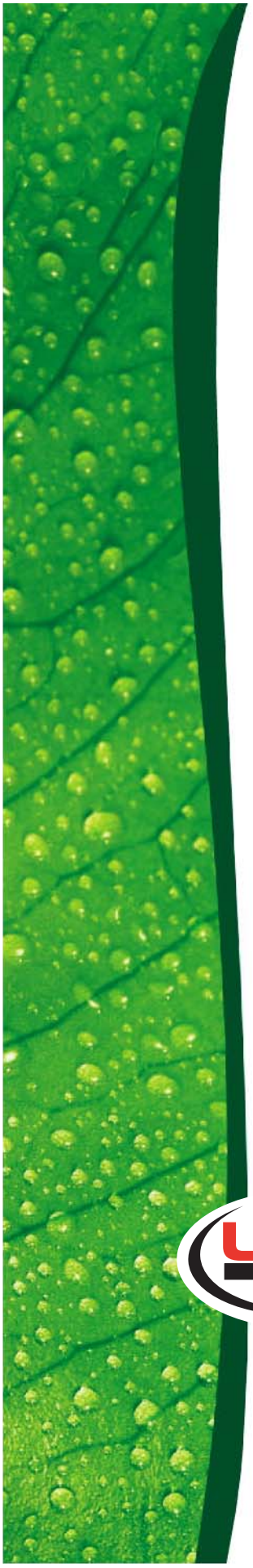

# Improving Pesticide Performance with Surfactant Technology:

## The LI 700® Way

**A White Paper for**
**Crop Producers, Retailers, Custom Applicators and Crop Consultants**

UAP CANADA


Improving Pesticide Performance

## Abstract

Adjuvants, which may broadly be described as anything added to a pesticide spray solution that is intended to change or modify its action, are not often proactively considered by crop producers. Rather, they tend to be purchased and used reactively, based on the need for things such as pH stabilization, to cite just one example, or when product label requirements specify their use. Frequently, the adjuvant a producer chooses to use is based on recommendations from a retailer, custom applicator or crop consultant. Increasingly, however, there is reason to view adjuvants not as just another input or production cost, nor to assume that all adjuvants are the same. With recent advancements in development technology, there is indeed reason for crop producers to expect more from adjuvants and their contributions to the efficacy of pesticide performance as part of an effective pest control strategy. In fact, this paper makes the case that adjuvants, and one class of adjuvants specifically – surfactants – should not be viewed just as 'additives', but rather as performance enhancers, provided they can demonstrate and deliver certain benefits.

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## INTRODUCTION:

*In today's crop production environment, the need to achieve maximum economic performance from each input is greater than ever. This paper considers the role that adjuvants and, more specifically, surfactants, can play in pesticide performance.*

## Understanding adjuvants

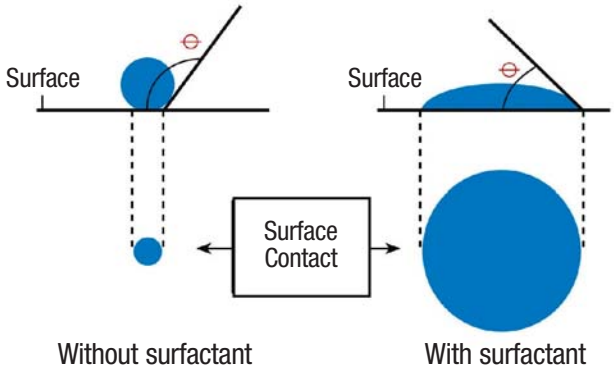
Simply stated, an adjuvant is a substance intended to improve activity or application of a pesticide. Some are added to the product at the time of formulation, others by the applicator to the spray mix just prior to treatment. There are three basic types of adjuvants: activator adjuvants (e.g. surfactants, wetting agents, penetrants, oils and salts); spray modifier agents (e.g. stickers, film formers, spreaders, spreader-stickers, deposit builders, thickening agents and foams); and utility modifiers (e.g. emulsifiers, dispersants, stabilizing agents, coupling agents, co-solvents, compatibility agents, buffering agents and anti-foam agents).

