

## Correct use of adjuvants

Nicholsons, The Park, North Aston, Bicester,  
Oxfordshire OX25 6HL

Tuesday 9th July 2024

## Contents

Contents .....	2
Agenda .....	3
Location.....	4
What are adjuvants and regulatory position when integrating them with crop protection products .....	5
Types of adjuvants and their properties.....	10
Influence of plant and leaf structures, crop canopies and densities, cropping situation, and water quality used for spraying.....	17
Commonly used adjuvants with different crop protection product types – insecticides, fungicides, herbicides. ....	26
How to choose the correct adjuvant and when you should consider use of adjuvants. Correct tank mixing sequences .....	32
Appendix .....	38

# Agenda



Time	Content	Speaker
<b>Nicholsons, North Aston</b>		
09:00 – 09:30	<i>Coffee, tea, and refreshments</i>	
<b>Presentations</b>		
09:30 – 10:10	<b>What are adjuvants and regulatory position when integrating them with crop protection products</b>	Selchuk Kurtev, Zest Sustainable ICM
10:10 – 10:50	<b>Types of adjuvants and their properties</b>	Selchuk Kurtev, Zest Sustainable ICM
10:50 – 11:00	<i>Coffee, tea, and refreshments</i>	
11:00 – 11:40	<b>Influence of plant and leaf structures, crop canopies and densities and crop situations (protected vs outdoor) and water quality used for spraying.</b>	Wayne Brough, HTA
11:40 – 12:20	<b>Commonly used adjuvants with different crop protection product types – insecticides, fungicides, herbicides.</b>	Selchuk Kurtev, Zest Sustainable ICM
12:20 – 13:00	<b>How to choose the correct adjuvant and when you should consider use of adjuvants. Correct tank mixing sequences.</b>	Selchuk Kurtev, Zest Sustainable ICM
13:00 – 13:45	<i>Lunch buffet</i>	
<b>Practical session</b>		
14:00 – 15:00	<b>Comparison work on adjuvant performance on different plant structures using different adjuvants and water volumes.</b>	<b>ALL delegates</b>
15:00 – 15:30	<b>Summary quiz for the learning from the day – delegates will be involved in completing a 25-question quiz with multiple choice questions.</b>	<b>ALL delegates</b>
15:30	<i>Wrap up and depart</i>	

