

Adjuvant Science 101

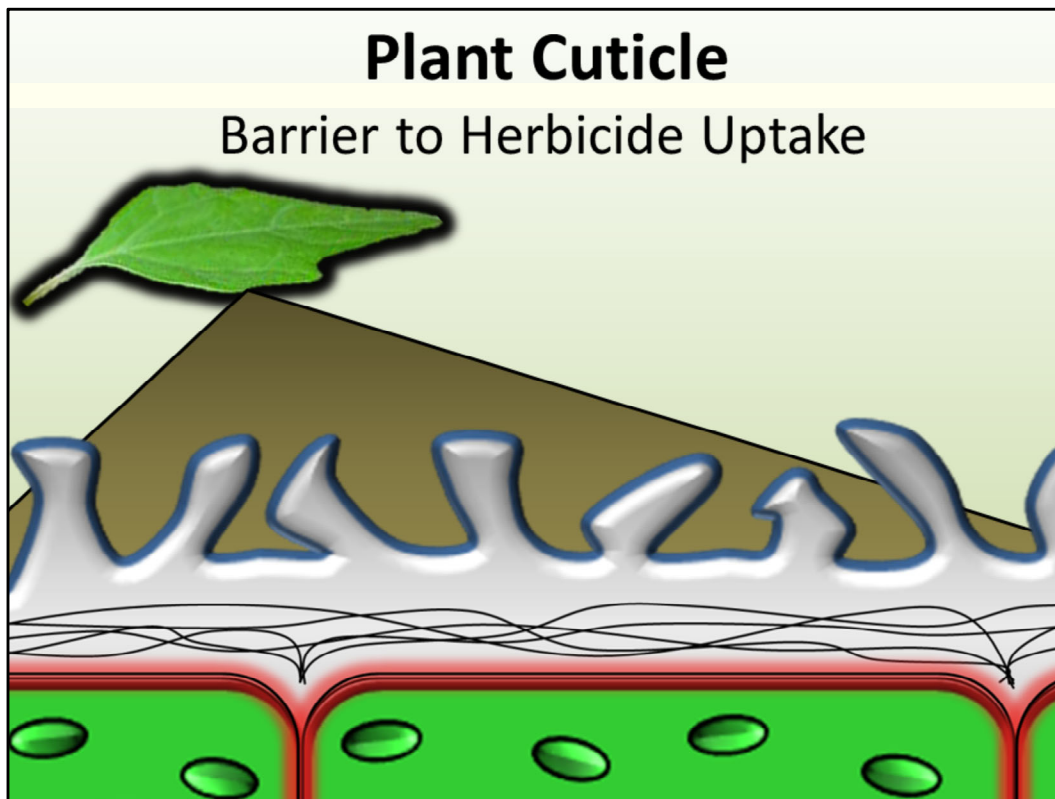
What every grower should know about adjuvants

By Daniel Bergman, Ph.D.

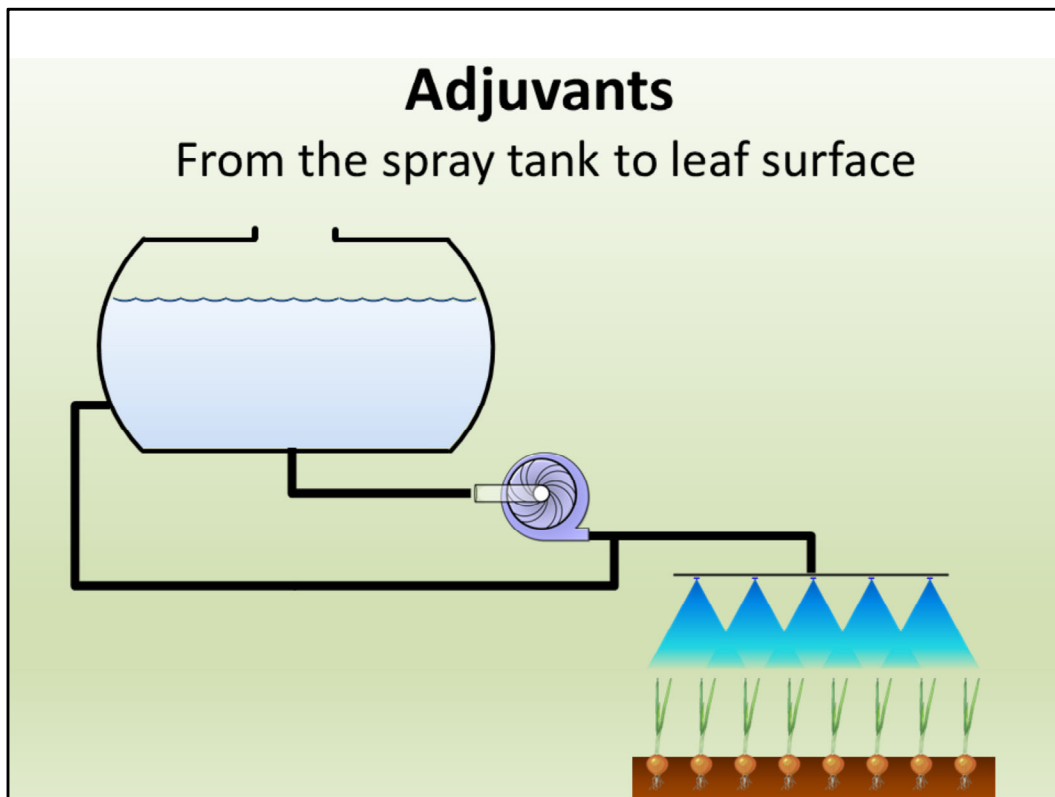
Nutrien/Loveland Products



Adjuvants are anything you put in the spray tank to modify some characteristic of the spray mix. Surfactants are a type of adjuvant that has as one of its property to reduce surface tension of water.

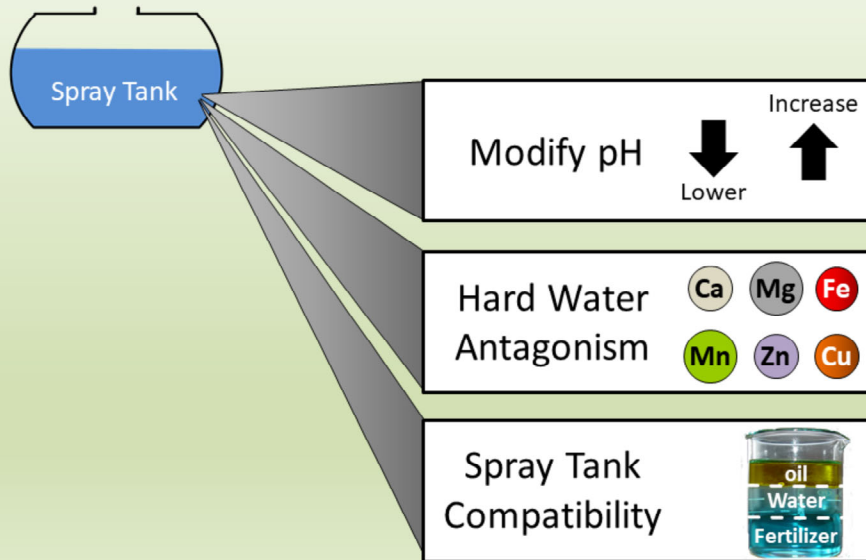


The plant cuticle is the primary barrier to pesticide penetration. Crystallized wax give can often give the leaf a bluish-green look – often referred to as glaucous. Imbedded in the leaf wax is cutin – which is like “rebar” which helps to keep the cuticles integrity. Lastly the pectin layer helps to adhere the cuticle to the cell surface.

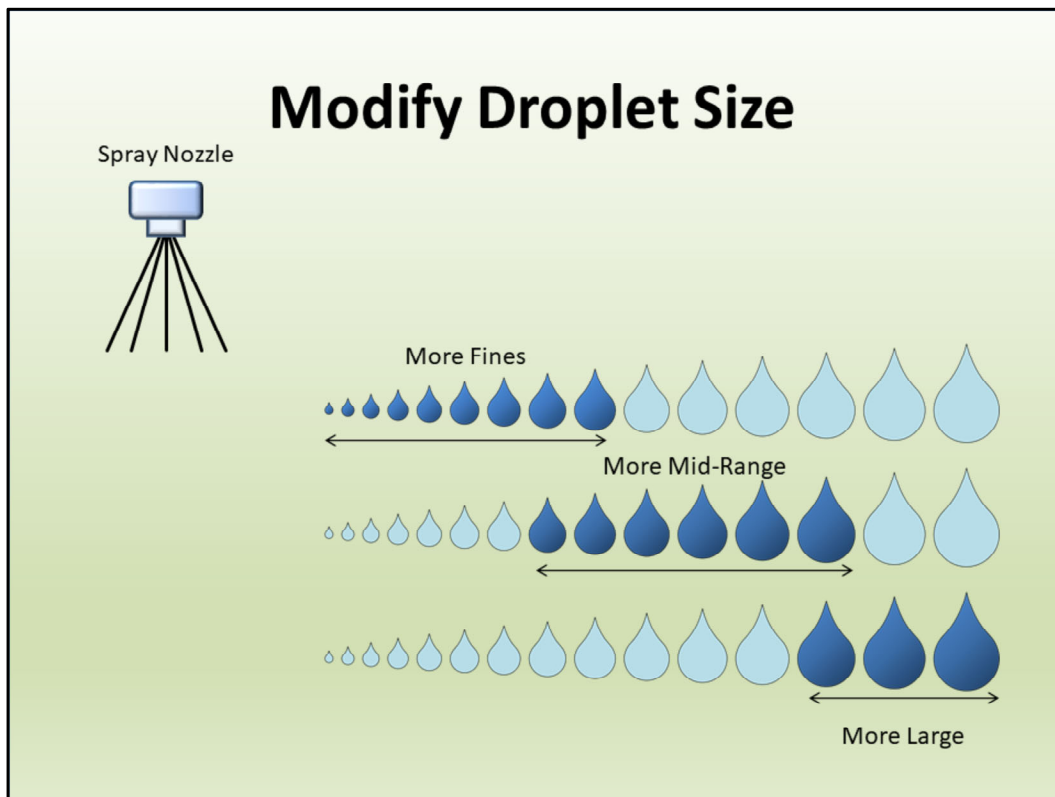


Adjuvants can help solve or correct problems from the spray tank solution to the leaf surface.