This paper focuses specifically on surfactants, which fall into the activator adjuvant category, and which influence the physical and chemical properties of the spray solution, including surface tension, density, volatility, and solubility. In turn, these properties modify the spreading, wetting, retention, and penetration of the pesticide.

## Surfactants defined

Surfactants are one of the most common types of activator adjuvants and are required for use with many post-emergent herbicides. The primary purpose of a surfactant or '**SURF**ace **ACT**ive **A**ge**NT**' is to allow for more contact between the spray droplet and the plant. It does so by reducing the surface tension of the water in the spray solution to that of an oil or solvent, which spread more readily on plant surfaces.

For a pesticide to perform its function properly, a spray droplet must be able to wet the foliage and spread out evenly over a leaf. Surfactants enlarge the area of pesticide coverage, helping to aid absorption so that more of the pesticide is taken up in the plant. This is particularly important when applying a pesticide to waxy or hairy leaves. Without proper wetting and spreading, spray droplets often run off or fail to adequately cover these surfaces.




There are four categories of surfactants: nonionic, anionic, cationic, and organosilicones. Nonionic surfactants are most commonly used because of their broad fit.

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## Not all surfactants are created equal

Most commonly used post-emergent herbicides will show increased activity when a surfactant is added to the spray mixture, but not all surfactants perform equally. Most can deliver only one or two of the desired functions. This underscores the need to carefully select these products and demand one that will deliver the most value. Without undergoing this due diligence, crop producers will not achieve optimal performance or benefit fully from their crop protection investments. More seriously, crop injury could result. ***The bottom line: pesticide performance can and will differ depending on what type of surfactant is used.***

> *"The real challenge is delivering more right-sized droplets that hit the leaf surface, stick and penetrate to improve pesticide uptake without causing unnecessary damage to the leaf surface. That is the order."*
>
> Dr. Dan Bergman
> Loveland Products

## The importance of making an informed surfactant decision

Producers should be keenly aware of the issues that can impede and/or reduce pesticide performance if the proper surfactant is not selected. There are both **controllable** and **non-controllable** variables that can affect performance, but the vast majority can be addressed with the selection and use of an appropriate surfactant.

### Non-Controllable: Growth Degree Days

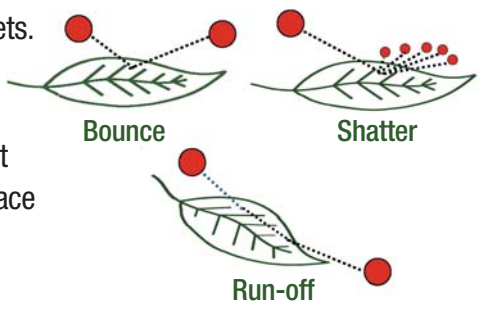
Time constraints and weather are two factors that regularly limit the ideal spray window. Weeds, for example, are easiest to control when they are small as the herbicide can more easily penetrate the developing leaves. As weeds become more mature, they develop thicker cuticles, which makes herbicide uptake more difficult. An effective surfactant minimizes this issue by breaking down the cuticle wall to aid penetration into the plant.

### Controllable: Poor Target Coverage

Poor target coverage occurs when spray droplets are too small or too large. Those at the small end of the droplet spectrum often don't reach the target or aren't big enough to be effective, while large droplets tend to inefficiently bounce off the plant. In both cases, the result is a reduction of the intended pesticide dose and an increase in off-target movement. Some surfactants play a role in helping create a more uniform spray pattern of mid-size droplets.

### Controllable: Poor Droplet Retention

Some plants have surfaces that naturally repel spray droplets. A waxy surface or an angled leaf can cause droplets to bounce or run off. The result is poor droplet retention and a reduction of the intended pesticide dose. A surfactant that is doing its job should retain more droplets on the leaf surface so the pesticide can do its work.