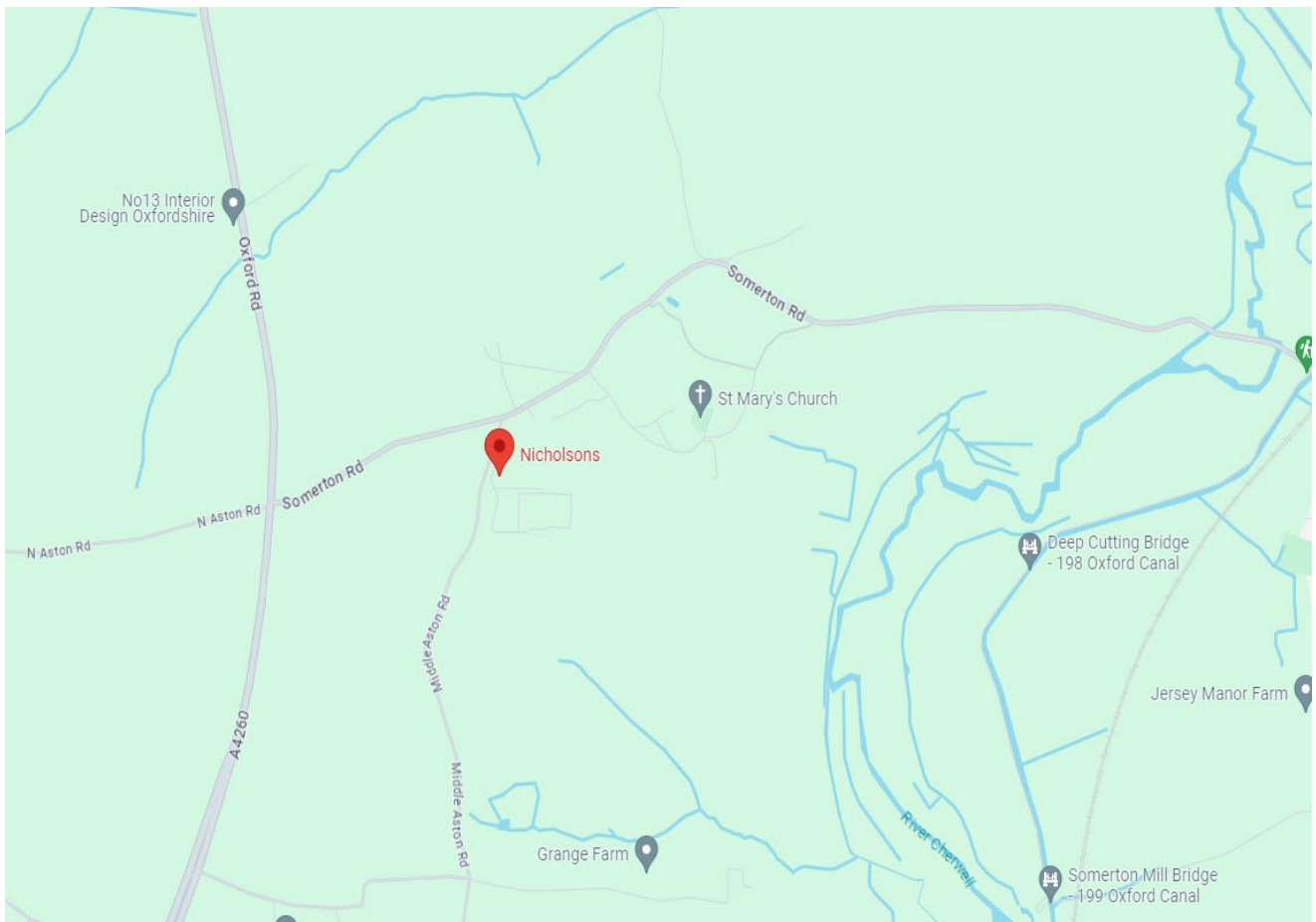
**BASIS and NRoSO continued professional development points will be available on the day of the workshop.**

# Location



## Addresses and locations:

**Nicholsons, The Park, North Aston, Bicester, Oxfordshire OX25 6HL**  
**What3words: ///twitches.pounces.defenders**





## Notes

### Definition of an adjuvant



Adjuvants are authorised under **Regulation (EC) 1107/2009** which defines 'adjuvants' as being:

'substances or preparations which consist of co-formulants or preparations containing one or more co-formulants, in the form in which they are supplied to the user and placed on the market to be mixed by the user with a plant protection product and which enhance its effectiveness or other pesticidal properties, referred to as 'adjuvants'.

Adjuvants are **NOT** plant protection products (PPPs); but, as they influence the way PPPs behave and the effects they have, they are subject to regulatory control.

