AGROCHEMICAL FORMULATIONS

The chemical and physical properties of an active ingredient, such as solubility in various solvents, susceptibility to degradation, melting point, acidity or alkalinity etc, often dictate the most suitable type of formulation. Formulation types include:

- Wettable Powders (WP)
- Water Dispersible Granules (WDG)
- Dry Flowables (DF)
- Flowables or Suspension Concentrates (SC)
- Emulsifiable Concentrates (EC)
- Soluble Liquid Concentrates (SLC)
- Water Soluble Granules (WSG)

The key differences between the above formulations are the type of delivery system used (1) with regard to solvents and (2) the use of surfactants that provide both physical and chemical stability. These inert systems are the product-specific components most likely to be affected by mixing multiple products.

SURFACTANT SYSTEMS

Surfactants are required to produce stable emulsions or suspensions that enable homogeneous application of chemicals. Differences in the nature of surfactants make them suited to specific formulation types, e.g. different surfactants are used in emulsion concentrates compared to suspension concentrates. The key parameter used to determine suitability of a surfactant for a particular type of formulation is the HLB (see page 34). Various chemical actives have a typical HLB assigned, which is then used to select an appropriate surfactant of similar HLB. Often a blend of two or more surfactants is used. This blend has an averaged HLB at the required value in order to improve stability over a wider range of water qualities. The amount of surfactant used is also very important for each particular product to perform as intended in the field.

When mixing products the final HLB achieved may sometimes be unsuitable for one or more of the components. Consequently, it may result in poor suspension or emulsion characteristics. This, in turn, may manifest as layering, settling or gelatinous materials blocking filters, which is referred to as antagonism. If adjuvants such as spray oils (which may not contain very much surfactant) are added, this may produce a similar effect, which is referred to as surfactant overload. Surfactant overload occurs when there is insufficient surfactant reserve in the formulations to cope with the addition of oil.

THE IMPORTANCE OF MIXING ORDER FOR AGROCHEMICALS

The manner in which a surfactant and active interact with each other when added to water in the spray tank is critical to reach a stable emulsion or suspension.

WETTABLE POWDERS

These must be added to the water first because they have a very large surface area to be wetted. In order for these particles to be dispersed as individual particles of the right micron size that ensure a stable suspension, the surfactant system for that particular active should not be compromised by the presence of surfactants of differing HLB or, in particular, a lipophilic (oily) substance.

WATER DISPERSBLE GRANULES OR DRY FLOWABLES

These require a similar process to Wettable Powders. In this case, the granules need to disintegrate into individual particles that will ultimately form the suspension.

As granules are heavier than powders, they break the surface of the water and sink towards the bottom of the tank. Again, if they contact oily materials prior to complete disintegration, the suspension stability is compromised.

FLOWABLES

These contain particles already wetted, but in a concentrated, slurry form. These particles disperse and suspend at a faster rate than dry products, but are still susceptible to antagonism from oil-based products and their specific HLB surfactant systems.

This is most likely to occur if the Flowable product is added to an emulsifiable concentrate or spray oil.
inhibiting the dispersant and suspending agents from working effectively. It can also occur if the Flowable has been added to a minimal volume of water, followed by the addition of the emulsifiable concentrate. In this case the concentrated mix is more likely to be antagonised and destabilised.

As the Wettable Powders, Dry Flowables and Flowables have very low solubility in water, they cause a minimal increase in the ionic strength of the water. This allows the suspension to remain stable and still provide capacity for emulsification of oil/hydrocarbon-based products. The emulsifiable concentrates can form stable emulsions in the available water, provided that the final HLB of the surfactant mix and functional chemistry of these compounds are compatible.

**SOLUBLE LIQUID CONCENTRATE**

These products, e.g. Glyphosate CT, are the final product type to be added. This is because the active is already dissolved in water and is therefore only diluted in the spray tank mix.

These products will increase the ionic strength of the water phase, but not usually enough to break or destabilise emulsions.

**ADJUVANTS**

Adjuvants, especially oil-based adjuvants, are added last so that all other products have the maximum chance of being fully dispersed/suspended or emulsified prior to this addition.

**OVERCOMING POTENTIAL USE PROBLEMS**

The most effective way of pre-screening mixes being contemplated for the first time is by conducting a jar test.

This test prevents costly, time-consuming and environmentally unfavourable situations occurring. Manufacturer’s guidelines should be followed because they have the best knowledge of the performance and capabilities of their products and surfactant systems in use. Manufacturers can predict, with more certainty than anyone else, the potential for favourable or unfavourable situations occurring.

**INVERT OR REVERSE EMULSIONS**

When introducing high load Oil/Wetter combinations such as Bonza® into the spray tank, following the correct procedure is important to prevent the possibility of a mayonnaise like thick white foam or cream forming that can cause problems in the tank mix. This phenomenon is known as an invert or reverse emulsion and it occurs if the initial contact of the oil with the spray solution takes place in too low water volumes.

Small amounts of water form emulsion droplets in the oil phase rather than small amounts of oil forming emulsion droplets in the water phase. Cold water can exacerbate the problem.

The key to prevent such occurrences is to ensure that oils are not mixed in low water volumes. The risk rises when using Granni Pot or Suction Probe systems.

- When an induction system is used the most reliable method to mix oil is to put only oil in the induction tank – do not pre-mix with water
- If a pre-mix with water is used in an induction system the ratio of mixing must be at least 1 to 10 (oil to water)
MIXING ORDER

STEP 1
Fill the spray tank to at least 70% full. Run agitation.

STEP 2
Add any water conditioners. Liasse (ammonium sulphate 2 L/100 L) LI 700 (at 100 mL/100 L-acidification rate).

STEP 3a
Add any WDG products.

STEP 3b
If you have added in WDG products - ALLOW AT LEAST 10 MINUTES FOR COMPLETE DISPERSION.

STEP 4
Add any Suspension Concentrate (SC) products.

STEP 5
Add any Emulsifiable Concentrate (EC) products.

STEP 6
Add any Soluble Liquid (SL) products.

STEP 7
Fill the spray tank to nearly full.

STEP 8
Add any glyphosate based products.

STEP 9
Add any adjuvants and fill the tank.

Unless sure, do not tank mix multiple products before checking compatibility charts/labels. Physical compatibility does not guarantee biological compatibility. Do not tank mix with other products or trace elements without reference to a Nufarm representative.