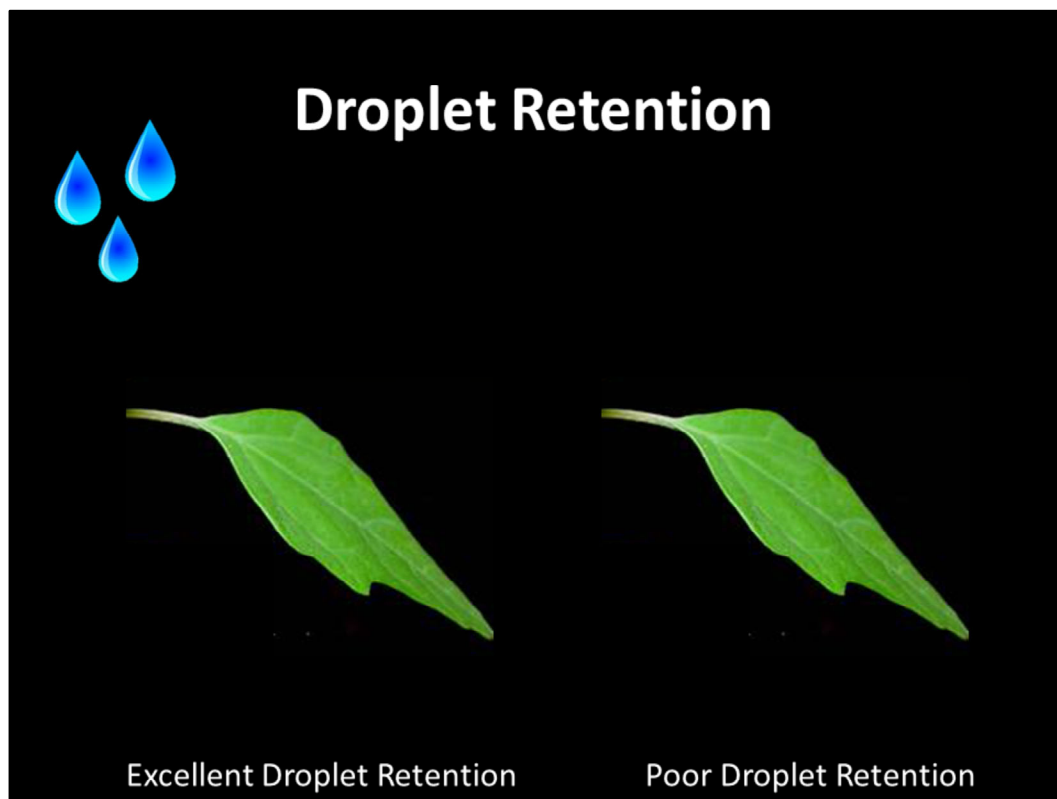
Adjusting the Spray Tank Environment



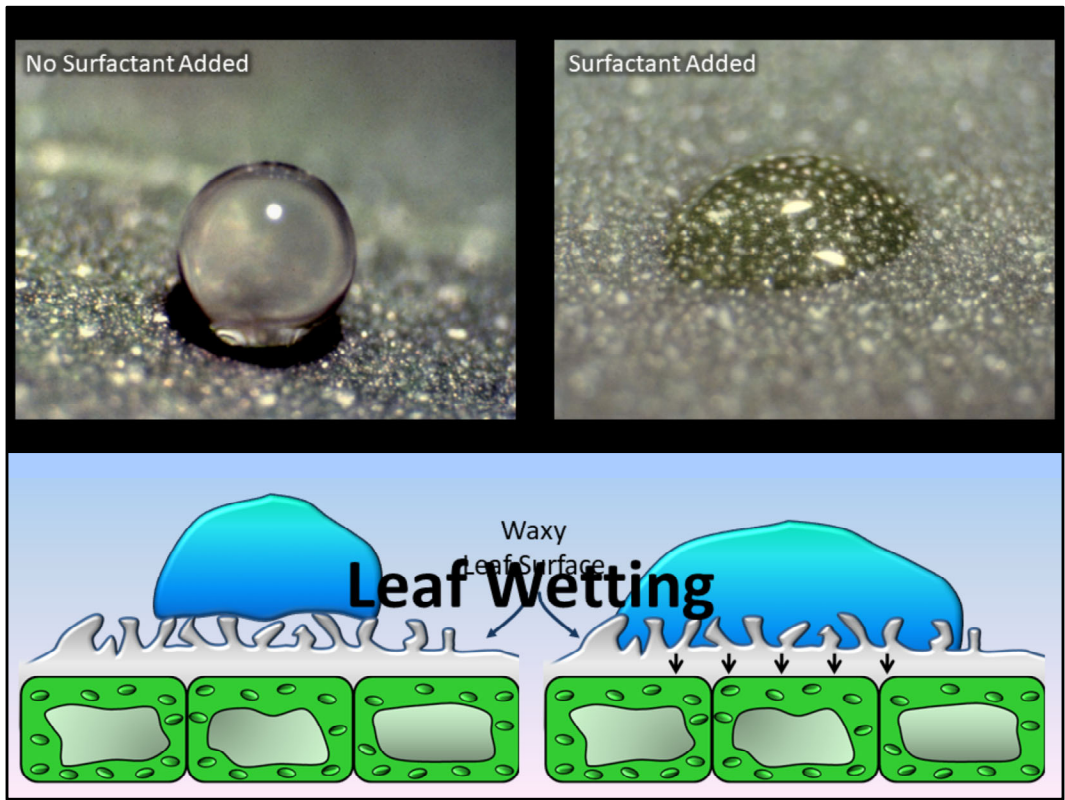
Three areas in which adjuvants can be used is to modify spray tank pH, reduce hard water antagonism & increase mixing efficiencies of diverse spray tank mixes – especially when a high salt fertilizer is involved.



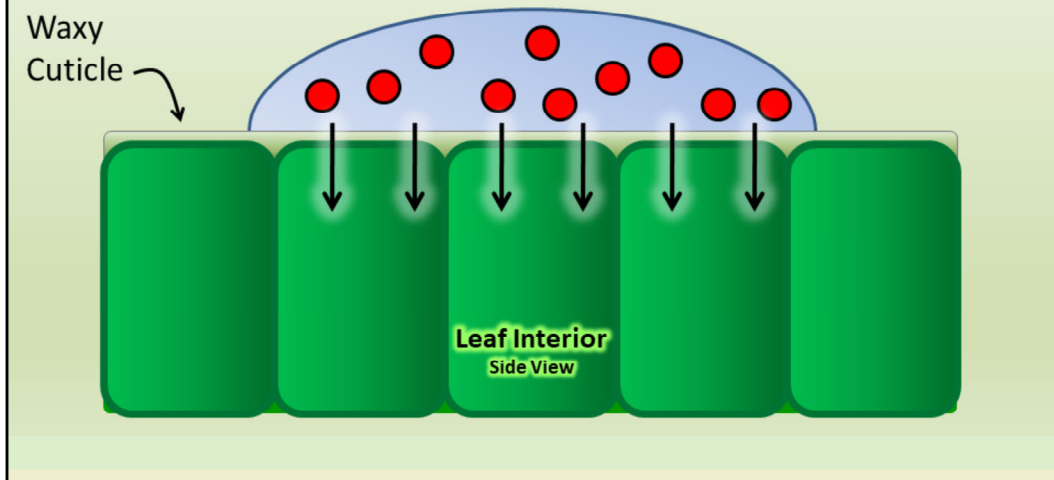
Adjuvants can be used to modify droplet size to reduce drift or increase droplet coverage.



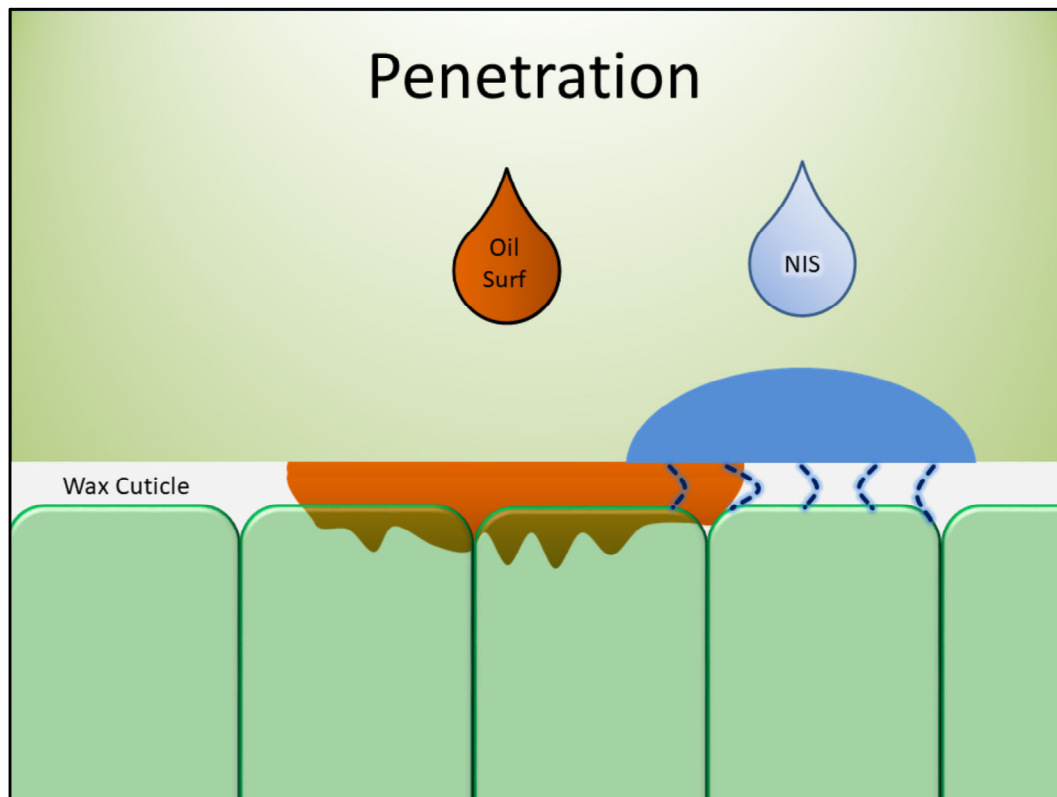
Adjuvants can also help and retaining the spray solution on the intended target which is often the leaf surface.



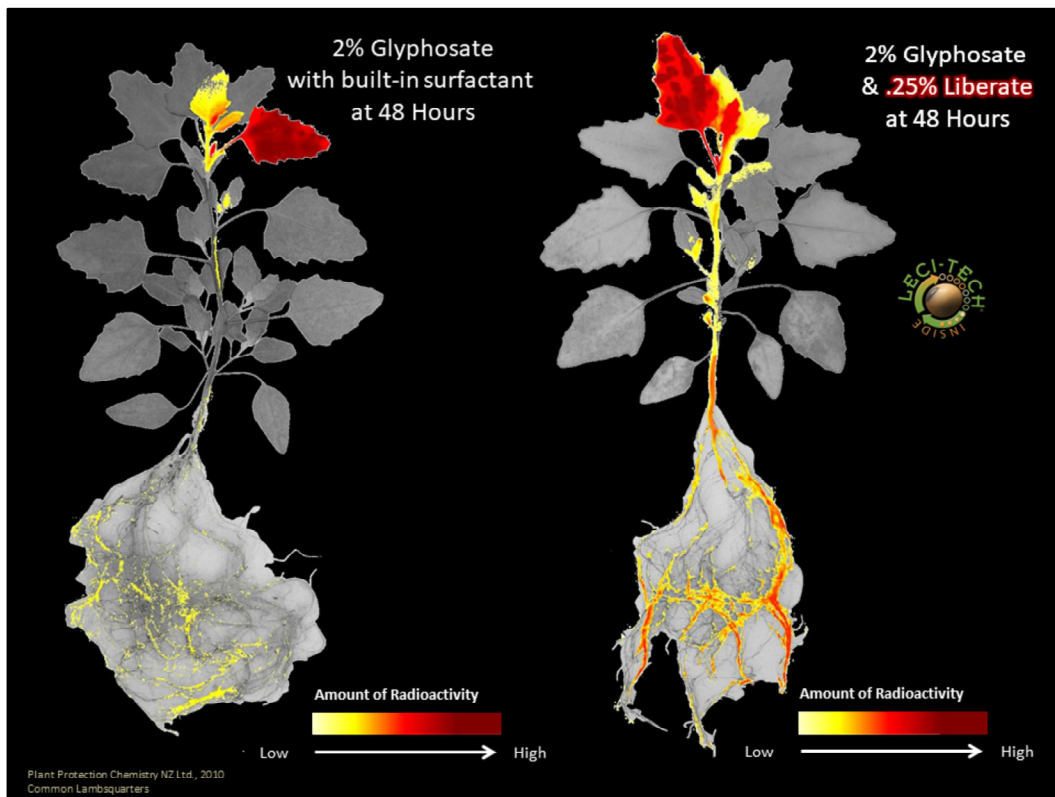
Uptake/Penetration



Finally, adjuvants can increase the rate of pesticide penetration through the plant cuticle and into the leaf surface.



Oil-based adjuvant system help in the penetration process by dissolving the active ingredient into the wax surface. Water-based surfactant system help hydrate and move active ingredients hydrophilic channels in the leaf cuticle.