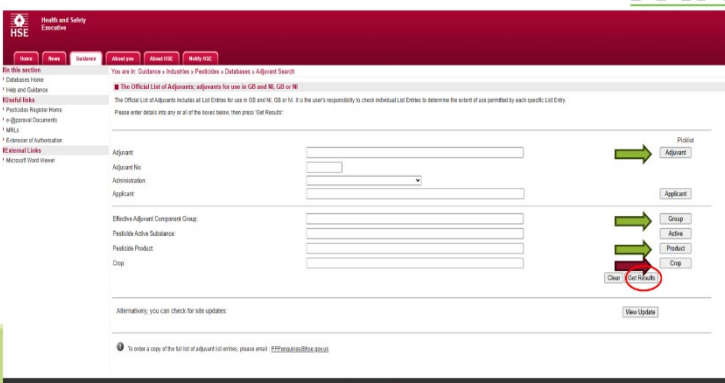
### Regulatory



- **The Official List of Adjuvants - [Adjuvant - Search \(pesticides.gov.uk\)](http://pesticides.gov.uk)**
- Crop specific approvals - be aware!
- Phytotoxicity claim not possible if used on unauthorised crop
- Spray records must highlight its use
- Possible dose rate reduction of certain products and crops
- Must carry out COSHH assessment
- Storage conditions



### Regulatory







## SUMMARY



- Adjuvants are regulated products!
- Must comply with pesticide statutory labels
- Strict use according to specific product recommendations
- Adjuvants cannot claim pesticidal activity
- Some products do not require entry into 'Official list'
- COSHH assessments are important
- On edible crops when using adjuvants often at half or lower rate

NURSERY PRODUCTION

Zest-ICM

☎ 0333 005 0167

✉ [nurseryproduction@hta.org.uk](mailto:nurseryproduction@hta.org.uk)



**zest**<sup>®</sup>  
Sustainable ICM



# Types of adjuvants and their properties

Selchuk Kurtev, Zest – Sustainable ICM



Notes

**zest**  
Sustainable ICM

**HTA**

Types of adjuvants and their properties  
Selchuk Kurtev, Zest Sustainable ICM

---

---

---

---

---

---

---

---

---

---

What I will cover

- Adjuvant groups and types
- Adjuvant properties and adjuvant tree
- Surfactants and Oils
- Examples of Utilities adjuvants

**HTA**

**zest**  
Sustainable ICM

---

---

---

---

---

---

---

---

---

---

Adjuvant groups

**HTA**

Enhance the 'biological activity' of pesticides

**Adjuvants**

Altering the physical characteristics of the spray solution for maximum performance

**Activating**      **Utility**

**zest**  
Sustainable ICM

---

---

---

---

---

---

---

---

---

---





### Surfactants – Activating adjuvants




---

---

---

---

---

---

---

---

---

---

### Surfactants – Activating adjuvants



#### Non-ionic

- Activator 90
- Transact
- Mixture B NF
- Intracrop Questor
- Intracrop Saturn
- Planet
- Solar
- Spraymac and X-Wet

#### Cationic

- Jogral
- Ryda

#### Organo-silicones

- Kinetic
- Bio Syl
- Siltex
- Slippa
- SP057
- Slither
- Silwet – L77
- AdjiSil
- Admix-P
- Break-thru
- Paramount
- SAS 90




---

---

---

---

---

---

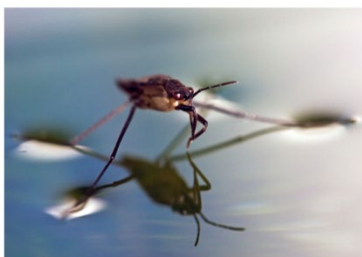
---

---

---

---

### Surfactants – Organo silicones



Can you explain this? –  
time for an  
experiment....




---

---

---

---

---

---

---


---

---


---

## Notes

### Adjuvant Oils



<p><b>Mineral</b></p> <ul style="list-style-type: none"> <li>▪ Cropspray 11E</li> <li>▪ Newman Cropspray Oil 11 E</li> <li>▪ BackRow</li> <li>▪ Barramundi</li> <li>▪ Contact Plus</li> <li>▪ Grounded</li> <li>▪ Sprayprover</li> </ul>	<p><b>Vegetable</b></p> <ul style="list-style-type: none"> <li>▪ Agropen</li> <li>▪ Codacide</li> <li>▪ Logic</li> </ul>	<p><b>Methylated</b></p> <ul style="list-style-type: none"> <li>▪ Phase-II</li> <li>▪ Actirob B</li> <li>▪ Zarado</li> <li>▪ Addit</li> <li>▪ Adigor</li> <li>▪ Amber</li> <li>▪ Saracen</li> <li>▪ Toil</li> </ul>
--	--	---




