100 = | Final jar volume 0.7L |
| Initial mix – starting water volume | 60% tank capacity | 0.7 x 0.6 = or 0.7 x 60% | Initial jar water volume 0.42L |
| Liquid AMS | 2000mL per 100L | 2000 ÷ 100 x 0.7 = | 14mL |
| 2,4-D | 800mL per ha | 800 ÷ 100 = | 8mL |
| Glyphosate | 2000mL per ha | 2000 ÷ 100 = | 20mL |

SOURCE: GRDC GROWNOTES, SPRAY APPLICATION MANUAL FOR GRAIN GROWERS

## Knowledge of formulation types is essential for mixing

Formulation type is sometimes indicated on the product label if it is incorporated into the name of the product (for example, Simazine 900DF for dry flowable, or Chlorpyrifos 500 EC for emulsifiable concentrate), but this is not always the case.

Examples of formulation types and products are shown in Table 1.

## Adjuvant types

The type of adjuvant is also important for determining the correct point during the mixing process that it should be added.

The addition of adjuvant to the tank mix can change depending on the formulation of the products actually being mixed.

Examples of adjuvant types and products are shown in Table 2.

## Mixing order

Table 3 and Figure 2 include the suggested mixing orders for a range of situations.

## Jar tests to assess physical compatibility

If you are unsure about the ability to mix certain products it is always a good idea to contact the manufacturers for further information, and to conduct a jar test to confirm physical compatibility (see Figure 2). A jar test can only tell you if the products are physically compatible (able to be mixed). It will not tell you if there are problems with biological compatibility, where one product may interfere with the biological activity of another.

## Summary

Mixing order is critical to ensure that tank mixed products perform to their potential. Understanding formulation type and adjuvant type are an important part of getting the mixing order right. If in doubt about the compatibility of products in a tank mix, contact the manufacturers and conduct a jar test to ensure they will mix.

## FREQUENTLY ASKED QUESTIONS

### When should I add adjuvants?

That will depend on the adjuvant type. Water conditioners such as ammonium sulfate should be added to the recommended amount of water before other products are introduced into the tank. Surfactants such as Wetter 1000 products are introduced at the end, unless liquid UAN is used which would go in after the wetter. If one of the products is an EC formulation the wetter would be added after the dry products, so always check the mixing order chart.

### Why do I get excessive foaming when I am mixing some products?

Often foaming results when using the Venturi system to fill the spray tank. Sometimes foaming can be reduced by having more water in the tank before introducing products or by using anti-foaming agents. Where these strategies do not work, it might require that filling be done using an external pump.

### How can I tell if products I have not used before can be mixed together?

Often there will be information about compatibility on the product labels. If specific information about the products you want to mix is not on the label, It is best to contact the manufacturer of the product before mixing takes place. If you are still in doubt conduct a jar test, which will let you know if they are physically compatible. Remember that even if they can be mixed, this will not tell you if they are biologically compatible.

### Why do some products 'gel' when mixed together?

Often this can result from a couple of factors interacting, which are water quality, mixing order and water temperature. Sometimes gelling can be accelerated if water is at a high temperature and water quality is not suitable. Other times gelling can occur with some products at low water temperatures. It is essential that water quality is considered as a part of the solution, and when using water conditioners that they be added to the water and sufficient time is allowed for them to dissolve before other products are added. Then make sure the correct mixing order is followed.

## RESOURCES

**Graham Betts, 'Water Quality and Your Spray Product' in *Adjuvants: Oils, surfactants and other additives for farm chemicals*, revised 2014 edition.**

**https://grdc.com.au/AdjuvantsBooklet**

## MORE INFORMATION

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