### Controllable: Poor Plant Uptake

Inefficient uptake of a pesticide into the plant is often the result of the cuticle that covers the entire above-ground portion of the target plant. Composed of water-repellent waxes, the cuticle can be a barrier for pesticide movement into the plant tissue. A correctly matched surfactant and pesticide product (i.e. active ingredient) will help penetrate the cuticle and deliver the intended pesticide dose.

### Controllable: pH Levels

Water pH (level of acidity) plays an important role in the stability and effectiveness of pesticides. Many crop protection products are broken down through a permanent and irreversible process called *alkaline hydrolysis* when mixed with high pH water (i.e. pH value greater than 7). Some surfactants, however, are also acidifiers that lower the pH of the water, preventing break down of the active ingredient. Check individual pesticide specifications to ensure that recommended pH requirements are met in order to maximize product efficacy.

**WATER QUALITY**

In addition to water pH, there are a number of other issues related to water quality to consider including debris, turbidity, dissolved minerals and water hardness that can affect pesticide performance. While they are beyond the scope of examination of this paper, readers are encouraged to investigate these issues, as appropriate, as part of an effective pest control strategy.

### Controllable: Water Solubility and Oil Solubility

Pesticides and their active ingredients are either water- or oil-soluble. In general, all surfactants are constructed of both lipophilic (oil soluble) and hydrophilic (water soluble) components. Surfactant molecules can be synthesized to achieve specific solubility characteristics often referred to as the hydrophilic-lipophilic balance (HLB). It is important that the degree of solubility of the surfactant in oil or water match the solubility of the pesticide. Surfactants that most closely match a particular pesticide's optimum HLB will optimize the formulation's spread on and penetration into plants.

### Controllable: Nozzle Performance

Effective nozzle performance is one of the keys to a uniform spray pattern. Unfortunately, many surfactants control drift by thickening the spray solution which can have a detrimental effect on both conventional and air induction nozzles. An effective surfactant does not compromise nozzle performance.

### Controllable: Pump Shear Degradation

Pump shear degradation occurs when the spray solution is circulated through a pump and loses its drift reduction function. Turbulence causes the fluid to 'shear thin', creating droplets that are too small with a tendency to drift off target. Surfactants that are not subject to this thinning effect are ideal.

- Confusion frequently occurs concerning the proper selection and use of surfactants with pesticides and, given the range of issues cited above, it's no wonder. But, let's be clear – it is wrong to assume that any product that lowers the surface tension of water or increases the wetability of a spray solution can be used as an effective surfactant. Clearly, there is more to think about when it comes to surfactant selection.

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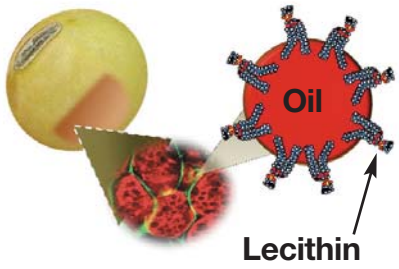
## SURFACTANT TECHNOLOGY:

*An important consideration when selecting a surfactant is the strength of the technology that the product is based on. Understanding the technology behind the surfactant will help crop producers chose the right product for their needs.*

## LECI-TECH™ surfactant technology

LECI-TECH is a patented, lecithin-based surfactant technology. Derived from soybeans, lecithin is perhaps best thought of or understood as the 'packaging' that holds the oil in the soybean seed. Lecithin derivatives are obtained from the hydrogenation/hydroxylation of natural soy lecithin and refined using special techniques.

Biochemically, lecithin is a lipid material belonging to the phospholipid class, which provides unique surface-active properties. As molecules, phospholipids contain both hydrophobic (fat loving) and hydrophilic (water loving) elements. For this reason, lecithin-based products work well with both oil-soluble and water-soluble pesticides.