---

---

---

---

---

---


---

---

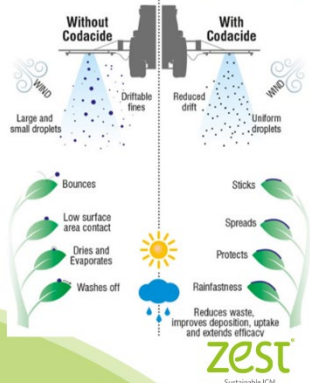

---

---

### Adjuvant Oils



- Often cheaper solutions
- Some risk on ornamentals, esp. in protected crops
- Very good use with pre-emergent herbicides
- Methylated and Mineral oils useful with insecticides
- Can leave shiny deposits
- Exposure to windy conditions can result in damage
- Caution when fungicides based on minerals used afterwards


---

---

---

---

---

---



---

---

---

---

### Adjuvant Oils




---

---

---

---

---

---

---

---

---

---





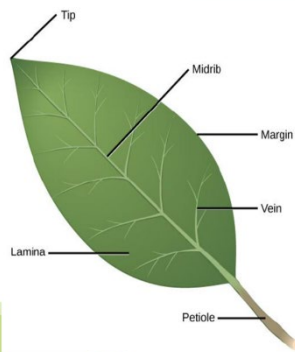




## Leaf structure



- Generally, a large surface area to absorb light
- Its upper surface is protected from water loss, disease and weather damage by a waxy layer
- Veins for structure and water/nutrient distribution
- Adapted to climate/stresses where the plant originates from




---

---

---

---

---

---

---

---

---

---

## Leaf structure



Plant adaptation	Function
Broad leaves	Provide a large surface area to absorb as much sunlight as possible.
Thin leaves	Provide a short diffusion pathway for gases to move into and out of cells.
Network of tubes (xylem and phloem)	To transport water, mineral ions and glucose (food) around the plant.
Lots of chloroplast	Contain a green substance called chlorophyll, which traps energy from the sun for photosynthesis.
Stomata	Tiny holes found mainly underneath the leaf to allow gases to diffuse into and out of the leaf. Each hole is a single stoma.
Guard cells	Controls the opening and closing of stomata.
Midrib	Provides strength throughout the leaf, keeping it upright and sturdy in the wind.
Petiole	Attaches the leaf to the stem.

---

---

---

---

---

---

---

---

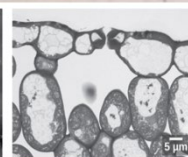
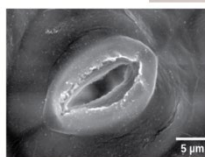
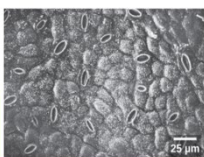
---

---

## Leaf structure (internal)



- Upper epidermis and cuticle layer- protection
- Palisade layer - photosynthesis
- Mesophyll - gas exchange into leaf from stomata
- Xylem and phloem - transport system




---

---

---

---

---

---

---

---

---

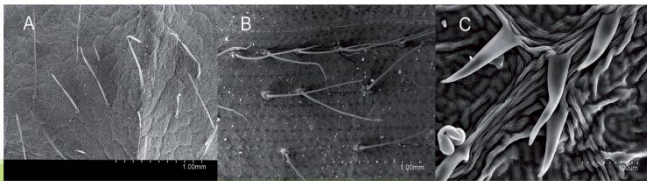
---

## Notes

### Leaf surface



- All aerial plant parts are covered by a hydrophobic cuticle that limits the bidirectional exchange of water, solutes and gases between the plant and the surrounding environment.
- Epidermal structures such as stomata, trichomes or lenticels may occur on the surface of different plant organs and play important physiological roles.