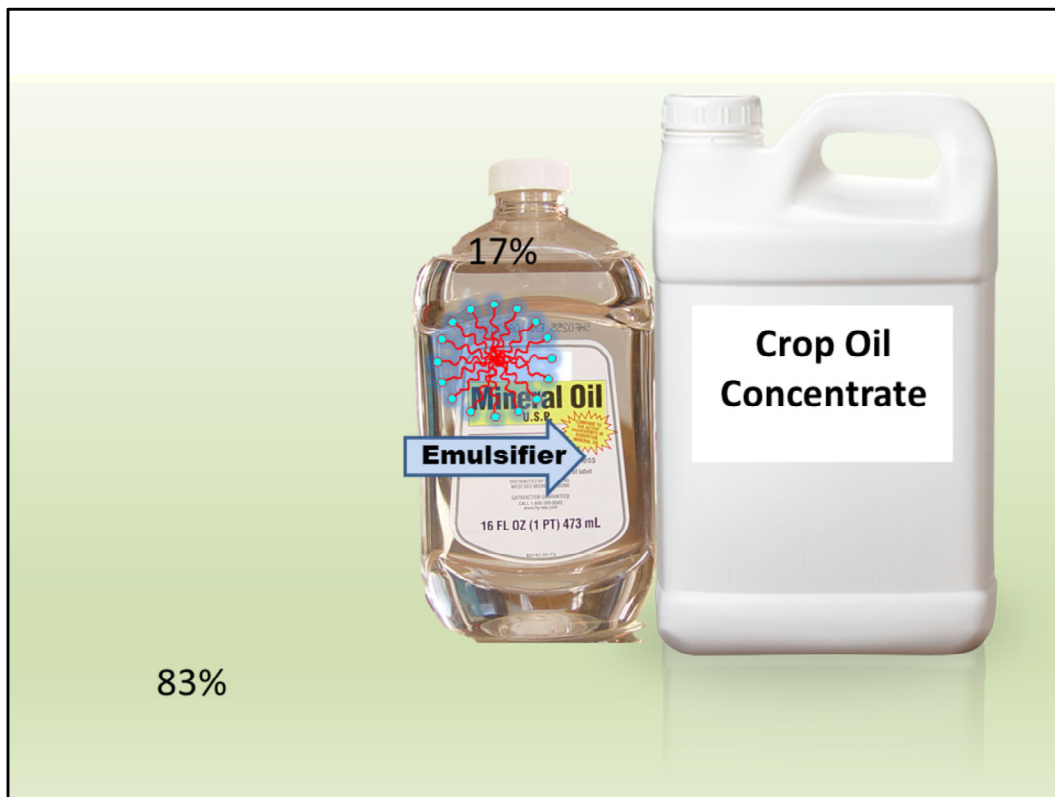


Here is an example of Liberate helping to get radio-labeled glyphosate through the plant cuticle allowing the plants piping system distribute the active ingredient.

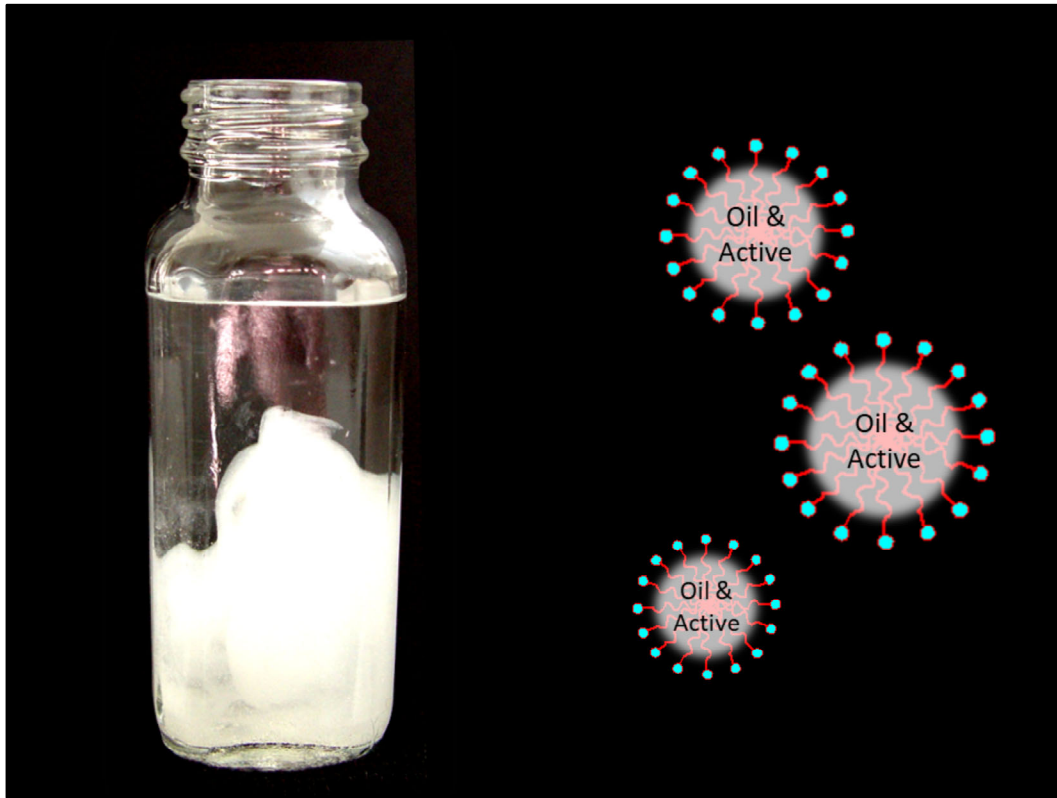
Surfactant Categories



Here is an example of various adjuvant categories asked for by various pesticide labels.



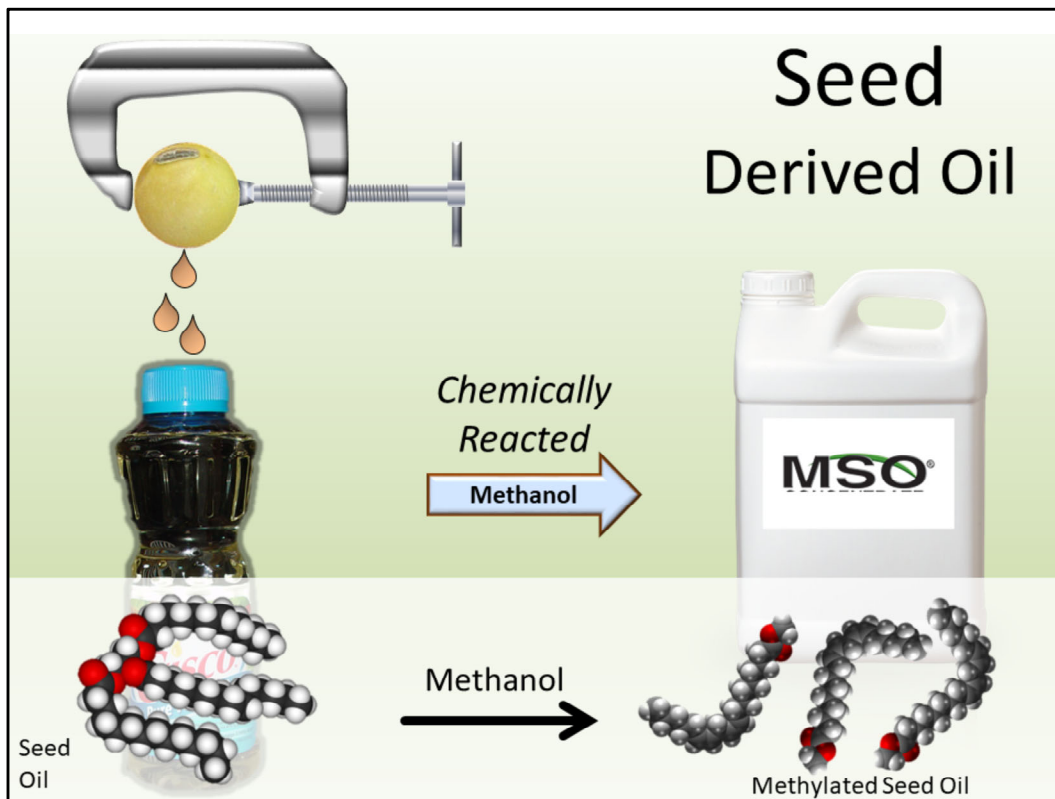
Crop oils (COC) is a blend of 17% emulsifiers and 83% paraffinic oil.



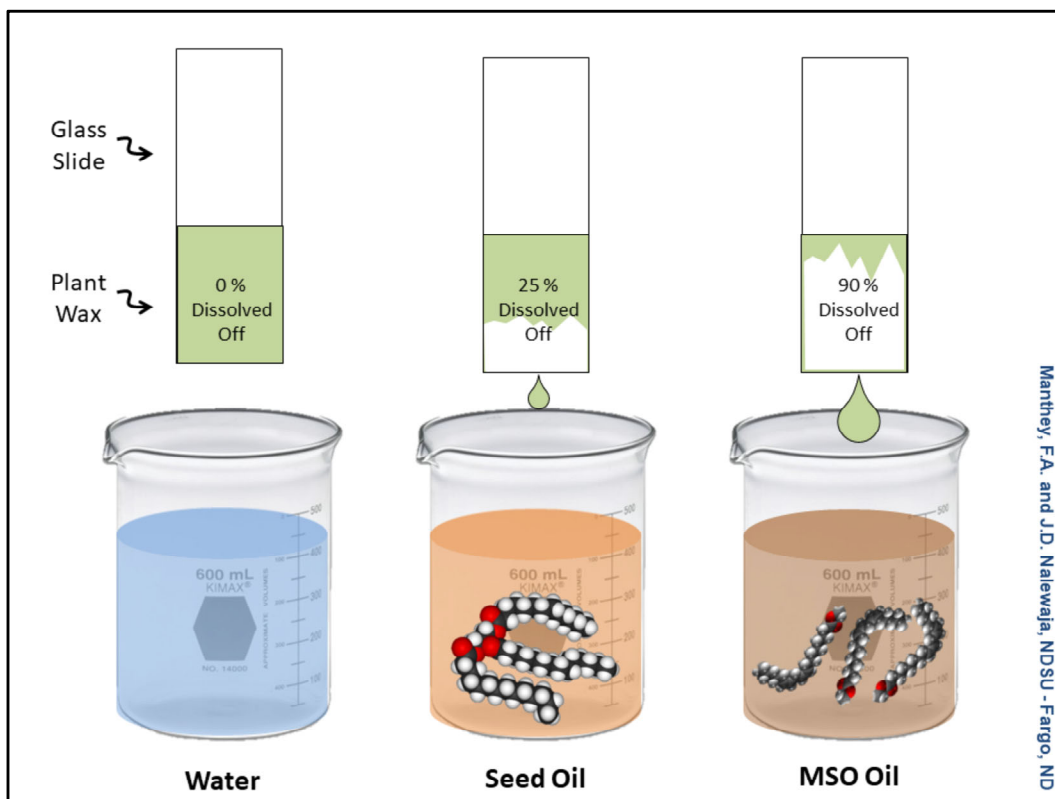
Surfactant Categories



MSO are blends of methylated seed oils and emulsifiers.



Soybean oil is chemically modified with methanol to produce a methylated seed oil.

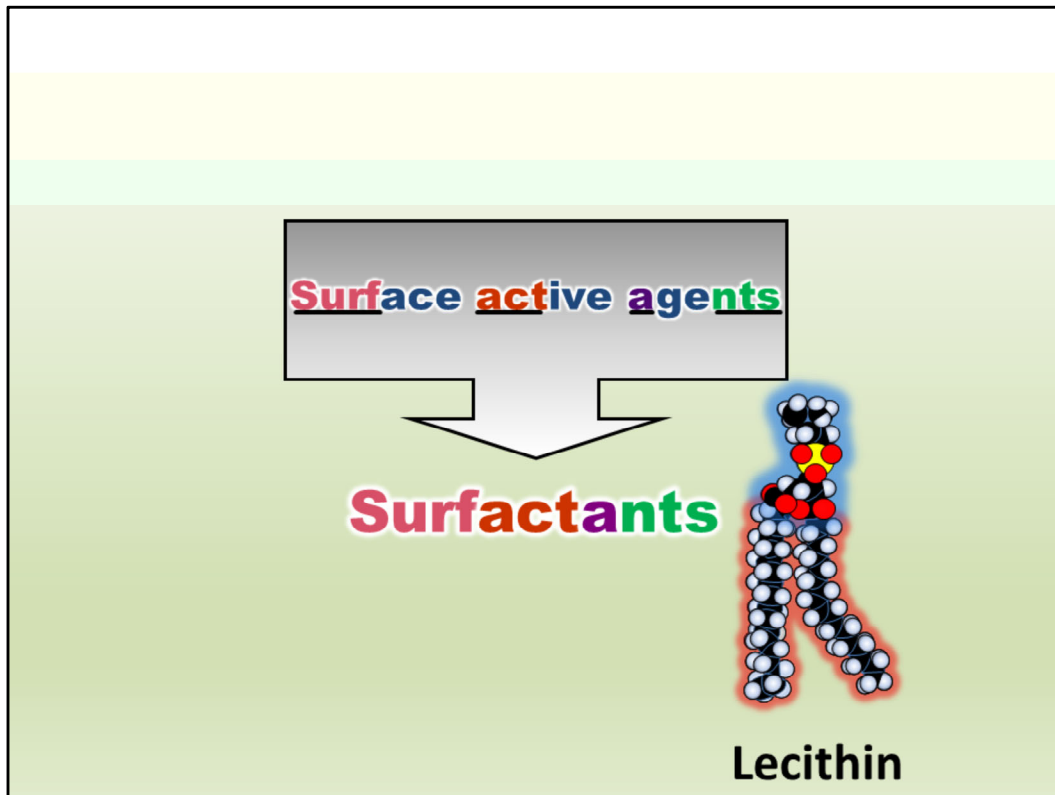


Methylated seed oils (MSO) tends to be a more aggressive adjuvants system. MSO has greater solvency on plant cuticles.