Lecithin-based products are also very safe bio-surfactants with superior heat and oxidation stability. Products based on this chemistry are not subject to the issues of pump shear degradation, reduction of nozzle fan angle or compatibility issues with most pesticide formulations.

## LI 700®: THE COMPLETE SURFACTANT SOLUTION

*LI 700 is a non-ionic penetrating surfactant that enhances the performance and reliability of foliar products. As the flagship LECI-TECH™ product (see chart at end of this section for LECI-TECH product details), this soy-oil based surfactant provides more uniform spray droplets that reach their target and stay put for faster product uptake and more consistent performance. LI 700 has a unique formulation that also acidifies the spray solution, effectively lowering the pH level.*

*Target chemistries include weak acid herbicides (e.g.s. glyphosate, dicamba, etc.) insecticides, fungicides and defoliants, but LI 700 can be used effectively with many crop protection products to provide the highest level of performance.*

## Maximizing pesticide performance

**Problem:** **Pesticide drifts off target**
**Solution:** **LI 700 produces more 'right sized' droplets that don't drift**

Pesticides have potential to drift off target when droplets are too fine. LI 700 reduces the chance of pesticide drift by reducing the production of small droplets. Phospholipid components within LI 700 put less stress on droplet production allowing for a more uniform spray pattern.

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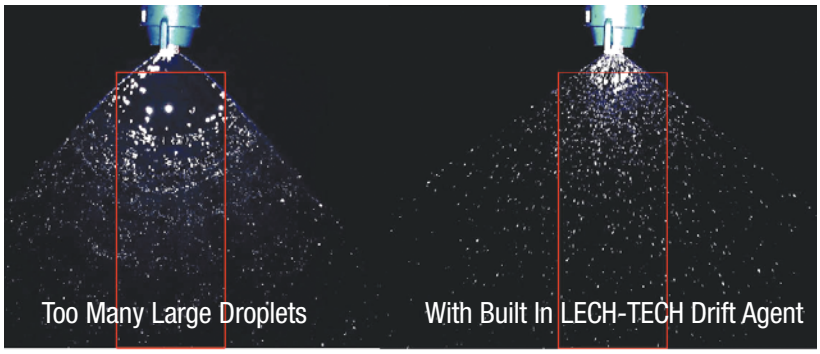
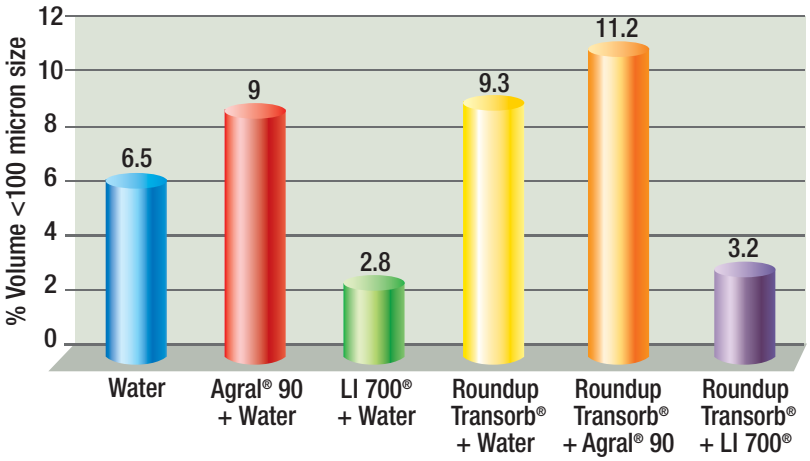
The result is more right-sized droplets, which avoid the problem of having small droplets that drift and large droplets that bounce off the plant surface. LI 700 also increases the velocity of spray droplets – this momentum makes droplets even less likely to drift. *In fact, LI 700 is labeled for lowering the potential for off-target spray.*