(Micrographs by V.Fernández, 2010) Adaxial surface of: (A) soybean; (B) maize; and (C) cherry leaf

### Leaf cuticle - wax layer

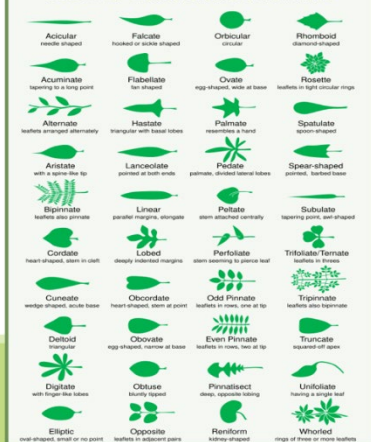


► The cuticle is a protective layer that covers the plant and separates it from the environment. In leaves this layer is hydrophobic and consists of an insoluble membrane submerged in solvent-soluble waxes. The cuticle of leaves is thought to have evolved as an adaptation during the transition from aquatic to terrestrial habitats, with its main function being to prevent excessive tissue water loss, but it also provides protection against UV radiation, being eaten, heat, mechanical stress, and pollution. Epicuticular wax is a waxy coating which covers the outer surface of the plant cuticle and is thicker in plants from arid climates.



### Leaf shapes

#### SHAPE & ARRANGEMENT



### Crop canopies

- Flat
- Vertical/erect
- Row crop
- Bed formation
- Leaf wall area



### Crop canopies



### Crop canopies

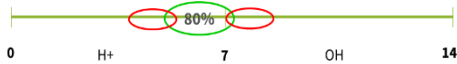






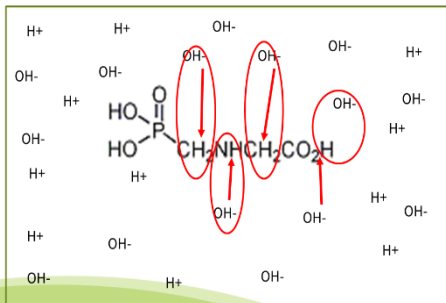
## What is pH?

- The balance between the OH and H ions in solution.



- Examples of low pH hydrolysis**
  - pymetrozine
  - Sulfonyl-urea herbicides
  - Acetamidrid
- Examples of high pH hydrolysis**
  - Glyphosate
  - 2,4-D amine
  - Glufosinate-ammonium
  - Chloropyrifos
  - Bacillus thuringiensis
  - Clofentezine
  - Captan
  - Indoxacarb

## How does it work?



## Carbonate/bicarbonate



- Water hardness**
  - Temporary –  $\text{HCO}_3$
  - Constant –  $\text{CaCO}_3$  and other positively charged metals (Mg, Fe)
- Actives affected by total hardness**
  - 2,4 D amine
  - Glyphosate
  - Fatty Acids
  - Clethodim
  - Indoxacarb
  - Iron more than 400ppm dissolves most actives
  - Optimum hardness below 150ppm

### Electrical conductivity



- **Salt formulated products:**
  - Fatty acids
  - Salts of glyphosate
  - Amonium salts – glufosinate ammonium
- **Positive (cations) Negative (anions)**

Calcium (Ca <sup>++</sup> )	Sulphate(SO <sup>- -</sup> )
Magnesium (Mg <sup>++</sup> )	Chloride(Cl <sup>-</sup> )
Sodium (Na <sup>+</sup> )	Bicarbonate (HCO <sup>-</sup> )
- **EC < 0.5 mS no effects**

---

---

---

---

---

---

---

---

---

---

### Turbidity



- **Haziness of the water**
  - Related to high organic matter and soil content
- **Active ingredient with soil/organic matter binding potential:**
  - Glyphosate
  - Diquat
  - Pyrethrins
  - Sulfanyl Urea herbicides(Chikara, Eagle and others)

---

---

---

---

---

---

---

---

---

---

### Compromised performance



- Mode of action
- Penetrating the insect cuticules
- Penetrating leaf structure
- Coverage
- Reduced persistence
- Slow activity

---

---

---

---

---

---

---

---

---

---



## Notes

### How to maintain performance?



- Water source knowledge
- Monitoring water parameters regularly
- Knowledge of active substances and reading product labels
- If it doesn't look right, its not right!