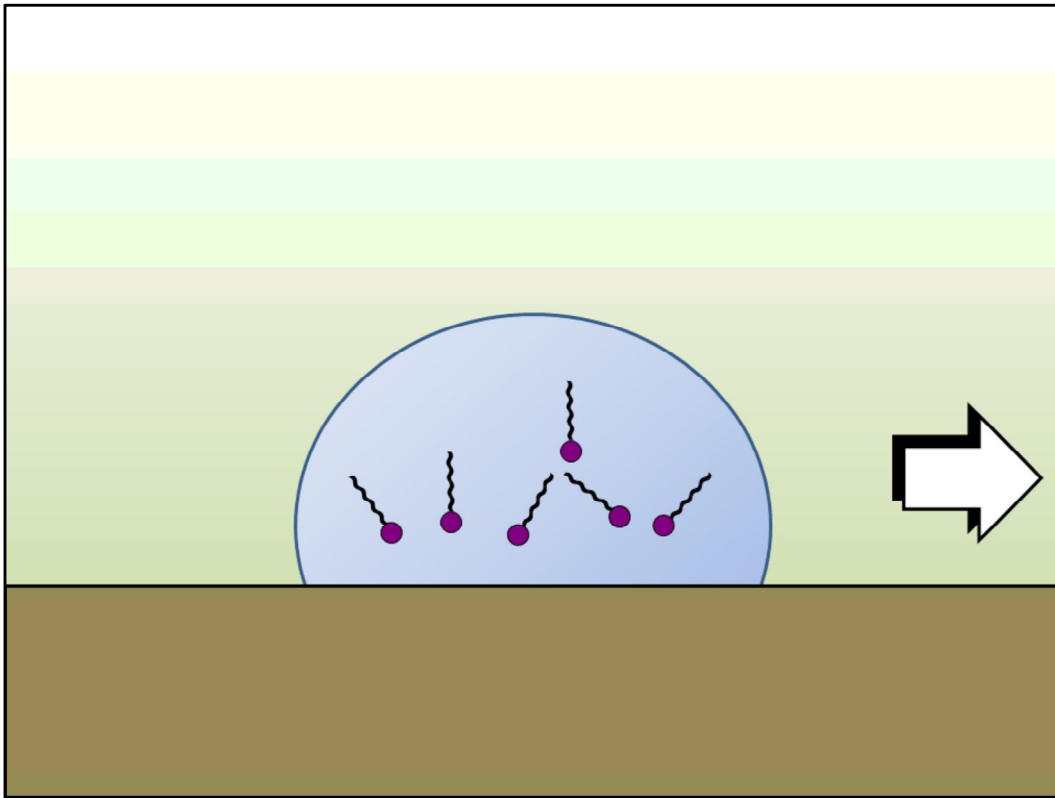
Surfactant Categories



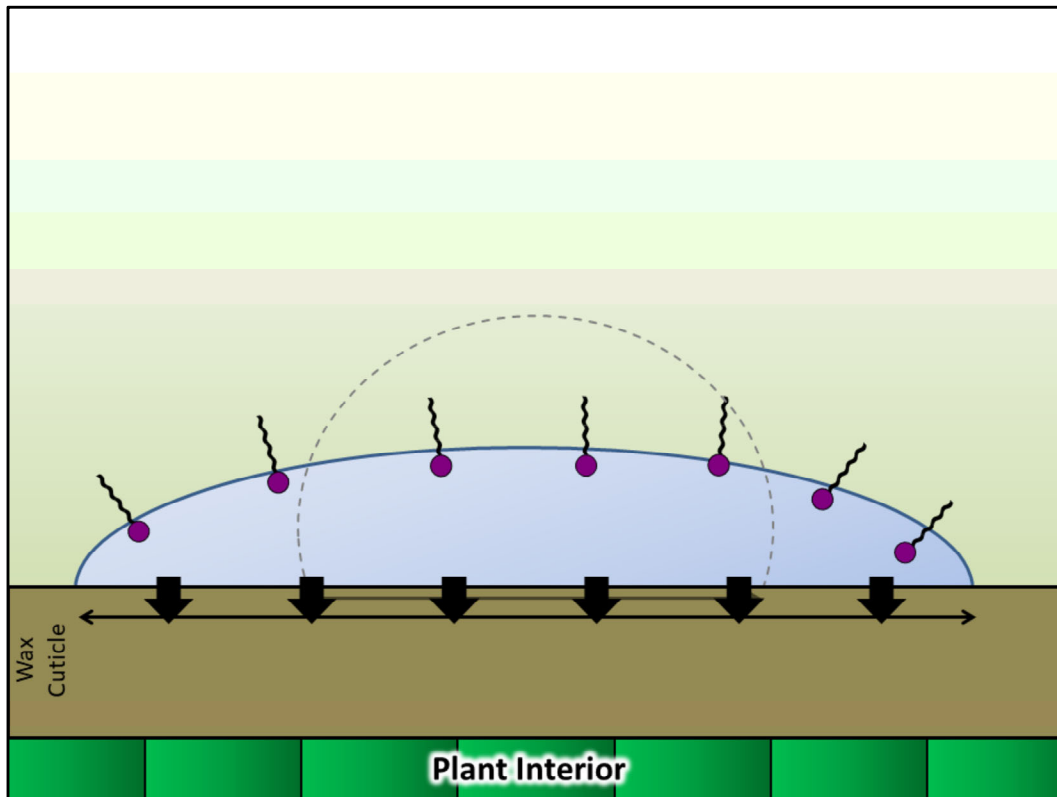
NIS – Non-ionic surfactant system are used both to wet and spread that active ingredient on the leaf surface and have varying degrees of cuticle penetration properties.



The word surfactant is coined from Surface Active Agent. These surfactants are made up of 2 chemical portions in the same molecule – both a water soluble and oils soluble portions.



Surfactants partition to the surface of a droplet and break the hand-holds that water molecule have on one another breaking the surface tension allowing the droplet to spread on a waxy surface.

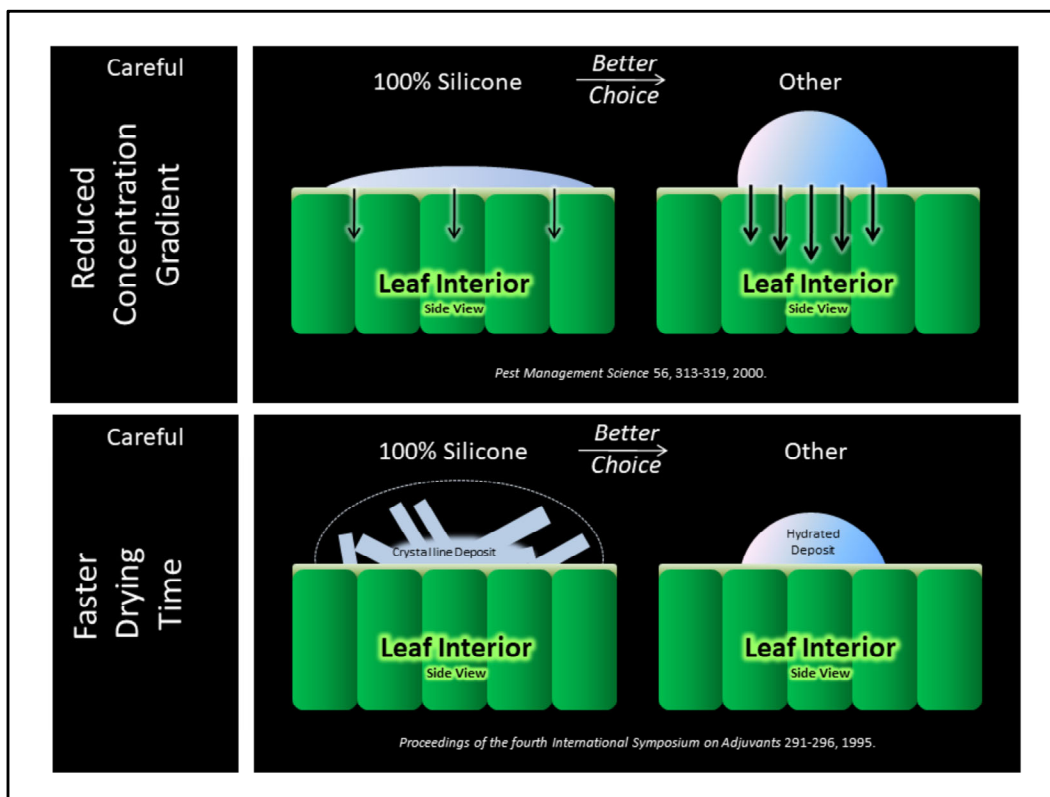


This results in greater spreading and wetting to the leaf surface.