**Spray Atomization Testing Effect of Different Products on Percent Driftable Fines**

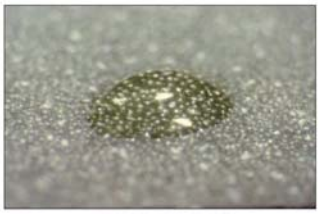



**Source:**
Thomas M. Wolf and Brian C. Caldwell, Agriculture and Agri-Food Canada, Saskatoon Research Centre, April 2001

**Problem:** Spray droplets won't stay on the leaf
**Solution:** LI 700 improves spray coverage and ensures that droplets stick

To get the best performance from a foliar spray product, droplet retention is essential – the spray solution needs to hit the leaf and stick to be effective. Spreading and adhesion properties of LI 700 ensure that more spray droplets hit the target and stay there to provide more consistent performance.


Without Surfactant


With Surfactant

**Problem:** Pesticide has difficulty penetrating through the leaf cuticle
**Solution:** LI 700 efficiently penetrates the waxy leaf cuticle

For a foliar-applied pesticide to be effective, it must be transferred from the leaf surface into the plant tissue. Waxy cuticles, which cover all plants, act as a barrier restricting pesticide movement into foliage. This is especially critical when plants are under environmental stress. LI 700 provides better penetration of this waxy leaf cuticle for quicker pesticide uptake. It also reduces evaporation, maximizing pesticide performance.

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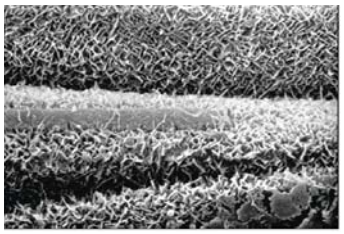
**Problem:** High pH water in the spray solution causes pesticide to break down
**Solution:** LI 700 lowers water pH to prevent pesticide degradation

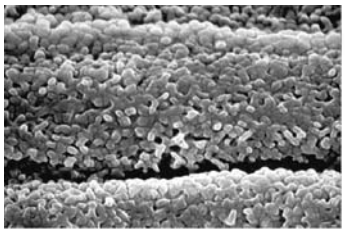
Many pesticides undergo a chemical reaction in the spray tank when mixed with water that has a high pH level. In just a few minutes, the pesticide will start to break down and lose a significant amount of the active ingredient. LI 700 works as a buffering-acidifying agent that lowers the pH of the water carrier. This ensures pesticide efficacy is maintained and crop producers get the most out of their significant investment. Be sure to check individual pesticide specifications to ensure that recommended pH requirements are met in order to maximize product efficacy – if a lower pH level is required, look to LI 700.

**Problem:** Crop and environmental safety
**Solution:** LI 700 is based on a naturally derived soybean product

Crop producers want products that are safe on their crop and the environment. LI 700 incorporates LECI-TECH technology – a patented, lecithin-based surfactant technology derived from soybeans, which is an environmentally friendly alternative to petroleum-based products. This technology also allows spray droplets to reach the critical micelle concentration (CMC) – the point at which maximum surface depression (spreading) is achieved – at a lower use rate than conventional surfactants. The result is less disruption on the plant surface, further contributing to improved crop safety.



Normal undisturbed structure



Structure after exposure to petroleum-based product

**Problem:** Pesticide solubility limits surfactant options
**Solution:** LI 700 works well with both water-soluble and oil-soluble pesticides

Pesticides are typically either oil or water-soluble, which limits the surfactants that they can be mixed with. With its combination of hydrophilic (water loving) and lipophilic (fat loving) elements, LI 700 is highly versatile. Its chemistry makes it effective in both water-soluble and oil-soluble pesticides.

**Problem:** Compromising nozzle performance for drift management
**Solution:** Optimal nozzle performance with LI 700

Some products thicken the spray solution to manage drift – a practice that compromises nozzle performance. LI 700 does not alter the viscosity of the product, allowing nozzles to deliver an optimal spray pattern.

**Problem:** Shear pump degradation
**Solution:** No thinning effect with LI 700

Some surfactants lose their drift reduction function once the spray solution has circulated through the pump. LI 700 is not subject to this thinning effect, thereby maintaining its drift management properties.