### Summary



Active ingredient	Optimum pH	Notes	pH5	pH 6	pH 7	pH 8	pH 9
2,4-d		Stable at pH 4.5 to 7					
Abamectin	6.0 - 7.0						
Acetamiprid		Unstable at pH below 4 and above 7					
Azadirachtin	3.0 - 7.0						
<b>Bacillus thuringiensis</b>	<b>6</b>	Unstable at pH above 8					
Bifenazate	<7						
Captan	5	pH 5 = 32 hrs; pH 7 = 8 hrs; pH 8 = 10 min	32h		8 hours	10 minutes	2 minutes
Chlorothalonil	6.0 - 7.0	Stable over a wide range of pH values					
Chlorpyrifos			63d		35d	1.5d	
Clofentezine					34h		4.5h
Cypermethrin							39h
Dicamba		Stable at pH 5 - 6					
Fenhexamid	5.5 - 6.5						
Flonicamid	4.0 to 6.0						
Fosetyl-aluminium	6	Stable at pH 4.0 to 8.0					
<b>Glufosinate-ammonium</b>	<b>5.5</b>						
Glyphosate	5-6						
Lambda-cyhalothrin	6.5	Stable at pH 5 - 9					
Myclobutanil		Not affected by pH					
Paraquat		Not stable at pH above 7					
Pymetrozine	7.0 - 9.0	(degrades at low pH)					
Spinosad	6	Stable at pH 5 - 7					200d









## Notes

### PGRs

- Mostly all with adjuvants, especially those applied to crop canopy
- Avoid using silicon based adjuvants due to phytotoxicity
- Avoid using oil formulations
- Penetrants and spreaders are advisable to use
- For outdoor use consider using stickers and penetrants



### General guidelines

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, 25A, 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



### General guidelines

#### Adjuvants

PRODUCT	CLASSIFICATION	ATTRIBUTES	EXAMPLE USAGE	RATE OF USE
ABATE	Silicon based anti-foaming agent.	Tank foaming reduction.	Where high levels of foam are produced in the tank solution.	50-250 ml / 1000 lt. Use low rate to start with and increase as required.
ACTIVATOR 90	Non ionic wetter.	Drift reduction. Spreads up to 7 times more than water. Use where surface wetting is desirable.	Contact insecticides. Broadleaved herbicides. Contact herbicides such as Diquat.	1 lt / 1000 lt. Add to tank last.
ALL CLEAR EXTRA	Balanced formulation of sequestrants and surfactants.	Tank cleaner.	Alter tank use. Good at removing difficult residues like the SU herbicides.	5 lt / 1000 lt. Avoid contact with the concentrate on metal.
CROPSPRAY 11E	Mineral oil adjuvant.	Weed control improvement. Reduces drift.	Difficult to control weeds. Difficult spraying conditions.	Max rate 25 lt / 1000 lt. Normal rate 7.5 lt / 1000 lt. Can have insecticidal use.
ENVIROWET	Silicon based non-ionic wetter and spreading agent.	Drift reduction 'super wetter'.	Improve uptake of foliar nutrients. Improve coverage on difficult targets such as waxy or hairy leaves.	1-2.5 lt / 1000 lt
GATEWAY	Silicone and fatty based sticker, extender and wetter.	Improves wetting, coverage and rainfastness. Increases uptake of systemic products and nutrients. Drift reduction. Frost protection.	Use in difficult weather conditions. On waxy or hairy leaved weeds. Anti transparent. Difficult target coverage.	1.25 lt / 10 00 lt. Add to tank last.
KANTOR	Penetrant wetter and spreading agent.	Improved coverage. Aids systemic product uptake. Mix compatibility.	Reduces the risk of tank mixing issues. Aids difficult canopy management.	1.5-10 lt / 1000 lt