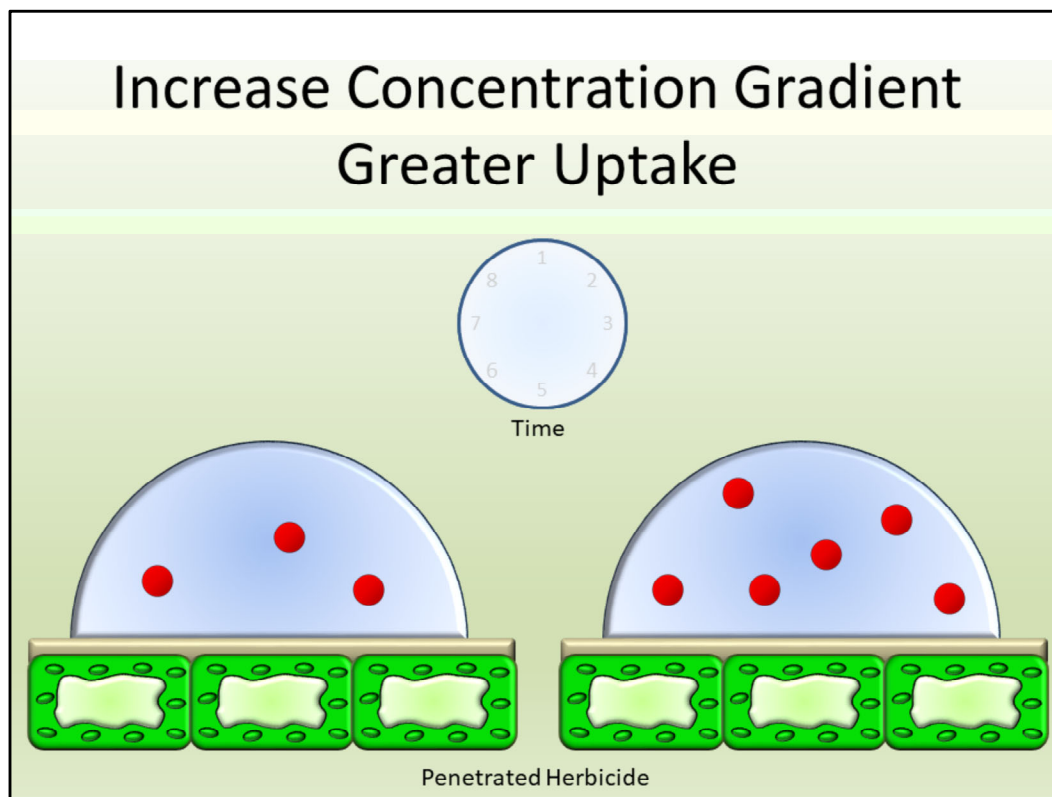
Surfactant Categories



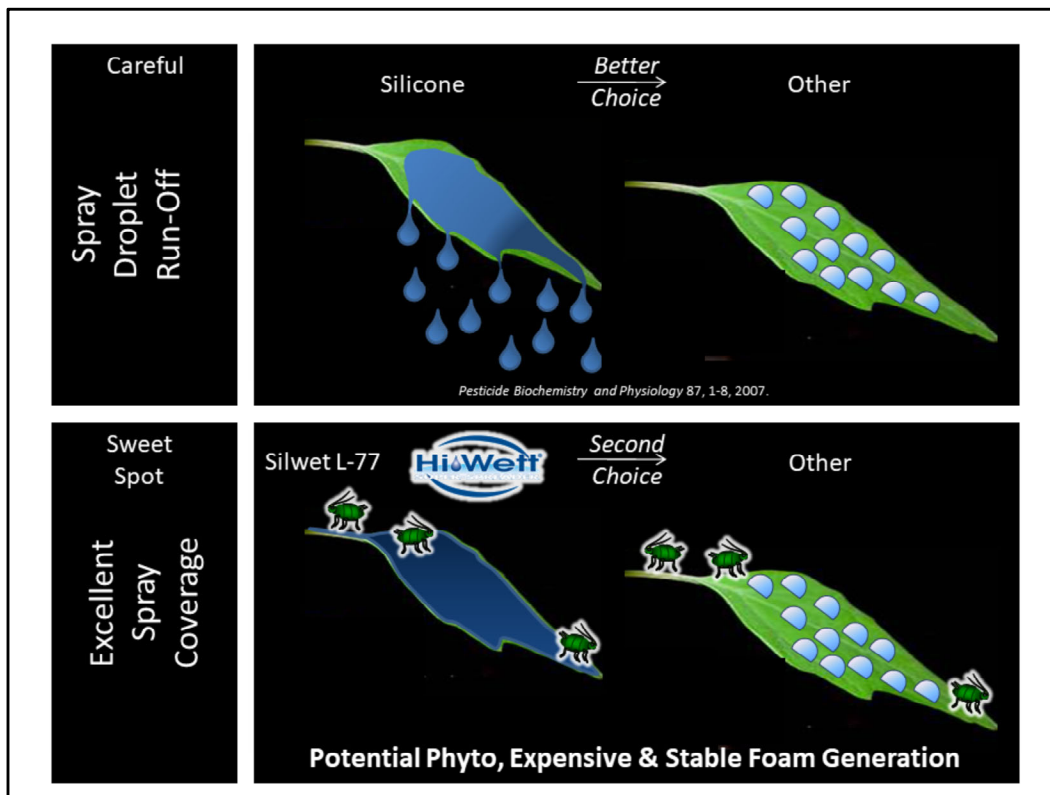
Silicone surfactant are a group of surfactants that can reduce surface tension lower than typical NIS. They are generally used at lower use rates.



Silicone surfactants can reduce the concentration gradient of the pesticide active ingredient over the leaf cell surfaces reducing uptake. In addition silicone surfactants with their super wetting ability can result in rapid droplet drying time. This also helps to reduce uptake of herbicides such as glyphosate.



This is a visual example of how concentration gradient can aid in the uptake of an active ingredient.



Additional problems with 100% super wetter silicone surfactants is spray run-off by mass flow. Silicone super wetter surfactants are often used in reduce gallon per acre applications with fast-acting contact insecticides.

Surfactant Categories



MSO Silicone surfactant blends tend to be easier to use – reducing some of the problems with 100% silicone surfactants.

Surfactant Categories



MSO/Silicone blends barrows some of the MSO penetration properties and some of the silicone surfactant spreading properties. Because these are blended in pre-determined ratios you tend to have less phyto or leaf surface run-off.

Surfactant Categories



Stickers are adjuvants that contain a resin which is designed to stick contact pesticide on leaf surfaces. This is especially helpful under rainfall or irrigation events.



Two common resin are synthetic latex and pine (Pinene) resins.

Spreader/Stickers



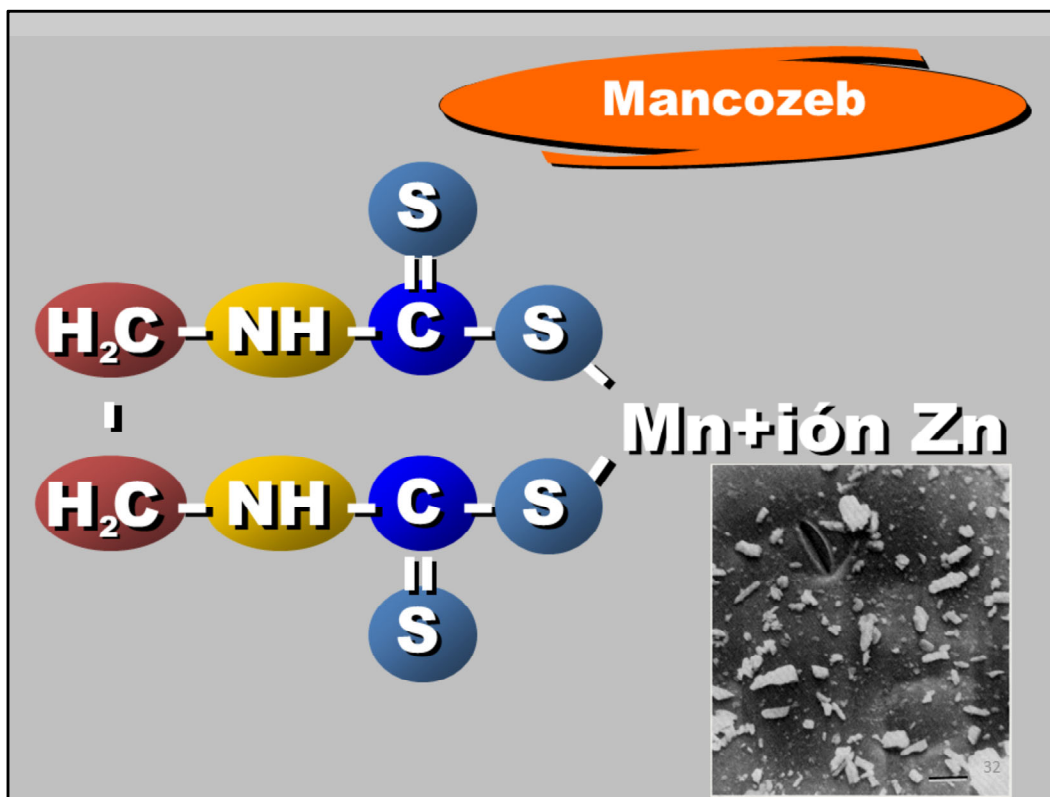
Some formulation, in addition to a resin, add NIS or Silicone surfactants in enhance initial leaf cover and spreadability.

Solid Matrix Carriers



- Mancozeb
- Copper
- Chlorothalonil

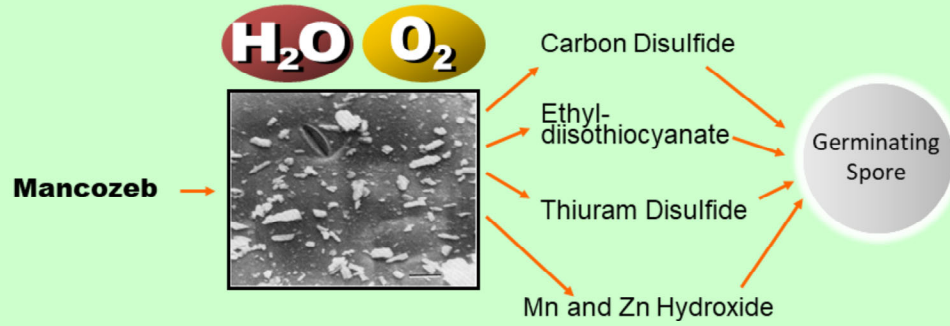
Here are some examples of pesticides that call for the use of a sticker.

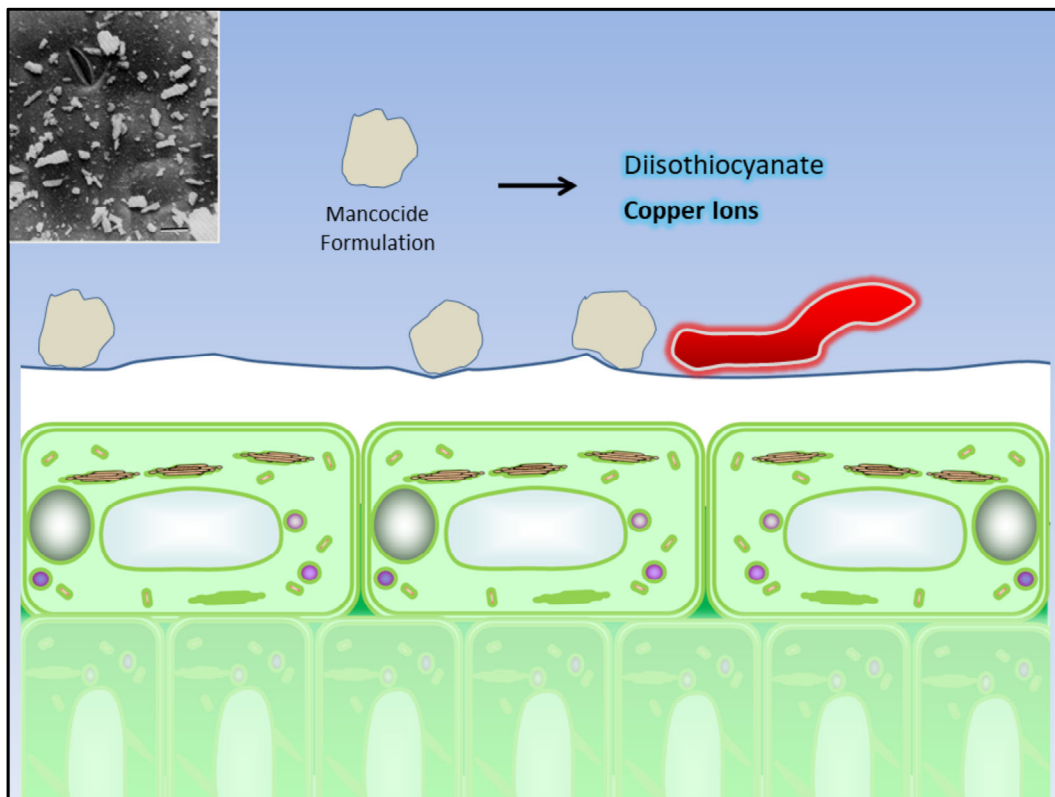


These actives are contacts and must remain on the leaf surface to have maximum function. Essentially these actives pollute the leaf surface to toxicants that kill fungi.