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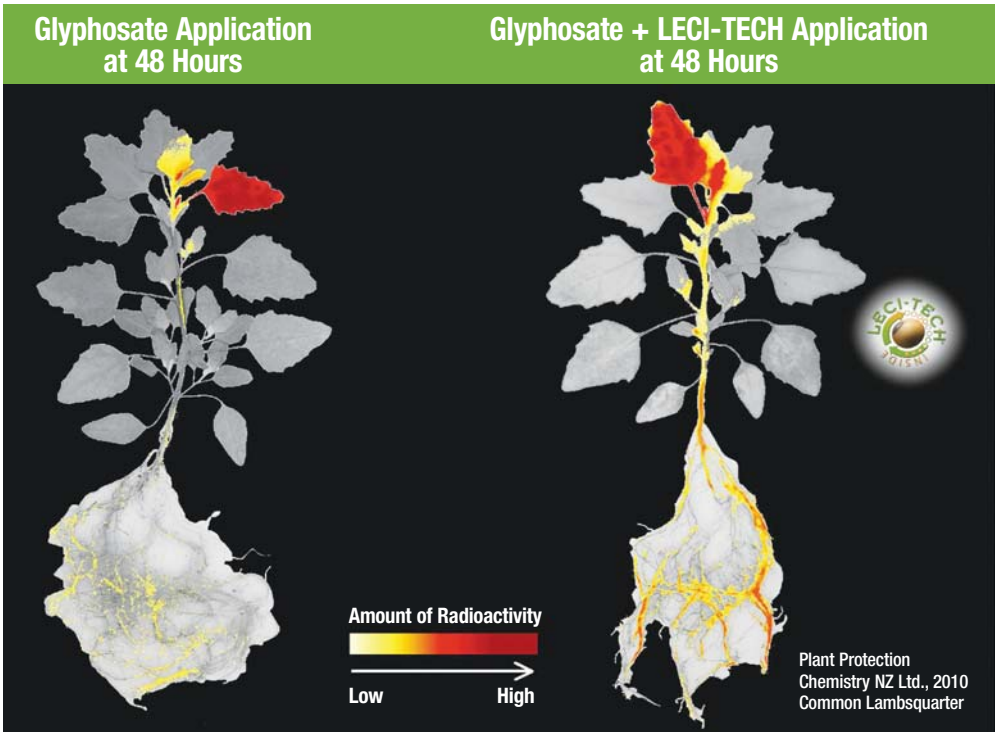
**Problem:** Glyphosate uptake and risk of drift

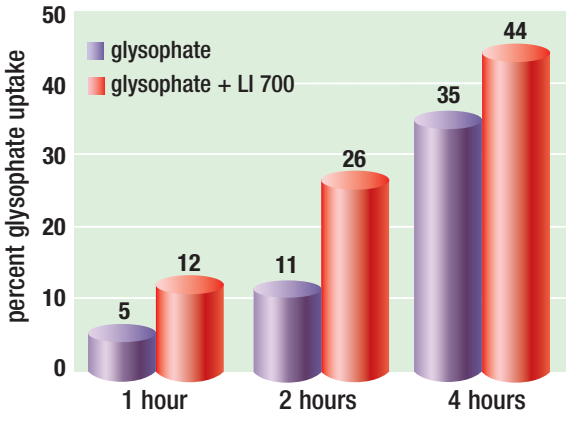
**Solution:** Improved glyphosate application with LI 700

With developments in direct seeding, pre-harvest management systems and glyphosate-tolerant crops, the high performance and accurate placement of glyphosate is critical. LI 700 is proven to provide improved foliar application of glyphosate, including faster uptake and rainfastness, for a better return on herbicide investment. The widespread use of glyphosate and its properties have also increased concerns about spray drift. LI 700 helps growers overcome this problem by reducing the number of fine droplets in the spray pattern, keeping glyphosate applications on target.