# How to choose the correct adjuvant and when you should consider use of adjuvants. Correct tank mixing sequences



Selchuk Kurtev, Zest – Sustainable ICM

Notes



How to choose the correct adjuvant and when you should consider use of adjuvants. Correct tank mixing sequences.  
Selchuk Kurtev, Zest Sustainable ICM

---

---

---

---


---

---


---

---

What I will cover



- Adjuvant purpose – Utilities or Activating?
- Plant morphology and crop growth
- PPP specific adjuvant needs
- Utilities adjuvant choice
- Tank mixing and sequence



---

---

---

---

---

---


---

---

Adjuvant purpose



- ✓ Most important consideration
- ✓ Legality of the use of the adjuvant with the PPPs
- ✓ Crop risk considerations
- ✓ Spray equipment, water volumes and spray quality
- ✓ Water quality and spraying conditions



---

---

---

---

---

---

---

---



Notes

**Plant morphology and crop growth**



- ✓ Most important consideration
- ✓ Legality of the use of the adjuvant with the PPP
- ✓ Crop risk considerations
- ✓ Spray equipment, water volumes and spray quality
- ✓ Water quality and spraying conditions




---

---

---

---

---

---

---

---

---

---

**Plant morphology and crop growth**




---

---

---

---

---

---

---

---

---

---

**PPP specific needs**



- ✓ READ THE LABEL AND OFF LABEL!
- ✓ Formulation of the product
- ✓ Active substance nature!
- ✓ Mode of Action and Group




---

---

---

---

---

---

---

---

---

---



Notes

Utilities adjuvant choice




---

---

---

---

---

---

---

---

---

---

Utilities adjuvant choice




---

---

---

---

---

---

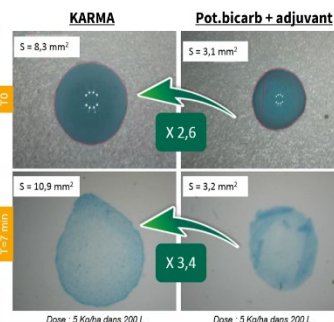
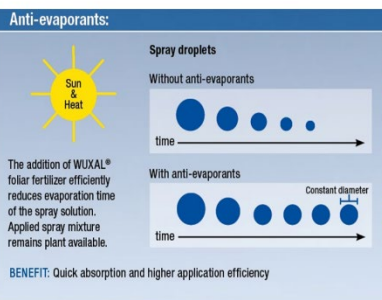
---

---

---

---

Utilities adjuvant choice




---

---

---

---

---

---

---

---

---

---





## Appendix

1. [Adjuvant - Search \(pesticides.gov.uk\)](https://pesticides.gov.uk)
2. [De Sangosse - Slug Experts - Complementary chemistry and molluscicides](#)
3. [Master tank mix adjuvants to push pesticide performance » Interagro \(UK\) Ltd](#)
4. [Attune Agriculture: Water vs. Surfactant vs. Ampersand Adjuvant \(youtube.com\)](#)
5. [Introducing Elasto G5 - how adjuvants can work for you \(youtube.com\)](#)
6. [WhatAreAdjuvants.pdf \(apparentag.com.au\)](#)
7. [Agricultural Adjuvant & Spray Additives - Intracrop](#)
8. [AdjuvantWhitepaper.pdf \(chsagronomy.com\)](#)



[www.hta.org.uk](http://www.hta.org.uk)

**zest**<sup>®</sup>

Sustainable ICM

[www.zest-icm.co.uk](http://www.zest-icm.co.uk)