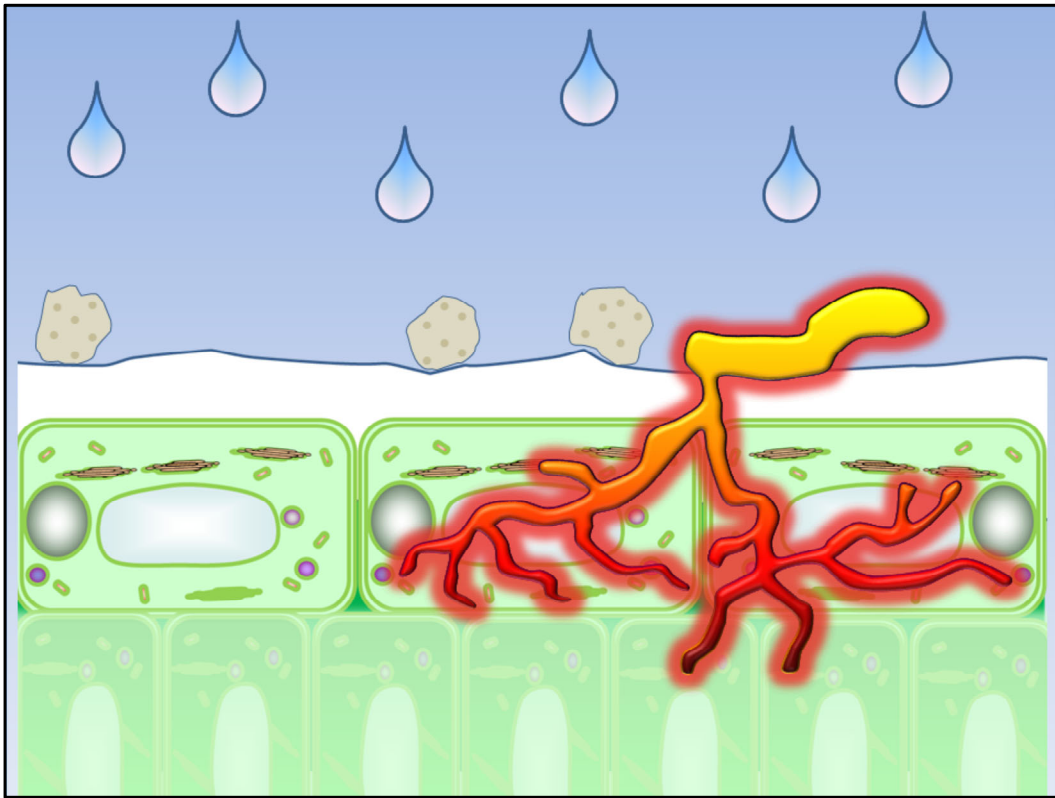
Mode of Action

Mancozeb

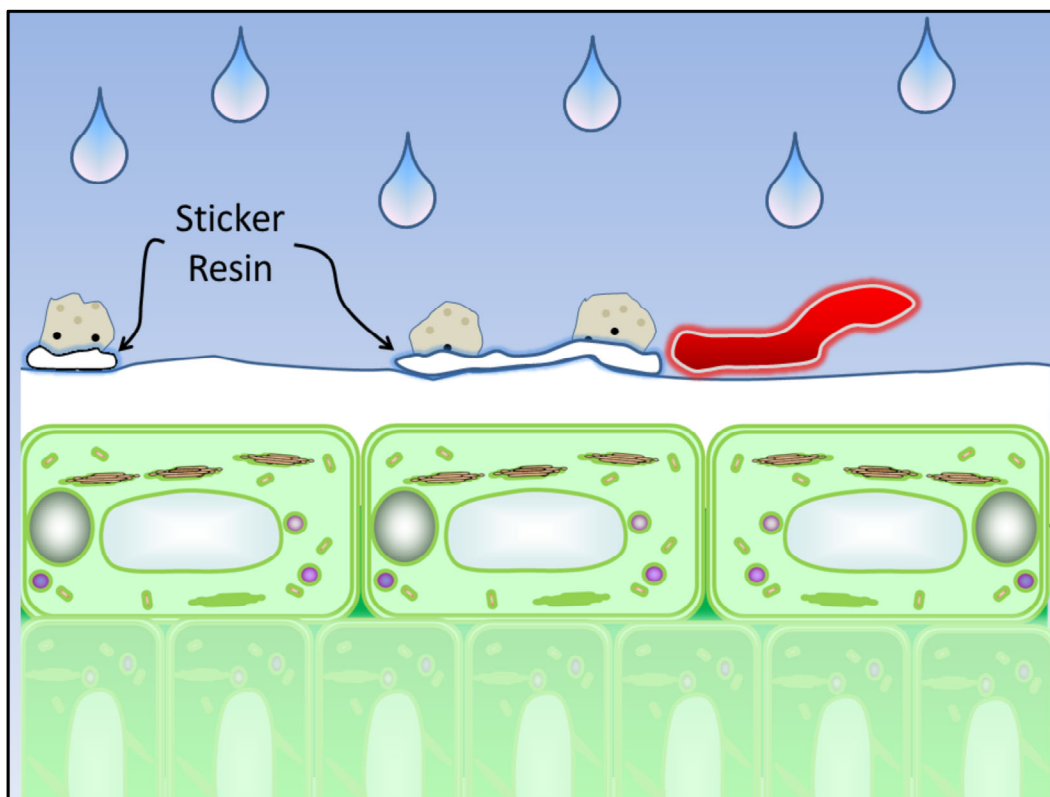




Here is an example of how these actives need to remain on the leaf surface to intercept germinating spores.



If you get a heavy rain or irrigation these contacts can be washed off the leaf surface reducing the active of the fungicide application.



The resins in stickers aid in the retention of these contact fungicides on the leaf surface thus giving greater protection under rain or irrigation events.

Surfactant Categories



Water Conditioners are adjuvants that reduce hard water antagonism which can reduce some pesticide active ingredient and reduce spray tank mixability.



Pesticide AI's or dispersants are not effected in soft water. If the water source contains a high amounts of calcium, magnesium or iron (hard water) reduction in the pesticide ai activity or mixability can occur. To fix this condition a water conditionor can be added to reduce the above problems.

Drive-By Method

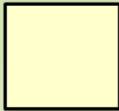


These materials sold at gas stations or market places are a sure sign you have hard water in the area.

Hard Water Signatures



Calcium
Dominated



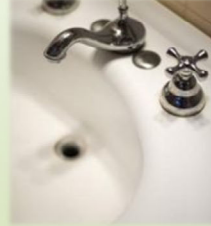
Chalky White



Iron
Dominated



Orange/Brown

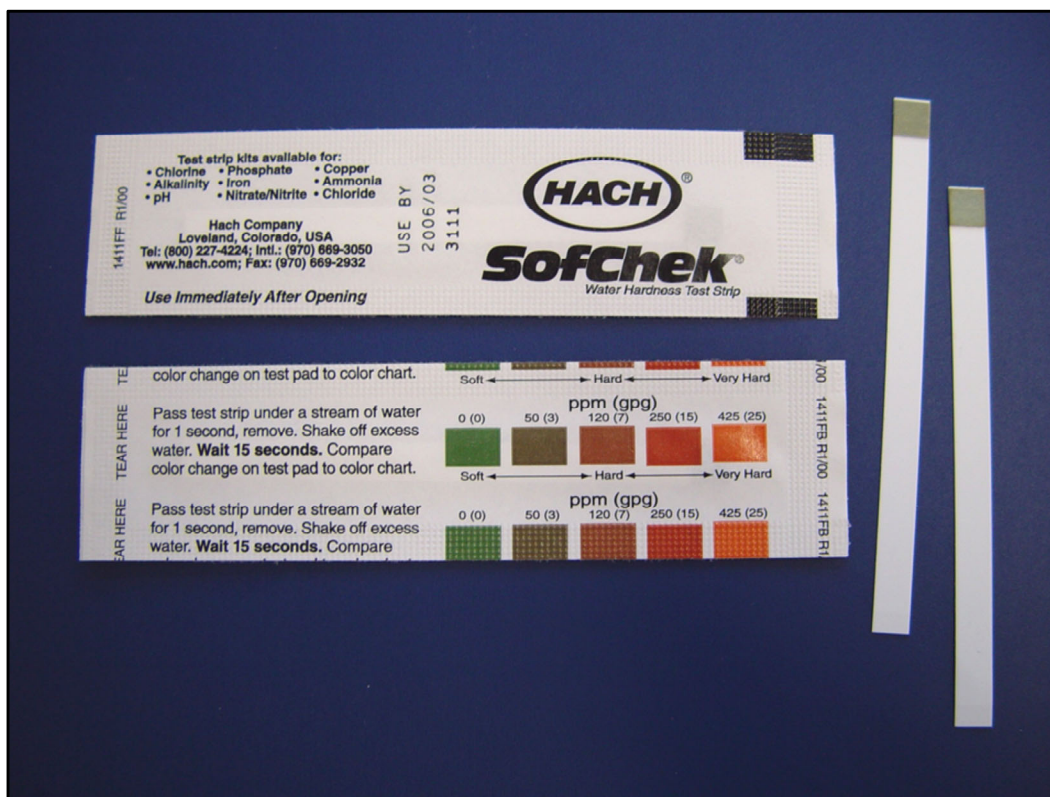


Magnesium
Dominated

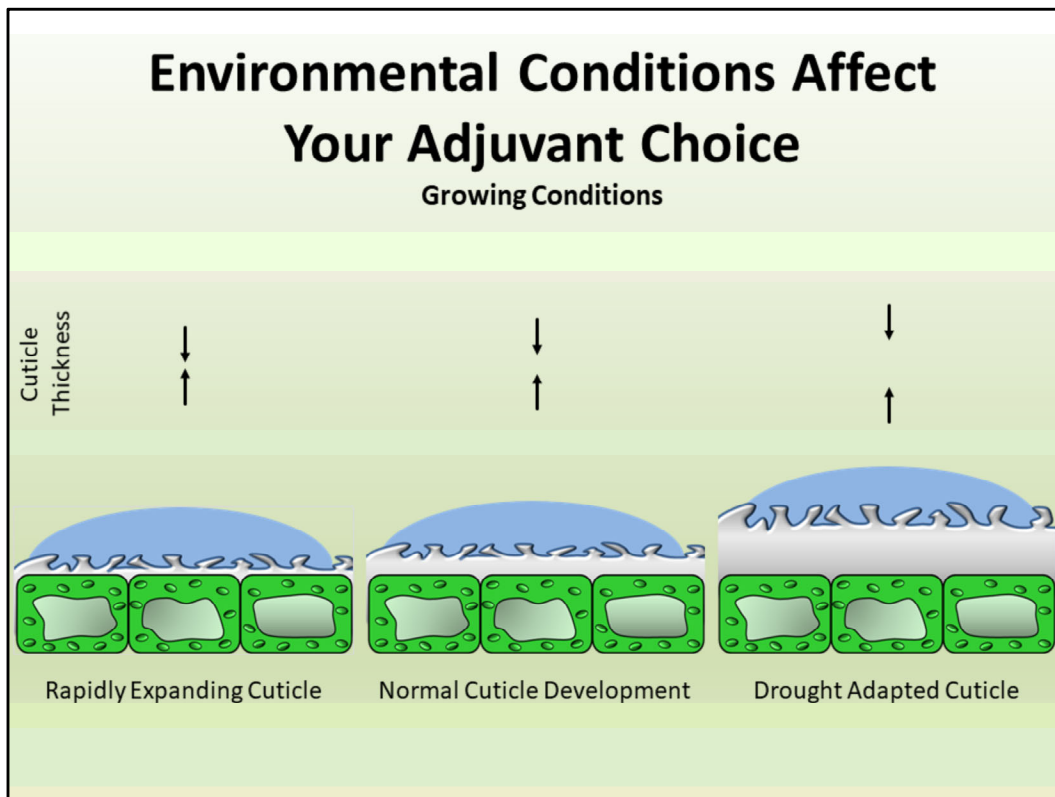


Gray

The color stains in sink are indicative of different hard water conditons.



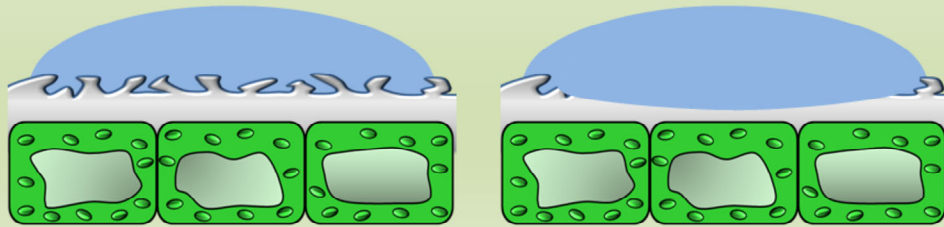
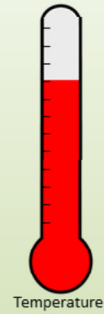
Hard water test strips can be used to quantify hardwater conditions of the water source in question.



Under drought conditions oil-based adjuvant system are often used vs. a NIS. Under rapid growing conditions where cuticle are thin NIS are often used vs. an oil-based adjuvant.