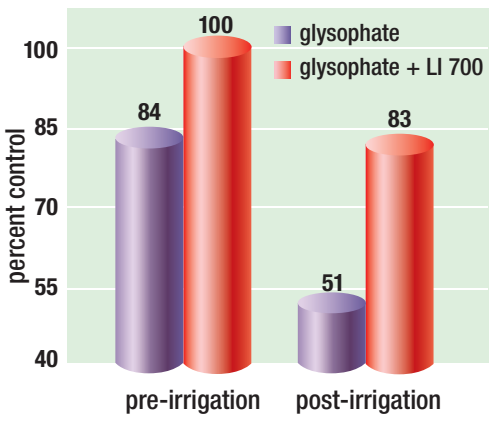

## Faster Uptake of Glyphosate

LI 700 increases Glysophate Uptake on 3 to 4 Week Old Lambsquarters




Source: Forest Research Institute, New Zealand

## Rainfastness with Glyphosate




Source: Oxford Research Group, UK

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**Problem:** Foam problems in the spray tank
**Solution:** Low-foaming properties of LI 700

Foaming is a common complaint from many people who work with surfactants. LI 700 is a low-foaming surfactant and will not cause foam problems in the spray tank.

- While most surfactants can perform one or two functions to enhance certain pesticides, LI 700 is a **complete** surfactant solution for a **broad range** of target chemistries including weak acid herbicides (e.g. all glyphosate formulations, 2,4-D, dicamba, etc.), insecticides, fungicides and defoliants. For more information about LI 700, visit **www.uap.ca** or contact your crop inputs retailer.

## The LECI-TECH Family of Products

| PRODUCT | Acidifier | Defoam | Deposition Aid | Drift Control | Penetrant | Spreader/ Sticket |
|---|---|---|---|---|---|---|
| LI 700 | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Liberate | | | ✓ | ✓ | ✓ | ✓ |
| VALID | | ✓ | ✓ | ✓ | | |
| MSO CONCENTRATE with LECI-TECH | | | ✓ | ✓ | ✓ | ✓ |

## CONCLUSION:

This paper has identified several surfactant-related issues that can adversely impact pesticide performance. It has also highlighted the importance of proper surfactant selection and use by crop producers to get the most out of their significant pesticide investments. Simply put, the type of surfactant added to the spray tank can enhance or reduce the performance of the pesticide.

When choosing a surfactant for a specific crop protection product, first consult the pesticide label to determine if a specific surfactant is prescribed. Beyond that, select a product that delivers maximum performance and crop safety.

This paper has clearly articulated the benefits of using LI 700 with LECI-TECH technology and how LI 700 can enhance the performance and reliability of foliar products in ways that other surfactants can't.

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In summary, LI 700 with LECI-TECH technology delivers superior performance based on its ability to:

- Provide better leaf spread (Spreadability)
- Have droplets remain on target to ensure pesticide effectiveness (Adhesion)
- Provide better breakdown of the waxy leaf cuticle to allow for enhanced pesticide penetration into the plant (Penetration)
- Better manage droplet size to minimize loss due to drift or evaporation (Droplet Management)
- Deliver better crop health due to less cell wall disruption of plant surfaces (Crop Safety)
- Utilize natural occurring soybean oil as its main ingredient (Environmental)

- A non-ionic penetrating surfactant, LI 700 also:
  - Lowers the pH of spray solutions to prevent degradation of pesticide active ingredients caused by high pH water
  - Can be used in crops where product performance will be enhanced by maximum product uptake into the target plants or where spray drift is a concern (e.g. glyphosate application)
  - Is a low-foaming surfactant that will not cause foam problems in the spray tank
  - Can be used with many other crop protection products to provide the highest level of performance

*"If use of the wrong surfactant increases the risk of poor performance and crop injury, think of the benefits that can be realized by using the right one."*

Dr. Dan Bergman
Loveland Products

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