Environmental Conditions Affect Your Adjuvant Choice

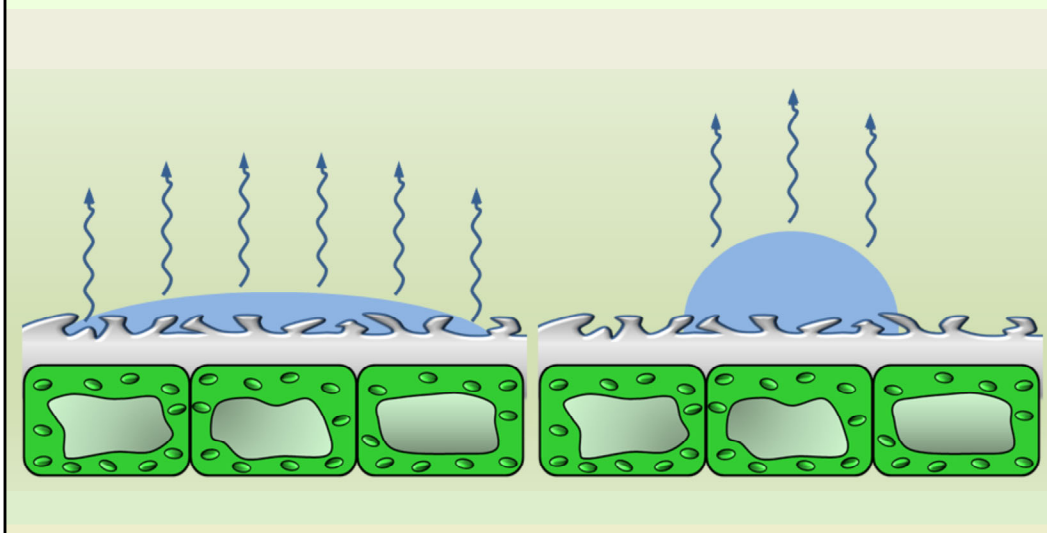
Temperature



Under hot spray conditions oil based adjuvant system tend to increase potential phyto

Environmental Conditions Affect Your Adjuvant Choice

Relative Humidity



Rapid droplet drying time can reduce uptake of active ingredients. Under high relative humidity tends to promote greater uptake.

Ingredients in Surfactant Systems

- | | |
|---------------------|---------------------|
| • Surfactant itself | • Drift Agents |
| • Humectants | • Acidifiers |
| • Defoamers | • Fertilizers (AMS) |
| • Oils | • Sequestrants |

Here are some of the components found in adjuvant systems. Surfactants reduce surface tension and aid in uptake. Humectants increase the droplets hydrated condition for a longer period of time. Defoamer reduce foam. Oils aid in pesticide uptake. Drift agents reduce driftable fines. Acidifiers reduce spray tank pH which can aid in solubility or prevent alkaline hydrolysis of various insecticides. Fertilizers can aid in uptake of some active ingredients. Sequestrants can reduce hard water antagonism and aid in mixability.

Summary

Spray Tank ➡ Leaf Surface

- ☐ Spray Tank
- ☐ Droplet Size
- ☐ Droplet Retention
- ☐ Uptake/Penetration

Summary

Adjuvant types

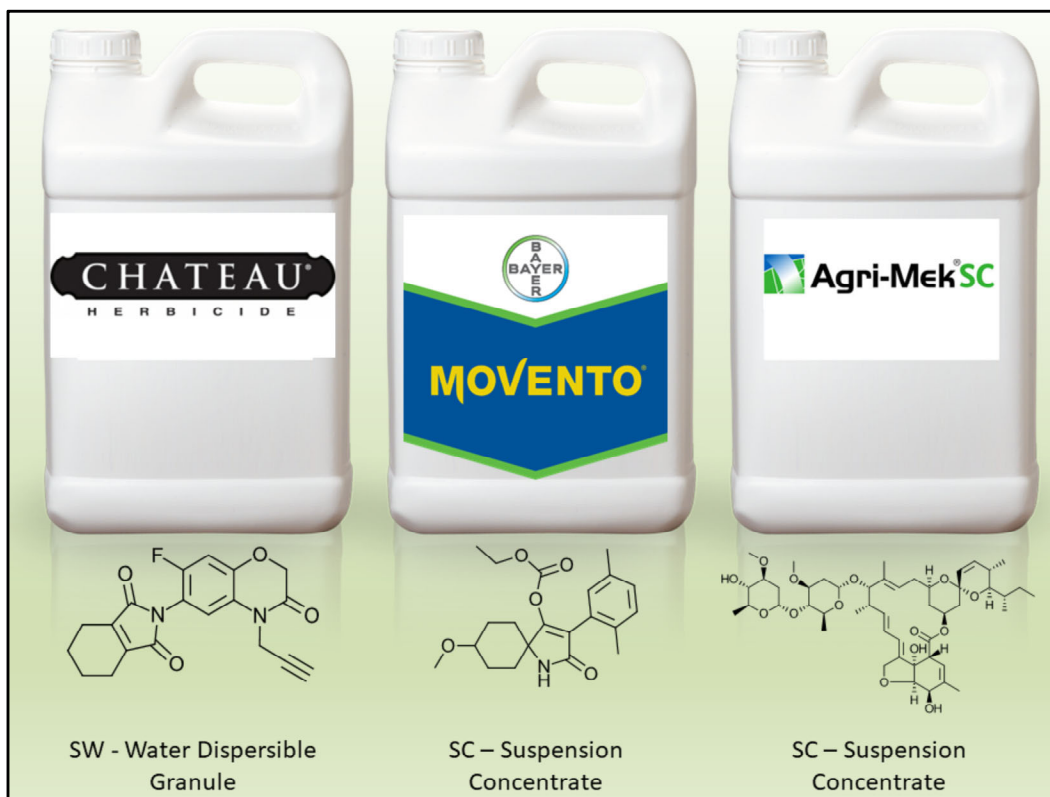
- ☐ Crop Oils (COC)
- ☐ MSO
- ☐ NIS
- ☐ Silicone – blends are better
- ☐ Stickers – Holds particles on leaf surface
- ☐ Water Conditioners – Remove Hard Water Head-Aches



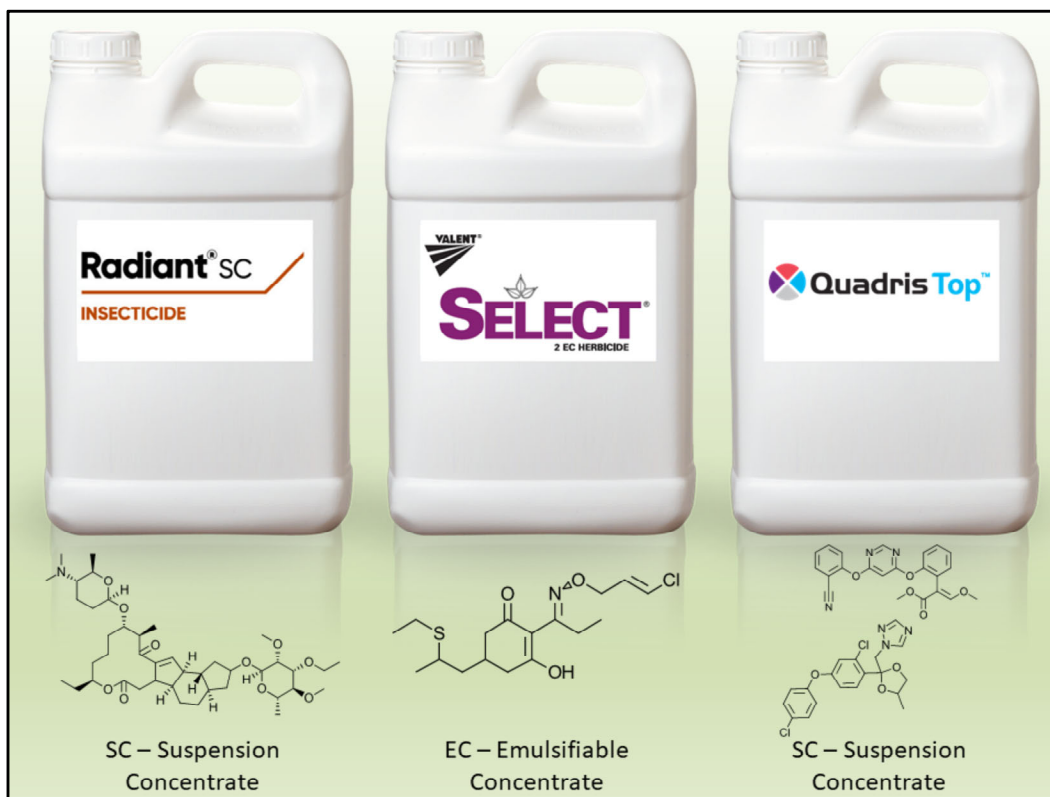
Intricacies of Adjuvant Use In Onion Production

By Daniel Bergman, Ph.D.

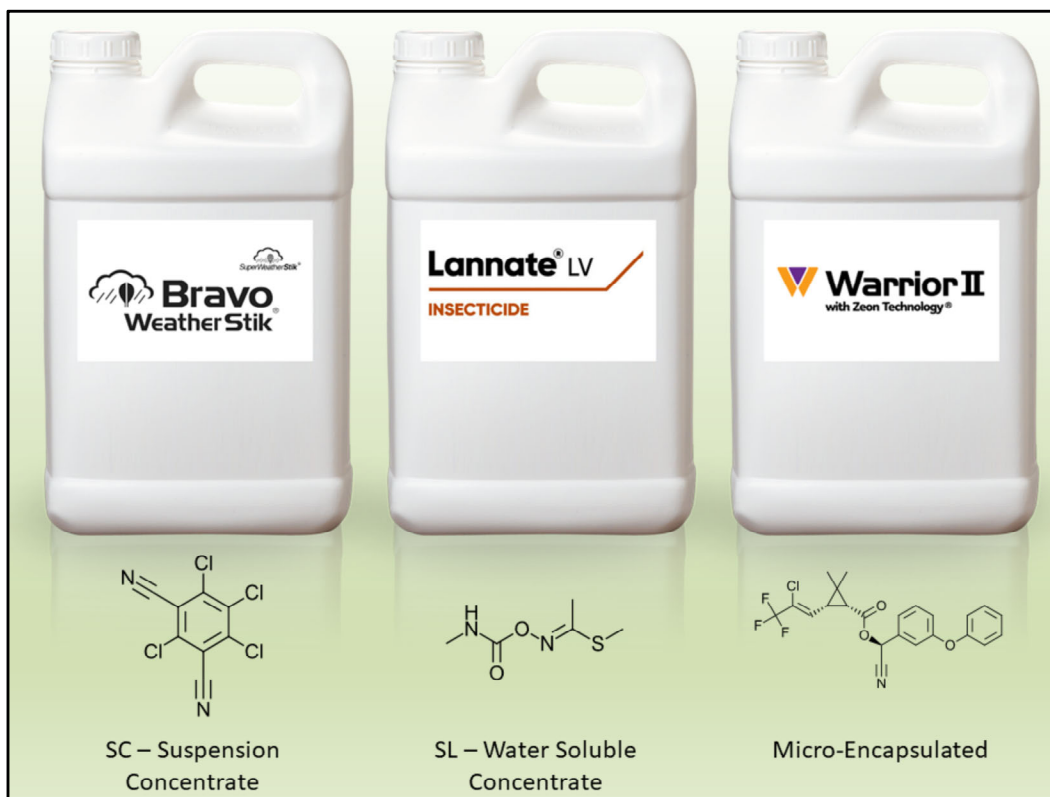
Nutrien/Loveland Products



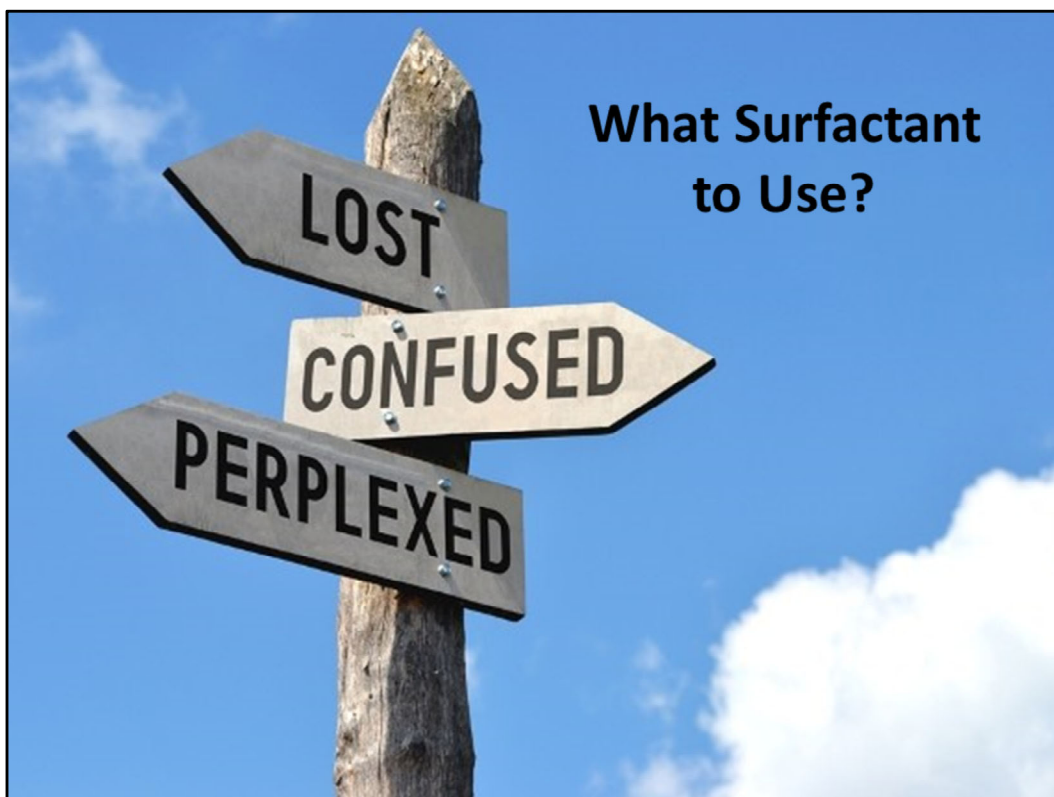
Examples of various pesticide formulation commonly used in onion production



Examples of various pesticide formulation commonly used in onion production



Examples of various pesticide formulation commonly used in onion production



So many adjuvant product available – which should I use?

Must always be mixed with NIS or Penetrating adjuvant

The addition of 1% COC or a silicone adjuvant may enhance

~~Do not apply with any~~ type of adjuvant

Pesticide Label Provides Adjuvant Recommendations

The addition of (NIS, or COC or blend) is recommended

Must be tank-mixed with spray adjuvant spreading & penetrating properties

Control may be improved with the addition of emulsified oil or MSO/Silicone

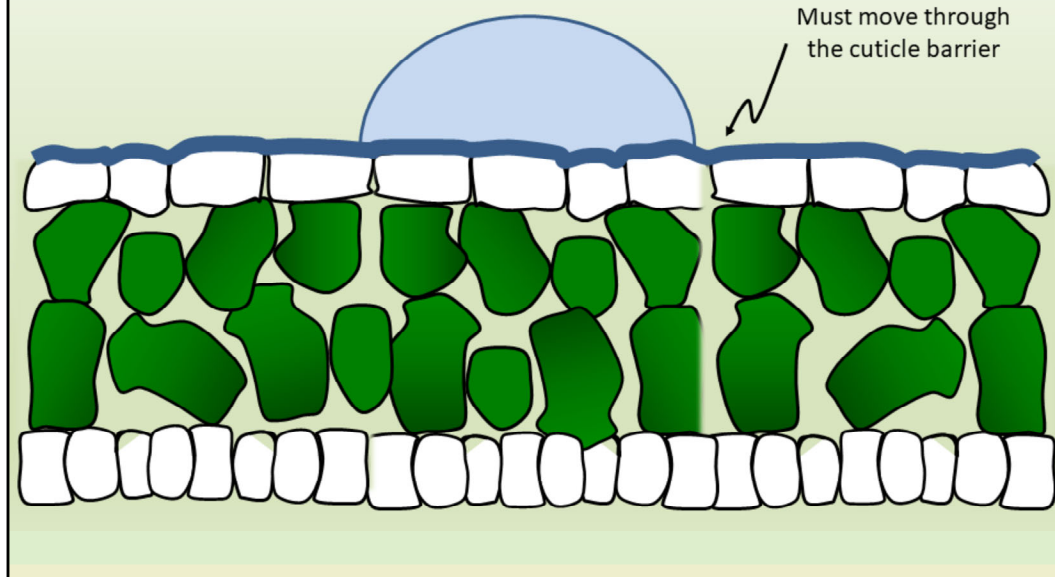
Always use a (COC) or NIS, COC

Highly alkaline water should be buffered

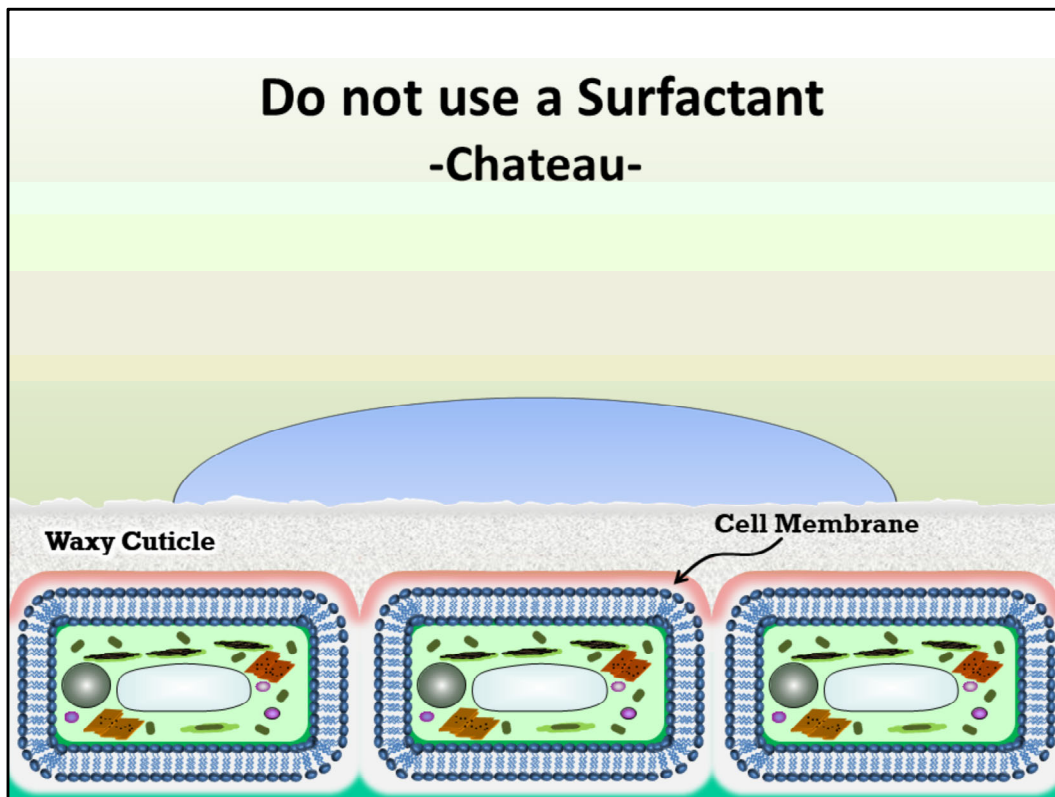


The pesticide label itself will direct you to the type of adjuvant systems to use.

With Translaminar & Systemic Pesticides Use a Penetrating Surfactant



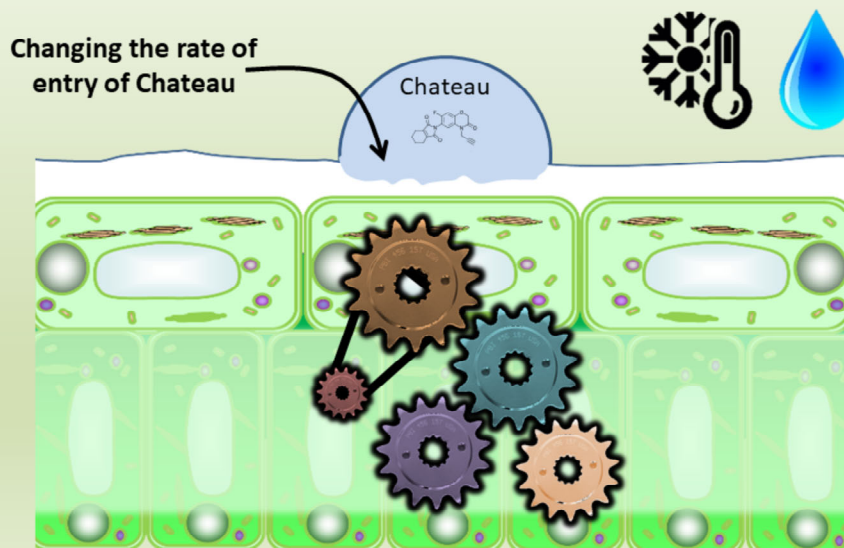
Both Systemic & Translaminar pesticide AI's need to get into the plant to be effective. Thus penetrating surfactants systems are often a good bet here.



Chateau tells us not to use a surfactant.

I don't want the adjuvant used with Movento to cause Chateau injury. Which spray should I make first? How much time should I separate the two sprays?

Chateau First when not stressed so you can metabolize Chateau



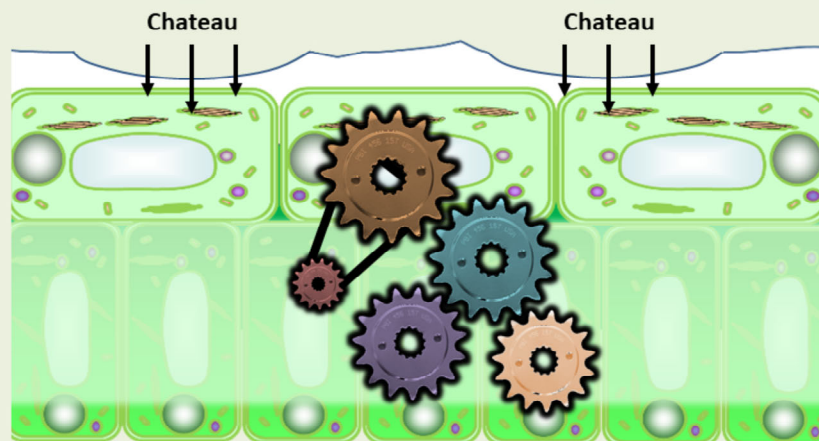
Use Chateau without a surfactant when the onion plant is not overly stressed and the cuticle is not damaged by a previous spray – the local rep told me wait 3-5 days before you apply another pesticide such as Movento that calls for a penetrating type surfactant system.

Don't want the adjuvant used with Movento (spreading & penetrating properties) to cause Chateau injury. Which should I spray first?

Chateau First when not stressed so you can metabolize Chateau

Movento Second after a stress-free period – 3-5 days after Chateau

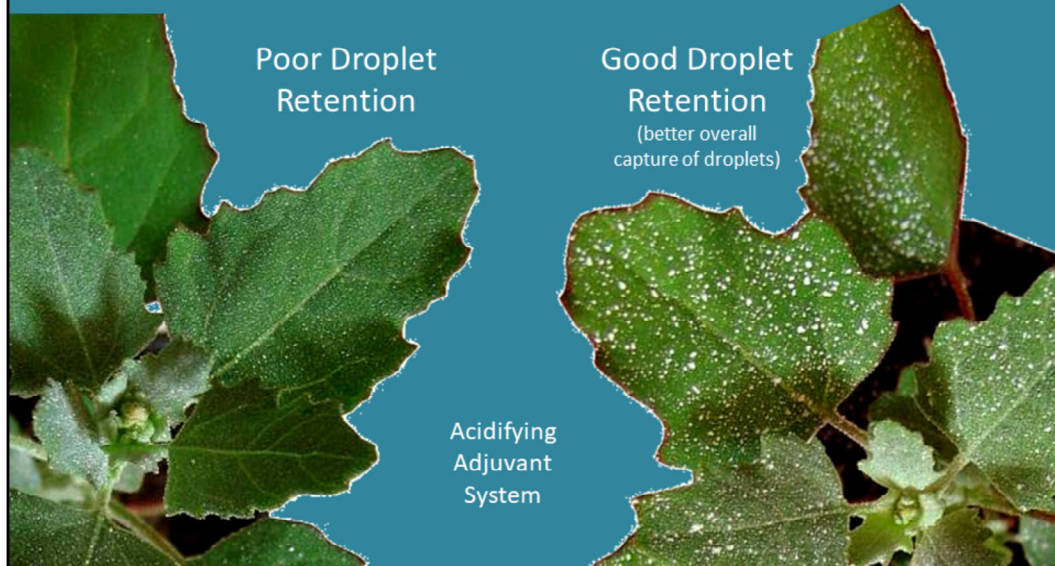
Movento First – with penetrating adjuvant



Chateau First when not stressed so you can metabolize Chateau. **Movento Second** after a stress-free period – 3-5 days after Chateau.

What about the use of adjuvants with foliar nutrients?

YES – A Good Idea!



Acidifying adjuvant system can give you greater droplet retention and metals are more soluble in acidic conditions – expectations are coppers & tins used for their bactericidal or fungicidal active. Always read and follow the pesticide label.